THE

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FROM THE PRESIDENT

Our effectiveness as a Submarine League depends to a great degree on the support and interest of its members and whether the members strongly identify with the League's objectives. As we enter into the GLASNOST era with a public euphoria that the cause of peace may be soon in hand, it may be difficult to fervently espouse the need for a strong, capable and modern submarine force. However, many of us remember several euphoric periods over the last forty-five years which were overtaken by the stark realism of political and/or economic realities. And so it goes .....

During periods of relative social calm, we have been blessed with patriots who could see the need to maintain and modernize our submarine force. This was not an easy calling at any level, be it R&D, technology application, or in architecture and construction. A far easier course would have been to submit to the budgetary and naysayer excuses for "holding the line" or "squarely face the austere budget realities." In spite of a morass of odds, a steady, firm and inspirational course was, and will again be, set and followed. I sincerely believe the Naval Submarine League helps, in a positive way, to set this difficult but necessary course and to shed some light along the way. But we must be prepared to do more. The struggle has only started.

Currently the NSL has five very active chapters which are continuously fine tuning their efforts to find their proper role in support of the League's more global objectives. Each of these chapters were the product of a few dedicated "spark plugs" at each location. Many helped with the chapter formation, but the spark plugs were members such as Bill Purdum, Jack Williams, Dan Heflin, Bob Gautier, Dick Tauber and Henry Palmer. These individuals took the chapter support package furnished by Headquarters, knocked on doors, scheduled meetings and just got things "rolling." Today we have NSL member concentrations at Charleston, Hawaii, Kings Bay, and Northern California which could adequately support NSL chapters. All that is needed for these new chapters to become realities is for a "spark plug" to step forward in each area and be willing to donate some of his/her time. The effort and tax on an individual's time is not that great and the reward of self-satisfaction in helping the submarine force is long lasting. Our headquarters team will supply resources, material and advice. We just need you to step forward and take charge. Please consider this as your contribution to ensuring our submarine force is prepared to respond to the next and inevitable challenge. As a goal, we need to develop two new chapters each year.

Finally, I wish you all good health and fortune in this New Year. We are very blessed to live in this wonderful country with our constitutional freedoms. We each need to be dedicated to making a continuing contribution in keeping our nation free, strong and vigilant. The challenge of the 1990s is upon us.

Al Kelln

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NUCLEAR SUBMARINES THE ESSENCE OF SEA POWER

Nuclear submarines, both strategic and attack, by complementing their long range weapons of great destructive power, have become the essence of a nation's sea power. Their excellent mobility and their stealth provide a fine control of the tempo of their operations and an assured element of surprise in their attacks. This insures a high level of efficiency in weapons delivery. Their guarantee of accurate and great firepower thus offers greater dimensions of military and political effects than realized in the past.

Moreover, the prime role of sea power is now to project power against the shore rather than to control the seas, as in the past. And, the nuclear submarine has apparently become the "capital ship" of major navies -- the major and essential element of a country's sea power.

Sea Power Today

The military aspect of sea power has changed radically since that identified in World War II. Then, sea power's basic role was to control the air over the seas and thereby through air power control the surface of the oceans as well. This also included a control of the threat posed by submarines, which in

WW II were fundamentally submersible surface ships which had to operate for the most part on the surface or very close to the surface of the oceans. This was evident in the Atlantic campaign against the German U-boats. When sea based air was able to cover the mid-ocean portion of convoy transits, the U-boat campaign against merchant shipping became unprofitable and U-boat losses soared. In the Pacific, U.S. submarines, operating well offshore, were little bothered by the threat of Japanese aircraft and hence control of the air over the oceans was generally lacking. Only the ASW aircraft over convoys contested the control of the seas near the protected shipping. Thus, the essence of sea power's potential was demonstrated by a control of the seas through the use of naval air power.

But with the advent of nuclear weapons, long range missiles carrying either nuclear or high explosive warheads, nuclear power in submarines, computers and satellites for communications, navigation and surveillance, the primary role of military sea power was changed. The projection of power from the seas against enemy shore objectives had become the true essence of naval sea power -- for realizing vital national political objectives. While control of the seas had become only a secondary function -- which because of today's technology was necessarily reduced in scope, i.e., control of a limited area of the oceans for only a limited period of time, sufficient to carry out a mission successfully.

Shortly after WW II and with the advent of nuclear weapons, the Navy shifted the prime role of the attack aircraft carrier to one of threatening the use of nuclear weapons to destroy an enemy's homeland assets. The carrier's attack aircraft, carrying nuclear bombs, became part of the U.S. Strategic Integrated Operations Plan, the SIOP, along with U.S. ICBMs and land based B-52s carrying atomic bombs. Clearly, deterrence of nuclear war had become sea power's prime political objective. But the range of sea based aircraft-delivery of strategic weapons was so limited that only a small portion of an enemy's homeland was likely to be covered by sea based aircraft. Then, with the advent of the nuclear powered submarine and its marriage to the long range nuclear-warhead ballistic missile, not only was greater assured naval delivery of strategic weapons achieved, but also the coverage of strategic objectives was increased, until today SSBNs can provide blanket coverage of the total economic base of an enemy as well as its civilian population. This capability has made the sea based leg of the strategic TRIAD the most important element in the U.S. deterrence posture -- particularly because of the system's survivability against an enemy surprise nuclear strike and its assured, discretely timed response.

In addition, the nuclear submarine's use of nuclear-tipped cruise missiles of long ranges, promises a theater land-target interdiction capability which tends to deter an escalation in the use of nuclear weapons in a ground war -- another increased dimension to sea power resulting from new and recent technologies.

Still another expansion of a nation's sea power used against the shore comes from the nuclear submarine's excellent capability for interdiction of shipping used in support of shore economies, war-making industries and supply of ground armies. In fact, the interdiction of ships on and under the entire area of the World Ocean, because of the virtually unlimited endurance of the nuclear submarine, has extended the battle ground for the use of sea power worldwide, including the new sea area of the Arctic Ocean.

How nuclear submarines respond to the changed character of sea power can be illustrated by how their capabilities are utilized in the pursuit of national interests.

Submarines in the Projection of Nuclear Power

The greatest change in the character of sea power has been the achievement of naval capabilities for projecting vast amounts of weapon power -- measured in many megatons -- from the seas against all of an enemy's homeland assets. Today the ranges of this projected power approximate at least ten times that for carrier based aircraft, and more than 200 times that for a battleship's 16-inch guns. Nuclear submarines (SSBNs) with very quiet, deep, and low speed operations, tend to remain extremely covert until the time of actually firing their missiles. Since SSBNs, operating in a deterrence mode, need not take any overt actions, they are extremely survivable while waiting for a firing order from a National Command

Authority. Then, with an order to use all or some of their missiles, SSBNs can produce a controlled time of weapon release which is unpressured, well clear of threatening enemy ASW operations, and likely to be unopposed at least for the duration of missile launch. With ballistic missile mid-course speeds of over 7 mach and with the payload of each missile splitting -- in the terminal phase of flight -- into many independently maneuvering reentry vehicles (MIRVs) carrying individual warheads of fractional megaton weapon power, the SSBN's strategic weapons are virtually assured of an arrival on target. This is such a foregone conclusion that the U.S. and the U.S.S.R. signed an anti-ballistic missile treaty in 1981 which eliminated possible defenses against such a weapon system. Significantly, the inevitability of ballistic missile success is virtually assured, even in the environment of nuclear bursts in an ongoing war.

Strategic ASW, which some believe would compromise the SSBN as a viable strategic system, has become a mission for mainly nuclear submarines. This mission is against SSBNs in bastions particularly under the Arctic ice cap or against very quiet SSBNs patrolling in the vast reaches of the oceans. In the first case, the protection of SSBNs in their bastions using perimeter defenses of mines, diesel-electric submarines and air ASW systems plus in-bastion protection by SSNs, seemingly makes the prosecution of strategic ASW by friendly SSNs too lethally costly for the number of enemy SSBNs that might be destroyed. Similarly, very quiet SSBNs operating in large areas of the oceans should be too difficult for enemy ASW forces to detect and attrite as to make the great numbers of ASW units needed for such a campaign -- to get only marginal results -- virtually out of the question.

With the deployment of torpedo tube launched, nuclear-tipped land attack cruise missiles of long range, every nuclear attack submarine (SSN) becomes a potential strategic as well as theater weapon system. Specifically, the U.S. has the nuclear land attack TOMAHAWK and the Soviets have the SS-N-21. These submarine-launched nuclear land-attack cruise missiles are under 2,000 miles in range, as for example, the nuclear version of TOMAHAWK (the TLAM-N) with its 1500 n.mi. range, Tercom navigation and scene-matching terminal guidance. SSNs are armed with this type of weapon for use against theater targets which support a major ground battle and also have the reach to attack many enemy homeland targets as well. For example, in the Kola Gulf area of the USSR, the TLAM-N might be used against Soviet shipyards, submarine bases, and airfields used by ASW aircraft, while theater targets would comprise battlefield concentrations of men and materiel, command and control and communication centers, arteries for resupply of embattled forces, etc.

In effect, nuclear attack submarines, armed with nuclear land-attack cruise missiles, add an important form of projected power to theater warfare. Significantly, SSNs are as likely to be as survivable and capable of using nuclear weapons with a high degree of surprise as SSBNs.

<u>Deterrence of Nuclear War</u>

So assured has been the SSBN's potential for vast destruction of an enemy's homeland population and war-making activities -- and this would include the small SSBN fleets of France and Great Britain -- that a World War III has been successfully deterred for nearly half a century.

If SSBNs are conserved as a fleet-in-being during a conventional war, their threat of colossal destruction serves not only as a means for concluding a conflict on favorable terms but also tends to deter the escalation of a major war to one using nuclear weapons. It is the mere presence of these modern-day undersea "battleships", the SSBNs, which amplify the political advantages accruing to a nation having this form of dominant naval power. They pose a constant threat to an aggressor who must realize that nuclear retaliation from nuclear submarines at sea is so certain as to cause an enemy to refrain from fighting a nuclear war.

<u>Interdiction of Shipping, Globally</u>

Large numbers of nuclear attack submarines are available to the major sea powers for preventing the flow of sea traffic on the oceans. Whereas shipping interdiction in World War II was confined for the most part to the North Atlantic and North Pacific, today a global dimension of submarine sea power is required to win a shipping attrition war -- and nuclear submarines with their virtually unlimited endurance provide this.

In World War II, "there were 25 Allied ships and 100 aircraft for each German submarine" -- Admiral Gorshkov's oft repeated statistic. On this basis, today's stealthy nuclear submarines, which are far more difficult for enemy ASW forces to combat than the diesel boats of WW II, and which would operate in considerably greater areas of the oceans, should easily exhaust all enemy ASW resources mustered to destroy them. Only friendly SSNs deployed against anti-shipping SSNs are likely to significantly reduce shipping losses. Moreover, the traditional concept of convoying ships is less viable today because of the submarine launched cruise missile and the long-range "smart" torpedo. A Soviet strategist notes that "nuclear submarines using cruise missiles can deliver attacks against strong screening ships without entering the zone of effective anti-submarine defense" -- thus achieving a temporary and limited measure of sea control over the waters close to a convoy, in order to successfully carry out the anti-shipping mission.

Think about it. The limited radius of action of sea based ASW aircraft, the short range of ASW warship efforts, and the greatly decreased ranges of detection on stealthy nuclear submarines now make the maintenance of a viable sea commerce most unlikely unless friendly SSNs can attrite large numbers of enemy SSNs before they arrive at the shipping lanes -- and this is the major strategy for U.S. attack submarines in war.

Might nuclear weapons be used in an antishipping war? Probably not, since the Soviets see the use of their tactical nuclear weapons as only against major targets, while the U.S. limited stockpile of similar weapons appears to dictate a discreet usage.

Today the West has many thousands of merchant ships to support their economies and war making efforts while the Soviets have a flag fleet of merchant ships which is second in the world in total number of ships.

The likelihood, then, that decisive results, good or bad, might come early in an antishipping campaign conducted by nuclear submarines seems much better than in the past. Enemy SSNs are either attrited at the beginning of a war successfully, or the great damage they would do to shipping should be in itself decisive.

Fleets (identified by the U.S. as battle groups) have traditionally done battle with similar fleets to contest control of the seas. But this would not be the case today. U.S. battle groups are faced by mainly a Soviet "fleet" of nuclear submarines and land based naval aircraft. The changes in the character of sea power which this dichotomy of fleets suggests have not yet been demonstrated. But the Soviets evidently believe that their nuclear submarines will prove to be the dominant offensive force at sea -- their capital ships for destroying enemy aircraft carriers and submarines. General Sokolovskii, writing on Soviet military strategy, notes that "Before attaining completely the political and military strategic aims of the war, the striking forces of the carrier fleet and enemy submarines must be defeated."

But rather than delaying a major decisive fleet-against-fleet action -- like the Battle of Midway -- until well into a war, the Soviets have indicated that the best time to achieve a decisive fleet victory is at the very start of the war -- like at Pearl Harbor. To that end, they have espoused a "first salvo" strategy -- a simultaneous initiating of a big war with an all-out massive use of weapons against an enemy's fleets, wherever, using mainly submarines assisted by land based cruise missile carrying aircraft. As keen students of the lessons to be learned from the Japanese attack on Pearl Harbor, their use of mainly attack submarines to ensure a high degree of surprise and their doctrine to follow up massive missile strikes with mop-up torpedo operations, show their appreciation of how decisiveness against an enemy's carrier-oriented surface fleet could be achieved. More than severe damage of major fleet elements is indicated. (At Pearl Harbor only the Arizona proved unsalvageable after the single initial massive aircraft attack. A follow-up second strike, taking advantage of the shock and damage produced by the first waves of planes would have produced far more disastrous results). Also, technological innovation in the form of shallow-diving aerial torpedoes played an important part, while Japanese midget submarines proved innocuous. But the Soviets' "first salvo" today should see some forms of technological innovation -- like homing guidance of their missiles which would insure hits against carriers tied up alongside piers. The use of mines should also be expected for interdicting U.S. fleet units sortieing from ports, and competent midget submarines (well proved by their testing in Swedish waters) should be on hand for the mop-up operations.

The "first salvo" is, from Soviet writings, designed for attack on more than a single fleet -- in port or at sea. Several Pearl Harbors simultaneously!

But can Soviet nuclear submarines prove that they have supplanted attack aircraft carriers as the dominant element in a nation's sea power for non-nuclear war? Only a major war between the superpowers can resolve this question.

However, the U.S. counter to this "first salvo" strategy might be -- with warning of the imminence of a war due to large deployments of submarines -- to trigger sea war with mainly nuclear submarines fighting nuclear submarines, to forestall any concentration of submarine weapon power against U.S. carrier fleets.

Today there is a recognition that the enemy's nuclear submarines must be decimated if a significant degree of sea control is to be enjoyed either in the underseas or on the seas, and that sea control is still required for the successful accomplishment of most naval missions. The path for gaining this control is through nuclear submarines combatting nuclear submarines.

In summary, nuclear submarines are today's major ingredient in a nation's sea power for deterring war, for deterring the use of nuclear weapons in a non-nuclear war and finally in deterring a strategic nuclear war. As a fleet-in-being, the threat posed by SSBNs should help terminate a war on favorable terms. In contesting control of the seas, SSNs are the major elements for achieving sufficient sea control to successfully carry out essential naval missions or deny an enemy his mission success. Sinking enemy shipping is best accomplished by nuclear submarines which can first assure a measure of sea control in the area of antiship operations before carrying out the basic mission of shipping interdiction.

No mention has been made of the role nuclear submarines might play in third power wars or against terrorism. Unfortunately, nuclear submarines are currently limited as to what they can offer since their weapons are ill fitted for such situations. But, if cruise missiles with conventional warheads had mid-course navigation provided by satellites and with accurate terminal homing from scene-matching devices, they would prove very useful for such low level military situations.

Phoenix

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TWO TARGETS FOR THE SUBMARINE FORCE

In order to thrive in the 21st century, the U.S. Navy's submarine force must expand its vision of the future, taking into its grasp the full range of conflict. The submarine force is powerfully positioned to sweep the Soviet Navy from the seas. But now, without dropping track on the Soviet threat, it must engage a second target: low-intensity conflict (LIC). If the submarine force fails to prove its capability to hold a firing position simultaneously on both targets, it may place its future at great risk.

Is the Cold War over? Perhaps. To the extent that the quest for communist world domination fueled the East-West confrontation of the past four decades, Soviet actions have brought on a thaw. That does not eliminate the threat, however. Soviet power remains in place. At best, what we are witnessing is the return from black and white ideological conflict to the classic balance of power. The Russian bear was born well before the communist revolution, and he is still alive.

Obviously, the West's policies have been effective. Containment has kept the Soviet Union in check, forcing the amazing retrenchment we now are witnessing. Military strength is the foundation of this success, with the U.S. submarine force a crucially important element. POLARIS, POSEIDON, and now TRIDENT assured the West three decades of nuclear deterrence, while the nuclear attack submarine sealed off Soviet options in the conventional realm. We must retain our submarine superiority and carry forward the new submarine programs currently in progress to continue to hold the Soviet Union in check.

Yet the submarine force should not base its entire future solely on its contribution to the conventional and nuclear deterrence of the Soviet Union. Defense dollars are very tight, and the Soviet threat is losing its sharpness, while new threats assert themselves. If the submarine force is to have a future, it must prove itself indispensable in a future world of diffuse and complex threats. The submarine force today must heed what Bob Dylan wrote in the 1960s: "The times, they are a changing."

Future threats: Although the United States continues to contend with Soviet power, it faces new threats as the bioplar world we know is transformed by uncertain alliances, emerging power spheres, and changing economic dominations that may bring changes in the military power of other nations. The United States must cope more effectively with that swirling pot of poison made up of drug cartels, terrorists, religious fanatics, violent ethnic forces, powerful insurgencies, decaying dictatorships, and crazy rulers that crowd the lower end of the threat curve and collect under the label of LIC.

The term LIC has broad meaning in current defense dialogue, but to the U.S. Navy, LIC means peacekeeping and crisis response on a global basis. The defense establishment and the Navy in general have addressed LIC, but this mission has yet to be properly detected, tracked, and classified by the submarine force. The U.S. submarine force can deal effectively with the high-intensity threat, be it Soviet or some new powerful national force of the future. Potentially our modern submarines can also make a significant contribution in LIC. We must exploit that potential much more fully and quickly than we have to avoid having the funding rug pulled out from under the submarine force.

Let me hazard a prediction: Defense funding is about to go into freefall. As it does, the combination of a reduced Soviet threat and the unavoidable price tag shock of modern submarine programs will bring projected submarine development to a standstill, unless the modern submarine can prove itself capable across the full spectrum of violence. In a nutshell, the submarine force must get into the LIC business in a big way.

But isn't this just a parochial pitch for submarines in a world where they are now less relevant? Absolutely not.

Our submarines already have capabilities for LIC. As the ultimate stealth platform, the modern submarine can threaten and execute strike missions with TOMAHAWK cruise missiles, insert and recover special forces, conduct clandestine intelligence missions, execute mine warfare, and control coastal waters through effective anti-submarine and anti-surface operations against enemy naval forces. These operations are less subject than those of other forces to hostage situations and combat losses which potentially restrict military action. Unfortunately, some of these contributions are under-developed. Even those we do exploit are kept hidden under a security basket, where neither potential supporter nor prospective victim may know they exist. It is time to take the wraps off what the modern U.S. submarine already can and does do in LIC.

