THE SUBMARINE REVIEW

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EDITOR'S COMMENTS

One of the objectives we strive to meet with every issue of **THE SUBMARINE REVIEW** is to provide some examples of the past to serve as lessons for the future. It has long been a practice within the submarine community that these lessons take some form of *sea stories*, usually involved, often long, and not infrequently the listener is left to figure out for himself the specific point of the lesson. When Admiral Rickover chose to deliver such a lesson, however, there was no doubt as to the specific point; the real trick was to get to the basic truth underlying the lesson being delivered. The leading FEATURE of this issue is a tribute recently given by Admiral Jim Watkins on the occasion of the 50th anniversary of the establishment of Naval Reactors. In it he recalls for us all the professional excellence, personal accountability, and willingness to continually learn which Admiral Rickover strove to instill in and require from us and our successors. It's a must read.

In his President's column, Vice Admiral Dan Cooper addresses some points raised by two experienced submariners about the future of the Force. He urges reading and careful consideration of those articles. Please note that those two pieces are located within this issue in the DISCUSSIONS section. We welcome any and all who wish to comment on these authors' opinions or offer their own. We will particularly welcome any extension of the discussion with suggestions as to specific directions to be taken to get out of any situation you might feel is not in the best interests of the Force, the Navy, or the Nation.

Two pieces which were started in the July issue are completed here. John Merrill's story of Holland's travails both in getting the first boat into the Navy, and in trying to protect his concepts for effective submarines, is concluded with plenty of material for each of us to mine for lessons. Also, Joe Buff's *novelist's view* of the extended future of submarines gives us another *out-of-the-box* way of looking at familiar subjects. We don't have to agree with all he is suggesting, and many of us may feel that practical advances will be found along other routes, but we should recognize that significant advances can, and will, be made in submarining.

Two other, longer running, series are capped in this issue. There is a piece by Dr. Fred Milford and Mr. Andrew Skinner on

Soviet and Russian torpedoes. We can all appreciate the tremendous amount of effort and scholarship which went into this work, and we thank the authors for adding so much to the body of knowledge about the most basic submarine weapon. While on the subject of torpedoes, one should go to the review of Captain Crenshaw's book by Rear Admiral Sam Packer. Sam suggested this review so that submarines officers could appreciate the problems which WWII destroyermen had with their brand of USN torpedoes. In addition, Commander Richard Compton-Hall offers a summary lesson from his series on Royal navy submarine winners of Britain's highest decoration, the Victoria Cross. In this, he makes clear that the lesson for today's and tomorrow's submariners is determination, or tenacity, or whatever is the current expression for continuing to do your utmost over the long haul.

Several articles in this edition of **THE SUBMARINE REVIEW** highlight issues which are of interest to the community, and are worthy of more general attention than they may be receiving. See the piece by Mr. John Welch, President of Electric Boat, with discusses some needed reform in the acquisition process for submarines, along with other suggestions. There is also a piece by two engineers at Newport News which calls out the great advantages to be gained from the development and adoption of electric drive. In addition, Commander Duk-Ki Kim of the ROK Navy has provided us with an excellent summary of submarine and ASW capabilities in northeast Asia.

Jim Hay

FROM THE PRESIDENT

Since a primary mission of the NSL is to educate its members and the civilian populace, and since the **REVIEW** is meant to be a thoughtful and thought-provoking publication, I commend to each of you three articles which are meant to force us to think and to consider where we have been and where we are going. Although most of us know where we have been and much of what has been done, few of us will fully agree about where we *should be* headed. Similarly, very few understand all the parameters within which the Submarine Force must operate—particularly programmatically and budgetarily. What is obvious is that the numbers of submarines (and all the Navy) are going down, and to stop at the QDR *low limit* of 50 SSNs necessitates a lesser glide path than we are on now. As of today we have 64 SSNs.

Two of the articles, one by Rear Admiral Bob Fountain, USN(Ret.) and another by Captain Ken Cox, USN(Ret.) are especially compelling. I am certain each will be accepted or questioned to varying degrees by each reader depending primarily on that reader's specific experience (and maybe where the reader *sits* now). On the other hand, one fact underlies any discussion; despite what the situation is today, it will change; and the questions raised are pertinent, even vital, for us to understand if we are to help enlightened people at least understand the ramifications of decisions on the future. I predict more than one reader can become emotionally *charged* by some of the statements but I charge each of you to read them thoroughly and understand the underlying message. It is not pretty but it is important.

The third article is a well-developed discussion entitled *Leveraging Submarine Power in the 21st Century* by Lieutenant David Allen Adams. After the first two, I believe Lieutenant Adams develops a good paper for discussion.

A second subject which I have found of interest in the last weeks is the evident change in the Defense Advanced Research Projects Agency (DARPA). For the last several years the Agency was not particularly interested in doing much with the Navy or the Submarine Force. That, despite the several studies which had attempted to highlight research areas which would seem to fit under the DARPA Aegis (if you will excuse the term). Even the fact that Congress (specifically, the Authorizers in the House) had directed

DARPA to do certain things and DOD was tasked to report DARPA's progress, little was done.

As of a few days ago, DARPA and the U.S. Navy have signed a memorandum of agreement to study future fast attack submarine design concepts. This initiative is in response to the recent Defense Science Board Task Force report, "Submarine of the Future". The study highlights the anticipated need for more diverse and flexible payloads to maintain warfighting effectiveness. We look forward to any ongoing developments.

It is with great sadness that I report the most untimely deaths of three who have been significant contributors to the submarine community and to the League. Rear Admiral Jack Jarabak, a recent flag selectee, was very effective in the world of submarine materiel and we were looking forward to many advancements under his watch. Captain Jim Keane was one of the founding fathers of the Naval Submarine League and a fine shipmate and example for all of us. Captain Tom Maloney was a frequent contributor to **THE SUBMARINE REVIEW** and in his position with General Dynamics was particularly effective in helping to get the submarine word before those in decision-making positions.

Finally, plans for the Centennial are proceeding apace with much work being initiated for the Smithsonian Institute exhibit.

Dan Cooper

IN HONOR OF ADMIRAL HYMAN GEORGE RICKOVER ON THE OCCASION OF NAVAL REACTORS 50TH ANNIVERSARY

By ADM James D. Watkins, USN(Ret.)

Editor's Note: These remarks were delivered at the U.S. Navy Memorial, Washington, DC on 30 August 1998.

Secretary Dalton, Mrs. Rickover, Admirals Bowman and McKinney, Distinguished Guests, Friend of Naval Reactors:

> "It troubles me that we are so easily pressured by purveyors of technology into permitting so-called "progress" to alter our lives without attempting to control it—as if technology were an irrepressible force of nature to which we must meekly submit."
>
> "On a cost-effectiveness basis the colonists would not have revolted against King George II, nor would John Paul Jones have engaged the Serapis with the Bonhomme Richard, an inferior ship. The Greeks at Thermoplyae and at Salamis would not have stood up against them, or had these cost-effectiveness people been in charge."
>
> "Great minds discuss ideas, average minds discuss events, small minds discuss people."
>
> "Good ideas are not adopted automatically. They must be driven into practice with courageous patience."

This is only a small sampling of the timeless words of wisdom so often given us by a unique human being, Admiral Hyman G. Rickover. In fact, most of us here on this 50th Anniversary Celebration of the Naval Reactors organization take great vicarious pleasure in linking ourselves—and probably more than we deserve—to this legendary Admiral. How often have we puffed ourselves up with great pride when we respond with an enthusiastic "yes" to such questions as "Did he really treat you that way?" We love to reminisce interactions with the Admiral, more and more with the passage of each year since our last encounter with him. That's a true legacy, for the Admiral is still with us and walks the halls of Navy and NR everyday. While he left us a dozen years ago, what great respect and admiration we celebrants still hold for him. For we are members of his very exclusive club. Perhaps the Rickover lore is the glue that continues to bind us all together after he left the NR leadership role and successfully passed the baton to three uniformed four-star successors.

It was 18 months after I reported to NR in the spring 1962 that I first began to understand the Admiral's long-range goals and objectives related to enhancement of naval officer professionalism. Prior to that time, I experienced a degree of humbling not unlike that during plebe year at the Naval Academy 17 years earlier. But, then, one morning, Mark Forsell and I arrived at the old N building on Constitution Avenue about 7:15 AM. This was the normal time for commencement of NR daily activities, that is, just prior to the possible 7:30 *pink slip* rebuke of selected authors from the previous day. Promptly at 7:30 the call came down from the Admiral, "Get Watkins up here." "What now, God" I thought. But having been somewhat numbed by frequent trips down the hall over the prior 1-1/2 years, I took the current impending trauma in reasonable stride. Clearly, I believed that this was just one more case of poor thinking and writing on my part—you know *like all those other dumb naval officers*. But on this occasion, a miracle was about to take place. Apprehensively, I entered the Admiral's office and he began yelling at me...but this time with a different ring to the voice. He said, "Watkins, go down the hall and tell Jack Grigg how to write a letter." He then dismissed me abruptly. Poor Jack obviously had his turn in the barrel that morning as had we all at one time or another. On my way out, I said to the Admiral's secretary, Jean Scroggins, "Jean, did you hear that?" Jean said to me rather matter-of-factly, "Mr. Watkins, today you have arrived." ...Well, I walked down the hall toward Jack's office with a skip and a smile, my first at NR. Admiral Rickover had *spooned* me in his own way. In fact, I can look back on his words that day as being the nicest compliment Admiral Rickover ever paid me in the more than two decades I worked for him. I might add here that, even though I left NR in 1964, the Admiral always considered me his employee until almost the day he passed away in 1986. At any rate, the light had just come on for me. I now understood his tactical plan to attempt to train all with whom he came in contact and through them, spread the good news throughout the Navy of the right way to do business. But I also realized that he would expend his energy only on verbally chastising those whom he still believed had the right stuff to help him achieve his goal of instilling a new sense of professionalism in future naval leaders, civilian and military. Woe to the person who was treated with kind words by the Admiral—clearly someone he assessed as not having the right stuff and hence totally unworthy of his time, attention and energy.

One of the key objectives inside his broader professional enhancement goal for all naval officers was to put into concrete such a strong and respected military and civilian body of professional and technical competence within Naval Reactors, sustainable long after his departure from the scene, that it would unlikely be dismantled by the normal bureaucratic decay mechanisms so often prevalent in government agencies. My experience is that most of these agencies find it much easier to relax standards than to set high ones and then hold to them. Rickover knew that unless his growing cadre of professionals was so imbued with his philosophy, and armed with his skills to see this philosophy brought to fruition, that the future of the Navy's nuclear powered fleet would be short lived. The fact that we are all here today celebrating 50 years of professional and technical excellence is testimony that this key objective was achieved and has been sustained for the 16 intervening years since he departed NR. Not an organizational ripple in the Navy's nuclear power program water occurred when the admiral was *piped ashore* for the last time in 1982; most importantly, the technical competence within NR remained intact. Yes, Admiral Rickover had won his hard-fought battle after nearly 40 years. What an incredible accomplishment.

Now, let me talk briefly about how a few of us worked hard to help ensure that a smooth transition to new leadership would take place.

In the fall of 1981, I was called back to Washington, DC at the behest of Admiral Hayward, then the CNO, and tasked to prepare everything necessary to assist in effecting a good transition from Admiral Rickover to his successor. I was CINCPACFLT at the time. I asked Bill Wegner to help me prepare the Executive Branch directives which would be required to accomplish this. Our first move was to discuss our planned approach with key supportive House and Senate leaders such as Scoop Jackson, Mel Price and number of other Armed Services Committee members, many of whom had served on the former Joint Committee on Atomic Energy during the early days when the Atomic Energy Commission was still in being. Our common objective, with their strong backing, was to put into place all the *best of Rickover*, if you will, to insure against any raid on his well-proven standards or practices.

Since time was then very short to effect legislative protection, Wegner and I set our sights on executive orders and related DoD directives, knowing that legislation would eventually be required to help guard against any future political mischief with the nuclear power program. We prepared all needed documentation, sent it forward from Navy to the Secretary of Defense, and to the White House. All this was done with Congressional knowledge. Documents were then signed by the President, the Secretaries of Defense and Navy and were ready for implementation by the Admiral's birthday, a date set by the Administration for his retirement. Wegner and I were amazed at how easily we marched our documentation through the normally hazardous route for such matters. But, the *old man* himself helped us. How? Well, he felt he had been rather shabbily treated by the Administration in what he viewed as a stealthy forced retirement move. As a result, he let them have some of his well-known broadsides and the Administration was then ready to sign almost anything at that point to move the process along...a classic Rickover maneuver. So, as ususal the Admiral had won again. The long range sustainability of the Navy's nuclear power program was a vitally important by-product of this resultant transition to new leadership in NR. The most important transition document was a Presidential Executive Order which set the stage for everything else. This Executive Order was turned into statue a few years later during Admiral McKee's tour. Admiral Rickover's visionary dream was now protected by law. By the way, it was another NR graduate, Mel Greer, who was a key member of the House Appropriations staff at that time who helped shepherd this legislation through the Congress. Those trained by Rickover were fast moving into other influential decision-making bodies in the government.

One related anecdote —what I didn't tell you in carrying out this transition process was that Admiral Rickover refused to talk to either Wegner or me about it. For he would view any such perceived complicity with us as acquiescence to whatever Administration schemes were underway to move him into real retirement. But the *old man* really knew what was going on based on a number of earlier political signals that his continued two year Congressional extensions on active duty were probably in jeopardy.

Shortly after his death, I was requested by Eleonore to give Admiral Rickover's eulogy at the memorial ceremony which was held here at the National Cathedral in 1986. I opened my remarks by employing a simple quotation from Voltaire in which he tried to capture the essence of a purpose of life as follows: "Not to be occupied, and not to exist, are one and the same thing." And, I can think of no man who better epitomized that tough standard. For Admiral Rickover was occupied. He was a unique individual who accomplished great deeds through hard work and struggle, and thereby gained respect f a nation and the world. He was an original thinker who dared to peer beyond boundaries set by others, and therefore accomplished that, about which, others only dreamed. This was a special American, naval professional, visionary, intellectual, engineer, iconoclast and most importantly, teacher—Hyman George Rickover—whose life and accomplishments we celebrate at this 50th Anniversary of the Naval Reactors organization he founded, nurtured to maturity, and passed on without a ripple to a committed team he had personally trained.

In 1984, the Admiral was asked once by the TV commentator, Diane Sawyer, in an interview, "Do you believe there's an afterlife?" Rickover responded, "I don't know. I've never talked with many of the people there." Ms. Sawyer responded, "You don't think it's likely there's a heaven and a hell?" He responded, "I think you make your heaven and hell right here on earth. You should act on this earth as if it were heaven." She asked no more questions along this vein.

On another mores serious occasion, however, for an address to be delivered at St. John the Divine in New York, the Admiral and Eleonore together wrote this final paragraph, which put into perspective the Admiral's beliefs about life:

> "The man who knows his purpose in life accepts praise humbly. He knows that whatsoever talents he has were given him by the Lord. And, that these talents must be developed and used, and that learning never ends. In this way, man renders thanks for the Lord's gift—and finds meaning in his life."

Admiral Rickover well used the many gifts given to him by the Lord, and found full meaning in his life, while sharing this meaning with those around him, many who are gathered here today. All those who served with him and those who follow in his footsteps are thankful—and blessed—that the Lord shared this gifted and talented man with us.

Happy 50th Anniversary, Naval Reactors.■

NAVAL NUCLEAR PROPULSION PROGRAM
50th ANNIVERSARY

As you gather to commemorate the accomplishments of the Naval Nuclear Propulsion Program and to pay tribute to the memory of Admiral Rickover, it is with the utmost respect that I extend hearty congratulations to all men and women associated with the Program from the United States Navy, our government, and American civilian industry.

In August 1948, the Program was created under the leadership of a brilliant, resourceful, and determined visionary, Hyman G. Rickover. This momentous event was the beginning of a scientific, technological, and military revolution that remains unprecedented among our Nation's peacetime accomplishments. Only six years later, USS NAUTILUS (SSN 571) forever changed the character of sea power by signaling the historic message, "Underway on nuclear power." Over the last half century, naval nuclear reactors have steamed over 110 million miles with an unmatched, absolutely flawless record of safety and performance. Today, nuclear powered aircraft carriers reign as the centerpiece of America's strategy of forward presence, and nuclear powered submarines remain a crown jewel of our Nation's defense arsenal.

As you gather to memorialize Admiral Rickover and to celebrate his remarkable legacy, recognize with well-earned pride the Naval Nuclear Propulsion Program's invaluable contribution to the peace and security of our great Nation. The men and women of the Armed Forces and the Joint Chiefs of Staff join me in sending best wishes for a memorable ceremony.

Sincerely,
Henry H. Shelton
Chairman

CNO RECOGNIZES 50TH ANNIVERSARY OF NUCLEAR POWER PROGRAM

It is with great pride that I offer my congratulations on the 50th anniversary of the Naval Nuclear Propulsion Program. This historic occasion reflects an unequaled record of professional excellence and technological breakthroughs.

In early 1955, the world's first nuclear powered submarine, USS NAUTILUS, put to sea. A mere five years later, USS TRITON followed the route of Ferdinand Magellan to become the first warship to circumnavigate the globe while submerged. That same year, USS GEORGE WASHINGTON, our first fleet ballistic missile submarine, fired the first Polaris missile while submerged. This amazing enhancement to our national defense was quickly followed by the world's first nuclear powered aircraft carrier, USS ENTERPRISE, guaranteeing America's dominance at sea.

These early successes led to the fleet of nuclear powered aircraft carriers, cruisers and submarines that proved so vital to achieving victory in the Cold War and maintaining the peace today. As we look to the future, nuclear powered warships will continue to protect our Nation by offering vital options for preserving the peace, responding to crises, and prevailing in war.

Nuclear propulsion provides our aircraft carriers with virtually unlimited range and endurance at high speeds, allows carrying substantially greater amounts of munitions and aircraft fuel, and dramatically reduces dependence on logistical support. These advantages result in increased operational flexibility, independence, and survivability.

Nuclear power also arms our submarines with the stealth and mobility needed to survive in the most lethal battlespace. Whether operating independently or in concert with aircraft carrier battle groups, nuclear powered submarines are critical to achieving forward presence, sea superiority, and strategic deterrence.

The remarkable contribution of nuclear powered warships to our national security results from the commitment and hard work of thousands of individuals—military and civilian—who have served and are serving in the Nuclear Propulsion Program. I salute these patriots and mariners as we commemorate this landmark event. Well Done!

Admiral Jay L. Johnson, USN

2000—THE SUBMARINE CENTENNIAL
Part II

Status Report by
ADM Hank Chiles, USN(Ret.)
and CAPT Dave Cooper, USN(Ret.)

In the April 1998 issue of **THE SUBMARINE REVIEW** we presented an outline of the planning for the Submarine Centennial Anniversary in the year 2000. The first paragraph of that article has become the theme for this commemoration:

> "Since 1900, our submarines have evolved from small submersibles with limited capability to proven warfighters in World War II to today's nuclear powered, multi-mission warships. Nearly 100 years of technological innovation and flexible adaptation to changing strategic and defense needs have made today's Submarine Force ready and able to respond decisively across the spectrum of conflict. The Submarine Force is poised to enter its second century of undersea dominance with the most highly trained people and advanced platforms in history."

Personnel from all submarine organizations—Naval Submarine League, U. S. Submarine Veterans of World War II and the United States Submarine Veterans Incorporated—are involved in this planning, designed to support active duty forces. Flagship events selected by the Submarine Force Commanders span the country and include:

- Smithsonian Exhibit Opening - Feb 00
- Washington, DC Birthday Ball - Apr 00
- **International Submarine Visits**
  - SUBLANT - Jun 00 w/NSL Symposium
  - SUBPAC - May 00 w/RIMPAC 2000
- San Diego Fleet Week Events - Aug 00
- SSN 23 Christening in Groton - Dec 00

Our concept continues to be a year-long celebration with events across the country and at overseas locations with decentralized planning and execution (after all weren't we bred for independent operations). Senator John Warner is seeking a Congressional Resolution honoring our celebration. Our communication points emphasize not only warfighting, submarine contributions in contingency operations and the Cold War, but also our immense contributions to nationally significant technology.

Plans for the Smithsonian American History Museum are proceeding under the leadership of John Shilling. John is actively in search of material for an interactive submarine display that will be appealing to young people, tell our story effectively to the American public, and highlight our Cold War submarine warfare contributions.

We have engaged a sculptor, Paul Wegner (Bill Wegner's son), to design a memorial statue. Our focus is on submarine personnel engaged in activities pertinent to the various eras of submarine warfare. We're currently considering a three-figure presentation of a lookout, officer on the periscope and a sonar operator. We've asked the Submarine Veterans of World War II to consider if they would like to sponsor a project to put a memorial window to lost submariners in the Navy Memorial in Washington DC in the heart of the Nations Capital.

The Citizen's Stamp Advisory Committee (CSAC) has placed our request for a Submarine Commemorative Stamp in the *under consideration* category. This does not mean we're approved for a stamp, but we're a lot closer than we were six months ago. Support for House Concurrent Resolution 229 "expressing the sense of the Congress that a commemorative postage stamp should be issued honoring the United States Submarine Force on its 100th Anniversary" now has 125 cosponsors. We need 93 additional co-sponsors in the next two months to get the House to throw their full weight behind this resolution and are working to achieve that goal. We have Congressman Sam Gejdenson to thank for getting this started. Many of you have written to the CSAC and your Congressmen urging their support. If this gets approved, it's because of your efforts.

We're working to have a commercially produced five-hour television series during the year 2000 that will highlight our history and the future of the Submarine Force.

We're interested in participating in the Rose Parade on 1 January 2000 in Pasadena, California and are looking for financial sponsorship to get this project rolling.

The listing of the centennial events and exhibits that are currently known is provided after this article. Please advise Al Burkhalter or Dave Cooper of problems with this list or events that should be included. It will take considerable resources to achieve these Centennial Submarine Force goals, and we're putting the package together to inform submariners everywhere of the help needed. We welcome your support and ideas. It'll be a fantastic celebration in 2000. Congratulations, submariners, you deserve it.■

U.S. SUBMARINE FORCE
100TH ANNIVERSARY CELEBRATION EVENTS

Date(s)	Event	Sponsor	Location
01 Jan 00	Rose Bowl Parade	CSP	Pasadena, CA
01 Feb 00	Smithsonian Exhibit Opening	N87	Washington, DC
01 Mar 00	SUBLANT Submarine Birthday Ball	CSL	Norfolk, VA
01 Mar 00	Seafood Festival	Pt Canaveral	Pt Canaveral, FL
01 Apr 00	Washington Birthday Ball	N87	Washington, DC
01 Apr 00	Submarine Stamp Unveiling	N87	Washington, DC/Groton, CT
01 Apr 00	Dedication of Deterence Pk	CSG 9	Bangor, WA
01 Apr 00	Pearl Harbor Birthday Ball	CSP	Pearl Harbor, HI
01 Apr 00	SUBGRU 2 Submarine Birthday Ball	CSG2	New London, CT
01 Apr 00	SUBGRU 10 Submarine Birthday Ball	CSG10	Kings Bay, GA
01 Apr 00	USS THRESHER Memorial Ceremony	CSL	Norfolk, VA
01 Apr 00	Azalea Festival (NATO Event)	CSL	Norfolk, VA
01 Apr 00	Dedication of Granite Memorial	Subvets, Inc./Subvets WWII	New Suffolk, NY
10 Apr 00	USS THRESHER Memorial Service	USSVI, Southern Tier NY Base	Endicott, NY

11 Apr 00	Centennial Navy Base	Subvets WWII	Great Lakes, IL
11 Apr 00	Subvets National Convention	Subvets Inc.	Atlantic City, NJ
01 May 00	**SUBPAC International Submarine Visit**	CAP	Pearl Harbor, HI
01 May 00	Fleet Week	CSL	Norfolk, VA
01 May 00	USS SCORPION Memorial Ceremony	CSL	Norfolk, VA
01 May 00	New York Fleet Week	N87/CSL	New York, NY
01 May 00	Beach Fest	N87/CSL	Pt Canaveral, FL
01 May 00	Tolling of Bells USS COBIA	Subvets, Inc.	Great Lakes, IL
12 May 00	Maritime Museum	Subvets WWII	Manitowoc, WI
13 May 99	USS PASADENA Salute, Ritz Carlton	CSS 11	Pasadena, CA
01 Jun 00	**SUBLANT International Submarine Visit**	CSL/NSL	NSL Symposium
01 Jun 00	N. Central Region Subvets WWII	Subvets WWII	Minnesota
01 Sep 00	Naval Institute Annual Symposium	N87/CSL	Norfolk, VA
01 Aug 00	San Diego Fleet Week	CSP	San Diego, CA
01 Oct 00	Pittsburgh Fleet Week	CSG 2	Pittsburgh, PA
01 Oct 00	Broward Navy Days	CSL	Ft. Lauderdale, FL
01 Oct 00	Army/Navy Game	N87	Maryland???
01 Nov 00	Cold War Submarine Memorial Dedication—Patriot's Point	CSG 10	Charleston, SC
01 Dec 00	SSN 23 Christening	N87/CSL	Groton, CT

Bold Items—Flagship Events

LEVERAGING SUBMARINE POWER IN THE 21ST CENTURY

by LT David Allan Adams, USN
Weapons Officer, USS SANTA FE

Editor's Note: Lieutenant Adams' paper won The Naval Submarine League Essay Contest for Submarine Officers' Advanced Class 98-020 in June of 1998.

Since John P. Holland's invention of the practical military submersible in the late 1800s, nations have often had a muddled conception of the strategic utility of submarine forces. Few statesmen imagined the coming nature of Germany's unrestricted submarine campaign against allied merchants during the First World War. Even fewer military strategists expected the United States to follow the German example, commencing unrestricted attacks on Japanese commerce at the onset of the Second World War. All but ignored before these wars, submarines were, by themselves, nearly decisive during them. In fact, several historians have concluded that "the American submarine campaign against Japanese seaborne commerce was a principal factor, perhaps *the* principal factor, in victory."[1] Since that time, submarines have become highly *process-improved*; possessing dramatically enhanced sensors and firepower as well as nuclear reactors that give unlimited submerged endurance. It seems hard to deny that submarines are currently the ultimate instruments of sea power. Nevertheless, critics argue that the U.S. Submarine Force is little more than a Cold War relic. They have chosen to ignore, however, the clearest lesson of 20th century naval history: **a nation that does not heed the leverage of submarine power, does so at great peril.** *(Editor's Note: Emphasis added.)*

Any confusion today about the role of American submarines stems from the fact that the Cold War Soviet submarine threat presented an overwhelming danger to U.S. security, driving the U.S. Submarine Force to focus on antisubmarine warfare (ASW) at the expense of clearly demonstrating its wider strategic relevance. A recently *diminished* Soviet/Russian submarine threat means the ability of the Submarine Force to act as a wider instrument of American sea power must be reestablished in the public mind. To most American submariners, their boat's continued contribution to our national security is intuitive. Unfortunately, submariners who must cope every day with shrinking budgets, reduced benefits, and intense operating tempos have little time for strategic assessments. Nevertheless, there are reasons for optimism. Explaining the enduring strategic utility of the Submarine Force can foster a renewed sense of purpose, that—when coupled to rediscovered warfighting values—can offer hope for a revitalized U.S. Submarine Force and the secure nation that follows.

A Renewed Sense of Purpose

Some military analysts claim "the U.S. Navy's attack submarine fleet has no potential blue water adversary that justifies its maintenance at the same level."[3] But this argument misses the strategic point. Despite the end of the Cold War, the United States remains a maritime nation and command of the sea—a mission to which our submarines are uniquely indispensable—is a basic foundation for our national survival. Our security, economic and military, depends upon our (and all other nations') unhindered ability to conduct peaceful international trade across the world's oceans. At the same time, America's forward-deployed naval forces are increasingly being called upon to act as a premier stabilizing influence on international relations.

