THE SUBMARINE REVIEW
APRIL 1997

A Quarterly Publication of the Naval Submarine League

THE SUBMARINE REVIEW IS A PUBLICATION
OF THE NAVAL SUBMARINE LEAGUE

NAVAL SUBMARINE LEAGUE • Box 1146 • Annandale, VA 22003
(703) 256-0891 FAX (703) 642-5815 E-Mail: subleague@aol.com

EDITOR'S COMMENTS

There are several out-of-the-ordinary points about this April issue which rate particular comment. First of all, the lead feature is not by a submariner but a Surface Warrior; and it concerns ASW rather than Submarine Warfare. Admiral Cooper comments on Admiral Fitzgerald's words in his column, and they were recommended to us by COMSUBLANT. Secondly, Admiral Pete Nanos' presentation on strategic systems highlights what the Navy is doing to provide the Submarine Force with a conventionally armed ballistic missile.

After the first two articles, one can be struck with a bad/good-/bad oscillation which occurs over the next three. The recent North Korean submarine grounding is ably recounted by Tom Belke, and two of Britain's best submarine writers, Richard Compton-Hall and Paul Kemp, offer an excellent pairing of the best and worst in submarining. On a somewhat different plane, but related by a wide swing within one subject, we have to note the great variation in reaction which we have received about the book Spy Sub, reviewed in this issue. Some saw it as an essentially accurate portrayal, while others felt it more prominently displayed some obvious prejudices developed from a narrow vantage point. Several reviews were submitted and we are happy to offer the one by Rich Lanning. We leave it up to the individual reader to make his own evaluation.

In another point to note about the book reviews, we have to call out Norman Polmar's comments on Russia's Arms Catalogue-Vol. 3 Navy as a report of a truly different kind of book. At almost $500 a copy it is not something everyone will rush out to buy, but it is a publication that ought to be made available in libraries so all of us can show just how sophisticated the Soviet Navy had become, and what any front rank Navy can achieve in platforms, equipment and weapons.

This issue also has three articles which treat hardware developments for the U.S. Submarine Force from the history of the materiel establishment, or the Bureaus as it was called in those years. Aside from the immediate interest inherent, and lessons to be learned, in each of those sagas, we do feel it is important to create a record of what was done, why it was undertaken, and who did it. When we look back at the technological progress in submarines, with breakthroughs made where they did not seem likely, we are suitably impressed; but more importantly we can see the need to speak of the past as a proper prologue to even greater advances yet to come. As we know, however, the history as it was recorded often does not tell the whole story, particularly the part played by the submarine crews which tried out the first models of each new bit of developmental hardware. So the invitation is out to all those who might have participated in trials or initial patrols to fill in the missing details in order to generate a fuller picture for those who will have to follow with ever more exotic gear.

Two contributions from officers completing Sub School's Submarine Officer's Advanced Course round out April's complement of general interest articles. These are both valuable commentaries and we are fortunate to have the up-to-the-minute snapshots of current life in the boats, as well as their recommendations for improvement. The League is justifiably proud of our part in encouraging this writing. For each SOAC class we sponsor an essay contest and we are never disappointed. We are particularly indebted to the fine staff of the SOAC course for providing the incentive to write, the time to do it and the thoughtful criticism which makes the effort worthwhile. It all goes to prove that dolphin-wearing Lieutenants and Lieutenant Commanders have lots of good ideas and love to convince everyone of the value in new thinking.

Lastly, there are two Discussion pieces to consider. Captain Denver McCune raises some points about the tightness of submarine shipmates...after the active duty is done. Admiral Dan Cooper has some recommending words for Denver's piece. Commander Don Gerry's offering on Future SSNs is not a new hull design, but a thoughtful look beyond the constraints of regional war to the threat of a global confrontation. The emergence of a new world power to challenge the United States is not impossible within the lifetime of any submarines we are now planning. We should consider what we are going to do with them in that case.

Jim Hay

From The President

As we approach our peak season for Naval Submarine League activity we find both the classified Submarine Technology Symposium (not yet categorized as *annual*) held in conjunction with Johns Hopkins' Applied Physics Laboratory and our Annual Symposium in June rapidly closing. For the latter, we are privileged this year to be honoring Admiral Bob Long as our **Submarine Hero**. As everyone knows, Admiral Long was skipper of a diesel boat and was one of the first nuclear submarine commanding officers. He also commanded the Atlantic Fleet Submarine Force and was the DCNO for Submarine Warfare and VCNO before finishing active duty as Commander-in-Chief Pacific. He has remained extremely active in the nation's highest advisory groups for Defense and is Chairman Emeritus of the League. There is no submariner who has done so much for so long for our Submarine Force, our Navy, and our Nation.

I recommend the lead article in this issue of **THE SUBMARINE REVIEW**, Vice Admiral Fitzgerald's speech at this year's ASW Improvement Conference. It's an excellent summary of the current state of the art, a most appropriate characterization of ASW as a Navy-unique warfare area, and a heartfelt call to coordinated action. (By the way, Admiral Jim Fitzgerald, probably the best recognized ASW proponent, will retire in July—the Navy and the Submarine Force will miss him.) All of you will be interested also in Commander Belke's Incident at Kangnung which tells of the ill-fated Sang-o operating out of North Korea and grounding in what can only be called enemy waters. If nothing else, it is a reminder to the world that the submarine threat can appear in many forms. Finally, Denver McCune, who did a superb job as President of the Pacific Southwest Chapter of NSL in San Diego, and who worked hard to include the SubVets of WWII and the SubVets, Inc. groups in NSL activities, raises thought-provoking questions in his article Silver Dolphins plus Gold Dolphins Equals Pride and Professionalism.

For the last year or so several of our members have been rather intimately involved in the Naval Studies Board examination of Navy 2035. For this study, the then CNO Admiral Mike Boorda, commissioned the Naval Studies Board, through the National Academy of Science, to re-look at, and update, their effort called Navy 21 done in 1988 for Admiral Jim Watkins when he was CNO. Over the next few months, once the study is published and released, we will be giving you some insight into the findings.

Hope to see as many of you as possible in May and June.

Dan Cooper

ABOUT ANTI-SUBMARINE WARFARE

An address by
VADM James R. Fitzgerald, USN
to the
ASW Improvement Program Conference
October 22, 1996

[Editor's Note: Vice Admiral Rich Mies, COMSUBLANT, has recommended publication of VADM Fitzgerald's speech as a matter of interest to the Submarine community.]

Good morning. Thanks for the opportunity to discuss something other than my current assignment. *[Editor's Note: VADM Fitzgerald is the Navy Inspector General.]*

Thanks also for the opportunity to talk to ASW professionals. I'm impressed so many *heavies* are here. I always enjoy talking about the art of ASW! My AAW* secondary warfare missions friends—I continue to call them *Nintendo Warriors*—always use that trite old phrase: "Awfully slow warfare" when they describe ASW. But, as you know, in a sense they're right. As an aside, I recently heard a sitting three star describe the solution to ASW as just needing to speed it up! I'm not sure he was aware that the speed of sound in water is somewhat slower than the speed of electrons in air, but that was his idea of the solution.

As you know, ASW demands patience—an un-American characteristic, and in a results-oriented society, a challenge. As Americans we want action, a quick decision, and if we don't get one we tend to become disinterested and move on. I'm also not telling you anything when I say it often takes more time to classify an ASW contact than it takes to complete an entire AAW engagement!

There is some truth to their assertion about slow warfare. But perhaps the difference is that ASW is the last of the warfare areas that has not lent itself well to automation, such as the Aegis combat system. You still have to think—generally ahead of your opponent—and all the time—perhaps the last great chess game. And therefore, in that sense, it is an art. You aviators know of guys who are just natural good *sticks*. You need *good sticks* at

---

* A glossary for acronyms is attached at the end of this speech.

ASW.

Of course, as we all know, ASW is an art conducted by that diminishing elite band of modern day warriors with:

- Superb discipline
- High esprit de corps
- Intellectual superiority

who,

- Reread a passage from The Hunt for Red October or Pete Deuterman's Scorpion Beneath the Sea, before they go to bed each night
- Cheered at the end of Das Boot!

Back to my *Nintendo Warriors*. It is also interesting to watch our secondary warfare mission area guys worry about *stealth* and *low observables*. You'd think they just discovered it. When I left the five-sided fort (Pentagon) all we were hearing about was radar cross sections of gnats and BBs.

You know what Washington is—that city that's completely encircled by the Beltway—a screen through which no logic shall pass! In the Pentagon there is no windmill too tall, and no axle too small! When we did the 1996 Congressional ASW assessment, the OSD PA&E guys didn't like it because there was not enough analysis in it. It did not matter that we empirically demonstrated a lack of capability in the real world and in fleet exercises!

You have been dealing with stealth and low observables since the invention of the submarine.

In World War II, submarines were submersible ships that brought the elements of stealth and surprise to naval warfare. Submarines were used mainly in the ASUW or anti-SLOC role. Fortunately for the Allies, we countered with an effective ASW strategy and ultimately adequate force levels (someone once did an analysis and came up with the interesting fact that we required seven ASW assets for every one enemy submarine—remember, submersible ship)—the beginnings of essentially almost all of the ASW weapons we rely on today. One could ask: "Which came first, the strategy or adequate force levels?" Did adequate force levels permit a strategy at all?

In the '60s and '70s with the advent of nuclear power, the true submersible brought forth a new dimension. The submarine now could be inserted into the anti-submarine equation. Independent operations to exploit covertness and endurance could be used to hold the Soviet SSBNs at risk. Since they could now go where no other ASW forces could go, they checked out of the Navy and formed their own. But the propulsion, sensors, and weapon technology of this period provided a jump in our Submarine Force capability and made us unmatched in both submarine and anti-submarine warfare.

But, technology was impacting our other ASW communities as well. The P-3 update III, the LAMPS MR III, the 60 Foxtrot, the QQ-89, SURTASS, and IUSS shifted to supporting tactical forces. Paradoxically, it was our potential adversaries that caused us to refocus—the *analogous response*. We found we weren't so hot. Unfortunately, because of the Walkers, they found out too. And along came their quieting programs and tougher boats. *Analogous response* occasioned the development of our first *ASW policy*. From this came our first attempts at what was incorrectly called *combined arms ASW*—really *coordinated ASW*—really taking advantage of what each of the ASW communities had to offer:

- Speed and the ability to revisit from the aviation community,
- Command and control, helicopters, and a modicum of endurance from the surface community,
- Stealth and endurance from the submarine community, and
- Long range cuing from IUSS.

We began to develop an ASW system. We began to do coordinated ASW. We refined our cuing, experimented with reverse cuing, and our various ASW communities began to develop a greater understanding of each others' capabilities.

We began operating as a team and a good team!

We relearned the laws of ASW:

- ASW is hard
- The oceans are unfair
- The carrier will always pass through datum
- When dealing with submarines, cheat—treachery here is an asset!

Exciting things were in the works—low frequency active, Swath-A, bi-statics, transient detection, broadband detection, the AWS-13F, the SQS-53C, the P-7, the update IV and SEAWOLF to name a few.

And then the world collapsed!

- The Berlin Wall melted.
- The Warsaw Pact members joined NATO.

• The Soviet Union dissolved.

• Our submarines rejoined the Navy and now have joined the battle groups.

What a difference a day makes. It is said that after Napoleon signed the 1802 Treaty of Amiens with Great Britain, he turned to his marshals and said, "Peace has been declared! What a fix we are in now!" And what a fix we are in now!

Few in Washington believe there is a submarine threat. You have senior leadership who ask, "Who would shoot a torpedo at us?" I ask you, "Who would fire a ballistic missile at us?"

• Even if you can show that there are over 400 submarines operated by 41 countries other than the U.S. and the Russians

• Even if you can show that the Germans will build an air independent propulsion submarine (Type 212) for anyone who wants it by the turn of the century

• Even if you can show that they will also build into it any submerged launched cruise missile you want, including Harpoon and submerged-launched Exocet, and

• Even if you can show that the only weapons export that actually increased over the last five years is the submarine.

The response is: "Yes, but no one knows how to properly operate them so there still is no threat." The lessons of the Falklands are lost. The issue today is what sells? TBMD and deep-strike sell. (And, perhaps in the current budget environment that is the correct attitude, it may be an issue of survival.) This is the view even though the two weapons that small countries can use to even the odds against large navies are mines and submarines:

• As did Iraq—with mines

• As did Argentina against the British in the Falklands with their 1974 vintage Type 209. Ever wonder why the VENTE CINCO DE MAYO didn't play in that conflict? Because the Brits said they'd sink anything outside of Argentinean territorial waters—as they did with BELGRANO! That got their attention.

You and I know that the small non-nuclear submarine in shallow water is a challenge. They are quiet on battery. They can bottom. They are a small acoustic target. We have little oceanographic data in shallow water. And the tactical environment will probably not be benign.

So what? And so what should we do about it? That's an interesting question.

As you know, reality is directly proportional to the distance from Washington. But, some good things are going on in Washington. Let me review for a moment some of them.

• Last year we completed the 1996 Anti-Submarine Warfare assessment for Congress that clearly articulated our difficulties.

• Many are beginning to feel we may have gone too far, too fast in using ASW as the bill payer for downsizing.

• We have gained an appreciation in the OSD and Navy secretariats and in OPNAV that the current process may not adequately assess the warfare mosaic of ASW as an interdisciplinary sport.

• We have established, at least the rudiments, of an N84, similar to the old OP71, to provide a systemic focus.

• We have managed to raise the interest level in the budget process to where ASW is not the first bill payer of choice.

There are other things going on too. The Naval Doctrine Command is continuing its efforts following last year's ASW CEB to develop the littoral USW concept.

But, what can and should you do?

• Make your senior leadership include meaningful and realistic exercises in your workups.

• Then tell it straight up. Don't embellish your capabilities. Tell it like it is, ASW is hard.

• Recognize that you and you alone really know the issue. Don't let the analysts in Washington dictate your requirements for you. Use this forum, the fleet ASWIP, to set forth your requirements to not only N84 but to all—your type commanders, your fleet commanders, OPNAV and the secretariat.

Beware of scenarios. You cannot generate a scenario today that, given time, we can't address. But that's not the issue, that's not how to define the threat. The threat is not pacing technology. Scenarios sacrifice future readiness. In 10-15 years some of you may be ready, but your sensors are inadequate to the challenge. So, so what!

But, I caution you, keep it simple.

• In many cases, you're dealing with people who in general don't understand your problem to the depth that you do.

• Many have never even been to sea. And for others it's been a decade or more—148 db (decibel) targets—don't recognize the problem.

• Many think that when you're talking about pascals, you're talking about the French philosopher and mathematician and wonder what the connection is. (To them a micro pascal is a little bitty French philosopher and mathematician.)

- Many equate ASW to just having a better submarine than the other guy.
- Many think analysis is the only way to develop truth. (Recall that analysis was developed because you either couldn't afford or couldn't replicate things at sea.)

Analysis is not a substitute for empirical evidence. You must be the voice. You must tell them what you require.

- Perhaps you need a fundamental paradigm shift in the ASWIP. Perhaps you need to game out the problem—walk it through the campaign, through intelligence (policy issues) to oceanography (data collection priorities) to cuing (programs) to tactical forces (coordination and synergy) to C4I to weapons, and develop your requirements in that manner.
- I've toured SEAWOLF and am aware of her capabilities and that of those that will follow her. Perhaps you need to decide if it's best to turn the ASW mission over to the IUSS/submarine communities. Can they do it?
- Perhaps you need more detailed reviews of what your representatives in OPNAV are doing on your behalf. For example:

> The SRQ-4 in the QQ-89 system is not being upgraded to take advantage of the Romeo. Is that important?

> There is no ORD or MINS for IEER for the Romeo. Is that important?

> There is no requirement for a mine hunting capability in ALFS (or PADS). Is that important?

> The Romeo may not be compatible with CV operations because of the tow bar edict. Is that important?

And there are many more.

Finally, you need to ask some hard questions:

- What is the Navy's ASW strategy?
- Given that strategy, what is the Navy's ASW concept of operations? Do we only fight forward with submarines, etc.?
- Given that concept of operations, what is the Navy's corresponding ASW investment strategy (integrated priorities)?
- Given that investment strategy, what are the key technologies we should be investing in? Let me tell you what I see: subs—good; surface—good enough; COTS—solution; air—hot

potato; C4I—everything dropped; weapons—no torpedo development program, all P3I, no assessment of warfare as a *system*—little or no coherence. If we think multistatic is the answer, who's ensuring the systems are compatible? Who's developing the C4I? Who's in charge?

Let me close with the following:

- The Navy is the only service with a unique environment—the ocean.
- USW/ASW is Navy unique. It is a core competency.
- We need to maintain a basis of knowledge of physics of the problem (ocean, craft, etc.) which will be lost faster than any other areas. Retain the intellectual capital.
- DDR&E and the JROC are taking over more and more of research and development and they are focusing on joint war fighting capabilities. They do not include undersea warfare. Service specific requirements are *falling off the table*.

Well, I think I've given you enough to think about. So what you're doing here over the course of the next couple of days is vitally important to the health of your warfare area, and ultimately to the Navy. You have a great opportunity and a great responsibility to either fix, or screw up, this thing.

So, thanks for the opportunity to visit with you today. I look forward to hearing what you have to say.

Here's your quiz: How many submarines does it take to constitute a threat? ■

NAVAL SUBMARINE LEAGUE

GLOSSARY

AAW	Anti-air warfare
ALFS	Airborne low frequency sonar
ASN(RDA)	Assistant Secretary of the Navy (Research, Development and Acquisition)
ASUW	Anti-surface warfare
ASW	Anti-submarine warfare
ASWIP	ASW improvement program
C4I	Command, control, communications, computers and intelligence
CEB	CNO Executive Board
COTS	Commercial off the shelf
DDR&E	Director of Defense Research and Engineering
IEER	Improved extended echo ranging
IUSS	Integrated underwater surveillance system
JROC	Joint requirements oversight committee
MINS	Mission needs statement
ORD	Operational requirements description
OSD	Office of the Secretary of Defense
PA&E	Program analysis and evaluation
PADS	Parametric airborne dipping sonar
SLOC	Sea lines of communications
SURTASS	Surveillance towed array sensor system
TBMD	Theater ballistic missile defense

STRATEGIC SYSTEMS UPDATE

by Rear Admiral G.P. Nanos, USN
Director, Strategic Systems Programs

It is my pleasure as the Aerospace Arm of the submarine community to provide an update on our thinking and our progress.

Usually, our deployed forces are the last part of a strategic systems presentation, but they are not the end of the story, they are the beginning and I just want to remind you of what we have deployed today. I am then going to spin off of that and tell you what we can do in the future and how we are going to get there.

Of course, the mainstay of our deployed force has been TRIDENT I C4 which has the Mk 4 warhead and the W76 reentry body. With over 700 patrols, over 170 flight tests and over 17 years of operation, this system has exceeded all our expectations: for range and for reliability and in the case of accuracy we have exceeded requirements by almost a factor of two. By every measure this is an exceptional system and meets all requirements, but it is aging. Although we intend to keep C4 in service longer than we have any other fleet ballistic missile and have learned a great deal from it, we are in the last decade of its life.

Our more modern Trident II D5, with not only the Mk4, but the new Mk5 warhead, is designed to have higher accuracy, higher yield, and be able to penetrate during extreme weather. We have commissioned the ninth D5 submarine in the Atlantic, the tenth is in the water and with the eighth on patrol, the major portion of our submarine based deterrent will from now on be Trident II.

Let's talk about D5 performance. My predecessor twice removed, Admiral Ken Malley, used to say you could draw a circle around the ends of a TRIDENT submarine and could put all the warheads in that circle from 4000 nautical miles away. That sets a reasonable, unclassified scale for the performance of the D5 system. We are up to 91 patrols, 58 flight tests, and 6 plus years of operation. Now, we can describe to you about where we are going to go with this system, starting with the systems role in the strategic deterrent force. For example, we ran a test in one DASO where we demonstrated the ability to reduce the system CEP by half under certain conditions.

A comment was made and a question posed several years ago by General Lee Butler about what could be done with a single missile. He postulated that if the National Command Authority ever elects to use strategic missiles, they may elect to do it on a one missile basis. So, we looked at something we called Supergroom. We asked the question: "If you really wanted to optimize an engagement what could you do?" It turns out if you groom a missile, freshly calibrate the guidance system, come to periscope depth, take GPS data to fill a Kalman filter with which to correct the ship's inertial navigation system, then immediately return to depth and launch it at a time such that the guide star for the stellar-aided inertial guidance system is exactly in the right place relative to the target, you can, in for certain scenarios, halve the CEP of a current TRIDENT missile. Although this has not yet been implemented in an operational sense--there's a lot of work that needs to be done in terms of doctrine and procedures--that capability is there, it is repeatable, and we have verified that.

Accuracy is really the coin of the realm in strategic deterrence in all forms, both conventional and nuclear, for the future. Let me expand on that a little bit.

We can chart the capability of our weapon system against targets and see what accuracy has done for us. The demonstrated capability of the D5 is excellent. Our capability for Mk 4, however, is not very impressive by today's standards, largely because the Mk 4 was never given a fuse that made it capable of placing the burst at the right height to hold other than urban industrial targets at risk. With the accuracy of D5 and Mk 4, just by changing the fuze in the Mk 4 reentry body, you get a significant improvement. The Mk 4, with a modified fuze and Trident II accuracy, can meet the original D5 hard target requirement. Why is this important? Because in the START II regime, of course, the ICBM hard target killers are going out of the inventory and that cuts back our ability to hold hard targets at risk. The Air Force has some plans for how to upgrade their ICBM force to restore that capability. We can do that with the Mk 4 reentry body for 10 cents on the dollar in terms of investment because of the accuracy of our system, and we have made this option available to the strategic CINC.

The D5 production schedule is an important issue for us because it equates to a large amount of submarine force dollars. There are two important aspects of the program that relate to this cost. Number one, the level of production for D5 missiles is low. It turns out that we have gone from the rate of six a month production down to one a month production with only a 25 to 30 percent increase in unit cost. I think this is a real tribute to your strategic industrial base, because by doing that, they have opened up the dollars in the top line for other submarine programs. I feel really good about the contributions of Lockheed-Martin and others in terms of realizing this level of control. I think that a decrease factor of six with only a 25 to 30 percent increase in unit cost is extraordinary and probably without precedent. Another key cost factor is that the reliability of the D5 weapon system has allowed the missile inventory number to be kept very low. I fly two less D5 missiles a year than I do for C4 based solely on the reliability of the D5 system; this equates to over 50 million in savings a year. The capability of the D5 system is hitting us in the pocketbook in a very beneficial way.

The schedule for the D5 conversion of our TRIDENT I submarines is in place. Of course as we enter into force with TRIDENT II, there is a question mark about what we do with the last four Trident I submarines: the ones not scheduled for backfit. Everything is being driven by the START treaty *entry into force* in terms of our plans. That is what will drive the elimination of the four non-D5 converted TRIDENTS, or conversion of those to other uses.

There is a continuing need in the Navy for covert special operations capability, for mine warfare capability and also the need to introduce more survivable vertical strike modules capable of handling Tomahawk and tactical ballistic missiles. We have worked very closely with N87 and NAVSEA to come up with affordable options for doing this, using converted Trident I submarines. You can have a broad range of options, anywhere from 125 to almost 200 strike missiles, combine that with special operations capability and even support all three missions in the same submarine. This is an extremely capable platform and we have worked very hard to come up with solid affordable options to allow us to extend its life.

We can also put some conventional warfare bite into this submarine and into the 688 with the vertical launch tubes. We have adopted a partnership role with the Army and have signed up to work with them very closely in a broad number of areas associated with missile technology. The Army tactical missile people are extremely competent, steadfast and good partners with extensive experience in tactical missiles. We bring to the game underwater- launch strategic missiles and perhaps, most important from the Army standpoint, expertise in hypersonic vehicles that can be used to deliver lethal force, particularly hard target penetrators on the battlefield. The Army, aside from a broad range of capability in tactical missile systems, also has extensive capability in the area of brilliant anti-tank munitions, multi-sensor terminal guidance and sensor fuzed weapons. We have been doing a lot of work with the Army and I'm going to update you on that. First of all, we did actually price a program to put ATACMS in a 688 submarine. We are continuing to work that hard, with particular emphasis on cost. We have also signed up, with our Army partners, to pursue the JROC approved mission need statement for hard and deeply buried targets. This program has gone to Milestone 0 and the Army is working with us to provide both sea-based and land-based weapons that can work with that. Perhaps the most important thing that has happened year is that we have an approved, OSD funded technical demonstration where we and the Army will demonstrate capability against hardened counter proliferation targets and weapons of mass destruction. As part of that activity we will fly a hard target penetrator in a Mk 4 reentry body from an ATACMS missile in 1999.

For submarine launched ATACMS, there is no magic involved. It involves taking existing operational systems and putting them together. Clearly, the trick is to make that missile fit the Tomahawk launch tube and to do that you have to make it a little bit longer and redesign the fins so that they will tuck in tighter.

It turns out that the former Loral, now Lockheed Martin Vought, is going to invest their own funds to reduce development risk further.

As an example, a casting was required to extend the missile so that the fins can fold into a smaller diameter. Again, this was done by Loral on their IR&D funding and they are going to build this up into a mockup of a Submarine Launched ATACMS Missile.

In addition, we have an actual prototype of a casting of a submarine launched ATACMS fin which will go into that mockup missile that they're putting together. My only commitment on the government side is to say if they build it I will wheel it into the Pentagon and around the E-ring one time to show everybody the commitment of industry to this program and the Submarine Force.

One other piece that has to be done is a new cable tunnel to allow the missile to fit into the launch tube. This also represents a significant commitment on the part of the Army. This is a type of modification to the missile which will not affect the Army's employment of the missile and the Army is willing to incorporate the change into all versions of the ATACMS missile, even their own. If we do the development for SLATCMS, they are willing to introduce modifications like this into their production missile to make it more affordable for us to get online with their production. So the Army is also playing very strongly and very supportive of our use of their missile.

The counter proliferation demonstration that I spoke about earlier will involve firing an ATACMS missile from the only launcher we have available, the M270, against a cut and cover bunker of the type used to house counter-proliferation targets. The missile will incorporate a Navy Mk 4 reentry body modified to carry a conventional earth penetrator and a control system, into a target out at White Sands Missile Range. After the tests prove the capability, a residual capability consisting of one Army artillery platoon equipped with penetrators will be available. There is no reason that the residual capability couldn't be a 688 submarine, but unfortunately we have to get the missile adapted to the submarine in order to make that happen. Once we become ATACMS capable, this capability will be available for us.

It turns out that in some areas this type of weapon plays very heavily. There was a joint multi-warfare analysis game run in the MRC-West scenario. It showed that although we turned back the tide, we did it at great cost, because there are a lot of the North Korean targets that we need to suppress that were just unattainable with our current order of battle.

The original game showed that against Seoul, for example, the North almost took Seoul and attained 90 percent of their objectives before they were turned back. By being able to take out the strategic artillery, the Nuclear Biological and Chemical capabilities, the C4I with the ATACMS penetrator the attack was turned back very quickly. They never attained more than 25 percent of their goals and it took eleven days out of that particular campaign. Overall in the MRC, it took eight days out of the campaign. In this game, the weapon was deployed from submarines, surface ships and from Army units in country.

Is it always going to be this good? Well, it's like automobile gas mileage; it depends on how you drive the car or in this case what scenario you are in. If you have hard targets that are a key to battlefield success and you can patrol along the coast to get within range and wait covertly, the submarine ATACMS combination plays very, very heavily. It really makes a dramatic impact on this particular MRC. This is the most impact, I understand, that they ever had from the introduction of a single weapon into a war game like this in terms of its affect on the outcome.

In going after hard targets, we have discussed how we are going to fly a new warhead on ATACMS. That has been funded. Although we are building it for ATACMS, it is built in a Mk4 reentry body and we can use a version of it on a strategic missile to address conventional targets at long range. This would allow a penetrator to be deployed out to four to six thousand nautical miles, delivered accurately, and be able to be gotten on target in the first hour of a conflict. In fact just a tungsten plug in a reentry body at full reentry velocity will do a great deal of ground shocking and cratering.

The Army likes our approach. We are working closely with them. It's a good effort. I think we have a lot of promise in both the long and the short range missile. Of course the strategic CINC has to agree to use of his strategic assets for conventional use. This is because, under the START treaty he is going to give up a weapon in the SIOP for each conventional weapon deployed.

In summary our main line programs are doing extremely well. Performance is in good shape. The team of the Type Commanders and the Fleet are working hard to keep the strategic force deployed and capable.

The existing off-the-shelf technology that's available to us today means that we can really extend the capability of these systems both in the strategic venue, as I mentioned with what a simple fuzing change will do for the Mk 4 reentry body, and also by expanding the role of submarines and submarine-launched missiles to other critical mission areas and conventional deterrence. I think there's a great future for ballistic missiles, aerospace and the Submarine Force together. ■

INCIDENT AT KANGNUNG

North Korea's Ill-fated Submarine Incursion

by CDR Thomas J. Belke, USNR

"It was very easy to start a war in Korea. It was not so easy to stop it."