A Dual-Capable Submarine Force: The current submarine force and its programmed future are prepared for high-intensity conflict. But only a fool would think we could raise a second submarine force for low intensity. And only a bigger fool would replace the fully capable big-war forces we now have and are planning with a low-intensity force. The only way to accomplish both missions is to create a single submarine force inherently powerful in both big wars and LIC.

We need a dual-capable submarine future. How do we get it? I offer some concrete proposals. The first is absolutely essential to the success of the other -- fully accept LIC as a major submarine mission.

If the leaders of the submarine force do so, and if defense planners in general can visualize the better possibilities inherent in an enhanced submarine force designed for both large and small wars, the other proposals follow naturally:

- o Tell the public exactly what submarines can do now in crisis response and contingency operations, such as the Persian Gulf and Mediterranean operations of the last decade.
- o Continue and expand submarine capabilities in special operations through force-wide training emphasis and through developmental programs that fall in place when the USS SAM HOUSTON (SSN-609) and the USS JOHN MARSHALL (SSN-611) leave service. Work directly with the Commander-in-Chief Special Operations

Command on marrying special forces requirements with new submarine capabilities.

- o Give the TOMAHAWK weapon system in submarines an organic targeting capability in conventional land attack as rapidly as possible.
- o Review the weapon loads of submarines deploying to certain forward areas to provide greater strike capability, even at the expense of the anti-submarine warfare mission.
- o Retain the options of post-START (Strategic Arms Reduction Talks) conversion of existing ballistic missile submarines to high-capacity strike warfare platforms for LIC.
- o Buy enough submarine strike weapons to possess a robust capability in this area for LIC. Develop future submarine strike weapons with an eye toward affordability and mission needs in LIC.
- o Seek the earliest real-world opportunity to demonstrate the effectiveness of strike operations from the submarine.
- o Evaluate the existing submarine capability to defeat small diesel submarines in coastal waters, this being the most likely ASW action in LIC. Undertake the improvements in training and equipment dictated by the results.
- o Explore submarine force improvements and new mechanisms in submarine operational command, control, communications and intelligence to make assigned submarine assets fully responsive to theater and joint requirements in LIC scenarios.
- o Evaluate submarine-launched remotely piloted sea and air vehicles for organic intelligence and targeting.
- o Enlarge the emphasis on submarine operations in direct support of battle groups.
- o Develop the doctrine, documentation, and training needed to conduct effectively all types of LIC operations from submarines. Require of submarine crews the regular demonstration of skill in LIC missions. Fully address these missions in basic, advanced, and senior-level submarine training curricula.
- o Ensure that LIC capabilities are a major design consideration in future submarine programs. Review

current programs for maximum LIC contribution within design limitations.

- o Seek every opportunity to highlight, to defense planners and the public, the strong qualities of the modern submarine as a platform for LIC.

The submarine force brings to the defense table a combination of highly capable weapon systems; the stealth and endurance of the modern submarine; a proven record of technological progress; a well-trained, disciplined, and highly motivated team of warriors; and a credible position with the public and the defense leadership. Having demonstrated that they have a proper track angle on the Soviet fleet, submariners must now achieve a firing solution on the low-end threat.

The first hurdle is the toughest one: sufficiently moving aside the submarine force's preferred mission against the Soviets to develop this needed second capability in LIC. This must be done. Both the threat possibilities and the funding realities of the future will demand that the submarine force have more to offer than simply the ability to clean the Soviets' clock.

Captain John Byron, USN

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THE SUBMARINE SLCM PROBLEM

The submarine SLCM, a sea-launched cruise missile, with its unique capabilities presents many diverse problems for arms control negotiators. Because a submarine employs the SLCM, the covertness of the submarine, its ubiquitousness, its high survivability in all levels of conflict, its great mobility (particularly when nuclear powered), and its capability to control the tempo of its operations, cause this missile system to have certain military and political capabilities which are considerably greater than for the cruise missile systems used by naval surface and air units.

The problems which the submarine SLCM creates for those trying to impose limitations on its numbers and use are difficult to solve, mainly because of the asymmetries which exist between the two parties involved -- the U.S. and the Soviet Union.

The U.S. plans only limited use of the anti-ship version of TOMAHAWK, whereas the Soviets consider the long-range anti-ship cruise missile (with either a conventional or nuclear warhead) of first importance in their major sea strategies -- their "first salvo" strategy for initiating a war and their fleet-against-fleet strategy for gaining control of the seas. For the nuclear land attack mission, the U.S. stresses their nuclear-tipped TOMAHAWK for deterring the use of enemy nuclear weapons in theater warfare, whereas the Soviets have indicated that their nuclear SLCMs are in effect strategic weapons in the land attack role. Note that there is a geographic asymmetry in strategic targets for nuclear SLCM attacks; the U.S. has the majority of its strategic installations within several hundreds of miles of its coasts, whereas the key Soviet strategic targets are deep inland. Major emphasis by the U.S. is placed on their conventional land attack mission using SLCMs which are being bought in far greater numbers than other versions of TOMAHAWK, while the Soviets have shown no significant cruise missile capability for their conventional land attack mission nor have they written about its application or importance.

Other asymmetries to be appreciated are the few classes of U.S. submarines using TOMAHAWK versus the large numbers of classes of Soviet submarines using long-range SLCMs. As to the capability to change warheads from conventional to nuclear, the U.S. has no means for readily converting their conventional TOMAHAWKS to nuclear-tipped ones whereas the Soviets have indicated a ready interchangeability of warheads. Moreover, all U.S. long-range SLCMs are similar in configuration whereas the Soviets have a wide variety of such submarine-launched cruise missiles as to their sizes and configurations. Additionally, the Soviets tend to use their anti-ship SLCMs in large salvoes while expecting only a few hits, whereas the U.S. will fire only one or two missiles at a time while expecting single-hit probabilities.

If these asymmetries are properly appreciated, it seems that acceptable solutions to arms control problems may be found.

Submarine SLCMs

There are relatively few submarine SLCMs in navies of the world and only the U.S. and the Soviets possess a long-range cruise missile capability in their submarines. The short range U.S. HARPOONs and Soviet SS-N-7s are proliferated to a few additional submarine navies but are seemingly of little concern to arms control negotiators. HARPOON is a turbo-jet driven, sea-skimming, subsonic-speed SLCM which in its submarine version is fired from standard size torpedo tubes and can carry its 507-lb warhead out to about 55 miles. The Soviets' SS-N-7, on the other hand, is fired from dedicated deck tubes and has twice the warhead weight while flying only to about 35 miles. Both are conventional weapons with sufficient standoff range to be a significant threat -- like the EXOCET -- to surface ships. (The EXOCET, which sank the British destroyer SHEFFIELD in the Falkland Islands war, however, is not classed as a cruise missile, being rocket propelled for its short flight.)

The long range submarine SLCMs of the U.S. and USSR -- fitted either with conventional or nuclear warheads -- must include those cruise missiles with about a 300-mile range in their anti-ship configuration since they have far greater range in the conventional land attack configuration and even greater range when carrying a nuclear warhead. The Soviets' SS-N-12 for example, is identified as having a 300-mile range while carrying a 2200-lb HE warhead at mach 2.5 speed. When fitted with a nuclear warhead its range should far exceed the 300-mile limitation. But even if the weight of the warhead remained the same, this missile, if flown subsonically, could fly to an estimated 1800 miles. Since it is virtually impossible to distinguish between missiles fitted with either conventional or nuclear warheads when they are deployed in a submarine without intrusion into the submarine, and since there appear to be no reliable means for externally verifying the presence of nuclear SLCMs on a submarine, all SLCMs of ranges of about 300 miles must be classed as long-range missiles.

The long-range submarine SLCM for the U.S. is the turbo fan-driven TOMAHAWK. It has four versions all of which closely resemble each other in configuration: a 1550-mile nuclear warhead version for land attack, (the TLAM-N); a 290-mile anti-ship missile with a Bullpup 1000-lb warhead of high explosives, (the TASM); and 800-mile land attack missile with a conventional shaped-charge warhead (the TLAM-C); and a similar-range land attack missile with a dispensing warhead of 166 BLU-97/Bs -- shaped charge fragmentation and incendiary bomblets -- for attack on enemy air bases, runway cratering, and air defense systems. The land attack TOMAHAWKs have a Terrain Contour Matching (TERCOM) mid-course guidance system with a Digital Scene Matching Correlator (DSMAC) system for terminal homing. TOMAHAWK can be launched from standard torpedo tubes and vertical launch tubes. Ready conversion of TOMAHAWK from a conventional to a nuclear warhead is not considered to be practical at this time.

At least half of the U.S. Navy's attack submarines are equipped to use TOMAHAWK and about 1500 TOMAHAWKs are in the present stockpile. The planned production of these weapons of all versions is 3,994. To greatly increase the flexibility of TOMAHAWK use, Collins Radio is designing a navigation system using two GPS satellites to provide continual fixes for mid-course guidance. This missile guidance is practical for virtually all parts of the world and gives highly accurate geographic positioning to the missile -- sufficient to make it applicable to Third Power conflicts and against terrorist activities, anywhere.

The Soviet stockpile of SS-N-3s, 12s, and 19s is already well over 3,000 with large numbers of additional missiles being produced including the SS-N-21s and 24s. The SS-N-21 is thought to be similar to the torpedo tube launched TOMAHAWK but with only a nuclear version. It is being deployed primarily in nuclear submarines but may possibly be used from Soviet conventional submarines as well. Most of the Soviets' long-range submarine SLCMs are deployed in the 29 ECHO-class boats, with their eight large deck-tube launchers. The ECHOs now carry the SS-N-12 which replaces the SHADDOCK 1.2 mach, 500-mile weapon which in the '60s and '70s was believed to have a nuclear land attack capability. This 12-ton, turbo or ramjet cruise missile with a 2200-lb HE or nuclear warhead for the anti-ship mission, flies at mach 2.5 speed to 300 miles. It can surface skim, uses a programmed autopilot with radar altimeter for midcourse cruising and has either IR or radar terminal homing. The SS-N-19 is an improved SS-N-12 and is launched from the 14,000-ton OSCAR's 24 vertical tubes. The Soviets latest submarine SLCM is the SS-N-24. It is presently being flown from a single YANKEE submarine, and is thought to be a missile for either a new class of submarines or for more YANKEE conversions from their original ballistic missile configuration.

The Anti-ship Long Range SLCM

Long range anti-ship SLCMs of about 300-mile range are of prime importance in the Soviets' sea strategies but of so little importance to the sea strategies of the U.S. that the TOMAHAWK anti-ship version has been belatedly funded and only 593 such missiles are in the present arsenal -- little more than a shipload of four per nuclear submarine. And, whereas the U.S. anti-ship missiles have only conventional HE warheads, many Soviet anti-ship missiles are thought to carry nuclear warheads. A surprise strike against attack carrier forces using only a few nuclear SLCMs would be easy to deploy and would be consistent with the Soviets declared strategy for a "first salvo" initiation of war against the United States. A nuclear SLCM might be the best means for destroying U.S. attack carriers in port areas.

The U.S. sees the anti-ship TOMAHAWK as useful against surface targets of opportunity. At the initiation of hostilities the submarine anti-ship SLCM might be used against valuable enemy ships which are located on the submarine's peacetime plots of area shipping and warships. It is also possible that in the far-out picket positions for protecting U.S. battle groups, submarines might be directed to take under fire enemy surface ships threatening the U.S. battle groups with their long range cruise missiles. There appears to be no allowance of missiles to be used against Soviet merchant ships and their escorts -- even though the Soviets have the second largest merchant fleet in the world.

The USSR, on the other hand, makes the submarine anti-ship SLCM the prime weapon in its major sea strategies with, secondarily, the land based naval bomber's anti-ship ALCM as a complementing weapon system. (Since the U.S. has no comparable long range naval air delivery system -- the P-3/HARPOON system not having comparable standoff delivery range -- the Soviets' anti-ship ALCMs thus pose additional problems in arms control deliberations.) In both their strategies, the "first salvo" for initiating a major war against the U.S. and the "fleet-against-fleet" strategy in an ongoing sea war, the submarine and air strikes against the major elements of the U.S. surface fleet can be with a relatively few nuclear SLCMs and ALCMs or with a great number of conventional long range cruise missiles delivered from a relatively few dispersed platforms but coordinated to ensure a few critical bursts or hits on their planned targets -- causing a decisive result from a single massed missile strike. The very large and steadily increasing stockpile of anti-ship cruise missiles -- for submarines, at least ten times that of the U.S. -- is a good indicator of the relative importance of the anti-ship mission to the Soviets as opposed to the U.S. Significantly, the Soviets' conventional submarine SLCMs are launched from basically only two classes of submarines, the ECHO and the OSCAR. However, the nuclear anti-ship versions, one of which is launchable from a standard torpedo tube and which is likely to be used from many classes of Soviet submarines, greatly compound the arms control problem relative to nuclear weapons. In this regard, conventional versions of the SS-N-21 -- like those of TOMAHAWK -- are likely to appear in several additional classes of Soviet submarines.

The Nuclear Land Attack SLCM

Only the U.S. TLAM-N, a nuclear TOMAHAWK of about 1500-mile range and reportedly with a 200 Kt warhead, seems to meet the requirements for a long range nuclear land attack SLCM and could be subject to follow-on START discussions. With only about 350 of such TOMAHAWKs in the present U.S. inventory, an elimination of all sea-launched nuclear SLCMs would affect no more than a few hundred such submarine weapons. However, this would basically eliminate the effective deterrence of nuclear war due to the theater threat they pose against battlefield and behind the lines objectives which support an enemy's ground and air warfare.

On the other hand, only the Soviet SS-N-21s and 24s are thought to be long range nuclear land attack SLCMs -- with their 1500 to 1850 mile ranges. Several other Soviet cruise missiles in their nuclear versions should exceed the 300-mile lower limit in range but are somehow not being subjected to any consideration as long range missiles. The SS-N-3s, 12s, and 19s, although recognized as having about a 300-mile range when carrying a conventional warhead, should carry a nuclear warhead close to 800 miles due to the decreased weight of the warhead and its reduced volume which can be converted to additional fuel tankage. Since the SS-N-12s and 19s are believed to have interchangeable warheads, the stockpile of nuclear land attack SLCMs can be, again, some ten times greater than U.S. nuclear submarine SLCMs. Significantly, although the accuracy of the Soviet SHADDOCKS in the nuclear land attack mission in the '70s was considered to be very low, today the newer missiles probably enjoy geographical navigation using a satellite system similar to Navstar for mid-course guidance of missiles while using good inertial guidance as well. The errors in terminal flight should thus be expected to be in the range of tens of meters.

It might appear that, by giving up their nuclear SS-N-21s and 24s in START negotiations, the Soviets could be losing all submarine nuclear cruise missile capability; but this would not be the case. However, eliminating nuclear land attack TOMAHAWKs would sacrifice a major U.S. capability to deter or fight a nuclear war.

Thus, the asymmetries between the two navies as to numbers of nuclear warheads assigned to submarine SLCMs and to submarine platforms which employ these weapons, seemingly make START agreements on nuclear SLCMs virtually impossible to consummate. And this might best serve U.S. interests. Importantly, submarine launched nuclear cruise missiles, while achieving attack surprise, can be discreetly timed in their use to produce a maximum political effect. As Max Kampelman, Head of the U.S. INF negotiating team noted, "the nuclear (U.S.) SLCM is a weapon to induce negotiations and a means to impose our will on the enemy."

<u>The Conventional Land Attack SLCM</u>

The conventional land attack SLCM should "alter many existing tasks performed by manned strike aircraft." Vice President Dan Quayle also notes in his recent article in the Journal of Defense and Diplomacy, "In some land attack missions, submarines will be critical to enable us (U.S.) to get safely within range of targets such as Backfire bomber bases and key defense complexes -- particularly because it may be necessary to attack Soviet naval bases." He also wrote that, "in the case of Libya, had we had enough conventionally armed land attack cruise missiles of the right range, and with the right targeting information, we might not have needed any manned aircraft." To these two applications of the conventional land attack SLCM -- for a major non-nuclear war and against terrorism -- should be added its use in low level conflicts involving third power countries. The evident U.S. emphasis on responding to these types of warfare with SLCMs is shown by the numbers of such TOMAHAWKs which are programmed, about 2650, versus the relatively few anti-ship missiles which have been programmed, only about 600. With an approximate range of 800 miles when configured with either an HE warhead or a warhead of multiple submunitions, the submarine conventional land attack SLCM adds an important new dimension to U.S. SSN operations. Moreover, while the U.S. submarine ASW mission is being reduced in scope because of the quieting of Soviet submarines, the submarine land attack SLCM is growing in importance. Even as a major war with the Soviets becomes increasingly unlikely, the projection of power from submarines is seemingly increasing, using TOMAHAWKs against the shore objectives of lesser countries in crisis situations or against countries harboring terrorist activities. TOMAHAWKs, with a frontal radar cross section "no bigger than a bird" and with a low trajectory in flight, by using TERCOM for mid-course guidance and DSMAC for terminal homing have an undetectability and accuracy that makes them appropriate for such missions. But having TERCOM for all possible trouble spots is such a monumental task as to be the Achilles heel of this type of cruise missile. A satellite navigation system for the SLCM will provide a more practical weapon for such types of warfare.

The Soviets' long range conventional SLCMs for land attack, on the other hand, are far larger in frontal radar cross section while their warheads are at least double the weight of those used by TOMAHAWK. Moreover, they are easier to track and destroy though flying at far greater speeds and they are believed to have insufficient terminal accuracy to be of much use in the conventional land attack role. It is possible though that their guidance systems have progressed well beyond those observed in the first generation Soviet cruise missiles and that they may have good terminal accuracies.

In effect, the greatest emphasis placed on a U.S. submarine SLCM capability is on the conventional land attack version of TOMAHAWK, whereas there seems to be little evidence that the Soviets have made this an important mission for their cruise missiles.

In summary: the SLCM is fundamentally a new form of air power which is employed in different ways and with a different emphasis on its importance in the naval strategies of the two superpowers.

Although START deliberations to date have indicated a Soviet requirement to address all SLCMs within the arms control regime under negotiation, it would appear to be unreasonable to include any SLCMs in START except possibly the long range nuclear ones. Thus for submarine SLCMs a definition is needed of which submarine-launched long range nuclear cruise missiles should be considered by START negotiators. For the United States, TOMAHAWK is the only nuclear SLCM and it has a maximum range of about 1500 miles. For the Soviets, however, there are five different types of nuclear submarine SLCMs which might be flown to an equivalent or longer range -- with three of them recognized as about 300-mile non-nuclear missiles but which fly a much greater distance by taking advantage of the lesser weight of a nuclear warhead and its reduced volume which can be converted to additional fuel tankage. Additionally, these three supersonic speed submarine SLCMs, when flown subsonically, can also have considerably increased ranges. Still, though the prime use of the nuclear submarine long-range SLCM differs between the U.S. and the USSR -- land attack for the U.S., anti-ship for the Soviets -- a ceiling on total nuclear warheads might be negotiated. But the great need of the U.S. to deter or control the enemy use of theater nuclear weapons and the

Soviets' threat against U.S. carriers which is posed by nuclear SLCMs, make some token number of nuclear submarine SLCMs for both sides reasonable. There is likely to be an insistence upon verification of numbers of deployed nuclear warheads for submarine SLCMs and an equal resistance to intrusion into submarines for verification. Thus, external means of verification are indicated.