As the most recent crisis with Iraq demonstrated, there is no substitute for naval forward presence, available at the onset of any crisis, to stabilize international disputes, engage or deter regional powers, halt aggression, and ultimately to enable joint victory should deterrence fail. The United States Navy must maintain a global stabilizing presence—underpinned by undersea superiority—or political instability will facilitate the slow erosion of peace. New threats to democratic capitalism will emerge, regional power rivalries will spiral out of control, and American airmen, soldiers, sailors, and marines will be called upon to pay an untold price in blood and human suffering to protect American lives, property and interests. Therefore, the outdated threat-based thinking that ties the Submarine Force exclusively to a blue water naval threat simply trivializes the wider strategic importance of American sea power, of which submarines are a critical part.

If naval forward presence is a linchpin of American strategic success in the coming century, then the Submarine Force is a vital, though not normally visible, element of that presence. During every recent international crisis, U.S. carriers and surface ships have captured the media spotlight, showcasing their ability to project American power ...*From the Sea*. In the media age, it is easy to forget that the U.S. Submarine Force, lurking sight unseen, ultimately holds many of the keys to any successful naval operation. It is the presence of our strategic submarines that deter the use of weapons of mass destruction against our forces, whether air, land, or sea. It is the presence of our SSNs that guarantees the safe passage of our carrier battlegroups to the scenes of distant crises. Possibly most important, it is U.S. attack submarines—normally arriving days before a carrier takes station—that must pave the way, prepare the battle space, and establish the local undersea superiority that prohibits a devastating submerged attack on our precious surface assets.

The Falkland's Conflict, the only significant naval battle since World War II, demonstrated that submarines are needed to enable effective naval power projection.[3] While the British surface fleet fell prey to deadly attacks from the air, a submarine, operating with impunity, sank the Argentine Navy's largest surface ship, GENERAL BELGRANO. Fear of further submarine attacks bottled up the Argentine carrier and her entire escort fleet in harbor. Argentina, of course, had no sophisticated ASW capabilities, but even the most modern surface fleet finds it difficult to detect and track submarines in the littorals. The South Atlantic War simply confirmed what submarines have long known—submarines are now the predominant weapon of power at sea.

Twenty-five hundred years ago, Themistocles proclaimed "he who has command of the sea, has command of everything." Today, American submariners should gain a renewed sense of purpose from the knowledge that only a nation that commands the undersea can expect to project its naval power and global influence across it. Since America's worldwide naval presence acts as a stabilizing influence, fostering a global trading economy that directly benefits the United States and our allies, it follows that American strategic success depends first and foremost upon the ability of the U.S. Submarine Force to blunt any challenge, large or small, to our nation's command of the sea.

No Time to Rest

While the current strategic circumstances point to the increasing relevance of naval forward presence, sea control, and submarines, the U.S. Submarine Force has no time to rest on its laurels. The claim that the United States lacks a true naval peer competitor offers little comfort because as the study of Mahan reminds us, "sea control must be asserted not assumed".[4] In the wake of the Gulf War, most nations realize that inviting a head-to-head confrontation with the U.S. fleet would be a foolhardy endeavor. Instead, they are rapidly developing asymmetric means of inhibiting American and allied access to and from the sea.

Today's Submarine Force faces additional challenges that constitute a real and present danger to global military and economic security. Modern conventional submarines are being built or purchased by many of the United States' likely regional competitors. Iran, for instance, has never forgotten how the U.S. thwarted their attempts to close the Straits of Hormuz during the Iran-Iraq War. Thus, they have subsequently amassed thousands of mines and purchased several Russian Kilo class submarines in an attempt to mitigate American naval influence in the Arabian Gulf. These acquisitions have set the precedent for the naval build-ups being pursued by almost every potential U.S. adversary. This unabated proliferation of cheap, lethal sea mines and conventional submarines makes it easier for even marginal powers to close critical choke points, inhibit international trade, and deny American access from the sea.

America's Submarine Force, to its credit, has been quick to contemplate innovative tactics and strategies to keep on top of these asymmetric undersea threats. But as the U.S. Submarine Force concentrates on littoral challenges, it cannot afford to ignore the Russian Navy's still significant capacity to field a number of formidable modern submarines. Deployments of their newest classes of nuclear boats have made acoustic parity the new norm of many U.S.-Russian undersea encounters.

To make matters worse, the Russians, apparently thirsty for capital, seem to be exporting more than just their advanced Kilo class diesel-electric submarines to the highest Third World bidder. Technological upgrades, developed in the former Soviet Union and elsewhere, are now available on the open market, providing even older submarines with enhanced quieting, sensors, and weapons that can markedly improve their stealth, submerged endurance, and combat effectiveness. Additionally, Russia's recent transfer of submarine technology to China and India suggests that the United States cannot rule out the possibility that a cash strapped Russia might sell off even its most sophisticated technologies, maybe even an entire modern nuclear submarine. Since submarines are, first and foremost, America's primary sea control assets, the Submarine Force has no choice but to keep one eye on Russia's increasingly sophisticated submarines and the other on the diverse and difficult asymmetric challenges that come with forward operations in coastal waters and shallow seas.

Today, U.S. national security demands that the Submarine Force dominate the littoral undersea environment without diminishing its open-ocean warfighting skills. At the same time, the Force is being called upon to conduct a wide array of additional littoral missions: strike, surveillance, and special operations among others. None of these missions are completely new to the Submarine Force. Submarines, for instance, have long been one of the United States' most important intelligence and surveillance assets. It is important to admit, however, that current SSNs can only offer a group of niche capabilities to help accomplish these collateral missions. While converting several Trident submarines to submerged arsenal ships may provide the Force with increased mission capabilities in these areas, the bulk of our early 21st century attack submarine fleet will still be capability-constrained to the hull of the Los Angeles (688) class. Taken together, however, the 688's robust undersea warfighting prowess and niche strike, surveillance, and special operations capabilities can contribute significantly to the littoral campaign.

Innovative thinking and new operational concepts are needed to take full advantage of today's attack submarine in the littorals. One suggestion made by Commander Kevin Peppe, former Commanding Office of USS ATLANTA, is that "a better employment concept may be to get the submarine in early, to do what it can do to enable the introduction of the heavy hitters."[3] This might include initial intelligence preparation of the battlefield, surveillance of enemy forces, and the use of unmanned undersea vehicles to map and neutralize enemy minefields. If the crisis escalates, the submarines could deploy special operations forces, either SEAL teams or Marine recon platoons, to perform targeting and tagging of key facilities like the enemy's coastal and mobile missile batteries. When ordered, submarines would be in position to neutralize any enemy diesel submarines and launch their Tomahawk missile at essential targets--previously tagged by its special operations forces. Having established local maritime superiority and neutralized many of the most potent enemy threats to the battlegroup, SSNs will have significantly reduced the operational risks to U.S. forces and truly paved the way for American power projection from the sea.

Rediscovering Warfighting Values

The success or failure of the American Submarine Force--whether enabling forward presence or contributing to the littoral campaign--will depend less on technology and tactics than on the institutional attitudes and professional values of everyday submariners. Despite its strategic relevance, the Submarine Force is struggling through what seems to be a continual downsizing. Many submarine officers are resigning because they see only increased family hardship coupled with a reduced opportunity for selection to promotion and command. Sometimes the best way to weather adversity is to look to those who served and sacrificed before you. Thus, Admirals Bowman, Mies and Ellis have called for a renewed commitment to our submarine history and tradition. Placed in a historical context, our troubles seem minuscule when compared to those faced by World War II submariners. Studying their exploits inspires us to professional excellence and calls us to strive to make a real difference today--instead of just to pass a promotion or screening board tomorrow. But as we remember the courageous wartime patrols of boats like WAHOO, BARB and GATO and as we look with admiration to our past heroic submarine commanders--men like Fluckey, O'Kane, Gilmore, Dealey, Cromwell, Street, and Ramage--for inspiration, we must also never forget the lessons that come from learning the rest of the story.

It is important to remember that the peacetime Submarine Force that entered the Pacific War in 1941 was hardly prepared for a fight.* Artificial and unrealistic peacetime naval exercises had led many submarine skippers to conclude that their boats were exceedingly vulnerable to attack by aircraft and to depth charging by sonar equipped surface ships.[7] Making matters worse, bold, innovative, risk-taking warriors were often reprimanded. Conversely, conservative *by-the-book* officers, known for their harsh discipline and impeccable paperwork, rose to command.[8] When the war struck, the Submarine Force found itself with a number of risk-averse officers in command positions. The results were predictable. Many submarine commanders placed a premium on caution and were more interested in bringing back their boats safely than in engaging the enemy. As a result, submarine skippers had to be relieved for lack of aggressiveness and replaced by the "men of audacity, unflinching courage, and instinctive tactical judgement" that today's submariners have grown to admire.[9]

There are signs that peace may have taken a similar toll on today's Submarine Force. Many current submarine officers have succumbed to zero-defects standards, management-by-inspection,[10] and cautious careerism that are all too reminiscent of the Submarine Force that entered the Second World War. To ensure that our early wartime history does not repeat itself, we must avoid gaming inspections, adhering mindlessly to Naval Warfare Publications, or concerning ourselves with the maintenance of a pristine, politically correct personal image. Instead, we must cultivate a submarine institutional climate where all submariners are trained to fight, encouraged for innovative tactical thought, and valued—above all else—for emulating the aggressive warfighting spirit that characterized all our truly great submarine heroes.

Breaking the Silence

Renewing our sense of purpose and rediscovering our aggressive warfighting values will help to improve Submarine Force morale while ensuring that our remaining submarines are prepared to fight. These moves alone, however, will not stop the perpetual downsizing of the Force. As one leading Congressman recently pointed out, "not even a minimum QDR Submarine Force structure can be maintained unless we get about building the new attack submarine (NSSN)."[11] Simple math reveals that even building one NSSN per year will not be enough. Our only hope is that submariners will break their traditional silence and clearly articulate the indispensable value of leveraging submarine power in the 21st century.

Armed with a renewed sense of purpose and commitment to warfighting values, we stand the best chance of convincing our fellow military officers, the public, and Congress that the strategic success of U.S. foreign policy in the coming century depends upon naval power in general and submarine power in particular. This argument must be made not for the good of the Submarine Force or the Navy, but for the good of the nation. I suggest we begin with these three points:

Submarines enable naval forward presence. History has shown that today only submarines can truly command the sea. Securing uninhibited access to and from the sea, submarines enable forward deployed naval forces to conduct the full range of stabilizing military operations including preventive presence, protecting international commerce, providing humanitarian assistance, and conducting punitive military strikes against violent rogue dictators.

This stabilizing naval presence—enabled by submarines—directly impacts the daily lives of average Americans. The benefits of naval forward presence are difficult to quantify, but are nevertheless tangible. Free markets abhor uncertainty; forward-deployed naval forces boost global economic activity by deterring war and by reassuring markets that conflict will be contained. A forward deployed U.S. Navy and Marine Corps also fosters the political and economic stability needed by states transitioning to democracy and free market economies. American taxpayers finally have their peace dividend, not in the form of defense cuts (which are paltry in comparison to the U.S. gross national product), but in the form of high economic growth rates fostered by a booming world trading economy.

A modernized Submarine Force, then, is a linchpin of American strategic success in the coming century. Submarines directly protect our vital international commerce, deter war, and enable naval forward presence to promote peace, stability, and economic growth. In this light, investing in submarine power, and naval power in general, is a small premium to pay considering the alternative—an increasingly unstable world economy, the slow erosion of peace, and the inevitable cost of wars that will be difficult to win in the first place without America's Submarine Force to ensure undisputed control of the sea.■

NOTES

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WAITING FOR START III: ARMS CONTROL AND THE SUBMARINE FORCE

Ambassador Linton F. Brooks
Address to the NSL Annual Symposium
12 June 1998

Introduction

Why talk about arms control at a conference of submariners? The subject is esoteric, the Cold War is over, and the prospects for progress are not good. So why take the time? The answer is that, along with missions and budgets, arms control serves as a significant constraint on the strategic Submarine Force and, perhaps, on the non-strategic force as well. The second answer is that the exact nature of those constraints is likely to remain unclear for quite a while.

I want to do three things this morning: explain how we got here, review where we are, and suggest some options for what might happen next. Before I do, I need to offer two caveats. Most of the people who have spoken to you yesterday and today are responsible officers speaking authoritatively. In contrast, I am speaking as an interested outsider. Some of these issues are being actively considered within the Pentagon. I'm not going to talk about what is happening inside the government, in part because I only have a limited view of the process.

Second, most observers have a bad track record in predicating arms control progress. Several years ago I stood before you and predicted that Russia would shortly ratify START II. I was wrong then, and I may be wrong now. So I'm not going to predict, I'm just going to offer possible alternative futures and suggest what they mean for our Submarine Force.

How We Got to Where We Are

We have been chasing strategic arms control for almost 30 years since the opening of the SALT I negotiations in November 1969. Over that period, there have been a variety of justifications for negotiated arms reductions. We wanted to save money—or really to avoid future expenditures, since arms control rarely saves money in the near term because of the costs of verification and dismantlement. We wanted to provide predictability for the future. We wanted to constrain specific Soviet systems like the SS-20.

But the most enduring reason for pursuing nuclear arms control has been to enhance crisis stability. Simply put, crisis stability requires that either side be able to absorb an initial attack and still respond with a devastating counter-attack. Arms control has tried to restructure strategic forces so as to remove any incentive for either side to strike first in time of great tension. As a practical matter, this logic calls for preferential elimination of ICBMs with multiple warheads, since they are most subject to a *use them or lose them* decision. Put another way, stability, which implies survivability, is what has made the strategic Submarine Force so important.

For most of the Cold War we sought crisis stability and other objectives in large, formal, complex, extended negotiations. That period culminated with the signing of START I in 1991. START I began the process of moving the Soviet Union to a more stabilizing force structure. It limited heavy ICBMs and encouraged a modest shift to air-breathing systems. Clearly, however, there was more to do.

A few months after START I was signed, the Soviet Union collapsed. In the aftermath of that collapse, the Bush Administration saw an opportunity and made a renewed push to eliminate ICBMs with multiple warheads. Since the dire economic conditions in Russia were becoming obvious, the United States offered a simple trade: we would reduce our forces to the level that Russia could afford if Russia would make those reductions in a way we liked, by eliminating so called MIRVed ICBMs. That trade was the essence of what became the START II Treaty.

How did this effect the Submarine Force? While START I was designed to protect a Trident force of 24 boats, as the Cold War ended the United States concluded that we needed fewer ships and the 18 Trident force came into being. That's the force that START II was designed to protect.

We signed START II in January 1993, just before the Bush Administration left office. The new Administration had made its ratification a high priority, and we confidently expected it to be ratified by the summer of 1993. We were wrong.

Initially, Russian ratification fell victim to a series of confrontations between President Yeltsin and his parliament. As time went on, new issues arose: the cost of implementation; the failure of the Yeltsin administration to explain what Russia's force structure will be, what it will cost, where the money will come from; disputes with the United States over the ABM Treaty and NATO expansion; growing recognition that the Russians could not afford to maintain even START II forces.

But the two biggest problems were the growing estrangement between the Russian Executive and Legislative branches and the evaporation of the initial euphoria following the collapse of communism. In that brief period where Russians saw a new world and did not yet see how grim that world would be, START II was concluded quickly and painlessly. As the grim reality of the Russian economic disaster became clear, the euphoria faded. In its place came resentment as the economic reforms urged by the West disrupted the patterns of decades. The United States came to be seen as seeking to take advantage of Russia in her time of weakness.

The Administration tried three main approaches to induce Russian ratification. First, to set an example, it gained Senate approval for the Treaty in early 1996. Second, it argued that only through START II ratification could the Russians gain equality. To reinforce this reasoning and to put pressure on Russia, the Congress and the Administration mandated that the United States would not reduce its forces below START I levels until the Russians ratified START II. The Administration defined *START I levels* as including 18 Tridents, despite the fact that the Nuclear Posture Review had concluded that only 14 were needed and that was all we were programming for. These tactics failed.

The Administration then tried a third approach. As time wore on and the Russian economic situation worsened, many Russians began to call for a new treaty at still lower levels, levels they thought they might be able to afford. After several years of resisting these calls, President Clinton met with President Yeltsin in Helsinki on March 21, 1997 and reached the following agreement:

- To amend START II to delay completion until 31 December 2007, a five year slip designed to make it easier for the Russians to comply.
- To negotiate a START III that would lower levels to 2000-

2500 warheads, also by 2007. This START III would also deal with warhead dismantlement and early deactivation of systems to be eliminated.

- And to resolve a number of issues associated with the ABM Treaty that were seen by some as hindering Russian ratification.

<u>Where Are We Now?</u>

That's how we got here. But where is *here*? Where are we now? Effectively, we are at *all-stop*. We have fallen into a disturbing pattern: the two Presidents meet, reaffirm the importance of prompt ratification, Yeltsin goes back to Moscow, and nothing happens. Last Friday (*Ed. Note: 6/5/98*) the Russian Defense and Foreign Ministers met with faction leaders in the Duma (the Russian parliament). It did not go well. Next week (*Ed. Note: week of 6/15/98*) there will be an elaborate briefing for at least 150 of the 450 member Duma at the Russian General Staff Military Academy. It will not go well either.

Two days ago the Duma formally delayed START II consideration and now will not take up the issue until September at the earliest. But action then seems unlikely. Many believe that by using his considerable power, President Yeltsin could force START II through the Duma. But that is looking more and more difficult. The Communists are the largest party in the Duma. Without their cooperation, ratification is impossible. But instead of working with Yeltsin they have just introduced a motion to impeach him. The motion will fail, but it won't improve relations or foster cooperation. Further, as most of you know, there was a major confrontation with the Duma over the choice of a Prime Minister. There will probably be an attempt to bring a vote of no confidence this fall.

Meanwhile, back in the United States, we still must submit the ABM agreements reached in Helsinki and codified later last year to the Senate. It is not at all clear that there will be the necessary two-thirds vote to ratify them. They are strongly opposed by Senator Helms, who chairs the Foreign Relations Committee. Failure to approve them would make a bad situation in Russia worse. Thus, looking at all these factors, I think the only honest assessment is that, because of international Russian political problems over which we have no control, we are extremely unlikely to see START II ratification in the near future.

What Happens Next?

It seems to me that there are four possible ways this drama may unfold. Each has quite different consequences for the Submarine Force. First, of course, I could be wrong—I have been before. Perhaps this time Lucy won't move the football and the Duma will act. The Administration, at least in public, seems to believe this. They are busy working to be ready to begin START III negotiations as soon as the Duma acts.

What will this outcome mean for the Submarine Force? First, we'll be able to go ahead with plans to reduce the Force to 14 Tridents. Second, since every strategic thinker I know wants to maintain 14 Tridents and a two ocean capability, we'll need an arms control regime that accommodates this at reasonable cost. One logical way to preserve 14 Tridents with fewer warheads is to negotiate a low cost way to reduce the number of accountable tubes on each ship. This will be especially required if, as I believe, START III ends up with lower levels than those the two Presidents agreed to in Helsinki. Third, we can expect Russian pressure to ban TLAM/N and further pressure (which I think the Administration will resist) to constrain non-nuclear sea-launched cruise missiles. Finally, yesterday you heard Vice Admiral Rich Mies describe an idea for converting some of the four Tridents planned for retirement into strike submarines carrying cruise missiles. For that conversion to be affordable, there needs to be some relief from existing dismantlement provisions. The Navy will need to decide whether to seek such relief in START III.

It is important to recognize that even if START II is ratified and START III negotiations begin in September, which I find wildly optimistic, reaching agreement will be a very long process. Warhead dismantlement and transparency will be complex and time consuming to negotiate. In addition, many argue that it is necessary to capture non-strategic warheads in any new agreement; doing so raises both negotiating and verification challenges.

Further, unofficial Russians purporting to speak for Defense Minister Sergeyev have been arguing that even the 2000-2500 warheads agreed to in Helsinki are more than Russia can afford.

They speak of lower limits of, perhaps, 1000-1300 ballistic missile warheads with some greater flexibility on bombers. If we actually get to negotiations, I think the Administration is likely to agree to reductions below the level of 2000 warheads, but that will be a time consuming decision. What all this says to me is that agreement before the end of the Administration is unlikely even if START III negotiations begin soon.

Suppose I'm not wrong and ratification continues to slip. What happens then? First, the Administration will, I think, have to redefine what it means to *remain at START I levels*. The cost of maintaining 18 Tridents will become crushing, as will comparable expenditures on Air Force systems. It seems illogical that arms control, which was supposed to limit nuclear arms, now could prevent us from reducing them. There are ways to redefine what we mean by START I forces in a less costly way, especially since the theory that our keeping these forces is pressuring the Russians seems to have been proven wrong.

The more difficult question is what to do in the face of continued Russian refusal to ratify START II. There are three possibilities:

- First, we could simply continue our present course, hoping that sooner or later the Russians will realize that ratification is in their interest. It is, but we have had no success in convincing them. I think this is what the Administration will do, but sooner or later—perhaps early in the next administration—this course will be seen as bankrupt.
- Second, we could scrap START II and proceed to negotiate a new treaty based on the Helsinki agreements, a kind of START II/START III amalgam. I expect that there will be calls to do this from arms control enthusiasts, but I think they should be resisted. First, it isn't clear that a new treaty will be any easier to negotiate or to ratify. More importantly, in a *blank sheet* negotiation, the Russians will certainly seek to retain some MIRVed ICBMs. For the United States to accept such retention would be devastating. The only reason we agreed to START II was to eliminate MIRVed ICBMs; the only reason to contemplate START III is to secure the benefits of START II. Walking back the MIRV ICBM ban would be strategically unsound and, in my

view, it would be extremely difficult to gain Senate approval for such a treaty.

- Finally, we could simply conclude that, for now, nuclear arms control with Russia has run its course and shift to a different basis for planning our strategic forces. I doubt the Administration will be willing to consider this, but perhaps it should.

How might this last idea be implemented? The United States would announce that, while continuing to comply with START I, we would size our strategic forces based on our needs as determined by the Nuclear Posture Review. Consistent with prudence and Congressional direction, we would reduce our forces in a way to maintain parity or slight superiority over Russian forces. We would make it clear that we were willing to re-engage in strategic nuclear arms control sometime in the future, but that we would not do so until there was clear evidence that the Russians were serious. START II ratification could provide such evidence.

<u>So What?</u>

I began this talk by asking why the Submarine Force should care about arms control. What does it matter? It seems to me that we face a period of strategic and programmatic uncertainty that will last at least throughout the rest of this Administration and, as far as I can see, has no clear end. I suggested four possible futures. Only the one where the Duma acts soon gives us any real predictability. Unfortunately, that appears to be the least likely.

We should, of course, not make too much of all of this. Submariners have always been flexible. We take pride in our ability to adapt to changing conditions at sea. Now, we'll have to continue to show that same flexibility in the programmatic arena for what may be a very long period of uncertainty about the future of nuclear arms control and thus of our strategic Submarine Force.■

THREE ISSUES OF IMPORTANCE TO THE SUBMARINE FORCE

by John K. Welch
President, Electric Boat
May 20, 1998

I am really very pleased to be here tonight to spend a few minutes talking about some subjects we're all keenly interested in. First: the nation's defense strategy and the role the Navy plays in executing his strategy. Second, the Navy's modernization plan and the role Electric Boat plays in implementing this plan. And third, the public debate on these very important issues and the role this roomful of people can play in shaping the debate.

There's an alternate way to examine these issues—what is the nation requiring of its armed forces; what is the nation providing them to execute their mission; and what can we in industry do to bridge that gap.

Let me begin with a broad brush assessment of where the United States stands today. As we enter the next century, there's no question that we are the sole military superpower in the world.

The Cold War is history, and the Western Allies, led by the United States, prevailed over what was truly an evil empire. But as that conflict came to a close, it was replaced by a potentially dangerous mix of instability and volatility. I'm referring to widespread regional unrest and global terrorism, which can erupt at any time to threaten our interests and those of our allies. The threat of a nuclear arms race on the Asian subcontinent—which caught our government by surprise just last week—is a perfect case in point.

To preserve what is nonetheless a period of relative peace, the United States must continue its commitment to remain engaged throughout the world—politically, diplomatically and militarily.

Almost a year ago to this day, the Department of Defense released its Quadrennial Defense Review (QDR). The QDR provided a comprehensive review of U.S. defense requirements based on emerging threats over the next two decades, as well as a strategy to maintain our global leadership and military superiority over that time span.

This strategy comprises three main elements. First is the ability to shape the international environment by promoting regional stability. Second is the need to respond quickly to the full spectrum of crises—from conducting concurrent small-scale contingency operations to fighting and winning two major theater wars. And third is the mandate to prepare now to meet the security challenges of an unpredictable future.

The force structure tasked with executing this strategy has undergone some dramatic changes in the post Cold War era. Since 1985, the U.S. defense budget has been cut about 40 percent. As a percentage of the GNP, defense spending is at its lowest level since before World War II. The number of uniformed men and women has dropped by nearly a third, and we have shut down military bases and installations around the world. Most of the ground and air forces based overseas have been returned to the United States.

Despite that, the military is performing more missions in more places than it was during the height of the Cold War. According to one national security expert, the U.S. Navy/Marine Corps team was called upon to respond to an international crisis-response operation every 11 weeks during the Cold War. Since then, the Navy/Marine Corps team has performed a crisis-response mission about once every four weeks.

Fewer bases, fewer personnel—more assignments in more locations. Increasingly, that means our national security depends on the Navy, its global capabilities and its very real forward-deployed presence.

Reflecting the changes in the post-Soviet world, the Navy has refocused its strategy on littoral operations, shifting its emphasis from the open ocean to the world's littoral regions. Some basic missions have remained unchanged—nuclear deterrence and anti-submarine warfare, for example. But even they have been de-emphasized with the shift in focus to conventional operations near and on shore. The evolving Navy is being shaped to dominate the maritime battlespace in littoral waters and to project power into the littoral battlespace ashore.

Now, many of you may be thinking that submarines don't seem to fit into the picture I have just described. In the past that may have been the case. But today, a growing body of strategists and visionaries believe that undersea forces will have growing importance in the future—especially in littoral warfare. In this future, hostile powers will employ asymmetric responses to U.S. naval power, and will develop potent capabilities to deny non-stealthy naval forces access to their coastal waters. Using space-based surveillance, cruise and ballistic missiles, mines and modern diesel submarines, these nations will try to exact a high price from conventional naval ships approaching their shores--a price that may be much higher than the American people are will to pay.

In the future seen by these thinkers--and I happen to agree with them--stealthy undersea forces will play a very important role in suppressing these hostile *anti-Navy* capabilities--thereby enabling the conventional U.S. forces to move into the littoral with much less risk.

This will not be an easy task for the U.S. undersea force to carry out, as it will include coastal surveillance and intelligence collection; mine detection and location; anti-submarine warfare against conventional or AIP powered boats in shallow water; employment of Special Forces ashore for reconnaissance, targeting and sabotage; and precision strikes against land targets on a large scale.

To this end, we are working on a very promising concept through the conversion of Trident SSBNs into platforms for precision strike and Special Forces operations. These conversions will add needed firepower and military punch in the near future, and will be ideal platforms for joint force experimentation--that is, testing new ideas and systems for the future.

I was pleased to learn that the Senate Armed Services Committee has just directed the Secretary of Defense to study the conversion of Trident SSBNs to a SSGN configuration. This is an important first step in developing the stealthy forward echelon that future warfare in the littorals will require.

Complicating this view of the future, however, are the realities of the late 20th century domestic environment. Chief among these realities is the bipartisan consensus in this country to balance the federal budget by 2002. This will help to ensure the health of the American economy, which is really the cornerstone of our national strength and security. But it also will impose some serious fiscal constraints upon the nation's ability to implement its defense strategy.

In a way, we've got a good news, bad news situation. The good news is that our defense strategy has a rock solid requirement for the Navy--and by extension, its industrial base. The bad news is that the defense budget—as it's currently configured—doesn't support required force levels.

In fact, the Navy today is roughly the same size as the Navy just before World War I. And we're building fewer ships than we were in 1932, at the depth of the Great Depression.

The bottom line is that if our nation doesn't maintain a production rate of at least 10 ships per year, the Navy will be unable to sustain a force level of 300 warships beyond 2010. Even more worrisome is the fact that if the current build rate of five ships per year continues, our fleet will shrink to 200 ships or less. I know the notion of this nation fielding yet another hollow force is extremely unsettling to everyone in this room. And the notion of a correspondingly gutted industrial base is just as troubling.

