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FROM THE PRESIDENT

A new year will have arrived by the time you receive this issue. Please accept my wishes for a rewarding New Year. Our League is healthy and growing, even though our rate of growth has, at times, been disappointing.

Our next Symposium and Business Meeting is in the final stages of planning. The final dates are 8-9 July, 1987. This corrects the dates previously published. The Symposium looks to be another winner, so please mark these corrected dates on your calendar.

The Directors have increased the number of Board members to twelve. This increase in your Board of Directors will allow for better representation from industry in addition to expanding the Board's breadth of outlook and scope of experience.

The Submarine League's Advisory Council has completed a comprehensive review of the League's organization -- on 11 August, 1986. The Council has recommended to the Chairman and the Board of Directors the following items:

	Subject	Action by Board of Directors
1.	Improve recognition for Corporate Benefactors	Agree
2.	Establish a Public Affairs Committee	Agree
3.	Promote Submarine League Membership for U.S. Allies	Agree
4.	Better inform government employees of their eligibility for League membership	Agree

5. Expand the Board of Directors to include executives of Corporations — Agree

6. Advertise for Submarine League membership — Agree

7. Deny Corporate Membership to foreign firms — Agree

8. Promote submarines without lobbying — Agree

Finally, I earnestly request that a few of our more creative members author articles for the REVIEW, or at least provide, in a letter to the Editor, your own ideas on articles in the SUBMARINE REVIEW. If you lack a subject for an article, perhaps one of the following subjects may strike a chord of interest:

- For what purposes might the large 30-inch torpedo tubes, planned for the SEAWOLF class SSN, be used?
- What is the value of a tanker submarine for refueling a carrier task force? Can a submarine replenish ammunition or other expendables?
- What role should submarines play in the Outer Air Battle? What capabilities should they possess? Can they survive at periscope depth?
- What should be the role of submarines in the Strategic Defense Initiatives?
- Should submarine rockets be developed for submarine weapons?

My best wishes to you all....

Shannon

FROM THE EDITOR

The challenge today for our submariners is how to deal with an enemy submarine force which by doctrine conducts its operations in coordinated combination with other forces. This is unlike our submarine force which is most comfortable with and which stresses independent lone-wolf operations. The Soviets moreover -- according to their writings and as indicated by their peacetime submarine operations, invariably demonstrate "closely" coordinated operations with other naval forces, i.e. submarines, surface warships, aircraft, satellites, and even fishing boats and merchant vessels which are evidently organized to function as naval auxiliaries. This doctrine of mutual support probably evolved from the character of Soviet double-hulled submarines -- relatively noisy, but with many pluses which might be capitalized on.

A new dimension in the art of submarining is involved. What might be required to deal with the Soviet concept of "mutually supporting operations" is difficult to come to terms with. But first, the temptation to consider such operations impractical -- because "we" don't use them and hence the enemy can't (because their communications are inadequate, etc.) or thy're not useful, anyhow -- must be put aside. Further, because our submariners feel that "closely" coordinated operations with other forces are overly hazardous, the Soviets, it may be thought, will similarly settle for "loosely" coordinated operations with other forces. Perhaps the greatest danger in loose thinking could stem from bad guesses about Soviet weapons and how they might be employed. If Soviet weapons are well designed for mutually supporting operations -- particularly if "stealth" characteristics are emphasized -- U.S. capability to effectively conduct lone-wolf operations against a combination of forces could be seriously impaired.

Wishful thinking is unlikely to change the threat being posed to our submarine efforts -- those directed against well protected enemy submarines. The consequences of this are pictured by Henry Young in his article in this SUBMARINE REVIEW.

U.S. advancement of the art of submarining, as we know it, seems necessary to be able to respond effectively to this comparatively new submarine problem. There are also various possible facets to this problem which need to be recognized in conceptualizing U.S. response. And past history would indicate that they are likely to materialize. First, the primary mission of our submarines may be changed from a forward barrier destruction of enemy submarines to an antisubmarine protection of convoy lanes -- because "the horses have left the barn," while the strategic submarines stay in their well-protected pens. Then, observation of Soviet mutually supporting submarine operations may only easily recognize two units operating together, as a practical form of "mutual" support, while several units -- 3 submarines, or two submarines and two destroyers, etc. -- would be seen as only aberrations.

Even more worrisome is the possible impact of new technology on U.S. response to Soviet coordinated submarine operations. Of first concern must be the Soviet's sound-quieting of their submarines -- even to backfitting of older subs with techniques that are evidently unlike those employed by the U.S. Then the use of their GLONASS satellite global navigation system may be far more vital to their operations than guessed at, on the basis of U.S. usage of a similar system. As for communications for supporting operations, it may be difficult to credit the Soviets with truly workable on-site communication systems when the U.S. has not emphasized this capability for U.S. submarine operations. And

finally, like the Soviets' sound-quieting program, the possibility of backfitting their many conventional submarines with a greatly extended underwater endurance system -- like a small auxiliary nuclear power plant or a fuel-cell system to augment battery power -- must be considered in light of how this additional submarine capability would impact on "mutual support."

Conceptualizing U.S. submarine tactics to deal with this problem may, at present, be a simple matter, based on present assumptions. And training our submariners to handle the ASW problem presented by enemy simple, coordinated forces is probably straight forward and manageable.

But to come to grips with the more complex possibilities -- or even probable ones -- is going to, it would seem, require an active discussion for which a "silent service" is ill suited. The Soviets, recognizing the rapidly changing nature of warfare, conduct an open forum through voluminous writings by military people. Hence, the fluidity of Soviet mutually supporting operations needs to be carefully tracked, evaluated and U.S. responsive tactics be devised and trained for.

VADM DeMARS SPEECH AT THE SUBMARINE SYMPOSIUM LIMA, PERU

I was asked to speak on the theme "The Submarine in the Nuclear Age." I see this topic as carefully chosen in that I was not limited to the "Nuclear Submarine in the Nuclear Age." This is an important distinction, as I am convinced there is a vital role for both nuclear powered and conventionally powered submarines in today's maritime arena.

Today, there is a worldwide awakening as to the value of submarines in naval warfare. Reading the naval journals from both sides of the oceans, one senses a growing appreciation of the value of submarines .... in my mind a foretelling of the supremacy of submarines. In this age of oceanic surveillance from space .... and the growing proliferation of air-to-surface and surface-to-surface missile systems, the stealth and relative invulnerability of submarines has brought them to the forefront of the world's navies. We are in the age of the submarine.

When we look at the navies of the Free World, we see a large number of new submarine programs -- Australia, Israel, the United Kingdom, France, and the Netherlands. Other nations as well are modernizing, and in some cases expanding their submarine forces -- Norway, Turkey, Spain, Portugal, Japan.

In South America, a similar modernization is taking place. Witness the new type 209 class submarines of the Peruvian Navy and of the navies of Brazil and Chile and the new TR-1700's of Argentina. Taken together, there is a growing body of evidence that the submarine is the prime naval weapon in both large and small navies of the world.

Submarines were of major strategic importance in World War II, in both the Atlantic and Pacific. In the Atlantic, the German U-boat offered the greatest peril to the eventual Allied victory. Winston Churchill stated that "The only thing that really frightened me during the war was the U-boat peril. I was even more anxious about this battle than I had been about the glorious air fight called the Battle of Britain. The U-boat attack was our worst evil. It would have been wise for the Germans to stake all upon it." Without question, had not the intensive Allied anti-submarine efforts and the advent of airborne radar

held back the brave U-boats, the eventual Allied victory would have been prolonged, with greater suffering on both sides.

In my country, a carefully kept secret has been the importance of U.S. submarine operations during World War II. Fully 55 percent of the Japanese merchant fleet and 38 percent of the Japanese Navy was destroyed by the relatively small force of U.S. submarines. Our submarine force made a major strategic and logistic impact on the termination of the war with Japan. This impact has not been widely recognized or appreciated by those outside the submarine community. Perhaps our "Silent Service" has been too silent.

We have enjoyed submarine superiority since World War II. This submarine superiority is essential to our national security. Just as the U.S. submarine force was of extreme importance in World War II, the deterrent power of our submarine force has been a major factor in ensuring that we have not had to fight a World War III during the past 40 years.

As you know, our submarine force is made up of strategic and attack submarines. While their missions are different, they both possess the nuclear submarine's prime attributes of stealth, mobility, endurance and firepower. The deterrent value of our strategic submarines is clearly understood. They are the most survivable leg of our country's strategic nuclear triad of manned bombers, land based missiles and strategic submarines. Today, there are 18 of these submarines on patrol in 20 million square miles of ocean with 320 alert missiles. The Soviets lack the ability to locate with certainty these submarines. The Soviets are thereby assured of swift and sure retaliation should they initiate a nuclear attack on the United States or her Treaty Allies. Our maintenance of submarine superiority

guarantees this deterrence and maintains a degree of peace throughout the world.

Similarly, but less well understood, our attack submarine force is a strong deterrent to war -- as long as we retain submarine superiority. Our attack submarine operations can be likened to guerrilla warfare. Our attack submarines move far forward into enemy waters, blend invisibly into the environment, pick the time and place of the attack, attack with tremendous firepower, then disappear to attack again. They provide a terrible uncertainty to any enemy.

The attack submarine force is the cutting edge of the United States maritime strategy. It is a ready force prepared to get underway on short notice, proceed deep into enemy waters and should war break out, sink the Soviet fleet. The Soviets know that we have this capability, making it a significant restraint on their worldwide adventurism. As long as the U.S. maintains submarine superiority, our submarines materially assist in maintaining peace in the world.

As for the nature of the U.S. submarine force, our ballistic missile submarine force is made up today of 7 new TRIDENT submarines and 28 of our older, but still potent, POSEIDON missile submarines. These submarines have two crews to maximize submarine time at sea.

We are building TRIDENT submarines at the rate of one each year. They are a superb ship -- the quietest nuclear submarine in the world, exceptionally reliable, and able to patrol vast portions of the ocean with essentially no risk of detection. Through improved maintenance procedures these TRIDENT submarines will be at sea in an operational status for 65 percent of their life time. This unseen, but most effective force is supported with about 10 percent of the Navy's budget -- a terrific bargain for the United States and for our friends and Allies who share the

benefits of world peace.

The United States has a force level goal of 100 nuclear attack submarines. Today, we have 97 with 19 under construction to replace older units. Our SSN's are primarily of the STURGEON or SSN-637 class and the LOS ANGELES or SSN-688 class.

All of our nuclear attack submarines were designed as highly capable, multi-mission submarines -- the best we could design. We have resisted a high-low mix approach. Submarines must be individually highly capable because of the relative inability to aggregate undersea forces for mutual support in a manner similar to surface forces. Basically, our attack submarines are designed to proceed deep into enemy waters alone and unsupported for long periods -- attacking all enemies encountered.

Four diesel powered submarines will remain in our force for several more years. We have resisted entreaties to build diesel submarines because we do not wish to divert our attention, and resources, from that which we do best -- build and operate the finest nuclear submarines in the world. Our argument is strengthened by the extremely professional diesel submarine forces of our friends and allies. We have not lost sight of the fact that a most valid role exists for diesel submarines now and in the future. However, our geostrategic position requires that our submarine force fight long distances from home in enemy waters and under the ice -- tasks ill-accommodated by diesel submarines. We prefer coordination with our allies whose diesel submarine forces can professionally accomplish those missions where they are best suited.