Nikita Khruschev
[speech before the Bulgarian Party leadership]

On September 17, 1996 a 111 foot 330 ton North Korean Sang-o Class diesel submarine (SSK) ran aground on a rock off the South Korean coast during what turned out to be a disastrous mission marked by desperation and death. North Korea's littoral submarine mission underscored a continuing of the North's ongoing strategy of brinkmanship in dealings with both South Korea and other nations including the United States.

Mission Overview

The mission of the Sang-o Class submarine and embarked reconnaissance team was to conduct the following covert operations:

- Reach the South Korean coast near Kangnung while remaining undetected and launch the embarked recon team.
- Conduct reconnaissance of South Korean military facilities to collect information for subsequent operations. These operations include photo reconnaissance of the Kangnung airport and Youngdong power plant.
- Make preparations for assassinating South Korean VIPs during South Korea's national sports games scheduled for 7 October 1996 in Chunchun, Kangwon Province. Such preparations quite probably included establishing one or more secret caches of weapons for future special operations in the Kangnung area.
- Recover the recon team and return to port while remaining undetected.

Chronology

April 1996. U.S. President Bill Clinton and South Korean President Kim Young-sam propose talks in which the two Koreas would discuss officially ending their 1950-53 Korean War with a peace treaty. Washington and Beijing would participate in the talks as mediators. Talks begin between Washington and Pyongyang regarding the proposed meetings.

July-August 1996. Twenty-three crew members of a modified Sang-o Class SSK and the three members of the associated North Korean recon team complete the final two of five preparatory submarine coastal infiltration exercises. These operations along the North Korean coast simulated anticipated conditions in the Kangnung area.

13-15 September 1996. North Korea's Committee on the Promotion of External Economic Cooperation (CPEEC) hosts an International Conference in the Free Economic and Trade Zone (FETZ) in the Rajin-Sonbong and Tumen River area of Northeast North Korea. Representatives from the U.S., Japan, China, Russia, Germany, Thailand, South Korea and the United Nations attend.

2000 13 September 1996. All members of the North Korean SSK crew and associated recon team pledge that they will fulfill their mission by reading a loyalty oath before Colonel General Kim Dae-shik, chief of the Reconnaissance Bureau.

Figure 1. Track of the North Korean Sango-o class SSK to Kangnung, South Korea, 14-17 September 1996.

0500 14 September 1996. The crew consisting of the Chief of the Operations Department, submarine crew members and associated recon team embark in a modified Sang-o Class SSK and sortie out of T'oejo port in South Hamgyong Province, North Korea. Their destination: Kangnung, South Korea—approximately 160 miles away. The SSK's SOA is approximately four knots.

2000 15 September 1996. The submarine arrives off the coast of Kangnung, about 60 miles south of the DMZ, and launches the three-man recon team in South Korean Army uniforms on the coast of Kangnung.

2100 17 September 1996. The submarine runs aground on a rock off the coast of Kangnung while it is approaching shore to pick up the returning recon team. For almost three hours, the crew unsuccessfully attempts to free the grounded submarine.

2350 17 September 1996. North Korean forces abandon ship. All 23 crew members safely land ashore carrying all available arms and equipment and join the three-man recon team.

0100 18 September 1996. A South Korean civilian spots the North Korean submarine stranded on a rock and reports the sighting to police and military authorities.

18 September 1996. North Korean personnel line up and shoot 11 of the 23 North Korean submarine crew members.

1630 18 September 1996. Li Kwang-su, a crew member, is captured at Bojon-ri, Kangdong-myon, Kangnung City while trying to flee.

18 September 1996. South Korean troops discover the 11 dead North Korean military personnel at Mt. Chonghak near Kangnung. Initial evidence and subsequent information confirm that these personnel were killed by other North Korean infiltrators.

19-30 September 1996. South Korean hunting troops exchange small arms fire with the fleeing North Korean personnel in a series of skirmishes. Eleven of the remaining fourteen North Koreans are shot to death in the areas of Dangyonggol and Mt. Chilsong near Kangnung. Ten South Korean soldiers are also killed in the fighting.

9 October 1996. The remaining North Koreans kill three South Korean civilians who were gathering mushrooms on Mt. Odae in Jinbu-myon, Pyongchang County.

Mid-Ocotber 1996. Two of the remaining three North Koreans are shot dead. One escapes.

20 September-7 October 1996. South Korea, the United

States, Japan and the United Nations express outrage and concern over the North Korean submarine incident. Progress toward peace negotiations, economic discussions and most humanitarian aid is jeopardized.

12 November 1996. U.S. officials, including Ambassador James Laney, state that there will be no further peace overtures until North Korea apologizes for the sub's incursion. North Korea's Foreign Ministry spokesman tells Pyongyang's Korean Central News Agency that North Korea "is compelled to interpret this as a revocation of the four-way talks". He says North Korea now has no need to hear any explanation about the peace proposal.

9 December 1996. The United States, on behalf of Seoul, commences negotiations with North Korean representatives in New York to resolve the dispute. Meanwhile, millions of dollars of South Korean aid to North Korean flood victims is suspended pending an apology for the submarine incursion.

29 December 1996. North Korea expresses "deep regret for the submarine incident...that caused the tragic loss of human life". North Korea said it "will make efforts to ensure that such an incident will not recur and will work with others for durable peace and stability on the Korean peninsula". While the South insisted the submarine was on a spy mission, the North insisted it accidentally drifted into South Korean waters on a routine training mission. Nevertheless, President Clinton welcomed the North Korean concession in the form of an apology by saying, "I am pleased that Pyongyang has pledged to prevent the recurrence of such an incident and has expressed its willingness to work with others for durable peace and stability on the peninsula". Constructive resolution of the incident is viewed as one of the Clinton administration's major foreign policy successes.

3 January 1997. A U.S.-led consortium resumes talks with Pyongyang toward a landmark nuclear pact with North Korea for building light-water nuclear reactors. South Korea is largely financing the reactors which were promised to North Korea in a 1994 agreement with the U.S. that halted Pyongyang's suspected nuclear weapons program.

6 January 1997. The U.S. Treasury grants a license to Minneapolis-based Cargill, Inc., a giant grain company, to export 500,000 tons of food to famine-struck North Korea. This step is viewed as a warming in relations between the U.S. and North Korea following North Korea's apology for the submarine incident.

12 January 1997. Even with improving relations following the submarine incident, U.S. foreign policy analysts continue to express concern on whether foreign aid will be enough to stabilize North Korea's shaky and flood-ravaged economy. North Korea's economic crisis and severe food shortage, which have worsened since 1990, still raise ongoing concerns over the stability of the Korean peninsula and East Asia as a whole.

Casualties

Total casualties associated the incident at Kangnung were 10 South Korean military, 3 South Korean civilians and 24 North Korean personnel killed, 1 North Korean captured and 1 North Korean escaped. Of the 24 North Koreans killed, 11 of the 23 submarine crew members—including Kim Dong-won, Chief of the Naval Operation Captain Department—were lined up and shot during 18 September by their fellow comrades shortly after abandoning ship at about midnight on 17 September. The helmsman, Ensign Li Kwang-su, was captured by South Korean hunting troops on the evening of 18 September. South Korean troops discovered the bodies of his dead shipmates at Mt. Chonghak on September 18th, within 24 hours after the crew abandoned ship. Evidently the North Korean recon team along with some members of the submarine crew viewed these eleven crew members as an unaffordable mission liability.

Over the next 11 days between 19 and 30 September, South Korean troops tracked down and shot to death 11 of the remaining 14 North Koreans. On 9 October, one or more of the remaining three infiltrators shot to death three South Korean men (ages 45, 54 and 69) who were gathering mushrooms on Mt. Odae in Jinbu-myon, Pyongchang County—about 40 miles south of the North Korea/South Korea border. Two of the remaining three North Koreans were later shot to death. Ten South Korean soldiers died while hunting down the North Korean forces. Ensign Li Chul-jin, age 28, was the only North Korean who escaped.

The Sang-o Class Submarine (SSK)

North Korea has an estimated 16 Sang-o Class SSK's with another four under construction as of July 1996 (Jane's Fighting Ships 1996-97). Sang-o's were probably reverse engineered from a Yugoslav design. The Democratic Republic of North Korea (North Korea) has a concentrated building program producing about six Sang-o's per year. These SSKs are small by U.S. standards at about one-third the length (111.5 ft) and less than one-sixth the displacement (275 tons surfaced/330 tons submerged) of our World War II fleet boats. The Sang-o Class's typical complement is 2 officers and 12 enlisted. However, the crew was augmented by additional personnel including a three-man recon team for this mission to bring the sub's complement to a total of 26.

Sang-os have a single diesel generator, motor and shaft that enables them to achieve 7-8 knots surfaced and 4 knots submerged. These SSKs have a nominal test depth of 500 feet (150 meters). Their limited propulsion constitutes a significant design liability amidst the especially strong tides and currents along the coast of the Korean peninsula. Sang-o SSKs have an estimated maximum operational endurance of 20 days at sea.

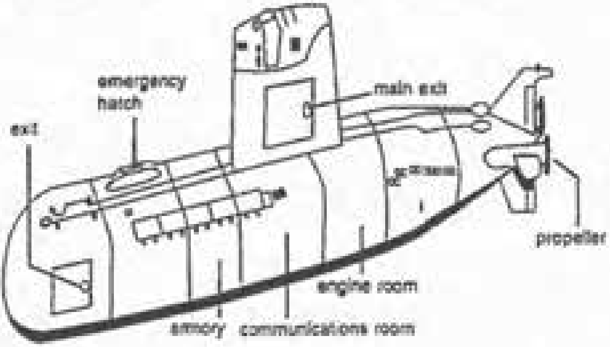


Figure 2. The Sang-o class submarine (SSK).[1]

While most Sang-o SSKs probably carry mines or Russian Type 53-56 torpedoes in two 21 inch (533 mm) tubes, the

---

[1] Li-Kwang-su. North Korean Submarine Incursion: The Infiltration of Armed Guerrilla Agents into the East Coast of South Korea: A Testimony by Li Kwang-su, a member of the Infiltration Group captured by South Korean Hunting Troops (Seoul: Korean Veterans Association, 1996), p. 7.

submarine lost off Kangnung was specially modified for special operations. The torpedo room, originally designed to store four torpedoes, was modified into a room to accommodate additional personnel. The submarine also carried a 107mm anti-tank rocket launcher, a 75mm anti-tank rocket launcher, and 190 other weapons including M-26 hand grenades, M-16 rifles and numerous miscellaneous combat gear. This particular Sang-o SSK also was configured with a lock-out chamber hatch providing an underwater swimmer delivery capability.

Operational Notes

Technically, 23 of the 26 North Korean personnel assigned on the mission were submariners (2 supervisors and 21 crew members). The remaining three individuals were recon team members. The submariners ranged in rank from Captain Kim Dong-won (age 50)—the most senior and the Chief of the Naval Operations Captain Department—to ENS Pak Jong-Kwan (age 27)—the youngest individual assigned to the mission. The crew included Lieutenant Commander Shin Young-kil, the political officer. The average age of the crew was 33—very old by U.S. standards. Captain Kim Dong-won, Lieutenant Commander Shin Young-kil and Ensign Pak Jong-Kwan were among the 11 crew members shot by their countrymen shortly after abandoning ship.

At the time of the mission, the East Sea current was flowing northward at about 1 knot—away from the Kangnung coast. Contrast this fact with the subsequent North Korean official statement claiming the sub drifted over 60 miles to the south.

The Sang-o SSK never issued a distress call or SOS.

The Sang-o SSK reached the South while remaining submerged throughout the almost two day voyage. Contrast this submerged transit with the subsequent North Korean official statement claiming that the sub was on a "routine exercise in our own North Korean waters". Of course, to the North Korean's credit, they do not recognize the South Korean government as a legitimate government, and therefore, the entire Korean peninsula is, from the North's vantage, their territorial waters.

The three members of the North Korean sniper team were dressed in South Korean Army uniforms.

Numerous propeller marks on the rock the sub grounded upon indicate that the main engine was operating normally while the crew was desperately trying to free the sub prior to abandoning ship. Contrast the propeller marks evidence with the North Korean statement that the incident was caused by "engine trouble".

Before abandoning ship, the crew set fire to the engine room.

The North Korean forces did not, at any time, request assistance or show any sign of surrender.

The North Korean submarine's homeport was T'oejo. Contrast this information from the captured crew member with the official Korean statement that Wonsan was the homeport.

By South Korean accounts, the North Korean submarine had more than 4000 items of 327 kinds of combat gear including weapons such as anti-tank rocket launchers, AK assault rifles and M-16 rifles (with serial numbers removed). Contrast this report with the North Korean statement that the sub had "only sniper rifles but no heavy weapons".

Operations Analysis

The combination of the Sang-o SSKs limited propulsion, poor charts, a significant coastal current, and strong tides probably were contributing factors in the submarine running aground. Lack of bow thrusters or any other secondary propulsion capability further limited the Sang-o's ability to free up its grounded stern. Details are not available as to whether attempts were made to alter the fore/aft trim and the sub's ballast before opting to abandon ship. Also, there is no indication that the North Koreans used ship's swimmers to attempt to free the SSK prior to abandoning ship. However, scuba fins, masks and diver's tanks were among the gear found aboard the abandoned vessel.

Given the apparent reconnaissance mission, transport of the 75mm and 107mm anti-tank rocket launchers initially seems excessive. However, the largest of these weapons--the Chinese (PRC) 107mm Type 63 Multiple Rocket Launcher (mountain model) can be broken down into man-pack sizes--although it weighs 618 pounds when fully assembled. Each 107mm rocket weighs another 42 pounds. [Jane's Weapon Systems.] Since significant modifications to the SSK had to be made including allowances for compensation and trim, successful transport of these weapons must have been a vital part of the intended mission. These weapons would probably have been staged ashore for future operations if the mission had been accomplished while remaining undetected.

Insights into North Korean Submarine Doctrine

The configuration and usage of this Sang-o Class SSK demonstrates one possible North Korean view of submarine operations is as a stealth seaward transport capability for the Army. Heavy Army influence on the Navy would result in a naval doctrine that primarily focuses on littoral operations.

North Korea Background

The Democratic People's Republic of Korea (North Korea) is a communist nation located on the northern half of the Korean peninsula. The heavily industrialized centralized socialist economy has had a declining GNP since 1990 due to 26 percent defense spending and poor economic policies. The economic crisis is worsened by serious floods and famine. North Korea's unique Juche personality-cult ideology built around the Leader, Kim Jung Il, emphasizes North Korea's radical *self reliance* and isolation from the outside world. Since North Korea's imploding economy stands as a constant contradiction to Juche ideology, their leadership walks a tightrope in trying to both survive as a nation while retaining political power by maintaining the illusion that it needs no outside help.

Timing of the Incident

The timing of the submarine mission to coincide with hosting the international conference in the Free Economic and Trade Zone reflects the ongoing contradictory principles of the ever-victorious socialist revolution based upon Juche and the dire need for foreign investment and humanitarian aid for short-term survival. The submarine mission may be viewed as only another in a long series of incidents designed to isolate the South while reaching out elsewhere within the international community. While such policies may be illogical from a Western world view, Kim Jung Il's purposeful strategy easily might accommodate such apparent contradictions.

International Response

20 September 1996. President of the U.N. Security Council: "The UNSC expresses deep concern over North Korea's latest infiltration of its armed agents into South Korea. The armistice agreement on the Korean peninsula must be maintained."

20 September 1996. U.S. State Department spokesman: "North Korea's act of infiltrating armed agents into South Korea is a grave provocation."

20 September 1996. Chief Cabinet Secretary of Japan: "It is a matter of sincere regret that such an incident took place this time, and North Korea must suspend such activities immediately."

20 September 1996. New York Times: "The North Korean submarine incursion is an unbelievable incident, or an anacronic incident that can appear in a movie."

20 September 1996. Le Shibdnya: "The infiltration of North Korean armed agents is an incident which confirms that South and North Korea are still under wartime conditions."

22 September 1996. New York Times: "In case North Korea continues provocations, the appeasement policy of the U.S. government toward North Korea will cool down rapidly."

2 October 1996. Yomiuri: "Since last July, North Korea has been strengthening its southward infiltration capabilities by newly organizing submarine units which are capable of carrying out such special missions as reconnaissance and special warfare."

4 October 1996. Asia Week: "The infiltration incident this time is the 14th of its kind since 1990, and as far as North Korea is concerned the termination of the Cold War on the Korean peninsula is still remote."

7 October 1996. Time International: "As the submarine incursion this time shows, North Korea is an unpredictable and dangerous country."

North Korean Response

13 September 1996. Armed Forces Ministry: "On September 13 our troops sailed out of Wonsan port aboard a submarine, but while they were engaged in a routine exercise in our own waters, the submarine began to drift due to engine trouble, and it finally ran aground on a rock off the Kangnung shore."

23 September 1996. Armed Forces Ministry: "After the submarine ran aground on a rock our soldiers had no choice but to go ashore, and it seems that the armed conflict took place because it was on enemy territory, but our submarine was carrying only sniper rifles but no heavy weapons."

27 September 1996. Korean Central News Agency: "We, as the injured party, have the right to pay back the damage with hundred-fold and thousand-fold retaliation."

28 September 1996. North Korean Mission to the U.N.: "Because we are the injured party, we have the right to retaliate, and it will be hundred and thousand-fold retaliation."

2 Octpber 1996. Colonel Pak Im-su, North Korea's chief representative, during a meeting at the DMZ in Panmunjom: "We will take retaliatory actions against the South, but the U.S. must not intervene. If the U.S. intervenes, we will take retaliatory actions also against the U.S."

11 November 1996. Foreign Ministry spokesman to the Korean Central News Agency: North Korea is "compelled to interpret this as a revocation of the four-way talks."

Aftermath

Though North Korea's apology for the incident at Kangnung was good news, concern still remains that starvation in the North could destabilize both North Korea and East Asia as a whole. To what extent foreign aid will stabilize North Korea remains to be seen. Their economic crisis runs so deep that, in the long run, some sort of catastrophic collapse remains a distinct near term possibility. Meanwhile, firm-but-patient U.S. diplomacy, in the aftermath of North Korea's ill-fated submarine incursion, will continue in an effort to establish a framework for peace talks between North and South Korea. Resolution of the nearly half-century-old Korean conflict would be a major step toward the establishment of diplomatic relations between the United States and North Korea.

[Note: All information contained in the foregoing article was obtained from unclassified sources in the public domain. Opinions expressed therein represent those of the author and not of the United States Government, U.S. Submarine Force, Naval Submarine League or any other organization.

RUNNING AMOK IN THE MARMARA

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

The Victoria Cross, Britain's highest military award, has been won by a total of 14 Royal Navy submariners in both World Wars. The VC, a bronze cross simply inscribed For Valor, compares with the Congressional Medal of Honor. This is Part 2 of an eight part series on British submariner VCs.

Submarines have influenced land battles to a marked degree. One of their first victories was won in the Dardanelles between November 1914 and January 1916. British, Commonwealth and Allied forces were engaged in an (arguably misconceived) Eastern Mediterranean undertaking to negate Turkey's help to Germany, to support Russia, and to divert a threat by the Central Powers towards the Middle East and the Suez Canal. The situation and geography are described in Daring the Dardanelles in the January 1997 issue of **THE SUBMARINE REVIEW**.

The youthful politician Winston Churchill, First Lord of the Admiralty, enthusiastically advocated a bombardment by battleships to neutralise Turkish troops on the Gallipoli peninsula followed by a dashing naval drive up the Dardanelles channel—through the ancient Hellespont separating Europe from biblical Asia Minor—to the Sea of Marmara and the Turkish heartland. Professional alarms sounded by admirals such as the redoubtable Jacky Fisher were disregarded. Churchill had actually visited the area three years before; but it is safe to assume that his supporters in government had no conception of the terrain. Certainly they did not have in the mind's eye a picture of the steep cliffs and hills surmounted by enemy guns behind what were to become landing beaches; nor could they visualise the defile through which ships would have to steam.

The dashing drive by heavy ships was frustrated, in March 1915, by unacceptable losses in a minefield at the foot of the Dardanelles and the sinking in May of the British battleships TRIUMPH and MAJESTIC by U-21 (Kptlt Otto Hersing) nearby. The Turks would not now be driven out of the strategic strip of land by naval guns alone.

Admiral Carden was obliged, despite misgivings, to make appropriate plans for a landing on the peninsula with mainly

Australian and New Zealand (ANZAC) troops.

Even if beachheads were established, the rocky countryside beyond was not conducive to a rapid advance. On the other hand the defending Turkish army was precariously placed by reason of its lengthy supply and reinforcement lines. These depended upon direct shipborne transport from Constantinople across the Sea of Marmara to Gallipoli from which the peninsula extends south-westwards, like a finger pointing to the Aegean. Alternative road and rail communications around the oval, lake-like Marmara were tenuous to say the least.

No unit, other than a submarine, could make its way through the 50 mile Dardanelles channel from Cape Helles to Gallipoli and break out into the busy Marmara. But could a submarine not only penetrate the heavily guarded straits but remain long enough in the Marmara, entirely unsupported, to inflict worthwhile damage on the shipping lanes?

Staff officers had their doubts: the submerged endurance of the modern E class was 65 miles at 5 knots—against a current racing up to 4 knots, and averaging 1.5 knots. The passage, except on a dark night (when navigation would be extremely tricky) would imply a prudent boat remaining dived for some 35 miles. One of the newest surface ships, say a turbine-driven destroyer, could theoretically speed from the Aegean to the Marmara in less than a couple of hours, if unopposed; but the opposition—searchlights, guns, mines torpedo-tubes—was far too formidable. A *submergible* stood a better chance—one of the despised brood whose upper-deck (and quite often upper-class) naval officers themselves descended into the oily bowels of their *tubes* and dirtied their hands, just like engineer officers...

Nonetheless, with a best underwater speed of 7 or 8 knots for one hour and a submerged speed made good of 3 or 4 knots against the current for no more than a few hours, an E-boat—the best of its kind in the teenage Submarine Service—would creep agonisingly slowly towards its destination. And where exactly were those rows of deadly eggs? At what depth? And what about the intelligence report of anti-submarine nets? How many patrol vessels were on the lookout? Could wireless messages pass over the high hills of the peninsula to and from the C-in-C? (No, they could not; but in due course a transmitting ship was stationed in the Gulf of Xeros, safely outside the battle zone but facing a gap in the mountains.) Would torpedoes cope with shallow draft targets? (No; but deck guns—albeit puny six pounders extracted from the army—were promised before long: meanwhile submarines would have to board small ships to blow them up with demolition charges.) Were the Admiralty charts of the area reliable? (Good question; give us another.) How did the Turks treat prisoners? (Why do you ask?)

Despite compelling reasons for doing nothing whatever, other than drinking duty-free gin in the makeshift depot ship, the submariners decided upon action.

Lieutenant De Fournier in the French SAPHIR made an attempt, unauthorised, to force the Dardanelles in January 1915 and quickly met disaster. HMS E15 (T.S. Brodie) commenced a properly planned expedition in March. "I wish you God speed in your hazardous enterprise", signalled Churchill; but the boat grounded before reaching the Narrows and was subsequently destroyed by friendly forces—no easy task—to avoid capture of the wreck.

At the end of April the gallant Australian AE2, captained by the Royal Navy's Henry Stoker, an ebullient Irishman, became the first Allied vessel to reach the Marmara; but after a few days Stoker was forced to scuttle his beloved boat, the victim of careless submarine drills abetted by density layers and possibly a faulty tank valve: all hands were saved and made prisoners of war. Unfortunately, Revenel, captain of the French TURQUOISE, did not scuttle when he ran his undamaged boat aground in the inland sea, under the guns of a Turkish fort, a few months afterwards: nor did he destroy secret papers which told of a forthcoming rendezvous with HMS E20 which was duly, and fatally, kept by the Turks.

The sad fact about Australia's AE2 was that, due to time lost by urgent repairs (she was forever breaking things), there had been no proper *work-up* for the raw but enthusiastic crew. Come to that, few of the submariners in 1914 had been adequately prepared by their navies for war: satisfactory training depended, individually, upon exceptionally keen and clear-sighted commanding officers.

It was well that the challenge of technology, the glimpse of early command, substantially more pay, and a loathing of gas-and-gaiters gunnery officers in big ships, encouraged sufficient men of quality to join the fledgling submarine service of the Royal Navy in the dozen years before war broke out.

Two such men, both exceptional but different in character, made their immortal marks in the Marmara. They were Edward Courtney Boyle, commanding HMS E14, and Martin Eric Nasmith (to become, adopting a family name, Admiral Sir Martin Dunbar-Nasmith) of E11. Both were awarded the Victoria Cross for their penetration of the Dardanelles and the devastation which they wreaked on the Turkish supply lines beyond.

When AE2 gleefully reported her arrival in the Marmara, before Nemesis struck, the quiet, competent Courtney Boyle was invited to follow forthwith in HMS E14. Boyle had been a submariner from 1903, virtually from the start, and he was painstakingly familiar with *The Trade's* nuts and bolts. Never a thruster, never demonstrative but always steady in the Nelsonian sense, he had quickly gained the confidence of his people who were a good deal younger than their captain's grandfatherly 33 years.

The passage up through the straits was not expected to be without incident, especially since the bulk of it was to be made on the surface under cover of darkness. Boyle stood on the tiny bridge by himself, shouting conning orders down the tower, with all loose gear unrigged so that the submarine was instantly ready to dive. The engines *made a horrible din* by night between steep cliffs: a fore-endman said the noise was like "a full brass band in a railway cutting", but Boyle stayed up to conserve the battery for as long as possible.

He dived through the gorge at Chanak, taking a successful potshot at an enemy gunboat enroute, but was suddenly deprived of sight through his search periscope. Hastily raising the attack periscope he found a Turkish sailor leaning over the side of a picket boat and clutching the primary instrument's lens with both hands. Boyle mentally awarded the man full marks for effort, and wound on more speed. A stray shot from a small destroyer, soon after he gained the Marmara, shattered the top window of the same periscope; but, apart from those trivial incidents, E14 miraculously escaped damage.

The continual appearances of patrolling vessels had little effect on Boyle's conduct; but they were irritating because the two officers, and most senior ratings, worked a tedious watch-and-watch system: calls to diving stations forced those off watch, getting their heads deservedly down for a bare couple of hours, to turn out yet again. No creature comforts were abundant for the ship's company of 37: the practically non-existent foul weather protection and the troglodytic sleeping arrangements were inherited from a niggardly 18th century Admiralty. Leading Stoker John Thomas Haskins noted in his private diary on the 7th and 17th days of the patrol: "we were allowed a wash."

Boyle's genius lay in cool-headedness and meticulous attention to detail. His exploratory 21 days in the Marmara were exemplary. The most significant sinking was the transport GUJ DJEMAL carrying 6000 troops and a battery of field guns to Gallipoli; but the greatest value of E14's patrol was deterrence--in the true submarine sense that has too often been forgotten. The mere presence of a submarine athwart the Turkish lines of communication was demonstrably disruptive; and therefore, after all torpedoes had been fired, Boyle was ordered to remain on patrol where he deliberately allowed the submarine to be sighted at every opportunity. He even contrived a dummy gun from a pipe, an oil drum and a few yards of Admiralty-pattern grey canvas. The contraption looked lethal enough to deceive several ships; and on 13 May E14's formidable appearance prompted an impressionable Turkish steamer to panic and beach herself.

Boyle's activities greatly worried the Turks and their German supporters: they started sending a proportion of reinforcements and supplies to the Peninsula armies by the longer and very much slower rail-and-road alternative route rather than through the shortcut Sea of Marmara.

On E14's return the French flagship's band played "It's a Long Way to Tipperary" and "God Save the King". Admiral Guépratte kissed Boyle on both cheeks and called him a "a lovely boy". Boyle dined that night on board the British flagship and managed to keep awake for long enough before tumbling into his bunk—only to be roused by a signalman who informed him that he had been awarded the highest decoration.

Martin Nasmith, captain of E11 and already noted as an outstanding submarine officer brim-full with new ideas, was another guest at dinner with the admirals on the evening that Boyle came back. As soon as he had garnered the latest intelligence, he returned to E11 and set off to follow in E14's wake, and widen it.

Nasmith, unlike Boyle, was ambitious: he knew where he was going in the Navy, and he was determined to get there. He was also inventive: for example, he produced the first sensible mechanical aids to attacking. This was at a time when the aim-for torpedoes was judged by eye, and it was being said that if an officer was good at shooting snipe he would probably become a good submarine captain.

One of the Staff directives was to "go and run amok in the Marmara". Nasmith would do just that, but Boyle's exploits had sent most of the bigger ships scurrying for port; and there was as yet no gun to deal with the smaller fry. Realising that some of his torpedoes would inevitably miss or run beneath light targets, Nasmith devised an illegal plan for restocking with tinfish.