So, given the disconnect between our strategy and the forces it requires, and the funding the nation is willing to provide, what do we do?

One obvious answer is for the DoD to get more for its money—to wring out every last bit of value out of every procurement dollar. It's easier said than done, but it is doable.

The process is acquisition reform—the effort to streamline and reduce the cost of research, development and procurement. It's encouraging to note that a great deal of progress has already been made in this area through the combined efforts of the DoD, the Navy and industry.

As a matter of fact, the DoD earlier this month honored five programs with the David Packard award for their contributions to acquisition reform. One of them—I'm very pleased to say—was the New Attack Submarine program, which was selected as the first major program to implement the integrated product and process development approach for the design and development of a complex warship.

As the first major acquisition program in the post Cold War era, the NSSN program serves as an example of how the customer—the Navy in our case—and industry can work as teammates to design and build ships that are both capable and affordable.

There are several aspects of the NSSN program that can illustrate this point, but I'll focus on just one—modernization.

The submarines we're designing will operate in the fleet for 30 years, perhaps longer. When you juxtapose that lifespan against an ever shrinking half life of technology, it becomes very clear, very quickly that the traditional approaches used to modernize ships are far too complex and far too expensive.

At Electric Boat, we have pioneered in designing our submarines for modular construction. Today, we're also designing them for modular modernization and technology insertion. In the same way that our ships are designed with weight margins, they must be designed to accommodate technology insertion routinely and affordably.

That's precisely what we're doing with the New Attack Submarine combat system, which is being optimized to take full advantage of the capabilities and savings available through the use of commercial electronics.

I'd like to spend just a moment on this because it really is an excellent way to illustrate how acquisition reform-related initiatives can provide improvements in both cost and performance.

Here's how it will work. First, the entire command and control system will be assembled and tested off-hull in a modular isolated deck structure. Within the deck structure itself, commercial-off-the-shelf equipment will be installed into standard electronic packaging racks. The fully outfitted module will then be loaded into the hull. With this approach, commercial components can be used while the required shock and acoustic isolation requirements are met. And in the future, this open architecture system can be efficiently upgraded. To top this off, the combat system of the first New Attack Submarine will go to sea with more signal processing horsepower than all the Los Angeles and Seawolf class submarines put together. And at a small faction of the development and acquisition costs of the previous classes.

That's just one great example of how the Navy/industry NSSN partnership can advance the cause of acquisition reform by developing innovative approaches that provide better ships at affordable prices.

There's another pretty exciting element to all this. Because it is the first major procurement program to define and implement the principles of acquisition reform, the New Attack Submarine program is leading the way for some of the Navy's other high priority programs—LPD-17, the Advanced Amphibious Assault Vehicle and the DD-21, the next generation destroyer that is being designed for land-attack missions. In a very real way, we are now establishing a benchmark for military procurement programs in the next century.

Let me emphasize the importance of affordability. If we in industry can't deliver new submarines at a price that fits within the Navy's fixed budget, the Navy will be unable to acquire the submarines required for the future—that is 10 or 20 years from now when the SSN 688 ships go out of service in large numbers.

As I have mentioned, we are committed to making the New Attack Submarine both capable and affordable. And I believe we have done well, especially at the low rates of production we are faced with. More needs to be done but we can't do it by ourselves.

A major element of affordability is stability, that is, a stable and predictable production rate. We proved that with the Trident program, where the 18th and last ship was built with 50 percent of the labor hours required for the first ship of the class. We need that kind of stability if we're going to drive more costs out of the New Attack Submarine program, and build the number of ships that the Navy needs.

With long term savings in mind, we are recommending that the Navy follow the contract for the first four New Attack Submarine with a multi-year procurement of five submarines over the four year period of fiscal years 2003 though 2006.

The purchasing and construction economies of this *multi-year* would give the Navy five ships for the price of four and a half or less—that's not small change.

I'm hopeful that the Navy, and ultimately Congress, will take advantage of the savings offered by a stable, multi-year acquisition of New Attack Submarines. With advanced procurement starting just two budget years from now, it's not too early to consider this approach. And it's in block purchasing that the really big savings are achieved.

Acquisition reform is obviously key to the effort to provide the armed services with the most effective equipment we can field. But there is another critical factor in this equation. And that concerns how the DoD spends the money it has.

While military spending has fallen for the last 12 years, the fact remains that the nation still spends a quarter trillion dollars for defense. That really should be enough to meet our worldwide responsibilities during a period of generally diminished international tensions.

The problem is this: only about one dollar is six is spent on modernization. One defense analyst claims that Americans actually spend more each year on beer and cigarettes than they do on equipping the military for the next century.

That brings us face to face with a remarkable paradox—an organization with a budget of a quarter trillion dollars that struggles to provide its employees with the latest tools they need to do their jobs. It's worth underscoring the fact that the jobs our servicemen and women perform entail risk to life and limb in the defense of our nation.

Right now, the DoD is spending substantial sums of money to perform health care, maintenance, data processing and many other functions that could be purchased less expensively from the private sector.

Top corporations—I'll include General Dynamics among them—have realized savings of up to 30 percent when they outsource non-core functions.

If the DoD realized similar savings on just half of the internal services it performs, it could free up more than $10 billion—enough to offset current funding shortfalls for weapons modernization.

There's another—much more politically volatile—avenue to take. That involves base closures.

Despite four rounds of base closings, the downsizing of the Defense infrastructure has not kept pace with the downsizing of the force structure. While force structure has come down by about a third, domestic infrastructure has decreased by only 21 percent. If our military is progressing toward the next century, their supporting infrastructure remains rooted in the past.

But base closure is a very tough political issue, particularly in an election year. Just a couple of weeks ago, after Defense Secretary Cohen described base closure as the only way to free up money for modernization, the Senate Armed Service Committee voted against two rounds of BRAC in 2001 and 2005. It's pretty clear that Congress has no taste for that kind of action—at least not this year.

There's another side to the base closure issue—and that is to prevent the process from diminishing capabilities and resources that are essential national security. Believe me, I'm not saying that for parochial reasons.

I'm thinking specifically of the Northeast region, which really is the undisputed seat of submarine technology for the nation. Within a fairly compact geographical area is the Portsmouth Naval Shipyard, the Naval Undersea Warfare Center, the Sub Base and Electric Boat. The capabilities represented by these organizations pretty much cover the full spectrum of the nuclear submarine world.

As these organizations have grown independently, however, they have not realized the level of synergy that can be attained among themselves.

We've got to start right now—not when additional base closings are authorized—to define how we can best leverage our strengths to provide a coordinated regional center for submarine research, engineering, construction, maintenance and refueling.

We've got to take advantage of the tremendous pool of talent we have available and creatively apply it to keep this long tradition of submarine excellence alive. A small but significant example of this kind of approach is in the use of Electric Boat employees to perform surge maintenance work at the Sub Base, and planning work at the Portsmouth Yard.

Both the public and private sides of the submarine community are under enormous pressure. At Electric Boat, we're four years into an extremely intensive re-engineering program, working relentlessly to keep the business going at an absolute minimal level of work. If you want to know just how low that level is, consider this—there are right now fewer than 2500 people in the United States engaged in submarine construction.

At the beginning of my remarks, I said I would describe what you can do to support the Navy's piece of the nation's defense strategy, its modernization plan, and industry's role in implementing that plan.

More than anything else, I would urge you to help shape the debate by avoiding complacency, by emphasizing the relevance and utility of submarines in the current defense environment, by understanding just how fragile the submarine industry is today. When the Navy and its Submarine Force are needed to deter an aggressor or win future battles, ships and sailors must be on scene and ready to fight. A capable Navy can't be built on a *just in time* basis. And if the 21st century should bring widespread peace and tranquility, the defense insurance our armed forces provide will have been worth the cost.

The Navy and the submarine community are telling their story better than ever—but it's got to be told better still. So I urge you to get out and bend a few ears. If ever a cause was worth the effort, this is it.■

DOLPHIN SCHOLARSHIP FOUNDATION

The 1999 Dolphin Cartoon Calendars are now available! The talent and humor displayed in this issue highlight aspects of submarine life ranging from modified exercise programs to the many different faces of a submariner.

As always, proceeds from calendar sales benefit the 102 sons and daughters of current and former submariners and support personnel who have been selected as Dolphin Scholars. Currently, the Dolphin Scholarship Foundation (DSF) provides a total of $306,000 in annual assistance to these bright and talented students.

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NEWPORT NEWS
SHIPBUILDING

THE ALL ELECTRIC SHIP: ENABLING REVOLUTIONARY CHANGES IN NAVAL WARFARE

by Robert E. Leonard
and Thomas B. Dade
Newport News Shipbuilding

Periodically a critical enabling technology is developed that truly revolutionizes a product. In the area of naval ship propulsion, gas turbines and nuclear power come to mind. The all electric ship including electric propulsion is such a technology as well. It represents the enabling technology for the next revolution in naval warfare. Some of the key benefits of an all electric ship include:

- Enables a revolution in warfighting capability
- Increased survivability through flexible power apportionment
- Retention of unrivaled acoustic stealth
- Superior technological growth potential
- Lower total fleet life cycle costs

A brief discussion on each of these benefits follows:

Enables Revolutionary Warfighting Capability. Current steam turbine, gas turbine and diesel propulsion systems require that a significant amount of power be dedicated to propulsion. With electric propulsion all of the available energy from the reactor plant, gas turbines or diesels is converted to electric power that can be apportioned between propulsion and other applications to best meet the ship's needs. The opportunity exists to direct the unused propulsion power for concepts such as high power weapons, sensors, and other future systems.

- Weapons
  - lasers to target and destroy enemy weapons and aircraft
  - microwave bursts to disable electronics
  - acoustic shock waves to destroy mines, torpedoes and other underwater weapons

- electromagnetic launch for increased capacity and range
- Sensors
  - high power active sonar systems could increase detection ranges
  - high power radar systems
- Future Systems
  - improved degaussing system
  - thrusters for improved low speed maneuvering
  - multiple autonomous vehicles could be readily *recharged* in situ

Many more warfighting system concepts could probably be added to this list today. Even more would be developed in the future once programs are established to take advantage of the additional available power.

Increased Survivability Through Flexible Power Apportionment. Survivability of an all electric ship will be greatly improved by allowing power to be applied where, when, and how it is needed. The power could be applied to offensive weapons, defensive weapons and countermeasures, or put into propulsion for a fast getaway. An all-electric ship also enables a distribution architecture that can be reconfigured around damage zones and an integrated system design that can provide propulsion power from multiple sources. Finally, it provides the ability to rapidly deploy, especially for nuclear submarines and aircraft carriers, by using the diesel generators to supply power until the nuclear reactor is brought on-line. This capability could be designed into future submarines and aircraft carriers. This increased flexibility will greatly improve survivability and warfighting capability.

Retention of Unrivaled Acoustic Stealth. Acoustic stealth has always been important for submarines and is becoming increasingly more important for surface ships for several reasons:

- acoustic mines and acoustic homing torpedoes are inexpensive and readily available on the open market
- reduces detectability by the enemy
- improves surface ship and submarine detection ranges by reducing own ship noise

The all-electric ship, and in particular the electric propulsion system, enables significant improvements in acoustic stealth. The primary signature for surface ships and submarines at high speeds has always been the noise created by the propeller. Reducing the RPM of the propeller has been shown to reduce propeller noise. Unfortunately, the Navy is reaching a point where the existing gear driven propulsion systems can no longer handle the high torque associated with lower RPMs without significantly impacting the ship. Their cost, size and weight are becoming prohibitive. The recent improvements in permanent magnet motors and solid state electronics technology now offer the opportunity to achieve significantly higher torque levels in a package small and light enough to meet the most demanding Navy applications.

Superior Technology Growth. Today's electronics, weapons systems and auxiliaries rely more and more on electric power. An all electric ship would provide the basic architecture to accommodate future technology growth much more readily than a conventional mechanical drive ship. In addition, technology being developed under Navy programs such as Power Electronics Building Blocks (PEBBs), superconducting motors, and direct energy conversion could be inserted into to an all electric ship.

Prospect for Lower Fleet Life Cycle Costs. Lower fleet life cycle costs are likely with an all electric ship for several reasons:

- Fuel Economy. A ship's fuel costs are dominated by the propulsion plant. The key to improved propulsion efficiency is the ability to operate at the maximum efficiency point for each component in the system. This is not possible with more conventional propulsion systems due to the inability to optimize efficiency over the full range of operating speeds. Electric propulsion enables each component (turbine generator, motor, motor controllers) to be loaded at its maximum efficiency point. A detailed examination of one naval ship application showed a 2 percent to 28 percent improvement in efficiency over the ship's operating profile. This improvement was achieved through specific system design features (such as modular motor and motor controller module design) and an efficient plant operating line up. As illustrated in Figure 1, using the most efficient plant operating line-up (enhanced control) results in significant improvement in efficiency below 50 percent power. The typical operational profile for Navy vessels indicates that a majority of their cruising time is at speeds below 50 percent power. The fuel cost savings associated with this efficiency improvement could be large.

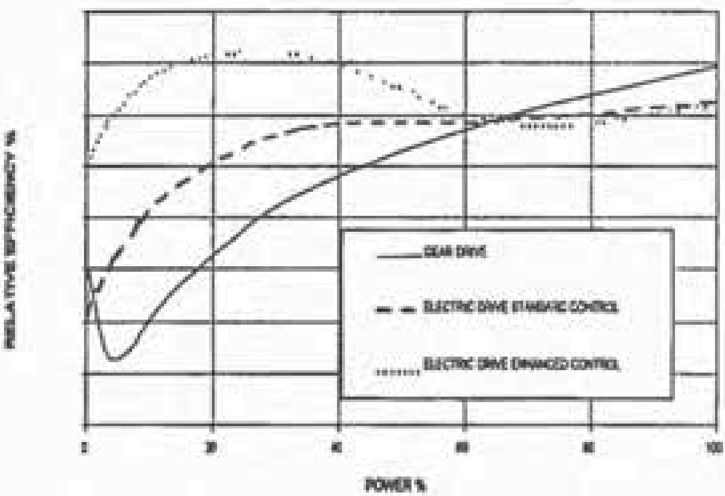

Figure 1: Relative Electric Propulsion Efficiency verses Power

- Reliability and Maintainability. The move to an all electric ship will reduce and in some cases eliminate the current steam, hydraulic, and high pressure air systems that tend to be high maintenance systems. In addition, one of the most avid supporters of an all electric ship has been the cruise ship industry. One reason for this support is the high reliability and low maintenance associated with an all electric ship and in particular electric drive.
- Operation and Arrangement Flexibility. Operationally, electric propulsion can be readily adapted to automation and monitoring. This can directly translate into reduced

operating costs through reduced manning. Arrangement flexibility enables ship designers to design more efficient systems. For example, future surface ship propulsion system designs, such as podded propulsion, could enable more efficient hull forms and propulsors by eliminating the shafting and related design constraints.

- Commonality. Use of common components throughout the Navy has the potential to drive the largest cost savings associated with an all electric ship. In addition to combat systems, communications, and other electronics being standardized across the Navy, the propulsion and electrical distribution systems could also be standardized. This standardization, or commonality, has the potential to significantly reduce acquisition, supply support, maintenance, and training costs. A more detailed discussion on the commonality approach is included in a later section of this paper.

To validate the lower total life cycle costs one can look at the commercial shipping industry. Cruise ships, shuttle tankers, and cable laying ships are good examples. Taking cruise ships as an example, many of the advantages discussed above are the very reason they have all gone to electric propulsion:

- Fuel Efficiency. Cruise ships spend a large amount of time at low speeds and have high non-propulsion loads, similar to Navy ships. The improved efficiency results in lower costs and higher profits.
- Reliability and Maintainability. The cruise industry only makes money when they can carry passengers. Low reliability and high maintenance are unacceptable.
- Operational and Arrangement Flexibility. Arrangement flexibility allows the ship designers to develop designs that maximize passenger capacity and overall ship efficiency. Carnival Cruise Lines recently put into service the ELATION, which uses podded propulsion to improve efficiency and lower fuel costs.
- Commonality. The cruise industry has moved to larger classes of ships using common components to reduce acquisition, maintenance and training costs.

Electric Propulsion—Enabler for the All Electric Ship

The primary impediment to an all electric ship has been the electric propulsion system. The Navy has installed electric propulsion systems on both submarines and surface ships in the past. Unfortunately, neither these systems nor the current commercial systems in use today possess the power density and acoustic quieting necessary for current or future Navy applications. Industry has, and continues to invest in permanent magnet motor and solid state electronics technology development and application. This investment has focused on both Navy and commercial applications. The result is a promising technology capable of meeting the rigorous demands of the US Navy. What remains to be done is the engineering and business analysis necessary to achieve commonality and the performance potential of each Navy platform.

Beginning in 1987, Newport News Shipbuilding (NNS), industry and the Navy embarked on studies for future electric propulsion systems and components. The results of these studies concluded that traditional motors did not offer the performance and power density required for Navy applications. Permanent magnet motors and solid state electronics offered the potential to overcome these obstacles. In 1992 Newport News Shipbuilding embarked on a program to develop and test a 3000HP permanent magnet motor. At the time it was the largest permanent magnet motor in the world. The results of this testing demonstrated that permanent magnet motors offer the performance and power density needed for Navy applications.

Electric Propulsion—Component Technology Advances

Recent advancements in permanent magnet motors and solid state electronics technology provide the technology needed for Navy applications. These advancements, driven by commercial industry, can be leveraged to reduce Navy development costs.

Permanent Magnet Motors and Motor Control Modules. Permanent Magnet (PM) motors, and the solid state switching devices used to control them, are what make electric propulsion so attractive for Navy applications. They offer the Navy power density, performance, reliability, maintainability and affordability. Two market factors have brought PM motors to the forefront for propulsion applications:

(1) improvement in permanent magnet technology resulting in their widespread use by industry has significantly reduced their cost, and

(2) commercial market development of solid state power electronics equipment has significantly improved the switching frequencies and power density needed to support PM propulsion motors

The power density of PM motors far exceeds other motor types. For example, for a given torque and horsepower an electric propulsion system incorporating PM motors could be up to five times smaller by volume than systems in use today. Figure 2 illustrates the relative sizes of PM, wound synchronous, and induction motors for a given torque and horsepower. PM motors also offer the flexibility to modify the motor and solid state controls to support quiet applications while maintaining common structural components and manufacturing methods with less quiet versions. For example, changes to magnet orientation and shape combined with improved control system algorithms and filtering of the input electrical waveform can improve the acoustic performance without affecting the basic motor and motor control module design. Reliability of PM motors is expected to be higher than other motor types. Use of permanent magnets on the rotor essentially make the rotor inert. This eliminates the types of faults that can occur on wound rotor machines.

Use of a modular design, not possible with conventional motor configurations, is the biggest advantage of the PM motor and motor control modules. Figure 3 is a completely modular design concept developed by Newport News Shipbuilding, Kaman Electromagnetics Corporation, and Northrop Grumman Marine Systems for common application across Navy platforms. Modularity enhances the ability to use components across Navy platforms. The smaller the module, or *building block*, the more likely it can be designed to meet multiple applications. Commonality across platforms could significantly reduce overall life cycle costs. In addition, a modular design incorporating removable stator modules, motor control modules and permanent magnets allows in place repair without costly hull cuts. Motor stator modules could also make the motor more fault tolerant. It is conceivable that each module is a motor in itself, a fault in one module will not significantly reduce the propulsion capability of the ship. In addition, due to the motor's sealed design it would require no scheduled maintenance (with the exception of sleeved bearings, if used) over the life of the ship. This design philosophy will significantly increase the reliability and reduce the maintainability and total life cycle cost of the system.

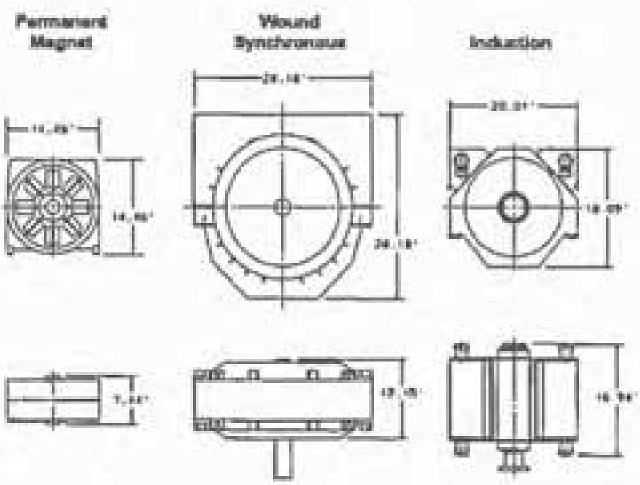

Figure 2: Propulsion Motors Sized for Comparable Torque and Horsepower

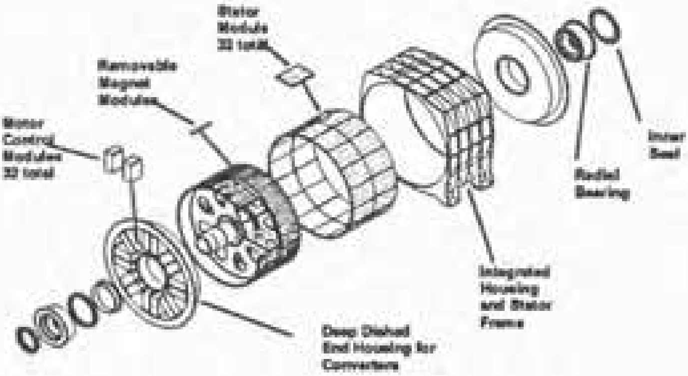

Figure 3. Modular Design Permanent Magnet Propulsion Motor

Acquisition cost is another key advantage of PM motors, especially when employing a modular design. By designing the motor with removable stator modules and magnets, the stator modules and magnets can be manufactured, assembled, and tested using the same facilities as existing commercial motors. The stators and magnets would then be assembled into the rotor and housing at any facility capable of fabricating the rotor and housing (existing propulsion gear manufacturers for example). All of this results in reduced labor, both in total and in specialization, which should eventually make the acquisition cost of PM motors less than any other motor type.

Electrical Distribution. The same advances in solid state electronics that went into the motor control modules also apply to the Ship Service Inverter Modules (SSIMs). SSIMs would be used in DC electrical distribution systems envisioned for future submarines, aircraft carriers, and surface ships. The SSIMs act as the intermediary between the distribution system and components. Given a DC distribution voltage, the SSIM converts this voltage to the appropriate DC or AC input needed for each component. They also enable the use of variable speed motors, which can improve overall system efficiency and acoustics.

Electric Propulsion—Work Remaining

Permanent magnet motor and solid state electronics technology has been demonstrated. What remains to be done is the engineering to achieve the full benefits of electric propulsion. Areas such as integration, commonality, and scaling all require further engineering development. A detailed discussion of each area follows:

Integration. How the motor, motor control modules and other electric propulsion components are sized and mounted will play a big part in the ultimate cost and performance of the system. For example, achieving the acoustic performance required for submarine applications increases cost. Finding a method to achieve submarine acoustic requirements without excessive increases in component costs is critical to achieving commonality between submarines, aircraft carriers, and surface ships.

Commonality. Electric propulsion offers the unique opportunity to apply common technology and components across the fleet. One approach to achieve this commonality is to develop a family of motors based on a common motor diameter (diameter is the driving cost associated with motor design and factory tooling) and then vary the length of the motor to achieve the specific torque, RPM, and horsepower requirements of the platform. It is possible that the NSSN, DD21, and all future surface ships can utilize the commonality approach. Lower horsepower auxiliary ships may require another family of motors to cost effectively meet their powering requirements.

The costs to bring electric propulsion to the fleet will be significant. Application of common electric propulsion components allows amortization of these costs over a wider customer base. Commonality also provides a more robust and stable acquisition program, which should result in lower acquisition costs. Probably the largest cost savings will result from the use of common spare parts, training, and maintenance requirements.

Due to the differences in prime mover RPM the common component development should focus on the propulsion motor, motor control modules and ship service inverter modules. Use of common propulsion and ship service distribution equipment across the Navy fleet has the promise of significant cost savings in logistics, operation and future technology improvements.

Scaling. Tools to predict the ultimate performance (acoustic, mechanical and electromagnetic) of electric propulsion components and systems continue to be developed. Validation of these tools cannot be accomplished until testing at full scale is accomplished. This is another area where a modular design supports affordable development. By designing the motor stator in modules (each powered by its own motor control module) and using removable magnets it is possible to test at full scale many critical performance parameters without constructing a complete motor assembly. Demonstration of acoustic (electromagnetic source levels), mechanical (thermal performance, shock), and electromagnet (torque) performance can be accomplished prior to embarking on full-scale manufacture. This significantly reduces the risk of going to full scale.

How Do We Get There?

The benefits of an all electric ship are clear. The technology hurdle associated with electric propulsion is within reach. What is needed now is the urgency, commitment and resources to ensure upcoming major acquisition programs such as DD21, future surface ships and a future NSSN can reap the benefits of an all electric ship. With adequate commitment and resources an electric propulsion system could be demonstrated and delivered within 6 to 8 years. Obtaining the resources needed to make it happen will require a clear set of goals and objectives to focus the Navy S&T, R&D, and acquisition communities. By focusing resources the advantages offered by an all electric ship can be achieved.

Summary

An all-electric ship has the potential to improve capability, reliability, expandability and affordability compared to other propulsion systems currently under consideration by the Navy. We must remember that ships being delivered today will be in the fleet for 30-50 years. It is essential they be delivered with the flexibility to adapt to the changing threats over their lifetime.

Electric propulsion is the key enabler for an all electric ship. A commonality approach will reduce development, acquisition, and total life cycle costs.

Now is the time to commit to the future. The rewards are high, the risks manageable, and all major Navy platforms can benefit.■

LOOKING FORWARD–SUBMARINES IN 2050
Part Two

by Joseph J. Buff

Editor's Note: The July 1998 issue of ***THE SUBMARINE REVIEW*** *introduced the concept of using a novelist's approach to the future, a la Jules Verne, to examine potential innovations to the technology and operation of America's submarines. A time frame for that conjecture was chosen far enough in the future to avoid issue with current programs and developments, but not so far as to be beyond concern. Mr. Buff, a professional writer, has used all unclassified, public sources as the basis for his extrapolations of* what-is *to* what-could-be.

Basic Physical Configuration

Submarines have come a long way from the shark-shaped bows, anti-fouling cables, and *cigarette decks* of World War Two. It's possible their basic physical configuration will continue to evolve in the future.

For openers, consider the idea of a *retractable* sail. A sail is in part a support for the periscope tube, and in part a platform from which to conn the ship while on the surface, with adequate visibility and protection from waves and spray. But with non-hull-penetrating periscopes (NPP) delivering electronic images on a TV screen, there is no longer a need for a direct optical path from the periscope objective down into the control room. Furthermore, while submerged there is no need for that protruding platform used just to maneuver on the surface. Thus, the sail could be moved to a different part of the hull and be designed to retract downward into a *well* along the boat's centerline. (Of course, some current submarine designs have fairwater planes mounted on the sail, but those could be moved to the bow instead.) What benefits might this arrangement provide?

1. Elimination of sloshing of seawater down into the control room when in heavy weather (which, admittedly, adds drama in old war movies, but can't be very good for equipment life or crew health and morale). On the other hand, though, there's something to be said for the CO and OOD being able

to shout through an open hatch right down into the control room, and then slide down the ladder to assume their submerged battle stations in a split second when preparing to dive.

2. Reduction of drag, of flow noise, and of wake extent and turbulence. The speed advantage of a retractable sail is probably minimal, but reduction of wake turbulence could be important to stealth, especially when near the surface.
3. Improved operating capabilities when running shallow. In particular, a retractable sail could give a FSSN (defined as *Future SSN* in Part 1 of this article) in the littoral zone another 20 feet or more of *headroom* in which to carry out its mission. (Of course, special steps would be needed to assure adequate separation between the periscope objective and the main hull while the periscope is in use, such as a longer mast made of high strength materials.)
4. Reduction of radar cross section when launching or retrieving rubber boats carrying SEALs, Marine landing parties, and other special operations forces. (See below for an idea on futuristic swimmer delivery vehicles.)
5. Reduction of active (and ambient) sonar cross section. The sail stands out like a *billboard* when insonified from abeam, relative to the specular reflection from the rounded hull. At some disadvantageous aspects, such as when well separated horizontally from a surface craft one is approaching or fleeing, because of the angles involved, the front, or leading edge, of the sail can significantly increase a submarine's Doppler signature as well.