In peacetime we strive to keep each SSN in its homeport 50 percent of the time for maintenance, training and crew rest. When at sea, our SSN's conduct training and exercise operations

about half the time; the balance of their time at sea is spent on extended deployments to the Mediterranean Sea, the Western Pacific, the Indian Ocean and to Northern and Arctic waters. During these deployments, the SSN remains at sea 70-80 percent of the time with only brief stops for logistic replenishment and crew liberty. When at sea, our SSN's operate submerged virtually all the time. We believe these deployments are essential to maintain the proficiency to carry out an effective maritime deterrent, and we frequently exercise our ability to deploy SSN's on short notice, fully ready for combat.

As you may have seen in the press recently, we are carrying out a very active program of operations in the Arctic region. It is considered necessary to deny the Arctic as a sanctuary for Soviet submarines. Last April, I visited an ice camp in the Beaufort Sea north of Alaska. There I embarked on USS HAWKBILL, that had surfaced through the ice. I spent a day on board and witnessed the ship's full capability to conduct anti-submarine warfare operations under many feet of ice. Not long thereafter, USS HAWKBILL rendezvoused with USS RAY and USS ARCHERFISH for exercises in the deep Arctic Basin and on 5 May they surfaced together at the North Pole. Operations such as this provide unmatched training in the most remote and harsh region of the world's oceans and demonstrate our ability to operate effectively in any environment.

I feel that our most potential enemy, the Soviet Union, has the same view of submarine superiority that we do. They realize that the U.S. has a strong technological edge, and they are working hard to close the gap. The Soviet submarine force outnumbers the U.S. by three to one. Over the past decade, the Soviet Navy has introduced 13 new classes of submarines. Their new Soviet submarine force is composed of large, complex, modern and expensive submarines. The

Soviets clearly desire to wrest submarine superiority away from the U.S.

The program to keep our attack submarines at the leading edge consists of three main elements: first, we are equipping our older attack submarines with improved sensors and weapons. Today's LOS ANGELES - 688 class is the best nuclear attack submarine in the world. Notwithstanding, we are now building an improved 688 which will be twice as effective as today's 688's. These ships will carry the added firepower of twelve vertical TOMAHAWK missile launchers in the bow, be much quieter than earlier ships, and will be fully capable of Arctic operations. Finally, we are well along in the design of the SSN-21 -- the SEAWOLF class -- which we see as the attack submarine of the next century. This submarine will embody the very best in advanced technology in its sensors, weapons and propulsion systems. We are designing this submarine now. It will go to sea in 1995. We are confident that we can maintain the tactical advantage over any challenger. We are ready in the U.S. Navy.

My talk has dwelled on the U.S. submarine force, but I would be most remiss if I did not express our dependence upon and appreciation for the support of our naval allies. We dare not go it alone, so we vitally depend on cooperation with the free world's navies to, in fact, keep the world free. Together, we are much stronger than the sum of our parts.

We of the free world's navies have always had an ability to communicate with each other more easily than our sister services, and it has served our nations well. There is something about sea duty that builds wariness, independence and clear thinking. I believe we share a common view of the threat to the free world.

Naval officers are bonded by the sea and, in

an even closer manner, submariners are a tight fraternity. In the final analysis, people are the most important part of the submarine superiority equation -- technicians, engineers, designers, builders, repairers, and most importantly, the crews. The U.S., like all submarine forces, look for the very finest young men, train them vigorously and expect the very best from them. It is a factor that binds international submariners together. One can sense the feeling of shared danger, mutual reliance and camaraderie borne of small crews that have molded us into a similar frame of mind irrespective of our navies.

Three months ago, I was in France as a guest of the French Submarine Force. I visited the dockyard which in 1911 produced Peru's first submarines, PALACOIS and FERRE. I did not know then that I would be privileged to represent the U.S. Submarine Force in Peru on this grand occasion. It is a distinct honor to be here and come to know better your most professional Submarine Force.

Vice Admiral Bruce DeMars, USN

FIGHTING IN DEFENDED WATERS

Issue

In the event of a major war, it is generally assumed that substantial numbers of Soviet SSBNs, general-purpose submarines and surface combatants will be committed to hiding-in or defending ocean areas adjacent to the USSR -- under the cover of land-based air and surface warships. In light of the intense threats against U.S. surface forces operating near the periphery of the USSR at the start of war, the burden of initiating an early offensive against Soviet naval power is likely to fall to U.S. and allied SSNs.

However, in conducting a campaign against one or more high-priority classes of naval targets deployed in or near Soviet home waters, U.S. SSNs also must face and overcome an ASW threat of uncertain strength. In conducting a general offensive against all classes of Soviet submarines, U.S. SSNs must avoid or escape prosecution by mines, other supporting Soviet submarines, surface combatants and sea-and land-based ASW aircraft, cued by overhead and underwater surveillance systems. In a focused offensive against Soviet SSBNs, U.S. SSNs might properly regard all other Soviet submarines as secondary targets and part of the defense.

The purpose of this article is to quantitatively explore certain aspects of a submarine campaign in defended waters and briefly consider their planning implications -- so as to raise some issues and stimulate discussion of this complex and important problem.

The exchange ratio is defined as the expected number of enemy submarines destroyed per SSN lost in fighting an unlimited number of engagements of a specified type. It is an important measure of the combat potential of an SSN. However, in fighting a number of enemy submarines protected by defending forces, a certain number of SSNs might be lost in encounters with the defense. These unproductive losses of SSNs to the defense mean that the attrition of target submarines will be less than that predicted, for sub vs exchange ratios.

Consequently, when fighting an undersea campaign in defended waters, the <u>effective</u> exchange ratio -- will be less than the exchange ratio, absent defenses, as usually defined. How much less will depend upon the strength of the defense.

The unique feature of a submarine campaign in

the presence of a continuously acting ASW defense is that as the campaign proceeds and target submarines are found and destroyed, the density of targets in the theater will decline. As a result, the time between engagements with target submarines will tend to increase, on average. Since the continuously acting defense has a longer time to work between target engagements, the probability of an SSN encounter with some element of the defense, instead of a target submarine, will steadily rise throughout the course of the campaign.

This increase in the relative strength of the defense is most pronounced after a substantial fraction of primary targets has been destroyed. Indeed, in the limiting case in which all target submarines have been destroyed, surviving SSNs that are unaware of the status of the campaign can only encounter elements of the defense.

Simply stated, each unit in a composite ASW defense can engage and destroy a searching SSN at a certain rate, characteristic of the interaction between that unit and an SSN. The sum of these lethal rates of engagement, from all ASW units participating in the defense, sets the overall rate at which an SSN will be destroyed by the defense.

Similarly, a searching SSN will engage its primary submarine targets at a certain rate that is proportional to the number of such targets present in the theater. Hence, the rate of engagement with target submarines will fall during the course of a campaign as they are found and destroyed.

At any time during the campaign, the relative rate of engagement between the defense and target equals the odds that an SSN will next engage an element of the defense, instead of a primary submarine target. Hence, the probability of a

lethal encounter with the defense, versus a target submarine, provides a useful measure of the strength of the enemy defense.

If the composition of the enemy's defense remains constant throughout the campaign, then the odds of encountering the defense, rather than a target submarine, must increase as the campaign proceeds, while the enemy submarine population declines.

The aim in the rest of this article is to suggest answers to the following questions about an SSN campaign in defended waters -- where there is an assumed SSN exchange in the absence of defense and an initial probability of a lethal encounter with the defense at the start of a campaign:

(1) Compared to the SSN exchange ratio in the absence of a defense, what is the effective exchange ratio for the entire campaign and what degree of attrition can X SSNs expect to inflict on Y target submarines -- protected by ASW defenses of different strengths?

(2) Is campaign effectiveness influenced more by the exchange ratio or by the SSN's ability to avoid the ASW defenses?

(3) Is it advantageous to overcommit a larger force of SSNs and then withdraw them all as soon as a predetermined number of SSNs have been lost?

(4) What advantage is gained by localization of target submarines in the pre-war period and then attacking these at the outbreak of war, before the ASW defense can have an effect?

Approach

These questions require quantitative answers, derived from an undersea campaign that allows for

the possibility of SSN attrition by a continuously acting defense.

A series of tables follow which show the predictions for a submarine campaign in defended waters, where the U.S. submarines enjoy a 5:1 exchange ratio. Specifically, the primary targets for a U.S. campaign are assumed to be 40 Soviet SSBNs deployed in Arctic seas. In this focused campaign, all other Soviet submarines are regarded as units of the defense -- to be avoided -- in addition to mines, surface combatants, sea-and land-based ASW aircraft and surveillance systems, in various combinations. The lethal encounters with the defense at the start of the campaign are then varied while U.S. losses are limited to a specific number of SSNs.

Question 1: Effective Exchange Ratio

As a base case, suppose that 10 BLUE SSNs with the exchange ratio of 5:1, hunt for 40 RED unprotected SSBNs. Table 1 summarizes the expected results of this campaign.

TABLE 1

Exchange Ratio = 5:1 and losses to Defense = 0

Forces		Survivors		Effective	BLUE Losses to	
SSN	SSBN	SSN	SSBN	Exch Ratio	SSBN	Defense
10	40	2	0	5:1	8	0

On average, the force of 10 SSNs can destroy all 40 SSBNs, for the price of 8 SSNs.

Now suppose that RED defends the operations area with various types of ASW systems. The net effect is to raise the probability of a lethal SSN encounter with the defense -- .05 at the start of the campaign. Instead of zero, 1-chance-in-20 is used, the expected results of this campaign can be shown. See Table 2.

TABLE 2

Exchange Ratio = 5:1 Initial prob of Loss to Defense = 0.05

Forces		Survivors		Effective	BLUE Losses to	
SSN	SSBN	SSN	SSBN	Exch Ratio	SSBN	Defense
10	40	0	9	3.1:1	6	4

Table 2 shows that, by confronting SSNs with a modest initial risk of a lethal encounter with the defense, RED can noticeably improve his effectiveness. Instead of losing all 40 SSBNs and destroying 8 SSNs, the addition of a low level of defense preserves 9 SSBNs, destroys all 10 SSNs -- 4 by the defense -- and reduces the exchange ratio from 5:1 in the absense of defense to an effective value of 3.1:1.

Although the chances of an encounter with a continuously acting defense might seem small at the start of a campaign, this initial risk steadily grows as target SSBNs are destroyed. The cumulative effect of this increasing risk of an encounter with the defense is the reason for the, perhaps surprising, effectiveness of a seemingly low level of defense. This effect can be seen more easily by raising the strength of the defense.

Table 3 shows the results of campaigns by 10 and 20 SSNs, where the chances of engaging the defense, rather than an SSBN, are 1-in-10 at the start of the campaign.

TABLE 3

Exchange Ratio = 5:1 Initial prob of Loss to Defense = 0.1

Forces		Survivors		Effective	BLUE Losses to	
SSN	SSBN	SSN	SSBN	Exch Ratio	SSBN	Defense
10	40	0	15	2.5:1	5	5
20	40	0	4	1.8:1	7	13

Against this stronger defense, 10 SSNs are able to destroy only 25 of 40 SSBNs (as compared to 31 of 40 SSBNs in the case of Table 2) -- for an effective exchange ratio of 2.5:1. This is half the exchange ratio when there is no defense. If 20 SSNs are committed to this campaign, then 36 of 40 SSBNs could be destroyed, but at an effective exchange ratio of 1.8:1.

Table 3 also reveals that by using 10 more SSNs, 11 more SSBNs are killed but 10 more SSNs are lost. Consequently, against moderately strong defenses, the cost of attempting to destroy a large fraction of an enemy force is likely to be high.