By international law torpedoes were set to sink at the end of a run if they failed to explode against a target; but Nasmith ordered the automatic sinking-valves on E1's fish to be blanked off so that any torpedoes which missed would surface. He was twice able to recover errant weapons thereby. On the first occasion he himself dived into the water to render the warhead safe, by removing the firing pin, before the torpedo was hoisted inboard by the standard derrick and lowered down through the fore-hatch into the fore-ends on rails—a problematical procedure because the submarine could not dive while the rails were erected. Next time he trimmed the boat down aft and sent D'Oyly Hughes, his more expendable Second Captain (Exec), to lead a team of six swimmers and coax the quiescent two-thirds-of-a-ton cylinder back into the stern tube.

Some of Nasmith's doings in the Marmara, where he carried out three long patrols in 1915, smack of gambling; but he took no more than calculated risks, and he discussed every plan with his officers. The morale of his men and the state of his battery were constantly on his mind. While successes mounted spirits were high, but welfare was notably absent in the stinking confines of an E-boat. He therefore permitted hands to bathe, three at a time for 10 minutes, in a quiet corner of the sea which was fast becoming *his*. If a swim was not practicable in a particular part of the Marmara he gave the crew a *make-and-mend*—half a day off—for washing clothes (in seawater), relaxation and a *spot of Swedish drill*.

As for the battery, E11 stayed on the surface whenever possible. Once, Nasmith captured a small sailing vessel, lashed the submarine alongside and trimmed right down so that only the conning tower was visible. The submarine's engines then charged the battery, with little chance of E14 being recognised from afar, while a sailor kept watch from the involuntary host's high mast.

Chance did not always favour E11 despite her phenomenal total of 122 (mostly small) enemy vessels destroyed and a railway line blown up by a landing party (commanded by the seemingly expendable Exec) between May and December 1915. A pugnacious little gunboat took a torpedo in her guts but retaliated with extraordinarily accurate gunfire before she went down: one shell passed through the submarine's exposed periscope (now exhibited in the Imperial War Museum, London). Nor did the crew invariably match Nasmith's exacting standards: when the wireless failed, and it became apparent that the operator had been negligent, lower deck was cleared in the control room where the criminal was publicly addressed by the captain:

> "I consider a man of this type more deserving of the death penalty than the unfortunate individual who, from work or fatigue, drops asleep at his post duty...(he) is a menace to this shipmates and a traitor to his cause."

The transmitting apparatus was repaired with unprecedented speed, and thereupon the disciplinary matter was dropped—not least because Nasmith openly admitted his own shame: "Owing to my inefficiency I am unable to tell this man how the repair should be made."

On the morning of 24 May a small steamer hove to under rifle fire. When E11 slid alongside to board a nonchalant figure on deck introduced himself as Mr. Raymond Gram Swing of the Chicago Daily News; he was glad to make the acquaintance of British submariners, but he had paid for a passage to Gallipoli where he intended to do some war reporting. Nasmith expressed his regrets for the interruption, and ensured that the reporter had a place in one of the ship's boats which pulled back to Constantinople. There, Gram Swing did nothing to contradict reports that 11, yes, 11 British submarines were roaming the Marmara: the figure was in error by a margin of 10 at the time, but the rumour helped further to discourage Turkish shipping—another example of inexpensive deterrence!

Nasmith's Victoria Cross was announced on 23 June 1915. The award was nominally for E11's first Marmara patrol; but a detached observer might reflect that it was deserved again and again for the missions which followed. Nasmith was the perfect example of thoroughly professional daring. Who else would have taken his submarine into Constantinople harbour to make torpedo attacks in the very heart of the Turkish Empire, throwing the capital's organisation into wild confusion? And take there, in sepia-tone, the first-ever periscope photographs of real merit?

The impertinent intrusion was made with only one-third of the crew closed up for action, while the remainder rested—doubtless allowing more space in the control room for the captain to get on with his business without overmuch fuss and noise. A contemporary had once criticised Nasmith, earlier, for a tendency to "hold on to the ball for too long"—that is, for wanting to be a one-man band. The critic had a point: but so?

Nasmith was undoubtedly the leading light in a minor submarine campaign that brought about major strategic results.

However, the virtual nullification of Allied surface seapower by the underwater threat of mines and torpedoes and appalling casualties amongst the armies spelled disaster for the Allied Dardanelles expedition. Evacuation of the Allied troops was ignominiously but efficiently completed, from their last toehold on Cape Helles, by 8 January 1916.

The withdrawal left scant pride in the combined fleets at the end of a dismal day; but the honour of the Royal Navy was at least partially redeemed by a small band of submariners who proved their ability to create havoc in enemy waters where surface ships could not, or would not, dare to go. ■

IN REMEMBRANCE

Leonard E. Adcock

RADM Raymond H. Bass, USN(Ret.)

George D. Cooksey, Jr.

CDR Charles F. Donaghy, USN(Ret.)

CDR Edward Frothingham, Jr., USN(Ret.)

LT Robert S. Northrop, USN(Ret.)

CAPT Frederick B. Tucker, USN(Ret.)

A WHOLLY AVOIDABLE ACCIDENT
The Loss of HM Submarine ARTEMIS
1 July 1971

by Paul Kemp

Paul Kemp is a naval historian (and NSL member) who has written a number of books on submarine history. He is currently engaged in writing a two volume history of the Royal Navy's Submarine Service for publication in time for the centenary of HM Submarine HOLLAND 1's commissioning.

There was nothing particularly unusual about the evening of 1 July 1971 in HMS DOLPHIN, home of the Royal Navy's Submarine Service. The working day had ended and only the duty watches were onboard the various submarines secured to the jetty. Just after 1905 the Trot Sentry of HMS OCELOT, an Oberon class diesel electric submarine, noticed that HMS ARTEMIS, an older A class submarine moored inboard of OCELOT, was very low in the water—so low that the sea was lapping round the lid of the after loading hatch. As water began to pour into the submarine through the hatch, OCELOT's Trot Sentry raised the alarm. But it was too late: ARTEMIS subsided gently into the muddy waters of Haslar Creek as the few men onboard tumbled up through the forward torpedo hatch. Three were trapped in the submarine and made an escape 10 hours later. The incident was treated with a certain amount of hilarity in the press. However, such a trivial disposing of the affair hid a serious situation where the submarine's command structure had collapsed. ARTEMIS' loss could have ended as a disaster with major loss of life. So just what had happened to cause the submarine to sink on that fine July evening?

ARTEMIS had just been undocked following the fitting of trials instruments prior to the submarine deploying to the West Indies. The Commanding Officer, Lieutenant Commander Roger Godfrey, was away at RAF Boscombe Down having discussions on forthcoming exercises. The First Lieutenant was on leave, so the docking separation was entrusted to the Third Hand who was currently *on report*.[1] The enquiry into ARTEMIS' loss criticised the decision to leave him in command on the grounds that he was, "Neither qualified nor competent to perform what in fact is an exacting task, and appreciated little of the problems which might arise. The succession of organizational and personal failures which occurred during the next few days may well have stemmed from this first unacceptable decision".[2]

The docking operation was conducted in an almost cavalier fashion. The end result was that when ARTEMIS undocked on the afternoon of 1 July, she was much heavier in the water than when she had been docked. As the dock was being flooded up, the Dock Master asked for Number 5 main ballast tank[3] to be flooded to the waterline with the vent open so as to achieve the correct undocking trim. As the water rose above the inlets for Number 4 main ballast tank, the Kingston valves were opened as was the usual practice. Unfortunately the siphon pipes to the after fuel group had been left open through negligence so that water vented from Number 4 tank into the fuel group. After the docking all ballast tanks were blown to full buoyancy but it was not appreciated that the after fuel group of tanks contained a good deal of water. No record had been kept of the submarine's draught marks when she was docked, so when the Dock Master commented that ARTEMIS seemed light in the water, the ship's officers were in no position to check his assertion but merely accepted is word. In fact ARTEMIS was almost three inches lower in the water than when she had entered the dock. The Engineer Officer then suggested that Number 5 main ballast tank be flooded to return the submarine to her usual trim. Although this action did

---

[1] For those unfamiliar with British procedure, an officer *on report* has had concern expressed about his performance and additional reports on him are being written inside the usual annual reporting cycle.

[2] HMS Artemis: Lessons Learned. Royal Navy Submarine Museum Archives, A1973/1.

[3] The layout of ballast tanks in an A class submarine was as follows: Numbers 1 and 5 tanks are single ballast tanks forward and aft respectively. Numbers 2 and 3 are port and starboard ballast tanks and Number 4 is a port and starboard tank which can be connected to the after external group of fuel tanks allowing extra fuel to be carried.

not affect the submarine's overall trim, it did appreciably lower the stern.

ARTEMIS was returned to DOLPHIN on the morning of 1 July in a cold move. The OOD, the Third Hand, left the submarine without checking on the duty watch organisation or detailing what work was to be done in the afternoon. As a result he was not in a position to know that the submarine's watertight integrity was being weakened by the unauthorised opening of hatches on the casing. Submarine Standing Orders (which are mandatory) clearly state that only two hatches can be open at any one time. Additional hatches could be opened for a specific purpose but only with special permission and had to be shut once the necessary work had been completed. That afternoon in ARTEMIS, the forward loading hatch was open as the principle means of entry to and exit from the boat. Subsequently the after loading hatch[4] was opened in order to remove an item of equipment. The Torpedo Officer then changed his mind and removed the item through the after escape hatch instead. On completion of the task he ordered a Leading Seaman to shut the hatches. However, the rating completely forgot to shut the after loading hatch and merely pushed the escape hatch shut from the outside without clipping it home. Although the hatch appeared shut, the lid was resting about half an inch clear of the housing. At the same time the leading seaman rigging the shore power line through the conning tower hatch found that the lead was defective as were two others that he tried. He made no attempt to shut the conning tower hatch but instead rigged a fourth lead through the engine room hatch (which had been opened in the forenoon to remove fuel hoses) and then forward through the engine room watertight door to the control room where he connected it to Number Two Battery Panel. This action fundamentally compromised the submarine's watertight integrity. At some time during this period the gun tower hatch was also left opened. Thus in a submarine which was already unusually low in the water, six out of seven hatches were open.

Lieutenant Commander Godfrey returned to HMS DOLPHIN shortly after 1230. He made no attempt to visit his submarine but

---

[4] An A class submarine such as ARTEMIS had seven hatches running from forward to aft as follows: forward escape hatch; forward loading hatch; gun tower hatch, conning tower; engine room, after loading hatch; after escape hatch.

contented himself with receiving verbal reports from his officers in the wardroom bar over a drink. He then returned home at 1300 and played no further part in the proceedings.

During the move back to DOLPHIN the possibility of *first filling* the external and emergency fuel tanks was considered. No clear orders were given although the CMEM[5] was given the impression he could do so if he wished. Neither the Third Hand nor the Engineer Officer realised the significance this evolution would have on the submarine's trim. The combination of *first filling* with Number 5 tank flooded would be to remove all reserve of buoyancy from aft of the fin. The forward tanks were filled first and then shortly after 1700 work started on filling the after tanks. There was no supervision of the operation. The CMEM, who was responsible, chose to remain in the comfort of his mess. He did not leave the mess to check on matters even when the LMEM[6] told him about *bubbling vents* on Number 4 ballast tank. Rounds were carried out at 1600 and at 1800 but no record was written up as the Rounds book could not be found. No one shut any of the open hatches on the casing, or even queried why all but one of the submarine's hatches were open. When the Duty Officer went ashore at 1820 he failed to notice that the after plane guards were well under water. This indicated that the first filling had dropped the stern by nearly 18 inches. The scene was now fully set for the disaster which was to follow, unless someone in authority recognised the pattern of incompetence and corrected the errors. No one did.

There were nine men onboard ARTEMIS that evening. The Duty Petty Officer, Petty Officer David Guest, was on the casing. The Trot Sentry was at his post by the forward loading hatch and the duty seaman was in the fin. The LMEM was first filling the tanks while five other ratings were inside the boat. At 1855 three cadets (aged between 12 and 14) from the DOLPHIN Sea Cadet Corps unit asked to visit the submarine and were shown round by the Trot Sentry. Meanwhile the Trot Sentry in OCELOT noticed that ARTEMIS was very low in the water and called out the Duty

---

[5] Chief Petty Officer Marine Engineering Mechanic. Perhaps better known as Chief Stoker in less sophisticated days.

[6] Leading Marine Engineering Mechanic.

Watch as did the Trot Sentry in OTUS which was lying in the next trot. OTUS' Commanding Officer came up onto the casing and went across to the jetty to raise the alarm.

ARTEMIS was very low in the water which was lapping round the edge of the after loading hatch. In fact water had been pouring into the submarine *unnoticed* for the past 10 to 20 minutes through the half inch gap in the after escape hatch. Some 12 tons of water had entered the submarine and brought the after loading hatch to the waterline. The LMEM saw water pouring in through the after loading hatch and went down to the engine room in an attempt to isolate the after ends. However he found that the door between the motor room and after ends was blocked by mattresses and bunk frames. He then tried to shut the engine room hatch but it was blocked with the shore power lead. He then went forward to shut the watertight door between the engine room and the control room but this too was blocked with the power lead.

Meanwhile Petty Officer Guest ordered the three Sea Cadets out through the forward loading hatch. This they did with commendable coolness, considering the water was coming in over the lip of the hatch. They were followed by three other members of the duty watch, the last of whom had to pull himself up out through the incoming water. The Trot Sentry then made the difficult but correct decision to shut the loading hatch although he knew there were still some other men inside the submarine. He then stood on the hatch to keep it shut until the submarine sank underneath him. Three seamen escaped out of the fin but made no attempt to shut either the conning tower or gun tower hatches. This simple action would have slowed the entry of water into the submarine considerably.

Inside the submarine, Petty Officer Guest and two other ratings, MEM Donald Beckett and LMEM Robert Croxen were trying vainly to shut the watertight door between the control room and the engine room. The power lead prevented the door being fully shut although after salvage it was found that the dogs had been partially engaged. They retreated forward and tried unsuccessfully to shut the conning tower hatch from inside. They were working in complete darkness, the lights having failed and many of the portable emergency lights being away for repair. By this time water was swirling around their knees, the submarine had a sharp bow up angle and their progress was impeded by the wardroom door having come off its housing. It was clear that they could do no more than look to their own safety. They entered the torpedo stowage compartment and successfully managed to isolate it. The fact that the Trot Sentry had stood on the lid of the loading hatch enabled them to get the clips on from the inside. In time they were able to establish underwater telephone communication with OCELOT. They then rigged the twill trunk in order to carry out a compartment escape but in such shallow water it took 10 hours to flood up the compartment and equalise the pressure. First to leave the boat was LMEM Croxen (who was only 22 years old), followed by MEM Beckett and Petty Officer Guest. The enquiry noted that, "The skill and determination of the ratings concerned, together with the Trot Sentry, are the only redeeming features of an otherwise sorry tale".[7] Six days later ARTEMIS was raised by the salvage vessels GOLDEN EYE and KINLOSS and the following year was sold to the Portsmouth scrap dealer Harry Pounds for breaking up. For some years her battered and rusted hull could be seen among the detritus of Pounds' yard from the M27 motorway.

The enquiry into ARTEMIS' loss was conducted by Flag Officer Submarines, Vice Admiral Sir John Roxburgh, a distinguished wartime submariner and an officer not known for mincing his words. The results of the enquiry were published in a Lessons Learned document, which Roxburgh ordered to be fully disseminated throughout Submarine Command and read by every officer and senior rating. The document concluded, "The submarine sank, not because of material failures, but because of the failure at all levels to maintain high standards in basic submarine practices...the officers onboard so lacked awareness of the risks of life in submarines, that they failed to relate the individual abnormalities which they knew to exist, and failed to take corrective action for any of them".[8]

ARTEMIS was an old boat and her loss barely dented the British order of battle, particularly given the burgeoning nuclear fleet submarine programme. Four years after her loss the last of her sisters went to the breakers. However, the lessons of this

---

[7] HMS Artemis Lesson Learned. RN Submarine Museum Archives A 1973/1.

[8] Ibid.

sorry tale are so obvious that they hardly need restating. Yet these simple truths are the ones that need emphasising time and time again. In August 1926 the British submarine N.29 had sunk in Devonport—causing six deaths—in circumstances very similar to those of ARTEMIS. The old saying that "He who forgets history is condemned to repeat it" can come horribly true. ■

A HISTORICAL PERSPECTIVE: U.S. Navy's First Active Acoustic Homing Torpedoes

by Tom Pelick

The Harvard Underwater Sound Laboratory (HUSL) was a scientific base for the development of active and passive homing systems for torpedoes during WWII. The scientists at Harvard and other Labs researched and developed concepts for potential applications in the defense of our country. As reported in the January 1996 issue of **THE SUBMARINE REVIEW**, by this author and in the April 1996 issue of **THE SUBMARINE REVIEW** by Dr. Fred Milford, the passive acoustic homing concepts were developed and engineered at HUSL and at Bell Labs. **The resulting product was produced by Western Electric, with assistance from General Electric, and became the first U.S. passive homing torpedo Mk 24 (FIDO).** There was an independent but cooperative effort between HUSL and Bell Labs. This passive homing system concept was then carried into many other passive homing torpedoes. HUSL also worked with General Electric in the development of the first active homing system for torpedoes.

Historical Background

Dr. Vanevar Bush suggested to President Roosevelt prior to U.S. involvement in WWII that scientists and engineers be utilized to assist in advanced technology applications for the military. In June 1940, President Roosevelt appointed a group of eminent scientists to become part of the National Defense Research Council (NDRC), with Dr. Bush as the chairman. In 1941, NDRC became part of the newly formed Office of Scientific Research and Development (OSRD). When Dr. Bush became director of the OSRD, Dr. Conant, President of Harvard, became the chairman of NDRC. Research laboratories were established at universities, such as Harvard, Columbia and Cal Tech at Pasadena. Top scientists, engineers, and technicians were hired to perform the needed research and development for military applications.

Research and Development

The role of a scientific laboratory to develop concepts, followed by engineering development by other Navy sponsored labs, and finally production by industry is still carried on today. The U.S. Navy has four university laboratories: the Applied Physics Laboratory at Johns Hopkins, founded in 1943; the Applied Research Laboratory at Penn State, founded in 1945 as the Ordnance Research Laboratory (ORL), with the transfer of HUSL personnel; the Applied Research Laboratory at University of Texas founded in 1945 as the Defense Research Laboratory with the transfer of HUSL personnel; and the Applied Physics Laboratory at the University of Washington, founded in 1943. After HUSL closed its doors following the end of WWII, many of the HUSL torpedo scientists, engineers, and torpedo men transferred to Penn State to work at the newly formed Ordnance Research Lab and to the University of Texas to work at the Defense Research Lab. Dr. Eric Walker, Assistant Director at HUSL, moved to Penn State to become the head of the Electrical Engineering Department and at the Navy's urging, formed the Ordnance Research Lab. Dr. Paul Boner, another Assistant Director at HUSL, returned to Texas and formed the Defense Research Lab. Each of the university labs have a different mission but maintain a cooperative effort since there may be overlapping tasks.

The Navy provides funding to these laboratories to do ongoing research. This is performed as a preventative measure for future application of this accumulated scientific knowledge to answer potential threats posed by unfriendly countries. When there is a threat, the Navy puts out an Operational Requirement to meet the threat with assistance from other Navy laboratories to provide an answer to the threat. After the conceptual system is formulated and prototype tested by the university laboratories, it is then available for contractual bidding by industry. The laboratories assigned to carry on the supervision of developmental engineering are largely the Navy laboratories, such as the Naval Underwater Weapons Centers (NUWC), at Newport, Rhode Island and Keyport, Washington. However, the university laboratories and the Navy labs will generally have some degree of involvement until after production and Follow-on Test and Evaluation. There is a variable degree of overlap. Navy funding categories for fundamental research and initial development are 6.0, 6.1 and 6.2. Prototypes were initially funded by 6.2 money, but today prototype development is funded by 6.3 money. Developmental work today is funded by category 6.3 and production is funded by category 6.4. However, as in the mission assignments, there is come overlap.

The feasibility of these concepts is tested in prototype torpedoes as Harvard and Bell Labs had done with the Mk 24 torpedo tests. Torpedo development is one of the missions of the Applied Research Laboratory at Penn State. ARL has been involved in the research and development of most torpedoes in the fleet today with the exception of the Mk 46 torpedo homing system which was developed by the Naval Torpedo Station at Pasadena, CA (later NOSC, San Diego).

Active Homing Studies

In addition to the passive homing studies at HUSL and Bell Labs under Navy Project NO-94 during WWII, active homing studies were being performed at HUSL and at General Electric under Navy Project NO-181F. This active homing objective was to obtain greater detection range through the use of higher directivity and a reduction of self-noise. Self-noise reduction was a challenging task and required comprehensive studies and experiments. The Mk 18 with electric propulsion was an initial test platform for several homing systems. Other self-noise reduction came about through solving ground loop problems, crosstalk between wires, and harmonics.

HUSL scientist and GE engineers each worked on an echo ranging active homing system. They encountered much difficulty until they learned more about the environment and were able to cope with the resulting acoustic problems. It was difficult for the early active homing systems to distinguish among echoes from the target and the echoes from the bottom, surface, and sealife. In addition, the vertical direction of the echo is confused by refractive properties resulting from thermal differences in the water and by reflections from the boundaries, surface and bottom. Also, horizontal steering at close-in terminal homing ranges is confused since multiple echoes were received from different sections of the target, such as the bow, stern and sail. At long ranges, the entire target is acoustically ensonified and appears as a point source.

However, as the range gets very short, multiple echoes appear from several sections of the target and this confused the active homing system's horizontal steering. Today's torpedoes are still faced with this problem but have more complex circuitry to provide more accurate horizontal steering.

The problem with the Mk 18, in addition to learning the environmental effects, was the internal noise level of the torpedo.

These active acoustic homing torpedoes may be categorized into first generation consisting of the Mk 32, Mk 35, Mk 37, Mk 43 and the Mk 44 torpedoes. The second generation may include the Mk 46 and Mk 48 torpedoes. The third generation would consist of the Mk 48 ADCAP and the Mk 50 torpedoes. Research work at the laboratories leads to improvements in existing torpedoes with advancements in computers and other technologies. For example, some of the transistors used in the Mk 48 are no longer available so new electronic parts replace them as needed.

Mk 32 Torpedo

The first active homing torpedo in the fleet was the Mk 32 torpedo. It was an anti-submarine weapon launched from aircraft and surface ships. It was developed by GE with some combined and competitive effort between HUSL and GE. The Mk 32 torpedo's homing system was only active and did not have a passive homing capability. The Mk 32 torpedo was about the size of the Mk 24 (FIDO) passive homing torpedo. It was 83 inches long, 19 inches diameter, 700 pound weight, electric propulsion, warhead of 107 pounds HBX, 12 knot speed, and a range of 9600 yards (24 minutes). GE had discarded its crystal transducers in favor of the HUSL magnetostrictive transducers.

Eventually, successful demonstrations of active homing were made by GE during June 1943 in the azimuth plane with the Mk 32 prototype. It would be in early February 1944, before the Mk 32 prototype demonstrated a successful homing attack on a target in three dimensions. Since GE did not have available facilities for production, Leeds and Northrup of Philadelphia was awarded the production contract. However, only 10 torpedoes were produced during WWII and none saw action.

There was some limited active homing work in a developmental torpedo designated the Mk 22. Bell Labs and Westinghouse experimented with active acoustics in the azimuth plane for terminal homing. This work was discontinued in favor of the planned Universal Torpedo to be designated as the Mk 35.

The ORL, in a combined effort with GE, continued post war development of the Mk 32 Mod 2 torpedo. About 3300 torpedoes were produced by the Philco Corporation in Philadelphia and the Naval Ordnance Plant in Forest Park, Illinois. This torpedo saw service from 1950 to 1955, when it was replaced by the Mk 43 torpedo.

The evolution of active homing systems continued at ORL and at GE. ORL pursued the concepts of the Navy Project NO-181 F, designating the work as ORL Project 4 while GE pursued a different approach. These two lines of effort resulted in two distinct types of active homing systems.

Mk 35 Torpedo

As noted earlier in this article, the Navy requested that work begin on a Universal type torpedo with an active homing system. GE was given the contract. The Navy wanted an active homing torpedo capable of being launched from aircraft, surface ship, or submarine. **The Mk 35 was the first generation deep diving, long range, acoustic torpedo designed to attack submerged submarines.**

The Mk 35 torpedo was based on the acoustic homing system performances of the homing torpedoes Mk 24 and Mk 32. It was originally designed as the Universal Torpedo capable of being launched from any type of platform. During development, the torpedo grew to 162 inches and 1770 pounds eliminating it from aircraft use. It had a 21 inch diameter with an electric propulsion system featuring a seawater battery. It was planned to have an active capability, passive capability, and use a spiral search pattern. It had a speed of 27 knots and a range of 15 kyds. The Mod 1 version reportedly failed OPEVAL. A Mk 35 Mod 2 torpedo was built with a redesigned homing system based on work at GE and ORL.

Between 1949 and 1952, GE at Pittsfield, Massachusetts built 400 units which saw limited service. It was withdrawn from further development and production in favor of the Mk 37 torpedo. The research, development and testing of this torpedo had cost between $14-15M.

Homing System Designs

The evolution of the active homing systems from HUSL continued in 1945 at ORL (now ARL) and GE resulted in two distinct active homing system. Both homing systems measured the target echo in terms of the leading edge rise time, amplitude, and echo length relative to the transmitted pulse. However, the HUSL/ORL design had a Doppler gate which separated the echoes based on Doppler of greater than 1.2 knots allowing a greater sensitivity to the amplitude detection of echoes from targets. The Doppler gate provided the first viable Doppler classification method of distinguishing targets from false alarms. This had the adverse effect of not detecting very low Doppler targets, but had the positive effect of significantly reducing the amount of false alarms from reverberation.

One of the designers remembers using a capacitor to slope the front edge of the transmitted pulse to obtain a narrower reverberation spectrum. It was the beginning of what we call today *Pulse Weighting* or *Waveform Shaping*. A square pulse would have a wider reverberation spectrum whereas an amplitude modulated pulse would have a much narrower reverberation spectrum. Also, the reverberation spectrum was also dependent on the length of the transmitted pulse. The narrower the pulse, the wider the reverberation spectrum. The wider reverberation spectrum made it difficult to detect Doppler targets. The GE system, without the Doppler gate, could detect the lower Doppler targets, but was subject to a higher false alarm rate.

The ORL transducer design provided a transformer for impedance coupling between the transmitter and transducer which resulted in a greater efficiency, whereas the GE design dumped the power directly into the mis-matched transducer impedance resulting in a loss of transmit power.

In addition, during transmit, the HUSL/ORL design provided the simultaneous driving of all four sectors of the transducer array. During the receive mode, the transducer produced outputs from four quadrants with different phase centers. The phase differences among these signals indicated the three dimensional direction of the arrival of the echo. The input circuit converted these voltages to four in-phase voltages of varying amplitude. The amplitude differences between corresponding pairs gave target angle information simultaneously in the horizontal and vertical planes.

This allowed the torpedo **to boresight** on the target during the attack. The GE system used a similar transducer with upper and lower halves rather than the four quadrants. Therefore, GE's system would provide directional steering in the vertical plane, but the horizontal steering was a *steeraway* technique. The torpedo searched by circling until it received a target detection, then it reversed the turn until the target was lost. This meant that the steering on the target was held at the side of the horizontal beam rather on boresight.

The processing of signals was a problem with receivers using an amplifier to process each signal from the transducer sectors. It was difficult to maintain the same gain in each amplifer. The HUSL/ORL receiver design addressed this problem by using a single amplifier. The average amplitude of the modulated singal was a measure of the received echo amplitude, the phase of the modulation envolope was an indication of target angle information, and the amplitude of the modulation envelope was a function of both the echo amplitude and the angle between the direction of echo arrival and the transducer axis.

MK 37 Torpedo

The ORL/HUSL active homing system design was selected for the Mk 37 torpedo and the contractor was Westinghouse at Sharon, Pennsylvania. ORL's Nick Abouresk was the Liaison and Project Manager for the technical direction of ORL's active homing system implementation into the Mk 37 torpedo. The earlier HUSL design was modified by replacing the larger vacuum tubes with miniature vacuum tubes and much attention was given to packaging, stability, and electronic noise reduction. The operating frequency was 60 Khz and the propulsion was a two speed electric motor. **This torpedo was the first fleet torpedo to have active and passive homing capabilities throughout the run.** It was 135 inches in length, 19 inch diameter, 1430 pounds, warhead of 330 pounds HBX-3, and used a contact exploder. It had a nominal detection and homing range of about 700 yards. This torpedo, which was produced in quantities of over 3300 units at the Naval Ordnance Park at Forest Park, Illinois, served as the U.S. Navy's primary submarine acoustic torpedo from the mid 1950s until the Mk 48 torpedo replaced it in the early 1970s.