The ideal physical arrangement of stations in the control room has been a subject of active study. Crewmembers with varying responsibilities need to interact and communicate rapidly during tense combat situations. Having separate compartments for sonar, weapons, and communications might interfere with this free flow of information and impair *group situational awareness*. This might be solved through a *duplex control room layout*, with a ladder-equipped balcony or mezzanine level above a conventional *main level* control room. This exploits three-dimensional packing to improve instantaneous human interconnectivity. Instead of speaking over intercom circuits or walking from one compartment to another, team members could speak directly and be in direct line of sight.

If diving depth is to increase substantially, then reducing the length of pipe runs that carry ambient high pressure seawater becomes more critical than ever. This has been receiving special attention since SUBSAFE in the 1960s, and will surely continue to do so. It can probably be anticipated, as we enter more and more an age of advanced *designer materials*, that substances will be developed to create cylindrical structures resistant to great pressure from the inside (i.e., pipes), as a necessary complement to building structures able to resist high pressure from the outside (i.e., hulls). *Different* designer materials might be optimized for these two *different* engineering challenges. (In fact, a material that's strong against compression but gives against tension would be ideal for deep diving torpedo warhead casings.)

Additional use of conformal wet and dry hangars, fitting within the basic teardrop hull shape, can also be expected in future submarine design, as an alternative to add-on external hangars or retrofitted pseudo-streamlined bulges. (The suggestion of adapting the missile compartment of *retired* boomers for this purpose is really the same idea.) This would reduce flow resistance, flow noise, wake turbulence, and active sonar cross section. There could be other advantages as well: a) the sub would be made more stable by removing substantial weight and water resistance from a point a relatively large distance from the longitudinal axis, b) equipment in a conformal hangar may be less exposed to damage by near misses from enemy fire, and c) add-on hangars and equipment containers tend to be highly conspicuous when in port and while egressing harbors, potentially reducing the security of operations by subs specially adapted in this manner.

Control Surfaces and Maneuvering Thrusters

A potentially useful design variation would be to alter an X-stern in a *box-stern*, with a <> shape, where the control surfaces intersect at their edges instead of in the middle. X-sterns give greater maneuverability than the traditional +-shaped rudder and stern-planes arrangement, and also give some redundancy in case of a partial failure among the control surface actuating systems. A box stern instead, with surfaces still 45 degrees off the horizontal like an X-stern, would form a cowling or enclosure around the screw propeller or jet orifice. This would reduce the sub's total emitted noise signature except from directly astern. Since the control surface now lie outside the propulsor's wash, instead of right in the middle of it, overall wake turbulence energy is more diffused.

Another useful feature might be an expansion of the concept of *auxiliary maneuvering thrusters* now deployed at the bow of some subs for use near the dock. Thrusters, perhaps miniature electric-powered pump jets, could be designed-in to provide both horizontal and *vertical* control at both bow and stern (where turning moments are greatest). These could supplement existing control surfaces and trim tank adjustments, enhancing maneuverability during underwater sub-on-sub dogfights or while cruising in the littoral zone, especially with respect to more reliable *depth keeping* in shallow waters. Such thrusters could also *substitute* for bow planes and X- or Y- or other type sterns when moving at dead slow speeds, or when main engines are stopped to drift stealthily with the current through a strait or along a beach. Furthermore, they might compensate for a possible loss of effectiveness of a box stern at low speeds, since the box stern's control surfaces, as mentioned above, would lie outside the immediate area of the propulsor wash.

And with such thrusters in place, why not consider retractable bow planes? Like the sail, they produce a strong echo from some aspect angles and contribute to flow noise and wake turbulence. Bow planes in some submarines are now already designed to be rigged in, for surfacing under the polar ice cap. Why not extend the concept further?

Connectivity

The ability for a submerged submarine to communicate with other friendly forces and national command authorities, and preferably communicate in both directions, will undoubtedly remain an area of active research for some time to come. This maintenance of connectivity becomes more difficult as a sub dives deeper, and as ASW detection measures make it more dangerous to come back up to VLF or lidar depth or launch a delayed radio or light-beam laser buoy. A variant on a couple of traditional ideas, gertrude (underwater telephone) and sofar (explosive charges signaling in the Deep Sound channel) might be helpful. This hybrid idea is to communicate acoustically, two way, covertly and potentially over thousands of miles, by *disguising messages in imitation of natural underwater sounds*.

Over long range, an SSBN might receive emergency action messages that imitate interocean whale dialogue but are in fact specifically designed packets of data, presumably themselves in encrypted form. Similarly, over tactical ranges, a carrier battle-group might give seaspace management orders to its accompanying attack subs, or issue updated targeting details to an advance-deployed SSGN for an SLCM launch, said communications being mistaken by any hostile third party for just a bunch of random shrimp clicks. Finally, a swimmer delivery vehicle might home-in after a mission on the boat that dropped it off by exchanging noises that sound to anyone listening like a baby dolphin and its mother calling each other. If such underwater connectivity were perfected, more range and flexibility would also result for the control of UUVs.

Special signal processors would need to be developed, to encode information and conversation for transmission and then for reception pass ambient noise through waveform structure *filters* to see if any genuine messages are present. Presumably these messages would be packaged in (highly classified) prearranged formats as to frequency spectrum and pseudo-random time distribution, in order for this means of communication to be reliable as well as stealthy.

Future Propulsion Plants

Ever since TURTLE went to sea and to war in 1776, submarines have been limited by the capabilities of their propulsion plants. One significant issue in future nuclear submarine design, which also impacts on tactical employment, is that of reactor cooling.

Although they have disadvantages, liquid-metal-cooled fission reactors might have certain advantages over water cooled ones. Because liquid sodium is a much more efficient absorber and transmitter of heat, liquid metal reactors run at core temperatures substantially lower than those of water-cooled plants. This could permit *quieter cooling systems*, and might also bring a nuclear sub closer to being able to *hover or even sit on the bottom*, at least for a brief period. It's conceivable that advanced materials might eventually be designed to safely carry waste heat away from the core, when operating at minimal output levels with a stationary boat, and deliver that heat to the outer hull of the reactor compartment. There, it would be removed from the submarine by natural convection into the surrounding sea, all without critical components of the reactor room overheating in the process. Since seawater gets colder with depth, leveling off at 39 degrees several thousand feet down, deeper operations would aid such hovering and bottoming tactics.

Another quite futuristic concept that could have great utility for nuclear submarines is *fusion power*. A fusion reactor might have some real advantages over a fission reactor:

1. In one promising type of design, the hydrogen fusion reaction takes place in a small frozen fuel pellet which is heated and compressed by powerful lasers. The main waste products of the fusion reaction are energetic neutrons, which deliver the heat output, and minute quantities of helium, which can readily be vented from the boat. If power to the firing lasers is cut, no further heat is generated. In contrast, due to radioactive decay of fission products, a uranium reactor continues to create significant heat even after having been scrammed. Thus a fusion reactor would be even safer to operate than current U.S. naval fission reactors.
2. When the fusion boat is eventually retired, the amount of equipment with residual radiation may be comparable to that of a fission boat, but there is no waste *core* of potentially dangerous radioisotopes like in a uranium reactor, which leaves behind tons of long-half-life toxins like plutonium or cesium-137. Thus fusion plants are more ecologically friendly.
3. Since a fusion plant generates no new heat once stopped, it would be much easier to design a sub capable of hovering or bottoming at will. This would obviously grant significant tactical advantages both in shallow seas and out in blue water.
4. Since the heat from a fusion reactor radiates outward from

a point source rather than occupying a physically extended core, fusion plants may be ideally suited to thermionic or thermoelectric (thermocouple) generation of electricity. That wattage could in turn be connected to advanced permanent-magnet (even superconductor) electric drive motors, maybe coupled directly to the main drive shaft. Such methods would be much quieter than existing power trains, with their stream turbines and reduction gears.

5. Hydrogen is available in profusion by electrolysis of seawater, and some fusion reactor designs may not even require the separation of the deuterium and tritium *heavy* isotopes. This being the case, a fusion powered nuclear submarine could literally gather its own fuel while it cruises in the deep! (Uranium also could be extracted from the sea, but would then need specialized processing into fuel elements which would have to be introduced into the *hot* reactor core while underway.)
6. Uranium reactors, when shut down, temporarily generate *fission poisons* that can effect restarting during a window between about one-half hour and ten or so hours later. Fusion reactors do not have this problem. Again, greater tactical flexibility is obtained.

A design disadvantage of fusion reactors is the need for an electrical *boost* to start up the firing lasers. This might be accomplished via a *ultra-high-specific-amperage battery*. It can be expected that in the future batteries will be able to store more and more electricity with less and less of a weight and volume penalty. That being the case, one can also look forward to solving the *fission poison* problem just mentioned for a uranium boat, by running a fission-powered submarine on batteries until the reactor can be restarted. (This is another potential argument in favor of electric drive.)

Now let's consider the other end of the propulsion plant. One aspect of terrain avoidance in high speed nap of seafloor tactics, and of aggressive submarine maneuvering in general, is the need for strong backing power. This argues for a screw (or pump jet power turbine) with controllable and reversible pitch. This would create immediate reverse thrust without even needing to change the direction of the main drive shaft's rotation, let alone stop and then engage an auxiliary backing turbine. Eventually such pitch control machinery, like that now used on gas-turbine-powered surface craft, might be able to withstand the pressure near the ocean bottom. Such a boat would then be able to brake very quickly, and when also equipped with a full suite of auxiliary thrusters could negotiate some very tight clearances among navigation obstacles wherever found.

The Nuclear Sub as Mother Ship

Given the seemingly never-ending debate on the relative merits of nuclear power vice alternatives like diesel boats or air independent propulsion (AIP), it's useful to write down a *Fundamental Propulsion-Type Equation* as follows:

FSSN + Battery-powered mini-combatants = Diesel/AIP + better speed, endurance, stealth and survivability

By minicombatants we mean *battery-powered combatant minisubs* designed to be carried by and deployed from nuclear attack submarines or SSGNs equipped with conformal hangars. The equation has a simple meaning: the FSSN provides fast transit times with unlimited endurance *plus* infinite recharging and air/water capacity for the ultra quiet minis. These minis can reach as far into the littoral zone as one might need to go, yet they can readily return to the mother ship out in deep water for a crew rotation, mutual updating of intelligence, and reloading of weapons. Light torpedoes, and smart mines, might be carried by the minis for use against small patrol craft or merchant shipping likely to be encountered near enemy coasts, stored until needed in a magazine in the parent boat. In fact, the *hard docking rendezvous* should take place while submerged, for greater security and survivability. Ongoing high intensity littoral domination is thereby facilitated. Under*water* replenishing, anyone?

Locally based diesel and AIP boats might also benefit by support from an FSSN or adapted FSSBN, recreating the old idea of the *milch cow*, except again with underwater replenishment now possible from a much more survivable *cow*. An electrically powered chemical plant in the nuclear sub can create an unlimited supply of oxygen, hydrogen, and hydrogen peroxide (which is

H2O2), directly from seawater. Reserves of diesel fuel and other consumables could be carried as well. The present writer has some bias, though, toward the purely battery powered minisubs. This is because oxygen, hydrogen, and hydrogen peroxide are all extremely hazardous materials. Pure oxygen systems are dangerous enough without the need to supply large quantities to Sterling cycle or fuel cell submarines. In addition, diesel and some AIP boats have noisy power plants, and basing them in forward areas near anticipated conflict zones can compromise security and invite a preemptive strike before they even put to sea. Of course, transfer of electricity from the mother ship to the batteries in the minisubs is tricky when surrounded by highly conductive seawater, but waterproof and pressure-proof electrical couplings do not seem an impossibility.

The future nuclear submarine would also act as a mother ship for *future swimmer delivery vehicles* (FSDVs). Recent development of robotic mechanical tuna, which actually move through the sea using the same swimming motions as the real fish do, suggests a SDV design that, like the secure gertrude suggested above, also hides in plain sight, disguised as part of the ambient ocean background. SDVs could be constructed as one-man vehicles that, from the outside, look and act (and sound) like sharks, dolphins, or smaller whales. The vehicle body would need to be large enough to accommodate the battery, operating controls and machinery, and the swimmer and personal gear. Presumably depth capabilities would be limited, as would endurance. Such FSDVs , resembling species endemic to the operational theater at the relevant time of year, thus able to fool sensors and lookouts alike, could penetrate even the most secure enemy harbor installations, cable landing sites, or other high value objectives.

Conclusion

This article has sought to trigger some additional useful thought about future nuclear submarine development, while also arguing that these expensive assets of necessity will remain indispensable parts of the United States' national defense. Acting as superstealthy mother ships for minis, and as the ideal milch cows for diesel or AIP boats, they'll provide a force rapidly and irresistibly to dominate any shallow water area in the world. Purpose-built and ordnance-laden strike subs will support the land battle far beyond the beaches. Strategic missile boats optimized for hiding, and attack subs optimized to eliminate the opposition's vessels both surface and submerged, will eventually make the entire ocean and all its nature boundaries part of their domain. Using, to their tactical advantage, both bottom topography and *every* acoustic and visual characteristic of the underwater medium, SSBNs will form the ultimate survivable deterrent, and SSNs will protect more capably than ever those global sea lanes critical to *any* prolonged future cross-ocean military conflict. Aggressor, rogue, or terrorist attack submarines, no matter how propelled, will be intercepted and destroyed far from our home waters. Connectivity and covertness will be enhanced greatly, as oceanography and engineering work together to let naval submarines and special operations forces deploy and communicate at will, indistinguishable from the ambient background of the sea, and in the very face of the enemy.

Since, at any point in the decades to come, there will certainly be other nations with the hard cash and the will to build, buy, or rent this sophisticated weaponry themselves, we neglect continued funding for research and construction at our peril.

But in ending let us be optimistic. Some day we may have submarines that refuel and even re-victual right from the very waters around them, trolling or skeining for the abundant nutritious life-forms there to feed the courageous men of their crews. This would extend submerged endurance until the only limit still remaining is the power of human determination, giving ever *deeper* meaning to the phrase, "Forward...*from* the sea."■

NAVAL SUBMARINE LEAGUE

APRIL 1990: INVENTOR-BUILDER JOHN P. HOLLAND DELIVERS FIRST U.S. SUBMARINE
Part Two

by John Merrill

Mr. Merrill retired from a long and distinguished career at the New London Division of the Naval Undersea Warfare Center. He currently writes historical works involving that lab and its accomplishments.

*Part I of this article appeared in the July 1998 issue of **THE SUBMARINE REVIEW**. In Part I, Mr. Merrill presented Holland's early work and the events leading to the building and testing of HOLLAND VI.*

HOLLAND VI

Early on, Holland perceived the problems related to building PLUNGER and the growing conflicts with the Navy's oversight. With difficulty, private financial support (a gift by Mrs. Isaac Lawrence of New York) was found for construction of Holland's sixth submarine in parallel with the ongoing construction of the Navy-sponsored PLUNGER. It turned out that the new submarine HOLLAND VI was launched in May 1897, several months ahead of PLUNGER.

Not without difficulties and several near tragedies, HOLLAND VI became a reality and was the first underwater craft successfully to combine two means of propulsion: one for the surface, the other for running submerged. Holland's design with the more efficient Otto engine for surface operation allowed for recharging the batteries used for underwater running. Outstanding operating features included longitudinal stability, quick submergence, enhanced hydrodynamic hull design, and a single torpedo tube and a dynamite gun that could be fired when either awash or submerged.[1]

After the launching, tests of submerging capabilities were met, adjustments made, and a successful dive achieved on St. Patrick's Day, March 17, 1898. Performance both underwater and at sea in open water demonstrated the boat's uniqueness and its fulfillment of Holland's design expectations. Frost brought his media skills to bear, (Elihu B. Frost, a lawyer with The Morris & Cummings

Dredging Company with whom Holland was affiliated until 1893. See Part I in **THE SUBMARINE REVIEW**, July 1998) and HOLLAND VI was brought to the attention of the public.

It was at this juncture that Roosevelt, then Assistant Secretary of the Navy, made his previously-cited recommendation for the Navy to negotiate purchase of HOLLAND VI.

By the summer of 1898, the submarine had been through some of its initial tests. A long underwater demonstration exceeded the requirements levied on PLUNGER. The need for some extensive modifications to the stern structure were identified. The Holland Company now required additional fiscal support for these alterations and to defray the cost of more submarine demonstrations for additional Navy scrutiny and convincing. These difficulties and others led Holland to his often quoted comment, "What will the Navy require next? That my boat should be able to climb a tree?"

Isaac L. Rice, a Bavarian emigre and well known successful lawyer and financier, was president of the Electric Storage Battery Company of Philadelphia which provided batteries for HOLLAND VI. After a demonstration ride during the summer on the new submarine, Rice became interested in forming a company to build submarines.

Rice brought his organizational skills and knowledge, including that of an authority in patent law, to the new submarine company and in February 1899 incorporated the Electric Boat Company on the foundations of the acquired Holland Torpedo Boat Company. Needed funds for the modifications to the submarine prior to the Navy's further testing were now available. The necessary exposure and publicity to convince the Navy to purchase were developed through the skills of both Rice and Frost.

The remodeling of HOLLAND VI was completed towards the end of March 1899. On 25 March, Holland left for Europe on a combination business and pleasure trip. Near the time of his departure, the Company's secretary, Frost, paid five years of back taxes on all of Holland's foreign patents--British, German, Swedish and Belgian.[2] This lien on his patents ultimately contributed to Holland's separation in 1904 from the Electric Boat Company, when he formally resigned. Regarding Holland's patents, Christman noted "Frost and others gained control of Holland's foreign patents and had many of his domestic patents assigned to the Electric Boat Company."[3]

In May 1899 the waters off Greenport, Long Island, were selected as a submarine testing site free from heavy water traffic and testing was resumed. Newspapers, weekly periodicals, and reports of rides on the submarine by the press, personnel of foreign navies and friends kept HOLLAND VI in the limelight. One of the prominent riders was Clara Barton, founder of the American Red Cross. She was the first woman to be on board while the submarine submerged. One of these tests off Long Island included a four hour long run which met the approval of the current Naval Board.

The submarine's performance was successful, but a sale to the Navy had not been made. In the opinion of both Rice and Frost, each of whom possessed excellent lobbying skills, that the best way to sell the submarine was to take it to Washington. This was accomplished by slowly towing the submarine to Washington via an inland passage witnessed by more than 5000 people along the way.[4] The passage included going up the Potomac River and berthing the submarine at the Washington Navy Yard during Christmastime.

Still, a positive decision for the purchase of the submarine was not at hand. On 21 and 24 January 1900, the *New York Times* reported in headlines "Rejection of the Holland Boat", and "Reports on the Holland Boat; Majority of the Navy Board Does Not Favor a Purchase". The negatives regarding the purchase of HOLLAND VI primarily stemmed from the Navy's previous government expenditures of the order of $90,000 for the unusable PLUNGER.

In March, after a winter of reconditioning and an almost daily showing of HOLLAND VI to various interested personages, an official test course was established on the Potomac River. The one mile course ran from Fort Washington in Maryland to Mount Vernon in Virginia.

On March 14, the day of the major exhibition, a naval tug with press on board towed the submarine to the test site. Two other vessels provided viewing platforms for naval officials including Admiral Dewey, the Assistant Secretary of the Navy, and House and Senate personnel. Among the crew of HOLLAND VI was Admiral Dewey's personal assistant, Lieutenant H.H. Caldwell, who later became the first commanding officer of a United States submarine. The submarine demonstrated its obligatory submerging, surfacing, and torpedo firing. Spectators and press alike were duly impressed. There were four more days of successful demonstrations during the next several weeks.

On April 11, 1900, the Navy purchased HOLLAND VI for $150,000 and it was turned over to the Navy on April 30. The Navy Torpedo Station at Newport, Rhode Island was designated as homeport and an all Navy crew was trained by September with the commissioning the following month.

The new submarine was modestly armed with one forward torpedo tube, three Whitehead torpedoes, and a bow-mounted pneumatic dynamite gun. HOLLAND VI was small but was considered the most advanced submarine in the world.

Epilogue

A few months later in September 1900, the newly acquired and only United States submarine participated in naval war games in the Atlantic off Newport, Rhode Island, as part of the defending fleet. During the exercises, Caldwell as Commanding Officer of HOLLAND made the impressive maneuver of bringing the submarine within hailing distance of the hostile flagship KEARSARGE. Caldwell announced to the battleship, "Hello KEARSARGE, you are blown to atoms. This is the HOLLAND."[7] Caldwell's action may have been premature, but it was certainly prescient.

The United States now had one submarine and the related technology would gradually grow and improve. Until World War I, 14 years away, acceptance of the submarine would come grudgingly from many quarters (including the Navy), but submarines would be built. It is noteworthy that even after the lessons of World War I and its obvious offensive capability, the submarine in 1919 would be discounted in favor of capital ships as the ultimate naval weapon.[8]

Between 1900 and 1916, the Electric Boat Company built 49 submarines with the Holland design and patents for the United States Navy. Holland, with his primary patents belonging to the Electric Boat Company and a continuing downgrading of his role, resigned at the end of 1904. Lacking his patents, the Navy in 1907 disavowed Holland's recent submarine designs. The later years were marked by litigation with his financial backers. One of his last inventions was an apparatus to enable sailors to escape from a damaged submarine. Aircraft and problems of flight were the focus of his creative energies until his death in 1914 at the brink of World War I.

A tribute to Holland occurred a half-century later. The United States Navy built an experimental test-bed diesel submarine, ALBACORE (AGSS 569), commissioned in 1953 and reconfigured five times (1953 through 1971). In one of the phases, "the control surfaces were moved forward of the propeller, a position which Holland had used in the initial configuration of HOLLAND VI and had changed, under pressure...Holland had the right idea after all."[7]

Commissioned in 1959, the nuclear powered fish-shaped SKIPJACK (SSN 585), which at the time was considered the fastest submarine in the world, reflected Holland's original naval architectural concepts to give submarines enhanced underwater performance.

The Electric Boat Company, just prior to the sale of HOLLAND VI, had expressions of interest in building submarines from countries such as Turkey, Venezuela, Mexico, Sweden, Norway, Denmark, and Russia. In the fall of 1900, the Electric Boat Company made licensing arrangements for the construction of Holland submarines with Vickers Sons and Maxim Limited as the builders in Great Britain. Thus, the British submarine fleet became a reality with the Holland patents.

The Congressional Record of 4 December 1902 included the J.P. Holland Torpedo Boat Company and the Electric Boat Company as part of the Military Industrial Complex. Submarine building, although small in the Navy's budget, was in the national and international limelight.

In 1904, after the recent addition of five Holland-type submarines to its Navy built at the insistence of British Admiral Sir John Fisher, First Sea Lord and creator of Britain's dreadnaught fleet, he made a most sagacious comment relative to submarines when he said, "In all seriousness, I don't think it is even faintly realized--the immense impending revolution which the submarine will effect as offensive weapons of war."[8] Ten years later, in 1914, Lord Fisher wrote in a still more positive vein that the submarine "is the coming type of war vessel for sea fighting."[9]

The August 25, 1905 *New York Times* headlined on page 1 "President Takes Plunge in Submarines: Remains Below the Surface for Fifty-five Minutes, He Manoeuvres the Vessel Himself..." On the same day on the editorial page under "Our

Submerged President," Theodore Roosevelt was cautioned to restrain himself from doing those *stunts* of adventure.

Accounts of Roosevelt's adventure indicate that the weather and the sea state on that day were far from ideal. The President's role during the trial trip was not as passenger but as participant with the crew of seven. At one point in the submarine's practice dives in the Long Island Sound, the President operated the controls. The submarine was PLUNGER, the Navy's second submarine, commissioned in 1903 and except for an additional 20 feet in length identical with HOLLAND VI. Following his trip on board PLUNGER, the President issued a directive that enlisted men detailed to submarines be granted an additional $10 per month as hazardous duty pay.[10] Under his Presidency, the Navy grew in numbers of ships while naval personnel increased from 25,050 in 1901 to 44,500 at the end of 1909.

In spite of the obvious shortcomings, the submarine had arrived. By the eve of World War I in 1914, there were 400 submarines in 16 navies. They were not all Holland designs, but his impact was seminal.■

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POSTSCRIPT TO VALOR

by CDR R. Compton-Hall, RN(Ret.)

All except three of the fourteen Royal Navy submariners who won the Victoria Cross were commanding officers: their stories have been told in previous issues of **THE SUBMARINE REVIEW.**[1] Was there something ineffably godlike about these submarine captains, or about holders of the highest awards in the United States and German wartime submarine services?

Happily, it seems that there was not. The great majority lived on the same planetary plane as the rest of us sinners, and they consistently exhibited a strong affinity with the human race.

Of course, every winning captain was keenly aware that he represented the gallantry of an entire well-trained submarine's crew--including unsung heroes who coaxed recalcitrant diesels and distillers; irrepressible cooks and stewards who contributed so much to morale; electricians and radiomen and radarmen and underwater sound experts who somehow kept motors and sets functioning efficiently when damp and boredom threatened to extinguish a vital spark; tormented navigators who (usually) found the way; surface lookouts who kept searching an assigned but unrewarding sector despite temptations to look elsewhere for excitement; torpedomen and gunners who checked and double-checked the weapons. But gaining the unfailing support of these men, to say nothing of the equally important girls they left behind, was an art in itself.

When, during the last war, cadets joined the Royal Naval College at the tender age of thirteen-and-a-half they were greeted by a gnarled Lieutenant Commander who insisted that they henceforth follow principles of leadership represented by the initial letters OATOUS. Not one of the officers who subsequently found himself in boats has yet remembered what the mnemonic stood for. A gunnery specialist, or a communicator maybe, might recall which officer-like qualities (OLQs) were so highly recommended long ago; but taking a submarine crew on prolonged patrol and in to battle was evidently not one of the scenarios which the good Commander had in mind.

Our finest submarine leaders have not conformed to any particular characteristics--or OLQs. On the contrary, holders of the highest awards have differed, sometimes widely, within their respective underwater fleets. In the U.S. Navy Ramage was not a lot like Morton; U-boat ace Prien did not resemble Kretschmer; and, amongst British holders of the Victoria Cross, Cameron was a mile apart from Miers. Personalities, although reassuringly normal in the main, have ranged from bombastically bellicose to quietly modest.

All the same, we ask, did they not share an identifiable quality that marked them out as potential heroes? Wanklyn of HMS UPHOLDER thought, under media questioning, that his special strength was imperturbability; and certainly it helps if the skipper is not prone to panic. But that alone would not account for valor over days, weeks or months: it is duration (in practically all instances) that distinguishes exceptionally bold submarine epics from the unquestionably brave but usually, by comparison, short-actioned deeds rewarded with top honors on land, in the air and on the surface of the sea.

Given professional skill, a submarine commanding officer needed (and still needs, as demonstrated by cold war operations) something more than guts: and for each one who wore the Knight's Grand Cross, or the Congressional Medal of Honor, or the Victoria Cross, one factor dominated all the rest—determination, sheer unflagging determination.

There is no evidence, anywhere, of a crew faltering while the captain remained determined. However, there were a few—a very few—bad commanding officers who somehow slipped through the selection process, and they were less than resolute. In any boat the slightest sign of hesitation by the command was damaging to morale and to performance.

Crews did not necessarily look for social niceties in their captains, and knightly virtues such as chastity were not regarded as obligatory; but there was a limit to what behaviour a crew would tolerate in officers.

Failure

A rare example of failed leadership and command was summarized for British Intelligence following the interrogation of survivors from U-606 sunk on 22 February 1943. The dark story deserves retelling if only to highlight the vastly more numerous accounts of submariners, in all the warring navies, who did their duty so supremely well. It is a lasting reminder of how *not* to run a submarine.

U-606, a workhorse Type VIIC displacing 865 tons submerged and with a complement of 44, was armed with fourteen torpedoes for four bow tubes and one stern tube.

The U-boat sailed for her first patrol on 22 August 1942, but she had not gone far when her captain was smitten with a disorder of the stomach which persuaded him to put back to Bergen where he was duly despatched to hospital. The other officers decided to devote their unexpected harbor-time to entertaining the nurses: all the wardroom's liquor was consumed in rather less than a week.