For the non-nuclear submarine SLCM, there is little START interest except possibly for the interchangeable warhead issue. But this is resolvable by external observation of submarine weapon loading. Thus, the non-nuclear SLCM arms control issue should be part of separate deliberations. Recognizing that the prime U.S. use of the non-nuclear submarine SLCM is for land attack while for the Soviets it is anti-ship, mutual reductions in these weapons pose an even more difficult problem for arms control negotiators. Submarine anti-ship SLCMs are essential to Soviet sea strategies with land-based bomber ALCMs complementing the submarine's missile capability. On the other hand, carrier based aircraft are essential to U.S. sea strategies while submarine land attack SLCMs provide the complementing function. Thus, it seems unlikely that there can be agreed upon limitations of non-nuclear submarine SLCMs, though a changed environment of reduced U.S. carrier strength and a similar reduced threat of Soviet reaction to U.S. power projection from the seas in a conventional war, can be cause for suggested reduction in submarine SLCMs for both sides.

Dr. Jon Boyes and W. J. Ruhe

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THE RASHER'S FIFTH

In July 1944, the USS RASHER (SS-269) was due for an overhaul, and a skipper was needed to take her to Pearl Harbor. Rear Admiral Ralph Christie, headquartered in Perth, West Australia, had several qualified individuals who were either helping out on his staff or directing the refit of submarines.

Commander Henry G. Munson, Class of '32, was one of those officers awaiting another boat assignment. After the USS CREVALLE's second war patrol he asked to be relieved of his command "to recoup and regroup." But after only two weeks in the COs' rest home at Cotesloe, Perth, Munson had gotten restless and volunteered to take over a repair group -- ostensibly to "better organize the refits and hurry the boats back to sea to put more Japs on the bottom of the ocean."

Around the sub base in Fremantle, it was rumored that Admiral Christie had gotten many gripes about Munson from the repair crews he managed; Munson had been pushing too hard, they complained. Thus, putting him on the RASHER was a good solution to the admiral's problem. Besides, ten weeks on the beach with a war going on was as much as a warrior like Munson could bear.

On 17 July, Commander Munson relieved Lieutenant Commander Willard Laughton of the RASHER's command. Munson brought with him Lieutenant (junior grade) T.W.E. "Luke" Bowdler, U.S. Naval Reserve, who'd also been put ashore from the CREVALLE for a rest. Munson, who admitted to night blindness, called Bowdler "my eyes for night surface attack." Bowdler, who ate lots of carrots, clarified much of the attack data and battle damage originally assessed by Munson in his patrol reports.

The RASHER left Fremantle on 22 July with orders "to patrol 'Whitewash' areas off Luzon from 14°15'N to 18°30'N and east of Longitude 115°E; in a coordinated search and attack group with USS BLUEFISH to terminate 30 August and return to Pearl."

On patrol, Munson was not a card player and spent little time in the wardroom. He either worked at his cabin desk or prowled relentlessly around the submarine, looking for problems. If he spotted one, he's ask one of the crew a quick question, impatiently wait out the answer, flash a grin to show understanding, and then be off. His main recreation was solving calculus problems -- using a pen. One of his officers, who had a master's degree in mathematics, commented: "No sonofabitch ever works calculus with a pen!" But Munson did. He'd sit there in his cabin with a burned-out cigarette dangling from his mouth. As he worked his calculations, he'd twist his lean face into a grimace, the bottom lining of his wild, blue eyes showing blood-red. Even the messengers approached him with great caution.

Munson always wore a complete khaki uniform with collar insignias, and black shoes. On the bridge, during night action, he wore a cap. He did, however, relax the wearing of black ties on board ship during patrol.

The RASHER's fifth patrol stayed fairly calm until early August, when things began to pick up: "5 August, 30 miles south of Scarborough Shoals. 2255 ... radar contact at 16,000 yards, 225° true. Began end-around at 14,000 yards; 6 August, at 0130 submerged for approach, target was the KOSEI MARU, 8,223 tons, escorted by one small SC-type on port bow with two 1,000-ton AKs on starboard side, (even AKs as escorts were known to roll over depth charges), all making 8 knots, zigging every seven minutes. Submerged. 0211 with starboard escort at 700 yards, angle-on-bow zero (escort headed directly at RASHER); got single-ping sonar range to target of 1,400 yards; fired 6 torpedoes with 60° right gyro angles, spread 2°. Timed five hits and heard break-up noises as we were forced to duck under the escorts. Four depth charges, distant, went off; surfaced with escorts milling around astern at 8,000 yards." (The ship was a confirmed sinking.)

Although it sounded like a routine maneuver in the patrol report, note the position of the RASHER at the time of firing torpedoes -- and the daring of this approach.

The real action started on 18 August. There were nine successive aircraft contacts to the north of the RASHER during the late afternoon. Munson suspected that this indicated an air patrol flying ahead of a group of valuable ships. His guess was a good one!

At 2009, with the RASHER surfaced, a radar contact was reported on a mass of ships approaching from the northeast -- range was 19,000 yards. The radar showed about 13 large contacts in three columns, and at least six smaller ones in escort screening positions. There was no moon; it was very dark with almost continuous rain. Munson wrote in his ship's log that "these were ideal conditions for a night surface attack."

Munson kept the RASHER idling in front of the approaching Japanese ships. She lay directly ahead of the oncoming escorts on the starboard side of the convoy (see Figure 1.)

USS RASHER's Night Action, 18 August 1944

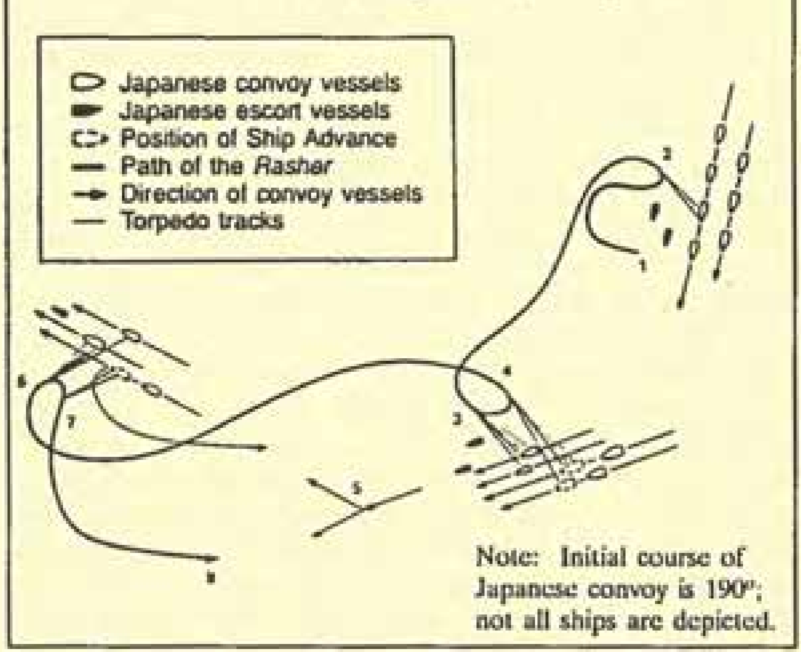


Figure 1

Key actions off northern coast of Luzon, Philippines: (1) 2009: RASHER makes radar contact on convoy at 19,000 yards. (2) 2122: two stern torpedoes hit from 2,800 yards; false aircraft sighting made by lookout. (3) 2206: four of six forward torpedoes hit from 3,300 and 3,900 yards. (4) 2214: four stern torpedoes hit from about 3,800 yards; three hits are on escort carrier TAIYO. (5) Convoy splits into two groups heading southwest and northwest; Munson follows latter group. (6) Four bow torpedoes hit from 2,200 yards. (7) 2333: Two stern torpedoes hit target, which slows to five knots and heads toward Luzon. (8) After shadowing crippled enemy ship, RASHER withdraws, out of torpedoes.

As the mass of ships, making 13 knots, closed the RASHER, Munson swung clear of the nearest escort, letting her pass within 1,500 yards. Nothing was seen in the intense blackness. When the RASHER's radar operator reported being confused by the many side-lobes from the big ships, Munson swung the

RASHER to port and opened the range to the near column of ships.

At 2122, two stern tube torpedoes were fired with a 2° spread and range of 2,800 yards at a big target. Lieutenant "Willy" Newlon, the torpedo data computer operator, then asked for a hold-fire because he didn't think the gyros were matching properly. However, the two discharged torpedoes were observed to hit, "sending up a column of flame 1,000 feet high while part of the ship blew off ... both parts burning fiercely." She apparently was a tanker. The near escort fired her guns wildly in all directions, and began to fiercely depth-charge something well astern of the RASHER.

At this point, a lookout, confused by the tracer bullets arching out from the convoy toward the RASHER, shouted "aircraft closing astern." Munson ordered full speed; very agitated, he shouted for the radar operator to check for a rapidly closing contact. Munson then dropped down into the conning tower to make his own check of the radar scope. He found no indication of a plane. But the delay which was created lost the RASHER a chance to shoot her other two stern fish.

Munson then hurried his boat up the starboard flank of the convoy, remaining 4,000 yards from the near escorts. During this maneuver, he sent a contact report in plain language to the BLUEFISH -- 83 miles to the southwest -- telling her skipper to join the action.

At 2206, Munson swung the RASHER around the stern of the convoy's starboard leading escort and charged toward the big ships at 15 knots. He only slowed the RASHER momentarily to fire six torpedoes from the forward tubes. They were aimed at a huge ship 3,300 yards away. The fish were spread 2° at 45 knots, and set for a six-foot depth. (The depth-keeping performance of the Mk-14 torpedoes had been so poor that Munson didn't want to risk any of them dipping under a target.)

The firing was done on radar bearings. The battle officer-of-the-deck, Luke Bowdler, unable to distinguish any of the ships being fired at, could not get check-bearings. When the first three torpedoes hit in the nearest ship, she started smoking heavily and small fires broke out all over her topside.

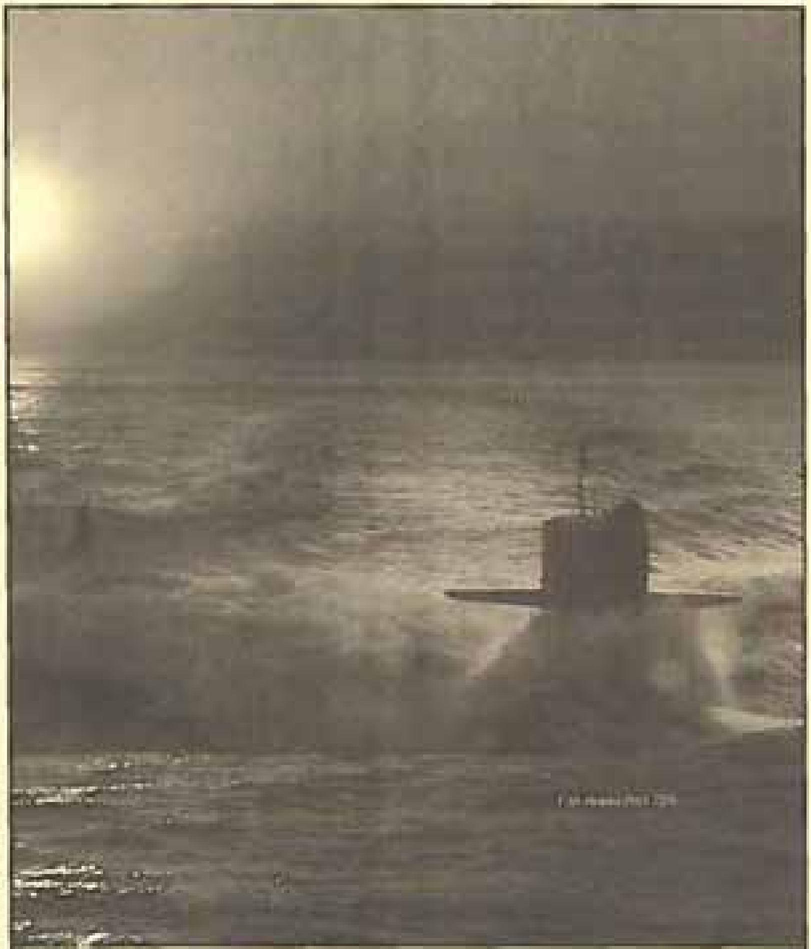
Luke saw enough of the torpedoed ship to claim that it was "a tremendous two-stack transport." A fourth torpedo -- timed to hit a ship off the port bow of the transport -- exploded at a range of 3,900 yards.

The RASHER was then swung hard left to bring the stern tubes to bear. The radar range to a big target in a third column of ships seemed excessive -- 3,800 yards. But Willy Newlon, from his station inside the conning tower, assured the skipper that it seemed by far to be the biggest ship on the radar, and should be worth shooting at. Through the misty rain, Luke had the impression that the ship was flat across the top, "like a very big tanker."

At 2214, the four stern tubes were fired at the huge target, and three hits were heard; a fourth hit was heard in a more distant ship. Two observed flashing hits on the near ship verified that she was indeed huge (not until after the war was it revealed by a Japanese prisoner of war that this ship had been the escort aircraft carrier TAIYO of about 20,000 tons, which sank as a result of the three hits). Munson pulled the RASHER clear for a rapid reload of the torpedo tubes.

At this point, the convoy had split into two groups. One group continued on a southwesterly course, and the other swung toward the northwest; Munson went after the latter group. (The group to the south was attacked by the BLUEFISH four hours later, with two large tankers damaged. One of these tankers was sunk in a second BLUEFISH attack at 0400 on the 19th, and at 0713 the BLUEFISH scored three hits on the second tanker, without sinking her.)

At 2245, Munson -- observing the radar in the conning tower -- noted that the "two-stack transport" damaged in an earlier attack had dropped out of formation, along with two escorts. (Apparently, she sank soon afterwards.) Munson then sent another contact report to the BLUEFISH, saying that only six torpedoes remained and that the RASHER was trying to head off the northernmost group of ships. This group, he noted, comprised three large ships plus one "very hostile escort," which seemed to have a radar because of interference on the RASHER's radar scope. This escort kept darting annoyingly toward the RASHER, then turning back to protect her ships.



At 2330, with the Japanese ships on a northwesterly course, Munson fired the RASHER's four remaining bow torpedoes at the leading target, "a cargo ship (an AK) of good size." The range was 2,200 yards. The first torpedo out of the tubes hooked right, steadied on a course, passed astern of the cargo ship, and hit another ship some distance beyond. The next three torpedoes hit their intended target and she exploded with a deafening roar. The AK was probably loaded with munitions, causing a pressure wave which swept across the RASHER's bridge.

Only two torpedoes remained and both were in stern tubes. Consequently, the RASHER was swung hard right and the last two torpedoes were launched at the closest ship; both of them hit. This ship promptly slowed to five knots and reversed course, heading for the coast of Luzon. The RASHER followed this crippled ship while an escort joined her belatedly -- to defend against further attacks.

Three hours later, the escort illuminated the damaged ship, only to be shot at by the vessel, which probably mistook her own escort for an enemy submarine. The escort's searchlight revealed the damaged ship as another two-stack transport of great size.

Meanwhile, Munson passed the word in the RASHER: "All hands can splice the main brace in the control room -- a shot glass of liquor for every man, until all the medicinal brandy is gone. Well done, Mates!"

Still later, the Japanese escort heard the RASHER take a "ping" with her sound gear while attempting to get the range on the transport without disclosing the radar. The escort charged back at the RASHER. Out of torpedoes, the deadly submarine was finally forced to withdraw.

Just before the early morning trim dive, USS SPADEFISH far to the north, was raised on voice radio. Commander Gordon Underwood, a classmate of Munson's, reported sinking one or possibly two troop transports which went by him at 0330 -- in the early morning -- headed west from the point of the RASHER's initial attack on the convoy.

The battle was finished. The RASHER had sunk at least three ships and damaged five more, with 16 hits out of 18 torpedoes fired -- that gave the RASHER 21 hits for the 24 torpedoes fired on the entire patrol!

Munson could only guess at the tonnage of Japanese ships he'd sunk or damaged as he headed his boat for Midway, the patrol terminated by Commander, Task Force 71 in Perth. Luke Bowdler and the battle lookouts were quizzed at great length as to what they observed, and how big they guessed the ships were that they vaguely saw through the rain. Bowdler insisted that "all of the eight ships hit were 10,000 tons or bigger." Munson didn't think so; he felt that a far more modest total tonnage was reasonable, and he wasn't sure that more than two had gone down. But when the RASHER pulled into Midway, a staff officer of Vice Admiral Charles A. Lockwood, Commander Submarines Pacific, was waiting on the dock. He and Munson then went into a secret conference with the RASHER's executive officer excluded; this was unusual. Between Midway and Pearl Harbor, Munson changed his tonnage estimates upward. His new figures brought the RASHER's toll to five ships, totaling 53,000 tons sunk, and four ships damaged for 22,000 more tons. This checked very closely with the official assessment made after the end of the war. Apparently, decoded Japanese messages had given Admiral Lockwood's command in Pearl Harbor a good deal of information on the actual ships torpedoed.

Munson and the RASHER were responsible for the most total tonnage of sunk and damaged ships for any single U.S. war patrol during World War II.

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COMMAND AND CONTROL OF STRATEGIC SUBMARINES

How reliable and secure is the command and control of U.S. strategic ballistic missile nuclear submarines (SSBNs)? The answer to this question is crucial since the ability to employ submarine launched ballistic missiles (SLBMs), which comprise the most invulnerable leg of the strategic nuclear TRIAD in a responsive and effective manner, is a fundamental requirement for stable deterrence.

Now that the U.S. Soviet INF Treaty is signed, the START Treaty is in the limelight. A strategic nuclear arms control regime with radically reduced force levels will raise complex questions that intimately affect each side's security calculus. For the United States, one of the more immediate questions concerns future force structure. How many of each type of ballistic missile and bomber weapon should the United States deploy?

In assessing the relative abilities of each TRIAD leg to accomplish U.S. deterrence and policy objectives in light of the Soviet Union's evolving strategic forces and target base, a number of myths persist about SSBN command and control (C^2). These erroneous views, if not rebutted, could have a most detrimental effect upon U.S. security. Proponents of these views would have the United States reduce the number of SLBMs relative to those of increasingly vulnerable fixed-site ICBMs, more expensive mobile ICBMs, and non time sensitive bombers which will confront increasingly numerous and capable Soviet air defenses. The result of such reductions would undermine deterrence in a crisis, if our adversary perceived the majority of our forces could not endure, and our own National Command Authority (NCA) felt impelled to use or lose the bulk of our strategic forces.

Specifically, these myths assert that SSBN communications are slow and unreliable and that sufficient safeguards do not exist to preclude the unauthorized or accidental use of Navy strategic weapons. Let us examine each of these myths.