Finally, Table 4 shows the results of again doubling the probability of a defense encounter at the start of the campaign from 1-chance-in-10 to 1-chance-in-5.

TABLE 4

Exchange Ratio = 5:1 Initial prob of Loss to Defense = 0.2

Forces		Survivors		Effective	BLUE Losses to	
SSN	SSBN	SSN	SSBN	Exch Ratio	SSBN	Defense
10	40	0	23	1.7:1	3	7
20	40	0	12	1.4:1	6	14
30	40	0	6	1.1:1	7	23

At this level of defense, the effective exchange ratios have fallen well below 2:1 and the exchange ratios for increments of force beyond the first 10 SSNs are 1:1 or less.

Question 2: Defense Avoidance

The expected number of SSBNs destroyed in a campaign in defended waters can be increased by improving either: (1) the SSN's ability to avoid or survive attacks by enemy ASW systems or, (2) by

improving the exchange ratio against SSBNs. But it becomes readily apparent that defense avoidance is far preferable to improving exchange ratios against undefended targets. This is particularly true for "closely" protected SSBNs -- and even more so if the weapons employed are not covert. If the SSN exchange ratio was improved 50% to 7.5:1 (under Table 4 conditions) a calculation would show that 10 SSNs could destroy 19 SSBNs -- only two more than for a 5:1 exchange, and only an 11% improvement.

However, a 50% improvement in defense avoidance -- by going from the .20% probability of loss to defenses of Table 4 to the .10% probability in Table 3 shows 8 more SSBNs destroyed for a 47% improvement in campaign effectiveness.

Thus, although the SSN exchange ratio should be the best attainable, capabilities for defense avoidance have a higher priority when fighting in defended waters. It might also be true that there are more technical and operational possibilities for improving SSN capabilities for defense avoidance of defenses as compared to increasing the exchange ratio. However, many relevant SSN subsystems contribute to both aspects of SSN performance.

Question 3: Overcommit and Withdraw

This question has an easy, and negative answer.

The larger the number of SSNs committed, the higher will be the force-wide rate of engagement with target SSBNs, but the rate at which the larger force of SSNs will encounter the defense will also increase in the same proportion. Thus, as shown by the Tables, an attack by 20 SSNs, followed by a withdrawal after the loss of 10 SSNs, would achieve the same result as an attack

by 10 SSNs alone, but in a shorter period of time -- which might be an important consideration.

One additional option promises to increase the effectiveness of a campaign in defended waters.

Question 4: Fast Start

If some number of target SSBNs can be localized or acquired and promptly attacked at the start of war, then the SSN force can gain an initial advantage before the ASW defense has an opportunity to be effective. In essence, a fast start enables the SSN force to destroy some initial number of SSBNs with maximum efficiency -- and in a short time. In a parallel campaign started with no SSBNs vulnerable, after the destruction of the same number of SSBNs as in the initial case, the size of the SSN force will be smaller, because of its exposure to the defense.

However, against a weak defense the number of SSNs saved will not be so large as to make an appreciable difference in final campaign outcomes. On the other hand, against a strong defense the advantage of localization is greater. Fast Start will save a useful number of SSNs in the beginning. But in continuing the campaign against a strong defense, these extra SSNs will exchange for SSBNs at generally less ratios, offsetting the initial advantage of the fast start.

Of course, the stronger the defense and the larger the number of SSBNs acquired, the greater the advantage of a fast start. Nevertheless, for force commitments likely to be of practical interest, this advantage does not appear to be great. This also means that the penalty against a fast start, in order to minimize the risk of compromising the mission by exposing SSNs to counter-detection in the pre-war period, should be small.

If SSBNs could be completely hidden from searching SSNs after war starts, a fast start becomes the only possible option for eventual attack.

Conclusions

When fighting in defended waters, SSNs should avoid the defense. However, in defended waters even seemingly small degradations in the SSN's ability to avoid the defense translate into noticeable reductions in campaign effectiveness.

For instance, a 5:1 exchange ratio in the absence of defense might be reduced by one-half, if the initial chances of encountering the defense, instead of a primary target, increase from zero to 1-in-10. And, the larger the number of SSNs committed, the greater the reduction in the exchange ratio. Such reductions in the exchange ratio must influence campaign planning by changing the relation between mission benefits and costs.

It is also difficult to overcome the effect of a modest level of defense by increasing the number of SSNs committed to a campaign.

The analysis also suggests that relatively small forces of SSNs, operating against weak or strong defenses, cannot substantially improve campaign effectiveness by a fast start against SSBNs. Viewed positively, this suggests that the SSN force need not be vulnerable in the pre-war period, for a small price in campaign effectiveness.

Unfortunately, the effect of SSN target classification capabilities on campaign effectiveness could not be examined. However, all measures that reduce erronious decisions which might reject valid targets or result in engaging elements of the defense, have significant value.

Of course, peacetime estimates of exchange ratios, defense strengths and other relevant factors are uncertain at best, for both sides. Hence the attrition suffered by each side still would be known only probabilistically. Initially favorable situations could turn sour and unfavorable situations unexpectedly turn sweet.

Fighting an undersea campaign in defended waters is shrouded in uncertainties that should challenge SSN force planning at the levels of strategy, operations and tactics for a long time to come. Sound insight into the nature of such operations is a prerequisite for effective force development and employment plans.

Henry Young

CROAKER'S FIRST WAR PATROL

[The notes on this patrol are taken from an account by a British observer, CDR R. B. Lakin, RN, and give a relatively detached view of what happened and why.]

This patrol resulted in the infliction of the following damage on the enemy:

SUNK	TONNAGE
1 KUMA Class Cruiser	5,300
1 Tanker or Ore Ship	10,000
1 Engines-aft Merchant Ship	3,500
1 Sub Chaser or Patrol Boat	500
TOTAL	19,300 tons

A full outfit of 24 Mark XVIII 29-knot electric torpedoes were carried, and all were expended.

The percentage of hits scored was 25% .
Duration of Patrol -- 43 days.
Distance steamed -- 10,371 miles.
Fuel used -- 107,954 gallons.

<u>19 July to 30 July, 1944</u>. The writer joined the USS CROAKER at Pearl Harbor on 19 July. CROAKER is a standard 1500-ton fleet type U.S. submarine, built in 1943 by E.B. Company, Groton, CT. She was commissioned 21 April, 1944. Her serial number is S-246, which indicates that she is the last of the thin-skinned boats, i.e., those having a pressure hull 5/8" thickness and designed diving depth of 300 feet. Submarines built subsequent to this have had the hull thickness increased to 15/16", giving them a diving depth of 500 feet. (As most of the patrol was spent in the Yellow Sea in depths of 25 to 30 fathoms, this disability was of no great concern.) Another disadvantage she suffered by comparison with the later series boats was that the bridge structure had not been cut down in accordance with the modified design and consequently was the old fashioned, covered-wagon type with an unnecessary amount of top hamper, and having a lookout platform forming a roof over the greater part of the bridge. The wind deflector was inefficient by British standards, and the bridge deck a veritable menace of pitfalls, obstructions, projections and blind spots, and a poor place from which to keep a lookout. The best that can be said is that one got used to it.

Just before sailing, a 40MM gun was mounted on the after deck of the bridge (cigarette deck), and consequently the starboard side of the bridge was largely occupied by a ready use ammunition locker for this gun (holding 84 rounds of ammunition in clips of four), on top of which was rigged a canvas and tubular metal bunk for the commanding officer who used this every night in the patrol area. A single 20MM was mounted before the bridge, which with the 4", was manned through an access door in the cab (similar to older

British S-boats). There was no gun tower. A slightly newer pattern, of the usual 4" gun, was mounted forward, having normal watertight tompion but with a different design of breech, which eliminated the waterproof box-cover over the firing mechanism. No great enthusiasm was shown for employing these weapons and in view of the extreme time taken to man them and to fire the first round (3 minutes), one can scarcely blame them.

The 20MM was kept in the ready position with a drum of ammunition in place while in the patrol area at night, and 40MM was manned on one occasion at night when it was thought possible that a patrol boat might be encountered in shallow water. During the passage-run, one 4" gun action from submerged was practiced, and all automatic weapons were used in an engagement with a profusely bleeding whale which the ship had unintentionally rammed. The ship suffered no damage from the collision, and the whale none from the gunfire. Several mines were sighted which, according to the operation orders, should have been destroyed, but the Officer-of-the-Watch usually felt that no opportunity was offered. The submarine invariably zig-zagged while on the surface, using either a set zig plan or the Arma Course Clock.

AIR CONDITIONING

This system was operated the entire patrol with the exception of periods of silent running. The remarkable difference in comfort that it made was only really apparent during those periods when it was not working. As an offshoot from the main air conditioning air supply, an extra unit was installed in the wardroom compartment just before sailing, as this part of the ship had previously been a dead spot in the ventilating and air cooling system. This unit produced a steady temperature of 50°F in officers quarters the entire patrol, during which times the battery

temperature underneath was never less than 90°F and the outside sea water and air temperature between 80° and 84°F. U.S. submarine officers say that the improvement in the upkeep of electrical equipment since installing efficient air conditioning is most marked, and certainly the writer has never before seen a submarine that had so little internal sweating.

USS CROAKER sailed from Pearl Harbor at 1330 July 19th. A dive for trim, off Barber's Point about an hour later did much to dispel any impression that these submarines are slow in diving, until the Diving Officer discovered that he had been 15 tons heavy in his trim. The passage to Midway was uneventful except for sundry defects which cropped up. The steering failed, followed by the planes and both were put into hand. All power to the internal announcing systems and alarms failed and also a fuel line to one main engine parted. None of these was serious, and all easily rectified.

The ship arrived at Midway in the forenoon of 23 July. The Commanding Officer, Jack Lee, and the writer had a discussion with the Commanding Officers of TANG and SEALION, both submarines which had recently returned from Yellow Sea areas, the former having sunk eight ships and the other five. They both reported sighting mostly unescorted single ships and gave an amount of useful information on the shipping routes. This personal encounter with those "last from school", was most valuable.

The ship sailed again at 1730, escorted for the first 30 miles by two Navy Dive Bombers, whose value the writer was unable to see, and for the next week ran westward (roughly along the parallel of 30° N) on the surface at two engine speed (14.5 knots), using 70 gallons of fuel per engine per hour. Course steered was Great Circle which, over this distance, was not very appreciably shorter

than the rhumb line, but was ordered by the operation order for outgoing submarines. A practice dive was made every morning and on several occasions the ship dived for an hour in the afternoon.

During surface running, a total of six lookouts (each with 7 x 50 binoculars) and two Officers-of-the-Watch were always on the bridge, and watch was kept through one periscope. In addition, the Officers, including the writer, stood four hour watches, which he considered too long, and the lookouts rotated every hour. Two of the six were volunteers. The lookout was at all times very efficient and vigilant and there was an unofficially approved monetary scale of rewards for sightings.

About the second day out from Midway an epidemic of common coldes started and raged throughout the boat. Several men were off the duty list for a day, but a gargle and some tablets of APC (similar to Vegamin) induced a good sweat and soon cured them. The cause of this was probably the usual one, of lookouts wearing insufficient clothing on the bridge.