When the captain's health improved a little he sent for a bottle from his private store. Unfortunately, that too had been ransacked. The officers went to see him—reckoning honesty to be the best policy—and, amidst some foot-shuffling, confessed. But the interview thereupon became so heated that they fled the hospital and told the rest of the crew that the doctors had forbidden any more visitors.

However, a sceptical petty officer disregarded the instruction and went to call on his captain who exploded when he heard what had been said: he ordered that no officer should attempt to see him again while he was sick. Significantly, the boat's enlisted men started to walk up to the hospital regularly, and they were welcomed.

When the captain failed to make much further progress Admiral Dönitz had him temporarily relieved by the captain of U-586 which was undergoing repairs; but, after an entirely unsuccessful patrol, Oblt Hans D. (who had briefly commanded the small, coastal 250-ton U-21 for training) was appointed as the new captain.[2]

Hans D. was aloofly Nazi, weak, and dominated by the first watch officer (*Eins Vee-Oh*, the exec) Weiner B. who lacked professional competence and was reportedly little short of an unsublimated sadist. It was he, apparently, who encouraged the captain to punish minor offences, such as purloining a packet of cigarettes, with a term in prison or consignment to the Russian front.

The ensuing patrol was promising although, early on, D. erred in signalling HQ to the effect that he had torpedoed the same ship twice and disposed of two merchantmen totalling 90,800 tons. A few days later U-606 sighted a convoy which she followed for three days in such foul weather that the captain and 1WO reckoned conditions were too bad for attacking.

Nonetheless, the waves were not too high for convoy escorts. When a destroyer threatened U-606 the officer on the bridge attempted to dive, but the quartermaster neglected to order tanks to be flooded. A seaman opened the vents on his own initiative and the boat escaped, albeit with damage from wallowing during a slow submergence. Soon after Christmas, and after 50 days at sea, U-606 limped into Brest with a number of serious defects. The crew was accommodated ashore.

On New Year's Eve the Petty Officers trooped down to the boat and along the passageway to the wardroom to wish their captain a Happy New Year. It is extremely unlikely that they did not know what was going on; but their story was that, on opening the door, they were confronted by a vast collection of bottles on the table surrounded by dishevelled officers and several partly or entirely naked women. After a few moments of shocked amazement, one of the intruders spat out *a short but vulgar word* and slammed the door.

The Petty Officers wanted to publicize their finding, but the captain had prudently invited the flotilla commander to the party and the affair was hushed up.

Morale was not high when U-606 next put to sea on 3 January for an intended seven long weeks of winter weather in the North Atlantic. In due course, in company with ten other U-boats, she was directed to convoy ON166.

Oblt D. fired four torpedoes and claimed three hits; but a swift and savage counter-attack by the Polish destroyer BURZA forced the boat down to more than 200 metres. Amidst creaking and groaning as the submarine passed her design depth the engineer discovered a weak spot near the after diving tank where a crack was beginning to show in the pressure hull. He informed the captain that the boat could not last more than half-an-hour.

All main ballast was immediately blown and U-606 shot to the surface at a steep angle. The first watch officer's nerve now gave way. Completely losing control of himself he ran through the boat and tried to get out of the after hatch: the captain, personally, had to restrain him.

A few hours later, at about 2000 on 22 February, the U.S. coastguard cutter CAMPBELL came upon the U-boat running, seemingly blind, through the darkness. The American vessel closed and, despite a bizarre collision with another U-boat en route, attacked U-606 with depth-charges and gunfire in which the Polish BURZA joined.

Oblt D. and some of the crew managed to reach the casing under heavy fire. The captain disappeared, struck by a shell, leaving a Chief Petty Officer in charge topside. The Chief found the responsibility too much for him: he ordered abandon ship, and every man jumped overboard—never to be seen again.

Meanwhile, the 1WO, engineer and a junior officer had sheltered below together with three Petty Officers and six seamen. When the gunfire eventually died away they cautiously came up on deck where they kept out the cold with an improvised meal of sausages and champagne laced with rum.

They did not have long to wait. Boats from the American and Polish ships were soon alongside the hulk in a moderating sea. All but one of the Germans were glad to scramble into the boats as prisoners, but a Petty Officer could not resist the opportunity to pay off old scores. He marched up to the first watch officer on the U-boat's slatted wooden deck snarling: "I have waited a long time to do this". He then hit the 1WO hard in the face, and jumped over the side.

When the remaining men climbed on board the rescuing vessels one of them, seeing the conning tower of U-606 still above water, demanded bitterly: "What sins have I committed in my life that I should have been sent to such a boat?"

It is a tragic tale. But perhaps it is no bad thing to hear the B-side of a record occasionally. Otherwise—how does the old song go?—"O Lord it is hard to be humble, when you're perfect in ev-ery way..." ■

NOTES

1. Personal experience and information, resulting from privileged aquaintance with officers and/or crew members (of the various navies) involved, and a number of their relatives, have supplemented archival records in compiling the VC series. Patrol reports etc (including definitive documentation relating to the HMS TORBAY/Miers patrol of 28 June to 15 July 1941) can be read in the Public Records Office at Kew, the Naval History Branch/Admiralty Library in Old Scotland Yard, Whitehall and (probably the best place to start) the RN Submarine Museum at Gosport.
2. There is no reason to distress surviving participants or relatives by using real names; but serious researchers can find full details in contemporary issues of the (British) Naval Intelligence Review and related records (e.g. the wartime Anti-Submarine Journal) in the RN Submarine Museum library and archives which also holds German reference.

SOVIET AND RUSSIAN TORPEDOES SINCE 1945[1]

by Frederick J. Milford and
A. Homer Skinner

The Russian Navy's interest in torpedoes developed very early. It has even been claimed that

> "The first self-propelled mine (torpedo) in the world was developed in Russia by the famous Russian inventor I.F. Aleksandrovskiy, who in 1865 submitted a detailed plan for a torpedo to the naval ministry. One year later, Whitehead, an Englishman, announced that he had invented the torpedo. In spite of the good data obtained during the tests of the Aleksandrovskiy torpedo, officials of the naval ministry preferred to buy the patent and torpedoes designed by Whitehead..."[2]

The first torpedoes and a manufacturing license were obtained from Whitehead in 1876, about five years after Whitehead began selling torpedoes. By 1881 Russia had acquired 250 Whitehead torpedoes, a scant four fewer than the Royal Navy. Through 1917 31 different types of torpedoes were acquired by the Russian Navy. Some of these were designed by Whitehead, others by Russian

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[1]This article is based almost entirely on recently published Russian language publications. No classified information has been used. In the interest of making the source clear no attempt has been made to correlate with English language sources. We note, however, that the data presented here does not always agree with existing English language sources. The main sources for general coverage of Soviet torpedoes have been the following Russian language publications:

V.P. Kuzin and V.I. Nikol'skiy *Voyenno-morskoy Flot SSSR 1945-1991* (The Navy of the USSR 1945-1991) St. Petersburg: Istoricheskoye Morskoy Obshchestvo, 1996.

Yu. L. Korshunivov and G.V. Uspenskiy, *Torpedo Rossiyskogo Flota* (Torpedoes of the Imperial Russian Fleet) Morskoy Oruzhie (Naval Weapons) No. 1, St. Petersburg: Gangut, 1993.

Yu, L. Korshunivov and A.L. Strokov, *Torpedy VMF SSSR* (Torpedoes of the Soviet Navy) Morskoy Oruzhie (Naval Weapons) No. 3, St. Petersburg: Gangut, 1993.

[2]Beloshitskiy, V.P. and Baginskiy, Yu. M. "Underwater Weapons" Moscow: Military Publishing House, 1960, p. 83 of the Russian version or p. 63 of the NISC translation (AD A046104).

engineers closely following Whitehead's designs. Some were manufactured in the Whitehead Fiume plant and others in Russian plants, primarily the Obukhovskiy naval arms plant and Lessner torpedo plant. This is interestingly the same buy, manufacture under license, improve, indigenous design approach that was followed by other countries, particularly Japan, in the development of torpedoes. The exception to Whitehead based designs was the acquisition of 75 Schwartzkopf 45 cm. torpedoes for use by submarines during the Russo-Japanese War. In view of the clouded provenance of Schwartzkopf designs, even this may not really be an exception. The Russian Fleet used torpedoes of various kinds in the Russo-Turkish War, 1877-78. A Russian torpedo boat fired the second Whitehead torpedo fired in combat, but both it and another missed. Torpedoes, launched by torpedo boats and destroyers, were used by both sides in the Russo-Japanese War, 1904-05. The Russian Navy fired 25 torpedoes from surface vessels during that war. Russia had torpedo carrying submarines operational in the Far East before the Battle of Tsushima, but we have found no claim that they launched any torpedoes during the Russo-Japanese War.

During WWI 230 torpedoes were fired by Russian submarines for a claimed 25 hits. Seventy-seven torpedoes were fired by their destroyers for a claimed 12 hits. The period from 1916 to the mid-1920s was a dark one for the Russian/Soviet Navy. World War One, the Revolution, Mutiny and Civil War all took their toll. As a result there was a hiatus in naval construction and development. In 1927 the first post-WWI torpedo, the 53-27, entered service. This was also the first 533 mm (21 inch) Soviet torpedo.[3] Only 52 of this model were produced and the Soviets admit "it was not a very good torpedo." Between 1927 and 1941 several new or improved torpedoes were introduced. These were straightforward steam torpedoes with reciprocating engines of either the Brotherhood radial type or from the 53-38 on the two cylinder, double acting Whitehead-Weymouth type. Exactly how the Soviet torpedo designers obtained the two cylinder engine design is not clear, but the most probable explanation is that they purchased Italian

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[3]These 533 mm torpedoes were first used in new cruisers commissioned in 1927.

Whitehead torpedoes that used the horizontal engine. From the 53-38 on, the Soviet torpedoes seem to have been relatively reliable. In "Russian Submarines in Arctic Waters", I. Kolyshkin brags a little that the Soviet torpedoes of WWII did not suffer from the exploder problems experienced by German, U.S. and Japanese forces. The most modern torpedoes used by the Soviet Navy in WWII were the 450 mm 45-36NU (1939), the 533 mm (53-38U (1939) and the 53-39 (1941). All were launched from surface ships and submarines. From 1944 on Ilushin Il-4 twin engine bombers were used to drop torpedoes (varieties of the 45-36A). In August 1944 the first Soviet electric torpedoes, 533 mm by 7.5 m ET-80s[4] were used against German targets. In addition, there was a little preliminary development of pattern running and homing torpedoes. Reportedly, during WWII Soviet submarines fired 1594 torpedoes and sank a total of 411 axis naval and merchant vessels; aircraft dropped 1294 for 399 sinkings; PT boats launched 845 for 190 sinkings and destroyers 16 for four sinkings.[5] The numbers for sinkings seem very high and we have not been able to verify them.

Post WWII Torpedo Development

The experience of all navies in WWII indicated that the primary targets for submarines were surface vessels including surfaced submarines. Soviet torpedo development naturally turned to the development of anti-surface vessel (ASV) torpedoes. One of the first steps was to exploit the German materiel acquired from the U250 which was raised in September 1944. These treasures included two flat nose G7es (TV), Zaunkönig, passive homing electric torpedoes, a G7e (TIII Fat), a G7e (TIII Lut) electric torpedoes. The latter two were equipped with two different pattern running attachments—one Fat (Federapparat) and the other Lut (Lagen unabhangiger). With these items as inspiration work

[4]In this *80* is said to come from 80 cells in the lead acid battery and an 80 hp motor.

[5]Korshunov and Strokov *loc cit* p. 17.

resumed on homing, electric and pattern running torpedoes.[6] The first success was the electric torpedo ET-46 (1946). ET-46 was longer and heavier than the G7e and carried an enormous 450 kg (990 pound) warhead. Pattern running was incorporated into the faithful 53-39 to yield the 53-39PM (1949). The first passive homing torpedo was accepted for service as the SAET-50 (1950). This was an electric torpedo (ET-46 envelope) with passive, azimuth only, homing; functionally similar to the German Zaunkönig and the U.S. Mk 28. Thus by 1950 the Soviet Navy had largely caught up with the U.S. anti-surface vessel torpedoes. The exception was in propulsion where the U.S. had operational NAVOL (high test peroxide) torpedoes. This shortfall was remedied in 1956-57 with the introduction of the 53-56 torpedo fueled by kerosene and oxygen which powered a reciprocating engine and the 53-57 fueled by kerosene and high test peroxide which powered a turbine. The 53-56 torpedo was remarkably similar to the Japanese Type 95, the 21 inch sibling of the famous Type 93 *Long Lance*. Development of the 53-57 peroxide torpedo benefitted from materiel and technical manpower from the German torpedo establishment. Between 1945 and 1976 the Soviet Navy put in service at least 17 submarine and surface launched ASV torpedoes. Active acoustic and wake homing, silver-zinc batteries and nuclear warheads were some of the new features to be found in these weapons. Most of these 17 torpedo types were 533 mm in diameter, one was 400 mm and two were 650 mm (25.6 inch) giants. The first of the 650 mm torpedoes, 65-73 (1973) was a straight runner capable of 50 kts for 50 km (17.5 nm) and carried a nuclear warhead. The second, 65-76 (1976) was a homing torpedo with a 450-500 kg warhead (a nuclear warhead was also available) otherwise the same as the 65-73. Most torpedo attack submarines from Project 671RT, [NATO Victor-2], on have been equipped with 65 cm tubes to fire these huge torpedoes and other weapons. In addition, most of the 10 Soviet submarine and surface

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[6]According to Russian language sources, work on homing torpedoes began in the 1930s, but was shelved because of other wartime priorities. Electric torpedoes, ET-80, were, as noted, in service with the Soviet Navy from mid-1944 on. There are some indications that pattern running torpedoes were developed during WWII. We have not yet found details or positive indication that they were used in combat.

vessel launched torpedoes with both depth and azimuthal homing had an ASV capability. Three air launched anti-surface vessel torpedoes were also developed. Of the 40 torpedoes tabulated below, only nine air launched and the SHKVAL[7] are pure ASW weapons with no ASV capability. This strong emphasis on torpedoes with anti-surface vessel capability was fully consistent with the post-WWII Soviet views that amphibious and carrier task forces represented severe threats to their security. As submarine and ballistic missile technology evolved, ASW became important and this drove the development of ASW torpedoes.

During WWII Soviet submarines sank perhaps three German submarines and lost no more than nine of their own to German and Finnish submarines. Soviet merchant shipping losses to submarines were modest.[8] This may have fostered a belief that ASW torpedoes were less important to the Soviet Navy than anti-surface vessel torpedoes.

Post World War II, early Cold War conditions did little to change that view. The NATO submarine fleet was numerically small[9] compared to that of the Soviet Union. In addition, homing in both depth and azimuth poses a whole new set of problems as opposed to azimuthal homing only. All of these factors may have contributed to what appears to have been relatively slow Soviet development of ASW torpedoes. It is possible that the appearance of NAUTILUS, the first SSN, in 1954 triggered a more urgent

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[7]Kunin and Nikol'skiy list SHKVAL as a "dual purpose" torpedo and describe it as "multipurpose" or "universal" in the text. This would normally imply use both as an ASW weapon and as an anti-surface vessel weapon. Soviet concern with enemy surface vessels, carriers in particular, also suggests an anti-surface vessel capability. Most other Russian language publications describe SHKVAL as an ASW weapon. We are inclined to believe that any anti-surface vessel capability is very limited.

[8]A 1989 Russian language publication indicates that the USSR lost 329 merchant vessels over 100 GRT during WWII and that 36 of these were lost to submarine attacks of all types. I am indebted to Andreas von Mach for these data.

[9]NATO navies included about 150 operational boats in 1950.

Soviet interest in ASW torpedoes.[10] The first Soviet ASW torpedo, the SET-53, became operational in 1958. As detailed in Table I, it was a large passive homing torpedo powered by lead-acid batteries. The SET-53 and a modification, SET-53M (1964), were, however, the only passive homing ASW torpedoes to enter service with the Soviet Navy. All of the other ASW torpedoes used active or active/passive homing. The first torpedo of this type to enter service was the 400 mm SET-40 (1962). It was relatively light, 550 kg (1200 pounds) with an 80 kg (176 pound) warhead. It used electric propulsion with a silver-zinc battery for a range of 8000 meters at 29 knots. Its active/passive homing system had an acquisition range of 600 to 800 meters. All in all a very competent ASW torpedo for that period. SET-65 (1965)[11] was larger, 533 mm, and improved, but generally comparable with the SET-40. Subsequent active/passive homing electric torpedoes, SET-72 (1972) and USET-80 (1980), were classified as *dual purpose* meaning capable of attacking both submarines and surface vessels. They were faster, longer ranged and large than the SET-40 and capable of operating to depths below 400 meters (1300 feet). Wire guidance was added first to the SET-53M to produce the STEST-68 (1969) and then to the SET-65 to yield the TEST-71.[12] TEST-3 (1977) is a modified TEST-71 for launch from surface vessels. An improved TEST-71, TEST-96, has been announced, but its status is not definitely known. The Soviet Navy also developed a class of *aircraft launched antisubmarine torpedoes* which included those launched as payloads of antisubmarine rockets. The first of these, AT-1, entered service in 1962. It was followed by two 533 mm (1965, 1973) and two 400 mm (1981) weapons.[13] One of each size

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[10]Kuzin and Nikol'skiy comment that Soviet submarines were the principal threat to NATO naval forces and that that led to NATO emphasis of ASW torpedoes. They say nothing, however, about why Soviet development of ASW torpedoes was delayed.

[11]Both the SET-40 and the SET-65 were advertised for sale in Vol. III of "Russian Arms" Moscow: Military Parade, 1996.

[12]TEST-71 is also for sale.

[13]APSET-95 is offered for sale. It appears to be very similar to the 400 mm AT-3 except that the speed is advertised as "up to 50 knots".

was launched from aircraft and the other as payloads for ASW rockets. Two submarine launched ASW rockets known as VYUGA were developed by the Soviet Navy. The smaller, 533 mm diameter, was very similar to the U.S. SUBROC. It carried a nuclear warhead and could be launched from 533 mm torpedo tubes. The larger rocket was to be launched from the 650 mm tubes of later Soviet submarines. It carried a 500 mm homing torpedo as payload and had no US/NATO equivalent.[14] Neither version of VYUGA is now in service. The functional equivalent of the U.S. ASROC was METEL which was launched from surface vessels and carried, as one option, a 400 mm torpedo as payload.

In addition to conventional (by US/NATO standards) torpedoes, the Soviet Navy developed several unique weapons. Four of these, RAT-52 VA-111 (SHKVAL), APR -1 and APR-2 were rocket propelled. VA-111, as noted is *officially* claimed to be capable of 200 knots and to operate in a supercavitating mode. The other three are 60 knot torpedoes. RAT-52 was an early, straight running, anti-surface vessel torpedo. APR-1 and APR-2 are ASW weapons with active/passive homing. Also relatively unique is the VTT-1 a wire guided, lightweight torpedo launched from helicopters. Finally we note that the Soviet Navy acquired a U.S. Mk 46 torpedo.

On the basis of this acquisition, they developed the KOLIBRI which is powered by a turbine and uses Otto fuel.[15]

Propulsion, Warheads and Guidance

Early post-WWII Soviet development of anti-surface vessel torpedoes focused on optimizing range, speed and warhead size.

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[14] R. Shmakov "Antisubmarine Rockets for Our Submarines" Morskoy Sbornik No. 5 May 1997. We are indebted to Franklin Hawkins for his translation of this article. It is not clear that the 650 mm VYUGA was ever deployed as a service weapon.

[15] Kuzin and Nikol'skiy say "Then [mid-1970s], thanks to a series of odd circumstances, we were able first to examine, and later actually to copy the USA's Mk 46 torpedo (and at the same time we were able to copy its thermal propulsion system with its monopropellant fuel)." They may have learned about Otto fuel in this way, but, to the best of our knowledge, all Mods of Mk 46 were powered by axial piston engines. Externally, these engines look much like turbines.

Warhead weight trades off directly against fuel and oxidant weight. For a given torpedo and propulsion system the product of range and speed squared is roughly proportional to the weight of propellant and oxidant (or battery weight for electric torpedoes). Clearly design flexibility is increased if the allowable torpedo weight is increased. Most Soviet 533 mm torpedoes weighed about 2000 kg (4400 pounds). For comparison, the two heaviest U.S. torpedoes were the Mk 16 at 4000 pounds and the Mk 17 at 4600 pounds; all others were under 4000 pounds. Propulsion systems that were wakeless were deemed to be advantageous for attacking surface targets, especially at long range. As acoustic homing became important, quietness also became a factor. The first post WWII propulsion system, employed in both conventional and homing torpedoes, was electric using lead acid batteries. The initial performance of these systems was comparable with the German G-7e (T-II) or the U.S. Mk 18. Weight and size differences account for most of the performance differences. Lead-acid systems were improved, yielding about a 20 percent increase in speed with no sacrifice of range. In due course, the advantages (and cost) of sea water batteries were recognized and one-shot silver-zinc and silver-magnesium battery systems were developed. These batteries yielded further increases in speed and range. Thermal propulsion was not neglected. Starting from the vintage reciprocating engine system that powered the 53-39 and variant torpedoes, the Soviet Navy explored the use of high test peroxide (HTP 85 percent H_2O_2) and pure compressed oxygen as oxidants.[16] These oxidants save weight because they avoid carrying the 80 percent nitrogen in compressed air and in the case of HTP the weight of the air/oxygen flask is eliminated. They have the further advantage of being essentially wakeless. Both turbine and reciprocating engines were used. The best of the 533 mm HTP torpedoes from a propulsion standpoint, was the 53-65, which had a range of 12,000 m at 70 kts with a 300 kg warhead. Great and relatively successful efforts were made to maintain the secrecy of the Soviet HTP and oxygen torpedoes. Kuzin and Nikol'skiy devote a paragraph to the subject. They say in part:

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[16]In addition to the references cited in footnote 1 see O. Chechot "Hydrogen Peroxide Torpedoes" Morskoy Sbornik No. 2, 1996.

"The absence of those kinds [oxygen and HTP] of torpedoes in the navies of the USA and UK was not due to any lag behind the USSR ... the USA ... had begun the development of a radically new thermal propulsion system using a monopropellant [Otto fuel] having a very high energy content."

Soviet torpedo designers caught up with this advance as a result of the access to a Mk 46 torpedo as earlier noted. The other interesting Soviet propulsion development was rocket or jet propulsion. Several such torpedoes appear in the tables designated RAT, APR or VA. The reported 200 kt speed of the VA-111 is phenomenal. The others are much slower and the APR varieties have active/passive homing.

Conventional Soviet anti-surface vessel torpedoes had warheads between 300 and 450 kg of high explosive. The 400 mm anti-escort weapons have much smaller warheads. The large warheads were directed towards inflicting serious damage on large aircraft carriers with a small number of torpedo hits. The same consideration originally motivated nuclear warheads. Conventional warheads for other classes of torpedoes carry 60 to over 200 kg of high explosive. The exact composition of the high explosives used in torpedo warheads has not been found in the unclassified literature. Soviet explosives used during WWII did not contain RDX, but contemporary warhead loads are probably equivalent to TORPEX, H-6 or HBX in underwater effectiveness against ships. Exploders for conventional warheads include multi-axis inertial (contact) exploders and a variety of acoustic, magnetic and possibly optical proximity devices. Again, the details have not been found in the unclassified literature, but the devices are described as active *electromagnetic* (probably more correctly magnetic), active acoustic and optical.

At least four nuclear warheads[17] for torpedoes began the design process. The first of these was the enormous 3.5-4.0 metric ton warhead for the proposed 1550 mm by 24 m, 40 metric ton T-15 torpedo. This design project originated in the Ministry of Medium

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[17]The material on nuclear warheads in Shirokorad, A.B. "Sovetskiye Podvodnyye Lodki Poslevoyennov Postryki" (Soviet Submarines of Postwar Construction): Moscow, Arsenal Press, 1997 has been particularly useful in preparing this section.

Machine Building and was aborted in the design phase at Navy insistence. The other three designs were completed and the warheads entered service. The second was the warhead designated RDS-9 which was designed for the 533 mm T-5 torpedo. The prototype warhead was tested underwater at Novaya Zemiya Nuclear Naval Weapons Test Area on 21 September 1955. The yield was estimated "arbitrarily" at 3 kilotons.[18] On 10 October 1957, again at the Novaya Zemiya test area, a T-5 torpedo with a nuclear warhead was fired from a submarine[19] at a cluster of submarine targets. Two submarines S-34 and S-20 were sunk and S-19 was rendered nonoperational. These two may have been the only underwater tests conducted by the Soviet Union. The T-5 torpedo entered service in 1958 as the Type 53-58. Roughly contemporaneously with the development of the T-5 torpedo a universal 533 mm nuclear warhead was developed. The idea was to design a single warhead that would fit most 533 mm torpedoes. This development was successfully completed and the warhead designated ASB-30. Fleet distribution of ASB-30 began in late 1962 and it became the practice to carry two such warheads in each submarine. The final nuclear torpedo warhead was used in the large 65-73, but details are not available to us.

Early Soviet anti-surface vessel homing torpedoes[20] had a strong design heritage from German WWII developments. SAET-50 SAET-60 and modifications used a passive homing system much like the WWII German Zaunkönig homing system. A horizontal array of four hydrophones was used to achieve a directional sensitivity with two lobes about 25 degrees right and left of the torpedo axis. The MGT-1 400 mm anti-escort torpedo used a similar passive homing system. Purely passive homing systems have limitations and in due course both active and active/passive homing systems were developed for the Soviet Navy. These seem to have evolved initially from the German *Geier* torpedo which had

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[18]Friedman "Word Naval Weapon Systems 1997-98" indicates a 15 kiloton yield for the "T-5 warhead". The W-34 warhead of the U.S. Mk 45 has been described as "low kiloton" yield.

[19]Identified by Shirokorad, *op cit86*, as S-144 commanded by G.V. Lazarev.

[20]In addition to the references cited in footnote 1 see O. Chechot "The Development of Russian Torpedo 53-61", Morskoy Sbornik No. 1, 1997.

been produced in limited quantities by the end of WWII. In addition to acoustic homing systems, many of the Soviet anti-surface vessel torpedoes employ wake following. Again, these systems may have had their origin in the German *Ibis* concept. Wake following torpedoes are equipped with sensors that detect a ship's wake and typically steer the torpedo in a sinusoidal path of decreasing amplitude up the wake to the stern of the target where a contact or proximity exploder detonates the warhead. Several kinds of wake sensors including turbulence, acoustic, electromagnetic and optical are mentioned in Russian literature. Wake homing is a special threat in that it is not vulnerable to noise makers or transponders which can be effective countermeasures against passive and active homers.

The guidance system for ASW torpedoes pose more severe problems. Because guidance in both depth and azimuth is required, the entire system is more complex, heavier, larger and consumes more power. There was very little WWII experience with ASW torpedoes on which to draw. The German Navy had not been particularly concerned with ASW during WWII and the only ASW torpedo to see actual service during the war was the U.S. Navy Mk 24, FIDO, Even with this and several torpedoes in late stages of development as a start developing good post-war ASW torpedoes was difficult. For the Soviet Navy, without such experience and only anti-surface vessel developments as background, the development process was surely even more difficult. The first Soviet ASW torpedo was the passive homing SET-53 which entered service in 1958 some eight years later than the passive homing anti-surface vessel torpedo SAET-50. The SET-53 used a mechanically scanned homing system. The SET-53 propulsion system and possibly the homing system were improved in the SET-53M, but no additional passive homing ASW torpedoes were developed. Beginning with the SET-40 (1962) all subsequent Soviet ASW torpedoes have used active-passive homing just as U.S. Navy ASW homing torpedoes have since the Mk 35 (1949). Wire guidance appeared when the STEST-68 entered service in 1969. A wire guided torpedo specifically for launching from surface vessels, TEST-3, and another specifically for launching from helicopters, VTT-1, have also been developed.

The Torpedoes

The following tabulation consists of the torpedoes listed by Kunin and Nikol'skiy using their classifications. Some minor additions from other sources have been made. Such additions are indicated by asterisks following the data.