Myth No. 1:
SSBN Communications Are Few, Fragile and One-Way

This myth suggests uncertain Emergency Action Message (EAM) receipt by an SSBN and questions the NCA's ability to employ SLBMs if required. Poor communications, it is alleged, make the SSBN little more than a blind behemoth whose survivable and enduring weapons cannot support deterrence, cannot be employed within carefully integrated and coordinated strategic war plans and, therefore, are useless in enhancing escalation control and war termination prospects.

The Facts:

Submarine Communications are Redundant

SSBN communications are not few, fragile or one-way. If the EAM is transmitted from Washington, it will get to the SSBNs. This confidence is due to the redundant nature of space-, air-, land- and sea-based SSBN communications which span the radio spectrum (UHF, HF, VLF and ELF).

An EAM directing strategic force execution would be transmitted by the National Emergency Airborne Command Post, the Navy-dedicated TACAMO aircraft which are continuously airborne (one each over the Atlantic and Pacific Oceans), several CINC airborne command posts, a number of land-based fixed and mobile HF, LF, VLF and ELF transmitters, and numerous ships in both the Atlantic and Pacific fleets. While electro-magnetic pulses (EMP) from early detonating warheads would undoubtedly disrupt some communications, EMP does not disrupt communication across the entire radio spectrum, and numerous EAM dissemination modes are EMP hardened. If nuclear strikes were preceded by a period of crisis, additional communications assets would be generated and dispersed to insure prompt EAM transmission and receipt by strategic forces.

Submarine Communications are Robust

The Administration's Strategic Modernization Program, which places highest emphasis upon command, control, communications and intelligence (C^3I), continues to improve the reliability of prompt and secure communications to strategic forces. The ELF communications systems for SSBNs have greatly increased the depth and patrol speed at which an SSBN can maintain connectivity to the NCA and the CINCs; the newly developed E-6A follow-on to the TACAMO aircraft will increase connectivity throughout SSBN patrol areas in which EAMs can be received (further complicating Soviet ASW requirements); and the survivable and redundant MILSTAR satellite communications system, which "will ensure survivable, effective and continuous control of strategic forces both during and after" an attack, is planned to be in place in the early 1990s. Beyond this, a satellite to submarine blue-green laser communications system is being developed and shows much promise.

NCA Assurance of SSBN Mission Accomplishment

If SSBNs do not communicate freely, how will the NCA know an Emergency Action Message was received and acted upon? First, alert SSBNs maintain continuous connectivity with the redundant communications systems and on the many frequency bands described above. Alert boats continuously copy a variety of communications traffic. They also participate in numerous command and control exercises while on patrol to assess connectivity and EAM handling/validation procedures. The communications performance of each SSBN patrol is evaluated by an independent (non-Navy) agency. These analyses verify that connectivity to alert SSBNs over the last two decades has been virtually unbroken. Those boats at sea and survivable but not in alert patrol status, regularly monitor shore- and air-based communications with the same high standard of connectivity.

Weapons System Reliability Tests and SLBM Operational Tests similarly assure the NCA of successful weapons system performance should an EAM be disseminated. TRIDENT submarines have completed more than ten ship-years at sea without a single day of degradation in assigned target coverage. All the factors of putting a weapon on target are calculated in advance. A very low probability of failure is calculated into warplans and appropriate redundancy measures are incorporated accordingly. Hence, the NCA has high assurance of the SSBNs fulfilling all required responsibilities.

SSBNs maintain radio silence. Continuous SSBN connectivity and their high weapon system reliability assures the President of a reliable mission execution and performance. SSBNs can, if required, issue post-launch reports. When on patrol, the SSBN's principal mission is to remain survivable. Its radio transmissions would not advance this mission. Hence, EMCON (Emission Control) is observed. Upon receiving an EAM, the SSBN's primary mission would be to fire its missile(s). Acknowledging EAMs before launch would not serve this mission, nor is acknowledgement necessary. It would not tell the NCA if the target were destroyed, since defense attrition, actual accuracy and weapon performance, and a host of other post-launch variables would remain unknown to the NCA. SSBN EMCON does not mean that once given a launch order, the SSBN could not be "turned off" since the NCA could issue such an order which the SSBN would receive with high assurance. While a submarine skipper prefers to maintain EMCON, issuing a launch report would not endanger SSBN survivability for the reasons already described. A quick post-launch transmission, if required, could be sent safely. Hence, the NCA is able to determine SSBN force status shortly after force execution.

Myth No. 2:
SLBM Release Procedures Are Inadequate to Prevent Accidental or Unauthorized Launch.

The Facts:

This criticism, completely false, is best refuted by an actual September 27, 1984, unclassified CNO memo on this subject:

> *Under no circumstances is an American submarine commander empowered to arm and fire nuclear weapons without specific authorization from the National Command Authority. Launch authorization must come from the President (or his successor to national command if the President is dead or incapacitated). The presidential authorization to release nuclear weapons is separately verified by several officers other than the commanding officer. The various keys necessary to complete the firing circuit are secured in the custody of several different officers and are safeguarded in ways that prevent unauthorized individuals from obtaining access. Numerous procedural safeguards also exist. All personnel who are involved in the U.S. Navy nuclear weapons program are carefully screened before entry, rigorously trained, and continuously monitored to insure high and reliable performance.*

A July 11, 1986, unclassified memo further elaborated on the stringent use-control measures and safeguards attending missile release procedures which prevent a single individual or group of individuals from releasing a nuclear weapon. These use control measures include: 1) the personnel reliability program; 2) locking the missile fire control system (only a two-man control team has access to the keys), the missile launcher system (only the commanding officer has access to the keys), and the tactical firing key (controlled only by the weapons officer); 3) simultaneous and independent verification and authentication of EAMs by a two-man team as well as the CO and executive officer; 4) concurrent target verification based on a two-man control team determining the specific missiles to be released by an EAM (with the CO and XO providing independent verification) and missile fire control target assignment verified by the CO and the weapons officer; and 5) independent launch authorizations (in specific format) to the crew required from the CO and XO, and the CO retains the ability to stop the system anytime during the launch procedure.

Myth No. 3:
An SSBN Can be Lost Without the NCA Knowing the Facts.
(The Case of the Lost SSBN)

Much has been said about the so-called one way communications to SSBNs. For instance, it is alleged that an SSBN might disappear during conventional hostilities unbeknownst to the NCA, thus leaving a gigantic hole in U.S. war plans. Some also question how the NCA would know whether an SSBN received an EAM or that the boat had been able to launch its missiles.

A discussion about an SSBN being lost begs the obvious question about SSBN survivability in an age of increasingly capable Soviet SSN and other ASW assets. Suffice it to say that 1) the TRIDENT SSBN is faster and many times quieter than POSEIDON-class boats (which the Soviets are still unable to localize and track after 25 years of service); 2) faster and stealthier Soviet SSNs, such as the AKULA class, while becoming more difficult for other submarines to detect and track, continue to be limited against U.S. SSBNs by the Soviets' inferior signal processing and passive acoustics capabilities; 3) a principal mission of Soviet SSNs is to protect their SSBNs, not pursue U.S. SSBNs, and 4) the Soviet SSNs that survive early attrition by forward-based allied ASW forces will have to search for these quieter, faster and more survivable TRIDENT SSBNs patrolling in 2 million square miles of ocean.

In the unlikely event that an SSBN were lost, the submarine emergency communications transmitter buoy which is carried on all U.S. SSBNs would automatically and quickly inform the submarine operational authorities through a global network of receiver nodes of the boat's disappearance, and if this were due to accident or a hostile act.

Communications to the SSBN force are secure and reliable and are becoming even more so with continuing modernization. The connectivity of SSBNs and the reliability of their weapons assure the NCA that the seabased TRIAD leg can and should be relied on to maintain the deterrent balance in any arms control regime.

Dr. John M. Weinstein

[The author is chief, Policy & Programs at the U.S. Nuclear Command and Control System Support Staff. At the time he authored this article, he was special assistant to the director for Requirements Capabilities, Strategic and Theater Nuclear Warfare Division, Department of the Navy.]

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"SUBMARINES: PEARL HARBOR TO TOKYO AND BEYOND"

[This essay, presented by Admiral Bernard A. Clarey, USN(Ret.), was delivered to the Social Science Association of Honolulu, Hawaii, on May 1, 1989, and was digested for the October 1989 SUBMARINE REVIEW to include only "The Submarines of Hawaii through WW II." The final portion of Admiral Clarey's essay, that involving submarines after WW II, is herewith printed.]

With a national decision made about 1947 to manufacture a nuclear power plant and install it in a new submarine, the program to build the USS NAUTILUS became a reality.

As the world knows, the success of our Navy nuclear power program has been superb in every respect. There is no doubt that the old Admiral, Rickover, deserves every credit given him for being the father of our nuclear Navy. In addition to submarines, we have had for many years nuclear-powered aircraft carriers, cruisers and destroyers. In addition to being a clean source of power, refueling is only required in the latest power plants about every 13 or 14 years.

Another bold action taken by the Navy in the mid-1950s was to build the POLARIS missiles and the submarines to launch them. This force during its lifetime has been the foundation of our secure strategic nuclear deterrent force. Funds were appropriated by Congress for 41 of these large boats each capable of launching 16 SLBMs (nuclear-tipped missiles). One of the remarkable things about the POLARIS program, however, was that when the program was started and the submarines were actually being constructed, we had never fired a rocket from beneath the surface. We had no experience with the effect of breaking through the interface between the water and the atmosphere. Would it work? Well, it did!

To get POLARIS operational in as short a time as possible, nuclear attack submarines on the building ways were cut in two, the sections pulled apart and the missile compartment installed.

POLARIS provided the United States with a secure strategic force always on station and ready to fire nuclear missiles in response to any attack by the Russians.

The first follow-on program to POLARIS was POSEIDON in which we fitted POLARIS boats with the new, longer range and more powerful POSEIDON missile.

The second follow-on is TRIDENT, a going program today. The TRIDENT submarine displaces 19,000 tons and carries 24 of the newest submarine missiles. Eight of these submarines are scheduled for basing at Bangor, Washington, where an entirely new facility has been built to support these craft.

To give you an idea of how big a TRIDENT submarine is, my wife broke out her computer the other evening and said to me, "if a TRIDENT boat were *hapai*, it could produce 48 *keikis*, the size of the first submarines sent to Hawaii in 1914."

Today's strategic missile boats, including our TRIDENTs, are the quietest, most survivable submarines in the world and represent the pre-eminent leg of our deterrent TRIAD. We have eight of these craft making deterrent patrols today, two more have been delivered and seven are under construction or authorized.

The attack submarine force, led by the LOS ANGELES and HONOLULU, 688-class nuclears, are capable of delivering sudden and overwhelming fire power against both land and sea-based targets using advanced capability wire-guided and target seeking torpedoes, as well as the HARPOON missiles and TOMAHAWK cruise missiles which are designed to attack both sea-based and land targets.

The entire submarine force costs less than six percent of the Department of Defense budget. The attack submarine force represents over 35% of the Navy's combatant ships but uses less than 10% of the Navy's budget.

The submarine has come a long way since April 11, 1900, when we commissioned our first one, the USS HOLLAND. Today's nuclear boats continue to expand their role in the wartime component of our national security strategy. Our nation's maritime predominance is absolutely dependent upon maintaining submarine supremacy.

Admiral Bernard A. Clarey, USN(Ret.)

USS GROWLER; PIONEER OF NUCLEAR DETERRENCE

Whether Americans are war hawks or doves, the whole concept and reason for deterrence can be defined by Theodore Roosevelt's apt quote: "Walk softly but carry a big stick." An aggressor will think more than twice before going in harm's way, knowing the enemy has retaliatory systems which could erupt into Armageddon. In the early 60s two American diesel submarines and their new weapons of destruction opened a new chapter in the arms race. The second GROWLER and her sister ship GRAYBACK were born out of this country's defense mandate to help insure that no present or future hostile nation would be safe should we be attacked.

Although the career paths of the first GROWLER of 1943 and the GROWLER of the early 60s are dissimilar, the cogent reasons for their existence point up our constant quest for the survival of democratic rule. The ends to which we will go to pursue and protect our way of life can be clearly seen in the cost we have paid in lives and technological expenditures for these two submarines.

On New Years Day, 1943, USS GROWLER (SS-215) left Brisbane, Australia under the command of Howard W. Gilmore for his fourth patrol. Gilmore had been in the Navy for 22 years and was awarded the Navy Cross for action during his first patrol. What would prove to be one of the most gallant actions in Naval History occurred on the night of February 7th. While traveling on the surface recharging batteries, Gilmore spotted a small Japanese provisioning ship a mile away. He ordered the crew to battle stations and began to close on the armed vessel. Neither Gilmore nor the lookouts spotted the enemy's course change towards them until it was too late. Out of the blackness the ship appeared intent on ramming the sub. Gilmore sounded the collision alarm and called for "Left full rudder." The swing to the left lined him up for collision. While making 17 knots, GROWLER slammed into HAYASAKI amidships. The bow of the sub crumpled like an accordion, the impact heeling the sub over 45 degrees.

Everyone on the bridge and below decks was thrown off his feet. Almost immediately the Japanese crew sprayed the GROWLER's bridge with a devastating fusillade of machine gun fire. Three men were killed instantly, while Gilmore was wounded. Clinging to the rail, he ordered, "Clear the bridge." Four men, two of them hit by fire scrambled down the ladder. The Executive Officer waited for Gilmore to come down the hatch, but to no avail. The last to be heard from the captain were words which would become submarine legend, "Take her down!" Hesitating for about a minute and fearful of losing his crew and the boat, the Exec disconsolately submerged to safety. Gilmore was posthumously awarded the Medal of Honor, the first man of seven in the submarine service to receive it.

After major repairs, GROWLER went back into action for another seven patrols. Her 11th was to be her last. Attacking a convoy while leading a wolfpack, Commander Thomas B. Oakley Jr. was lost with all hands, cause unknown. The life of

GROWLER was ended, until 14 years later when her namesake slid down the ways of the Portsmouth Naval Shipyard.

A second GROWLER (SSG 577), was commissioned August 30, 1958. She has since become indelibly etched in history as the forerunner of today's TRIDENT fleet. Originally scheduled as attack boats, GROWLER and GRAYBACK had their hulls extended 50 feet during construction to accommodate two cylindrical hangars fitted over their bows. They were to house the older REGULUS I and newer REGULUS II missiles. After training along the East Coast and Caribbean, GROWLER proceeded to her home port at Pearl Harbor in September, 1959. America's first Nuclear Deterrent Mission began March 12, 1960. GROWLER departed Hawaii with REGULUS surface-to-air missiles armed with nuclear warheads.

Unlike its successors POLARIS, POSEIDON and TRIDENT, the winged REGULUS was air-breathing and could only be fired on the surface. The cruise missile had other shortcomings such as its large size compared to the submarines which carried it. It also needed to be fueled and serviced before firing either on deck or in the on-board hangars. Of course the longer the sub was on the surface the more vulnerable it was to detection and attack. The large-volume hangars also presented the problem of flooding while on the surface, creating an extreme heel or even sinking the boat. Also, the bulbous bow made for noisy and unstable maneuverability both on the surface and underwater.

In 1957 development had already begun on a solid rocket fuel intermediate-range missile in the form of POLARIS. During her short career GROWLER had made nine deterrent patrols, paving the way for the new breed of missiles and the nuclear submarines that would carry them. As they came on line, GROWLER was decommissioned and placed in reserve in May 1964. Her active life as a deterrent was for only six years. For 28 years thereafter GROWLER lay idle at Puget Sound and Mare Island. She had been stricken from the active list and was slated to be a target for our new weapons technology. This was not to be, however, for a man with strong navy ties stepped in to save GROWLER and preserve her history and achievements.

In 1987 Zachary Fisher, Founder of the Intrepid Sea-Air-Space Museum in New York City requested the Navy transfer the boat to his museum. In September, 1988, at his own expense, Fisher had the boat towed from the West Coast to Tampa, Florida, where work was completed on the interior and exterior to make her ready for public exhibit. The second GROWLER made the last leg of her voyage up the East Coast into New York Harbor. Here an endless procession of visitors would pass through her hangars and compartments beginning in July, 1989. The sub's permanent resting place is in company with two illustrious surface ships, the carrier INTREPID, and destroyer EDSON, at the foot of West 46th Street on the Hudson River. Fisher's philosophy regarding this deterrent submarine is pragmatic; to inform and show people of all nations the weapons and the facts, to enable them to make intelligent decisions about their mutual security.

For SS 215 and SSG 577, both submarines had one poignant similarity, their means to an end. As summed up in the words of one of GROWLER's crew, on New Years day, 1961, -- while she cruised deep under the Pacific on her second deterrent patrol, -- a young officer entered into the log the following: "Not our idea of fun and good cheers, but doing our job to ensure many New Years."

Larry Blair

NONACOUSTIC MEANS OF SUBMARINE DETECTION

Any disturbance of the physical environment caused by a submarine suggests the possibility of remote detection. The disturbance must be measurable at a distance and must be discriminated from the background of similar naturally occurring disturbances. Such an anomaly is frequently called an observable. To be useful, a detection system must perform two functions -- detection and discrimination -- to some degree of confidence.

The following is a brief description of some of the more frequently discussed means of nonacoustic detection:

- o **<u>Local Changes in the Earth's Magnetic Field</u>**
  As a large piece of ferrous metal, the steel-hulled submarine causes a local disturbance in the earth's magnetic field. This disturbance or anomaly can be detected with a device (MAD) that measures the local magnetic field. If a nonmagnetic hull material is used, the magnetic signature decreases but is not eliminated, since the submarine contains some ferrous parts, and the nonmagnetic shell does not shield the magnetic effects of this internal material.
- o **<u>Bioluminescent Detection</u>**
  The sea contains bioluminescent organisms of many kinds, the most relevant to detection being dinoflagellates. These organisms can generate light when they are physically stimulated in the boundary layer of a submarine or in its wake. This phenomenon has been studied as a method for detecting submarines from the air or space.
- o **<u>Submarine-generated Waves on the Surface of the Ocean</u>**
  Moving submarines, at high speeds and shallow depths, generate surface waves behind them. At reasonable depths and speeds, however, wind-generated surface waves mask the minute submarine waves.
- o **<u>Submarine-generated Internal Waves</u>**
  Internal waves are oscillations of the thermocline that can be caused by a solid body moving in the ocean. Internal waves in turn cause water motion at the surface that is not directly observable but that can influence preexisting wind-generated ripples and waves on the surface. These changes in the surface can in principle be detected by radar. The ocean always contains internal waves that are generated by storms, currents, tides, whales, surface ships, and submarines.
- o **<u>Submarine-related Changes in the Sea Surface Temperature</u>**
  Submarine nuclear reactors generate an enormous amount of heat, which ultimately must be rejected into the surrounding seawater. Water has a very high capacity to absorb heat with a small change in

temperature, however, and a moving submarine raises the water temperature by a very small amount. A moving submarine may also change the temperature of the sea surface by mixing lower cooler water with upper water, thereby leaving a trail of cool surface water that could be detected with infrared (heat) sensors.