Since the Mk 37 torpedo had electric propulsion, it would swim out of the torpedo tube instead of being impulsed, thereby reducing the launch transients and the detectability of the launching submarine. Wire guidance was later added to the torpedo making it 26 inches longer and 230 pounds heavier. The submarine fire control system was also modified to take advantage of the wire guide capabilities.

After replacement of the Mk 37 in the U.S. fleet by the Mk 48, the Mk 37 torpedo was sold to several countries. Today, the Mk 37 torpedo is being used by many countries, including Israel. However, the vacuum tubes in the homing systems of the original versions have been replaced by solid state electronics. U.S firms, such as Alliant Tech and Westinghouse, have contracts to modify and service these torpedoes.

Mk 43 Torpedo

As stated earlier, the Mk 32 torpedo was discontinued in favor of the Mk 43 torpedo. The Mk 43 Mod 0 was developed and produced by GE at Pittsfield, Massachusetts. It was an inexpensive lightweight air-drop torpedo. After 500 of these units were built, they were discontinued in favor of the Mk 43 Mod 1 and Mk 43 Mod 3 torpedoes.

The Naval Ordnance Test Station (NOTS) in Pasadena, California and the Brush Development Co., Cleveland, Ohio, developed the Mk 43 Mod 1 with a 10 inch diameter, 91.5 inch length, 260 pounds weight, warhead of 54 pounds HBX, active homing with a helical search pattern, and a 15 knot speed and a range endurance of about 4500 yards. Brush Electronics and Naval Ordnance Park produced 5000 of these torpedoes until they were replaced by the Mk 44 torpedo. **It was the first lightweight torpedo capable of being launched from helicopters, fixed wing aircraft, and surface ships.** The Mk 43 torpedo was in the fleet from 1951 to 1957 and was replaced by the Mk 44 torpedo. The Mk 43 torpedoes were sold to the British and perhaps other countries.

Mk 44 Torpedo

The Mk 44 Mod 0 torpedo was a replacement for the Mk 43 torpedo with improvements in speed, warhead size, acoustic homing changes, and pre-launch progrmmable search modes. It was developed by NOTS and GE. It was the first air-launched fleet torpedo with a seawater-activited battery to provide power. It was produced at GE and later at the Naval Ordnance Plant. It was in service from 1957 through 1967 on destroyers and aircraft as an ASW weapon until it was replaced by the torpedo Mk 46. The Mk 44 torpedo was sold to foreign governments and also produced in Europe by NATO countries.

Mk 46 Torpedo

The Mk 46 was developed by Aerojet General, Azusa, California and NOTS. It was the first air-launched deep diving, high speed ASW torpedo with active/passive homing and represents the second generation in airborne ASW weaponry. It entered the fleet in 1965 and went through several modifications, from Mod 0 through Mod 5. The Mod 2 version was 102 inches long, a diameter of 12.75 inches, weight of 508 pounds, speed of 40 knots, range of 12,000 yards. The Mod 4 version is also capable for use in mine systems, such as Captor.

The Mk 46 Mod 5 torpedo was built based on the Near-Term Improvement Program, NEARTIP, and resulted in improvements in acoustic performance in deep and shallow water, countermeasure resistance, guidance and control, and the fire control system. A driving force for this NEARTIP torpedo was to respond to the anechoic coatings on Soviet submarines. The Mk 46 Mod 5 is primarily an ASW weapon and can be launched from surface ships, fixed wing aircraft, helicopters, ASROC, and mine systems. According to Jane's about 20,000 Mk 46 torpedoes were built for U.S. and foreign use. It is estimated that the U.S. fleet may have at least 13,000 Mk 46 torpedoes in its inventory. More current torpedo modifications will provide significant improvements as the advances in computer and electronic technologies continue. It has not been replaced despite the new advanced Mk 50 torpedo primarily due to cost and reduction of the threat. Jack Slaton, (who worked at ORL, NOSC Alliant Tech, and is now retired) was one of the chief designers of the Mk 46 homing system and was a major contributor to the Mk 50 homing system.

Mk 48 Torpedo and Advanced Torpedoes

As torpedo technology improves because of research at university and Navy laboratories, these weapons are greatly improved and this in turn provides the submariner with a higher probability of success. The Mk 48 torpedo, which replaced the Mk 37 torpedo in submarines will be discussed in a future issue of **THE SUBMARINE REVIEW**. Also slated for future publication will be the Mk 48 ADCAP and the Mk 50 torpedoes.

Information Collection and Review

I would like to thank all those who have provided information which helped me to assemble this article on the early active homing system in torpedoes and the events leading to the development of these torpedoes. Reconstruction of history and publication of events can be very rewarding, but it can also serve as a lighting rod attracting a few dissenting and minority opinions as well as many favorable comments. I would appreciate any information you might have on the development of the Mk 48 torpedo that may be included in my next article.

Tom Pelick
609 Berkshire Drive
State College, PA 16803

FLOATING WIRE ANTENNAS: COMMUNICATING WITH A SUBMERGED SUBMARINE

by John Merrill

The concept of a wire antenna for submarines arrived on the Navy's communication horizon in 1954, the same year as the launching and commissioning of the first nuclear submarine USS NAUTILUS (SSN 571). Six years later, in 1960 USS TRITON (SSNR 586) was able to deploy a buoyant cable antenna and maintain continuous radio reception during its historic circumnavigation of the world while submerged. From its beginnings, the floating wire antenna has provided capabilities which have steadily improved and reflected the communication needs of nuclear submarine platforms.

In the mid 1950s, interest in this type of antenna at the Navy Underwater Sound Laboratory[1] in New London was directed to the communication requirements of the diesel submarine while submerged. During these early years, research worked with this antenna toward providing the submerged submarine a send-and-receive capability. The frequencies of interest were 2 to 30 x 10^6 Hz. At that time, submarines periodically still rose to, or neared, the surface to charge batteries and conduct radio frequency communications.

NAUTILUS, a true submersible with the ability to spend extensive periods submerged, provided additional submarine antenna challenges including new speed and depth considerations. As the nuclear submarine program grew, each new class of attack and fleet ballistic missile submarine brought fresh, interesting, and difficult challenges to the Underwater Sound Laboratory (USL) antenna engineers, scientists and technicians.

Technology, patience, support and hard work gave a viable buoyant cable antenna to attack and strategic submarines by the mid-1960s. Today, an inboard retrievable buoyant cable antenna is part of the antenna suite of all U.S. submarines and those of major foreign powers.

---

[1] Excellent guidance was provided to the author by Anthony Susi, the Laboratory's long-term buoyant cable antenna manager. Susi's involvement with buoyant cable antennas on both national and international levels covers more than 30 years.

James Tennyson

Introduction of this submarine antenna concept resulted from the initiatives and investigations of James Tennyson, a physicist and inventor working in the Radio Communications Branch of the Electromagnetics Division of USL. He came to the New London Laboratory from the Naval Research Laboratory in February 1947 when the submarine radio research group was still in a formative stage.

Beginnings

In October 1944, during Word War II, a German conference was held on underwater antennas in Berlin. Minutes of this wartime conference mentioned the possible use of a floating cable antenna towed by a submarine for radio communications. The report of the conference came to the attention of Tennyson in the early 1950s. The idea caught his interest. After some preliminary research and limited encouragement, he proceeded with development of an experimental floating wire antenna. The initial thrust was to use a floating wire to address the problem of intra-fleet communications. An early goal was to provide a range in the order of 20 miles.

First problems included how to make an antenna that would float. This was one of the tasks that John Amaral, a long time radio engineer at the Laboratory, helped to resolve. He assister Tennyson in all the early experiments and at-sea tests. At the Laboratory he fabricated the first antennas that would float. His installations and tests of these early floating wire antennas included the submarines BARRACUDA (SST 3), BONITA (SS 551) AND BASS (SS 552), *[Editor's Note: BARRACUDA was redesignated from SSK1 to SST3 in July 1959. BASS and BONITA were redesignated from SSK2 and SSK3 to SS 551 and SS 552 respectively in December 1955.]* as well as others. One early sea test with floating wire antennas involved Amaral in an under the ice exercise in the North Atlantic involving three diesel submarines and an at-sea transfer from one diesel submarine to another in a polynya.

The Antenna

Initial laboratory investigations into the capability of an antenna to radiate while floating just above sea water were conducted at the USL test facility located at Fishers Island, New York, six miles from the New London Laboratory. An underground laboratory below a 50 foot diameter ground level sea water test pool allowed measurements to be made on antennas placed in the pool simulating the condition of a submerged submarine.

The first *floating wire* antennas as previously mentioned were made at the Laboratory. A 100 foot length of a standard coaxial cable (RG-14/U) was used. Flotation was achieved by using 50 small football-shaped fishnet floats six inches long and three inches in diameter along the cable.[2] The outer jacket and metal braid were stripped from the last 25 feet of the cable. Floating on the surface, this 25 foot length of center conductor separated from the sea water by the cable's dielectric became the active part of the antenna. For the next several years, this was the basic design.

In July 1954, Tennyson and Amaral conducted a successful at sea test with the experimental antenna on the submarine USS TUSK (*SS* 426). The first communication was between TUSK and the laboratory site on Fishers Island, New York. As mentioned previously, the interest was in transmitting and receiving while submerged. Later in 1962 and 1964, Tennyson was awarded patents for his floating wire antenna invention.

The early antennas with floats were about 100 feet long. The lead-in end was attached to an antenna fitting on the sail while the outboard end was always made so that the antenna could not reach and tangle in the screw. The original antennas were throw-over-the-side wires with floats.

The concept was a success. However, during the following years both difficult and first-ever technological challenges were continuously addressed. Antenna frequency considerations, how to make an antenna that would be buoyant without the fish net floats, and how to have an overall antenna system compatible with the submarine's requirements were some of the problems that lay beyond this first demonstration on TUSK.

---

[2] Early laboratory experiments used cables placed on wooden 2x10 inch planks for flotation. Later, when submarine-tested early antennas were returned to the Laboratory, the football-shaped floats were found to be much reduced in size due to the pressure at the depths where the antenna had been towed.

First Buoyant Cable

In 1956, further development of the antenna at USL was transferred to the Antenna Branch of the Laboratory's Electromagnetic Division. An RF cable for the antenna that would have buoyancy and not require floats was sought, and the first length was delivered by a cable company in 1958. Obtaining the sufficient buoyancy, cable strength, and ease of handling the cable were some of the many antenna requirements which had to be met. Between 1959 and 1969, with the cooperation of many cable manufacturers, USL developed approximately 36 different versions of single conductor and coaxial buoyant cable.

USL antenna engineers Warner Adams and Richard Jones developed the first mechanized system. In August 1958, it was tested at sea onboard USS BARRACUDA . This system was the inaugural use of an inherently buoyant cable with a cable payout and retrieval reel (on the afterdeck of BARRACUDA). It was also the first time that up to 1000 feet of cable could be streamed, allowing the submarine to communicate at deeper depths. COMSUBLANT reported that viable submarine-aircraft and submarine-surface ship communication ranges were achieved from a submerged submarine. The external reel system arrangement was overtaken by further developments which provided an inboard launching and recovery of the buoyant cable.

RF Reception Below Periscope Depth

Emphasis in succeeding years was on developing the buoyant cable antenna concept to meet the operational requirement for VLF and LF reception below periscope depth. Developing an antenna compatible with the nuclear submarine's changing speed and depth requirements was elusive, at least initially.

However, by the end of the 1950s, USL was manufacturing fixed-length buoyant cable antenna installations which provided submerged reception on a number of landmark submarine missions.

In 1959, USS SKATE (SSN 578), using an early one inch diameter buoyant cable antenna received broadcasts under the Arctic icecap while making a North Pole transit. (The previous year, NAUTILUS was the first submarine to make the transit.) The following year, 1960, USS TRITON, using a smaller diameter

(5/8 inch) buoyant cable antenna, maintained continuous radio reception during the previously cited historic circumnavigation of the world while submerged. The antenna was streamed throughout the entire trip without mishap or failure. The first fleet ballistic missile submarine, USS GEORGE WASHINGTON (SSBN 598), successfully used a fixed length outboard connected type buoyant cable antenna during an early patrol (1960) and reliably received VLF broadcasts while remaining completely submerged.

The fixed length outboard connected type limited submarine operability when using the antenna. In order to receive, the several hundred foot antenna restricted the submarine's speed and depth. Further, if the antenna was damaged or cut, the submarine would have to surface to replace or repair it since the antenna was not inboard retrievable.

Antenna Inboard Retrievability Demonstration

In 1960, U.S. Navy Commander (later Captain) Arthur P. Sibold, Jr., during his assignment as Senior Program Officer and Executive Officer on the staff of the Commanding Officer and Director of USL, investigated the inboard recoverability problem and identified an innovative solution. At this time, USL was heavily involved in several aspects of Polaris submarine communications, including both electromagnetic and acoustic.

He proposed the idea of using a line wiper of the type found in the oil drilling industry to pay out and reel in the USL developed floating wire antenna from inside the submarine. He conducted a test in June 1960 onboard USS HARDHEAD (SS 365) off New London. The line wiper was developed in the mid 1950s by Bowen-Itco in conjunction with paraffin removal in oil well operations under pressure. The test was successful in demonstrating that a floating wire antenna could be paid out and retrieved from inside the submarine.

On 3 June 1960, Commander Sibold wrote a USNUSL Technical memorandum outlining his design concept, *Recommended Approach to Development of a Recoverable Floating Wire Antenna*. This was followed by an 8 June 1960 Technical Memorandum, *Report of Test of Recoverable Floating Wire Antenna*, which reports the sea test results.

In 1964, Commander Sibold filed for a patent on his invention and was granted a patent for a Pressure-Proof Hull Fitting on

April1 2, 1966. The patent addressed providing the submarine with the capability of launching, repairing, and recovering of devices such as a VLF communications antenna towed astern while the submarine is underway and submerged.

Inboard Retrievable Buoyant Cable Antenna Systems

Tennyson's invention brought about practical reception of RF signals below periscope depth. The nuclear submarine brought with it the necessity of receiving while submerged. The Polaris program increased the requirements for submarine communications. New speed and depth needs as the new nuclear classes evolved kept increasing the challenge. Commander Sibold's demonstration pointed the way to provide an antenna system which could be brought inside the submarine for repair, replacement or stowage while the submarine was underway and submerged.

The device, called a transfer mechanism, to accomplish the inboard handling of buoyant cables hundreds of feet in length led to an evolutionary research and development program; and in the early 1970s, a standard transfer mechanism was available (BRA-24).

Like all submarine antennas, buoyant cable antennas confront extreme temperatures, high pressure, severe drag forces and high sea states. In addition, buoyant cable antennas accommodate the transfer mechanism and are wound and unwound from a drum. Mechanical requirements are measured in thousands of pounds of pull. Further, the antenna had to meet the radio frequency specifications.

Between 1959 and 1989, a series of ten developmental antennas were produced most of which were configured with a 0.65 inch diameter antenna which has become the standard size. The antennas had a steadily increasing break strength of 1000 pounds in 1950 and finally as much as 5000 pounds in some current designs. It was the advent of the commercial production of Kevlar as an antenna strength member that brought about the enhanced break numbers. The results of these improvements is seen in the speed/depth performance curves of these carefully designed and produced antennas.

In general, buoyant cable antenna effectiveness was improved by in-line electronic miniaturization, materials developments, and other advanced techniques. Over several decades, the realization of better cables, active in-line amplification at the antenna element, design and development of improved connectors compatible with the transfer mechanism and other devices led to a series of patents to various Laboratory personnel: A. Susi, L. Carnaghan, R. Phillips, and B. Pease.

ELF and the Floating Wire Antenna

In 1963, under the broad Polaris Special Projects Program called Pangloss, extensive efforts were being made to address a solution to communicating from land to submerged submarines. At that time, extremely low frequency (ELF) was an experimental candidate to satisfy the Navy's need for secure radio wave transmission to submerged fleet ballistic missile submarines.

An intensive six weeks of communication tests were made starting January 21, 1963 with a receiver installed on USS SEAWOLF (SSN 575). At that time, the experimental ELF transmitter was located in North Carolina and the transmitting antenna was 109 miles long, oriented northeasterly. The submarine was equipped with a 1000 foot trailing wire antenna, at the end of which was a pair of sensors. Signals in the ELF spectrum were measured at ranges of about 2000 miles in the North Atlantic with the trailing antenna at keel depth. At greater depths, signals were received at a range of more than 500 miles with the antenna. ELF permitted reception at antenna depths much greater than was possible with VLF. The tests on SEAWOLF using a floating wire antenna supported the feasibility of ELF reception by a submarine at operational depths.

These communication tests established that a deployed submarine could receive messages from the continental United States without severe reductions in the submarine's operational capability during reception. This was a *first* in the history of submarine communications.

During the extensive at-sea testing conducted over a number of years during the development and implementation of ELF, the Laboratory's buoyant cable was a key element of the submarine suite. For example, a successful ELF communication test was conducted in 1976, using a floating wire antenna, on a submarine traveling at 16 knots at a depth of 427 feet under 33 feet of Arctic sea ice. The Wisconsin ELF test facility was the signal source.[3]

Summing Up

Submerged reception at operational speeds and depths at frequencies of the order of tens of Hertz to the Megahertz region are the result of 50 years of hands-on effort at the New London Laboratory. Support by the Navy in Washington, and a multiplicity of sea tests on diesel and all classes of nuclear submarines at locations around the globe brought Tennyson's vision to a firm reality and a submarine antenna capability which will improve further in the future. ■

[3] The operational transfer of the ELF communications system from Commander, Space and Naval Warfare Systems Command, to Commander Naval Telecommunications Command took place in October 1989. The buoyant cable antenna has always been a pivotal element in the successful performance of the ELF communication system.

U.S. NAVY TORPEDOES
Part Four: WWII Development of Homing Torpedoes 1940-1946

by Frederick J. Milford

Important as the WWII improvements in conventional torpedoes were, the real revolution was in the development of homing torpedoes, i.e., torpedoes which autonomously seek their targets at least during the final portions of their trajectories. The exact date when the homing concept first occurred to torpedo developers is lost, but the general idea was discussed early in the 20th century[1] when torpedo ranges got long enough that very accurate aiming was required and relatively small angular dispersion could cause misses. Not, however, until the mid-1930s, when electronic technology provided the means for implementing the concept, was it possible to begin serious development of homing torpedoes. Programs were initiated by the German Navy in the mid-1930s and by the Royal Navy in the late 1930s. The German program suffered a hiatus from 1939 to 1942 because the expectation of a short war lowered its priority, but two torpedo types for U-boat use against surface vessels were produced during 1943. Royal Navy results, mainly dealing with acoustics, were not pursued, but were made available to the U.S. Navy. U.S. programs, as we shall relate, began in December 1941 and produced an air launched anti-submarine torpedo that entered service and sank submarines 17 months later, in May 1943. Several other important homing torpedoes were developed for the U.S. Navy before the end of the war and two of these were used against enemy targets.

Background

Homing torpedoes are dramatically different from the gyro-controlled, set-depth torpedoes used against surface ships in that

[1] J. Küsters "Das U-Boot als Kriegs- und Handleschiff" Berlin, 1917 quoted in Eberhard Rössler "Die Torpedoes der Deutschen U-Boote" Herford: Koehlers, 1984, p. 136. Küsters mentions Swedish Captain Karl O. Leon's idea of adding *ears* and mechanisms to control the rudders of long range torpedoes in such a way as to home on the target's propeller noise.

once they acquire their target, they home on it autonomously using onboard controls. In addition to the obvious advantage of homing in the horizontal plane in attacking surface targets, homing can operate in the vertical plane thus providing an important capability against submerged submarines or shallow draft escorts. The homing concept is obviously very attractive, so attractive in fact that only one new non-homing torpedo has entered service with the U.S. Navy since 1944 and that was the wire guided Mk 45 to which special constraints applied.

A successful homing torpedo must:

- detect the target and indicate its direction relative to the torpedo axis
- process this directional information to generate orders to the vertical and horizontal rudders
- be provided with propulsion machinery and other mechanisms that do not interfere with the homing system
- be provided with adequate safety features to prevent attacking the launch platform or other friendly forces
- be sufficiently rugged to withstand launching, water entry and other challenges inherent in its use.

Rational analyses of target signatures and probes that might provide information about target location for use in homing torpedoes have been made many times. The result, even today, is invariably that the best, and possibly the only practical, possibilities are acoustic. Target detection and tracking using underwater sound had, of course, been developed during the inter-war years for surface vessel anti-submarine purposes and for defensive and offensive use by submarines. These sonar systems were of two types, passive, which simply listened for noise generated by the target, and active, which detected the reflection or echo of a probing sound pulse emitted by the system. Such shipboard systems provided starting points for torpedo homing systems, but their size and weight were both much too large for torpedoes. Developing equipment that satisfied the size, weight and performance constraints associated with installation in a torpedo body was a challenging task. The first U.S. homing torpedoes used passive systems that detected ship noise, primarily cavitation noise from the screws. The directivity needed to generate homing rudder orders was provided either by mounting the hydrophones around the circumference of the torpedo and using body shadow and hydrophone directivity to provide directivity or by mounting an array of hydrophones in the nose of the torpedo and relying primarily on hydrophone directivity. Soon after development of passive homing began, U.S. work was started on active homing based on a miniature active sonar. The problems associated with fitting an entire sonar system, using vacuum tube technology, into a torpedo body while leaving room for the propulsion system and a meaningful warhead were very severe. It was, in fact, not until early 1944 that the first active homing torpedo made a three dimensional acoustically controlled run. Ultimately, however, acoustic torpedoes incorporated passive homing for target acquisition and active homing for the attack phase.

Detecting a target and indicating its direction are not enough. This information must be converted to rudder motions that will direct the torpedo to the target. Conceptually this is relatively simple. In the case of passive homing, amplified signals from say the left and right hydrophones can be compared and the control circuits arranged to move the rudders to steer in the direction of the stronger signal. A similar, but slightly more complicated, system can be used for control in the vertical plane. This approach was used in the Mk 24 torpedo, also known as FIDO, discussed below. Simple as the process sounds, there were many problems that were important in these early days of electronics. For example balancing the left and right amplifiers was enough of a problem that the early systems used a single amplifier, which was switched back and forth between the left and right channels. Stability of the control system also required study. In 1942 these were problems at the cutting edge of engineering technology. That they were solved expeditiously in the face of similar demands for communications, radar, sonar, fire control and nuclear weapons, to mention some of the competitors for electronic development was a tremendous triumph.

An acoustic homing system can work only if the torpedo is quiet enough that its self noise does not mask the noise or echo that is the target signal. This means minimizing both the hydrodynamic noise, especially that originating in cavitation, and the propulsion machinery noise. These issues and the constraints of electrical propulsion, which was used with most WWII homing torpedoes, led to rather slow, short range torpedoes, in many cases so slow that they were effective only against submerged submarines or slow moving actively searching escorts.

As with conventional torpedoes, there were, during WWII, three launch platforms for acoustic torpedoes, aircraft, submarines and surface vessels, and two classes of targets, surface vessels and submarines. These platform-target combinations impose constraints or design requirements on homing torpedoes that are not operative, or at least much less important, in the case of conventional torpedoes. The major new safety requirement was that the torpedo should not home on the launching platform[2] or other friendly vessel. This requirement was satisfied in a variety of ways. To protect surface vessels, ceiling switches disabled the homing system of air launched weapons when the depth was less that a preset value, say 40 feet. Floor switches similarly protected submerged submarines from their own anti-escort torpedoes. Straight enabling runs to the vicinity of the target; anti-circular run devices and other safety features were also added to some of these new torpedoes. Further, during WWII Allied aircraft did not drop homing torpedoes when operating in conjunction with surface ASW forces. Incidents did, however, occur. HMS BITER was chased by a homing torpedo giving rise to the doggerel "BITER bitten by FIDO."

U.S. Navy Homing Torpedo Development During WWII—An Overview

The development of homing torpedoes during WWII was done almost entirely under the auspices of the Office of Scientific Research and Development (OSRD) and its subsidiary the National Defense Research Committee (NDRC). Wartime production of homing torpedoes was accomplished by standard BuOrd procurement contracts with industrial firms, primarily Western Electric, Westinghouse and General Electric. Major research and development contracts were issued under the authority of the Office of Emergency Management (OEM) to Harvard University, Western Electric Co. (Bell Telephone Laboratories), General Electric Co. and Westinghouse Electric Corporation with smaller contracts to other universities and commercial firms. Many subcontractors

[2] With non-homing torpedoes the main threat are prematures and circular running torpedoes, which have caused a number of tragic submarines losses, damage to firing submarine and near misses.

worked for the major contractors on special aspects of torpedoes. Each of the major contractors and Brush Development Co.[3] developed one or more homing torpedoes through the prototype stage. In several cases two contractors developed competing models designated by the same Mark, for example, the Bell Telephone Laboratories (BTL) and the Harvard Underwater Sound Laboratory (HUSL) developed competing versions of the Mk 24 and HUSL and GE developed competing versions of the Mk 32. In other cases competing torpedoes had different Marks. (The Brush Mk 30, for example, was developed, as a backup, in parallel with the Mk 24.) Thus, there was significant competition, but also a great deal of cooperation. This combination helped to produce the first operational U.S. homing torpedo in the remarkably short time of 17 months from initial concept to first combat success. One estimate suggests that the competition saved a full year in the development cycle.

Homing torpedoes developed along two lines: torpedoes based on straight runners (primarily Mk 13, Mk 18 and Mk 19) with standard 21 inches x 246 inches or 22.5 inches x 161 inches envelopes and smaller torpedoes with 10 inch or 19 inch diameter envelopes seven to eight feet in length. The principal technologies that were newly incorporated to make homing torpedoes were underwater acoustics (hydrophones); hydrodynamic and mechanical quieting; electronic controls and servomechanisms. Though such items are commonplace today, in the early 1940s they were revolutionary.

The number of torpedoes under development was large as indicated by Table 1, but only three, Mk 24, Mk 27 and Mk 28, saw service during WWII. All but one, Mk 21 Mod 2 (a homing version of Mk 13), used electronic propulsion and this was the dominant mode of propulsion for new U.S. Navy homing torpedoes until high submerged speed nuclear submarines forced a return to thermal, albeit advanced thermal, propulsion in the Cold War era.

---

[3] Brush developed the Mk 30 outside of the NDRC framework under a direct contract with BuOrd.

Table 1

Homing Torpedoes Under Development During WWII

(Service torpedoes in bold.)

	Design and Development	Service Dates/Total Production	Platform /Target	Comments
Mk 21-0 22.5"x161"	Westinghouse	NIS/few	AC/SV	New torp. Elect Prop. and passive homing. Mk 13 envelope
Mk 21-2 22.5"x161"	HUSL/BTL-/ORL	NIS/312	AC/SV	Mk 13 w/passive and acoustic homing. Steam prop.
Mk 24 19"x84"	**BTL/-HUSL/GE**	**1942-48/4000**	**AC/SS**	**FIDO later PROCTER. Passive acoustic homing.**
Mk 27 Mods 0-3 12"x90"	**BTL**	**1943-46/1000**	**SS/SV**	**CUTIE Anti-escort. Passive acoustic homing**
Mk 27-4 19"x125.75"	**Post WWII development, distinct from Mods. 0, 1, 2 and 3**			
Mk 28 21"x246"	**Westing-house/BTL**	**1944-60/1750**	**SS/SV**	**Passive acoustic homing**

Mk 29-0&-1 21"x246"	Westinghouse	NIS/few	SS/SV	Improved Mk 28. Sea water battery
Mk 30 10"x90"	Brush Dev. Co.	NIS/3	AC/SS	Backup for Mk 24. Passive homing
Mk 31 21"x246"	HUSL/ORL	NIS/few	SS/SV (SV/SV?)	Passive homing Mk 18
Mk 32-0&-1 19"x83"	GE/HUSL	NIS/10	AC/SS	Active homing, FIDO envelope
Mk 32-2 19"x83"	Post WWII development, distinct from Mods. 0 and 1			
Mk 33 21"x156"	BuOrd, GE, Exide	NIS/30	SS/SS;SV	Passive homing
HUSL is Harvard Underwater Sound Laboratory; BTL is Bell Telephone Laboratories, ORL is Penn State University Ordnance Research Laboratory. NIS indicates *never in service*.				

<u>Selected U.S. Navy Homing Torpedoes—WWII Era</u>

Among the acoustic torpedoes developed during WWII there were two that represented critical milestones. The MK 24 was the first passive homing torpedo developed for the U.S. Navy and the Mk 32 was the first active homing torpedo. The Mk 35 was the first active-passive homing torpedo and it was based on research and development started during WWII. The actual Mk 35 torpedo development program seems to have begun quite late in the war and more properly belongs to the post WWII era. We will focus here on the Mk 24 and Mk 32 torpedoes and comment briefly on some of the others.