<u>August 6</u>. Shortly after coming to periscope depth, the alarm sounded and an attack was started on what appeared to be the fighting tops of three NAGATO class battleships. Unhappily, these were soon identified as fishing junks, a fairly natural mistake since the visibility inshore in the forenoon was inclined to be hazy and there was some mirage effect. A decision was made to patrol nearer the shore and this resulted, at 1630, in sighting a merchant ship at a range of 11,000 yards, coming southward from Nagasaki, course of 175°, evidently altering course for navigational purposes only. When sighted, the submarine was fairly fine on the starboard bow, and probably over estimated the distance off track as she found herself later almost dead ahead at 3,000 yards, and was compelled to make an advancing turn away

to port, which was accomplished all in good time, enabling her to fire four stern torpedoes set to 6 feet on tracks of 105° to 120°, at a range of 800 yards. All missed, which was as surprising as it was depressing, since this one looked in the bag, and the only reason the Commanding Officer had fired as many as four, was to make sure of getting a certain hit on the submarine's first attack. The target was a 3,500 ton merchant ship in ballast, and it seems very probable that the torpedoes ran under, since conditions were perfect, being almost flat calm with a slight ripple. The target passed unconcernedly on its way, as likewise did the four electric torpedoes, which further contributed to their already invisible quality by not exploding at the end of the run.

The Commanding Officer was very loath to give up this ship, which had already cost four torpedoes, so when CROAKER found herself dead astern with the range still closing, he fired three single torpedoes at 1,500 yards on a 180° track (a questionable shot at the best of times, as the writer with some diffidence suggested). At any rate, the first torpedo which was fired while the submarine was still doing a good 17 knots leaped out of the water and settled down with a considerable bias to starboard. The next, fired after a reduction in speed, made a poor discharge too. It was discovered that the control party in the conning tower had fired, in error, the top tubes instead of the bottom, so the third torpedo was fired at about 2,100 yards range with about 7 knots headway on the ship. This appeared to run straight, but being trackless, one couldn't tell. It missed also, and after that, the attack was abandoned.

Monday, August 7. At 1100, the Officer-of-the-Watch sighted the mast and fighting top of a cruiser at 14,000 yards approaching from the southward at 14 knots. An exciting attack ensued in which several sharp turns had to be made as the

target, an unescorted 5,300-ton KUMA, was making large zigs every three or four minutes. Eventually the last four stern torpedoes were fired immediately after taking a ping range of 1,000 yards on a 140° track. The Cruiser zigged away on firing, probably on the leg of his irregular zig plan, and after three minutes had elapsed since firing, hope of securing a hit was slender, so the Commanding Officer raised the periscope to try and get another shot in from the bow tubes. He was just in time to see the entire stern and mainmast of the Cruiser disappear in a pillar of flame and smoke. She had providentially zigged back and caught the last torpedo of the salvo at the extreme end of its run (4,500 yards for electric torpedoes). A lucky shot indeed! Pandemonium ensued in the control room which was anyhow seething with people and cigarette smoke. The writer contributed a modest cheer to the general din, which was making it impossible for the Diving Officer to be heard, and then was invited to inspect the target through the periscope. The Cruiser presented a very stirring sight, having already assumed a big list to starboard, and was awash up to the after funnel. It was possible to see down the funnels and the crew were leaping over the side. The still and 16mm movie cameras were secured to the periscope and a number of pictures taken, (which were the first technicolor periscope movies of their kind). This operation was interrupted by the report of screws approaching from the south. Cameras were hastily removed, leaving the Commanding Officer with no eye piece for his first all around look. A patrol boat some miles away was headed towards us and an aircraft which appeared to be the sole escort of the Cruiser was commencing to search, so CROAKER was taken deep to 300 feet, and shut off for depth charging.

For the next seven very sweltering hours the submarine remained deep while a spasmodic and unsystematic dropping of depth charges was carried

out. Twenty-three depth charges in all were heard. At 1800, the submarine regained periscope depth. Nothing was in sight. After air conditioning, and fans were switched on, the boat began to cool off, and its drooping occupants revived like wilting plants after a good watering.

Monday, August 14. While making the nightly excursion into the shallows, a radar pip appeared at a range of 17,000 yards at 0100, while off Chosei To. This was tracked and overtaken, and its course and speed determined as 305° 8 knots, over a period of 60 minutes steady plotting. CROAKER at 18 knots gained a position 60° on the target's port bow at a range of about 7,000 yards and then turned to starboard for a large track at 2,000 yards (which is the ideal combination usually sought by U.S. submarine Commanding Officers). Thanks to the excellent radar plotting and TDC operation and a very good judgement on the Commanding Officer's part, it was a remarkably well timed attack, and CROAKER arrived in position and slowed down on a steady course a few minutes before the gyro angles were most favorable for firing. The target, a 3,000-ton engines-aft merchant ship in ballast, obviously unaware of our presence, somewhat naturally assumed that she was safe when within a chain of islands and steaming in 7 fathoms of water. Four bow torpedoes were fired on a 75° track at 1,500 yards range.

CROAKER turned to seaward immediately after firing and increased speed to 20 knots. One torpedo, only, hit, and that one right aft, blowing off the stern and bringing the target to a standstill, but showing no desire to sink. CROAKER turned around and approached the stopped ship, from which the crew were evacuating in a small boat. The Commanding Officer did not wish to approach nearer than 2,000 yards to fire the coup de grace, but however some confusion arose in the conning tower about the gyro angle on the torpedo, (a straight shot seemed to present more

of a problem to the fire control party than an angled one). By this time the submarine was deemed too close and the Commanding Officer pressed the firing key. The torpedo firing reservoir had not been charged, but on hearing the firing solenoid lift the TGM hastily charged it and the air started to eject the torpedo. Meanwhile, the swing on the ship was increasing and the Executive Officer had inquired and had been told not to fire, and had released his grip on the firing key. The impulse was cut off and the torpedo was left running, half out of the tube. By the time this catastrophe had been discovered and straightened out, the running time for the torpedo was nearly exhausted so it was jettisoned with a full impulse.

CROAKER then readvanced to finish off her prey with a certain acrimony on all sides. After some preliminary juggling for position the sixth torpedo was fired at the target and struck it in the stern about 20 feet forward of the first one and the ship rolled over and sank in under one minute. It was somewhat unfortunate for the crew that they, mystified no doubt by the CROAKER's antics, should have elected to return alongside the ship at precisely the same moment as the torpedo.

Wednesday, August 16. Dived and patrolled submerged off Kakureppi Island. At about 2100, when the submarine was proceeding south some five miles off the shoal water, the radar got a contact at 11,200 yards on a small ship. CROAKER was astern on the starboard quarter and proceeded to overhaul at 18 1/2 knots, adjusting course to keep about 6,000 yards off track to make certain of being outside visibility range. The two plots and the TDC soon agreed on an enemy course of 190° speed 9 knots, and so when CROAKER was about 60° on the enemy's starboard bow she turned 90° to port and ran in on a 90° track. There was no moon and it was a dark and starry night with the enemy

against a rocky shoreline. He came in sight at 3,500 yards -- a very low silhouette -- and appeared to be a 500-ton submarine chaser steering a steady course. CROAKER reduced to 7-8 knots and at a range of 1,500 yards, fired a single electric torpedo set to two feet from the bow tube on a 92° track, turning away on firing and increasing to twenty knots. The target's length could not have been more than 150-180 feet, and the writer was extremely dubious about the success of such a shot, and so it was much to his amazement, and joy that, hardly had the submarine reached it's "escape" course than there was a glorious explosion accompanied by a sheet of flame and burning debris, and the patrol boat disappeared from sight without a trace. It was a most spectacular hit, and an admirably timed and executed attack which was a triumph for the radar tracking party.

Thursday, August 17. CROAKER continued to patrol southward on the surface. Between midnight and 0200 a phantom radar contact was chased. This frequently occurred during the patrol and the pip usually broke up, proving it to be a rain cloud, or else by its stationary position was eventually identified as one of the many islands which abounded in these waters. However, at 0215, a good sized ship was detected about 15,000 yards ahead and to the southeastward. The radar tracking party got busy and produced an enemy speed and course of 8 knots, 210°. The ship was evidently coast-crawling in the usual manner. CROAKER had some distance to make up, and not a great deal of time to spare as dawn broke at about 0350, so increased speed to 19 1/2 knots and commenced to overhaul at a distance of 6,000-7,000 yards off track. Radar then detected a zig to port by the enemy, and it was apparent that he was going to pass through a narrow channel between two groups of islands (Matsu To), the same channel where CROAKER had been cheated of a ship on Sunday, 13th, by the interference of the supposed patrol boat during the final stages of the

approach. This time there was no other ship around and just sufficient time before daylight to run outside the islands to the starboard side of the channel and attack the ship as it emerged.

The submarine accordingly hauled out to starboard, passed the islands close on the port hand and swung to port as soon as it was clear to do so, steadying on a 90° track. The target, a large loaded engines-aft tanker or ore ship of about 10,000 tons, came into view at 4,000 yards, and the submarine fired three torpedoes at 2,200 yards, confidently expecting, with the previous success on the PC boat fresh in mind, to get three hits. One torpedo ran erratic, and one hit only resulted, and that right forward, which merely reduced the enemy's speed by four knots. Three more torpedoes (the last) were fired, allowing enemy speeds of 0, 2 1/2, and 5 knots. One hit right aft, and the ship collapsed, rolled over and sank in a very few minutes. CROAKER retreated to seaward, all torpedoes expended, and dived in 17 fathoms as dawn was breaking over the nearby islands.

August 23 - 31. On passage from patrol area to Midway. For the first two days a head wind of force 4 and heavy seas were encountered, reducing the submarine's speed by 2 1/2 to 3 knots, and making the bridge very wet. This appears to be caused by the large, unnecessarily wide upper deck casing which extends from beam to beam of the ship and serves no more useful purpose than is achieved by the narrow British variety. Many of the crew, several of whom had never been to sea before were prostrated with sea sickness during this period.

TORPEDOES AND FIRE CONTROL

It has been mentioned before that CROAKER carried a full outfit of (24) MARK 18-1 electric torpedoes. The choice of his torpedo outfit rests with the Commanding Officer, and now that the

early development troubles of electric torpedoes have been overcome, more and more CO's are electing to use them entirely, and are willing to accept the slow speed for the greater advantages of invisibility. They rarely give trouble nowadays after they have been installed on board, and the regular maintenance, once a routine for charging the batteries has been arranged, is less than for an air torpedo.

The MARK 26 torpedo, mentioned in the last periodical report, has been tested and approved, and is in production. This has the same range as the MK 18-1 -- 4,500 yards, but an increased speed of 45 knots. The propulsion is electric through a silver plate battery using salt water electrolyte, which does not enter the cells until the torpedo is fired.

In the opinion of the Submarine Command, the day of the air torpedo will definitely be over when experiments have been completed on another new torpedo, which is propelled by an enriched air cycle and whose exhaust is almost completely soluble in water. A torpedo of this type was contemplated in the early 30's but the idea was never developed owing to the outbreak of the war. The present proposition will have a speed of 45 knots for 11,000 yards and carry a 1,100 lb. warhead. At the moment production of the MK 18 is about 300 per month, and insufficient to meet demands; preference in the issue of these is therefore given to submarines operating in areas where daytime attacks only are likely to be undertaken.

Depth setting policy is also under revision. It is now considered by a number of experienced and successful CO's and by the Submarine Command, that torpedoes set to depths of 20 feet for merchant ships are needlessly deep and will not inflict as much damage on the ship as those set as shallow as weather conditions will permit, which

on hitting increase the venting of the ship's hull and add to the fire risk.