- <u>Laser Detection</u>
  The sea is relatively transparent to blue-green light. A burst of blue-green laser light could penetrate the sea, reflect off an object, and return to the sensor. The round-trip travel time of the laser-burst indicates the depth of the object, but cannot discriminate, for example, between a large whale and a submarine.

<u>Magnetic Anomaly Detection</u>

Magnetic anomaly detection (MAD) devices are used to detect changes in the background magnetic induction that are associated with submarines. Terrestrial magnetism usually varies slowly over distance, but when a submarine is present, the field changes rapidly and may be detected by a low flying aircraft carrying MAD equipment.

Submarines contain a large amount of metal that becomes magnetized in the course of normal operations. The permanent magnetic field associated with the submarine remains until active measures are used to demagnetize it. The earth's magnetism induces a transient magnetic field that depends on the spatial orientation of the submarine. The total magnetic field of the submarine is the vector sum of the permanent and induced magnetic fields.

The strength of the magnetic field at a distance from the submarine is inversely proportional to the third power of distance. The shape of the earth's magnetic field lines are distorted by the submarine according to how far away it is.

The earth has a strong and very complex magnetic field that varies with time and location. On a small scale the earth's magnetic field is very irregular, and small natural magnetic anomalies associated with ore deposits may be indistinguishable from submarines by MAD equipment. When searching areas in which there is a high level of geologic noise, MAD operators must set their receivers at a low sensitivity. According to a Navy study, "At these settings it will be difficult, if not impossible, to see a small submarine anomaly. Parts of the Norwegian Sea and the seas around Iceland are areas where geologic noise may interfere with MAD operations."

The U.S. currently deploys two types of MAD equipment on its ASW aircraft. These systems can detect the submarine magnetic field at no more than a few thousand feet. Area magnetic surveillance is technically feasible with a distributed system of many MAD systems. But even if some highly sensitive MAD system were widely distributed in the ocean, simple countermeasures could render it virtually useless. Small dummy submarines could carry coils that reproduce a magnetic signature of a much larger submarine. Military submarines themselves could carry coils that neutralize their own magnetic field by imposing an equal and opposite magnetic field from the coil.

Detection of Submarine-induced Bioluminescence

The primary sources of ocean bioluminescence are certain species of the plankton dinoflagellates. The mechanical stimulus of a moving submarine hull and its turbulent wake will elicit luminescence from organisms disturbed or killed. The power and persistence of this light is a function of the organisms' population density and species, environmental conditions and submarine speed. Luminescence is expected to be strongest in the turbulent regions associated with a submarine -- that is, hull boundary layer and the wake. The radiant flux of an individual organism varies widely among species. The most common may radiate $.002 \times 10^{-9}$ watts, while other organisms may radiate 20×10^{-9} watts or more.

The population density of bioluminescent organisms varies with location and depth. According to one study, "Under natural conditions, bioluminescence is maximum around midnight and minimum around midday. This diurnal periodicity is attributed in part to downward migration of the organisms during the day and return migration to surface waters at night. Most luminescence is found between 50 and 150 meters and is associated with dense dinoflagellate populations in continental shelf areas up to 60 degree north latitude. Maximum luminescence frequently occurs at the thermocline. The amount of light generated by a submarine wake can be estimated by multiplying the volume of water disturbed by the wake, the number of organisms per unit volume, and the light power emitted per organism. Measurements of ocean bioluminescence suggest typical values for the North Atlantic and North Pacific as 10^{-6} to 10^{-5} watt/m/micron[11]. The reason for analysis overestimates, as to the light outputs of a wake, is that it is generally assumed that all organisms glow constantly, when in fact dinoflagellates flash only intermittently for a duration of about 100 milli-seconds.

In order to reveal the presence of a submarine, the light energy must pass through some depth of water and atmosphere and still be sufficiently strong relative to reflected and scattered sunlight or moonlight to be detected. Exponential transmission loss is assumed between the source and the surface. It is clear that during the daytime the bioluminescence is lost within the surface reflection. At night, disturbances on the sea surface may be detectable. However, for submarines below 50 meters the signal to noise ratios may be too unfavorable and submarine wakes generated below 50 meters are unlikely to reach the surface. In essence, it is the depth of the submarine-generated light that precludes its detection from above the surface.

<u>Detection of Surface Waves Generated by Submarines</u>

The physical effects and problems associated with detection of submarine surface waves are related to the near-field and far-field waves which are generated by a moving body -- a large submarine. Comparing submarine generated waves with typical wind-generated surface waves, it is noted that the submarine wave is negligibly small relative to wind waves.

The near-field disturbance of the surface appears as a hump of water (sometimes called a Bernoulli hump) over the moving submarine which dies rapidly with distance from the submarine. The general shape of the disturbance is not very sensitive to changes in depth, but the height of the disturbance increases as the square of the speed and decreases as the square of the depth. The surface disturbance is limited in extent to a few ship-lengths. The amplitude of the wave is very small but, under certain circumstances, measurable. An OHIO-class submarine running at 20 knots and at 30 meters depth would generate a wave at most 15 centimeters high. Under more realistic patrol conditions (5 knots at 100 meters), the wave is on the order of a millimeter.

The far-field disturbance shows up as a wedge-shaped Kelvin wave pattern behind a moving source-sink pair. In general, both transverse and divergent waves may be present, and these are contained within an angle of 19.5 degrees to both sides of the line of motion. For typical speeds and depths, transverse waves dominate. Wave height varies with the submarine diameter, speed, depth, distance and length. Speed and depth are the most important factors, since wave height decays exponentially with increasing depth and decreasing speed. The waves decay slowly behind the submarine, with the square root of the distance. Even for very shallow depths and speeds up to 12 knots, the surface wave is only of the order of millimeters, and for depths greater than 100 meters, no wave is generated at reasonable speeds.

The near-field wave, or Bernoulli hump, is a single, localized perturbation, a few hundred yards in extent, and is three orders of magnitude below the peak of a typical wave spectrum. The prospects of detecting such a disturbance are extremely dim, irrespective of the sensitivity of a space-based system. The far-field Kelvin wave pattern covers a greater area but it can only be produced at high speeds and shallow depths. With the mildest of precautions, these waves are virtually nonexistent.

Submarine-generated Turbulent Wakes and Internal Waves

As the submarine moves through the water, some of the energy of propulsion goes into generating a turbulent wake behind the hull. Typical wake lengths associated with submarines below 125 feet are on the order of 100 yards at 6 knots and 30 yards at 2 or 3 knots. It can be assumed that the submarine wake will disturb the temperature structure of the seawater. Cooler water from below the submarine will be drawn up into the wake, and warmer water from above will be drawn downward into the wake. The mixed wake will therefore be slightly cooler than the water just above it and slightly warmer than the water just below it. Studies suggest that the wakes may be detectable a few kilometers downstream before the turbulence decays to an undetectable level. When the turbulent wake collapses, it can drive an internal wave in the density-stratified layers of the ocean. Submarines also generate internal waves by the movement of the hull alone. These internal wave patterns associated with the hull are sharply concentrated along the line of motion.

Internal waves cannot be seen directly as undulations of the surface, unlike a submarine wake which attains a maximum height of 8-25 meters above the hull at a distance of 300-3000 meters behind a submarine traveling at 5 knots. Once this wake ceases to grow or collapse vertically, it usually continues to spread horizontally. This wake may be detectable a few kilometers downstream before the turbulence decays to an undetectable level.

Internal waves cannot be seen directly as undulations on the surface. The internal wave generates horizontal currents near the surface that modulate existing surface ripples whose wavelengths are on the order of centimeters. The modulation takes the form of changes in the ripple wavelength and steepness, which in turn alters the radar scattering properties of the rippled surface. The modulation of surface waves can in principle reveal the pattern of underlying internal waves. Synthetic aperture radar can be tuned so that the radar backscatter depends on the wavelength of the short surface waves. It is known that the submarine wake will collapse fairly rapidly so that the potential energy in the wake can be transferred to inner waves. A recent review of all the subsurface hydrodynamic mechanisms that could modulate the surface ripple field concluded that although the large surface gravity waves have a dominant effect on the surface ripples, the surface wave modulations by the internal wave can still be shown to be observable.

The surface manifestations of internal waves, or the vortices of an internal wake, may be linked to the presence of a thin film of natural organic material and oil that is commonly found on the ocean's surface. Movement by the submarine can sweep the film into regular patterns which might be detectable by a sensor with sufficient spatial resolution. The slicks reduce the surface tension, which can affect the wave characteristics and energy dissipation in capillary waves. The variation in surface roughness may then be detected using the synthetic aperture radar.

Detection of Submarine-generated Temperature Changes

Submarines change the temperature of the water in two ways: by mixing the thermocline, and by direct heating through the reactor cooling system. These two processes may tend to cancel each other, since upwelling of cool, deep water is offset by rector heating. If either a cool or warm temperature anomaly is present at the surface, it may be detected by ASW forces.

The temperature of the ocean surface can be measured by measuring the infrared or microwave radiation emitted by the surface. Since only surface temperature is detectable, only the submarine-induced temperature anomalies that reach the surface can be detected.

Assuming that a 5-knot submarine's heat is mixed into a wake 11 meters behind the propeller, then at a distance of 1,100 meters downstream, the temperature of the wake is only 0.02° C higher than the surrounding water. At 20 knots it is 0.005° C.

Detection of Submarines by Laser

Lasers can be an active nonacoustic detection device because of the depths to which blue-green light penetrates seawater. Such a detection system would consist of an airborne laser/detector which would send short pulses into the ocean and from the return energy determine if a pulse had been either reflected off or been absorbed by a subsurface object. The laser must have sufficient power to compensate for round-trip attenuation and the large reflection loss off the submarine. The greatest loss by far occurs in the few hundred meters of seawater through which the beam must pass. Since moderate fog strongly attenuates blue-green light due to scattering and clouds have much the same effect, and since clouds and fog cover 60 percent of the ocean's surface, both laser detections and detections of surface temperature anomalies involve relatively poor risk systems.

Conclusions

Most of the technologies discussed can be defeated simply by operating the submarine deeper. The signal-to-noise ratios decrease dramatically, usually by several orders of magnitude, with an increase in depth on the order of 100 meters. Operating submarines below 100 meters should foil most


In the defense of our nation, there can be no second best.
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foreseeable nonacoustic detection systems. This may not apply to the detection of internal wave effects. Not enough is understood about this phenomena to properly evaluate its detection possibilities, but at the same time no breakthrough in this direction seems to be in sight. For most systems, it is likely that relatively short-range sensors on aircraft are more feasible than long-range sensors on satellites.

[*The material in this article is digested by special permission from Appendix 3 of* *__Strategic Antisubmarine warfare and Naval Strategy__* *by Tom Stefanick*]

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DISCUSSIONS

THE D-5 SHOULD FLY

The recent failure of the TRIDENT II (D-5) submarine launched ballistic missile (SLBM) flight test has not gone unnoticed in the Congress or by the program's critics. Recently, the Senate Appropriations Subcommittee rejected any new procurement funding for the missile. Elsewhere, some critics, citing the missile's costs and asserting that it is a destabilizing first strike weapon, have even called for its abandonment. There is no truth in these allegations and not pressing ahead with the TRIDENT's weapon program would be injurious to the country's national interests.

The $155 billion price tag associated with the TRIDENT II's D-5 "system" in a recent editorial suggests to the unwary reader that this is the cost of the missile. In fact, the $155 billion figure includes, in addition to the SLBM, the costs of developing and procuring 20 super-survivable TRIDENT class submarines. These new subs are being built to replace the twenty-plus year old POSEIDON class boats in the mid-1990s. In light of recently observed improvements in Soviet submarine quieting and the fact that we cannot count on anti-submarine warfare technology to stand still over the next decade, such modernization is indeed prudent.

The actual cost of the missile itself is approximately one-third the figure cited above. The research, development and acquisition costs of the D-5 appear less objectionable when viewed from the proper perspective of total life-cycle costs. Most costs, for R&D, associated with the D-5's development have already been disbursed and the remainder of the acquisition costs will be spread over the next 10-15 years.

It is untrue that the D-5 undermines deterrence and that it is a first strike weapon. The deterrence of nuclear war has been the paramount U.S. national security objective of the postwar period. The U.S. has relied upon its strategic triad of land-, air-, and sea-based forces to maintain a stable deterrent balance between the U.S. and the Soviet Union. Principal qualities of the sea-based leg are its relative invulnerability and prompt response times. SLBMs strengthen deterrence by guaranteeing that the United States respond appropriately to any nuclear attack by the Soviet Union (or future nuclear power) against this country or our allies, irrespective of that attack's success against our ICBM or bomber forces. With the increasing hardness of the Soviet target base, the D-5's accuracy and yield-enhancements will allow it to engage a broader portion of enemy assets. This has stabilized deterrence because it provides this country with credible retaliatory options between the unsavory extremes of prompt capitulation and massive retaliation. Furthermore, any additional targeting efficiency resulting from the D-5's accuracy and yield improvements could provide additional flexibility in U.S. arms control positions. Hence, it is incorrect to argue that the less accurate and capable C-4 SLBM is sufficient for U.S. deterrence requirements, especially if full Peacekeeper or stealth bomber procurements are not achieved.

The most serious criticism of the D-5 is that its accuracy and short time of flight make it a potential first strike weapon, one that could destabilize a superpower crisis by placing Soviet weapons in a "use or lose" situation. While theoretically plausible, this argument is less convincing upon closer scrutiny.

The Soviet Union, like the U.S., is well aware that increasing missile accuracy threatens the survivability of fixed assets. To overcome this problem, and apart from any continued interest to active and passive defenses, the USSR is deploying two new mobile ICBMs, a new SLBM and the new TYPHOON class strategic submarine. Hence, in spite of increasing U.S. missile accuracy, a decreasing percentage of Soviet strategic forces is vulnerable to the use-or-lose imperative cited by critics of the D-5.

One should note that the entire TRIDENT fleet would never be at sea at the same time. More than half of the assets would be undergoing replenishment or overhaul or be in transit between home ports and patrol areas. It is not at all certain that sufficient D-5s would be on station to conduct a first strike against the USSR.

Even in the incredible scenario in which the U.S. planned a "disarming" preemptive strike, D-5s would have to be supplemented by ICBMs. If SLBMs were launched first, Soviet ICBMs could be launched from numerous unscathed silos before U.S. ICBMs arrived. And if U.S. land-based missiles were launched first with SLBM execution staggered to allow all missiles to arrive simultaneously, the Soviet Union would have substantial tactical warning to launch its missiles out from under the attack.

Fears of the destabilizing nature of the D-5 SLBM are less valid than often asserted by armchair strategists. In short, the calculus of deterrence is far more complex than sophomoric platitudes incorporating only missile accuracy, numbers of weapons and throw-weight.

Dr. John M. Weinstein

SUBMARINERS OR NUKES?

Submarine Officers are by definition warfare specialists. They are trained to fight and their readiness to go to war has not been questioned. The ability of the United States Navy to send almost its entire submarine fleet to sea on very short notice has been proven in major exercises. This demonstrates that the material readiness of the submarines is high. But what of the tactical readiness of the wardrooms?

Submarines are manned almost one hundred percent by nuclear trained officers. Their history of operating nuclear reactors is exemplary and this gives them the sometimes affectionate nickname of "Nukes". The real question that needs to be asked is, can these nuclear-trained officers also be just as effective submarine warriors. Or more simply put, "Are they Submariners or Nukes?"

Today's submarine officers are, from the very start of their careers, classed as Nuclear Officers. Their training begins at Nuclear Power School for 6 months and at a Nuclear Power Prototype for another 6 months. Finally, prospective submarine officers arrive at the Submarine Officers Basic Course. Only then do they actually learn something, albeit very little, about the art of operating a submarine. The Basic Course teaches submarine officers about the basic systems, organization, management, and operations of a submarine and touches on the basic tactics involved in operating a submarine during peacetime and against a hostile enemy.

After the Basic Course, young junior officers report to their first submarine with enough knowledge about nuclear power plant design and their operations, yet they are invariably sent into the engine room to qualify as Engineering Officers of the Watch. Three months later, they emerge as qualified EOOWs and attempt to gain knowledge of the rest of the ship to further their qualifications.

The qualification process leads a junior officer to becoming a Diving Officer of the Watch, Surfaced Officer of the Deck, Ship's Duty Officer and then seven months later, the proces of qualifying as an actual Submerged Officer of the Deck begins. For the junior officer, the total time which it takes to complete all of these and the final submarine qualifications is about thirteen months. The junior officer is exposed to some tactical information and operations -- about the same amount as a driver education student is exposed to freeway driving. The qualification process gives the young officer a minimum knowledge of the submarine and during his at sea evaluation he is tested on his safe-operating abilities. Rarely is there a test of the junior officer's ability to fight the submarine. Once the junior officer proves he is a safe operator, he is awarded the gold dolphins.

The junior officer considers this a major achievement and then begins to focus his attention on administrative matters. The major reason for this is that his C.O. views the newly qualified officer as no longer being burdened with qualifications and thus is able to handle a larger share of the paperwork. It is then up to the junior officer to take advantage of his new found freedom and apply himself to learn everything he can to become a real submarine warfare specialist. The junior officer, on his own, needs to increase his knowledge of tactics and become the warfare specialist that everyone expects. This requires extensive effort on the part of the individual. The average junior officer will find himself becoming overly involved in the actual operations of a division and this can take most of his time. But, the junior officer should count on his Chief Petty Officer to run the division properly while he serves in a supervisory capacity -- thereby freeing himself to study and learn tactics. This gives the junior officer a chance to learn the art of submarining.

Throughout his time onboard his first submarine, the junior officer should keep himself focused on the idea of being a warfare specialist.

The role of the Commanding Officer in the training of junior officers is of vital importance. The Commanding Officer should take every opportunity to train his junior officers in all aspects of operating and fighting the submarine. This requires an extraordinary amount of time and energy. But, the amount of administrative work that the Commanding Officer has to sort through might easily drag down the best of men. The very good Commanding Officers take every open time slot to get their junior officers qualified as OODs while putting them in challenging situations whether real or imaginary. At sea this means having sonar run a tape simulating a threatening enemy ship and observing how the junior officer reacts. This also includes the sending of even the more experienced officers to sea on other submarines when the submarine is in drydock for an extended period of time. The Commanding Officer must be the impetus for warfighting training and he must instill in his junior officers the drive necessary to keep warfare competence at the top of their priority list. And, the junior officer must continually strive to take every occasion to exercise his ability to operate the submarine aggressively and to keep his entire watch section proficient in detecting, evaluating, attacking, and evading a potentially hostile enemy.

Training during peacetime to prepare for war is a form of deterrence. The wardroom that keeps its readiness and knowledge-level high knows that it will be the wardroom that makes it back from a successful war patrol.

The amount of training seminars that the junior officer attends in one week is awesome. As a minimum he will enjoy one hour of divisional training, one hour of departmental training, one hour of EOOW training, one hour of DOOW training, one hour of Officer training, and one hour of training on his collateral duties (Quality Assurance, Scuba Diving Officer, Sound Silencing, etc.). As anyone can see by this list, there is only one place that tactical training can be incorporated -- into Officer's Training. But Officer's Training is usually not used for the purpose of developing tactical proficiency. Normal topics include Suicide prevention, Safe Navigation/Piloting, and Grounding and Collision avoidance. While all of these topics are necessary and important, can we say that tactical proficiency is less important?