1) Submarine and Surface Vessel Launched Anti-Surface Vessel Torpedoes

ET-46 (1946): 533 mm x 7.45 m; 1810 kg; 450 kg warhead; straight run; depth 2-14 m; electric, lead acid; 6 km @ 31 kts, sub launched.

SAET-50 (1950), [SAET-50M (1955)]; 533 mm x 7.45 m. 1650 kg; 375 kg warhead; passive homing, 600-800 m acq. range; depth 2-14 m; electric, lead acid; 4 km @ 23 kts [6 km @ 29 kts]; sub launched

53-51 (1951): 533 mm x 7.6 m: 1875 kg: 300 kg warhead; straight run; depth 2-14 m; recip., air and kerosene; 4 km @ 51 kts, 8 km @ 39 kts; sub or surf launch

ET-56 (1956): 533 mm x 7.45 m; 2000 kg; 300 kg warhead; straight run; depth 2-14 m; electric, lead acid; 6 km @ 36 kts; sub launched

53-56 (1956): 533 mm x 7.7 m; 2000 kg; 400 kg warhead; straight run; depth 2-14 m; recip, oxygen and kerosene: 8 km @ 50 kts, 13 km @ 40 kts; sub or surf launch

53-56V (1964): 533 mm x 7.7 m; 2000 kg; 400 kg warhead; straight run; depth 2-14 m; recip, air and kerosene: 4 km @ 50 kts, 8 km @ 40 kts; sub or surf launch

53-57 (1957): 533 mm x 7.6 m; 2000 kg; 305 kg warhead; straight run; depth 2-14 m; turbine, peroxide and kerosene: 18 km @ 45 kts; sub launch

53-61 (1961): 533 mm x 7.7 m*; 2000 kg*; 305 kg warhead; active homing, wake following; depth 2-14 m; turbine, peroxide and kerosene; 15 km @ 55 kts, 22 km @ 35 kts; sub launch

53-65 (1965) [53-65M (1969)]: 533 mm x 7.7 m*; 2000 kg*; 305 kg warhead; active homing, wake following; depth 2-14 m; turbine, peroxide and kerosene: 12 km @ 70 kts, 22 km @ 44 kts; sub launch

53-65K (1969): 533 mm x 7.8 m; >2000 kg; 300 kg warhead; active homing, wake following; depth 2-12 m; recip, oxygen and kerosene: 20 km @ 45 kts; sub or surf launch

SAET-60 (1961) [SAET-60M (1969)]: 533 mm x 7.8 m; 2000 kg; 300 kg warhead; passive homing; depth 2-14 m; electric, silver-zinc; 13 km @ 42 kts [14 km @ 40 kts]; sub launch

MGT-1 (1961): 400 mm x 4.5 m; 510 kg; 80 kg warhead; passive homing; depth 2-10 m; electric, silver-zinc; 6 km @ 28 kts; sub launch

65-73 (1973): 650 mm x 11 m; >4000 kg; nuclear warhead;

straight run; turbine, peroxide and kerosene; 50 km @ 50 kts; sub launch

65-76 (1976): 650 mm x 11 m; >4000 kg; >450 kg high explosive warhead (nuclear option); active homing, wake following; turbine, peroxide and kerosene; 50 km @ 50 kts; sub launch

II) Air Launched Anti-Surface Vessel Torpedoes

45-54VT (1954): 450 mm x 4.5 m; ~950 kg; 200 kg warhead; straight run; recip, air and kerosene; 4 km @ 39 kts; droppable from 10,000 m

45-56NT (1956): 450 mm x 4.5 m; ~950 kg; 200 kg warhead; straight run; recip, air and kerosene; 4 km @ 39 kts

RAT-52 (1952): 450 mm x 3.9 m; 627 kg; 240 kg warhead; straight run; solid rocket; 520 m @ 58-68 kts

III) Surface and Submarine Launched Antisubmarine Torpedoes

SET-53 (1958) [SET-53M (1964)]: 533 mm x 7.8 m; 1480 kg; 100 kg warhead; passive homing, 600 m acquisition range; depth 20-200 m; electric, lead acid; 8 km @ 23 kts [14 km @ 29 kts, silver-zinc battery]; sub or surface launch; the first Soviet ASW torpedo

SET-40 (1962); 400 mm x 4.5 m; ~550 kg; 80 kg warhead; active/passive homing, 600-800 m acquisition range; depth 20-200 m; electric, silver-zinc; 8 km @ 29 kts; sub or surface launch

SET-65 (1965): 533 mm x 7.8 m; 1750 kg; >200 kg warhead; active/passive homing ~800 m acquisition range; depth ~400 m; electric, silver-zinc; 15 km @ 40 kts; sub or surface launch

STEST-68 (1969): 533 mm x 7.9 m; 1500 kg; 100 kg warhead; wire guided; active/passive homing, 800 m acquisition range; depth 20-200 m; electric, silver-zinc; 14 km @ 29 kts; sub launched

TEST-71 [TEST-3 (1977)]: 533 mm x 7.9 m; 1750 kg; >200 kg warhead; wire guided; active/passive homing, ~800 m acquisition range; depth to 400 m; electric, silver-zinc; 15 km @ 40 kts or 25 km @ 35 kts; sub launched [surface launched]. Improved versions designated TEST-96 have been announced and offered for sale.*

IV) Surface and Submarine Launched Dual Purpose Torpedoes (Antisubmarine and anti-surface vessel)

SET-72 (1972): 400 mm x 4.5 m; ~700 kg, 60-100 kg warhead; active/passive homing; depth >400 m; electric, silver-magnesium; 8 km @ >40 kts; surface and sub launched

VA-111 SHKVAL (1977): 533 mm x 8.2 m; straight run; depth ~400 m; solid rocket motor; 11-15 km @ ~2100 kts; sub launched

USET-80 (1980): 533 mm x 7.9 m; >200-300 kg warhead; active/passive homing with wake following; depth >>400 m; electric, silver-zinc; ~20 km @ 45-50 kts; surface or sub launched

V) Air Launched Antisubmarine Torpedoes

AT-1 (1962): 450 mm x 3.9 m*; 560 kg, 70 kg warhead; active/passive homing; acquisition range 500-1000 m; depth 20-200 m; electric, silver-zinc; 5 km @ 27 kts; helicopter launch

AT-2 (1965) [AT-2U (1973)]: 533 mm x 4.8 m; 1050 kg, 80-100 kg warhead; active/passive homing, acquisition range 1000 m; depth 20-400 m; electric, silver-zinc; 7 km @ 25 or 40 kts; launched from ASW aircraft or as payload of ASW rocket [METEL]

AT-3 (1981) [UMGT-1 (1981)]: 400 mm x 3.8 m; ~700 kg, 60 kg warhead; active/passive homing, acquisition range 1500 m; depth 1500 m; electric, silver-magnesium; 8 km @ 41 kts; launched from ASW aircraft or helicopters [also launched as payload of ASW rocket]

Kolibri (n.d.) 330 mm x 2.7 m; 250 kg, 44 kg warhead; active/passive homing, acquisition range ~1000 m; depth 15-450 m; turbine, monopropellant; 5-8 km @ 45 kts; launched from ASW aircraft or helicopters

VTT-1 (n.d.) 450 mm x ?? m; 540 kg, 70 kg warhead; wire guided, active/passive homing; acquisition range 500-1000 m; depth 20-200 m; electric, silver-zinc; 5 km @ 28 kts; launched from ASW helicopters

APR-1 (n.d.) 350 mm x 3.7 m; 650 kg, 80 kg warhead; active/passive homing; acquisition range 1300 m; depth >400 m; solid fuel rocket propulsion; 0.8 km @ 60 kts (alt speed 25 kts); launched from ASW aircraft

APR-2 (n.d.) 350 mm x 3.7 m; 575 kg, 100 kg warhead; active/passive homing; acquisition range 1500 m; depth ~600 m; solid fuel rocket propulsion; 1.5 - 2.0 km @ 62 kts; launched from ASW aircraft and helicopters.■

THE MODERNIZATION OF SUBMARINE FORCES AND ANTISUBMARINE WARFARE CAPABILITIES IN NORTHEAST ASIA

by Lt-Cdr. Duk-Ki Kim, ROK Navy

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During the past decade, the proliferation of advanced, diesel-electric powered submarines and ASW forces has been nowhere more apparent than in Northeast Asia. Although the increases cannot be ascribed to any single type of ships, modern surface combatants accounted for most of them.

China has made a definite decision to acquire a new version of SSBN and SSGN by the early 21st century. Japan's Maritime Self Defence Force (JMSDF) has already acquired a new 8,900 ton U.S. Iwo Jima type LPD (landing platform, dock), with a full length flight deck and island superstructure capable of carrying large helicopters, which are capable of ASW and surface warfare. Other new major surface combatants in the region include China's Luda class destroyers and Japan's Kongo class Aegis destroyers.

An increase in modern submarine forces is also taking place. Japan continues to build Harushio class submarines, while South Korea is trying to acquire improved Type 209s and Taiwan is seeking to acquire 6-10 submarines in the region. In spite of the fact that the Asia-Pacific countries have curtailed their submarine building and procurement programs because of the serious economic problems from the end of 1997, most Northeast Asian countries, except for the two Koreas, will continuously push for the modernisation of submarines and ASW forces in the next decade. This paper examines that effort in China, Japan, Taiwan and the two Koreas.

The Chinese Navy

In recent years the Chinese have attempted to upgrade their equipment with imported technology and have begun to produce missiles and electronic systems of a relatively modern design. Recently, China has sought to benefit from economic hardship in Russia by buying Russian weapons and technology, such as Kilo class submarines and Sovremenny class destroyers, at bargain basement prices. Despite its economic immaturity, China has been pressing forward with a vigorous plan to modernise its naval forces, allocating a huge amount of money for military spending. In fact, China is the country which has made the greatest leap in a naval arms buildup in the post Cold War era. It is significant that China has been engaged in such an arms buildup in view of the relative decline in the military threat.

Modernisation of Submarine Forces The Xia class SSBN was launched in 1981, three years after the keel was laid. The missile launching system apparently gave trouble for several years. Two of the class may have been built, with one lost in an accident in 1985. Only one remains and rarely goes far from port.[1] A new Type 094 SSBN is under development and due to start building soon but its construction may be delayed because of concentration on SSNs. It will be some time before China has an SSBN force even like that of Britain and France and she will continue to rely on land based missiles. Russian advisers are helping design a new Type 093 SSN based on the Russian Victor III—the first of which is expected to be launched in 1999 for completion in 2001. Chinese submarine construction has not been without difficulty. The Ming class diesel-electric submarines developed so slowly that foreign experts suspected technical problems as construction was suspended, then resumed. The last was launched in 1996 and 13 are in service. They were replaced in production by the Song class (Type 039) the first of which was running trials in 1997. In 1995, China acquired four Russian Kilos—the last pair being the newer

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[1]For the historical background of China's submarine development, see Lt-Cdr Duk-Ki Kim, "Modernization of China's Submarine Forces", THE SUBMARINE REVIEW, January 1997, pp. 53-57.

Type 636.[2] There is a single modified Romeo class (Type ESSG) submarine with C-801 anti-ship cruise missiles. This system is also fitted to some of the Hans for surface launch. A new version, capable of underwater launch from torpedo tubes, is under development. (See table 1.)

Table 1. <u>Current Submarine Forces and Acquisition Programs in Northeast Asia</u>

Nations	Submarine Capabilities	Modernization Programs
China	5 Han class (SSN)	Nuclear powered attack submarines. These were commissioned from 1974 to 1991.
	Type 094 SSBN	This class is developing to be delivered by 2000.
	Type 093 SSGN	This class is similar to Russian Victor III. It will be delivered by 2002.
	1 x 2 Song class	The first of which was launched in May 1994. Two more will be built.
	13 Ming class	Five improved Mings are included.
	3 x 1 Kilo class	These were ordered from Russia in 1993. The first two were Type 877. The third is Type 636. A fourth is expected to be delivered in 1998.
Japan	0 x 3 Improved Harushio class	The first of a new class approved in 1993. It will be delivered from March 1998 to 2000.
	7 Harushio class	These were built in 1990-97.
	1 Uzuzhio class	Built in March 1978. Being replaced progressively by Yuushio and Harushio vessels.
	10 Yuushio class	Built in February 1976-May 1989.

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[2]U.S. Office of Naval Intelligence (ONI), <u>Worldwide Submarine Challenges</u> (Washington, DC: ONI, 1997), pp. 20-21 and Joris J. Lok, "Regional Submarine Program Stalled", <u>Jane's Defence Weekly</u> (hereafter JDW), February 18, 1998, p. 37.

South Korea	6 x 3 Chang Bogo class 3 KSS-1 Tolgorae class 8 Cosmos class	Licensed production from Germany. The first was commissioned in June 1993. Those of the second class were assembled and built in Korea. A total of nine will be built by 2001. Midget submarines (175 tons) Midget submarines (83 tons)
North Korea	22 Romeo class 16 x 4 Sang-O class 48 Yugo class	The programs started from 1973 to 1995. Being replaced progressively by the Sang-O class. These are mainly used for special force operations. (330 ton mini submarines). It will be built by 2077) Midget submarines (110 tons).
Taiwan	2 Hai Lung class 2 Hai Shih class	These were commissioned 1987 and 1988. Built in 1973.

Sources: The Military Balance 1997/98 and Jane's Fighting Ships 1996-1998.

ASW Capabilities. Recently, the Luhu and Luda class destroyers, and the Jiangwei class frigate, all entered fleet service in the Chinese Navy. During Chinese Premier Li Peng's visit to Moscow in December 1996, Russia agreed to deliver two Sovremenny class destroyers which will give the Navy improved ASW and surface strike capabilities.[3] Even though major surface

[3]For more comprehensive analysis of PLAN's modernisation programs, see Gene D. Tracey, "China's Navy in the 1990s", Asian Defence Journal (hereafter ADJ), No. 10/89 (October 1989), p. 44; "Reporters Visit Nuclear Submarine Base", Jianchuan Zhishi (Naval and Merchant Ships), 8 August 1989 in FBIS/China, 31 January 1990, pp. 62-63; Ling Yu, "New Trends in the Chinese Communist Navy's Destroyer Force", Wide Angle, 16 June 1990, pp. 40-49; Philip L. Ritcheson, "China's Impact on Southeast Security", Military Review, Vol. 74, No. 5 (April 1994), p. 46; Stephen L. Ryan, "The PLA Navy's Search for a Blue Water Capability", ADJ, No. 5/95 (May 1994), p. 30; John Wilson Lewis and Xue Litai, China's Strategic Seapower: The Politics of Force Modernisation (Stanford, CA: Stanford University Press, 1994); You Ji, "The PLA Navy in the Changing World Order: The South China Sea Theatre", in Dick Sherwood (ed.), Maritime Power in the China Sea: Capabilities and Rationale (Canberra: Australia Defence Studies, Australian Defence Force Academy, 1994), pp. 93-95; You Ji, "A Test Case for China's Defence and Foreign Policies",

ships, such as destroyers and frigates, are capable of ASW, only Luhu and Luda class destroyers and Jiangwei class frigates can carry ASW helicopters. The other surface forces which run ASW are Haijui and Hainan class patrol vessels. Even though Haijuis and Hainans have Thompson SS 12 VDS sonar, they have only depth charges as ASW weapons.

Moreover, the naval air force which runs ASW is relatively weak. Currently, the number of Harbin SH-5, which entered into service in 1989, is being increased to a total of about 30. A maritime patrol version of the Y-8 transport, which first flew in 1985, is to replace four Be-6 Madges. The Zhi-8 Super Frelon, which was built in China from late 1991, supplements the Aerospatiale SA-321 G which was delivered from France. Zhi-8's are equipped with French Thompson-CSF Sintra HS-12 dipping sonar and locally built Whitehead A244 torpedoes. The production of Harbin Zhi-9As (Dauphin 2), which are equipped with HS-12 dipping sonar and Whitehead A244 torpedoes, as main shipboard aircraft, is ongoing. Currently, China has agreed with Russia to obtain 12 Kamov Ka-28s, which will be deployed aboard some Luhu class destroyers and Jiangwei class frigates, to improve ASW capabilities.[4] The navy has 18 destroyers, 34 frigates, about 100 patrol vessels, and 64 helicopters (9 SA-321Gs, 5 Zhi-8s, and 50 Zhi-9As) and 15 land-based maritime aircraft (4 Be-6 Madges, 8 Y-8s and 10 SH-5s) for ASW. (See table 2.)

Contemporary Southeast Asia, Vol. 16, No. 4 (March 1995), pp. 384-85; Lien Ho Pao, "Newly Purchased Russian Submarines Transits Taiwan Straits", Hong Kong Newspaper, in BBC Summary of World Broadcasts (hereafter SWB), 22 February 1995, p. FE/2234, G/5; "China Planned to Purchase Six Attack Kilo-class Submarines from Russia", Gukbang Ilbo, March 6, 1995, p. 2; Paul Beaver, "China Plans its Greatest Leap Forward", Jane's Navy International (hereafter JNI) (July-August 1995), p. 11; You Ji, "The Chinese Navy and Regional Security", ADJ, No. 9/95 (September 1995), p. 12; Jason Glashow and Michael J. Witt, "Boost in Chinese Build-up Fuels Asian Worry", Defence News (hereafter DN), January 29-February 4, 1996, p. 6; Norman Friedman, "World Naval Development", U.S. Naval Institute Proceedings (hereafter UNIP) Vol. 122, No. 3 (March 1996), p. 124; and "China Expands Reach with Russian Destroyers", JDW, January 15, 1997, p. 5.

[4] "Russian Kamovs Set to Boost Chinese ASW", JDW, March 4, 1998.

Table 2. A Comparison of ASW Capability Forces in Northeast Asia

ASW Forces	Countries				
	China	Japan	Taiwan	DPRK	ROK
Surface Ships					
Destroyers	18	10	11	0	7
Frigates	34	48	18	3	9
Corvettes	0	0	3	0	27
Patrol Craft	100	0	0	6	0
Maritime Aircraft Craft					
Helicopters	64	100	18	0	20
Land-based Maritime Air craft	15	99	31	0	23

Sources: Jane's Fighting Ships, 1997-1998 and The Military Balance 1997/98.

The Japanese Maritime Self-Defence Force

Japan has already expanded into the world's third largest surface fleet—in response to regional insecurities and the draw-down of U.S. forces. Any change in U.S. strategy in the Pacific region could generate profound changes in Japanese maritime strategy. Since 1994, in the scale of the defence budget, Japan became the world's second largest country in military spending. Recently, Japan's ruling party called for an increase of 4.5 percent in defence spending for the first time since the current budget ceiling system was introduced in 1982.[5] Japanese policies regarding the post Cold War situation in Asia can be represented in part by the open expression of its intention to expand its international role in the military sector. Japan's SDF, for constitutional reasons, is not composed of armed forces organised for the purpose of carrying our forward force projection. But they have grown into one of the most powerful military forces in the Asia-Asia Pacific region.[6]

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[5]"Japanese Cabinet Prepares to Adopt Tough Budget Ceiling", ADJ, No. 9/96 (September 1996), p. 80.

[6]Steward Henderson, Japanese National Security Policy: Changing Perceptions and Responses, Canadian Ministry of External Affairs and International Trade Policy Planning Staff Paper No. 92/1 (Canada: Canadian Ministry of

The characteristics of Japanese military capabilities can be noted in the modernisation of its naval forces. The military threat posed by Japanese military power comes not only from its nuclear weapons potential but also the growth of its naval capabilities. Japan's reinforcement of its ground and air forces is designed to enhance its defensive capabilities, but the strengthening of its naval forces attracts world attention because it represents the expansion of Japan's projection of power. It is already involved in maritime operations out to 1,000 nautical miles, which takes it almost as far south as the Philippines. In regional terms, Japan already has a substantial and very modern naval force, including some 100 maritime combat aircraft and 64 major surface combatants.

Modernisation of Submarine Forces. Currently, the most effective element in Japan's Navy is its modern submarine force. The MSDF has 16 submarines in two flotillas. There are seven submarines of the Harushio class (of 2,750 tons submerged), the first built in 1990 and the last delivered in March 1997. Nine older Yushios are being replaced by a new Oyashio class from 1998. The Oyashio is the first of a new class of SSKs. It is anticipated that there will eventually be six of this class. Japan is not looking to NATO models, apparently preferring to develop its own technology and to acquire U.S. Harpoon missiles and mines. In the wake of Japan's recession, future naval plans have been scaled down, but the planned procurement of five submarines by the end of the century remains unchanged. Development is pursued with discretion, particularly in high tech areas, but since July 1994 a technology management group has facilitated the bilateral exchange of military technology in which there are still gaps, especially in the area of command and control. A Japanese submarine squadron takes part in RIMPAC, the multinational exercise around the Hawaiian Islands, that takes place every two years involving the United States and Canada, as well as South Korea. (See table 1.)

Modernisation of ASW Forces. The MSDF is currently building several Kongo class (9,485 tons) destroyers equipped with the Aegis system and Murasame class larger ASW destroyers that would be capable of operating in high threat areas. Kongo class destroyers were commissioned in 1993, 1995 and 1996. These

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External Affairs and International Trade, 1992), pp. 7-8.

ships have SQS-53B bow mounted active search and attack sonar and towed array, and are equipped with six 324mm torpedoes, and 90 Standard and ASROC weapons—29 cells forward and 61 cells afterward. They can carry SH-60J Seahawks. The first of the Murasame class destroyers was commissioned in March 1996 and the second of this class, HARUSAME, commissioned in March 1997. A further five ships in this class are planned to be in service by March 2001. Most of the destroyers have Nec OQS-4 or 5 sonar, and are equipped with torpedoes and ASROC launchers. They can carry Seahawk or Sea King helicopters. The navy has 10 destroyers and 48 frigates, including 24 FFHs and 24 FFs, for ASW missions. Even though the frigates have sonar and torpedoes, they do not have ASROC launchers and helicopter platforms.

Long-range surveillance duties are primarily the responsibility of maritime patrol aircraft, while the separately controlled Maritime Safety Agency carries out Coast Guard duties. As there are no aircraft carriers or major amphibious ships to escort, and the whole navy is still confined to within 1,000 miles of the coastline, this leaves the large destroyer and frigate force somewhat short of obvious employment except when it joins up with the U.S. Navy, which retains a carrier group based at Yokosuka, largely paid for by Japan. The navy's ASW air forces are about 100 P-3 land-based maritime aircraft, six land-based helicopter squadrons consisting of about 60 SH-3A Sea Kings and four shipboard helicopter squadrons consisting of about 50 SH-60J Seahawks.

Two Korean Navies

South Korea is placing greater emphasis on its long-range air and naval capabilities, procuring hundreds of new combat planes from the United States and building dozens of new frigates and destroyers. North Korea is unable to compete with South Korea in high tech conventional arms due to its financial problems and appears to have placed greater emphasis on the development of ballistic missiles and weapons of mass destruction. Without Russian logistics assistance, however, it is questionable whether North Korea's many Russian systems will remain workable. In late 1993, North Korea bought some 40 ageing attack submarines from Russia, ostensibly for scrap metal. The boats will probably be used for spare parts for North Korea's own obsolescent Romeo class submarines—basic attack vessels with virtually no ASW potential. Furthermore, the North Korean Navy is badly affected by the economic catastrophe overwhelming the country.

Modernisation of Submarine Forces. South Korea's programme for nine Type 209 submarines is picking up speed with the first of the class, CHANG BOGO, commissioned in 1993. The class is due for completion in 2001. Only one of the nine is German-made, and all of the others are being built in South Korea. The original plans for a total of 18 submarines are unlikely to be funded,[7] but current programs aim at nine.[8] Compared with Chinese and Japanese submarines, the two Korean forces are very weak. South Korea's new submarine project, which will upgrade the existing Type 209-1200 submarines for a batch of six 1,500 ton submarines with air-independent (AIP), might be delayed for several years by its economic problems.[9] North Korea has brought only 16 coastal submarines of the Sang-O class into operational service since the beginning of the 1990s.[10] (See table 1.)

Modernization of ASW Forces. South Korea is building Korean Destroyer Program (KDX) class (King Kwanggaeto class) destroyers; the first of which was launched in October 1996 for delivery in 1998, with the second and third scheduled for handover in 1999. While the First KDX is still being built, the South Korean government approved the first three ships under the improved multi-purpose destroyer (KDX-2) program in April 1996. According to the program, the KDX-2 has a full load displacement of nearly 5,000 tons, with the prototype due for delivery in 2001.[11]

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[7]Joris Janssen Lok, "South Korea's Naval Build-up Continues", IDW, May 8, 1993, p. 7 and Jane's Fighting Ships 1994-1995, p. 247.

[8]IDW, October 30, 1996, p. 17 and "Hyundai Court Move Stalls Daewoo Submarine Order", JNI, Vol. 103, No. 1 (January-February 1998), p. 55.

[9]"Hyundai Court Move Stalls Daewoo Submarine Order," JNI, Vol. 103, No. 1 (Janu**a**ry-February 1998), p. 55 and Joris J. Lok, op.cit., p. 33.

[10]Joseph R. Morgan, Porpoises Among the Whales: Small Navies in Asia and the Pacific, East-West Special Report, No. 2 (Hawaii: East-West Centre, 1994), p. 27 and Jane's Fighting Ships 1994-95, pp. 97-98.

[11]Antony Preston, "Regional Naval Review 1997-Asia-Pacific Regional Navies Continue to Expand", Asian Military Review, Vol. 5, No. 6 (December 1997-January 1998), p. 40.

This ship is superior to the KDX in terms of endurance, sea-keeping and combat capability. The core enhancement is an improved weapons systems for anti-ship and anti-air missiles. Systems considered for the KDX-2 include Harpoon anti-ship missile, MK-41 Vertical Launch System for firing standard SM-2MR Block III/IV ASROC and a five inch main gun.[12] Even though the navy's next generation KDX-3 class destroyer, which will be much larger than KDX-2, was on the drawing board, KDX-3 programmes were delayed for several years by the economic crisis. The other two main shipbuilding programs are Ulsan class ASW frigates and Po Hang class large patrol corvettes.[13]

The major forces for ASW in the ROK Navy are ex-U.S. destroyers, frigates and corvettes. The destroyers have sonar and torpedoes, but the frigates do not have ASROC launchers and helicopter platforms. Nevertheless, the North Korean Navy has just three frigates—one Soho and two Najins—and six Hainan class patrol vessels for ASW roles, and does not have naval air forces. Naval air forces of the ROK Navy with ASW capability consist of two land-based ASW squadrons—15 S-2E and eight P-3Cs—and one shipboard helicopter unit, which has eight Alouettes and 12 Lynxes. (See table 2.)

The Taiwanese Navy

Lessons learned from the Gulf War have resulted in the Taiwanese government adopting a strategy of acquiring high technology weapons systems to upgrade its fleet. Utilising its own impressive industrial and high technology base to build ships in Taiwan and to develop indigenous technology so as to neutralise Beijing's blockade attempts is another priority. Naturally, changing circumstance has been followed by new procurement choices. Even though Taiwan's emphasis on amphibious warfare, for instance, has slowly declined, ASW concern is still increasing.

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[12]Robert Kaynoil, "Next-Generation KDX to be Bigger, Better", IDW, May 8, 1996, p. 17; "KDX-2 Destroyers Sails Ahead", INI, Vol. 101, No. 6 (June-August 1996), p. 6; and Anthony Leung, "South Korean KDX-2 and KDX-3 Programmes", Naval Forces (hereafter NF), Vol. 17, No. 4 (1996), pp. 8-11.

[13]For more details, see Prasun K. Sengupta, "Regional Warship Design and Construction Capabilities", ADJ, No. 12/97 (December 1997), pp. 49-50.

The less modernised component of Taiwan's substantial, but ageing, destroyer fleet is also starting to be phased out, while the frigate fleet, which runs ASW and surface warfare, is expanding. Taiwan has been able to concentrate on a plan aimed at upgrading all three branches of the armed forces. In August, 1991, Defence Minister Chen Li-An pronounced "modernisation of weapons" as the "key task", and, according to one report, Taiwan plans to spend $40 billion on arms over the next decade.[14] The PRC Navy is improving its naval blockade capability around Taiwan through the purchases of a potentially large number of Kilo class submarines, two Sovremenny class destroyers and the production of additional large surface combatants.