RADAR

The reader could not have failed to notice the constant reference to radar in the narrative and the part it played in the success of the patrol. In fact, three out of the four ships sunk were detected by radar and it was largely due to the accurate information that it gave, that the subsequent attacks were successful. Radar tracking or shadowing forms a large part of the working up period, and a very competent team had been trained in CROAKER, whose efficiency and productions of accurate enemy data impressed the writer. Small wonder that night surface attacks are preferred and practiced more than day submerged attacks, and in general are more skillfully executed. The night attack directed by radar is no longer the hit or miss, hurried browning shot affairs of yore. In fact the data obtained is based on continuous plotting with all guess work eliminated and is considerably more accurate than resulting from periscope observations.

This happy state of affairs will exist just so long as the enemy persists in failing to "catch on" to radar, or at any rate to operate his present electronic equipment sufficiently well to constitute a menace to submarines. When that happens, and the submarine is no longer able to penetrate screens or approach surface ships without being detected, it will have to rely on picking up the enemy before they are aware of his presence (this is probable since the enemy will be the larger target in most cases), then submerging ahead of his estimated track and finishing off attack with the radar-periscope combined with sound.

The SJ radar in CROAKER functioned extremely

well in spite of being the most hard worked unit in the ship. It went wrong only once, and then in a big way, requiring fourteen hours work by the combined team of two electricians and the radar officer to coax it back to life.

The writer could not find himself in agreement with the amount of smoking which took place in the submarine while dived, and the fact that the sounding of the battle stations alarm was regarded as a signal for every member of the crew to start charging the air with nicotine. After several hours running, with air conditioning and the fans stopped, the air in the ship became foul.

WW II STEAM TORPEDOES vs ELECTRIC

The Navy is presently involved in acquiring a "low cost" antiship torpedo for submarine use. It would therefore seem useful to recall World War II submarine experience with "steam" (now known as "thermal") torpedoes and "electrics."

The U.S. started the war with Mk 10 and Mk 14 steam torpedoes -- with the Mk 14 later converted to the Mk 23 by primarily eliminating the Mk 14's low speed feature. By late 1943 the battery-powered Mk 18 "electric" torpedo appeared in the operating submarine forces. In 1944, 30% of all torpedoes fired were Mk 18s, but by 1945 far greater numbers of Mk 18s were being used than Mk 14s and 23s. The Mk 14s cost over $10,000 per copy, while the more easily produced Mk 18 was costed at about $2,500 each, and being supplied at 300 per month in late 1944.

A brief rundown on the character of these antiship torpedoes shows:

- The Mk 10 torpedo -- a carryover from WW I development -- used steam turbines powered by

the combustion of air and alcohol with a water spray injected into the combustion pot to form steam to run the turbines. The exhaust from the turbines was then dumped overboard, creating a visible wake behind the torpedo. The Mk 10 made 36 knots, had a 485# torpex warhead and ran 3500 yards.

- The Mk 14 was a similar "steam" torpedo of 46 knots speed, 4500-yard range, a 668# torpex warhead and with a Mk 6 exploder, (the main troublemaker through the early years of the War).
- The Mk 23 was similar to the Mk 14 but had the Mk 14's low speed feature, of 31.5 knots speed and 9000-yard range, eliminated.
- The Mk 18 was a quiet, wakeless electric torpedo with a simple contact exploder -- fashioned after the German electric torpedo captured in 1942. The Mk 18 made 29 knots when at about 70°F battery temperature. However, and not clearly understood by early users of this weapon, when the torpedo batteries were at a low temperature on firing, the speed was likely to be several knots lower then expected. This resulted in -- at that time -- unexplained misses. Its warhead held over 600#s of explosives similar to the Mk 14, and its range was 4500 yards. An improved electric, the Mk 46 made 45 knots, using a silver electrode and seawater electrolyte and was in production by the end of the War.

The World War II U.S. experience with steam torpedoes highlights certain shortcomings of noisy, wake-making torpedoes when fired against surface ships -- whether escorted or not. Fired at ships in daylight, the wakes were likely to be seen -- with warships taking rapid evasive action and merchant ships sounding an alert which frequently caused convoys to be zigged away -- preventing a follow-on submarine attack. At the same time, the rapidity and accuracy of

counterattacks as a result of sighting the wakes put the firing submarine at considerable hazard because its position was easily established for both the warship escorts and escorting aircraft. When firing steam torpedoes at ships in shallow waters the submarine was doubly in jeopardy because of its restricted mobility in evading a pin-pointed rapid counter attack.

Some examples from U.S. submarine patrol reports can serve to illustrate these observations:

- S-37"s sixth war patrol, 1942: "at 2300 sighted a raiding party of 4 DDs in column and two heavy ships on their quarter -- the "Bougainville express." Closed for a 90°-track shot on the lead destroyer. Range 1200 yards on firing. Mk 10 fish were evidently spotted, as DDs promptly zigged away, then headed back at S-37 and carefully placed 16 depth charges, close, (only 2 seemed far off)."
- SEADRAGON's fifth war patrol, 1942: "A DD was seen searching for SEADRAGON. Earlier her periscope had probably been spotted by a large force that passed over SEADRAGON. An undetected approach on the DD was made and three Mk 14s fired. The first torpedo was observed to be making a good trail of smoke (it might have had its smoke ring missing). It was spotted quickly by the DD which swung to miss all 3 torpedoes. Then the DD charged back at SEADRAGON with some charges very close -- 3 per string. A 4-motored plane followed up with depth charges on SEADRAGON's slick."

  Six days later: "Spotted a small freighter with minelayer escort. At 1500 yards, fired 3 Mk 14s and got one hit. Within a minute, depth charged by minelayer with a good close pattern. Freighter was observed being taken

in tow by minelayer as bombers kept dropping occasional bombs near SEADRAGON's periscope."

Four days later: "SEADRAGON's bridge watch sighted the wake of a torpedo and SEADRAGON was turned sharply away. One fish was sighted missing ahead." (The Japanese used "thermal" wake-making torpedoes, as well.)

Six days later: "4 tubes were made ready and 3 Mk 14 torpedoes had been fired at a Jap sub when SEADRAGON caught a bomb from an escorting aircraft, doing considerable damage and causing the 4th torpedo to be jammed halfway out of the tube."

Four days later: Fired 4 torpedoes at a transport, escorted closely by two DDs. Immediately after a hit was made, a DD was over SEADRAGON laying depth charges in accurate strings, some of which shattered light bulbs, broke gauges, etc."

- CREVALLE's third war patrol, 1944: "Lined up on a huge tanker, fired 6 Mk 14s and got 3 hits. Two bombs hit close aboard CREVALLE during firing. The first bomb was believed aimed at the wakes of fish just launched. Over 60 depth charges were heard in the first rush, with the depth charging starting almost immediately with the launch of the 6th fish. All charges were very close except for one which sounded fairly far away."
- HARDER's fifth war patrol, 1944: "All six Mk 23s missed. Target apparently saw their wakes and was observed to zig sharply away causing last 4 to miss, (first two were observed to be erratic).
- REDFISH first, 1944: "Two Mk 23 torpedoes were observed to be running nicely but putting up a terrific smoke trail. The torpedoes were almost at their 2 AK targets in a large convoy, when steam was observed coming

from the whistle of one of them. (This indicated a single-toot which warned the rest of the convoy that the ship was being attacked from the starboard side. Frequently with such a warning, the entire convoy would be zigged away, preventing the low-mobility conventional submarine from getting in a second torpedo attack.)

A few days later: "Made a periscope attack on 4 ships plus 3 escorts. At 1515 fired 4 Mk 23s at large tanker then let go 3 false target shells as REDFISH was taken deep. At 1517 heard two hits and a minute later felt 56 depth charges -- the first 25 dropped apparently on the false target shells, so they weren't very close." (The use of evasion countermeasures highlighted here shows their necessity due to great rapidity of counterattack stemming from a good knowledge of the firing submarine's location.)

- SHARK II's first war patrol: "Mk 23 torpedoes were again seen to leave a bluish colored smoke along their wakes. 1730, sixth torpedo hit the leading freighter. 1732 first pattern of 10 depth charges. All close.
- GUARDFISH's eighth: "At 0746 heard a timed hit on second ship. Everyone in our sub heard one of our Mk 23s pass down on starboard side and cross over the maneuvering room. This must have been our #3 torpedo making a circular run. At 0749 the first of many depth charges. Two shook the boat considerably."

The experience of U.S. submarines using the Mk 18 torpedoes was somewhat different:

- CROAKER's first, 1944: "Four Mk 18 stern torpedoes fired at a range of 800 yards. All missed. All torpedoes probably ran under, and the 3500-ton merchant ship "sailed uncon-

cernedly on its way, as likewise did the 4 electrics."

A day later: "A KUMA class cruiser was attacked submerged with four electrics. A lucky zig of the cruiser made it blunder into one of the invisible fish, which hit in the cruiser's stern and sank her." (Note that a good ASW warship was unaware of the torpedo attack.)

In summary: "Preference in the issue of Mk 18 torpedoes is given to submarines operating in areas where daytime attacks only are likely to be undertaken."

- SUNFISH's fifth: "Five Mk 18s were chosen (from a mix of 18s and 23s) for this daylight attack with 4 hitting a gunboat and a medium freighter in a convoy of 5 merchant ships and 3 escorts. A minute after hearing two loud torpedo hits took twelve close depth charges."
- SPADEFISH's first: "In a periscope attack, fired four Mk 18s at a MUTSUKI class DD. All missed. No evidence DD detected the torpedoes." Later: "A DD passed ahead. In the glassy sea he would have spotted the Mk 23s remaining, in time to avoid."
- A bulletin of Ordnance Information Report 1-45 noted that on one patrol, "A full load of Mk 18-1 torpedoes were carried on this patrol. 23 of those were fired at enemy targets and as far as is known, all ran "hot, straight and normal." Would prefer to carry them rather than Mk 14s or 23s."
- DRUM's 11th: 26 October, 1944. 0357, "fired four stern Mk 18-1s at 4000-ton freighter. Got 3 hits. Escort on bow of target did not chase us." Later at 0637. "Daylight submerged attack. The ships are now zigging every three minutes. In the next 15 minutes we shifted targets four times."
- SEADRAGON's 7th: 24 October, 1944. 1055, "day submerged attack. Fired four Mk 18s,

got 2 hits. Sank an AK of 5000 tons. CHIDORI escort at 1101 dropped first of 8 depth charges, not too close." Later, at 1214 fired four Mk 18s at range of 1000 yds. Observed 3 hits. Ship sank in less than two minutes." 1218, "first of 15 depth charges from CHIDORI escort. None too close." Later, 1404, "submerged attack. Fired four Mk 18s at 4000-ton AK. 2 hits. CHIDORI on short scale. 1405, first of 25 depth charges. None too close."

- TANG's 5th: 11 October, '44. "in fact, the performance of the first twenty-three Mk 18-1s in all running perfectly, with 22 hits, attest to this." (The 24th was a circular run which sank TANG.)
- BARB's 10th: 15 November, 1944. 2336, "fired six bow Mk 18-1s at SHOKAKU class aircraft carrier with 4 destroyer escorts, torpedo run 3500 yards. One hit, as target zigged about 3 minutes after firing."
- GREENLING's 11th: 0939, 10 November, 1944. "Day periscope attack on WAKATAKE class DD. Fired four Mk 18-1s, one hit. Destroyer did not counter attack. Lost depth control and did not see the DD sink."
- PINTADO's 3rd: November 3, 1944. 2150, "night submerged attack with six Mk 18-1s on SHOKAKU class aircraft carrier, escorted by several DDs. 4 hits, two in carrier and two in TERUTSUKI class DD. Saw DD blow up and sink. Aircraft carrier damaged."
- ATULE's 1st: 0505, 20 November, 1944. "Fired 4 stern Mk 18-1s, 2540 range, at HATSUHARA class DD. One hit. 2 1/2 minutes later his stern went under." Later, on 27 November, "On only the submerged attack, the first, was there any counter action."