Today, the amount of scheduled time that a submarine officer is able to spend on gaining tactical knowledge and improving the chances of surviving in battle is at best minimal. The tactical training of all officers should, however, be made the number one priority of every ship in the Navy. The training schedule should reflect this with at least one hour of every day devoted to tactical training. This would put the emphasis on warfighting. An increased amount of time devoted to tactical training will help to stress the importance of being a submariner first and a nuclear officer second.

Another yardstick to measure nuclear training against submarine training is the time spent for advanced training in each area. Some of the junior officers are able to attend a two week school, Junior Officer Tactics Training, which further increases the junior officer's knowledge of how to operate and fight the submarine. This is in stark contrast to the required extensive two-month school, Prospective Nuclear Engineer Officer course. This teaches the developing junior officer everything that Naval Reactors feels is important to learn about the nuclear power plant.

The examinations that the submarine goes through do little to help improve the tactical proficiency of the junior officer. Every year a submarine experiences the Operational Reactor Safeguards Exam and the Tactical Readiness Exam. Prior to and during the former exam junior officers are hard at work preparing for this test. Each reactor exam requires three Engineering Officers of the Watch to train the watch sections and stand the watch during the exam. In dramatic contrast, the tactical exam tests the submariners tactical abilities, but the role of the junior officer is reduced to that of an evaluator or coordinator. What is really tested is the Commanding Officer's ability to fight the submarine. This reasoning seems to point to the fact that the CO will be on the CONN during any hostile encounter and that battle stations will be manned; but during a casualty in the propulsion plant, the Engineer will not be in charge of reactor operations and the junior officer and his watch section must handle the casualty alone. These are starkly different views. The junior officers need time for actually operating the submarine to increase both their confidence and their knowledge of handling the submarine. The tactical exam needs to be restructured to test not only the functioning of the battle stations team but also the ability of the junior officer and watch section to successfully engage a target of opportunity during hostilities. This improves the ability of the Commanding Officer and his junior officers in their warfighting.

The United States Submarine service has not been accused of being unable to fight successfully. This is in part due to the large margin of acoustic advantage enjoyed by our submarines and to the relative ineffectiveness of enemy anti-submarine surface and air platforms. But both of these aspects are changing for the worst. Current and future submarine officers must learn to fight a submarine which is almost equal to enemy submarines and not as easily hidden from the other enemy forces. To account for these equalizing capabilities, the submarine force must first acknowledge that there is a deficiency in the tactical training of the officers and then add to the training pipeline's extensive requirements to emphasize tactical proficiency. This will ensure that the submarine force maintains its warfighting edge and its tradition of having the highest warfighting readiness of any section of the U.S. Navy.

The Submarine Officer should be a warfare specialist. The nuclear training that he receives is required to ensure the safe operation of the naval nuclear reactors. However, there is little doubt that this training should be supplemented with an increase in tactical training.

Submariners or nukes? The answer is both. The important thing is that out junior officers be trained to be submariners first and foremost. There is no insignia showing nuclear qualifications. The gold dolphins have a ***submarine*** in the middle -- not a nuclear reactor. This fact should be brought to the attention of anyone questioning whether they are "Submariners" or "Nukes."

LT Wade H. Schmidt, USN

■

DROWNINGS IN THE SUBMARINE SERVICE?

There have been at least four drowning deaths in the last twelve months in the Submarine Service. It is time for an examination of procedures and the life saving equipment made available to our sailors. This is not a new hazard!

The recent events aboard the BARBEL are an embarrassment to the Submarine Service. It is easy to say, "Well, it was their fault." They were not following good submarine practices by not wearing harnesses and kapok jackets." I suspect a "Personal for" has been issued. That is traditionally what is done and the problem is called "fixed." But is it? Let's do more this time.

In 1978 there was a series of drownings and we did exactly the same thing. We became strict for awhile about wearing kapok life jackets and harnesses.

If a problem continues to resurface, is it solved? Should the particular "solution" to this problem be re-examined?

"But the new Type 1 life vest provides the best buoyancy for an unconscious victim," it is argued. Certainly, for a sailor who is unconscious and in the water there is nothing currently available to him that provides more buoyancy than his Type 1 life vest. Few sailors realize how likely they are to be unconscious once they end up in the water. 35% of those who go overboard are incapacitated in the process. Very few however, receive critical injuries before entering the water. Contrary to popular belief, in almost every case a normal evolution precedes an injury and a proper safety harness could have prevented the immersion all together.

Then how do the majority of victims end up unconscious? They swallow or inhale a large amount of salt water as they hit the water. These men do not immediately lose consciousness. There is sufficient medical evidence to prove that an individual does not black out instantaneously. He looses consciousness about sixty seconds later.

In the past year there have been three submarine personnel merely injured as they dangled from their safety harness. These harnesses force the individual to hang from a hook in the middle of his back. Who could possibly help himself in that attitude? Even the latest innovation, the turning line, is of little value other than as a nuisance. Of note, turning lines are not being universally retrofitted. If the hooks were in front on the harness, an individual would have a considerably easier time conducting a self rescue.

Now for the most controversial question - Why do sailors prefer not to wear their life jackets topside? The answer is quite simple; the jackets are bulky, cumbersome and very hot. For the submarine service, the traditional Type 1 life jacket is simply not an appropriate piece of gear. There must be a better answer.

The time has come for a technical evaluation of the safety harness and life jacket duo. As an initial suggestion, it is recommended that commercially available harnesses and inflatable life jackets be used in combination. An inflatable jacket? Why not? It provides equal or greater buoyancy than a traditional jacket. Most commercial inflatables are rated at 45 lbs of positive buoyancy, while Type 1's rate at either 21 or 32 lbs of buoyancy. With commercial combination there would be no excuse for not wearing a harness or jacket. The commercial gear would be very light weight, significantly more comfortable and dramatically cooler. Below decks, finally, two people in life jackets could pass each other in the passageway. Aviators have acknowledged the value of the inflatable in their "fanny pack," with a single CO_2 cartridge to inflate it. An integrated harness and vest however, would have two chambers and two CO_2 cartridges.

The integrated harness is meant as a security harness and a device to prevent an individual from washing overboard in the first place. A deck security harness is frequently confused with a harness intended to protect a man working aloft. They are very different devices. The deck security harness and the safety harness for working aloft should be two entirely separate and unique harnesses.

For ten years composite harnesses have met with total success aboard recreational and commercial craft. No one has drowned wearing one of them. There are currently over 12,000 of these harness-life jacket combinations in use today. Made of extremely strong synthetic fibers, integrated harnesses are not subject to the rotting problems of Kapok jackets.

As a final comment on security harnesses, in a well publicized accident several people nearly drowned on the sailing vessel PRIDE of BALTIMORE because they could not escape their harnesses. Within the last year two submarines have inadvertently submerged while on the surface. The outcome would have been significantly more disastrous had personnel wearing harnesses been topside. Also, some men have died because they were dragged backward by their harnesses and were unable to escape. The commercial industry has adopted a harness with a positive-action release at both ends of the lanyard. The Navy should certainly consider this modification to its current harnesses provided they are worn in conjunction with some form of life jacket.

The U.S. submarine force regularly applauds the seamanship of our fraternal brothers, the Brits. They wear inflatable life vests. Maybe we should be taking a lesson from them and recognize that the traditional Kapok jacket and chain safety harness have become outmoded. There is an obligation to provide our sailors with the best safety equipment the Submarine Navy can afford.

Christopher Carver

■

THE SEAWOLF SCALE MODEL

If the next generation of U.S. subs has quieter propellers or includes unmanned craft, those subs will be the grandchildren of the $64 million SEAWOLF (SSN-21) scale model docked here at Sandpoint, Idaho.

Long after the first SEAWOLF class attack submarine is launched, the self-propelled, computer-controlled model here will continue to be useful, says the Admiral in charge of the SEAWOLF program, Rear Admiral Millard Firebaugh. "I envision that this vehicle will be used to test propellers for many generations of submarines to come." he said in an interview last summer. Trained as a naval architect, Firebaugh is overseeing the design and construction of the Navy's first new class of attack submarines in 18 years.

Firebaugh was in Bayview last June to review progress on the testing of quieter propellers, a major component of the work at the David Taylor Naval Ship Research Center's acoustic research detachment in Bayview, which is near the northern tip of the Idaho Panhandle.

Here at the foot of 40-mile long and 1,100-foot-deep Lake Pend Oreille, the Navy has tested submarine models and propellers since 1942.

Because quiet running is a major goal of submarine warfare, underwater noise researchers here were among the first people to see what the SEAWOLF class subs will look like.

"We kind of had the first look at it because we had the first models," said George Guedel, the manager of the acoustic research station at Bayview.

In addition to running the working model through an underwater forest of hydrophones and other listening devices, the Navy has buoyancy-propelled models used to test the noise generated by a hull as it travels through the water.

For those tests, researchers use a non-self-propelled model nick-named "Kamloops." The model is hooked to a cable, pulled to the bottom of the lake and then released. Researchers train their sonar on it as it rises.

"There are two areas of development," said Guedel, -- "one is to reduce the noise the sub makes as it moves through the water and the second is to reduce the noise which the sub radiates which can be detected."

The first is the bow area noise the sub makes as it pushes through the water which interferes with its own sonar. The second is noise from people and machinery inside the sub.

Most test runs occur at night, when the lake's waters are quietest. The sensors listening to the sub would be overwhelmed by a small outboard motor on the lake five miles away, rain or the water, or waves whipped up by wind.

The use of the self-propelled model marks a radical change in Navy propeller design testing and in the type of research at Bayview.

In the past, new propeller designs were tested by manufacturing full-sized prototypes, which had to be placed on full-sized submarines and tested in the ocean, where background noise can overwhelm sensitive listening devices.

The prototypes were expensive to make and the testing work took working subs out of service for lengthy periods of time.

So, when the SEAWOLF program got under way, the Navy decided to try testing propellers a new way: quarter scale on a scaled-down model in Idaho's Lake Pend Oreille.

Built in San Antonio by Sperry Corp., the self-propelled model is nick-named "Kokanee" after a local land-locked salmon. It was delivered to the research base by rail and launched from a special launching track built in the backyard of a local sawmill.

Standing in a dry dock at the bow of the 88-foot-long model, Firebaugh said the battery-powered, computerized sub has already shaved years off the design of a quieter propeller.

Despite whistleblowers' claims that the model has never worked properly, Firebaugh said it was pressed into service more quickly than he expected and is now working well.

Captain Davis, who is overseeing the acoustic testing program said the Navy has been able to test five different propeller types in six months with the "Kokanee."

Contrast that with prior propeller testing. When the propeller was designed for the now-aging LOS ANGELES class subs, it took 10 years to test it, Davis said.

In the process of building a sophisticated propeller tester, the Navy has developed one of the largest and most responsive underwater vehicles around. "As a hydrodynamic test vehicle, this is more sophisticated than anything the Navy labs employ," said Firebaugh.

The computer navigation and operation equipment may have some interesting uses in the future, the admiral said, though he declined to specify whether the Navy is working on an underwater "drone" similar to the Israeli Army's remote-controlled air reconnaissance drones. "It is certainly an interesting technology. The Navy is interested in the technology of autonomous underwater vehicles."

As the SEAWOLF project has moved forward, the base at Bayview has grown. In 1986, the base employed about 20 people. Now there are about 35 government employees and 75 federal contractor employees at the base.

In the fall of 1986, the Navy floated a $3 million barge onto the lake to house research equipment. Two stories tall and 190 feet long by 60 feet, it was custom built by the Dix Corp. of Spokane to house the SEAWOLF model. And last spring, the Navy added a 140-by-7-foot barge at Bayview to hold a $1 million workshop. The base is also, at times, used by private firms doing government contracts and by NATO scientists, particularly the British.

Dean S. Miller

■

NEW IDEAS

HIGH DATA-RATE COMMUNICATIONS TO DEEPLY SUBMERGED SYSTEMS

There is a need to develop a high power, high data-rate, extremely low frequency (ELF) communications system that will allow faster, deeper communications with submerged submarines and other undersea systems.

The only electromagnetic waves able to penetrate deep into the ocean are those that are generated at extremely low frequencies. The rate that data can be transmitted at these extremely low frequencies is a function of the effective radiated power of the generated signals. The current U.S. ELF system for communicating with submerged submarines is located in Wisconsin and Michigan. Because the system radiates at very low power (2-5 watts) its ability to communicate with submarines is severely limited -- it only serves as a "bell ringer" to direct submarines to come to shallow depths and deploy their antennas to receive messages at a higher frequency. While the current U.S. system accomplishes its necessarily limited mission, it has the obvious disadvantages of lack of timeliness and increased submarine vulnerability -- submarines lose time in ascent and are more susceptible to detection at shallow depths.

In the past decade, research at several institutes and universities has demonstrated a practical, new method for generating ELF waves. ARCO Power Technologies, Inc. has extended this research and formulated a concept for a higher power ELF communication facility of significant military value. While the facility's operation would initially be focused on proof of concept, it would have operational utility for the U.S. Navy the minute it begins transmitting. And it would be built in such a way as to permit its rapid expansion into a full operational facility that would complement the current Wisconsin/Michigan ELF site by providing up to 100 watts of radiated power, allowing deeply submerged submarines to receive data at depth, in quantity, and in real time.

This new system would enhance the deterrent value of the U.S. strategic submarine fleet and would also enable the U.S. Navy to take on new strategic and tactical missions due to:

- Enhanced communications with deeply submerged submarines;
- Real time control of command activated mines, mobile mines, and unmanned undersea vehicles;
- Real time targeting/retargeting of SLCMs;
- Enhanced C^3 for ASW; and
- Capability to jam enemy ELF systems.

<u>How the New ELF Communications System would work</u>

High Frequency waves that have been modulated at extremely low frequencies are radiated into the lower ionosphere. These ELF-modulated high frequency signals create disturbances in the earth's electrojet -- a naturally-occurring current that flows in the lower ionosphere in the earth's polar and equatorial regions. These disturbances create a large antenna that radiates signals at extremely low frequency, corresponding to the modulation of the high frequency signal.

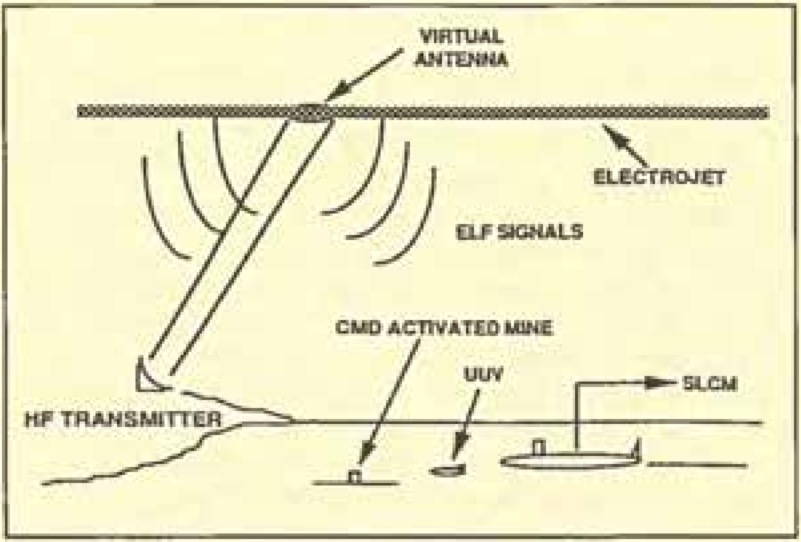
The resulting ELF signals can be received anywhere in the world and are capable of penetrating deep into all the oceans. The high strength of the created signals is attained by scanning the high frequency transmitted beam across the lower ionosphere to increase the size of the ionospheric antenna.

The new ELF system would require a 2000 ft^2 control facility which could be trailer-mounted, plus a one quarter square mile antenna farm that is sparsely populated with simple antennas raised approximately 50 feet off the ground. (This compares to the current Wisconsin/Michigan site that includes 148 miles of buried cables, transmission facilities, and a 28-mile above-ground cable antenna.)

The new system should be located in the U.S. as far north as possible to take maximum advantage of the polar electrojet phenomenon. This argues for a site on the north slope of Alaska. Several options are available that would permit integration into the existing North Slope industrial infrastructure.

Special features comprise:

- Up to 50 times faster message transmission;
- Worldwide ELF coverage from a single transmitter site;
- The system is jam resistant as result of frequency agility;
- It uses a relatively small, relocatable transmitter.



F. J. West, Jr.

REGULUS PROGRAMS

Regarding David Stumpf's need for REGULUS material, we have four submariners in the Orlando area who may be of help to him. CAPT Mike Sellars, USN(Ret.), COMSUBRON ONE during REGULUS I and II tests; CAPT Joe W. Beadles, USN(Ret.), COMSUBDIV III during the tests; CAPT Pete Burkhart, USN(Ret.), CO of a REGULUS launching sub, and CAPT Maury Horne, USN(Ret.), Flag LT and then Ops Officer for COMSUBPAC during that period.

A meeting could be set up here for a mutual exchange of information which, in spite of a 30 year lapse of time, may be of use to Dr. Stumpf.

This use of the NSL is a good example of furthering the objectives of the NSL.

Mike Sellars

P.S. A good article by Chick Clarey!