After the Chinese missile exercises on 21-23 July 1995, on 8-13 March 1996 Taiwan embarked on a naval expansion program and took delivery of six French La Fayette class frigates to bolster its ASW and anti-surface capabilities against Chinese attack. In 1997, the navy purchased 100 torpedoes and support equipment from the U.S. Department of Defense under a $66 million contract to bolster its ASW capability.[15]

Modernisation of Submarines. The existing submarine force of four is small, and Taiwan is facing enormous problems supplementing it. In the 1980s Taiwan acquired two 2,600 ton Hai Lung class submarines (based on the Dutch Zwaardvis class), built in the Netherlands and armed with torpedoes capable of carrying a 250 kilograms warhead up to 12 kilometres.[16] Taiwanese submarine deals with France, Germany and the Netherlands have met with protests from Beijing. It was also reported the navy tried but failed to acquire an export license from other countries to build up to 12 submarines. Australia, wishing to export its new Collins class, categorised the diesel electric submarine as a lethal weapon and stated that a contract of this magnitude was impossible. Currently, the Taiwanese Navy is considering possible indigenous self-construction of submarines because of failed attempts to buy

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[14]Joseph R. Morgan, op.cit., p. 22.

[15]Ed Blanch, "Asia's Arms Buys Herald New Race?", Pointer (March 1997, p. 1.

[16]Dora Alves, "Submarines in East Asia", THE SUBMARINE REVIEW, (October 1995), p. 63.

modern submarines on the international market.[17] (See table 1.)

Modernisation of ASW Forces. Antisubmarine warfare is increasingly important for Taiwan to counter missions against them by mainland China. The Fleet's existing 12 frigates are being increased by a further eight.[18] The KANG DING is the first of six modified French La Fayette class (3,500 tons) frigates ordered in September 1991. The first two, KANG DING and SI NING, were delivered in 1996 and the last vessel, CHEN DU, was handed over to the navy in January 1998.[19] Additional purchases of three retired U.S. Knox class frigates are planned up to a total of nine. The navy has five Cheng Kung class (4,200 tons) (Kwang Hua I) guided missile frigates, which are the locally-built variant of U.S. Navy's OLIVER HAZARD PERRY (FFG 7) and equipped with Hsiung Feng II SSMs and modern ASW systems. The Cheng Kungs are also armed additionally with two S-70C antisubmarine helicopters.[20] Cheng Kung and Kang Ding class frigates will improve Taiwan's ability to locate and attack Chinese submarines. Two more are under construction but an improved version of Cheng Kung class frigate (Kwang-Hua II) has been delayed indefinitely. The modern frigates are replacing older destroyers, some of which have been so heavily modernised they will remain in service for another decade. Seven Gearings have capabilities approaching to the Cheng Kung class equipped with SM-1 and

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[17]Barbara Opall, "Taiwan Trims Industry Goals", DN, September 1-7, 1997, p. 4 and IDW, February 25, 1998, p. 16.

[18]Thomas A. Dorhan, "East Asia and the Pacific: The Security of Region", in Douglas J. Murray and Paul R. Viotti (eds.), The Defence Policies of Nations, 3rd ed. (Baltimore: The John Hopkins University Press, 1994), p. 346.

[19]Weapons for this class are mainly equipped with U.S. Harpoon SSMs, ASROC and Italian-design guns and each frigate carries a Sikorsky S-70C(M)1 Thunderhawk helicopter. J.A.C. Lewis, "Taiwan's Navy Receives Final la Fayette Frigates", IDW, February 4, 1998, p. 16.

[20]Apart from the two previously commissioned frigates, CHENG-KUNG and CHENG-HO, the navy has six additional frigates planes to be completed by the China Shipping Company by 1999. Christie Su, "Navy Commissions Third Frigate", *The Free China Journal*, March 10, 1995, p. 1.

Hsiung Feng II missiles.[21] Naval aircraft to be used for ASW missions, include 18 recently acquired helicopters. Nine Sikorsky S-70Cs are equipped with search/dipping sonar, depth charges and torpedoes. Furthermore, 31 S-2 ASW aircraft have been upgraded. Currently, the Taiwanese Navy is considering procuring a number of P-3 maritime patrol aircraft from the United States to improve ASW capabilities. (See table 2.)

Conclusion

The effectiveness of submarines cannot be underestimated as recent naval warfare has shown in the 1982 Falklands conflict with the loss of the old Argentinean cruiser GENERAL BELGRANO (an ex-U.S. Brooklyn class cruiser) by the Royal Navy's nuclear attack submarine HMS CONQUEROR. The effectiveness of antisubmarine weapons in shallow waters in Northeast Asia remains open to question. Even though most navies have no ocean-going submarines, the silent running SSKs are a potent threat. The current effectiveness of the SSKs will require navies to have very powerful ASW capabilities to counter a dual threat.

The greatest weakness of the old type SSKs in the region is their limited underwater endurance, a factor of limited battery life and lack of auxiliary electrical power. What is significant today is that some of the recognised limitations of previous generation SSKs are being overtaken by the modernisation programs based on new technology in Northeast Asian navies. Most Northeast Asian countries are still faced with ASW problems, as they can operate only in inshore waters, yet still rely on depth charges and torpedoes which were designed to attack targets in the open ocean and have a dubious performance record in shallow seas. Furthermore, acoustic homing torpedoes are at a distinct disadvantage due to noise reflection from the shallow sea bottom, in particular in the Yellow and East China Seas. Even though there is still a discord between submarine forces and ASW capabilities in Northeast Asia, in the 21st century, most navies will continue to modernise their ASW forces, including major surface vessels and maritime patrol aircraft and helicopters, to solve those weak points.■

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[21] Ibid., p. 1.

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.

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

THE 1931 NAUTILUS EXPEDITION TO THE NORTH POLE

by Midshipman William G. Clautice
February 1959

Editor's Note: Captain Bill Clautice wrote this article during his First Class year at the Naval Academy. It is reprinted here both for its inherent historical interest and for an illustration of how Arctic operations looked to an aspiring submariner of almost 40 years ago. References and footnotes have been deleted for ease of reading.

From Failure to Success

Until the year 1931, the Arctic had been crossed only twice in the history of the world, once by airship and once by airplane. It was in this year that Sir Hubert Wilkins was to attempt to make the crossing beneath the frozen ice pack in a submarine. He failed and it was not until 27 years later that man succeeded in this task.

Why the Arctic

It may be said that the potential profits of any such expedition may be divided into two parts—the scientific and the commercial. Of primary scientific interest was the possibility of establishing permanent meteorological stations for the purpose of seasonal forecasting. Since the Arctic is the critical breeding ground for much of the weather experienced by the Northern latitudes, such explorations were of economic significance to farmers, consumers, umbrella manufacturers and aviators.

There were great possibilities in the commercial awakening and opening up of some of the lands bordering on the Polar Sea. Siberia has over 20 rivers emptying into the Arctic Ocean, with abundant forests and rich deposits of gold and platinum. Her rich black soils provide probably the best wheat-growing lands anywhere in the world. The submarine could transport these products to New York via the Polar-under ice route—about half the distance of the Canal route.

Of strategic value, the Arctic Ocean is the central area of the earth's land masses. Naval operations there will always be of paramount importance. Though unrealized at the time, this area is ideally located for radar pickets on the perimeter of the ice pack and would conceal Polaris-type submarines under the ice with utmost efficiency. A principle arm of our national defense lies in this region.

The History of the Idea

The thought of exploring the Arctic Ocean by submarine actually preceded the attempt by almost 300 years. In 1648 an ancestor of Sir Hubert Wilkins, known in the history of British science as Bishop Wilkins of Chester, penned a work entitled Mathematical Magick. Chapter V of Book II in this volume was headed *Concerning the Possibility of Framing an Ark for Submarine Navigations. The Difficulties and Conveniences of Such a Contrivance.* In this chapter he speaks of such a contrivance being safe "from ice and great frosts, which do so much endanger the passages towards the poles". In 1869 Jules Vernes' Twenty Thousand Leagues Under the Sea contributed much to later planning. However, it was Simon Lake in 1897 who built the first submarine designed for *under ice* work, ARGONAUT. The following is the preamble to his patent on this invention:

> This invention relates to submarine vessels, and is particularly designed for navigating in water covered by surface ice, and has for its object, first, to provide a submarine boat with means for engaging the under side of the ice to furnish a sliding contact therewith and to combine with such means for ballasting the boat, in such a manner that the contact between the boat and the bottom of the ice will be reduced to a minimum; second, to provide the boat with a vertically adjustable guide or guides projecting from the boat and adapted to engage the surface of the ice or the water bed and guide the vessel over the uneven surface thereof; third, to provide a traction wheel arranged to engage the under surface of the ice and means for rotating the said wheel to propel the vessel; fourth, to provide improved means for supplying air to and exhausting it from the interior of the boat and the engine; fifth, to provide means for rendering harmless back explosions of the engine; sixth, to provide

novel torpedo mechanism for blasting the ice, blowing up ships, and the like; seventh, to provide means for affording an exit from the boat through the ice; eight, to provide novel means for establishing telephonic communication between the submarine vessel and another vessel or a fixed station, and, lastly, to provide certain other features of invention, hereinafter fully described.

While the United States was occupied with purchasing conventional submarines from Lake for military purposes, there was one who seriously considered this means of conveyance for a more peaceful purpose, that of Arctic explorations. This was Sir George Hubert Wilkins.

<u>Biography of Wilkins</u>

Wilkins was born in South Australia in 1888, son of a sheepherder and youngest of 13 children. Bad years and drought caused hard times and curtailed his formal schooling, but he continued his education by mail order catalogues. Meanwhile, he observed how the land became scorched for lack of rain, how the animals died and how hardworking people were driven to begging because the country was changing into a desert. It was during these years that his thoughts of becoming a polar explorer began to ripen. In order to forecast weather for longer periods one needed to know the conditions in the entire atmosphere. To complete the picture it was particularly necessary to have observations from the polar regions, and hence his desire to become an arctic explorer.

At age 20, Wilkins proposed his life plans for the next 40 years to include the first 20 years traveling in as many different regions as possible, especially the polar areas and during the following 20 years he would employ what he had learned in organizing a network of meteorological stations in the polar regions for their importance in daily and long range weather forecasting.

Despite the fact that his period of traveling extended long beyond the proposed 20 years, his career was little short of phenomenal. He was commander of the first airplane to cross the polar region. He was wounded nine times while acting as a front line correspondent with the Australian Corps in World War I.

As a pilot, his first thought was exploring the polar regions by airplane. However, frequent conversations with the famed explorer, Vilhjalmur Stefansson, convinced him that with a submarine it would be possible to go wherever one desired in the Polar Sea, carrying an abundance of excellent scientific equipment and instruments, and with sufficient time and opportunity to perform a series of valuable observations.

Planning the Expedition

In the summer of 1928, Wilkins met Commander Sloan Davenhower, who was Simon Lake's partner and son of John Davenhower, master of JENNETTE of De Long's expedition in the Arctic. Davenhower was a graduate of the Naval Academy in 1907, served on submarines from 1909 until 1912 when he joined the Lake Torpedo Boat Company. Returning from work in the Arctic and Antarctic, Wilkins again met Davenhower in 1930, and brought up the question of finding a submarine suited for use in the ice. Lake, Davenhower and Wilkins discussed the project at length and were convinced that a submarine for such an expedition should be completely designed and built from the keel up. However, the funds at Wilkins' disposal were insufficient. At first it was decided to use the little DEFENDER, privately owned by Lake and Davenhower. With this decision it might be said that plans were definitely underway for what was to be the spectacular event of the decade—a polar crossing by submarine.

Not completely satisfied, due to the extremely small size of DEFENDER, other possibilities were sought. In accord with the London Agreement, some of the comparatively modern submarines belonging to the Navy were to be destroyed. Among these was O-12 built by Lake in 1917 and, according to him, suitable for reconstruction at a small cost.

Since Wilkins was not an American citizen, negotiations with the Navy Department were handled by Lake and Davenhower. On June 3, 1930 the O-12 was transferred to the U.S. Shipping Board which in turn leased it to the firm of Lake and Davenhower for "$1.00 a year on condition that it be put at the disposal of Wilkins for no other than Arctic research work; further, that within five years the ship should be returned to New York for destruction, in compliance with the terms of the London accord."

O-12 was 175 feet in length, had a beam of 16 feet, 3 inches and surfaced draft of 18 feet, 10 inches. Her displacement was 485 tons surfaced and 566 tons submerged. She had two sets of engines—500 B.H.P. (410 rpm) 6 cyl. 4 cycle Sulzer Diesel engine and two motors—440 H.P. Diehl Mfg. Co., with Cutler-Hammer magnetic controllers.

The vessel had two propellers, immediately beyond which were found the two horizontal rudders used during submersion, and the conventional vertical rudder. Both the screws and elevated rudder extended far over the side of the ship and could thus easily be damaged when in the ice. A submarine with only one propeller would have been preferable, but such a type was not available.

At the economical surfaced speed of 11 knots she had a maximum operating radius of 7326 miles. At a submerged speed of 8 knots she could run for more than 40 hours, allowing a maximum underwater radius on one battery charge of about 125 miles. However, it was later pointed out by Harold Sverdrup, the chief scientist aboard, that this submerged radius should never have been proposed since the diesel engines were electrically started and required so much current that they could not be started if the batteries were more than half emptied.

The problem of recharging the batteries while under the ice pack is most interesting. There are throughout the ice pack leads or polynyas which are nothing more than openings or holes in the ice. Wilkins' experience of 15,000 miles of Arctic flying and 5000 miles of walking of the ice had shown many patches of water five to ten miles apart even in winter. It was believed that a conventional submarine could surface within these clear areas. If not, a telescoped breather apparatus would admit the necessary air through drilled holes in the ice. There was also a five day supply of air on board for the crew in case of emergency.

The reconstruction period took place primarily at the Philadelphia Navy Yard from June of 1930 until January of 1931, at which time the vessel was towed to the Mathis Shipyard in Camden for finishing touches. At a total refitting cost of $200,000 the following special features were incorporated in her design for this Arctic expedition:

1. Heavily reinforced bow
2. Collapsible bowsprit
3. Diving compartment and airlock

4. Special bow lights protected by heavy glass
5. Telescopic conning tower and iceborer
6. Observation chamber and escape lock
7. Sled deck
8. Jackknife periscope
9. Emergency air drills
10. Pneumatically controlled guide wheel and arm
11. Special propeller guards.

Of particular importance, though later found to be inoperable, were the three ice drills, two of which were to be capable of drilling through ice 100 feet thick. These were to provide induction air for the diesels and an exhaust line in case of emergency. The third drill was to be capable of drilling a hole two feet in diameter through ice 13 feet thick to allow members of the crew to exit the boat.

In the forward end of the old torpedo room was installed a new diving compartment and air lock. By bringing the air pressure up in this compartment equal to the water pressure outside, the hatch could be opened allowing the diver to emerge and return. Soundings were to be taken and specimens collected and observed in this compartment.

The refitting completed, Davenhower announced: "The ship is seaworthy." O-12 was then rechristened by Lady Wilkins on March 24, 1931 with a rather distinguished name to be long remembered in the annals of history.

> "Ship, I name you NAUTILUS. Go on your wonderful adventure. In your heart is sacred treasure. Bring that treasure safely back to me."

Among those present was Jean Jules Verne, the grandson of Jules Verne.

<u>Scientific Undertakings</u>

"The principle aim of an explorer today must be to thrill and amuse his public; scientific work in order to be carried on at all must be made secondary to the showy side of an expedition." The spectacular was evident. However, scientific results were the goal;

the submarine the means.

In planning and supporting the scientific program, Lincoln Ellsworth was appointed Director of Scientific Research. Though he did not actually accompany the Wilkins' expedition, he was to rendezvous with it at the North Pole as navigator of the Graf Zeppelin's 8000 mile Arctic flight headed by Doctor Hugo Eckener.

The purpose of the expedition was to carry out a geophysical investigation on a route between Spitsbergen and the Bering Sea. In reporting on this purpose before the National Research Council of the National Academy of Science in June of 1930, Wilkins suggested the following areas of investigations:

1. Meteorology as to advisability of weather stations between 75 N and 80 N and between 50 W and 170 W determined by upper air as well as surface observations
2. Measurements of gravity by Meinesz gravity apparatus
3. Hydrography by sonic and mechanical depth finders
4. Oceanography with respect to currents, ocean bottom and water temperatures
5. Terrestrial magnetism
6. Ice distribution by photographs from balloons
7. Radio and television broadcasting experiments.

It was later decided to conduct spectrographic investigations of light penetrating through the ice and sea water. Biological material as well as marine inhabitants of the Arctic Sea were also to be collected for further investigations. As will be pointed out later, all of these scientific experiments were conducted, allowing the expedition to be termed "successful" despite the fact that the North Pole was never attained.

The Voyage

On the 4th of June 1931, NAUTILUS put to sea to make the crossing from New York to Plymouth, England, where additional scientific equipment was to be installed. However, on 13 June, a cylinder on the starboard engine cracked, rendering that engine useless, and on 14 June her port motor became disabled. She was forced to send for assistance before her batteries were completely exhausted. The helpless vessel was subsequently rescued and towed 1000 miles to Cobb, Ireland by USS WYOMING. WYOMING had aboard 975 midshipmen from the Naval Academy, bound for Copenhagen on their annual cruise.

The entire voyage, until NAUTILUS finally reached Spitsbergen, was plagued by mechanical failures primarily because the engines had been idle for five years. Doubtless, Commander Davenhower had this possibility in mind since he kept well in the track of Atlantic shipping and was in frequent communication with other ships. During the crossing, the submarine's periscope and bridge were washed away by high seas so that at times she was running completely blind. Among others in the series of overwhelming delays were several breakdowns in *Iron Mike*, an automatic steering gear developed by the Sperry Company.

Ports of call were Davenport, England for repairs and Bergen, Norway to take aboard scientific equipment and men who would be in this work—Mr. Harold Sverdrup, Dr. Bernhard Villinger and Mr. Floyd Soule. Sverdrup was to take the meteorological and oceanographic observation; Villinger would take the gravimeter measurements, make the collection of plankton, assist in the chemical-oceanographic analyses and the spectrographic determinations of light under the ice; Soule would make the magnetic observations, supervise the echo soundings and some of the chemical-oceanographical investigations.

Approximately one month behind schedule, on August 5, NAUTILUS departed Bergen and a week later, on 12 August, having paused briefly at Tromso and Skyervoy, the Arctic submarine was at last on her way. The one month delay was critical since the perimeter of the ice pack extends rapidly to the lower latitudes as summer wanes in late August. Heavy pack ice was encountered on 19 August and on the 20th, amidst temperatures below 0 degrees C inside and out, the deck was made clear for diving. However, much difficulty was experienced with the ice drills and it was not until 21 August that again the word was passed: "Down with the radio mast, ready for diving." For Wilkins it was a very tense moment. He had banked everything on proving that a submarine could be used successfully probing under the Arctic ice.

It was at this moment that all hope for reaching the Pole was lost. In making a last minute check, Davenhower had gone aft to check the propellers and the rudder. There was no diving rudder aft.

Unable to dive, with the propellers dangerously exposed to the moving ice and the hull already leaking due to an earlier collision with an ice floe, an ordinary man would have made the decision to return to Norway and abandon the expedition for the year 1931. However, Wilkins did not for a moment consider turning back before he had accomplished some of those objectives which were yet possible. The next two weeks were devoted to a thorough testing of all scientific equipment on board as well as putting to trial most of the mechanical apparatus specifically designed for under-ice work. The boat was rigged for diving, the bow submerged to a down angle of 10 to 15 degrees and *nudged* under the ice to a distance of approximately three-fourths of the length of the boat. The ice drill was tried but was found to be completely useless. The diving chamber was also used on several occasions and proved very satisfactory.

Radio communication was cut off for six days from 29 August until 8 September when moisture in the air spoiled the coils of the transmitter. When communication was re-established, rescue parties had been formed, as hope of survival was slight. On September 4th, William Randolph Hearst, whose newspapers had an exclusive on reporting the expedition's progress, sent a telegram urging Wilkins to return to safety. But Wilkins' reply was: "We shall continue as long as we are able to perform anything positive." On September 7th, when all had been done that was possible with the inadequate means at his disposal, the decision was made to return home.

NAUTILUS returned to Spitsbergen on 9 September. She was badly battered, leaking at two points, dented and scarred, with the drill mechanisms shattered, part of the ice runners crumpled, a permanent list of thirty degrees, damaged propellers, periscope and wireless masts, and with only a few spots of paint remaining on the entire hull.

After much deliberation, permission was finally granted by the U.S. Shipping Board, and the Arctic submarine was scuttled in the Bergen Fiord near Hellen at 200 fathoms on the 20th of November 1931.

Scientific Results

The measurements of the pull of gravity by Villinger were of great importance to Geodesy, the study of the earth's form, since previously no reliable work had been presented on the gravity in the upper Arctic region. Accurate calculations as to the oblateness of the earth at the Pole were then possible by comparing the pull of gravity at the Pole with that at the Equator.

The expedition also investigated the theory of Isostocy, i.e., the theory that the floating equilibrium of the earth's crust is attained by gravity forces from the Polar area.

A new type apparatus was built in Holland from the design of Professor Vening Meinesz for these gravity measurements on board NAUTILUS. The curves of three pendulums were photographically registered and from the oscillation period, the weight element was determined. Despite the fact that measurements could only be undertaken when the submarine did not roll or pitch, eight uninterrupted readings of one-half hour or more were taken.

By means of fathometer observations, three submerged mountain ranges were discovered 500 to 600 fathoms below the ice floes, with valleys 2000 fathoms deep, between Greenland and Spitsbergen.

It was also found that the Arctic Sea consisted of four temperature gradients; a cold layer on the surface, a warm layer caused by currents from the Atlantic Ocean, another cold layer, and still another warm layer which is heated by the earth's surface.

For chemical, meteorological, and oceanographical observations the vessel was stopped about every 30 miles at 10 different stations. Bottom samples were obtained, but they yielded only information as to the type of bottom deposit in that area.

The instruments lowered through the diving chamber could be seen 80 feet below sea level. Water samples and plankton were collected at depths up to 2000 fathoms.

1931-1958

After 1931 there were several published accounts of further Polar explorations by submarine, but the Second World War *snuffed out* the only one planned by Wilkins. Accompanied by his wife, Lady Wilkins, he was to make a second attempt, in 1938, in an air conditioned submarine being built in England, completely equipped with a newly designed ice drill. The war in Europe, however, postponed indefinitely this expedition.

In 1938 Russia planned a submarine voyage similar to Wilkins' to explore the Arctic area to determine the possibilities of establishing an air line to the United States over this route. This also was delayed by the threat and finally outbreak of war.

Though most of the information is classified, Naval operations were conducted in the Arctic area in 1946 and there are accounts of several fleet type boats sailing a few miles under the ice pack and returning.

At exactly 11:15 PM (EDT), August 3, 1958, the summit was attained. NAUTILUS (SSN 571) passed under the North Pole. Thirty-six hours later she emerged from under the ice in the North Atlantic having entered off Alaska's Northern coast. The Arctic had been crossed once again—this time by submarine.

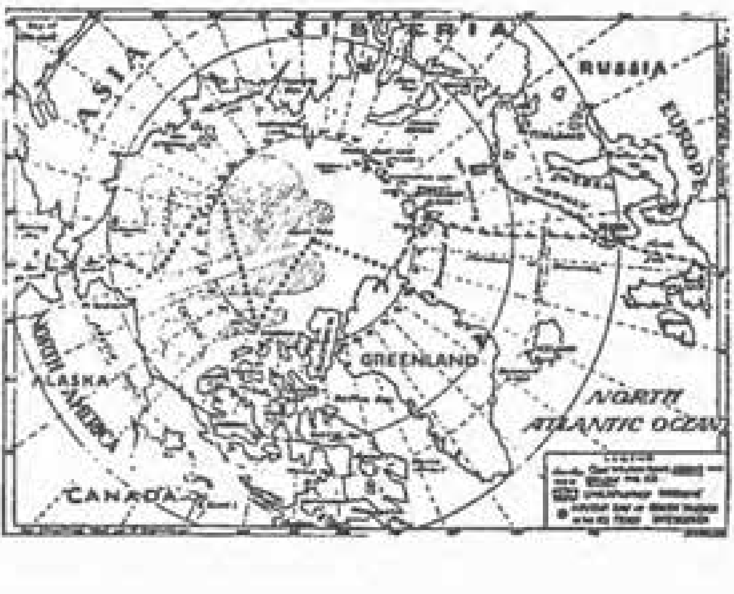
The vain attempt of the first NAUTILUS expedition in 1931 was far from a final defeat but rather a necessary stepping stone to success. One participant observed that "The future will show if anyone will cross the Polar Sea in a new and better submarine. I believe it can be done."

The future has shown that the Polar Sea could be crossed by a "new and better submarine". However, some of those features which enabled NAUTILUS (SSN 571) to accomplish this feat were no doubt unknown to the author of these words. Little did he realize that a boat completely independent of the atmosphere was necessary for this work. Rather than be dependent upon a gyrocompass which was untried in the higher latitudes, an inertial navigator would provide the means of navigation for *piercing the Pole*. There were no ice drills or inverted sled runners aboard and above all, the source of power was a nuclear reactor.

Hardly aware of the impending danger, NAUTILUS of 1931 may well have been his grave. The mysterious disappearance of the diving rudder was actually a fortunate misfortune. The leads of such a size to accommodate a surfaced boat were not, as believed, within the necessary radius of operation. The ice drills failed completely and certainly the gyrocompass would have become erratic in latitudes higher than the 83 degrees to which they penetrated. They would undoubtedly have been caught in the phenomenon of longitude roulette.

Further, the living conditions on board the nuclear NAUTILUS were greatly improved over those of Wilkins' boat. While in 1931 the crew was experiencing below freezing weather within a moist damp boat, where drinking water was non-existent, those aboard the 571 were warm and relaxed in a controlled environment with all the comforts of home. In addition, the modern NAUTILUS was faster, able to dive deeper and carry more scientific equipment. Television became her seeing eye, viewing the formation of the underside of the ice while she was in the true medium—under the sea.

So it is that man has conquered the undersea Polar passage though not without failures, the foundations of success. "If you succeed, go on; if you don't succeed, go on."■



SEIZING THE INITIATIVE

by RADM Robert R. Fountain, USN(Ret.)

Having recently attended the 1998 Submarine Symposium and having had subsequent opportunity to reflect upon the proceedings of that meeting in the light of some years detachment from the daily imperatives of the Force, I want to share what may be certain unpopular views with The League membership. I could not avoid an eerie feeling of deja vu in listening to the distinguished speakers of the Symposium—a feeling that the occasion resembled much too closely an imagined conference of battleship admirals in the 1920s, faced with a wave of disarmament on the heels of great victory, long on self-congratulation for past exploits but short on incisive thought for the wars of the future. In the admonition of a senior submariner not to allow submarines to be decoupled from the modern battlegroup was the echo of failed pre-WWII battle fleet concepts of submarine employment, as well as of the surface Navy's desperate embrace of the carrier as their Cold War force level salvation. Such budgetary tactics of weakness may help hold the line in the short term, but ultimately will cost us the respect of the Congress and our uniformed peers.

It is time to abandon the rearguard effort and seize the initiative in redefining undersea warfare for the future. The central objective cannot be the preservation of the general purpose submarine per se, although there will be ample roles and missions for these in the future still. The overriding objective must be the most effective and efficient waging of future wars at and from the sea. I found it disturbing that the thoughtful challenge issued to the assembly by a distinguished member of our fraternity, now a senior member of the Secretariat, was met with near derision. Equally troubling is the aversion to any broadening of the Force's charter lest it syphon limited resources from the submarine core. In the end, it is our responsibility to defend the nation, not to protect the submarine.

Modern warfare concepts are built upon force synergies and a grasp of the entire battlespace. They are no longer platform-centric. The undersea dimension cries out for someone to take charge of the total picture, a commander who will focus on a strategy for winning the war beneath the sea, not just for the employment of submarines or for their budgetary justification. There are some encouraging signs of a gradual drift of the Force in this direction, the assumption of responsibility for undersea surveillance systems, and more recently, the responsibility for operation of small special forces submersibles and COMSUBLANT's assumption of the role of COMASWFORLANT, CTF 84. Each of these new roles was, I perceive, forced upon a reluctant Submarine Force, rather than seized by the Force as an opportunity.