As to how the Mk 18 performed relative to the Mk 14s or 23s, a box score of hits versus torpedoes fired -- by submarines returning to Pearl Harbor in June, 1944 -- showed the following

results: of some 83 Mk 14s and 23s fired, 31 were assessed as hits. Whereas, of the 47 Mk 18s fired, 14 were assessed as hits. This gave the Mk 14/23 torpedoes about a 36% hitting probability as against the Mk 18s 30%. It was observed from a reading of a few of the patrol reports that where there was a choice, the Mk 18 was used for daylight submerged attacks. That, plus its slower speed and possibly its running slower than expected may partially account for the lower percentage of hits achieved. The slow speed of 29 knots would cause more misses against zigging targets; and the poorer tracking data and timing of firing as experienced in periscope approaches might also account for some of the disparity. But more study of patrol reports appears necessary to give good definitive answers to the difference in hit probability observed for this small segment actually tabulated.

It should be recalled that U.S. submarines were fitted with a simple torpedo-warning-device consisting of four small sonar listening heads implanted in the outer hull which covered all four quadrants. The loud enemy torpedoes, it was felt, should be detected sufficiently far off to allow for effective evasive maneuvers by the U.S. submarine shot at.

Today, noisy torpedoes which leave either a wake-trail or produce an infrared scar on the surface of the ocean should be readily detected by greatly improved surface and air ASW forces. Use of infrared binoculars to spot thermal torpedoes which are wake chasers must be considered. And satellite detection of pronounced infrared scars becomes increasingly likely. "Cool" torpedoes may be at a premium for war usage. Considerable work is being done to produce thermal torpedoes with exhaust gases which are soluble in water to reduce wakes and thermal scars. Efforts are also being directed to closed cycle thermal engines which virtually eliminate wakes and reduce thermal

scars. Just running a torpedo deep through most of its trajectory is a satisfactory solution for deep water environments. But so much of antiship operations proved to be in shallow waters during World War II, as illustrated by an examination of patrol reports, that today's antiship torpedoes must seemingly be designed for shallow water use as well as deep water use.

Quite obviously the 29-knot "electric" of World War II was too slow a weapon to fire against high speed warships. But the electrics of today of up to 45 knots speed, have the necessary speed for use against the highest speed warships while maintaining their "stealth" characteristics. Rear Admiral Heaslip, the Head of British Submarine Forces, has stated that his TIGERFISH torpedo, a high speed "electric", is his "stealth" weapon for submarine attacks on surface ships. And it is this weapon which is being proposed for consideration in the present competition for a U.S. low-cost antiship torpedo. Importantly, a "stealth" weapon by reducing the amount of warning which it gives to a target in its attack, makes it difficult for the target or its escorts to counter the weapon through evasion or countermeasures. And this element of surprise may be more important today than it was in World War II where Mk 14s got hits despite their wakes having been sighted early in their trajectories.

This has not been an attempt to provide a case for one type of torpedo versus another, particularly since the thermal and electric torpedoes of today have little resemblance to those of WW II. But it does seem that the submarine experience of WW II needs to be recalled to keep present-day comparisons in a proper perspective. The stakes are too high in choosing the best kind of antiship torpedo to not take cognizance of general principles involved in torpedo usage.

PHOENIX

CINCPAC'S SUBMARINE VIEWS

During World War II, submarines were decisive in the battle of the Pacific. Submarines will be equally important to the outcome of any future conflict in the Pacific. This conclusion is brought into question only by a growing Soviet ability to checkmate our submarines. This seeming heresy to submarine enthusiasts is, rather, an admission of improving Soviet strategy and tactics, the sound quieting of their boats and their technological improvements in both submarine and anti-submarine operations. The Soviets have quantitative superiority. To also bow to a Soviet qualitative superiority imperils the future.

"Why submarines?" The "man in the street" can tell you what submarines are for, what their strengths are, and how important they have been in wartime. But their use in peacetime is not as well appreciated. Nonetheless, they contribute importantly to our peacetime deterrence mission. On the strategic side, they currently provide our most secure leg of the triad since SAC's land based missiles and strategic bomber bases can be pretargeted. On the conventional side, aggression is deterred because the Soviets know they are up against the world's finest submarine force. Only if the Soviets continue to believe they are second best will our submarine force make a vital contribution to deterrence.

In our efforts to make a point, the word "vital" is used too often, but in this case, it is vital that the U.S. retain technological and tactical superiority in its submarine force.

Most commanders are prone to rank missions for the submarine force in similar fashion. First comes strategic deterrence. Our squadron of Bangor-based TRIDENT SSBN's, armed with 24 TRIDENT I missiles each, will continue to provide us with a suitable deterrent to nuclear war well

into the 21st century. Second, there are the things that SSN's do well -- surveillance, interdiction through mining, destruction of Soviet combatants, and disruption of Soviet merchant shipping. Third, the submarine's role in special operations is coming into prominence.

The force is well prepared to do all these things. For the most demanding task, killing other submarines, our new LOS ANGELES-class submarines with a high speed capability, the latest in sensor and underwater weapons systems, and our most modern sound quieting techniques, give us the best anti-submarine unit in the world. The LOS ANGELES-class is backed up by our STURGEON and PERMIT-class SSN's which are being modernized with new sensor and fire control systems. There can be little doubt about the Soviets allocating a large number of their submarines to sink our battle groups. To survive, the group must be proficient in the full spectrum of anti-submarine warfare. Our SSN's are the most effective means to counter the Soviet cruise missile and torpedo firing submarines. On the other hand, our attack submarines will be tasked to sink Soviet surface combatants as the opportunities develop. Our attack submarines will allow the commander to disrupt the enemy sea lines of communication by sinking Soviet merchant shipping and, at the same time, by their presence, make our own commercial and supply links with our many allies rimming the Pacific Basin a bit more secure.

All this represents an ambitious course of action that will keep our submarines busy. To succeed requires quality platforms manned by top-notch crews. Today, we have both. Technology is producing these platforms, and we continue to attract and retain superior people in the submarine force through the use of special incentive pay, excellent training and education programs, challenging duty assignments, and high promotion and advancement opportunities. This

class act must be supported by a substantial investment of our resources if we are to maintain the edge over the Soviets -- and, of course, we must.

We have completed our last TRIDENT hull to be loaded initially with the TRIDENT I missile. The next TRIDENT off the ways will be outfitted with the Trident II D-5 missile and the upgraded ship systems to support this new weapon. Starting with the first overhaul of OHIO, the eight initial TRIDENTS will be backfitted with the D-5 missile. The TRIDENT II missile will add to our strategic flexibility by giving us more accuracy and greater throw-weight. Modernized 688-class submarines are making their initial appearance into our order of battle. These submarines have full Arctic capability, are equipped with the vertical launch system for TOMAHAWK, and have a more powerful propulsion plant. The SSN-21 advanced design fast attack submarine project is well underway. This new platform will sport major advances in sensors, weapons, and sound silencing.

Since we suffer from a one to three deficit in numbers, it is not illogical to argue that our forces must be at least three times better than the Soviets. Such a ratio becomes more and more difficult each passing day. The Soviets build new classes of submarines almost as fast as we build new individual units. Their latest models, including the AKULA SSN, are closing the technology gap. The MIKE and SIERRA-class SSN's are both advanced follow-on designs with quantum leaps in sensor and sound quieting technology. The TYPHOON SSBN's are difficult to detect with improved tactics and a capability to patrol beneath the Arctic ice cap. New ballistic missiles and cruise missiles are being tested and will soon be ready to deploy. Soviet non-submarine ASW prosecution is getting better and better with the introduction of the nuclear-powered KIROV cruisers, the towed sonar equipped UDALOY

destroyers, and brand new, redesigned BEAR "F" ASW patrol aircraft.

The increased sophistication of Soviet ASW forces enhances their ability to provide the traditional echeloned defense of their conventional and SSBN strategic assets. Our submarines will have to pass through an expanded three-dimensional sea control/sea denial area populated by increasingly capable surface and submarine ASW forces while overhead the modernized BEAR F's patrol farther afield.

Aside from anti-submarine operations, yet another new threat in the Soviet arsenal is the SS-NX-21 submarine-launched cruise missile. Modified YANKEE-class submarines and other general purpose Soviet submarines are expected to deploy this long-range, nuclear-capable, land-attack cruise missile system this year. This system could be used in a theater or strategic role or against U.S. targets such as command, control, and communications facilities and naval bases. The SS-NX-21 will give elements of the Soviet general purpose submarine force a nuclear land-attack role which will considerably complicate our ASW battle management problem since we have no option but to counter.

The Soviets are also aggressively updating their submarine communications and support systems. We expect them to deploy an extremely low frequency (ELF) communications system, which will be used to contact their submarines under most operating conditions. For physical protection, they continue constructing protective tunnels at their submarine bases for berthing and refitting. The Soviet oceanographic research fleet, larger than the rest of the world's combined, contributes to their increasingly precise knowledge of the oceans, and enables their navy to make optimum use of its weapons, sensors, and platforms.

The Soviet operators are getting smarter, too. Each year, their large naval exercises demonstrate a progressively greater degree of complexity and sophistication. Their blue water tactics, command and control, and operating experience are accumulating at an astounding rate. We have observed that many of these complex exercises center around ASW prosecution techniques. The Soviets are working hard and spending a lot of money -- and producing results.

Our strength as a world power has traditionally centered on our ability to develop the most technically advanced weapons systems and man them with the smartest, best trained people. These characteristics remain the keys to maintaining our superiority in submarine operations. It is necessary that we continue with aggressive research and development programs. We must tend to emphasize to our people programs to make sure we attract talented young men for submarine service, men who can understand and effectively employ some of the most complex defense equipment in the world. Without our continued national dedication to these truths, the Soviets will erode a superiority that is vital to the nation.

Admiral Ron Hayes, USN
Commander in Chief, Pacific

USS BURRFISH AND THE PALAU RECONS

Following the Marianas campaign, 3rd Amphibious Force Commander, Vice Admiral Theodore S. Wilkinson, requested that COMSUBPAC, Vice Admiral Charles A. Lockwood, task one of his submarines to conduct a covert reconnaissance of Palau Islands prior to the planned amphibious landing there.

Based on her availability at the time, Vice Admiral Lockwood assigned USS BURRFISH (SS 312),

LCDR William B. Perkins commanding, the mission -- one that would involve the only submarine-launched recon of World War II conducted by Navy Underwater Demolition Team personnel.

Of the nine reconnaissance group volunteers, five, -- Bob Black, John MacMahon, William E. Moore, Leonard Barnhill and Warren Christensen came from UDT 10. Two, -- LT M. R. Massey and Chief Howard L. Roeder, came from the UDT's Maui, Hawaii Training Staff. And two others, Chief Ball and Emmet L. Carpenter, were from the Sub Base, Pearl Harbor.

The five from UDT 10 were specially selected because of the advanced swimming, diving, rubber boat and recon training they'd previously undergone as members of the clandestine OSS Maritime Unit.