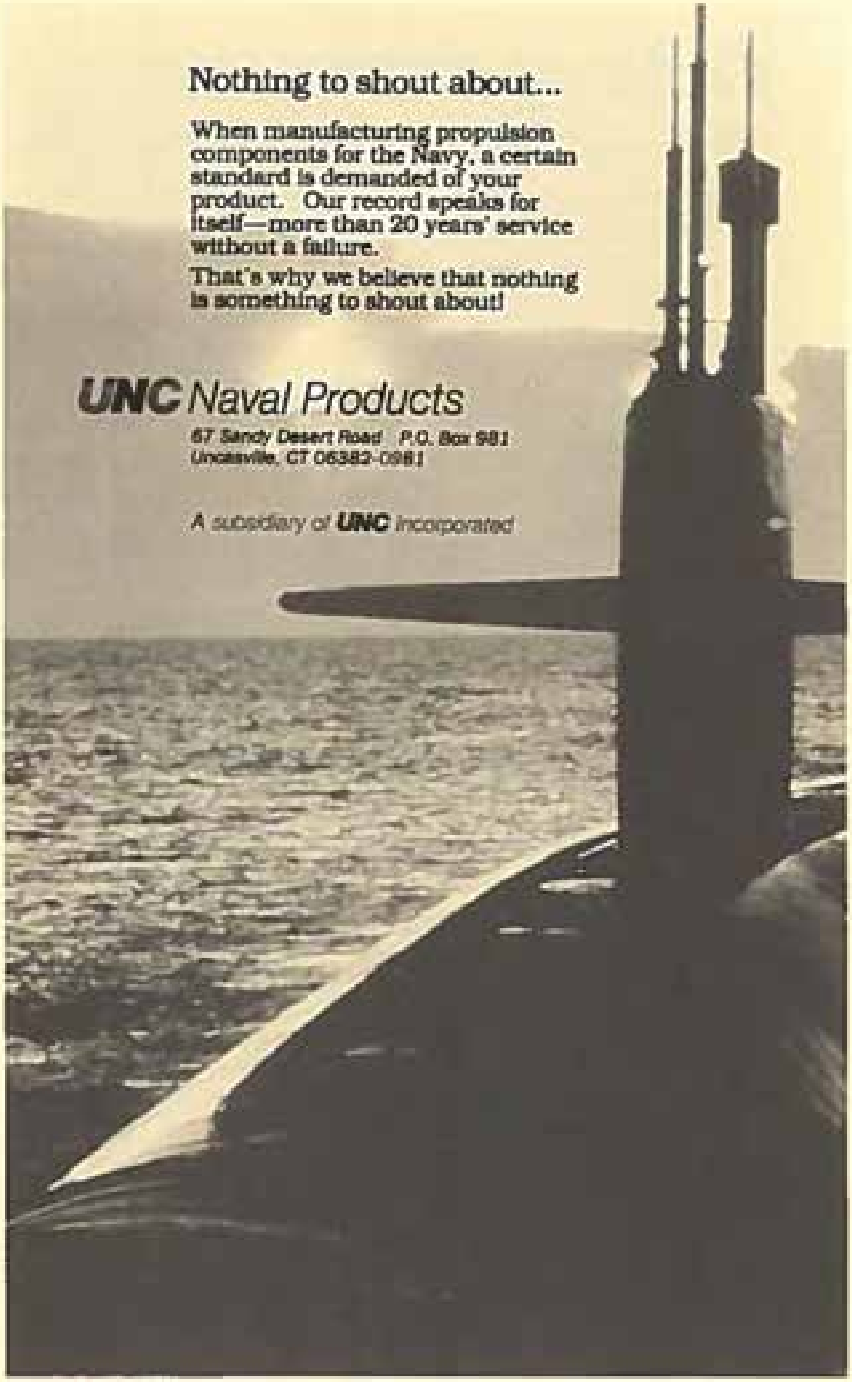
■

REGULUS PROGRAMS

Relative to Dr. Stumpf's request for information on the REGULUS programs: I was commissioning Executive Officer of the USS HALIBUT (SSGN 587), with Walt Dedrick, the Captain, and Chuck Baron as Weapons Officer. HALIBUT was designed to carry four REGULUS Is or four REGULUS IIs, but when the REGULUS II program was scrapped, we figured out how to carry five missiles. I was transferred after the shakedown cruise and relieved by John Mangold. Bus Cobean relieved Walt Dedrick after a patrol or two. I then became Submarine Squadron One Material Officer for a short time. As such, I tried to assist in keeping all five of the REGULUS boats in good condition. The information I have relates to the period between late 1958 and late 1961.

Rear Admiral Paul J. Early, USN(Ret.)

■



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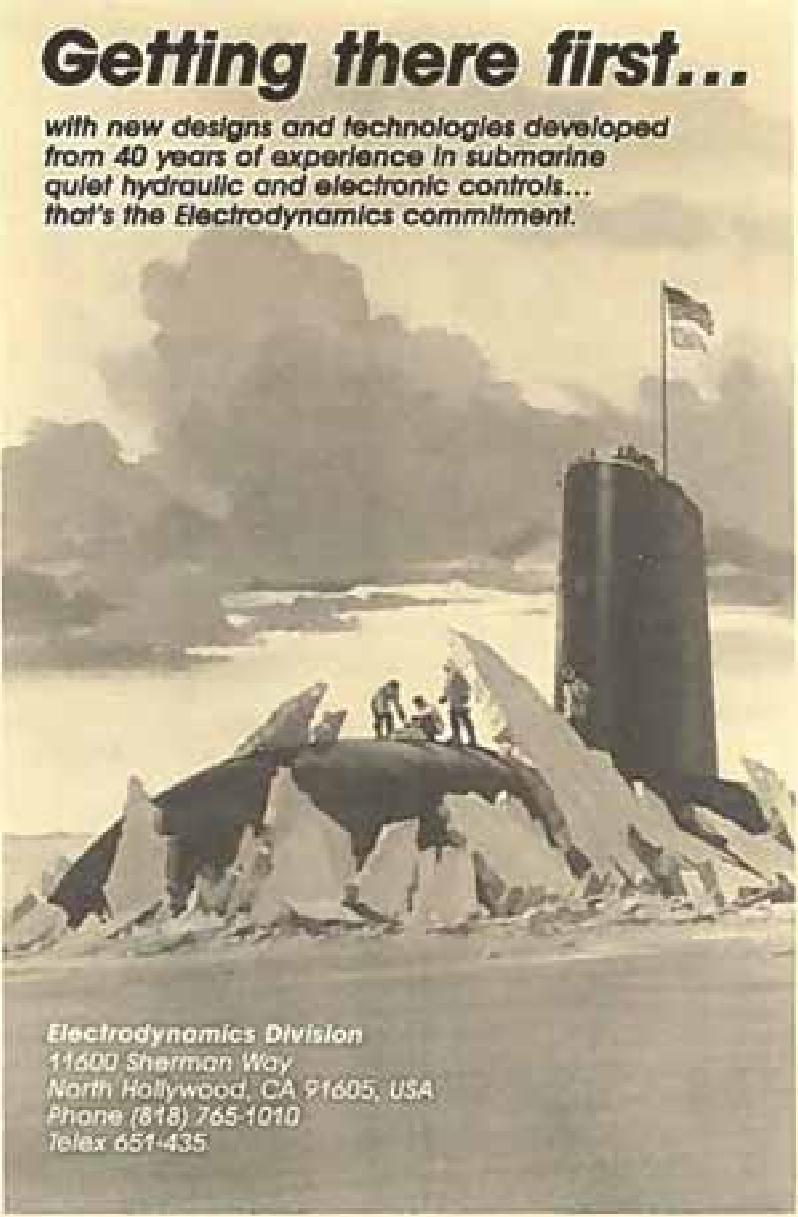
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GERMAN SEEHUND INFORMATION?

I found K.J. Moore's emerging technology article in the October issue of THE SUBMARINE REVIEW excellent. If it can be interpreted as nibbling at the edges of prejudice, as I have so interpreted it, I think the open forum concept is alive and well. Congratulations.

I was also glad to see "want ads" by writers on page 91 of the October issue. I would appreciate it very much if you could print the following item for me in the next issue:

I am writing a history of the modern submarine and would appreciate any information from support staff or operational participants in tests of German Seehunds at Key West and Fort Lauderdale, June-September 1945. Please respond to Richard J. Boyle, P.O. Box 157, Los Ojos, NM 87551-0157. (505) 756-2543.

Dick Boyle

■

SUBMARINE FORCE'S 90TH BIRTHDAY

NSL has opened a dialogue with OP-02 concerning a joint NSL/Navy effort in 1990 to produce a pictorial publication commemorating our 90th birthday. Our goal would be to complete the project in time to be available at the various 91st submarine birthday balls in 1991. If warranted, the 90th commemorative would serve as the baseline for the 100th! Those NSL members wishing to assist with time, effort, advice, personal photographs, or whatever, are requested to write or call:

Naval Submarine League
P.O. Box 1146
Annandale, VA 22003
(703) 256-0891

■

IN THE NEWS

o The Defense Department's Soviet Military Power 1989 notes:

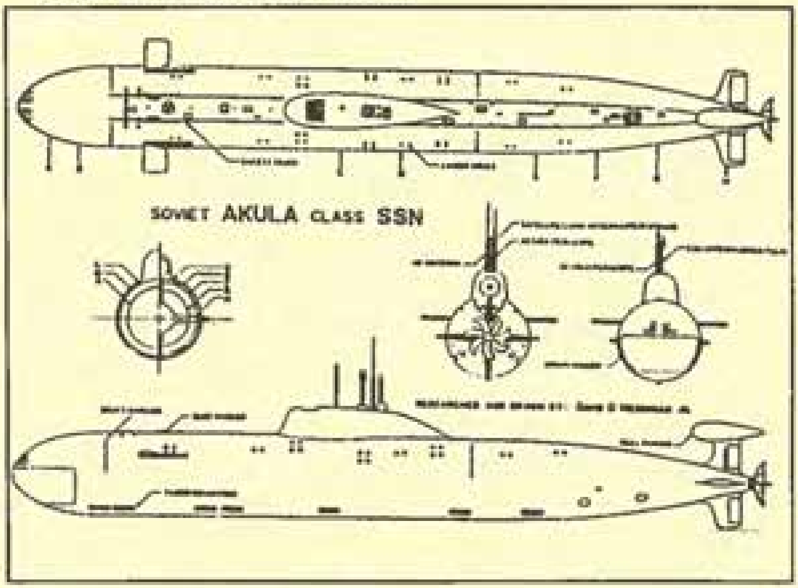
> The development of the SS-N-21 SLCM, a nuclear land-attack cruise missile which became operational in 1987, is one of the most significant Soviet submarine-related developments in recent years. The SS-N-21, which is launched from torpedo tubes, may be carried by specific classes of properly equipped current-generation or reconfigured submarines. This complicates Western threat assessments since some newer-generation SSNs are more versatile and can also function as strategic strike platforms.
>
> The Soviet's emphasis on improving their ASW capabilities is reflected by the introduction in recent years of two new classes of SSNs (AKULA, SIERRA) and by the increasing numbers of improved ASW aircraft and surface ships. New Soviet SSNs have demonstrated marked improvement in quieting at specific operating profiles that approaches that of some later-generation U.S. SSNs.

o NAVY NEWS & Undersea Technology of 13 November reports India's intention to return their CHARLIE-class nuclear cruise missile submarine to the Soviets. It was leased in January 1988 and renamed the CHAKRIS. It has reportedly suffered from radiation leaks and is linked to the death of an Indian scientist who spent time aboard. An Indian official said the lessons from the CHARLIE will be applied as India moves to develop nuclear propulsion for submarines.

An article in the 28 October edition of the same publication reported that India would lease a second CHARLIE early next year and it will be named CHITRA.

o Jane's Defense Weekly of 24 June shows the Soviet AKULA submarine and notes that the Soviet Navy has four of these submarines operational with a fifth being built.

Note the curved blades of the propeller and the shape and fairing of the submarine's sail. A look-alike of the ALFA, it "produces noise levels that the U.S. had not projected the Soviets to attain until the early 1990s" according to Rear Admiral Brooks, Director of U.S. Naval Intelligence, and carries the torpedo tube launched SS-N-21 2,000 km range cruise missile.



o NAVY NEWS & Undersea Technology of 20 November tells of Soviet experiments with an air-independent submarine named the BELUGA. It uses a closed-cycle diesel and carries oxygen "usually in liquid form" for the combustion. Also, "for thermodynamic efficiency, Western researchers have found an inert gas, such as argon, must also be injected in the intake." The BELUGA at 1900 dived displacement tons is smaller than the Soviet's mass-produced conventional submarine KILO, but travels faster submerged at 22 knots than the KILO's 20 knots. With 5,350 shaft horsepower (shp) compared to the KILO's 4,000 shp, the BELUGA's speed does not reflect the disparity in power-to-weight ratio.

o Maritime Patrol Aviation of October 1989 notes that the Indian Navy has taken delivery of its sixth "export version" of the Soviet KILO-class diesel electric submarine.

And, Israel has decided to acquire two DOLPHIN-class submarines from HDW West Germany, with Litton-Ingalls Shipbuilding managing the program which will use $180 million in U.S. foreign military sales money. Also, Italy is building a closed-cycle diesel engine 300-ton submarine, the S-3000, which will have an endurance of 1400 nm at 6 knots, be manned by seven men and will carry four Whitehead A-184 torpedoes.

- o Navy News & Undersea Technology of 13 November notes that the U.S. Navy "would like to use HY 130 steel on later-model SEAWOLF subs -- for even greater hull strength." Only Japan and Sweden reportedly have the technology to make HY 130 steel of the type needed for the SEAWOLF. Japan Steel Works make HY 130 steel for hydro-cracking equipment used in American oil refineries and a Commander in the Japanese Maritime Self-Defense Force confirms that Japan can make submarine hulls of this steel.
- o A PROCEEDINGS/October 1989 article by LT Stephan Flynn of the U.S. Coast Guard notes that in World War II, 338 mines laid by the Germans' submarines temporarily closed all the ports on the East Coast. "The vital naval port of Charleston, SC, remained closed for 13 days. Current Soviet mines are far superior to those German mines." Estimates of the Soviet stockpile of mines run as high as 400,000 mines of all types. The author says that the Coast Guard could make a major response to a mine threat against East Coast ports by equipping their vessels larger than 41-foot utility boats with a portable side-scan sonar for mine location and a state-of-the-art Loran receiver for navigational accuracy. Then they could "use divers on board the cutters to defuse located mines." In addition, the possibility of seeing Soviet Spetznaz forces landed from submarines "to infiltrate enemy territory before the outbreak of war to destroy major economic and military installations" must be considered, and the Coast Guard has had the responsibility of port security since World War I. Also, Flynn feels that strategic arms control agreements are likely to produce "a decline in numbers of submarine-based nuclear missiles which would mean that more Soviet attack

submarines would be free to operate overseas and in U.S. coastal water." Flynn doesn't want to see a repeat of the U-boat slaughter of our merchant ships off the Atlantic coast as in World War II and recommends that the Coast Guard be made more capable to provide an ASW defense.

o SEA POWER/ July 1989's article on ASW by L. Edgar Prina tells of the "crisis" facing the U.S. Navy due to "the increased capabilities of Soviet submarines over the last several years." As emphasized by Melvyn R. Paisley, assistant secretary of the Navy for research, development and engineering, in March 1987:

> *"We are faced with a crisis in our anti-submarine warfare capability which undermines our ability to execute the [U.S.] maritime strategy."*

Prina then notes:

> *"The reality of the increased capabilities of Soviet submarines over the last several years has finally sunk in.*
>
> *The Soviet improvements have been across the board -- in diving depth, speed, sensors, sturdiness, and silencing. Of these, silencing is by far the most important.*
>
> *The reason for U.S. concern is obvious. The quieter the opposing submersible, the more difficult it is to detect and destroy it. And, if the U.S. Navy's ASW capabilities were to be seriously eroded, it would have a profound impact on: (1) this country's ability to reinforce its NATO allies in Europe; (2) the survivability of the Navy's aircraft carrier battle groups; and (3) the defense of America's coasts from missile-firing submarines. But do something we must; we must build what will amount to an entire new ASW capability by the time the Soviet Union has built a significant number of new submarines."*

According to Rear Admiral Thomas A. Brooks, the director of naval intelligence, the Soviets currently have a force of about 30 modern submarines as first-line ASW platforms -- about one-third of their SSN order of battle. The 30 include a few of the relatively new AKULA and SIERRA classes and more of the Victor III type.

"AKULA produces noise levels that the United States had not projected the Soviets to attain until the early 1990s,"

Brooks said. By "noise levels" he meant, of course, *non*-noise levels -- i.e., the newer Soviet SSNs run much more quietly than their predecessors and are therefore much more difficult to detect by acoustic means.

What may not be known to U.S. intelligence is whether the Soviets intend to backfit their new silencing technology into the VICTOR IIIs and earlier SSNs already in the active fleet.

[Ed. note: Although these "3rd generation" Soviets subs create a significant ASW problem for our attack submarines, they do not force our submarine force to shift to a new primary mission -- either intelligence collection or land attack using cruise missiles -- as evidently called for by some alarmists. By the year 2000, there should be no more than about 50 such very quiet Soviet nuclear submarines, while the rest of the present submarine force of over 300 submarines although they may be backfitted with some silencing techniques and become quieter they are not likely to have the quietness of the 3rd generation Soviet nuclear attack submarines. The much publicized improvement of propellers to reduce noise is only one of many sound quieting measures which are necessary to achieve great quietness. Additionally, there are more than 400 submarines in the rest of the world (excluding the Soviet submarines) which might have to be dealt with and which are not backfitted with new sound silencing techniques].

o SEA POWER/July 1989 also has information on the new periscope for attack submarines: A "non-penetrating periscope," intended for use aboard LOS ANGELES-class (SSN-688) and next-generation SEAWOLF-class (SSN-21) nuclear-powered attack submarines, will provide electronically-generated images of a wide range of sensor data unobtainable with conventional optical periscopes.

The Kollmorgen system will consist of a rotating sensor module, or pod, mounted on a mast built into the free-flooding sail of the submarine. The two-stage mast will be extendable to 20 feet above the top of the sail. The sensor pod will contain a television camera capable of scanning both the sky and the surface of the sea. An infrared sensor will provide thermal images for night operations. The sensor pod also will be equipped with an electronic support measures (ESM) receiver, for passive detection of surface and airborne threats.

The TV (color or high-resolution black and white) and thermal (infrared) images will be shown on either of two monitor displays -- built by Singer Librascope -- housed in a single console.

The Naval Sea Systems Command (NAVSEA), in cooperation with DARPA, will install the Kollmorgen prototype aboard the nuclear-powered attack submarine USS MEMPHIS (SSN-691) in June 1990 for testing.

o The Foreward to <u>Jane's Fighting Ships</u> 1989-90, by the editor, Captain Richard Sharpe, RN(Ret.), in summarizing the status of naval activities worldwide, provides some information as recorded here:

New Soviet submarines are entering service at the rate of about five/six nuclears and four diesels (with three for export) per year, which is a reduction on new hull numbers, but not in weapons capabilities. The increased size and magazine capacities of the TYPHOON and OSCAR II classes more than compensate for the slight reduction in annual building rates over the period. TYPHOON and DELTA IV class SSBN programmes continue and new attack submarine production centres on the lengthened OSCAR II SSGN at one a year, the AKULA SSN, also at one a year (which could double if normal precedent is followed and a second yard is involved), the VICTOR III at one a year and the SIERRA at one every other year. The AKULA is the multi-purpose successor to the VICTOR with the SIERRA being the much more expensive follow-on to the titanium hulled 45 knot ALFA class. In addition, the nuclear attack submarine numbers are being augmented by the conversion of the older YANKEE class SSBNs, which have had their ballistic missile tubes removed so that overall SLBM numbers remain within SALT limits. Three have completed conversion with an enlarged central section, which it is assumed is a cruise missile/torpedo/mine magazine. The conversion takes about two years and up to another 13 of the class are in dockyard hands.

The impression of Soviet incompetence is too easily overstated. Ships and submarines deploy for long periods and seldom get into difficulties. In the Indian Navy, which is in the unique position of being able to make direct equipment comparisons, at least one commanding officer is on record as preferring the robust, simple and workman-like Soviet weapon systems to the complicated, manpower intensive, and less reliable technology of the West. And how much tactical skill do you need to launch a homing torpedo or guided missile against economic and reinforcement shipping, which by its own admission NATO has insufficient forces to defend? Time and again the eye is caught by the sheer numbers of modern submarines and major warships. Neither should we forget the weight of experience which is slowly being acquired, not least by contact at sea with Western navies. If self criticism is allowed to flourish and Command initiative given some encouragement, this could become a navy with even more formidable potential than it has already. Forecasts of the development of the Soviet Fleet in the next decade tend to focus on the speed of the technology transfer by a combination of Western commercial greed and Soviet theft and espionage, all of which in the Gorbachev era are flourishing as never before. Of greater significance would be liberalization of their officers and men from the dead hand of central control and slavish adherence to the training manuals. Although this is an issue recently much discussed in Soviet military journals, there are few signs yet that it is having much of an impact at sea.

o SEA TECHNOLOGY/October 1989 has an article by Arthur Lee and Brian James on "Power Sources for Unmanned Underwater Vehicles." The goal of the current UUV Prototype Program of the Defense Advanced Research Projects Agency (DARPA) is to produce a prototype platform. The current design calls for an energy subsection of 104-inch length with a usable inner diameter of 39 inches.