<u>Passive Homing and the Mine Mk 24 (Torpedo)</u>[4]. The first of

[4] The Mk 24 homing torpedo has not, in my opinion, received the attention it deserves. The most comprehensive published document is Mark B. Gardner "Mine Mk 24: World War II Acoustic Torpedo", Journal of the Audio Engineering Society, Vol. 22, no.8, October 1974, pp. 614-626. "A History of

the new homing torpedoes was a response to the damage being done to Allied shipping by German U-boats. From the beginning of WWII through 1941 Allied shipping losses to submarines averaged over 170,000 tons/month and aircraft were proving to be remarkably ineffective in destroying submarines.[5] One consequence was that even before the U.S. entered WWII, parts of the Navy were reconsidering homing torpedoes as air launched ASW weapons. In "the fall of 1941" (probably late November or early December), the Navy asked NDRC to consider the feasibility of a small, relatively slow-speed, acoustically controlled, air launched, anti-submarine torpedo.[6] Submarines were thus specifically added to the torpedo target list rather than being incidentally included when surfaced or at periscope depth as

---

Engineering and Science in the Bell System: National Service in War and Peace (1925-1975)", Murray Hill: Bell Telephone Laboratories, 1978 contains some information that is not included in Gardner's paper. These publications focus on the BTL/Western Electric projects, but clearly indicate that important contributions were made by other organizations. More recent is Tom Pelick "FIDO—The First U.S. Homing Torpedo", The Submarine Review, January 1996 and correspondence by Milford and Polmar in the April 1996 issue of The Submarine Review. Robert Gannon "Hellions of the Deep" University Park, PA: Penn State University Press, 1996 tells more of the Harvard story. The primary documentation is contained in reports submitted to NDRC by HUSL and BTL/WE.

[5] This oversimplifies a complex situation. Between September 1939 and December 1941 aircraft were credited with sinking four U-boats and shared credit for four other kills. The major problems were inadequate aircraft and ineffective weapons. Improvement in both and revised attack tactics resulted in more successes and for the entire war more U-boats were sunk by aircraft than by surface vessels.

[6] Summary Technical Report of Division 6 NDRC, Vol. 1 "A Survey of Subsurface Warfare in World War II", Washington: NDRC, 1946, p. 209. The request probably evolved from a memorandum by Captain Louis McKeehan, USNR dated 24 November 1941 in which he asked "Is it feasible to devise acoustic equipment for homing control of a self-propelled, torpedo-like body?" McKeehan was a mine expert and had been Desk N Mines and Nets at BuOrd. The reorganization of BuOrd in February 1941 put R&D for all underwater weapons in Section Re-6 of the Research Division(Re). McKeehan headed Re-6 for part of the war.

surface vessels.[7]

In response to the Navy request NDRC convened a meeting at Harvard on 10 December 1941. Two weeks later at a second meeting the following requirements were outlined:

- size to fit 100 pound bomb rack, i.e., smaller than 19 inches x 90 inches
- droppable from 200 to 300 feet at about 120 knots
- electric propulsion using lead acid storage battery
- 12 knots for 5 to 15 minutes
- 100 pound high explosive charge
- acoustic homing with greatest possible range

The participants in the meeting responded as follows: General Electric agreed to design and fabricate the propulsion and steering motors. David Taylor Model Basin (DTMB) would assist in any way possible, primarily hydrodynamics and propulsion. DTMB actually supplied the propeller and shell designs and the first few actual shells used in the Mk 24 program. HUSL and BTL each undertook the independent, but cooperative and information sharing, development of experimental torpedoes with their main contributions being acoustic control systems and integration. The entire project proceeded very rapidly. Some of the key events in the development of Mine Mk 24[8] (FIDO), are shown in the almost unbelievable schedule which follows.

---

[7] Conventional torpedoes had been fired at submarines, mainly surfaced, during WWI and the practice continued during WWII. The U.S. submarine patrols from East Coast bases and Panama during 1942 were essentially anti-submarine patrols. WWII, however, saw the first development of specific ASW torpedoes capable of attacking submerged submarines efficiently and effectively. We view this as a significant augmentation of the torpedo target list.

[8] Several reasons for calling the Mk 24 torpedo a mine have been advanced. Security was certainly one reason. The other is given variously as recognizing the role of the mine warfare establishment or keeping the torpedo establishment and its baggage out of the project.

Chronology Mine Mk 24 (Torpedo)		
First Meeting	Dec 1941	
HUSL Proposal	Dec 1941	
BTL Proposal	Jan 1942	+1 month
Design Freeze	Oct 1942	+10 months
First Production Unit	Mar 1943	+15 months
500 units by	May 1943	+17 months
First kill	May 1943	+17 months

The entire development from conception to first kill was accomplished during the general time period in which the previously described Mk 14 problems were solved. The contrast in the rate of progress on the two problems is striking. Mk 24 also established the four hydrophone acoustic sensor arrangements that were the dominant passive homing system for U.S. acoustic torpedoes in the period 1941-1950.

The Mk 24 that emerged was 84 inches long, 19 inches in diameter and had a total weight of 680 pounds. It was propelled by a General Electric five horsepower, 48 volt electric motor using an Exide lead acid storage battery for power. The warhead, containing 92 pounds of high explosive, occupied the forward 14-1/2 inches of the weapon. These features were substantially different from those of early torpedoes, but more significant differences were to be found in the control system.

Target detection was accomplished by four hydrophones symmetrically arranged around the circumference of the torpedo mid-section in the left, right, up and down positions. Such an array is useful for target acquisition because the four hydrophones together cover essentially all directions from the torpedo and for homing because *body shadow*, meaning that the hydrophone on the right side, for example, being in the acoustic shadow of the torpedo body could not hear a target on the left side, provides directionality. The basic idea is to compare the signals from the left and right hydrophones and move the rudder in such a way as to steer towards the stronger signal. In the BTL implementation of this scheme, the hydrophone signals were amplified, rectified and subtracted. The combined signal drove a DC amplifier which, in turn, controlled a differential relay that caused the rudder motor to move in the appropriate direction to reduce the input voltage (hydrophone derived voltage plus rudder potentiometer voltage) to zero. The vertical control circuit was identical except for including inputs from a hydrostat that measured depth and a pitch pendulum, which were also voltages derived from potentiometers.

These signals caused the torpedo to operate at a fixed depth until a sufficiently strong acoustic signal was received. When such a signal was detected, the hydrostat/pendulum control re-established if the torpedo rose above a ceiling set at about 40 feet. This prevented the torpedo from attacking surface vessels including surfaced submarines. These control systems produced rudder angles that were proportional to the difference in strength between the signals from the right and left (or up and down) hydrophones. Such proportional control was distinctly different from the *bang-bang* (rudder hard left or hard right) controls that had been used ever since the Obry gyro was introduced, but detailed analysis and experimental work at HUSL showed that the *bang-bang* (no rudder position feedback) controls would perform equally well.

The Mk 24 development program was notable not only because of the speed with which it was completed, but also because of the thorough development testing and subsequent quality control. During subsystem development there was a continuing series of tests to measure and verify essential performance characteristics. Testing included drop tests, checking fitting to aircraft and occasional drops from aircraft in addition to the usual laboratory testing of the mechanical, electrical and electronic designs. BTL alone conducted 192 in-water test runs with their experimental models between 16 April and 20 October 1942 and a comparable number of tests was conducted by HUSL. Later, HUSL conducted an extensive series of tests on Western Electric production torpedoes dropped by PBY aircraft.

Both the HUSL and the BTL programs produced successful prototypes. The BTL Mk 24 production design, which started from the BTL experimental model, used important features from the HUSL model and incorporated a number of improvements suggested by development testing. The design was frozen in October 1942. At that time Western Electric was given a sole source contract for production of the torpedoes. Subcontractors included General Electric, Electric Storage Battery Co., and interestingly enough, a bathtub manufacturer for the shells. The first production model was delivered in March 1943 and 500 had been delivered by May 1943. The first U-boat attack using the Mk 24 was U-640 which was attacked and sunk on 14 May 1943 by a PBY from U.S. Navy VP 84.[9] The Mk 24 was eventually responsible for sinking 37 enemy submarines,[10] about 15 percent of the submarines sunk by air escort or air ASW operations between May 1943 and the end of the war. This torpedo was a major success whose achievements have long gone unheralded.

Reflecting the perceived urgency of the requirement for an air dropped, homing ASW weapon, another passive homing torpedo, Mk 30, was developed by Brush Development Co. under a BuOrd contract as a backup for the Mk 24. This 10 inch diameter torpedo progressed through the successful prototype stage, but because of the success of the Mk 24 it was never put in service. It was, however, a precursor to the active homing Mk 43 Mods 1 and 3 which were in service from 1951 to 1957.

Two other passive homing torpedoes saw service in WWII. The Mk 27 torpedo was a submarine launched anti-escort weapon based on the Mk 24. The original Mk 27 Mod 0 was a minimally modified Mk 24 with wooden rails to fit 21 inch torpedo tubes, a floor switch (instead of a ceiling switch) so it would not attack the launching submarine, and various arming, warm-up and starting controls to suit a torpedo tube, swim-out launch mode. Eleven hundred Mk 27 Mod 0 torpedoes, known as CUTIE, were built by Western Electric and delivered between June 1944 and April 1945. Production on a subsequent order for 2300 torpedoes continued until the end of the war. One hundred and six were fired against

---

[9] The often reported sinking of U-266 by an RAF Coastal Command Liberator has been re-evaluated and is no longer attributed to FIDO. U-640 and U-657 were interchanged in early post war reports. The statement in the text reflects the most current evaluation available to me.

[10] Various numbers of kills are reported. In my opinion, the most probably correct numbers are 340 torpedoes dropped in 264 attacks of which 204 were against submarines. In 142 attacks U.S. aircraft sank 31 submarines and damaged 15; in 62 attacks against submarines other Allies, mainly British, sank six and damaged three. Most of these submarine sinkings were German U-boats in the Atlantic but five Japanese submarines were sunk by FIDOs, one, I-52, in the Atlantic and four in the Pacific. OEG Study No. 289, 12 August 1946, is the main source for this conclusion.

enemy escorts. Thirty-three hits sank 24 ships and damaged nine others. Later versions of the Mk 27 were longer and heavier. Mod 3, which was slightly over 10 feet long and faster, had a 200 pound warhead and a gyro for straight runout before beginning to search for its quarry. Only six were completed before the project terminated at the end of the war. The post war Mk 27 Mod 4 was different from the wartime versions, especially in that it could attack submerged submarines, and is discussed in the next part of this series. The Mk 28 was a 21 inches x 246 inches, 20 knot, submarine launched anti-surface vessel torpedo with a 585 pound warhead. It was equipped with passive homing and gyroscopic control which competed for rudder control. About 1750 of these torpedoes were produced by Westinghouse and Western Electric. Only 14 were fired with four hits during WWII, but the torpedo remained in service until 1960.

The remaining passive homing torpedoes developed during WWII were generally and perhaps surprisingly successful, but were overshadowed by earlier successes or reached production readiness too late in the war to be used. Some of these programs did, however, influence post war torpedoes. The Mk 29, in particular, was the first torpedo designed to use a sea water battery[11] for propulsion and offered other improvements that were used in later torpedoes. The Mk 33 appears to have been the first submarine launched anti-submarine torpedo developed by the U.S. Navy, but only 30 of them were built for test and evaluation.

Active Homing and the Mk 32 Torpedo. Active homing, the second milestone, is significantly more complex than passive homing and only two torpedoes of this kind, Mk 22 and Mk 32, were developed during WWII. Mk 22 began as an effort to add active homing to the Mk 14 torpedo but ended up as a standard Mk 18 electric torpedo design modified by Westinghouse and BTL to include active homing in azimuth only. The homing system transmitted a pulse of 28 KHz sound using both halves of a left-right split transducer. Echoes received by the two halves were processed separately and their relative phase was used to determine

[11] The first torpedo to use a sea water battery was a Mk 27, but this was purely experimental.

the direction of the target. From the relative phase a course correction signal was generated and this signal controlled a change in the gyro angle. The gyro maintained course control between pings of the sonar. The implementation of this scheme with minimal modification of the basic Mk 18 torpedo required a great deal of ingenuity including, in particular, a complex mechanical device called the *translator* which took signals from the servo amplifiers and power from the propeller shaft to drive the course input for the gyro. One of the problems that is encountered in active acoustic homing systems, but not in passive systems, is reverberation, i.e., reflections of the transmitted sound pulse from random features in the surface, body and bottom of the ocean. Reverberations are effectively false targets and without special features an active acoustic torpedo would often home on them. Fortunately, reverberations die out quickly. In the Mk 22 system, the receiver was blanked for 40 milliseconds after the transmitted pulse and the amplifier gains programmed to increase with time, (time variation of gain, TVG) in order to avoid the reverberation problem. The guidance system was successful, but by 1944 azimuth only homing, even for 21 inch torpedoes, was less attractive than the combination of vertical and horizontal homing offered by competing systems. Work on the Mk 22 was terminated before production designs were completed.

Two competing designs were developed for the other WWII active homing torpedo, Mk 32. One design was developed by HUSL and the other by General Electric both beginning in 1942. The Mk 24 body was used, in fact Mk 32 was designed as a conversion of that weapon[12] with the passive homing system replaced by a small active sonar. Size and weight constraints were severe. The total available volume was less than two cubic feet in the mid-section of the torpedo, space for the transducers in the nose and the space occupied by the Mk 24 depth control in the tail section. Weight was limited to less than 50 pounds. These space and weight constraints meant that the best options could not be used if there were a lighter or smaller option that could do the job satisfactorily. The second problem was to devise a control system that functioned on the basis of short, 30 millisecond, widely

---

[12] "Acoustic Torpedoes" Vol. 22 of the Summary Report of Division 7., NDRC. Washington: OSRD, 146, p. 76.

spaced, 0.7 second separation, inputs rather than continuous inputs characteristic of passive homing systems.

The GE system that emerged used a magnetostrictive transducer, four elements wide and eight elements high, that was split into an upper half and a lower half. This configuration made it possible to use phase comparison and proportional control in the vertical plane where it was necessary to home on a submarine hull that measured around seven meters from keel to deck. In the horizontal plane, where the target was about 70 meters wide, a simpler on-off was used. In the absence of an echo the rudders were hard over to port and the torpedo circled in that direction. When an echo was received the rudder was shifted to hard starboard and remained in that position until about one second after the last echo was received. At this point the rudder was reversed and the process repeated. The torpedo thus apparently homed on either the bow or stern of the target, but the dynamics of the torpedo and the electronic time constants shifted the actual homing point toward the center of the target. The main virtue of this homing system was that it used the same amplifiers as the vertical control system without adding complex circuitry and so saved weight and space.

Homing signals in the vertical plane were derived by comparing the phase of the signals from the two halves of the transducer. The up or down signals were used to drive a pendulum frame in which the pendulum was suspended. Electrical contacts connected the horizontal (diving) rudder motor to its power source in such a way as to keep the pendulum centered in the frame. The system thus controlled the pitch angle, and consequently the rate of climb, directly. A hydrostat was installed, but it was used only to control the mode of operation, e.g., set the depth ceiling, and did not provide servo inputs that affected the horizontal rudder.

Reverberation and other false target problems were dealt with by a combination of time variation of gain and blanking. It is interesting that this system also switched between a search mode and a pursuit mode presaging the on-board logic of modern torpedoes.

An experimental Mk 32 produced by General Electric made a successful sound controlled three dimensional run in February 1944, 22 months after the concept was first presented to NDRC. Tests against target submarines began in July 1944 and were successful. Leeds Northrup was selected to produce the GE version of Mk 32 and 10 pre-production units were completed and tested before the project was canceled at the end of WWII. Later, with deliveries beginning in 1950, Philco produced a substantial number (about 3300) of the somewhat different Mk 32-2 torpedoes for fleet use by destroyer type vessels. This torpedo is discussed in a subsequent part of "U.S. Navy Torpedoes".

The HUSL system was different. The transducer was symmetrically divided into four quadrants. The echo signals in these four quadrants were processed in an ingenious electronic system to obtain rudder orders. The system also contained a Doppler enabling system that prevented homing on reverberation and other false targets including wakes. While the HUSL system was not selected for the Mk 32 torpedo, many of its features were incorporated into the Penn State Ordnance Research Laboratory Project 4 system which was the basis for the very successful Mk 37 torpedo.

Homing torpedoes ascended to paramount importance during WWII and the principal practical techniques, active and passive acoustic homing, were well established by the end of the war. The stage for subsequent U.S. Navy torpedo development was thus, as we shall see in the next part, set during WWII. ■

USS ETHAN ALLEN (SSBN 608) - week of May 6, 1997 in Pearl Harbor, HI. Contact:

CAPT Jim Harvey
COMSUBPAC N4
(808) 474-5567 or
(808) 422-8147

USS DOGFISH (SS 350) - October 1-5, 1997 in Virginia Beach, VA. Contact:

B.W. Wild
408 Kellam Road
Virginia Beach, VA 23462
(757) 497-0266

USS ROBERT E. LEE (SSBN 601) - September 26-27, 1997 in Las Vegas, NV. Contact:

Rick D. Stubbs
P.O. Box 10
Cawker City, KS
(913) 781-4340

USS SEAWOLF (SSN 575) - August 8-10, 1997 at Quality Resort, Mission Valley, San Diego, CA. Contact:

Jack Burdick
3594 Normount Road
Oceanside, CA 92056
(619) 941-6798
E-mail: burdicjj@sce.com

Charlie MacVean
3528 Liggett Drive
San Diego, CA 92106-2153
(619) 226-0824

THE PERFECT SHOOTER

by LT Robert J. Walker III, USN

[Lieutenant Walker wrote this article while a student at SOAC. Upon completion of the course, he reported to USS BUFFALO (SSN 715) as Navigation/Operations Officer.]

On January 16, 1991, the Submarine Force launched the first shots fired in anger since the end of World War II. The war shots were not traditional torpedoes but were instead the Tomahawk Land Attack Cruise Missile (TLAM). Besides the obvious implications of war shots being fired, this event marked another important milestone for the Submarine Force. This milestone was that the submarine could indeed perform more missions than the traditional undersea and surface warfare missions (USW and ASUW respectively) that we have trained for over the past 100 years. We had been saying that we had this capability for years, but the Submarine Force had come into its own as a very effective platform working in support of the battle group.

The submarine brings to the table a variety of unique capabilities that make it probably the most suited platform for TLAM employment. First, the submarine equipped with the vertical launch system (VLS) can employ a maximum salvo comparable to the Aegis cruiser or the Spruance destroyer. Second, the submarine can do this while remaining undetected. The submarine can covertly ingress and egress a launch area. Third, submarines have the added capability of rapidly being able to swap missions among different missiles without incurring significant time penalty. At this time, surface platforms do not have this capability. Current hardware and software configurations of the surface platform fire control systems do not allow for changes to a mission stored on a missile to occur without incurring significant time delays.[1] This capability makes the submarine an excellent choice as a backup shooter. Fourth and finally, the submarine because of its flexibility can subsequently turn around and perform a variety of other

---

[1] Surface combatants are making software and hardware modifications that will give them the rapid reload capability. This capability will probably be available by the end of FY97.

missions while in the area. Whether that mission be indication and warning (I and W), special warfare insertion, mining, or traditional USW and ASUW, the submarine is truly the most versatile platform in the inventory. Versatility is an important consideration when faced with the fact that we as a Navy will have to work within a force structure that can support two major regional conflicts (MRCs) simultaneously.[2]

There is probably not one of our leaders that denies the force multiplication that the submarine brings to the battle group. However, are we truly preparing our submarine crews as well as we could to allow them to be successful in the strike warfare arena? I don't think that we are. We as a Navy are promulgating guidance that is broad, diffuse, and sometimes conflicting. We are providing training that is disjointed and at times conflicting with how strike warfare is actually conducted in theater. **I believe that we are setting our submarine crews up to fail.** Specifically, I would like to address the two most important issues that are facing us not only as a Navy but as a Submarine Force as well. Those issues are the guidance that we are promulgating and the training that we are providing.

Guidance

There is not one Navy-wide central authority on the submarine employment of land attack cruise missiles. There are many hands in the pie and each theater of operations has a different shade on how business is to be conducted in their area of operations. For instance, the Pacific Fleet does things a little differently than does the Atlantic Fleet. For that matter, the Seventh Fleet does business differently from the Sixth Fleet who in turn does business different from the Fifth Fleet. To successfully participate in the cruise missile strike arena, we in the Submarine Force must be familiar with at least eight different documents and Naval War Publications (NWPs). In some cases depending on the theater of operations, the content of the documents changes. This, at the very least could be a very confusing task. If the guidance and procedures for the strategic missile program were as varied and

---

[2] Scott C. Truver, "Tomorrow's Fleet-Part I,", U.S. Naval Institute Proceedings, July 1996, pp. 51-56.

disjointed as is the guidance and procedures in place for the submarine employment of Tomahawk cruise missiles, the Cold War would not be over. A meeting of the minds must occur to consolidate all applicable guidance. The other part of the problem with regard to the guidance applicable to the Submarine Force is that procedures and for that matter the basic technology of the missile itself changes so rapidly, the applicable changes to the NWPs are very slow to be promulgated. All of this combined, leads to a very serious training problem for the submarine. What is applicable and what is not? Type Commanders (TYCOMs) have tried to put their hands around the problem, but the results have been as varied as the guidance that has been promulgated. For example, the TYCOMs have published a Readiness and Training Memorandum[3] (RTM) that summarizes all the reporting procedures during the course of a TLAM strike. This document in itself is a very good summary for the reporting procedures contained in both of the Fifth Fleet and Seventh Fleet Concept of Operations but should not replace the source documents. Those source documents need to be as concise and consistent as is the RTM. We have in sense, created another piece of paper with which we expect the submarine to be familiar. There has to be one central authority on how we conduct strike warfare. The one consistent factor here is that we in the Submarine Force are training to a different standard than what we are expected to produce.

Training[4]

We need to be a more consolidated Navy in our training of submarine crews on the command and control topics for cruise missile employment. What does this mean you might ask? Specifically, submarine crews in the conduct of TLAM training, typically receive their training from the submarine school house

---

[3] COMSUBLANT Readiness and Training Memorandum 4-96.

[4] A majority of the discussion that pertains to cruise missile employment training will deal with battle group issues. The reason is that the most likely scenario for the submarine to shoot TLAMs will be at the tasking and in conjunction with the battle group.

and their parent squadron. What this leads to is an incestuous relationship of sorts where we have submariners training submariners in much the same manner as we have done for the more traditional submarine topics for years. I pose the question, whose procedures have we used in real world conflicts where TLAMs were actually shot? The answer is easy. Those procedures belong to the battle group and theater commanders who have at their disposal many different warfare communities. The result is a very wide spectrum of resources with regard to TLAM command and control. In order for the submarine to be able to participate in this arena we need to understand command and control. How better to do this than by opening our doors a little and exposing our wardrooms to some of the excellent training vehicles that are available from the other communities. Part of this is accomplished by the submarine actually participating in the battle group work-up. More and more submarines that are tasked to deploy with battle groups are getting the benefit of the battle group work-up. This was not always the case and the result was a very steep learning curve for the submarine. Another excellent training vehicle for submarine officers is the outstanding command and control type courses[5] that are offered by the Fleet Training Centers and the Afloat Training groups. These are great courses, not so much because of the curriculum of the course (which is very good), but more because we are shifting away from the incestuous relationship that we are so used to in submarine training. The course is typically taught by someone outside the Submarine Force and the students themselves come from a wide variety of warfare specialties. We need that infusion of fresh blood. I do not believe, however, that the whole problem lies with the Submarine Force not understanding command and control. Part of the responsibility lies with the battle group commander. Not only does he need to understand the capabilities that the submarine can bring to his area of responsibility, but he needs to understand the limitations and operational constraints of

[5] Fleet Training Center Pacific and Atlantic offer a few very good courses. One is called the C4I course. This is a one week course which gives a very broad overview of the whole C4I architecture. The other is the Command and Control Watch Officers course. This is a three week course that gives a more detailed C4I course concentrating on the watch officer perspective.

the submarine as well. We are still experiencing growing pains in this area. The issue of training jointly is important because as long as the TLAM is to be a National Command Authority asset, we need to be as joint as we possibly can be.

For the most part, we do a very good job training our submarines in the fundamentals of TLAM employment. The school houses recognize that the cruise missile arena is ever changing and they will try to incorporate the lessons learned and the deviations from promulgated guidance as they occur. The TYCOMs have done a very good job with the weekly strike exercises as well as promulgating the lessons learned from these exercises. Each of the above venues does a very good job in teaching the fundamentals but there are some significant shortfalls that are making it hard for the submarine to utilize its full potential as a TLAM shooter. We do well at providing segmented training on various aspects of the missile problem, but we currently have no mechanism available to train our submarine crews from start to finish (more specifically from copying a tactical mission data update (MDU) to launching a maximum salvo of missiles). It would be nice if we had some sort of onboard simulation that would actually allow us to exercise the full salvo capability that the submarine has to offer without actually shooting real missiles.[6] For that matter, we can't even test the entire VLS system without completely energizing the tube and powering up the missile. The submarine commanding officer will not know if there is a problem with his launch system until the very last moment. We need to have the ability to exercise the entire system so that not only will we know how it works, but will it work.

A large percentage of the problems that we are experiencing in the fleet have to do with the training of our crew on the VLS. Currently, we are limited in our ability to train our fire control technicians (FTs) and torpedomen (TMs) in the procedures and functions of the VLS tube. We have three tools available to us that can provide at least some training. First, there is a training

---

[6] The vertical launch platforms have available to them a simulator that allows them to exercise one VLS tube. For employment of missile salvos, the submarine will have to induce operator simulation. The attack center has the ability to exercise salvo shots but it would be nice to have the ability to exercise our onboard tubes.

VLS tube at NUWC in Rhode Island that is used for a specific VLS course that local area boats can send their FTs and TMs to. This course trains our sailors on the fundamental operation and maintenance of the VLS tube. This is great for local area sailors but for west coast sailors in these times of limited TAD funds, it is many times impractical for the average submarine sailor homeported in San Diego or Pearl Harbor to attend this course.[7] Second, Naval Submarine Training Center Pacific and the Submarine School in Groton have a trainer called WLSOT which stands for weapons launch simulation operator trainer. With the new software upgrades, this is actually becoming a very good training tool. This trainer allows simulation of tube power-up, to include various casualty scenarios. Third, there are some submarine onboard trainer (SOBT) programs that are decent. Unfortunately, each of these tools, although good at teaching the fundamentals, fall short of the mark. Without the ability to fully exercise our tubes without aligning the missile and powering the tube up we are setting ourselves up for problems down the road. This again makes a strong case for incorporating an onboard trainer that will simulate powering-up multiple tubes.

Another training issue has to do with the instruction that is provided in regard to how we operate our fire control systems. With the many variants of fire control systems in the fleet there are also as many variants to the different procedures on how these systems are to be operated. Specifically, there are certain glitches in all of the different fire control systems that require a work-around to fix the glitches. What I am referring to is the dreaded *tribal knowledge* syndrome. Some of these work-arounds are provided for in the procedures, some are not. The result is that we end up trusting our sailors to be so familiar with the systems that these work-arounds can be applied when the rubber meets the road. As we all know, this cannot always be done. We have got to do a better job in not only training our sailors on their respective fire control systems, but also in promulgating these work-arounds to the fleet.

There has been much progress with regard to the consolidation of the varied guidance that exists in the fleet. As of this writing

---

[7] There has been consideration to incorporate the VLS course into either the FT A or C school but the disposition of this idea has not been decided.

there are only three concepts of operations (CONOPs). Each contains roughly the same format and information. There are some subtle differences with regard to required reports as well as guidance regarding fly-out altitude, however the content of the three CONOPs are roughly the same. The one problem that we are still running into is that lessons learned are not getting promulgated into the NWPs rapidly enough to make a difference. Other problems lie with the changes in missile technology. For example, the fueling of the missile has not been an issue for the last two years. However, the flow diagram used for missile mission matching still addresses the issue of partially fueled missiles. There are other examples too numerous to mention but the lag time in both guidance and lessons learned is presenting a significant training problem to the fleet.

Regarding training, we have to make every effort to insure we put our best foot forward when it comes to sending our submarines to shoot cruise missiles. I propose the following:

1. We make every effort to insure that we are breaking the submarine away to participate in the battle group work-up. Right now this is the very best training that we can offer the submarine in terms of the employment of cruise missiles. This is the only way that we can truly integrate the submarine into the battle group role. Some homeports have a significantly harder challenge fitting the battle group work-ups and exercises into the already jam packed POM period of the submarine. The other side to this is the money consideration. In these austere time of funding cuts and downsizing, it is getting increasingly harder to break our submarines away from other than basic training needs of the TYCOM and parent squadrons. To alleviate some of these problems the Navy is utilizing existing technologies, such as local area networks (LAN) or visual tactical training (VTT or VTC) to configure the existing attack trainers such that we in the Navy can conduct exercises over the network. Such trainers like the Battle Force Tactical Trainer (BFTT)[8] specifically are utilizing this

[8] BFTT utilizes T1 lines and existing LAN technology to connect school house attack centers with surface ship mock-ups at the fleet training center to conduct battle group exercises. The result would allow submarines to work-up with the battle group without leaving homeport.

technology. The great thing about this is that the submarines can participate in battle group exercises without ever leaving port.