With little time available, mission preparations commenced immediately. The nine-man recon group practiced rubber-boat work, launchings, etc., from a destroyer in waters off Maui -- the UDTs brushing up on their hydrographic survey techniques.

After having informed LCDR Perkins of the mission, VADM Lockwood discussed it with him; its various aspects in general and detail.

The BURRFISH, meanwhile, was getting special attention. For underway stowage of the recon group's deflated 7-man rubber boats, free-flooding, holed, 8 foot-long cylindrical tanks -- which housed the boats -- were fitted to the BURRFISH deck abaft the conning tower. The rubber boats were inflated and deflated by a special device originally designed for Army rubber pontoons. This was necessary to save precious operational time. As RADM Perkins, USN(Ret.) recalls, however, "Once aboard BURRFISH the recon group became integral with our crew. The problem

was to give them something to do, so we arranged a high periscope watch in daytime which helped a little."

On 10 July, 1944, the recon group embarked on BURRFISH. She then slipped out of Pearl and headed west-south-west to her objective. Enroute, LCDR Perkins received word that carrier air strikes and bombing raids had been planned for the Palaus and that he wasn't to enter the area until 30 July.

He then received further word from COMSUBPAC that he was to collect data on the ocean currents in and around Peleliu -- his number one priority. This was in addition to the initial request of VADM Wilkinson for intelligence on reefs and water-depths plus more detailed information on underwater obstacles that air and previous periscope recon photos had showed the Japanese to be emplacing.

Conditions could hardly be described as optimum when BURRFISH finally entered the mission objective area for her night recon work. Along with bright moonlight, there was considerable enemy radar activity. Undeterred, LCDR Perkins conducted daylight submerged patrols in and around the passage between Peleliu and Anguar, making periscope observations. The two photographers aboard took periscope photos. Thus, ocean current data and intelligence on possible landing beaches was gathered by BURRFISH.

On the night of 9 August, 1944, BURRFISH rendezvoused with the USS BALAO at a point east of Anguar Island. There, LCDR Perkins delivered current data charts and periscope photos to the BALAO's skipper -- who speedily delivered them to VADM. Lockwood and Wilkinson -- before BURRFISH was conned back to the vicinity of Peleliu.

On the night of 11 August, BURRFISH surfaced

in a decks awash status, off the southeast tip of Peleliu Island. The First Lieutenant and two submariners then moved out onto the after deck followed by five of the reconnaissance group. While the submariners, supervised by their officer, removed a rubber boat from its container and inflated it, the camouflaged, grease-smeared recon team personnel made a final check of their gear -- swim fins, face mask, UDT knives. After the boat was fully inflated, the crew of the BURRFISH placed the boat in the water alongside BURRFISH. Recon-team members then made short, shallow dives into the water, clambered aboard the rubber boat and paddled it shoreward for their first reef-reconnaissance. Following a long paddle they anchored the boat about 1,000 yards offshore and swam on in. Under the noses of Japanese patrolling the beach, they went about their hydrographic survey work, then returned to their boat.

There, according to a pre-arranged plan, a UDT 10 member dove underwater and with his knife, tapped a coded message on a piece of coral. Offshore, BURRFISH's sonar operator alerted his skipper that the rendezvous signal had been received. So LCDR Perkins gave the order to proceed to the point where the tapped signal had come from.

The recon team brought back valuable information, reporting that what recon photo analysts had interpreted as sea grass were actually cement railroad-tie obstacles. They would have to be demolished by other UDTs prior to any landings.

While further recon work was necessary, LCDR Perkins advised COMSUBPAC that persistent, heavy enemy radar activity, bright moonlight and the frequent sorties of Japanese patrol planes based on Peleliu forced him to temporarily abandon what appeared to be too risky an effort. He then

pointed BURRFISH's nose northeast towards Yap.

Five nights later, on 16 August, BURRFISH submariners successfully launched another recon team. The team headed for the beach off the southern tip of YAP Island -- the site of the Japanese Pacific-Central communications headquarters. Led by LT Massey, the recon team conducted another valuable reef reconnaissance before returning to BURRFISH. But this intelligence was never needed since Yap was bypassed in the U.S. island-hopping campaign.

Again on 18 August, BURRFISH inserted a recon team for the reconnaissance of a beach on the northeast coast of Gagil Tomil, an islet in the Yap group. After departing BURRFISH at 2000, the team paddled to within a quarter mile of their objective where they discovered a barrier reef just below the surface. Fearing that breakers would carry the boat ashore, Chief Roeder ordered the boat's anchor dropped. Then leaving Ball -- his best navigator -- behind, he led the rest of his team on in. Fifteen minutes later Bob Black, one of the original UDT volunteers in 1943, returned to the boat with Carpenter, who couldn't handle the strong currents. They reported to Ball that they'd found barricades of palm-log cribs full of wire-linked rocks. Then, Black swam back to rejoin the recon team.

Several hours later, well past the return time, a worried Ball and Carpenter pulled up the anchor and commenced paddling for a sweep along the reef, trying to locate their overdue mates. But no one was found.

At midnight, BURRFISH surfaced at the prearranged spot to retrieve the recon team. No one was there. The submariners waited and watched -- hoping for the best. At about 0300 hours, a light from the rubber boat was sighted. BURRFISH then recovered the boat with only Ball and Carpenter in

it. Almost immediately thereafter, LCDR Perkins had to dive his boat to avoid some incoming radar-equipped Jap planes.

Despite the dangers of the continuous patrol plane activity and the area searches by powerful radars on Yap, LCDR Perkins patrolled off the Gagil Tomil beach until daylight of the 19th. This was the agreed-upon escape beach for a daylight pickup. Search efforts around the island were continued throughout the 19th and into the 20th of August. In the interim the skipper had to put a damper on the urgings of UDT 10 members, Barnhill and Moore, who were powerful, experienced swimmers. They figured they could out-muscle the rough, stormy seas for a close-in search effort. LCDR Perkins however had to regretfully inform them that it would be a suicidal effort. As he recalls: "At dark on 20 August, it became apparent that rescue of our three men was not to be. Accordingly, we departed the area for refit on Majuro Island."

Later, an intercepted radio message confirmed the worst fears of the UDT people on board BURRFISH. Bob Black, Howard L. Roeder and John MacMahon had been captured by the Japanese. Before they were killed, they'd been ruthlessly interrogated, but gave the enemy -- as per instructions -- false information about UDT capabilities. All three were posthumously awarded the Silver Star.

Warren Christensen, Leonard Barnhill and William E. Moore were also awarded Silver Stars at a ceremony at their Maui base while LT Massey received the Navy Cross for his participation in the only UDT sub-launched recon of World War II. All the surviving UDT team members were then given the further honor of being entitled to wear the Submarine Combat Insignia.

During debriefs, LCDR Perkins suggested that

if a similar-type operation was planned in the future, it should not be conducted during bombing raids, nor against well-defended objectives. Also, operational U.S. planners decided that Submarine UDT operations were too risky. Hence, when one was requested later, permission to conduct it was not granted.

John B. Dwyer

[This is an excerpt from Dwyer's to-be-completed book, USN SUBMARINE AMPHIBIOUS, SPECIAL-WARFARE OPERATIONS -- WW II to the PRESENT.]

KINGS BAY, GEORGIA

The Kings Bay region is a place that has been populated for thousands of years. Archeological research conducted under a Navy contract prior to development disclosed prehistoric Indian presence throughout the area.

Early in the 19th century, what is now the submarine base, was the site of two plantations, one owned by Thomas King, the other by John McIntosh. Where the Port Services building is now located, King developed his plantation. Buying the land in the 1790's, he developed a small plantation. Elsewhere on the base, John Houston McIntosh built a considerably larger plantation which grew cotton and sugar cane.

The Army began to acquire land at Kings Bay in 1954 to build a military ocean terminal for shipping ammunition in event of a national emergency. By 1958, the Army's $11 million project was completed. This construction included a 2,000-foot long, 87-foot wide concrete wharf, along with 47 miles of railroad tracks throughout the base. A 10-mile-long, 200-foot-wide channel, dredged by the Army to 32 feet, provided access between the bay and the ocean via the St. Marys

entrance channel.

Because there was no immediate operational need for the installation, it was placed in an inactive ready status. Though never reactivated to serve in its primary role, it was used twice for other missions. In 1964, as Hurricane Dora hammered the area, nearly 100 area residents were sheltered aboard the base. Also, during the Cuban Missile Crisis, an Army Transportation Battalion of 1,100 men and 70 small boats took up positions at Kings Bay.

The chain of events which led to today's combination of high tempo submarine operations out of Kings Bay and the complex construction project that is reshaping the face of thousands of acres of land, began in 1975. At that time, treaty negotiations between Spain and the United States were in progress relative to U.S. submarine presence in Rota, Spain. A proposed change to the agreement involved the withdrawal of the Fleet Ballistic Missile Submarine Squadron -- SUBRON 16 -- from its Rota base.

Anticipating this action, the Chief of Naval Operations ordered studies to select a new SSBN basing site on the East Coast of the United States.

In January, 1976, a draft treaty between Spain and the U.S. was initialed by the negotiators, calling for withdrawal of Squadron 16 from Rota by July, 1975. The treaty was later ratified by the U.S. Congress in June, 1976.

A site selection steering group evaluated more than 60 sites along the Atlantic and Gulf coasts. By summer, 1976, the number was down to five: Narragansett Bay, RI; Cheatham Annex, VA; Charleston, SC; Kings Bay and Mosquito Lagoon, FL. A study to evaluate each site relative to cost and availability, explosive safety requirements,

growth potential, etc. was conducted. From this study, Kings Bay was selected and the Navy's decision was announced by the Secretary of the Navy in November, 1976.

In early 1978, the Navy began preparations with transfer of the property from the Army to the Navy.

On July 1, 1978, the Navy raised its flag at Kings Bay and started preparing for the incoming squadron of submarines. One year and one day later, Commander Submarine Squadron Sixteen embarked aboard the Submarine Tender USS SIMON LAKE (AS 33), arrived at Kings Bay.

Four days later, USS JAMES MONROE (SSBN 622) pulled alongside the tender and began a routine refit. Since that time, Kings Bay has been an operational base, supporting 1/3 of the nation's underwater deterrent force.

Meanwhile, in May, 1979, Kings Bay was selected by the Navy as its preferred site for an East Coast Strategic Submarine Base for support of TRIDENT and future generations of strategic submarines. In October, 1980, the Secretary of the Navy, Edward Hidalgo, officially announced the decision: Kings Bay would become the Atlantic home for the new OHIO-class submarines.

On April 1, 1982, the title of the base was changed from Naval Submarine Support Base to Naval Submarine Base -- reflecting the growing significance of Kings Bay.

Today, the originally planned submarine support base -- a facility to refit submarines homeported elsewhere -- has nearly been completed. Its cost of about $125 million, comprises a package, sized to meet the demands of the mission of supporting a squadron of fleet ballistic missile submarines, a submarine tender, and a floating drydock.

The TRIDENT basing decision however touched off a building project of vastly larger magnitude. Through the 1980's, the Navy will spend more than $1.7 billion in the military construction effort alone.

Current facilities will be expanded to meet the requirements that will enable Kings Bay to serve as a homeport, refit site and training facility for the Navy people that will operate and maintain the next generation of strategic submarines that will arrive at the end of the decade.

In addition to adding to existing facilities, three major new commands will be added to the base.

A two-sided challenge is being met at Kings Bay. While the largest peacetime construction project in the history of the Navy is progressing, an operating squadron of strategic submarines depend on the Kings Bay facilities and the skills of the people assigned there, to meet their critical national defense mission.