The power source for this prototype is a secondary silver-zinc battery with a usable energy density of 65 watt-hours per pound. The battery will provide 300 kilowatt hours of energy. But the energy objective is to provide a power source of 3,360 kilowatt-hours representing a draw of 10 kilowatts for 36 hours.

For the current design, a vehicle transit speed of 9.5 knots with an active payload requires 14.5 kilowatts and an on-station loiter draw of 2.5 kilowatts. So, for 3,360 kilowatt-hours a mission profile of 1,000 nautical miles transit radius with 184 hours (7.7 days) on station or 650 nautical miles transit radius with 590 hours (24.6 days) on station is possible. Of the attractive power sources examined, the advanced proton exchange membrane cell (APEM) was found to be the most suitable for a compact, mobile application like the UUV.

The APEM cell uses a thin ion exchange membrane in place of a flowing electrolyte. This polymer membrane, also called a "solid polymer electrolyte," consists of a perfluoro linear polymeric backbone with immobilized side chains of sulfonic acid radicals. The electrodes are fabricated with a thin film of platinum catalyst supported on carbon and are bonded onto each face of the solid polymer electrolyte. At the anode, hydrogen gas becomes ionized and the electrons are fed to the external load. Hydrated hydrogen ions diffuse through the polymer chain from anode to cathode. At the cathode, the hydrogen ions react with the oxygen molecule and the electrons to form water.

The use of a membrane instead of a flowing electrolyte allows the cell to operate very simply, with few moving parts, and the cell occupies only a small volume relative to the fuel and oxidant volumes. In addition, the APEM can operate at a low temperature (180°-200°F), allowing a quick startup time when used with H_2 and O_2. When a complex fuel is used, an external hydrocarbon reformer or fuel processor is required to react the fuel with water to generate hydrogen for use in the fuel cell.

Liquid oxygen was found to be the most volumetrically efficient means of oxidant storage for mission durations of up to six months. The combination of a chemical hydride and LOX can offer as much as nine-fold improvement in UUV mission time over the baseline silver-zinc system, but the combination of a hydrocarbon fuel and LOX was found to be the best overall performer in terms of enhancement of mission capability and minimization of logistic burden.

o SEA POWER/November 1989 in an article by James D. Hessman says that "Despite Gorbachev's rhetoric about cutting the USSR's defense expenditures, the Soviet Union today spends an estimated 15 to 17 percent of their gross national product on defense, while the U.S. spends less than 6 percent." And, that Secretary of Defense Cheney disclosed that the Soviets have "opened a second production line for the AKULA-class cruise missile submarine."

o A report by Admiral C. A. H. Trost on the posture and Fiscal Years 1990-91 Budget of the U.S. Navy includes these thoughts:

> *I am particularly mindful of Soviet submarine capabilities and the threat they pose to our ability to support our interests and allies overseas. Thus our own antisubmarine warfare efforts remain my top warfighting priority. The new SSN-21 SEAWOLF attack submarines and the Long Range Air ASW Capability Aircraft are the essential next generation of ASW forces. There are no silver bullets or easy pat answers to ASW. Nor is there a technical breakthrough on the horizon to make ASW simple. The combined efforts of all our ASW forces -- surveillance systems, attack submarines, ASW aircraft and helicopters, and surface combatants -- are needed to defeat a large submarine threat. To succeed at ASW you have to do it the old fashioned way; work hard, keep the pressure on enemy submarines in their home waters, and combine all forces at your disposal. Numbers and capability make the difference in ASW -- a lesson we learned in World War II that remains valid today.*

o NAVY NEWS & Undersea Technology of 21 August says a presidential report on the TRIDENT's D-5 missiles suggests that if a new arms reduction agreement requires a reduction in nuclear arms, "TRIDENTs might carry fewer than 24 submarine-launched ballistic missiles. To stay within the guidelines of a potential treaty, the report suggests reducing the number of missiles carried on each sub in order to keep the number of TRIDENTs high. The alternatives for the U.S. are either to develop an entirely new SLBM with fewer warheads or reduce the numbers of missiles per submarine. The 475 kiloton warheads of the D-5 are the first SLBM warheads sufficiently large and accurate enough to eliminate Soviet missile silos and bunkers."

o NAVY NEWS & Undersea Technology of 14 August tells of a study done by the Congressional Research Service which looks at the effects on submarine force numbers if current shipbuilding plans are followed. "If budgetary pressures limit the Navy to two SSN-21s per year, the sub fleet size drops to the low-to-mid 80s by the year 2005 and stays there. The only other possibility for maintaining a 100-boat force is to extend the service lives of our SSNs beyond 30 years. But it is not clear whether this option is either technically feasible or cost effective." The Navy 21 study -- an examination of the service's needs in the next century -- proposes an even larger submarine, an SSGN, for construction. "It would be capable of carrying several hundred long-range missiles for land attack, anti-air warfare, anti-satellite missions, anti-ship strikes and even launch of satellites."

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BOOK REVIEW

THE U-BOAT OFFENSIVE, 1914-1945
By V. E. Tarrant
Published by Naval Institute Press, Annapolis, MD
ISBN # 0-87021-764X

The U-Boat Offensive, 1914-1945 was written by V.E. Tarrant, of Cardiff, Wales, after a concept inspired by Eberhard Rossler's "The U-Boat", which he states, is "the definitive work on the technical evolution of Germany's Unterseeboote." In his preface, the author states his aim to "complement Rossler's work by chronicling the strategical and tactical evolution of the U-Boats through two world wars, ..." Mr. Tarrant's book is, indeed, a chronicle of the (strategic) role of the U-Boats in Germany's overall strategy and the tactical options which were employed in support of that strategy. It states -- sometimes convincingly -- the reasons which influenced or determined the changes of strategy and tactics.

The first part of the book describes the evolution of strategic employment of U-Boats from the coastal and fleet defense concept at the outbreak of World War I, to the aggressive anti-shipping role by single units operating in designated areas on the high seas, to the concept of the Wolf Pack which emerged in 1917. The many charts and tables of U-Boat successes in this conflict reinforce historical conclusions regarding the importance of several strategic factors on both sides of the conflict, including: shipbuilding capacities, use of convoys, and the entry of the United States into the war.

The author then summarizes the activities between the two wars, during which Germany maintained its technical and industrial capability for building the submarines needed for World War II -- first covertly, and then with the full knowledge of Great Britain and other countries.

The international mood of this period between the wars allowed Germany to keep abreast of technical developments in submarine capability and construction and to ignore or supercede the limitations of the Treaty of Versailles, and subsequent naval arms-limiting agreements. The culmination of this post World War I period was a naval agreement in 1935 between Germany and Great Britain, in which "Germany was given the right to possess a tonnage (of submarines) equal to that of Great Britain. Germany agreed, however, not to build beyond 45 percent of British tonnage unless special circumstances arose!" (reviewer's emphasis and exclamation point). Suffice it to say that this enabled Germany to prepare for employment of the U-Boat in World War II.

The third part of the book describes the manner in which the U-Boats were employed in the second war, building on -- although not always very well -- the experience gained in the first. The need for and utility of the famous wolf-pack tactic is clearly shown, and many of the same factors as in the first war are seen as major considerations, if not decisive. In addition, the technology of warfare added the following new factors to the overall strategic equation: the use of air power in pro-and anti-submarine operations; command, control and communications considerations (control from shore, shadowing and reporting, radio direction finding, etc.); and the Allies' ability to intercept and break the German ENIGMA cryptographic code.

The book is written from the German perspective, and is quite objective and evenhanded in its approach. But the attempts at underscoring its authenticity, by using German terminology and titles make for awkward reading. It appears to be thoroughly researched and is presented in a convincing manner. It is an important addition to the library of knowledge of the war at sea in modern times.

The book contains many interesting photographs, and is replete with tables, charts, and statistics which illustrate and underscore the text. Unfortunately, the format chosen for the book results in very small print in order to accommodate the photographs and charts. Furthermore, the charts are small and without cartographic references, and so are more illustrative than informative as an addition to the text.

The reader who is looking for an account of the period from 1914-1945 from the eyes of U-Boat commanders will not find it in this book. Nor will the reader find many "sea stories" or entertainment. But it is a solid account, based on updated historical information, and is a worthwhile addition to the library of any serious student of naval or submarine warfare. Perhaps the greatest benefit to the reader is the insight into the evolution of employment of the submarine as a weapons system, and the lessons which should be considered in current and future construction and employment programs.

CAPT Albert J. Perry, USN(Ret.)

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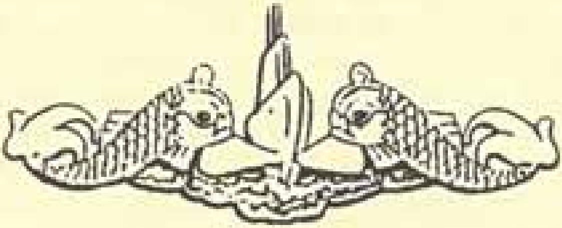
IN REMEMBRANCE

Rear Admiral Edward J. Fahy, USN(Ret.)
Rear Admiral Oliver F. Naquin, USN(Ret.)
Charles D. West
Mary Crutchfield



MEMBERSHIP STATUS

	Current	Last Review	Year Ago
Active Duty	911	918	898
Others	2819	2883	2744
Life	172	166	158
Student	25	25	27
Foreign	54	54	41
Honorary	20	20	10
Total	4001	4066	3878

HAVE YOU GOTTEN 2 NEW MEMBERS FOR 1989? 1989 ALL STAR RECRUITERS

According to our records, our top recruiters for Calendar Year 1989 are:

Richard Compton-Hall, with a credit of **10** new members!

Jim Burritt, with a credit of **4** new members (Jim is President of our Hampton-Roads Chapter).

Ensign Matthew S. Graef, with a credit of **3** new members.

Ten new members listed **Submarine School** as the reason for joining.

Nine new members listed **Mid-Atlantic Chapter** (**Henry Palmer** is President).

If you did better than those listed, you were not listed because the new members neglected to give you credit for an introduction to NSL. We suggest you "tailor" those cards you pass out with your name already inscribed.

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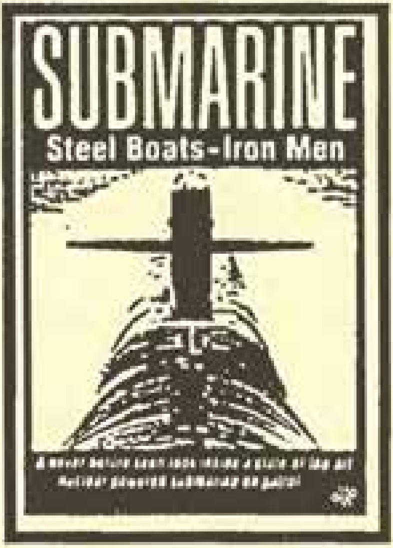
WE WANT TO KNOW!

The SUBMARINE REVIEW is your magazine, and it should serve your needs and desires. Please help us to help you - take a few minutes and tell us what you would like to see more of, less of or whatever. Comments about form and/or format of the Submarine Review will also be welcomed. While we obviously cannot make everyone happy all the time, all comments and suggestions will be considered.

* *

SUBMARINE: Steel Boats, Iron Men

SPECIAL PRICE FOR NSL MEMBERS!!



The NSL is pleased to offer its members VHS copies of **Submarine: Steel Boats, Iron Men** at a special price. The sixty minute film, produced by Varied Directions, Inc. with the assistance of the NSL, gives the public its first look inside a nuclear submarine in twenty years. A film team caught the Commanding Officer and crew of the USS HYMAN G. RICKOVER in action. Also included are interviews with some of the most honored submarine commanders, and an overview of the development and strategic use of the submarine in both world wars.

To order your copy at $49.95 plus $5 shipping and handling,
call 1-800-888-5236 or 206-236-8506
or write:
Varied Directions, 69 Elm Street, Dept. SR
Camden, ME 04843

(A portion of the proceeds will go to NSL)

Schedule of Television Airings
of
SUBMARINE: Steel Boats, Iron Men

1. **Maryland Public Television - WMPT**
   11767 Bonita Avenue
   Owings Mills, MD 21117
   Contact: Ann Engelman, Program and Acquisition Mgr.
   Phone: (804) 489-9476
   Was aired on: 15 November 1989, at 8 PM

2. **South Carolina Education Television Commission**
   P. O. Drawer L
   2712 Millwood Avenue
   Columbia, SC 29205
   Contact: Jesse Bowers, VP of Programming
   Phone: (803) 737-3200
   Will air on: Tuesday, 20 February 1990, at 8 PM
   Sunday, 25 February 1990, at 12 Noon

3. **Connecticut Public Television - CPTV**
   240 New Britain Avenue
   P. O. Box 6240
   Hartford, CT 06106-0240
   Contact: Andrea Hanson, Program Director
   Phone: (203) 278-5310
   Will air on: Saturday, 10 February 1990, at 9:30 PM

4. **KBPS Channel 15**
   5164 College Avenue
   San Diego, CA 92115
   Contact: Peggy Cooley, Programming
   Phone: (619) 594-4986
   Will air on: Tuesday, 30 January 1990, at 8 PM
   Friday, 2 February 1990, at 2 PM
   Sunday, 4 February 1990, at 4 PM

5. **KCTS Channel 9**
   401 Mercer Street
   Seattle, WA 98109
   Contact: Avon Killion, Director of Broadcasting
   Phone: (206) 728-6463
   Was aired on: Wednesday, 13 December 1989, at 10 PM.

6. **Hawaii Public Broadcasting Authority - HPTV**
   2350 Dole Street
   Honolulu, HI 96822
   Contact: Carlos Molina, Programming Manager
   Phone: (808) 955-7878
   Was aired on: Wednesday, 6 December 1989, at 8 PM

7. **WHRO Channel 15**
   5200 Hampton Blvd
   Norfolk, VA 23508
   Contact: Patrick Arnoux
   Phone: (804) 489-9476
   Date for airing TBD, probably late February 1990.

8. **WHYY Channel 12**
   150 North 6th Street
   Philadelphia, PA 19106
   Contact: David Othmer
   Phone: (215) 351-1200
   Will air on: Saturday, 24 February 1990, at 9 PM

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U.S. SUBVETS/THRESHER MEMORIAL

Dear Shipmates

The New Hampshire/Maine THRESHER BASE of U.S. SubVets have taken on the responsibility of raising $6,000.00 to pay for the proposed Thresher Memorial which will be erected in Albacore Park hopefully on or about 10 April 1990. We hope to fast track the fund raising effort and would appreciate any donations be forwarded as soon as possible. All donors who choose so will be acknowledged and any request for anonymity will be honored. This is a National effort and your help is needed and welcomed.

Please mail donations to U.S. SubVets/Thresher Memorial, P.O. Box 370, Tamworth, NH 03886.

Thank you!

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[P.S. U.S. SubVets/Thresher Memorial is also running a nationwide raffle; a 3-ticket book is just $5.00. The winning ticket will receive a video camcorder worth $1,400.00. Consult your local NSL Chapter or correspond with Mr. Larry Rollins, Senior Vice Commander, Thresher Base, Box 2932, Freedom, NH 03836.]

NSL LIBRARY

We are collecting any and all submarine associated technical, fiction and non-fiction written or video works. The NSL Library is principally intended to be a research library for submarine history or technical projects for researchers in the Washington Capitol area and to be responsive to government or civilian inquiries.

It is anticipated that the library will be open for business in about a years time. Mrs. Helen Williams has volunteered to serve as organizer and Library Manager. Members are encouraged to give or bequeath their submarine associated written or video collections to the NSL. We can arrange for shipping and handling. Those persons interested should contact CAPT John Vick at (703) 256-0891 for additional details.

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NSL/USNA SUBMARINE WRITING COMPETITION

The Naval Submarine League and the United States Naval Academy conducted a pilot submarine writing competition in the fall semester 1989. Fifty-four midshipmen submitted bright, fresh ideas in submarine technology, weapons, and tactics in unclassified articles intended for possible publication in THE SUBMARINE REVIEW. These forward-thinking future naval officers offered new insights (and re-examined old ones) into the future of the Submarine Force -- and perhaps their own.

Prizes will be awarded to the top three entries as follows:

First Prize	______	$200.00
Second Prize	______	$150.00
Third Prize	______	$100.00

The Naval Academy judging committee includes distinguished military expert Martin Binkin and prize-winning author LCDR Tom Cutler as well as some outstanding submarine officers assigned to the Naval Academy. A special "well done" is due LCDR Doyle Gillespie who continues to be our sparkplug in the Yard.

The excellent quality of the submissions and tremendous interest generated at the Academy has stimulated discussion of expanding the competition to include NROTC units.

Names of the prize winners will be published in the next issue of THE SUBMARINE REVIEW.

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SUBMARINE TECHNOLOGY SYMPOSIUM - 1990

The Johns Hopkins University
Applied Physics Laboratory
8, 9, and 10 May 1990

The 1990 Submarine Technology Symposium will provide a classified forum wherein those technologies that may be important to the capabilities of submarines and related systems can be advanced and examined by experts in government, academia, and industry. The objective is to broaden the technical base available to the Navy and to expedite the operational availability of this important technology. The theme of this third Symposium will be to examine technologies which could enhance the performance of the submarine's role in ASW. The program will comprise five technical sessions.

Advanced Submarine ASW Concepts
Dr. Edward A. Frieman, Director
Scripps Institution of Oceanography

Platform Technology
Mr. Michael Powell, Manager, Submarine Technology Project, Newport News Shipbuilding

Weapons and Countermeasures
Dr. Raymond Hettche, Director, Applied Physics Laboratory, Pennsylvania State University

Sensors, Countermeasures & Off-Board Systems
Dr. Philip A. Selwyn, Technical Director
Office of Naval Technology

Foreign Technology
Dr. Gordon C. Oehler, National Intelligence Officer for Science, Technology and Proliferation
Central Intelligence Agency

In addition to the five technical sessions, an interactive round table discussion moderated by VADM B. M. Kauderer will be held on the final day for the audience to explore important issues raised during the Symposium.

Attendance is by invitation, and restricted to U.S. Citizens with a DoD SECRET clearance and a certified need-to-know. Since space is limited to 500, registrants will be considered in the order in which responses are received. League members holding a current DoD SECRET clearance and certified need-to-know who are interested may obtain additional information by writing to:

Mrs. Patricia Dobes
Submarine Technology Symposium 1990
Post Office Box 1146
Annandale, VA 22003
Telephone (703) 960-7781
FAX: (703) 642-5815

NAVAL SUBMARINE LEAGUE HONOR ROLL

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22. IBM CORPORATION
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26. LORAL SYSTEMS GROUP
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29. INTERSTATE ELECTRONICS CORPORATION
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