The largest single missing dimension of the undersea battle not yet consolidated in submarine hands is mine warfare. While anathema to submariners since our WWII experience, mine warfare has a role in beyond-surf zone ASW and undersea warfare generally. In frustration over Gulf War failures the Congress has for the moment consolidated mine warfare under Marine cognizance, but would readily accede to someone else who had a concept stepping up to the plate. While surf zone mine warfare may in fact have more in common with riverine, swamp and beach mine warfare than with that practiced in deeper waters, and thus perhaps rightly belongs with the Marines, clearly mining and mine countermeasures in deeper waters have little to do with the Marines and much indeed to do with undersea warfare as a whole.

Organizationally, I would like to see submarine vice admirals ensconced as Commander of ASW and Undersea Warfare in each fleet with rear admirals in charge of strategic and attack submarines, surveillance, mine warfare and special forces/deep submergence operations subordinated to them. It should be the responsibility of those undersea warfare commanders to develop broad strategy for response to the full spectrum of undersea challenges, from traditional forward area operations to strategic open ocean sea denial and SSBN security, to anti-diesel and manned submersibles in confined seas. Such strategies must employ to full advantage all the assets available. Mines and surveillance systems may very well be our most effective response to diesel submarines and other small submersibles in shallow littoral waters, with submarine operations directed toward longer-ranged targets in deeper waters.

With all due respect to my friends who are laboring mightily to solve the submarine's communications problem, the continued employment of submarines in integrated direct support of fast moving battlegroups is a waste of scarce and expensive assets. Where battlegroups can afford to operate on relatively fixed geographic stations, submarines and tactical surveillance systems can be usefully employed in associated ASW operations, communicating intermittently in high data rate information bursts. Transiting battlegroups are better served by speed and longer-termed submarine and area surveillance ASW operations conducted in advance of the transit.

Despite recent demonstrations, submarines are best employed in the land attack role when pre-strike stealth and surprise are at a premium, or in those situations wherein the air and surface-to-surface missile threat is so severe at launch ranges offshore as to raise the cost of surface ship or carrier-launched strikes to unacceptable levels. Even then, the submarine is a one time punch designed to gain access for surface forces to follow. The inherent logistical problem of rearming a missile-launching submarine obviates its use in a sustained bombardment.

Those responsible for developing strategies for submarine employment, and the more generalized issues of undersea warfare, must use a scalpel when carving out roles and missions. The submarine is an expensive instrument, to be used skillfully in specialized tasks for which it is uniquely fitted, in a broader matrix of applications for which other elements may be better suited. Above all, we must expand our vision and command to include the entire panoply of undersea warfare applications and weaponry, from the surf line and harbors to the deepest ocean reaches.■

HORSES AND BOATS: THOUGHTS ON THE U.S. SUBMARINE FORCE IN THE 21ST CENTURY

by CAPT Ken Cox, USN(Ret.)

An elite organization...Great historical record...An asymmetrical threat...Expensive to maintain...Dated weapons systems...Superior mobility...Huge infrastructure...Romantic attachment...Entrenched bureaucracy...Searching for a mission. Sound familiar? It should; this was the status of the horse cavalry (in the United States and elsewhere) in the 1930s, but it is equally applicable to the United States Submarine Force (the *boats*) entering the 21st century.[1]

Background

Edward L. Katzenbach's *The Horse Cavalry in the Twentieth Century: A Study in Policy Response*[2] provides a good point of departure for a perspective on the future of the Submarine Force. The cavalry metaphor is not far fetched and has been artfully employed by others to describe the Submarine Force. For example, Captain Jim Patton has made the point that the submarine (in particular, the nuclear submarine) is akin to the cavalry owing to its self-containment and other characteristics. Patton opines that submarines assumed the mantle from the cruisers at some point around the middle of the 20th century, when air power eliminated the cruiser's forte of being fast enough to get away from retribution following a shipping or coastal attack.[3]

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[1]Submarines were originally a coastal defense scouting force—so small that they flew boat flags and thus gave rise to the term *boats* by which they are affectionately called today.

[2]Edward J. Katzenbach, Jr., "The Horse Cavalry in the Twentieth Century: A Study in Policy Response," in *American Defense Policy*, 4th ed., eds. John E. Endicott and Roy W. Stafford, Jr. (Baltimore: Johns Hopkins University Press, 1977), 366-73.

[3]See Captain James T. Patton, USN(Ret.), "Strategic Employment of U.S. Submarines in the New Security Environment," *Proceedings of the Sixth Submarine Technology Symposium* (U), (Laurel, MD: Johns Hopkins Applied Physics Laboratory, 11-13 May 1993), 53-59.

Katzenbach's thesis is that the lag time—that lapsed period between innovation and a successful institutional or social response to it—is probably on the increase in military matters. He posits that there is not the urgency that there should be in the military to make major institutional adjustments in the face of the challenge of new weapons systems, if for no other reason than the problem of testing is so difficult. And that the absence of any final testing mechanism of the military's institutional adequacy, short of war, has tended to keep the pace of change to a creep in time of peace, and, conversely has whipped it into a gallop in time of war. He makes the insightful remark that the military history of the first half of the 20th century was studded with institutions that have managed to **dodge the challenge of the obvious**. As an example, he cites the Coast Artillery, which in the United States persisted, with little or no justification, until the middle of the Second World War. Today, this issue is relevant to the Submarine Force; it is dodging the challenge of the obvious.

The Challenges

At Sea. What is the challenge at sea? The bipolar threat of the Russian Navy, especially its enormous submarine force, is gone and not likely to reappear for the foreseeable future. If the building (or non-building) rates of the Severodvinsk class SSN and the Boray class SSBN, coupled with the serious deterioration of the Russian operating forces are any indicators, then what is on the horizon? Is the threat the Kilos and other Third World submarines; the conventional and nuclear submarines of China; the Sango class submarines of North Korea; the high speed semi-submersible special operations force (SOF) raiding craft? Or is it a combination of all of them?

Certainly, against all types of submarines in the open ocean, the nuclear submarine is, and will remain, the foremost option to track, and destroy, if ordered. If the threat is the conventional diesel powered (or air independent propulsion) submarine operating close to the battlegroup, based on the Royal Navy's 1983 experience in the Falklands, the nuclear submarine is a potential problem not a solution, e.g., "Sounded sub, Sank same!" In this case, the nuclear submarine can provide the outer ring of defense, and with air/surface-launched torpedoes and other ordnance being used in the ASW

Summary

So where all does this lead? Katzenbach in his conclusions writes:

> The military profession, dealing as it does with life and death should be utterly realistic, ruthless in discarding the old for the new, forward-thinking in the adaptation of new means of violence. But equally needed is a romanticism which, while perhaps stultifying realistic thought, gives a man that belief in the value of the weapons system he is operating that is so necessary to his willingness to use it in battle...Whether a man rides a horse, a plane or a battleship into war, he cannot be expected to operate without faith in his weapon system. But faith breeds distrust of change... Finally, change is expensive, and some part of the civilian population has to agree that the change is worth the expense before it can take place.[4]

For the Submarine Force, as it should have been for the horse cavalry, the answer would appear to be obvious. While keeping faith with the submarine achievements of World War Two and Cold War, the Navy hierarchy (not an *ad hoc* Think Tank group or Defense committee) must make a pragmatic appraisal of what submarines (in consort with other joint forces) can meaningfully contribute to national security in the 21st century. And after that soul searching, the Navy must get a jump on the lag time described at the beginning of this paper through implementation of innovative concepts and technology insertion. It is equally obvious, that approach must be taken and embraced by the Executive and the Legislative Branches (the civilian population alluded to by Katzenbach), and they have a sense of ownership.

To keep the Submarine Force from pricing itself out of business, an important criterion must be: *How much is enough?* This applies to civilian and military infrastructure, OPTEMPO, as well as the submarine themselves. Likewise, does each and every submarine have to be all things to all people? For starters, the

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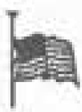
[4]Katzenbach, 372.

series production of a somewhat smaller, albeit almost as expensive, version of SEAWOLF (i.e., the NSSN)[5] may not be the most cost effective way to proceed. What may be required is a blend of submersible platforms, not every one a *super submarine*, to cover the span of anticipated missions, while at the same time ensuring a sufficient number of submarines and qualified, motivated personnel to do the job. It may be heretical to say, but unless major institutional changes are made, the *boats* as we know them today may follow the course of the horse cavalry.■

IN MEMORIAM

LT Gene L. Albert, USN(Ret.)
CDR H. Collins Embry, USN(Ret.)
COL Albert R. Haney, USA(Ret.)
RADM(sel) John. P. Jarabak, USN
CAPT James P. Keane, USN(Ret.)
CAPT Thomas C. Maloney, USN(Ret.)



[5]With its submerged displacement of 7700 tons and an expected crew of 113, the NSSN is larger than the early Polaris class SSBNs, which displaced 6888 tons and had a crew of 112 officers and men.

NAVAL SUBMARINE LEAGUE
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RE: WALDO LYON: A LEGACY OF DEDICATION

August 10, 1998

I was distressed and saddened by Dick Boyle's *tribute* to Waldo Lyon (*Waldo Lyon: A Legacy of Dedication*, **THE SUBMARINE REVIEW**, July 1998, pp. 115-117). To use a tribute to a great submarine pioneer for an unbalanced attack on Navy leadership was wrong. Waldo Lyon gave so much to the Submarine Force that any written eulogy to him should have been devoted to his achievements and contributions.

I have often compared Dr. Lyon and his role in the development of Submarine Arctic Operations to that of Admiral Rickover and nuclear power. Service to country, insistence on quality, and dogged determination to achieve goals were common traits. Both were individuals usually correct...and both were not universally popular. I ask that you recall the sentiment around Washington as Admiral Rickover's career drew to a close and his life clearly was nearing its end. He became a bit out of touch, as I remember. But in death, and certainly to the Submarine Force, Admiral Rickover was a true hero and was addressed as such.

Similarly, your publication should have remembered Dr. Lyon in a wholly positive way. The insinuations of ignorance on the part of Navy leadership, (which are unfortunate and wrong), should be the subject of separate articles with a balance as to current realities. I firmly believe our Submarine Force leaders are doing as much as they can in the Arctic in a funding environment that is not understood by many, including Dr. Lyon or Boyle.

Dr. Lyon's legacy will live forever in the Force. He created a capability when we needed it most, and the Force's current (and recent past) leadership know and appreciate that fact. The bottom line follows: Dr. Lyon was a real hero and national treasure. He should be remembered as such.

Sincerely,
George B. Newton
20104 Woodtrail Road
Round Hill, VA 20141

RE: THE NAVY TIMES BOOK OF SUBMARINES

March 18, 1998

Recently I was given a copy of the book *The Navy Times Book of Submarines* by Brayton Harris (**THE SUBMARINE REVIEW**, July 1998, p. 138). I found it of great interest, particularly since I spent about 22 years of my 30 year Navy career in the submarine service. The book is generally well written and very enjoyable. However I did notice several factual errors concerning matters about which I have first hand knowledge.

On page 347 the author states "...but two submarines were converted as commando delivery systems by adding recycled missile hangars (see Chapter Thirty-Two)..."

Comment. The page 347 statement that missile hangars were "recycled" is not accurate. USS PERCH (ASSP 313) and USS SEA LION (ASSP 315) were converted from fleet type submarines (SS) to troop carrying submarines, designated as ASSP in 1948, well before the first conversion of other submarines for Regulus missile duty. PERCH had a hangar which could carry either a HUP-1 helicopter or a landing vehicle tracked (LVT). I served in PERCH (based in San Diego), my first submarine assignment, in 1955 and 1956. To my knowledge, the hangar on PERCH was built by Mare Island Naval Shipyard for the PERCH conversion and was not a recycled missile hangar. In PERCH up to one hundred Marines were berthed in the forward, midships and after troop compartments. These troop berthing compartments were converted from the forward and after torpedo rooms, and from the forward engine room. The hangar on PERCH was only used for stowage of outboard motors and gasoline during my tour on board. Despite a contrary statement in *The Fleet Submarine in the U.S. Navy* by John D. Alden, there was not internal access to PERCH's hangar from below decks. The hangar could only be accessed from topside by opening the hangar door.

On page 368 the author states "GRAYBACK and GROWLER were the first boats converted to handle Regulus, by using PERCH-type troop compartments as hangars."

Comment. USS TUNNY (SSG 282) and USS BARBERO (SSG 317) were the first two submarines converted to handle the Regulus missile, well before GRAYBACK and GROWLER. Both TUNNY and BARBERO had hangars similar (in size) to the hangar on PERCH, perhaps not surprising since Mare Island Naval Shipyard accomplished all three conversions.

Following retirement of the Regulus I missile system in 1964, USS TUNNY was converted from a SSG to a troop carrying submarine to replace USS PERCH. Her conversion involved carrying troops in her former Regulus hangar. The hangars in GRAYBACK and GROWLER were quite different since they were designed to hold one Regulus II missile each, a missile twice the size of the Regulus I carried aboard TUNNY and BARBERO. The Regulus II never entered service, having been canceled in favor of the Polaris missile system. GRAYBACK and GROWLER carried two Regulus I missiles in each of their two missile hangars for a total of four missiles each. The hangars aboard GRAYBACK and GROWLER were never "PERCH-type troop compartments", they were designed specifically to carry Regulus II and Regulus I missiles.

Much later, after their deterrent missile patrol days were over, both GRAYBACK and GROWLER were planned for conversion to support SEAL operations. GRAYBACK's missile hangars were converted to carry swimmer delivery vehicles and allow submerged lock-out and recovery. She operated in that role in the Western Pacific for a number of years. Because of the cost of the GRAYBACK conversion, about $30 million, plans to convert GROWLER were canceled. I served in Guided Missile Unit 10, which supported the Regulus boats, as a nuclear warhead officer in 1958 and 1959. From 1959 to 1960 I was on Submarine Squadron One staff as Regulus missile flight planning officer and prepared Regulus missile training flight plans and supervised Regulus missile training operations for BARBERO, GRAYBACK, GROWLER, HALIBUT and TUNNY. From 1960 to 1962, I served in USS BARBERO, making three deterrent missile patrols. From 1963 through 1966 I served as Assistant Operations Office on the Pacific Submarine Force staff, and prepared operation orders for the Regulus deterrent patrols. Later in the 1972-1974 period I served as Chief Staff Officer for Submarine Flotilla Seven, under which command USS GRAYBACK operated.

Sincerely,

John F. O'Connell
Captain, USN(Ret.)
215 Green Street
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(703) 548-9107

PRINCIPLES UNDER DICTATORS

August 16, 1998—Haifa, Israel

I was carried away by the courageous act of Oskar Kusch, the German U-boat commander in WWII; he was an extraordinary man (THE SUBMARINE REVIEW, April 1998, p. 136).

To throw Hitler's portrait into the trash can on board a German submarine in wartime—that's something which can be understood and appreciated only by those who themselves lived and served under a dictatorship, and I was one of them—I served in a Soviet submarine. I would rather expect a Soviet navyman to become a *human bomb* than mustering the courage of throwing Stalin's portrait into the trash can.

I admire very much Commander Oskar Kusch and would like to find out as much as possible about this remarkable man. Can you help me, please?

Yours sincerely,
LCDR Joseph B.Y. Roitman, SN(Ret.)

FOR A SUBMARINE CHAPLAINCY

September 9, 1998

My name is Scott Callaham and I have served five years as a submarine officer, from 1993-1998. During that time, I was a Naval Submarine member and representative for the wardroom of USS JEFFERSON CITY (SSN 759).

I left submarine service in May of this year to pursue my calling to become a Navy Chaplain. I am now a student at Southwestern Baptist Theological Seminary in Fort Worth, Texas.

I am performing research in the area of chaplain ministry to the Submarine Force. I would like to ask if it would be possible to be put in contact with people who could help me in this task. Such people include chaplains who have served with submarine squadrons, staffs, etc. and submariners who have benefitted from chaplain ministry.

There is no specific period of history that I am concerned with. Rather, any and all information you might have in this area would be immensely appreciated and of great assistance.

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SALVAGE MAN
Edward Ellsberg and the U.S. Navy

by John D. Alden

Naval Institute Press, Annapolis, Maryland, 1998
Many photographs & maps
ISBN 1-55750-027-4

Reviewed by CAPT Len Stoehr, USN(Ret.)

Born in 1891 of Russian-Jewish immigrant parents, he was ambitious, articulate, and an academically outstanding Naval Academy graduate and engineering duty only (EDO) officer. He was also unconventional, assertive, and controversial. He was twice passed over by Navy boards for promotions that many others felt were well deserved. He was once promoted by act of Congress. Does all this sound familiar? Before you answer, remember that this is not a review of an H. G. Rickover biography. You have also been given an obscure clue in that Admiral Rickover was born in 1900. All of the descriptive material applies to Rear Admiral Edward Ellsberg, USNR(Ret.). Ellsberg was what was known in the early postwar years as a *tombstone* admiral. He received his promotion to rear admiral on retirement in recognition of combat decorations received while on active duty.

John Alden, as a professional engineer, a prolific writer (he has written several books and many professional and historical articles), a submariner, and retired EDO, is eminently well qualified to undertake the writing of Ellsberg's biography. He has used all of his skills and experience in the completion of the task. The book, as might be expected of one written by another engineer, is technically accurate and detailed in its descriptions of many of Ellsberg's salvage projects. What is not necessarily expected is the often moving and emotionally charged descriptions which he brings to both many operational incidents and the long and exceedingly happy and loving relationship between Ellsberg and his wife, Lucy.

Ellsberg first rose to national prominence through his work as salvage officer in the raising of USS S-51 (SS 162). S-51 had been running on the surface about twelve miles south of Block Island (at the eastern end of Long Island Sound) on the night of 25/26 September 1925 when she was rammed by the steamer CITY

OF ROME. S-51 went down immediately, but the bridge watch of four men and six others were able to get out before it went down. A boat from CITY OF ROME managed to rescue three of these men. Streams of bubbles rising from the boat were sufficient to mark the wreck's position in 132 feet of water. The Navy, at the time, had no operational salvage organization and Ellsberg had no salvage experience. However, when he informed his superiors, in particular Rear Admiral Charles P. Plunkett, the Commander, Third Naval District and Commander of the Brooklyn Navy Yard (where Ellsberg was then stationed), that he was sure that he could raise the submarine, he was given the job. As the Salvage Officer, he would have the possibly mixed blessing of working directly for the Commanding Officer, Submarine Base, New London, Connecticut and on-scene commander of the salvage operation, Captain Ernest J. King. King was already renowned as a leader who would back his subordinates to the hilt, but could also be terribly tough on those who did not meet his standards. (Ellsberg apparently met those standards because he often consulted with King regarding his assignments and other problems during his later career.) While the salvage of S-51 is sufficiently interesting and complex to deserve a book length treatment, for our purposes it should be adequate to note that Ellsberg's work, during which he was trained as a diver and invented a deep water cutting torch, won him a Distinguished Service Medal and a promotion to Commander by act of Congress. It also brought him national prominence that he fully exploited as an author and lecturer in a civilian career that commenced less than a year after the S-51 was sunk. Apparently Ellsberg was never one to hide his achievements and his flair for self-promotion led him into a number of conflicts with his seniors and contemporaries in the service. On the other hand, he also had enough loyalty to the Navy to give up a lucrative civilian career and voluntarily return to active duty to assist in the salvage of S-4 (SS 109) after she was rammed off Cape Cod in late 1927, and again at the start of World War II. His exploits during the war included salvage work in the Red Sea and off the coast of North Africa and, later, with the artificial harbor caissons used in the invasion of Normandy. Ellsberg's work at Massawa, where he worked with the British, with contractors, and with the Army to salvage scuttled Italian floating drydocks and provide shipyard services to the Royal Navy, was particularly outstanding from the standpoints of both technical innovation and leadership. His problems with civilian contractors and military contracting officers will bring smiles of recognition to many of those who have suffered through similar situations.

Commander Alden has written a very readable biography that, in some parts, could easily be termed a page-turner. Some of the descriptions of the salvage operations soar with vivid detail and the book is hard to put down. One minor gripe concerns the fact that Alden obviously likes and cares about his subject. As a result it seems that the many slights and obstacles that Ellsberg was faced with often seem to be the result of jealousy or other petty motivations. There are numerous references in the book to situations where it appears that Ellsberg pushed perhaps more than a little too hard. To have achieved the many successes that he did, Ellsberg was probably not the sweetest kid on the block. It does not make him a lesser man to show this. Nevertheless, Commander Alden does allow small undercurrents of Ellsberg's self-promotion to appear at times. Perhaps it is too much to ask that a biographical author not admire his subject.■

MEDITERRANEAN SUBMARINES
Submarine Warfare in World War One

by Michael Wilson and Paul Kemp

Crécy Publishing Ltd., Wilmslow, Cheshire, UK 1997

ISBN 0 947554 57 2

Reviewed by Antony Preston

The literature on submarine warfare in World War One is voluminous, but most of the better known English language work concentrates on the havoc wrought by U-boats in the North Sea and the Western Approaches. When the Mediterranean is discussed, the focus is almost always on the achievements of the Royal Navy in the Dardanelles in 1915-16; even the efforts of the French in that theater are largely ignored.

The authors have rectified this, documenting and analysing all the belligerents and their submarine operations, even those of the Russians and Bulgars in the Black Sea. Michael Wilson is a former submariner, and he looks at the problems with a sympathetic eye. The achievements are all the more remarkable when we remember that effective submarines had been in service for little more than 15 years. Yet even that short span was sufficient to turn the submarine into an advanced weapon of war. Torpedoes were sufficiently reliable, and so were diesel engines and electric motors. Living conditions were primitive, but already the concept of an elite was emerging in all the submarine operating navies, prepared to accept the danger and the dirt.

The heroes are the officers and enlisted men who fought so hard, notably the French, who valiantly persevered with attempts to penetrate the main Austrian fleet base at Pola, and the Austrians, who achieved great results with small numbers of largely obsolescent boats. There are not many villains, apart from senior officers like Admiral Haus, who berated Linienschiffsleutnant Rudolf Singule for not sinking the other cruisers after he had torpedoed the big armored cruiser GIUSEPPE GARIBALDI! The Italians showed excessive timidity, and the British failed to achieve the results they hoped for in the Adriatic, despite their ill concealed contempt for their Italian and French allies. There are sad stories too, like that of Nazario Sauro, navigator of the Italian boat GIACINTO PULLINO, which ran aground of the Dalmatian coast. Although serving in the Italian Navy, Sauro was a subject of the Austro-Hungarian Empire, and when the submarine grounded some of his crew apparently beat him up for suspected treachery. One hopes they were conscience stricken when the Austrians hanged him as a traitor at Pola. The photograph of him in captivity, still bearing the bruises on his face, is very moving.

The extent to which the authors have trawled among surviving archives can be seen in the unusual photographs and the comprehensive bibliography. There is also analysis of the results: 16 battleships and large cruisers were sunk in the Mediterranean by torpedoes or submarine-laid mines, and hundreds of merchant ships. Eight submarines were sunk by other submarines, five of them Allied, and two were sunk by air attack. Main characteristics of all the belligerents' submarines are provided. A fascinating book and a worthy addition to the literature on submarine warfare.■

SOUTH PACIFIC DESTROYER

by Russell Sydnor Crenshaw, Jr.
Naval Institute Press, Annapolis, Maryland, 1998
ISBN 1-55750-136-X
Reviewed by RADM Sam Packer, USN(Ret.)

This book should be read by all. It is a fascinating and factually precise account of the Solomons naval campaign in the South Pacific as seen from the viewpoint of a young naval officer in positions of increasing responsibility aboard a fighting destroyer, USS MAURY (DD 401), during this critical period of World War II. Captain Crenshaw describes in realistic and at times almost understated terms the extremely rigorous, demanding, and often terrifying events in the area of the Solomon Islands during the period of December 1942 to August 1943.

There are three elements of the book which are particularly worth noting, and for the submarine community, the third point is of particular note.

First of all, the book is written with a warmth of understanding and a great personal touch for the officers and men of the ships which fought in that tough area when denying freedom of movement to the Japanese, and in fact eventually turning around their advance, became so important to the outcome of the war in the Pacific. Captain Crenshaw writes with authority on the events of the period—he was there and knows well about which he and his shipmates endured, and on some occasions were able to enjoy. To put the intensity of the combat in perspective, during this eight month period in the Solomons area the Japanese had some seventeen cruisers and destroyers sunk and nine severely damaged, while losing a number of other ships including five submarines. American losses in that area during the same time period included eight cruisers and destroyers sunk and eight severely damaged, not to mention thirteen PT boats sunk or otherwise destroyed. Of our Allies in that region, Australia and New Zealand, the latter also suffered casualties to include severe damage to two cruisers. Captain Crenshaw captures the continual and intense pressure of the situation very well. His narrative is well constructed and makes the book very readable.

As a second point, although not specifically called out by the author as a situation of significance, there is an excellent representation of the total environment in which the war was being fought in the Solomons. In terms of today it was both a joint and combined operation. The forces of the U.S. Navy (ships, air, and ground), U.S. Marine Corps (ground and air), and U.S. Army (ground and air), were all fighting together along with forces from Australia and New Zealand as well, and with friendly elements from the many islands involved. Command and control of the forces involved worked, probably not without some breakdowns and confusion, but it worked. There were strong individuals at the higher levels in the various chains of command in that part of the world who reportedly differed on some issues, but, as Captain Crenshaw's book portrays, again without specific reference to this aspect of the war, the combat situation on the ground—and at sea and in the air—in the Solomons focused the efforts of those involved towards their common objectives and dictated that extensive coordination was necessary to achieve them.

The final point to make about this book is one of which, I must admit, I was not aware and that was the extent of the torpedo problem beyond the Submarine Force during the war. I think all submariners either experienced, if they were there, or heard about, in the case of those like me who came after the war to the Submarine Force, the torpedo exploder problem and how it became such a critical matter. Until I read this book, I did not realize that the problem was also experienced in spades in the destroyer force, and was also a concern in the PT boats and for the torpedo planes. The author describes the frustration of destroyers firing torpedoes at enemy targets, and at derelict Navy ships, without success even at close range; the difficulty in convincing those up the chain of command (to include those in Washington and at the laboratories) that there was a torpedo problem which wasn't the doing of the firing units; and the final eleventh hour focus of senior attention which eventually led to fixes of this operationally disastrous condition. Of interest, Captain Crenshaw relates that Alfred Einstein early in the war was shown with pride by the Navy a secret Mk 6 exploder and immediately described, in writing, why it would not be reliable! The author makes the point very clearly that weapons testing must be conducted realistically and thoroughly. One must wonder if today we are conducting enough full-up torpedo testing to include detonation at a target. This reviewer does not think so.

In summary, this book is recommended reading, not only for the points highlighted above, but also for its contribution to the historical record of tough battles fought in a remote area for important national and international interests—the book also needs to be read for its lessons to be learned, many of which are pertinent today and will be tomorrow. Although containing a wealth of very detailed information reflecting both the personal experience of the author as well as his extensive preparatory research, this is a very readable book. Many of us remember well the classic text *Naval Shiphandling*—Captain Crenshaw continues his writing mastery with this book.■

Captain Frank Wadsworth, USN(Ret.) Is composing a collection of Rickover stories which many submariners (and others in the nuclear field) should enjoy. If you are willing to share shome of your experiences with the *Kindly Old Gentleman (KOG)*, please send some samples to Frank. Both serious and amusing anecdotes are desired. What form the end product will take depends upon the inputs received. But Frank will not alter or publish your inputs unless you agree with the wording and the general context. Whatever the end product, it will be truthful and as objective as possible. If any opinions are added to the collection, they will be clearly identified and attributed to the proper owners.

Please send to: Frank Wadsworth, 15 Matson Ridge, Old Lyme, CT. Phones: (860) 434-3959 in Old Lyme, (401) 466-8958 in Block Island, FAX (860) 434-3722; e-mail: fwads@aol.com.

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NAVAL SUBMARINE LEAGUE
P.O. Box 1146
Annandale, VA 22003
(703) 256-0891

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Rank, Service, if applicable

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I was introduced to the Naval Submarine League by ____________________

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