2. Cruise missile employment is a mission that the surface community seriously trains for. The surface community has a dedicated work-up for cruise missile employment. The work-up involves a training group that is solely dedicated to insuring the surface ship is ready to employ its TLAM. Following the dedicated training availability, there is a certification period where the ship has to be certified to employ its cruise missiles. Without imposing additional training requirements on the submarine, we need to broaden the submarine POM period to include a more intensive work-up to better prepare the submarine for cruise missile employment. We do not do a very good job of this.

3. Part of the proposal in number 2 above does not have to do with the training that we provide, but more with our ability to provide onboard simulation so that the submarine crew, and for that matter the submarine, can be tested from start to finish. Specifically, from receiving the mission data update all the way through the launching of a maximum salvo, the submarine should be able to test both the procedures as well as the launch system so that problems can be solved prior to time of launch. However, providing onboard simulation, is not the only answer. We need to also be able to provide training on our weapons launch systems to our sailors. Mock-ups such as those at NUWC need to be more accessible to our sailors.

The picture that I present is not as dire as it appears. We as a Submarine Force and a Navy as well have done wonderful things in a very short period of time. What we really need to do now is take a hard look at those processes and material issues that really need attention. ■

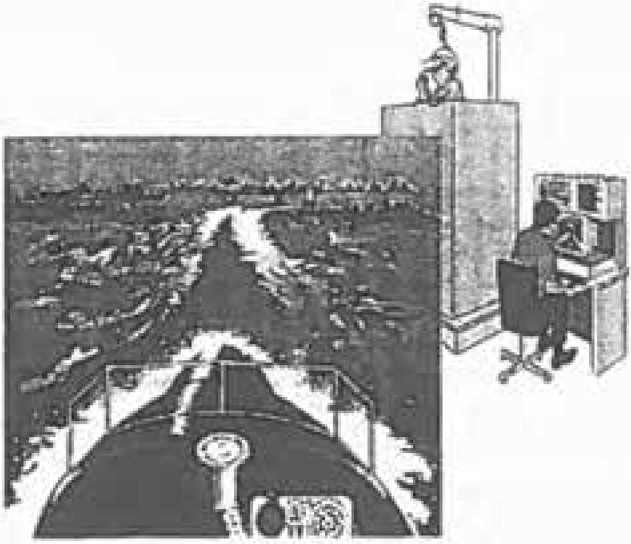
SUBMARINE OOD SHIP HANDLING TRAINING

by Robert T. Hays, Ph.D.
Naval Air Warfare Center Training Sys. Div.
Orlando, Florida

Virtual Environment (VE) technologies are maturing at a rapid rate. They are being hyped extensively in the entertainment world, are providing innovative training techniques for medical diagnosis and surgical procedures, and can now afford training opportunities for the submarine community that have not been available in the past. This article describes an Advanced Technology Demonstration project called Virtual Environment for Submarine Ship Handling and Piloting Training (VESUB), which is the first attempt to bring the VE out of the laboratory and make it available for real-world Navy training.

Land-based simulator facilities currently exist for training submarine navigation and ship handling teams. These systems do not, however, provide harbor and channel ship handling training of the officer of the deck (OOD). OOD training, under a variety of geographical and environmental conditions, is primarily obtained from on-the-job experience which is extremely limited due to the amount of steaming time available for entering and exiting harbors. Therefore, an alternative, simulation-based training capability is needed.

The goal of the VESUB project is to develop, demonstrate, and evaluate the training potential of a stand-alone virtual reality-based system for OOD training and also to integrate this system with existing Submarine Piloting and Navigation (SPAN) training simulators. A head mounted display (HMD) will be used to provide the trainee with a simulated 360 degree visual environment containing all of the required cues associated with harbor and channel navigation as well as varying geographical and environmental conditions. Voice recognition and syntheses will be used to provide communications training. Once the stand-alone version has been demonstrated and evaluated, it will be interfaced with a SPAN trainer and its team training effectiveness will be evaluated.



The above figure is an artist's representation of the VESUB system. On the right side of the figure, an instructor is shown seated in front of three screens at the Instructor/Operator Station (IOS). Two of the IOS screens are used to create, modify and control training scenarios. The third screen is used to monitor the performance of the trainee, who is shown standing in the bridge mock-up. The trainee is wearing the HMD and communicating with the simulation via a hand-held microphone. The inset shows what the trainee sees through the HMD. The visual scene will include a representation of the bridge area (for either the 688I or the 726 classes), including the bridge suitcase and the compass repeater. The trainee will also be able to see simplified charts and a course card when he looks down and to the right or left. In the distance, the visual scene will display buoys, navigation aids, traffic, and any other visual cues that the trainee requires for the ship handling task. When the trainee turns his head, a head tracker mounted above the mock-up will sense the movement and the computer will change the visual scene appropriately. Thus, the trainee will be able to turn to the stern and observe the rudder move in response to a helm order.

The VESUB training system will provide simulation-based training for OOD ship handling skills that, currently, are only taught on-the-job. Such training has the potential to reduce ship handling errors and save lives and property by allowing trainees to experience complex ship handling scenarios (e.g., adverse weather conditions, uncooperative traffic, equipment failures) in the simulation rather than encountering them for the first time in the real world. Furthermore, VESUB will afford the opportunity for many more trainees to experience ship handling scenarios than is now possible due to the limited number of times submarines enter and leave port. This is especially critical for the ballistic missile submarines, which are deployed for long periods of time.

By integrating the VESUB training system with SPAN systems, OODs will be able to experience the team training environment which will enhance the performance of the entire submarine piloting and navigation team. In addition, the integrated VESUB system will reduce the workload of the SPAN instructors who must currently play the role of the OOD in the existing training systems.

During FY95 and FY96, over 25 submarine subject matter experts experienced an exploratory version of the VESUB system that was developed under the Virtual Environment Training Technology program. This system allowed these experts to articulate additional requirements for the VESUB system. Some of these included: more accurate submarine models for both fast attack and ballistic missile submarines; the effects of currents on the submarine models; environmental effects (e.g., fog, rain, wind); dynamic traffic; complete and accurate vocabulary for the voice recognition system; and many others. During FY97, with the help of additional submarine subject matter experts, formative evaluations of the VESUB system will be conducted to ensure the inclusion and accuracy of as many environmental and modeling features as the technology will support. The formative evaluations will also focus on the incorporation of instructional features in the VESUB system. These include methods for measuring trainee performance and providing feedback, the design of instructional scenarios, and the usability of the VESUB IOS. The results of the formative evaluations will provide guidance so the system development contractor (Advanced Marine Enterprises) can enhance the system before it is taken to Navy schools for training effectiveness evaluations in FY98.

An Implementation Planning Group (IPG), consisting of active duty submarine personnel from schools, squadrons, groups, and systems commands, as well as government researchers, has been established to provide guidance during the formative and training effectiveness evaluations. The IPG will also provide recommendations for incorporation of these VE technologies into Navy training. The results of the training effectiveness evaluations will be documented in a final technical report and will also be used to produce a specification for procurement of operational systems. Current plans call for incorporation of VE technologies in the next generation SPAN trainers to be procured beginning in FY99. With the inclusion of VE technologies, the new SPAN trainers will afford complete ship handling training capabilities for the OOD, as well as the rest of the piloting and navigation team.

VESUB will be one of the first examples of a VE training system developed for and evaluated in a real-world context. The results of the VESUB project will provide capabilities that can be used in many other training contexts. Considerable interest has been shown for using VE technologies for surface ship handling training to avoid the high costs of current training systems and to training tasks that are not supported in these systems. There is also a high level of interest in placing systems, like VESUB, aboard the vessel to support mission rehearsal. As VE technologies mature and training developers and instructors learn more of its capabilities, it is likely that virtual environments will become a major asset for training in the 21st century.

MAKING ADMIN EASIER

by LT Harry L. Ganteaume, USN
Engineer
USS NEBRASKA (SSBN 739)(Blue)

[Editor's Note: This essay was a winner of the Naval Submarine League award for the Submarine Officers' Advanced Course 96040 at the Naval Submarine School.]

The administrative requirements associated with the operation of today's nuclear powered submarines can be overwhelming. Looking over a typical Executive Officer's (XO) Action Tickler or an Engineer's Records Review Tickler makes one wonder where they find the time to accomplish anything else. While most of these requirements provide the means for collecting information vital to our continued success, they frequently divert us from focusing on improving our warfighting skills and furthering our professional development. The benefits of reducing this administrative burden range from increased training opportunities, especially at the CO/XO to junior officer level, to improved inport quality of life. Since the elimination of these requirements is, in most cases, not feasible, it is in our best interest to reduce the time it takes to complete them. With today's technology and the high rate of computer literacy in submarine crews, this can be an easily achievable goal. There are numerous tools already in place which have allowed us to work smarter rather than harder with respect to our administrative duties. The use of a computer program to facilitate the management of a command's Communications Material Security (CMS) account and the installation of Land Area Networks making electronic routing of supply requests and message traffic possible, are just two of many examples. Unfortunately, there is one area which has not shown much progress at the shipboard level over the past few years, the Preventive Maintenance System (PMS).

The current PMS system has been in place for several years and has proven extremely valuable in maintaining the material condition of our submarines at an optimum level. However, its management and administration usually require a significant amount of time, mostly due to the large number of pieces of equipment, each having numerous maintenance requirements. The nature of this system makes it well suited for the use of a computer database program as an administrative aid. Such a program would not only reduce the effort and time required to manage and administer this important system, but it would also reduce the cost and time lag associated with its administration. Some of the features that could be incorporated in such a program and how they would improve our current system are:

1. Capability to update maintenance requirements by using either a telephone line or a computer disk, eliminating the cost and time delay associated with printing revisions/updates bi-annually. A summary of changes could accompany the new documentation for easy reference.

2. Capability to include the procedure associated with each maintenance item, providing the same information contained in the current Maintenance Requirements Cards (MRCs). This would provide ship's personnel with instant access to any MRC for review or printing in preparation for performing the job. Ships could customize the MRCs by adding information regarding specific tagout references, requirements for work packages, material history data entry, etc. This feature would prevent common delays caused by misplacement or illegibility (caused by wear and tear) of MRCs, and would facilitate the research and preparation of any required tagouts.

3. Capability to list maintenance requirements by specific events (situational requirements) or periodicity. Such a feature would allow ship's personnel to quickly develop accurate and complete lists without the need for reviewing every requirement associated with each piece of equipment, significantly reducing the amount of time required to prepare, update and review cyclic and quarterly PMS schedules. Additionally, this feature would facilitate the planning for infrequent evolutions, such as a dry docking, by generating a list of all maintenance requirements associated with the evolution of concern.

4. Capability to issue alerts when a possible lack of compliance with a maintenance requirement is detected.

5. Capability to create backup copies to computer disks to provide reliability against a hardware failure. This feature could be incorporated into the program, automatically creating a backup copy at specified intervals.

There are a lot of theories addressing some of the recent mishaps which have occurred across the Submarine Force. One point which comes up frequently is the loss of the father-son type training between experienced submariners (CO, XO and senior Department Heads) and junior officers. I am not sure what has caused this trend, but I feel that the administrative demands placed on a submarine's supervisory personnel are a contributing cause. The introduction of administrative aids to the fleet will hopefully reverse this trend and will allow us to invest more time in our operational and tactical development. The proposal described in the previous paragraphs is just an example of how we can further improve our efficiency as administrators. An effort to modernize the PMS system may already be in progress, if not, I hope this proposal will plant a seed for future development. More importantly though, in my brief submarine career I have seen many positive changes in the way we carry out our administrative duties, a trend which needs to continue if we intend to maximize our operational proficiency. It will pay great dividends! ■

THE SUBMARINE REVIEW

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

Articles for this publication will be accepted on any subject closely related to submarine matters. Their length should be a maximum of about 2500 words. The League prepares **REVIEW** copy for publication using Word Perfect. If possible to do so, accompaning a submission with a 3.5" diskette is of significant assistance in that process. The content of articles is of first importance in their selection for the **REVIEW**. Editing of articles for clarity may be necessary, since important ideas should be readily understood by the readers of the **REVIEW**.

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

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

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

SILVER DOLPHINS PLUS GOLD DOLPHINS EQUALS PRIDE AND PROFESSIONALISM

Can We Help It to Continue?

by CAPT J. Denver McCune, USN(Ret.)

Service in the armed forces of our nation provides the individual with many opportunities and rewards that are extolled by the individual services' various recruiting organizations and our military leadership. These benefits are offered by a country that appreciates the fact that this world is still a dangerous place, and that the true *cost of peace* is strength. Strength of our armed forces is derived from several sources, which includes the personnel themselves, the equipment available for their use, and the national political will to employ that strength.

Personnel strength can be measured in sheer numbers of people, the training and education they have achieved, the quality of their leadership, and their morale at any given time. All of these factors, when coupled with the most appropriate equipment for each given situation, provides our nation's capability for response, when mandated.

One of the most significant factors in a successful war-fighting military organization is the interacting relationship between officers and enlisted personnel. Each has a long-standing and sound relationship and each bears significant responsibilities towards the other. There is no single military *outfit* that can function properly without the dedicated contributions of both parts of the equation—and all of the professionals involved are very aware of that fact.

Having said the above, let us now turn to the specific interactions and relationships between enlisted personnel and officers on board USN submarines. The very confined environment of a submarine, coupled with lengthy voyages of those vessels, provide a forced familiarity that cannot be avoided. After a World War II war patrol, 30, 60, or even 90 days of continuous submerged operations, or a *peacetime* six month deployment from home port, it is not at all unusual for many men in a specific submarine to be intimately aware of other men's personal lives or habits. This applies to officer or enlisted men alike—and between either. A healthy outgrowth of this camaraderie can be one of mutual admiration for another's abilities, particularly regarding such items as intellect, sense of humor, personal dedication, etc.

During the constant training and operations involved in all submarine operations, each enlisted man and officer's contribution to the success of the team effort is obvious for all to observe. The newest enlisted man's efforts to become qualified for his Silver Dolphins and the youngest officer's similar work towards earning his Gold Dolphins are under constant scrutiny by everyone. Each person on board works to gain acceptance by the others, and they respond in a similar manner. Check points are established to ensure progress is steady, laggards are suitably *motivated*, and rewards are offered for meeting or exceeding goals. These relationships have been in existence throughout the long history of the U.S. Navy Submarine Force, and are expected to continue. A three word description of this effort could be **pride and professionalism.**

These words are the cornerstones in the life of the successful active duty submarine officer and enlisted man, alike. They echo in their daily relationships at sea and often when ashore in a military environment. However, when those men take off their uniforms during their personal liberty or leave time on the beach, in spite of military law requirements never ceasing, the close working relationship that existed when actively involved in the military arena is not required or expected to continue. In other words, the familiarity found at sea is not required, desired, or even considered necessary in the personal social lives of either. When absent from the ship, modern civilian social mores and values provide relevant emphasis on patterns of daily behavior. In spite of current efforts to *normalize* our democracy, the normal social strata defined by such things as education, income, personal or professional responsibilities, or organizational memberships, become some of the understandable defining guidelines for their behavior.

There are three major national organizations that exist to perpetuate the memory and serve to support the U.S.Navy's Submarine Force. Each of them has their own purposes, creed, or charter, and slightly different membership requirements. There are active duty and former submarine officers and submarine enlisted men as members of each of these groups. The Naval Submarine League (NSL) has many submarine-supportive members who have never seen a real submarine. The NSL also has Corporate memberships. Some women belong as members of a "ladies auxiliary" to the Submarine Veterans of World War II (SubVets, WWII), in strong support of their husbands membership. Submarine Veterans, Incorporated (SubVets, Inc.) is growing and picking up many areas of responsibility being passed along by the inexorably shrinking SubVets, WWII. Each of these groups has its own emphasis on social interaction, ranging from intensive to virtually non-existent. Participation varies by both the organization itself, and within each geographic location. Membership in any of these organizations can be relatively inexpensive and require very little in the way of personal commitment of time or money.

The Problem

Recent interesting statistics clearly indicate that the number of our nations elected representatives with **any former service in one of the branches of the armed forces** is decreasing rapidly. Additionally, members of the administrative staffs that support those successful political professionals are also markedly deficient in any background military experience or understanding, whatsoever. In fact, more and more of these two groups that control our defense strength and ultimate future itself, have their own heritage in the turbulent times of the 1960s and 1970s, when military recruiters' cars were being fashionably overturned and burned on our nations campuses, ROTC units were being stoned or disbanded, and successful draft-dodging was a survival art-form.

What can we do to make sure that our current submarine sailors, enlisted and officer, are aware that those of us in these three vibrant organizations are working hard (and together) to support them? This is especially true in these days of dwindling national fiscal resources and the ill-perceived notion by many that threats to our nations security no longer exist.

Proposed Solution

A partial answer to the foregoing question lies in the two following thoughts:

1. Let us (the three submarine *outfits*) strengthen and share each of our membership base as much as possible. Increased membership numbers will increase revenues and if we continue to improve *quantity*, we will most certainly be able to manage

quality.

2. **Strong, cohesive and coordinated support of the current active duty Submarine Force by all three** of these organizations will provide much greater opportunity for recognition and respect by our nation's political administrators. Another word for this is *clout*. This unified endeavor will be readily noted by our active duty Submarine Force.

To get us on a track for better communications and coordination, the following suggestions are offered for consideration by the NSL, Submarine Veterans of World War II, and Submarine Veterans, Incorporated:

1. Each continue to maintain their current membership policies, but advertise as widely as possible to the general public and active duty Submarine Force regarding their respective organizations. Present a *united front* regarding the cohesiveness of the three associations.

2. Encourage a minimum of one **combined** annual meeting each year, on a local basis. Each organization to get a minimum of 33 percent of meeting time to *show and tell*. The goal is to simply establish communications and provide growing friendship. Rotate the *hosting* organization on successive years.

3. Establish a joint annual meeting between the top national officers of all three groups. The goal would be to discuss support for the current U.S. Navy Submarine Force and to share in an understanding of each other's major missions, etc. Promulgate results of meeting to respective memberships, to show solidarity of purpose.

Conclusions

There can be many discussions regarding the melding of former submarine officers and former submarine enlisted men and current submarine officers and current submarine enlisted men and civilians and contractors and other patriotic USA citizens in our three organizations. It is submitted that there is no doubt that many current and former enlisted men do not relish any relationship whatsoever with officers, other than the minimum required for active duty. It is further submitted that there is no doubt that many current and former officers similarly do not relish any relationship whatsoever with enlisted men, other than the minimum required for active duty.

On the other hand, there are some of each (officers and enlisted men) who do enjoy a limited social relationship amongst the others, most particularly after they have left their active duty for whatever reason. These are also the officers and enlisted men who hold a mature understanding of the appropriate relationship at all times, and genuinely respect the roles of the other. Invariably, each of these submarine men have, at some time or another, had the lives of all of their shipmates in their own hands at sea - and sharing a social Dr. Pepper or two at a combined meeting of officer and enlisted submariners is really not that big of a problem. It is therefore postulated that these are the desired men for whom membership in any of our three outfits would prove most beneficial. All would be welcome, and all are needed, if we are to support today's Submarine Force pride and professionalism with a truly coordinated united effort.

[Captain McCune served in TIRU, SABALO, CATFISH, THOMAS A. EDISON, and commanded SEA ROBIN during his naval career. He is the recent past president of the Pacific Southwest Chapter (San Diego) of the Naval Submarine League (Life Member), an Associate member of SubVets, WWII, and a Life member of SubVets, Inc. He resides in La Costa, CA.]

NAVAL
SUBMARINE
LEAGUE

AMERICA'S NUCLEAR ATTACK SUBMARINES IN THE FUTURE
Will They Be Relevant?

by CDR Donald D. Gerry, USN

Introduction

America's Forward...from the Sea Navy is a mission based, littoral force. Many contend that the limited shallow water capabilities of the nuclear attack submarine (SSN) make it a prohibitively costly, and seemingly unnecessary, member of this force. However, what the SSN's detractors don't foresee is that in the near future the nuclear submarine will be the principal counter to several unique national security threats.

The U.S. SSN Today

With a hostile nation afoot, rationalization of military programs is easy—if they've got one, we need a better one! So it was for U.S. SSNs in the Cold War. The Soviet Union, committed to the possession of a powerful submarine force, posed a clear threat to the United States. Consequently, the issue for the U.S. was never whether submarines were necessary. Rather, the question was simply how many submarines were needed and how expensive would they be. Today, this rudimentary basis for SSN force structure is obsolete. Responding to cries for a *peace dividend* after the collapse of the Warsaw Pact, the Navy announced in Forward...from the Sea: "...the most important role of naval forces...is to be *engaged* in forward areas, with the objective of *preventing* conflicts and *controlling* crises."[1]

Overnight, America's Navy became a critical component in the national security strategy of engagement and enlargement. Swiftly, yet subtlety, threat became ancillary. Forward...from the Sea proclaimed littoral operations as preeminent and aircraft carrier battle groups (CVBGs) as centerpieces. The traditional mission of SSNs—anti-submarine warfare (ASW)—was conspicuously absent. Although SSNs were considered integral elements of CVBGs, their role had unquestionably shifted to that of secondary, supportive warships. Furthermore, the utility of SSNs to a CVBG remained a contentious issue. Thus, given the high cost of procuring and maintaining nuclear submarines, national leadership began asking questions. Are SSNs relevant to the national security strategy? Does the United States need SSNs? Many said no. Indeed, America's newest SSN, SEAWOLF, was pronounced a Cold War relic. Even the SSN's staunchest supporters agreed that lacking a well defined mission, the Submarine Force's future prospects appeared bleak.

Still, the international environment rarely remains static. Russia sustains, and China is currently developing, naval weaponry that seriously threatens United States security. Much of this hardware can only be challenged by SSNs. If global developments maintain their present course, the popular tide will again shift for America's submarines. They will not only be relevant to the nation's defense, they will be vital.

U.S. SSNs and the Future Russia

When the Soviet Union collapsed, its Navy suddenly faced numerous problems. Of the massive surface fleet which once sailed the globe, only a handful of ships could be kept operational. Naval bases from Murmansk to Vladivostok were full of decrepit hulks seeping toxins into coastal waters. Cases of political infighting, including removal of a submarine base's electrical power, were widespread. Readiness and morale within the Russian Navy was at the lowest level in a generation.[2] To the casual observer, it appeared that the Russian Navy no longer had the capability to threaten American forces. Additionally, any hostile intent seemed to have abated. In 1994 Russia declared its strategic weapons were no longer aimed at American targets[3] and its Pacific fleet wouldn't deploy.[4] Apparently, the Russian bear had been de-clawed.

Despite Russia's public posture shifts and material problems, America would be wise not to jump to conclusions. Russians, proud of their global leadership, are keenly aware of the attribute from which they draw their power. Landmass and population might seem logical candidates, but the plight of Brazil (landmass) and India (population) demonstrates that these elements do not ensure status as an impact player. In reality, Russia is a major world actor for one reason—its nuclear arsenal. Recognizing this, the Russian General Staff continues to funnel precious resources into *residual [strategic] deterrence*. American friendship notwithstanding, Russian authorities are committed to strategic parity with the United States.[5]

With START treaties forcing an increased reliance on the seaborne component of its nuclear triad, Russia's Navy has become the principal benefactor of its nation's determined strategic policies.[6] While other military programs languish, illustrations of a lively nuclear ballistic missile submarine (SSBN) program abound. A new SSBN class is under development and should begin delivery at the turn of the century. A Typhoon class SSBN, severely damaged by fire and thought to be a candidate for scrapping, was repaired and remains operational. And, the super-quiet SEVERODVINSK SSN, a key to Russia's layered *bastion* SSBN defense scheme, will soon be launched.[7]

Will the United States need SSNs to counterbalance Russia's vibrant but seemingly benevolent SSBN program? Absolutely! Russian SSBNs are still on patrol and many old strategic facts of life remain germane. In fact, military planners should recall why SSNs were used during the Cold War to hunt missile submarines. Soviet SSBNs usually operated in contiguous waters. The probability of maritime patrol aircraft (MPA) or surface anti-submarine warfare (ASW) assets surviving, let alone succeeding, close to the Soviet Union was considered small. Besides, if the SSBN proceeded under ice it was invulnerable to MPA and surface vessels. The diesel-electric submarine (SS), a potentially cheap alternative to the SSN, was susceptible to counter-detection during battery recharging and lacked the endurance for lengthy ASW prosecution. The stealthy SSN, an excellent ASW platform with unlimited stamina, was the obvious choice.

With the oceans of the world remaining wonderful cloaks for strategic forces, none of the tactical reasons America chose SSNs to stalk Soviet SSBNs have changed. Still, many feel U.S. submarines aren't needed to check friendly Russian forces. After all, America doesn't keep tabs on British or French SSBNs. Nevertheless, it is a real possibility in a nation as hungry and unstable as Russia that a hostile opportunist could rise to power. Although capabilities can take decades to develop (and Russia's SSBN capability is currently powerful), intentions can change overnight. In fact, recent events indicate that Russia's intentions may not match popular Western perceptions.

Though promising to remain in home waters, Russian submarine operations remain aggressive. Oscar class guided missile submarines (SSGNs) recently sortied to the central Pacific and

Atlantic Oceans to simulate attacks on deploying U.S. CVBGs. Cruise missile capable Akula class SSNs also operated near Trident submarine bases in 1994 and 1995.[8] As if forward submarine operations were not enough to indicate that the Russian Navy was not as benign as had been thought, in 1995 a Typhoon launched an SS-N-20 exercise ballistic missile from the North Pole. In performing what was "... theoretically impossible according to the logic of recent years",[9] Russian leadership boasted, "Whatever people say, the Russian Navy and its nuclear forces are not dead...".[10] A Russian newspaper provided the civilian perspective that "... [the Navy] is alive and battleworthy".[11] The polar launch of a ballistic missile illustrates a capability which only nuclear submarines can counter. Were SSNs removed from the American arsenal, Russia would be granted de facto under-ice sanctuaries for its submarines. Ironically, the United States has firmly declined repeated Russian requests for this type of "ASW-free zone" during past arms control negotiations.[12]

Even if the Russian government remains friendly, other developments ensure the necessity of an American SSN fleet. By most accounts Russian armed forces are "riddled with criminal groups...who hire out their services as hitmen." The prospect of a rogue submarine under Russian *mafiya* control, unthinkable in the days of stringent Soviet security, is now a possibility that cannot be ignored.[13] Given the level of disorder and unrest throughout Russia; *mafiya* influence, power, and corruption will not abate anytime soon. Already hampered by severe cutbacks in other ASW programs, a U.S. Navy without SSNs would be hard pressed to respond to the threat posed by a nuclear capable Russian submarine operating under control of an illegal, non-government entity.[14]

U.S. SSNs and the Future China

In 1962 the Soviet Union decided to challenge the Monroe Doctrine by sending nuclear missiles to Cuba. When Kennedy responded with a naval blockade, Khrushchev realized he had no proportionate response. Indeed, with nothing mightier than World War II era cruisers in his Navy, the Soviet Secretary General could not oppose the powerful U.S. fleet.[15] Khrushchev learned too late that in order to secure world-wide interests in the 20th century a nation needs a blue-water navy. The U.S. Seventh Fleet recently taught the People's Republic of China (PRC) the same lesson.

Chinese leadership, hoping tough talk and aggressive nationalism would buoy the communist government's prestige, attempted to influence the March 1996 Taiwanese elections.[16] Employing a typical post-Mao strategy of military intimidation coupled with diplomacy, China blatantly sought to sway votes from President Lee Teng-hui with live-fire war games.[17] Enter the United States. Proclaiming Chinese missile launches "an act of coercion", America dispatched two CVBGs to the area.[18] Taiwan, anxious but not pressured, conducted its election under the protection of the Seventh fleet. Badly outgunned, the Chinese completed their exercises and withdrew to pre-crisis status. Furious with American gunboat diplomacy, Chinese authorities angrily denounced U.S. actions as "ridiculous...interference" in internal matters.[19] Nonetheless, lacking a blue-water navy they had no choice but to swallow the bitter pill of foreign intervention. Their bluff had been called.

The Taiwanese election was the latest regional dispute in which lack of force projection seriously limited Chinese alternatives. A long standing problem, inability of the People's Liberation Army Navy (PLAN) to satisfactorily leverage events has been an achilles heel for the PRC. Yet, as early as 1975 Deng Xiaoping recognized the need for an up-to-date Navy to preclude superpower interference in Chinese foreign affairs. Unfortunately for Deng, the government lacked the means to procure such a fleet.[20] In fact, under Deng's sweeping reforms of the early 1980s, defense received the lowest priority for state allocations (after agriculture, industry, and science and technology).[21] However, the PLAN's fortunes are starting to shift. Experts point to several years of explosive economic growth[22] to support predictions that the PRC will possess the world's second largest economy by the year 2010.[23] Though this estimate may be optimistic, China is clearly beginning to enjoy the wherewithal to support a substantial military-industrial complex. Nevertheless, PRC coffers will never be infinite. The Chinese, with ports and airfields full of outdated hardware, are going to have to carefully select between competing requirements. Which programs will be top priorities? Indications point to the PLAN's submarine force. Consider China's recent decisions.

Years before the 1996 Taiwan crisis, China was determined to modernize its sub-surface fleet. The 1994 purchase of four Russian Kilo submarines was the first increment in a program aimed at acquiring up to 22 of these modern boats. The new Song class, an indigenously produced SS, is expected to incorporate a significant amount of Kilo technology and utilize improvements provided by Israeli submarine experts.[24] The Chinese nuclear submarine program is also being upgraded. The PLAN's five Han class SSNs have been fitted with sophisticated French sonar systems[25] and may be armed with wake homing torpedoes acquired as part of the Kilo contract.[26] Development of follow-ons to the Han class SSNs and Xia class SSBNs is well underway.[27] And, recent agreements between Russian President Yeltsin and Chinese President Zemin indicate that Russia may be ready to use the Taiwan crisis as an excuse to provide China with sophisticated nuclear technology or one of its premier boats. Troubled by possible U.S. expansion of NATO, Yeltsin agreed with Zemin that Taiwan is an internal Chinese affair and Washington has been guilty of "hegemonism".[28] Moreover, Russia has set a precedent by renting nuclear submarines to India.[29] Were the PLAN to have access to Russian submarine secrets, the jump in Chinese underseas capability could be swift.

The pre-1996 upgrade of the PRC's navy and submarine force was driven by many factors. First, there were a series of unresolved regional disputes. Paracel, Spratley, and Senkaku Island sovereignty debates were ongoing.[30] Second, there was the question of reunification with Taiwan. With Lee Teng-hui in office, this issue simply wasn't going to evaporate. Finally, naval procurement by China's neighbors was accelerating. In 1994 eight Asian nations adjacent to the PRC accounted for almost one half of the world's orders for new naval vessels. With submarines representing a substantial portion of these purchases, underseas warfare improvements were imperative.[31] Yet, despite all the reasons the PRC had to improve its submarine force, the 1996 Taiwan crisis will probably be regarded in the future as a turning point.

Though the Chinese have long known that they don't possess the wherewithal to challenge America's SSNs, the United States emphasized the point during the Taiwan affair. For the first time during a regional contingency, America announced that SSNs would be on patrol.[32] Already pursuing vigorous submarine acquisition, the PLAN was provided with clear justification for its aggressive programs. Thus, just as the Soviets pursued a dramatic buildup of their surface fleet in the wake of the Cuban missile crisis, an embarrassed PRC will undoubtedly redouble its quest for top notch submarines.[33] Although the PRC's submarine force may not be the world's best today, American actions ensure that it will try to be in the future.

If the day arrives that PRC submarines are on a par with front line Russian SSNs, America had better ensure it still owns a dominant SSN fleet. With substantial percentages of world trade traversing sealanes adjacent to the PRC, it will remain vital that the United States be able to project power and influence in the western Pacific.[34] To quote Singapore's leader Lee:

> "Asia needs the American security umbrella for protection against China and to guarantee the stability in which economies thrive."35

With highly capable PRC submarines roaming the seas, U.S. combat or presence missions in the Pacific rim could be in grave danger without SSN protection. Threatened by an array of nearby air and sea assets, task force units would have little time to conduct demanding ASW searches. Should PRC SSNs begin striking allied shipping, a Task Force Commander's options would be minimal. Just as Argentinean task forces lacking credible ASW capability were forced into port after a British SSN sank the GENERAL BELGRANO, the U.S. might be forced to withdraw. Having learned its lesson in the Taiwan Straits in 1996, having closely observed declines in U.S. ASW funding and expertise[36], having watched America terminate its costly SSN program, the PRC would have taught the imperialist foreigners a lesson in power projection.

Other Possibilities

Many believe Russia's economy simply can't sustain a modern military infrastructure and that the collapse of the Russian submarine force is only a matter of time. Yet, such a disintegration would not match the Russian track record. After World War II the Soviet Union was devastated. With no great need for oceanic power and no tradition of naval success, the U.S.S.R. expended the extraordinary national treasure necessary to build the world's largest submarine fleet.[37] Similarly, despite a shrinking economy Russia continues to build and operate submarines that rival the world's best.[38] Social upheaval and political unrest notwithstanding, history is clear on one point—Russia will always pursue a formidable submarine force.

Two arguments have become popular among those who contend China and its submarines will never constitute a threat to the United States. First, there is the theory that China will become an adversary only if America treats her like one. Proponents of this position argue that America's engagement strategy will lead to adequate Sino-U.S. relations.[39] Unfortunately, this premise ignores current realities. Anti-foreign nationalism has replaced ideology as the foundation of communist power. Calls for "the sacred mission of reunification [with Taiwan]"[40] and for "living space [in the Spratleys]"[41] indicate that resolution of international disputes involving China will be neither swift nor peaceful. Furthermore, after U.S. intervention in the Taiwan Straits, many in China's leadership view America as an enemy.[42] Given the animosity in the relationship between the two nations, it seems overly optimistic to assume engagement will be singularly successful.

The second commonly held position is that the PLAN will never achieve its submarine modernization goals. The point is made that China's defense budget in 1995 fell to only 1.5 percent of Gross National Product (GNP)[43] and that the PLAN remains a largely antiquated force. Why should things improve in the future? To begin with, China disguises much of its military funding. Arms sales and monies hidden in other portions of the state budget are not reported as military spending but significantly contribute to PLAN outlays. In reality, although reported defense spending has consistently dropped as a portion of GNP, real military funding grew 40 percent since 1988.[44] With respect to outmoded equipment, China has demonstrated an ability to develop and employ sophisticated technology when there has been a national will to do so. China's indigenous production of a hydrogen bomb only two years after exploding a crude atomic device is ample evidence of its technical potential.[45]

Conclusion

Will SSNs be relevant to America's defense in the years to come? Put simply, they will be vital. Russia, friendly or not, will continue to operate an impressive SSBN fleet. Without SSNs, America would cede invulnerable patrol areas to Russian submarines capable of inflicting massive damage on the territory of the United States. With a nation whose populace is rife with organized crime and as susceptible as any to a dictatorial coup, this is a risk the United States must not take. China, home to a dangerous mix of nationalism, militarism, territorial disputes, and hatred of foreign intervention, is committed to the acquisition of modern submarines. Explosive economic growth and foreign technological assistance all but assures that China will have the wherewithal to achieve its goals. As a result, America must have SSNs to ensure the safety and effectiveness of future naval operations along the Pacific rim.

NOTES

1. U.S. Department of the Navy, Forward...from the Sea (Washington: 1994), 1.

2. Dr Mark Galeotti, "Russia Country Briefing", Jane's Defense Weekly, Vol. 24, No. 18, 4 November 1995, 30 - 49.

3. Dr. Christoph Bluth, "The Russian View of its Strategic Nuclear Arsenal", Jane's Intelligence Review, June 1994, 263 - 265.

4. Kensuke Ebata, "CIS Spells Out Defensive Plan", Jane's Defense Weekly, Vol. 17, No. 25, 20 June 1995, 1050.

5. Ibid., 263.

6. Ibid., 267.

7. Galeotti, 47.

8. Charles Aldinger, "Russian Subs Said to Shadow U.S. Warships", Rueters, 8 December 1995.

9. "Training Launch of Ballistic Missile Near North Pole", 2X2 TV, Moscow, 25 August 1995.

10. "Russians Hail Missile Launch as 'Great Success'", Agence France Presse, 29 August 1995.

11. "Russia Fires Ballistic Missile from North Pole", Jane's Defense Weekly, 9 September 1995, 6.

12. A. Koretskiy, "Russia on Submarine Patrol Zones. Russia Wants Cut in Patrol Zones", Kommersant Deyli, 19 October 1994.

13. Galeotti, 33.

14. Jim Bussert, "Russian Submarine Fleet Poses Ominous Concern", National Defense, November 1994.

15. Raymond V.B. Blackman, Jane's Fighting Ships 1962-63, (New York: McGraw-Hill Book Company, Inc. 1963) 419 - 423.

16. Steven Mufson, "Maoism, Confucianism Blur Into Nationalism", The Washington Post, 19 March 1996.

17. Michael Dobbs, "Chinese Revert to Mao Formula In New War of Nerves on Taiwan", The Washington Post, 16 March 1996.

18. Steven Mufson, "China Plans Live-Ammunition Tests", The Washington Post, 10 March 1996.

19. Steven Mufson, "China Warns U.S. Against Taiwan Role", The Washington Post, 12 March 1996.

20. Bradley Hahn, Strategic Implications of People's Republic of China Nuclear Weapon and Satellite Rocket Programs, (Hong Kong: Asian Research Service 1980), 15.

21. Karl W. Eikenberry, Explaining and Influencing Chinese Arms Transfers, (Washington, D.C.: National Defense University 1995), 7.

22. Steven Mufson, "Upbeat Premier Puts Growth Goal at 8 Percent for '96", The Washington Post, 6 March 1996.

23. Eikenberry, 53.

24. Robert Sae-Liu, "Submarine Force Priority for China's Modernization Plan", Jane's Defense Weekly, 13 May 1995, 18.

25. Raymond Cheung,"Meeting New Challenges - Taiwan Bolsters ASW Capabilities", Naval Forces, No. VI Vol XIV 1993, 9.

26. James C. Bussert, "Chinese Submarines Quietly Amass Strength in Pacific", Signal, June 1995, 76.

27. Sae-Liu, 18.

28. Joseph Kahn, "China, Russia Flaunt New Camaraderie In an Apparent Warning to the U.S.", The Wall Street Journal, 26 April 1996.

29. Martin Douglas, "Submarines--Third World", Naval Forces, No. VI Vol XIV 1993, 26.

30. John Jordan, "The People's Liberation Army Navy (PLAN)", Jane's Intelligence Review, June 1994, 282.

31. Stewart Walters, "Asia Aims Its Sights Underwater", Asian Defence Journal, June 1994, 52-58.

32. Steven Mufson, "Beijing Warns U.S. on Naval Display", The Washington Post, 19 March 1996.

33. Fred Joseph Zuniga, Soviet Naval Diplomacy, (Ann Arbor, MI: University Microfilms International 1980), 35.

34. Walters, 52.

35. Mufson, 19 March 1996.

36. Bussert, 75.

37. David Woodward, The Russians at Sea, (London: William Kimber and Co. 1965) 226 - 228.

38. Galeotti, 30.

39. David Shambaugh, "China's Military, Real or Paper Tiger?", The Washington Quarterly, Spring 1996, 32.

40. Steven Mufson, "China Plans to Resume War Games", The Washington Post, 16 March 1996.

41. Mufson, 19 March 1996.

42. Ibid.

43. Shambaugh, 21.

44. Ibid.

45. Hahn, 19.

APPENDICITIS?

by CDR M.S. Terrass, USN(Ret.)

The August 1996 issue of Naval History had an article *"Operating Under Pressure"* concerning appendectomies performed by Pharmacist's Mates at sea on submarines on patrol during World War II. The article caused me to recall a very different submarine appendicitis situation.

I was CO of USS TRUTTA (SS 421) assigned to Squadron 12 in Key West, Florida. Sometime during the late summer of 1961 we were on weekly ops in the *deep hole* in the middle of the Gulf of Mexico. We were providing services to give Navy ASW patrol aircraft opportunities to locate and track a submerged submarine. We were submerged roughly 21 hours per day. We would surface for about an hour and a half around noon and again near midnight to charge batteries and send our surfacing and next diving messages and receive radio traffic. It was a necessary but not demanding assignment. My personal schedule was oriented to the periods on the surface and after diving around 0100 I would sleep until around 1000 when I would arise, shave and dress in time for a cup of coffee before lunch and the noon surfacing.

One morning, Wednesday as I remember, I was met by the Exec when I entered the passageway and noted our Chief Hospital Corpsman standing nearby. The Exec said, "Captain, we have a situation you need to know about". "Medical?" I asked. He answered in the affirmative and said that the Corpsman thought that one of our men had an acute case of appendicitis. We then sat down in the wardroom and I quizzed the Corpsman as to why he had arrived at that diagnosis. He ticked off the patient's symptoms and showed me passages in his medical books which supported his diagnosis. He convinced me so I had the Exec draft a message reporting the situation to the Squadron to be transmitted as soon as we surfaced.

Shortly after we surfaced and had sent our messages, we received a message directing us to come up on single sideband voice radio. Once on SSB we were directed to have our Corpsman discuss the case with the Squadron doctor on the tender in Key West. The doctor concurred in the diagnosis and then the Squadron Operations Officer asked to talk with me. He directed us to steam at best speed toward the Dry Tortugas for a helicopter transfer of the patient, and stated that he would handle notifying the aircraft squadron of the situation and would send us instructions regarding resuming the exercises once the patient had been transferred. The weather was good so the helicopter came out farther than normally would have been the case and within several hours the transfer was effected with no problem.

We reversed course and headed back toward the *deep hole*. We received our instructions and before very long submerged and resumed the aircraft exercises while continuing on back to the *deep hole*.

Near midnight, we surfaced and sent our surfacing and diving messages. I was in the Control Room, rigged for red as normal for night surface operations. Shortly one of the radiomen presented me with the message board. He said, "This is the circuit log sheet but we thought you might want to see this message from the Squadron before we take the time to type up the smooth version." The message read something to the effect that the patient had arrived safely at the Boca Chica Naval Air Station and was successfully operated on for a confirmed appendix 20 minutes later. The Chief Corpsman was on duty as the Chief of the Watch at the hydraulic manifold so I passed the message board over so he could read the message. His face broke into a broad smile and then he wiped his brow. Body language clearly indicated relief. "Chief", I asked, "why did you wipe your brow like that"

He said, "Captain, that's the seventh time I have made a diagnosis of appendicitis and the first time I have been right."

I was just as glad that I had not been aware of the *Doc's* track record in regard to appendicitis when we sent our message reporting the situation. In retrospect, however, given the circumstances, I doubt that I would have acted any differently even if I had known. ■

POLARIS—STILL ON PATROL

by Noreen E. Wagers

"It's only child's play" is an expression that we've all used. This scene is only child's play, or is it?

The small playground, on Virginia Avenue in North Charleston, is nestled within the trees, just barely off the road. This playground isn't large, new, nor does it have the most modern equipment. It isn't anything fancy, only the bare necessities guaranteed to please the young at heart.

However, towering over the grounds like a giant gatekeeper on permanent guard duty, is the shell of a Polaris missile! This fixture creates quite a paradox at the playground as one expects to see only the swings, monkey-bars, and the park benches in this tranquil setting. One wonders if the children that play near it are even aware of the vigilant watch over them.

Many of us can recall as children the frequent testing of the Emergency Broadcasting System and being huddled together in school halls during attack drills.

We remember hearing our friends and neighbors talk of constructing backyard shelters. Terms such as, A-bomb, fallout, geiger counters, civil defense shelters and rations were common to us. Most of these terms have long since been erased from our memory. Today, however, we mustn't be fooled into a false sense of security.

Perhaps, this towering armament from the past still serves a very useful purpose by reinoculating us with a *shot of reality* to the great importance of keeping our defenses strong and never letting our guard down—the future of our children may ultimately depend upon it!

NAVAL SUBMARINE LEAGUE
HONOR ROLL

BENEFACTORS FOR MORE THAN TEN YEARS

ALLIED-SIGNAL OCEAN SYSTEMS
AMERICAN SYSTEMS CORPORATION
ANALYSIS & TECHNOLOGY, INC.
APPLIED MATHEMATICS, INC.
BABCOCK AND WILCOX COMPANY
BIRD-JOHNSON COMPANY
BOEING NORTH AMERICA
BOOZ-ALLEN & HAMILTON, INC.
DATATAPE, INC.
CAE ELECTRONICS, INC.
COMPUTER SCIENCES CORPORATION
CORTANA CORPORATION
DIAGNOSTIC/RETRIEVAL SYSTEMS, INC.
EG&G, WASHINGTON ANALYTICAL SERVICES CENTER, INC.
ELECTRIC BOAT CORPORATION
GLOBAL ASSOCIATES, LTD.
GNB INDUSTRIAL BATTERY COMPANY
GTE GOVERNMENT SYSTEMS CORPORATION
HAZELTINE CORPORATION
ELIZABETH S. HOOPER FOUNDATION
HUGHES AIRCRAFT COMPANY
KAMAN DIVERSIFIED TECHNOLOGIES CORPORATION
KOLLMORGEN CORPORATION, E-O DIVISION
KPMG PEAT MARWICK
LOCKHEED MARTIN CORPORATION
LOCKHEED MARTIN/ELECTRONIC SYSTEMS
LOCKHEED MARTIN FEDERAL SYSTEMS COMPANY
LOCKHEED MARTIN OCEAN, RADAR & SENSOR SYSTEMS
LOCKHEED MARTIN TACTICAL DEFENSE SYSTEMS - AKRON
LOGICON-SYSCON CORPORATION
LORAL LIBRASCOPE CORPORATION
MARINE MECHANICAL CORPORATION
NEWPORT NEWS SHIPBUILDING
NORTHROP GRUMMAN CORPORATION
PRC, INC.
PRESEARCH INCORPORATED
PURVIS SYSTEMS, INC.
RAYTHEON COMPANY, EQUIPMENT DIVISION
ROCKWELL INTERNATIONAL CORPORATION
SAIC
SIGNAL PROCESSSING SYSTEMS
SEAKAY MANAGEMENT CORPORATION
SIPPICAN, INC.
SONALYSTS, INC.
SPERRY MARINE, INC.
SYSTEMS PLANNING & ANALYSIS, INC.
TREADWELL CORPORATION
VITRO CORPORATION

BENEFACTORS FOR MORE THAN FIVE YEARS

HYDROACOUSTICS, INC.
LUCENT TECHNOLOGIES/ATS
PLANNING SYSTEMS INCORPORATED
RADIX SYSTEMS, INC.
RIX INDUSTRIES
SARGENT CONTROLS & AEROSPACE
TASC, THE ANALYTIC SCIENCES CORPORATION

ADDITIONAL BENEFACTORS

ADVANCED ACOUSTIC CONCEPTS, INC.
ALLIED NUT & BOLT CO. INC.
AMADIS, INC.
ARETÉ ENGINEERING TECHNOLOGIES CORPORATION
BATTLESPACE, INC.
BURDESHAW ASSOCIATES, LTD.
CUSTOM HYDRAULIC & MACHINE, INC.
DIGITAL SYSTEM RESOURCES, INC.
DYNAMICS RESEARCH CORPORATION
ELS INC.
EMERSON & CUMING, INC.
HAMILTON STANDARD SEA & SPACE SYSTEMS
HOSE-McCANN TELEPHONE CO. INC.
HUSSEY MARINE ALLOYS
JOHNSON CONTROLS
LOCKHEED MARTIN TACTICAL DEFENSE SYSTEMS
LUNN INDUSTRIES, INC.
MCALEESE & ASSOCIATES, P.C.
PRECISION COMPONENTS CORPORATION
RAYTHEON E-SYSTEMS/FALLS CHURCH
SYSTEM PLANNING CORPORATION
VEHICLE CONTROL TECHNOLOGIES, INC.
WESTINGHOUSE ELECTRO MECHANICAL DIVISION

NEW ASSOCIATES

B.L. Commons
E.G. Crane
TMCS(SS) F.H. Enano, USN
CAPT W. Fritchman, USN
LCDR K.A. Larson, USN(Ret.)
LT E.V. Pagal, USN
CAPT A.F. Rawson, Jr., USN(Ret.)
LT. A.H. Skinner, USN(Ret.)

E-MAIL ADDRESSES

THE SUBMARINE REVIEW continues its list of E-Mail addresses with those received since the January issue. We can be reached at subleague@aol.com.

Ackley, Dick, rackley@infowest.com
Banner, Dave, dbanner@home.bellatlantic.net
Beam, Alan, arbeam@aol.com
Bjerkaas, Allan, allan.bjerkaas@jhuapl.edu
Bjerke, Roger, rogerb@erols.com
Blaha, Doug, dblaha@ccsinc.com
Blake, Lloyd, BlakeL@decaf.curtin.edu.au
Blount, Robert, RHBlount@aol.com
Bornt, Butch, butch@rpi.edu
Browder, Ed, Edthebrow@aol.com
Busavage, John, JGBUSAVAGE@aol.com
Carre, David, davelynn@series2000.com
Cederholm, Walter, waltertcederholm@ussev.mail.abb.com
Chestnut, Ernie, ELCJR@aol.com
Cole, Thomas, ThomasC510@aol.com
Cole, Bryan, bwcole@juno.com
DeRonck, Henry, deronchj@ifc.hsd.utc.com
Dietrich, Rolf, deitrich@prodigy.net
Donovan, Dan, dandonovan@sprintmail.com
Donovan, Dan, dandonovan@sprintmail.com
Doyle, Mike, doylempat@aol.com
Dunn, Frank, FDunn@blue.cc.odu.edu
Gairing, Donald, DAG91@aol.com
Gouge, M.J., gougemj@ornl.gov
Grant, Patrick, grantp@top.net
Greenman, Robert, RPGreenman@aol.com
Greer, James, jgreer@mindspring.com
Griffiths, Chip, griffich@js.pentagon.mil
Guille, Les, lguille@mnsinc.com
Gustin, Bruce III, gustin3@spb.swfpac.navy.mil
Haigis, John, john_hagis@cpqm.saic.com
Hamlin, Kent, 105317.3177@compuserve.com
Hansell, William, hansell@ix.netcom.com
Hilborn, Roy, rhilorn@CASDE.com

Hopkins, R. Scot, shopkins@mindport.net
Hopkins, Thomas, tmhop@aol.com
Jenkins, Scott, 70733.1046@compuserve.com
Johnson, Steven, sijohnso@nosc.mil
Jolliffe, John, casas@cts.com
Kenhart, Craig, craig.kenhart@alliedsignal.com
Lowell, Robert, rlowell@darpa.mil
Maine, Guy, MAINEGUY@aol.com
McHugh, Michael, mlmchugh@MIT.EDU
McNichols, J.P., mcnich60@aol.com
Meltser, Thomas, TomPatriot@aol.com
Metzgus, Greh, coppersmith@sprintmail.com
Minter, Ted, TedE@webtv.net
Moore, Richard, rmoore@visi.net
Morrison III, Julian, 102575.3073@compuserve.com
Mosier, Jr., John, djmosier@gnatnet.net
Murphy, Dave, delex@erols.com
Nahrstedt, David, duchess2@concentric.net
Olson, Thomas, OlsonTom@aol.com
Orzalli, Jack, JOrzalli@aol.com
Papineau, Paul, TCCB19B@prodigy.com
Penn, George, gpenn@redshift.com
Petro, Joe, petroj@cotf.navy.mil
Petruy, Willie, wpetruy@erols.com
Polmar, Norman, wordsmh@msn.com
Ramsey, William F., wramsey@kendaco.telebyte.com
Randrup, Peter, hardhead@erols.com
Randrup, Peter, hardhead@erols.com
Rawlins, Bob, logedit@metro.net
Richard, Park, parkr@juno.com
Ruddy, Chuck clruddy@ccgate.hac.com
Runne, Robin, runne@umpire.com
Samples, Dave, dsamva@aol.com
Schlitz, John, JOHN_SCHLITZ@AMS.COM
Schlitz, John, John_Schlitz@amsec.com
Schmidt, Steve, schmidts@nosc.mil
Schmitt, Steven, schmitt_sr@nns.com
Schuster, Andy, shusterar@aol.com
Scott, Hugh, hpscott@aol.com
Seiwald, Michael, mseiwald@globus.com

Shearer, Jr., Oliver, oliverjr@uno.com
Shipman, Scott, shipmanj@vitro.com
Sidner, William, bsidner@mindspring.com
Siegel, Kent, ksiegel@mrosenblatt.com
Silakoski, Tony, tonysx@aol.com
Stacey, John, jstacey@earthlink.net
Sullivan, W.F., WSulli7188@aol.com
VanLandingham, C.H., chvanlan@crosslink.net
VanMetre, R. Brian, rbvan@msn.com
Wadsworth, Frank, fwads@aol.com
Walker, Frank, Jr., ftwalker@msn.com
Warburton, Thomas, Thomwarburton@coregroupinc.com
Ward, Glenn, GlenHWard@aol.com
Whelan, Harry, hwhelan@aol.com

<u>Changes</u>
Bruns, John, jbruns1969@aol.com
Fatek, Bill, w-fatek@mail.idt.net
Koczur, Dan, dkoczur@globalus.com
Mandelblatt, Jim, jimm@ewaprg.com
Manning, Jeff, jmanning@eagnet.com
Parmenter, W., WParmen505@aol.com
Vellom, Lee, skipvell@dakotacom.net
von Suskil, Jim, von.suskil@worldnet.att.net
Yarbro, John, yarbro@erols.com

NAVAL SUBMARINE LEAGUE

U.S. NAVY GENTLEMEN TREAT STUDENTS RESPECTFULLY

[Editor's Note: Taken from the DEAR ABBY column by Abigail Van Buren © UNIVERSAL PRESS SYNDICATE. Reprinted with permission.

DEAR ABBY: In light of all the negative publicity given to some of the American servicemen with regard to their ungentlemanly behavior, I would like to share an experience I had recently.

I am a female American college student studying abroad at a program in Spain. Recently, three girlfriends and I went down south to the British colony of Gibraltar to sightsee. There, in a lively bar, we encountered about 40 U.S. Navy submarine men who were temporarily stationed there.

We four girls started a conversation with these Navy men centered around the men's families—they all carried pictures of their girlfriends or wives back home; some even had snapshots of their babies.

While my father may have been leery about his daughter sitting with 40 men, I felt entirely at ease. Not once in the course of the evening was there a lewd remark or an inappropriate gesture directed at us girls. After spending a few hours at this bar, we all went dancing. Again, not a disrespectful hand was laid on my friends or me. To top off the night, when we girls were ready to go back to our hotel, the entire group walked us through the dimly lit streets and saw us safely to our doorstep.

Abby, without a doubt that was one of the most remarkable nights I had in my four month stay in Europe. The U.S. Navy is to be commended for grooming its men to be respectable, honorable and chivalrous gentlemen. Thank you to the submarine crew of JAMES K. POLK.

Lora Wilson

TORPEDOING A MYTH
(Another Perspective on the Battle of Midway)

21 February 1997

Rear Admiral Metcalf has set the record straight on the lack of effectiveness of the single torpedo attack by a U.S. submarine, NAUTILUS, at Midway (**THE SUBMARINE REVIEW**, January 1997). It may be interesting to look at the enemy's viewpoint of the NAUTILUS attack, the only part played by any of the 15 U.S. submarines deployed in the pivotal battle.

As early as 1955, Captain Mitsuo Fuchia, IJN and Commander Masatake Okumiya, IJN, in Midway: The Battle That Doomed Japan wrote of the battle:

> "Some three and a half hours after the bombing attack, a new menace appeared. The flame-racked carrier [AKAGI] now lay dead in the water and had begun to list. Commander Amagi, scanning the adjacent sea, suddenly discerned the telltale periscope of a submarine a few thousand meters from the ship. Minutes later, at 1410, Lieutenant Commander Yoshio Kunisada, a damage control officer, saw three white torpedo wakes streaking toward the carrier. They seemed sure to hit, and Kunisada closed his eyes and prayed as he waited for the explosions. None came. Two of the torpedoes barely missed the ship, and the third, though it struck, miraculously failed to explode. Instead, it glanced off the side and broke into two sections, the warhead sinking into the depths while the buoyant after section remained floating nearby. Several of KAGA's crew, who were swimming about in the water after having jumped or been blown overboard when the bombs struck the carrier, grabbed onto the floating section and used it as support while awaiting rescue. Thus did a weapon of death become instead a lifesaver in one of the curious twists of war." (p. 185)

Following interviews with Japanese veterans of the battle, Samuel Eliot Morison, in his volume Coral Sea, Midway and Submarine Actions, May 1942—August 1942, (1961) wrote:

> "Commander Amagi, flight officer of KAGA, swimming near the burning carrier, saw a periscope rise above the

surface. The submarine, which has never been identified, [believed to be NAUTILUS] fired a torpedo at KAGA which hit. 'But,', said Amagi, 'it was such a glancing blow fired at such an angle that the torpedo bounced off the side of the ship and circled slightly, after which the warhead dropped off and sank, although the body of the torpedo remained floating near me... Several of our sailors clung to the floating after part of the torpedo'—a use of American torpedoes not anticipated by the Bureau of Ordnance." (p. 126)

To again quote Fuchida and Okumiya:

"Not one of the many observers who witnessed the last hours of this great carrier [SORYU] saw any sign of an enemy submarine or torpedoes. There was a succession of explosions in the carrier before she sank, but these were so unquestionably induced explosions that they could not have been mistaken for anything else. It seems beyond doubt, therefore, that American accounts which credit U.S. submarine NAUTILUS with delivering the *coup de grâce* to SORYU have confused her with KAGA. Nor, as already related, did the submarine attack on KAGA contribute in any way to her sinking." (p. 189)

An Editor's Note to this passage in the Fuchida-Okumiya book states:

"Since NAUTILUS' claim to have finished off SORYU has hitherto been accepted in all U.S. accounts of the Midway battle, the American editors (i.e., U.S. Naval Institute] have carefully reexamined the available evidence and are satisfied that it overwhelming supports the accuracy of the story as given here, indicating KAGA rather than SORYU to have been the target of the NAUTILUS attack and further indicating this attack to have been ineffectual... The Japanese battle report records no submarine attack on SORYU at any time...records for destroyer HAGIKAZE confirm that, while she was standing by crippled KAGA on 4 June, she carried out a depth charge attack on an enemy submarine [NAUTILUS]. Records for destroyers HAMA-

KAZE and ISOKAZE, which was standing by SORYU, mention no encounter whatever with an enemy submarine."

Thus, details of the NAUTILUS attack have been in print, in English, for more than 40 years. Hopefully, NAUTILUS (SS 168) can now be remembered for her many accomplishments, especially pre-invasion reconnaissance and as a commando carrier, and not for the myth of her accomplishments at Midway.

Norman Polmar

MORE ABOUT MK 14s IN LOW POWER

February 23, 1997

This letter is further to my ongoing controversy with Mr. T.J. Pelick, about production and usage of certain WWII submarine torpedoes.

I continue to disagree with his statements concerning lack of usage of the Mk 23 as opposed to the Mk 14.

I have conferred with those of my colleagues who are nearby; their qualifications and mine are listed below:

W.J. Germershausen - 9 ships, including 6 in the Japan Sea

W.P. Gruner - 5 ships, including 1CL and 1DD

R.M. Metcalf - 10 ships, including 1DD and 1SS

We agree as follows:

None of us ever fired a Mk 14 in low power.

None of us ever knew or heard of a producing skipper who chose to fire a Mk 14 in low power.

Firing a Mk 14 in low power was almost invariably a last chance, desperation shot at heavy warships that had got by at long range.

We estimate that not more than one percent of all Mk 14 warshots were fired in low power.

The development of the Mk 23 and the production of 9500 units reflected the foregoing. Deliveries to boats (i.e., the split between 14 and 23) were probably determined by base and tender torpedo shops schedules and deliveries into stock. As far as we skippers were concerned, the only choice to be made was steam or electric; we neither knew or cared whether Mk 14 or Mk 23, because we never intended to fire a Mk 14 in low power.

RADM R.M. Metcalf, USN(Ret.)

February 24, 1997

I would like to thank all those, especially Dr. Fred Milford, for his review of my articles. For example, in the July 1996 **THE SUBMARINE REVIEW**, I indicated (based on the memoirs of the developer) that the Mk 27 Mod 4 was initially developed because the Russians held the fast German Type XXI U-boats at Vladivostak and the *Navy was concerned that the Russians may enter the Korean War*.

Fred aptly pointed out that the Korean War came a few years later after initial development began on the Mk 27 Mod 4 and the Mk 34-1 torpedoes. Apparently, the developers memoirs which were recently written had a time error relative to the Korean War. However, as stated, the fast German Type XXI U-boats at Vladivostak were a driving force in the initial development of the Mk 27 Mod 4 and the Mk 34-1 torpedoes. Later during the Korean War, the Navy accelerated the development of the Mk 27 Mod 4 and the Mk 34-1 torpedo because of potential Russian involvement with the German Type XXI U-boats.

Reconstruction of events are somewhat difficult and can be subject to errors depending on the amount of available data and the source. Constructive responses to these articles are welcome if they contribute to historical accuracy. It takes considerable time to research and write these articles. Since I was not a part of the activities during WWII, I rely on documents, scientists, engineers, developers, Navy personnel, and others for some of the information. Most comments I received were favorable. There was a dissenting opinion by Admiral Metcalf on the use of low speed for the Mk 14 torpedo. Admiral Metcalf's opinion is important since it differs from the statement made by E.W. Jolie in his compendium* on torpedoes. Since it would be interesting to assess this difference, I would appreciate hearing from other submariners, especially in the late parts of WWII when there were many submarines in the Pacific. These will be added to the data bank of knowledge to ensure adequate representation.

Tom Pelick

---

* A Brief History of U.S. Navy Torpedo Development, NUSC TD 5436, 15 September 1978, by E.W. Jolie.

SUBMARINE ARSENAL SHIP AND TRIDENT SSGN

3 March 1997

I am pleased that Hank Chiles and I are in agreement concerning the viability of the submarine arsenal ship concept (January 1997 **THE SUBMARINE REVIEW**). However, I would call attention to his last sentence: "This concept deserves rigorous analysis."

I hope by that he means that alternatives of the SSN 688 and Trident SSBN should both receive rigorous analysis. Further, that analysis should not address only the technical issues (conversion, logistic support, etc.), but also operational issues (what are comparative manning costs, are more than four such undersea craft required, should the arsenal ship and special forces transport be combined in a single hull, does size affect maneuverability in probable operating areas, etc.).

The arsenal ship is a viable concept and the stealth feature of submarines—albeit acquired at a high cost—could be attained through conversions of existing submarines that would otherwise be retired. Such conversions, however, must make use of the optimum platform.

Sincerely,
Norman Polmar

THE FURHER LED, BUT WE OVERTOOK HIM

by Phil Durham
Published in 1996
The Pentland Press, Ltd.
1 Hutton Close
South Church, Bishop Aukland, Durham
ISBN 1-85821-365-7
Price £16.50
Reviewed by CAPT W.J. Ruhe, USN(Ret.)

The Fuhrer Led is an account of a British Royal Navyman's charming memories of the Second World War. It is not a run-of-the-mill submarine book. But amongst his many adventures on surface ships as well as submarines, including the U boat GRAPH, there are sprinkled the wartime activities of submarines of many different countries. These are doubly interesting because his observations compare them to the British and German submarines he served in. For example: when this tiny British submarine STOIC arrived in Freemantle, West Australia, "the U.S. submarines there were four times our size and half as fast again, contained cabins for officers' showers, and they even held cinema shows in their fore ends, at sea. Their most junior rating received a higher rate of pay than our most senior CO, a commander."

His subtle humor delightfully pervades much of this book. When his Commodore advised the officers of the battleship BARHAM, in which he was an 18 year old junior midshipman (a "snottie"), to take regular exercise, Durham writes: "by which he did not refer to weight lifting, glass by glass."

His poetic descriptions of the environment in which he was serving are gems. When he spent the winter of '39-'40 in the cruiser NORFOLK operating close to the Arctic Circle, he reflects that: "My lasting memory of the first winter of the War was of greyness; grey paint, grey seas, grey skies, grey clouds, grey dawns and grey dusks—a monochromatic world with variations of shade and tone but never of colour."

Durham also has piercing insights. When operating with the Battle Fleet he reflects: "Yet the days of these great, old battleships, vast armoured gunforts, pachyderms of the ocean, unmanoeverable, wet at sea and capable of just over 20 knots when all 24 boilers were at full steam, were drawing to a close."

This is a book of colorful adventures which show that the naval profession can be about the most exciting job a young man can enjoy. But let's get on with Phil Durham's doings and let the reader of this book review decide what position on his bookshelf he'll assign this book to.

From the battleship BARHAM he was transferred to HMA/S trawler BERYL as her second: "Coal burning and slow, it was commanded by an Asdic bosun, a warrant officer specialized in what is now called Sonar." Later, the trawler MOONSTONE captured intact an Italian submarine in the Red Sea and BERYLE sank a U-boat while patrolling the entrance to Grand Harbour in the Malta siege. "This was much better than life in an overcrowded battleship gunroom. It was clear that discipline did not depend on shining white uniforms and salutes."

Shortly he went to the 10,000 ton cruiser NORFOLK where while sleeping in a hammock slung in a passageway he "heard a loud explosion 200 yards on the port beam, followed by a second in our wake. No source of the explosions was evident. But later, Lord Haw Haw, the German propagandist, incorrectly reported that a U boat near Orkney had sunk a County Class cruiser. Premature firing of magnetic torpedo heads was a familiar problem to both Germany and Britain then and later."

Durham also describes his surroundings at the edge of the icepack near Iceland: "Lit by a few minutes of the recently risen and already setting sun, two pink ethereal snowy Icelandic mountains floated, only to fade again as though they had never been." And, (near Greenland) "the wind blew up from gale to hurricane, with jagged roaring foam-streaked white topped breakers, superimposed, and often combining with the swell, riding down and crashing about the ship."

You can see why I like this man's writing. It's full of the drama that is found while serving on or under the sea.

In early 1940 he was in the destroyer ECHO in the middle of the battle for the Norwegian port of Narvik. Because of the continuous air raids "ships ceased anchoring in harbour, but instead kept slowly steaming up and down, often just drifting, but always ready to give a burst ahead on the engines if necessary (to avoid the bombs dropped from high altitudes). Most bridge watchkeepers suffered *Narvik-neck* from too much looking up and sky scanning. A Norwegian youth in idiomatic English said he'd seen a black painted submarine flying a Norwegian flag steaming south that morning. But there'd been no radio message about this friendly sub's movements. The airwaves were too cluttered by fighting in Holland and the North Sea to justify transmitting the signal on the air."

Before leaving ECHO she was ordered to search for survivors of the ARANDA STAR, torpedoed by Gunter Prien whose U-boat had earlier sunk ROYAL OAK in Scapa Flow. "On reaching her lifeboats we steamed into clarts of floating, black, viscous oil, with small pieces of cork, wooden barrels and spars and numerous life jackets, many of them supporting lifeless bodies."

Then he reported to the 32,000 ton battle cruiser RENOWN, with "torpedo duties". And from there he, as a sub lieutenant was ordered to shore schooling in HMS VERNON where he suffered through German bombings night after night. On one raid "two incendiary bombs of molten magnesium set the roofs of houses, a church and a cinema ablaze." But Durham and a pal contained the blazes and had the movie theater crowd evacuated. Then, "we reached another burning house from which a tearful woman dashed out, who screamed: 'Get Gramma out. She's in the shelter and won't come out.'" But my pal dashed into the corrugated iron shelter "and emerged from the blazing house with a spluttering, screaming, kicking indignant old lady over his shoulder. The sight was unforgettable."

From school he reported aboard the destroyer LAFOREY in mid '41 as Gunnery Control Officer. His ship, with much submarine *ping time* joined a huge force at Gibraltar going to the rescue of a beleaguered Malta. "We were part of the 18 destroyer escort round the battleships PRINCE OF WALES, NELSON, and RODNEY and the carriers ARK ROYAL and ARGUS, plus several cruisers and nine merchant ships." Suffering the sole loss of a merchantman after countless bombing attacks, Durham's destroyer entered Malta's Grand Harbour where "The shores were lined by a waving cheering mob," while, "There were deep gashes of bomb damage in the familiar skyline." On the way back to Gibraltar "someone clambered down the ladder and shouted "ARK's been torpedoed." The carrier ARK ROYAL was sunk off *the rock* on 13 November 1941.

There were more epic stories of heavily escorted convoys punching their way to Malta, with the carrier EAGLE sunk by two sub-fired torpedoes on one operation. Additionally there were several ASW actions by LAFOREY acting as an escort. "Early in December, while with a convoy, the first *Woolworth* (a dime store escort) carrier, HMS AUDACITY was sunk by a U-boat west of Gibraltar. But the escorting destroyers succeeded in sinking no less than five of the U-boats against which her aircraft were offering protection.

Later, half asleep, Durham heard "Alarm starboard, all guns load with SAP." Then a searchlight pierced the gloom to reveal a U-boat rolling heavily, beam on to the swell. Men were climbing over the submarine's conning tower onto the deck where they clung unhappily. HESPERUS, whose depth charges had blown U-93, a large Type IX U-boat to the surface, tried to board her. Alas, before reaching her prize, its bow sank and it slid below the waves, tipping a struggling mass of humanity into the water. With heaving lines and rescue nets LAFOREY and HESPERUS saved 16 men. Of the remaining 30 of her crew there was no more to be seen."

Towards the end of LAFOREY's commission, a monkey was brought aboard when LAFOREY helped to take Diego Suarez in Madagascar. Then, on a final convoy operation to Malta, Minnie the monkey who was given the usual *tot of rum* to soothe her nerves during a bombing of the ship, "was discovered cowering in a dark corner, her teeth chattering and on the verge of hysteria. The shots of rum took their ultimate toll with Minnie suffering from alcohol addiction, eventual DTs and a drunken death."

With the approval of Durham's request for submarine duty, he was first granted leave "to await the metamorphosis from hunter to hunted" then, having missed a three month submarine officer's training class, he was assigned to L-26, a First World War boat, until the next class convened. But those plans were shortly canceled along with his basic schooling and he was assigned to GRAPH, the captured German Type 7C, U-570. It was of the same size, 750 tons as the S class British boat in which he'd first served for a few months. However, the U-boat while making the same speed submerged (8 knots), could make 19 knots on the surface with her MAN supercharged diesels. Her 7/8 inch hull gave her twice the diving depth (600 feet), she carried twice as much fuel oil with some outside the hull and had far greater range than the coastal S-boats. She had only 1/3 the water supplies and "her seamen and stokers slept in any corner of the deck they could find." GRAPH had six torpedo tubes (one was aft with a reload) and carried 14 torpedoes. Her main ballast tank vents were operated from the control room by 90 foot long shafts. Her 88 mm deck gun had watertight binocular sights and she housed two periscopes, a *patrol* scope in a well and an *attack* scope at which the skipper sat, high above the control room deck. With a quarter of the reserve buoyancy of British boats, GRAPH on the surface "bucketed about so violently that it was not possible to stand or move without holding on." Thus, "when running in a pooping sea, the sea gurgled over and swirled us up till we (the bridge watch) were hanging face down, moored by our harness lifelines, high above the deck of the bridge. As we swung to and for, I looked up at the surface of the water, green and sparkling several feet above." And, "Controlling depth in rough weather left little margin between the Scylla of breaking surface and the Charybdis of dipping the captain (on the periscope)." Scylla in Greek mythology was a nymph turned sea monster while Charybdis was the daughter of Poseidon who when thrown into the sea spewed destructive whirlpools--both being grave threats to Odysseus.

GRAPH was planned to infiltrate a German wolfpack and torpedo a few German U-boats before the deception was recognized by Admiral Doenitz. But her one northern patrol proved to be her last since she was forced to go into refit because of the fragility of her aluminum MAN diesels (that were remarkable for being reversible). Durham was hence transferred in July '43 to STOIC, a newly commissioned S class submarine.

While dry docking STOIC, preparatory to joining an operating flotilla of submarines, Durham tells of a British Navy yard experience somewhat similar to one I had in 1943 (with U.S. shipyard workers when with SEADRAGON). Durham's experience, I feel, justifies his version. "Waiting on the jetty to position the large timber supports of the narrow-keeled circular-hulled boat, were about 80 dockyard maties. They were not an impressive sight, lolling against bollards, some playing cards, others reeling about drunk and only about a dozen showing any signs of helping to tow the floating supports into position. On the fore casing our crew watched in frustration and requested permission to help. But they were told that any move to assist and the whole squad (being paid double for overtime) would down tools and walk off on strike. With over twice as many available as were needed to do the job, it took twice as long as it should. So much for working hard for *Victory in November 1943*, as the posters urged."

At New Year of 1944 STOIC was on her way to the Far East to join the British forces fighting in the eastern Indian Ocean. After two uneventful patrols in Malacca Strait, on her third off Penang she bagged on 12 June 1944 the 1130 ton KAIWAN MARU and "returned home, entering harbour proudly flying a Jolly Roger."

A month later Durham returned from leave to find STOIC sporting "an experimental camouflage, with three triangles of darker green paint (darker than the overall green painted hull), smaller ones on fore and aft casing and a bolder one with its apex at the top of the conning tower, designed by the artistic third hand of SURF. A practice attack on STORM, similarly camouflaged, found her silhouette so broken as to make estimations of her course far more difficult, resulting in adopting this camouflage for all boats in the flotilla."

When a junk was boarded near Penang (while trying to control the carrying of cargoes to the enemy) "out from below popped the Chinese crew for all the world like rabbits fleeing a ferret, while perched on the fallen sail, a scraggly hen, alarmed by the commotion, clucked anxiously." (This hen, like the one on CREVALLE in my War in the Boats, later produced eggs for selected STOIC crew members.)

Then STOIC went to Freemantle from which she did a 35 day patrol in the Java Sea "not without success." Between patrols "the zest to fight The Battle of Perth soon began to hazard the Battle of the Java Sea. But with the threat of cancellation of night leave things rapidly improved."

On 16 December 1944 STOIC torpedoed SHOEI MARU in Sunda Strait. "Two loud explosions range out in quick succession. Jock took off his earphones to rub his ears ruefully. We had hit. We heard a couple of thumps followed by a distant metallic rumble, almost certainly breaking up noises caused by the collapse of ship's bulkheads under pressure during the descent to the bottom, sounds quite distinct from the volcanic rumblings we had become accustomed to in the Sunda Strait area. Before it was even dark, we departed the area and headed west towards Britain after receiving a final congratulatory signal from the U.S. admiral."

In April 1945 he "joined a party for U-boat surrenders." And on 8 May, VE day, he took over U-248, a submarine like GRAPH but with a snorkel. He noted that "Our nostrils were assaulted by a nauseous stench of rotting food and stale urine (up forward) resulting from their method of gash (garbage) disposal by gathering it to load into an empty torpedo tube, then firing out the contents with a charge of compressed air. The inevitable spillage had been left to rot."

To celebrate VE day, he was given U-776 to sail up to Westminster Pier to allow visiting by so many interested in seeing a captured U-boat that "it became clear we were involved in crowd control as well."

As a finale to his book, Durham noted that "while waiting for the *perisher* which would qualify me for my own (British) submarine command" he could wind down in DOLPHIN, the Portsmouth, England submarine base. He concludes: "Seeing the works of the Lord and his wonders in the deep during the Second World War had not proved unenjoyable while it lasted." A conclusion agreed with by the SubVets of WWII whenever I meet with them.

This is an outstanding, highly literate story of a truly observant and poetic submariner about his experiences which pretty well cover the entire gamut of *ship operations* during *the Great War*.

<u>SPY SUB</u>
by Roger C. Dunham
Naval Institute Press
Annapolis, MD
1996
ISBN 1-55750-178-5

Reviewed by Rich Lanning

<u>Spy Sub</u> is touted as a completely true spy thriller of a still classified hunt for a Soviet submarine. While the plot is certainly plausible, the veracity of this claim will be left to the reader to determine. The reader should not expect a technical thriller of the caliber of Tom Clancy or the riveting style of Michael Crichton. Nor should the reader expect to learn any great secrets about submarine operations or technology. The time period in which this story unfolds is during the turbulent '60s. What limited technology that is revealed is certainly dated by today's standards

but still makes interesting reading, especially considering the time period. What the reader will be given is a well written account of what life is like onboard a nuclear submarine.

The central premise of the novel is the search for a sunken Soviet Echo class nuclear submarine by a very unique U.S. nuclear submarine. A submarine that at one time was configured to carry and deploy Regulus cruise missiles. The author, an alleged crew member, chronicles his career from leaving Submarine School and reporting onboard USS VIPERFISH to his leaving the service. While the real name and hull number of the actual U.S. submarine used on this purported mission have been changed, as well as the names of the crew, the book does contain an assortment of photographs of what, one has to assume, is the actual ship and her crew.

The author has done an excellent job of providing a vivid and accurate portrayal of the human element of being deployed on a nuclear submarine. Anyone who has spent time in a submarine at sea will relate to the events depicted and soon find themselves reminiscing about their own experiences. You can hear the alarm bells ringing, the creaking of the boat as it descends into the depths, the clanging of water-tight doors; you can smell the tell tale odor of the submarine, the aroma of fresh bread baking in the galley; and lastly you can sense the fear, boredom and frustration experienced by these sailors. This book describes the nuclear submarine world in a manner similar to how Das Boot described the diesel submarine environment experienced during World War II. One can easily see how, psychologically, little has changed between the lives of modern nuclear and World War II diesel submariners.

The book does tend to diverge from the main story line a little in its overly heavy focus on the Vietnam War. There is little relation between the war and the ship's ultimate mission. Only until close to the end of the book is the reader afforded some understanding of why so much emphasis was placed on the Vietnam War. While the author portrays himself in the book as a patriotic supporter of the war, one can sense from the writing that this may no longer be the case. At the very least, troubled reflections on the war by the author are apparent.

A great deal of time and effort is expertly devoted to developing the story line around the first mission of USS VIPERFISH. The reader will find it difficult to put the book down. The common saying that submarine life is days of boredom interrupted by moments of terror is adroitly validated. Unfortunately, the second and potentially more interesting mission is basically glossed over leaving the reader with an almost anti-climatic finish. There are a great many questions left unanswered. The one absorbing point at the end is the graphic portrayal of the power Admiral Hyman G. Rickover wielded at this time.

For those desiring to expand their knowledge on submarines or attempt to verify/clarify some of the details provided in the book the author does furnish a source list. The references listed would make interesting reading in and of themselves. Not surprising, the vast majority of the references are copyrighted pre-1990s.

The book is very easy reading, almost completely devoid of technical jargon and the rash of acronyms one would typically expect in a military related novel. This book can be read and enjoyed by even those with no military background. It would certainly be recommended reading for the loved ones of sailors trying to understand what it is like to spend months at sea in a submarine. Be forewarned the book, at 222 pages, is a little expensive but well worth it.

RUSSIA'S ARMS CATALOG—NAVY

Edited by Nikolai Spassky
Military Parade (Moscow)
Order from ZIGZAG Publishing Group (New York)
(212) 725-6700 Fax (212) 725-6915

Reviewed by Norman Polmar

If you have ever wondered how the torpedo loading hatch opens on a Russian SSN, or how the Russian MG-74 self-propelled sonar countermeasures system works and what its characteristics are, or how many weapons are carried by an Akula class SSN, then this book is a *must* for you. This is an unclassified catalogue of the Russian Navy's submarines, surface ships, aircraft, wing-in-ground-effect vehicles, missiles, torpedoes, sonars, fire control equipment, communications gear, coastal; defense weapons, and even swimmer weapons.

The book is one of a series of seven so-called catalogues being published in 1996-1997 by the Military Parade organization. The firm was previously known for its excellent, slick paper magazine Military Parade. The high quality of that journal was atypical of Soviet publications, which were always known for their grainy, third- or fifth-generation photos.

Like Military Parade, the NAVY volume of the catalogue series is inundated with crisp, color photography, drawings of ships and other systems (although the drawing of the Typhoon SSBN is inaccurate), and several *how it works* drawings of torpedoes, countermeasure devices, and mines.

Each entry is accompanied by a brief discussion text and characteristics. The several descriptions of ASW weapons, torpedo countermeasures, and submarine weapons and systems should be of particular interest to Submarine League members. The torpedoes that are described in NAVY are carried by submarines, surface ships, and aircraft; they are:

- 53-65K acoustic homing torpedo
- APSET-95 acoustic homing torpedo
- SAET-60 acoustic homing torpedo
- SET-40 acoustic homing torpedo
- SET-65 acoustic homing torpedo
- TEST-71M wire-guided acoustic homing torpedo

There are, obviously, other torpedoes in Russian naval service. Still, these weapons—described by text, cutaway diagrams, characteristics, and operating diagrams—are representative of Russian torpedo technology. One assumes that these weapons are also for sale to other nations. However, that statement is not universal for the book's entries—it is highly unlikely that any nation could purchase a Typhoon SSBN or Kirov class nuclear battle cruiser.

The more interesting entries include the swimmer (ie., SEAL weapons) and anti-swimmer weapons, and the vast array of electronic and fire control equipment described in the book.

The breadth and level of coverage is unprecedented for an unclassified publication. Produced by Military Parade magazine—the glossy journal of the Russian military-industrial complex—NAVY was prepared under the *general supervision* of Fleet Admiral Felix Gromov, the Commander-in-Chief of the Russian Navy, and a board of 16 senior, active duty naval officers.

The book does have flaws, the major one being that most of the items described have their Russian project numbers or names and not their U.S.-NATO code names. And, of course, this is a catalogue and not a reference book like Combat Fleets or Jane's Fighting Ships; thus NAVY does not contain data on new ships and aircraft not yet in the fleet, nor does it provide order-of-battle numbers. Further, the $495 price tag places the book beyond the reach of most individuals. However, it should be on the shelves of all major commands and offices where the Russian Navy is a topic of discussion.

(The other volumes in the series are: ARMY, AIR FORCE, and PRECISION WEAPONS AND AMMUNITION, published in 1996-1997; the volumes STRATEGIC MISSILE FORCES, AIR DEFENSE, and MILITARY SPACE FORCES will be published later this year.) ■

MEMBERSHIP APPLICATION

Individual Membership Rates:

Regular (including Retired Military)

☐ 1 year	$25.00
☐ 3 year	$68.00

Active Duty, students, and naval Reserve Active Status (Drilling)

☐ 1 year	$15.00
☐ 3 year	$41.00

Life Membership Rates: (ALL)

☐ 34 years and under	$585.00
☐ 35-50 years old	$475.00
☐ 51-65 years old	$320.00
☐ 66 years and older	$175.00

Corporate Membership

1 - 50 employees	$ 400.00
51 - 100 employees	$ 800.00
100 - 500 employees	$1,200.00
over 500 employees	$1,600.00

Donor/Corporate Contribution

(in addition to dues)

☐ Patron	$1,000.00
☐ Sponsor	$ 500.00
☐ Skipper	$ 100.00
☐ Advisor	$ 50.00
☐ Associate	$________

Persons residing outside the U.S. please remit an additional $15.00 per year for mailing costs

The Naval Submarine League is a tax-exempt, Virginia not for profit corporation.

Two-thirds of Memberships Dues and 100% of donations are tax deductible

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

MEMBERSHIP APPLICATION

Date ____________________

I hereby apply for membership in THE NAVAL SUBMARINE LEAGUE. I certify that I am a citizen of the United States or a citizen of an allied country ____________________

____
Signature

Name ____
Rank, Service, if applicable

Address ____

____

Phone (Business) ____________________ (Home) ____________________

Employer and Address ____

____

____

Position/Title ____

I was introduced to the Naval Submarine League by ____________________

ENCLOSED MONIES

☐ __________ Membership Dues

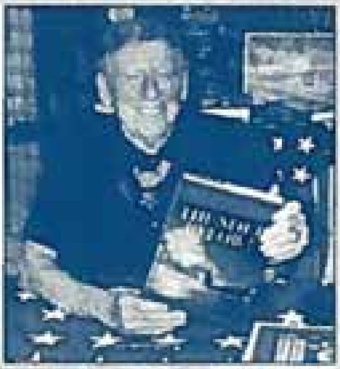
☐ ______________ Donation

See Reverse Side for Rates

Your membership will bring you ....

* The Submarine Review
* Avenue to keep current on submarine issues
* Ability to contribute to public awareness of submarine capabilities
* Association with a dedicated group of people
* Invitation to Annual Meeting
* Forum for Exchange of thought on submarine matters

In command of the USS *Barb* for five Pacific War Patrols.



At the VJ Day + 50 Ceremonies

Admiral Eugene B. Fluckey, USN (Ret.) shown autographing his best seller, ***Thunder Below*** at VJ Day + 50 in Pearl Harbor. Awarded the Congressional Medal of Honor and four Navy Crosses, he was chosen as the speaker for the U.S. Navy in World War II and introduced President Clinton at these Ceremonies. Steven Spielberg now has the film rights for *Thunder Below*.

Admiral and Mrs. Eugene Fluckey invite you for an Old-Fashioned Southern Thanksgiving on The Mississippi Queen.

Margaret and I look forward to having you join us as we follow Mark Twain and the wake of the USS *Barb*'s ensign up the Mississippi River. We cruise to Vicksburg past stately Antebellum plantation homes that escaped the ravages of the War Between the States and then enjoy the two jazz-filled nights in the French Quarter where the "Saints go Marchin' in"

November 23-December 2, 1997

For information about our Cruise or my book *Thunder Below*, write or call.

TRAVEL ANYWHERE
237 Saint James Place
Philadelphia, PA 19106
APT Member

(800) 998-7058 • (215) 923-4300

NAVAL SUBMARINE LEAGUE
P. O. Box 1146
Annandale, Virginia 22003

NON-PROFIT ORG.
U.S. POSTAGE
PAID
PERMIT NO. 106
LUTH/TIM, MD.