NAVAL SUBMARINE BASE KINGS BAY MISSION

The mission of the Naval Submarine Base Kings Bay, Georgia, is to provide support to the Submarine Launched Ballistic Missile System and to maintain and operate facilities for administration and personnel support for operations of the submarine force.

Also, within capabilities, Kings Bay provides logistic support to other activities of the Navy, and like all Naval installations, is ready to perform any other function which may be directed by higher authority.

Fleet Ballistic Missile Submarines, the Navy's strategic nuclear force, are equipped with

sea-launched ballistic missiles for attack and with torpedoes for defense. As the most survivable component of the U.S. strategic nuclear forces, these submarines must be capable of executing a broad range of options upon receipt of directions from the national command authority.

They are highly survivable and reliable no matter how or when hostilities might be initiated. These qualities provide the basis for the fleet ballistic missile submarine force's significant contribution to the overall strategic balance in the world today.

CDR Frank Evans
JO1 Lamar Raker

DISCUSSIONS

REDUCED OXYGEN for FIRE SUPPRESSION

If one can decrease the intensity , initiation, or rate of fire spread, one "buys time" so that what otherwise might be a disaster could be prevented by having enough time to take corrective action. It is suggested that in submarines the oxygen concentration be decreased, and that the upper limit of 19%, instead of the present 21%, be made the norm for routine operations. The value of 19% is chosen because cigarettes will still smolder at about this level.

Fire in a submarine is a constant menace to the welfare of submarine crews, particularly during peacetime and wartime patrols. In 1980-1984, 104 submarine fires -- at sea and in port -- were reported, and they cost the Navy in excess of six million dollars. Perhaps those damages could have been greatly reduced by altering the composition of the inhabited atmosphere to retard flames. Case histories and fire research have both shown that the destructive power of flames

is proportional to the concentration of oxygen in the atmosphere.

Recently, simulations of submarine hull-insulation fires in air -- 21% oxygen -- have shown that temperatures in a sealed compartment can reach fatal levels in less than two minutes, suggesting that a conflagration can easily incapacitate a submarine within a very short period of time.

Fire damage aboard submarines may be diminished by reducing the concentration of oxygen with rapid or delayed additions of nitrogen to the atmosphere. Human activity, moreover, should not deteriorate from a deficiency of oxygen, since the total amount of oxygen in the compartment is unchanged by supplemental nitrogen. In other words, the rate of flame-spread depends on oxygen concentration and human activity depends on the absolute amount of oxygen in the atmosphere.

It is apparent that fire is dependent on the percent of oxygen whereas life is dependent on the partial pressure of oxygen. Crews presently maintain their oxygen, equivalent to living at any altitude between Washington, DC, and El Paso, Texas. But even lower concentrations of oxygen may be safe, since it is common knowledge that residents of Denver, Colorado, perform many complex tasks without ill-effects from living at an altitude where there is only .175 atm. of oxygen partial pressure in the air breathed. Similarly, students at the U.S. Air Force Academy appear to study effectively at their high altitude. Thus, submarine crews could operate with lowered concentrations of oxygen as long as their partial pressures of oxygen are maintained at acceptable physiological levels.

As opposed to fire, the sustaining of life is oxygen partial pressure dependent -- not oxygen concentration dependent. Humans show a very wide

tolerance to large changes in oxygen partial pressure. It can be shown that humans can live in from 1.09 to .12 atm. partial pressure of oxygen. In the Apollo disaster, the atmosphere was pure oxygen at 16 psi. (and we all remember the almost explosive Apollo fire at Cape Canaveral which killed three astronauts) while people in Bolivia live at .12 atm. partial pressure of oxygen. The implication is that humans could easily tolerate 19% oxygen concentration in a submarine. The 1.0 atm. total pressure, this gives a partial pressure of oxygen of .19 atm., roughly equivalent to that in the Blue Ridge mountains of Virginia.

The Naval Research Laboratory has proposed that submarines operate continuously at 19% -- at about 1 atmosphere of pressure or slightly below -- rather than at the maximum of 21% permitted now. The reason for choosing 19% is based on cigarettes still being able to smolder somewhat. Thus, the crew would not have to forego smoking. After all, a smoldering cigarette is also a fire, and at lower oxygen levels it tends to go out -- causing interesting psychological effects on the crew. For non-smoking crews the 19% restriction might not apply. That 19% is quite acceptable to submarine crews, has been repeatedly shown by submarines operating under these conditions for stretches of 24 hours or longer, often without the crews being aware of it. This has been documented by the atmosphere habitability logs of operating submarines.

One concern is that if the upper limit of oxygen is set at 19% for submarines, excursions below .19 atm. partial pressure might occur, and the physiological significance of this is not known. Indeed, the physiological impact of an upper limit of 19% for 90 days in a submarine is also not known, particularly when one considers that submarines can operate with carbon dioxide levels up to .8% and other gases and vapors are

much higher than that in "air" and must be taken into account.

In a submarine, the atmosphere is not "air." The composition varies. According to the Submarine Atmosphere Control Manual there are limits for many gases and vapors. It is noted that only for 1-hour emergency conditions is the oxygen concentration allowed to be above 21%. Excursions in the other direction, however, are common. For a 24-hour period in one submarine, the concentration of oxygen averaged somewhat below 19% and the crew was not perturbed about it. Concentrations as low as 17.5% oxygen have been permitted in submarines for many years. However, at this particular point, the partial pressure is still .184 atm., even though the total pressure was above 1 atmosphere, accounting for the low concentration of oxygen.

Additionally, rayon, cotton, and filter paper won't ignite at about 18.5% oxygen, and at 19% oxygen the burning rate of these materials would be about 10% less than at 21% oxygen -- but also, at 19% there would be a greater delay in flame induction time, there would be both slowed and lessened amounts of heat release, and fire spread would be slowed considerably. All of these factors "buy time" for damage control actions.

Two very significant problems with fires in confined spaces are that they get out of hand very much faster than normal and that temperatures quickly reach lethal levels.

There is an induction period before the fire becomes violent. In the Apollo disaster, the "bend in the knee" was less than 15 seconds. If one drops a cigarette on a sofa in the evening, the bend in the knee might occur at 0300 the next morning. If there is a break in a hydraulic line, the ignition of the emitting mist might also "bend the knee" in seconds. In many fires it is often

only minutes. The important thing is to "buy time" by postponing or eliminating the "bend" by being able to have a long enough induction time to put the fire out before it gets out of hand. Reduced oxygen will "buy time."

In connection with the concept of sudden extinguishment, a system has been proposed that, in the event of a runaway fire in a submarine, .5 atm. of nitrogen be dumped suddenly into the compartment. Adding .5 atm. of nitrogen raises the total pressure to 1.5 atm. -- and the concentration of oxygen drops to 14% but the partial pressure of the oxygen stays the same.

The bottom line is that we can indeed slow fires down markedly by diluting the atmosphere with an inert gas, such as nitrogen, as long as we stay within physiologically acceptable levels. This buys time, if nothing else, and could spell the difference between an incident and disaster.

Dr. Homer Carhart and
CAPT Douglas Knight, MC, USN

POLARIS SURVIVAL: HOW TO WIN THE BATTLE

Miller, Neeb, Lee and Fullinwider, in their SUBMARINE REVIEW article, "The Battle for Polaris Survival," describe a wargame conducted to assess the survivability of POLARIS. In 1961, the Joint Strategic Target Planning Staff (JSTPS) questioned the survivability factor of 1.0 attributed to the POLARIS system. Three blue force POLARIS missile submarines were opposed by a formidable red force of nine surface action groups (SAGs), 1,000 trawlers, 50 BADGER aircraft, 40 diesel submarines and nine SSNs. In the game the three SSBNs had to transit undetected to their launch points while opposing forces attempted to detect and maintain contact until launch time. To win, the three POLARIS submarines had to launch all of their missiles before the opposing forces attacked and destroyed them.

It is our contention that this question could have been better and more persuasively investigated with some simple analysis. When POLARIS "won" by achieving a survivability of 1.0 (36 Missiles launched), the general officer convening the game proclaimed the results inconclusive.

Considering some of the extraordinary circumstances of play, it is small wonder. For instance, the authors describe how it was necessary at one point for 12 missiles, each with a 25% probability of failure, to be launched successfully. Dice and probability tables were used, and there were no failures. The probability of that occurring is 0.032. Other approaches might have been taken, and in view of the criticality of POLARIS, should have been. We will outline one.

We tried out a simple model and conducted an analysis that would have provided the JSTPS with the advantages of clear cut cause-and-effect

relationships, increased flexibility, and variance of parameters to test the sensitivity of results -- with an answer provided in a shorter amount of time.

Our analysis was performed using the identical forces, strategic setting and tactical characteristics that were described in the SUBMARINE REVIEW's article. The analysis assumed, as did Jerry Miller's wargame, that all events occurred in the Norwegian Sea. Because it was not clear from his article whether the surface forces were in active or passive search, two cases were investigated and probability of survival of the SSBN was calculated for each case.

The first used a passive area search model with the searcher's sweep width reduced, to account for counterdetection and evasion by the SSBN. SAG and trawler detection ranges were 10,000 and 2,000 yards respectively.

In the second case, labeled the "ping and listen" scenario, an active sonar capability was given to the SAGs and trawlers. Both utilized an intermittent active search at tactically advantageous intervals. If an SSBN was within detection range (10,000 or 2,000 yards), the SSBN was detected.

In both cases red submarine force detection range was a function of SSBN speed and is represented in the graph in figure 1.

Specifically, the SSBN was much more detectable at higher speeds. So, if it speeded up to evade red surface searchers it became more vulnerable to red submarines. In all cases the overall survival probability of POLARIS was virtually 1.0.

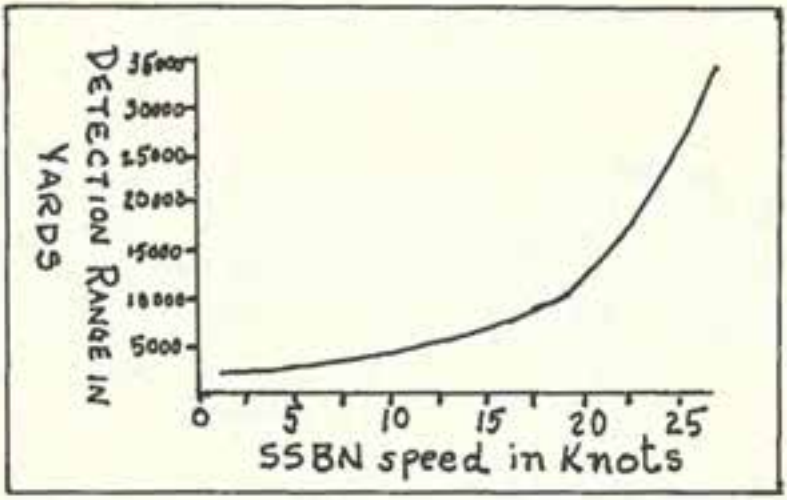

Figure 1.

The general model used to derive the probability of a U.S. SSBN not being detected (P) is:

$$P = (1-P_1)\cdot(1-P_2)\cdot(1-P_3)$$

Where P_1 is the probability of enemy trawler detection, P_2 is the probability of SAG detection, and P_3 is the probability of SS/SSN detection.

In CASE 1, the probability of "passively" detecting the U.S. SSBN by enemy platforms is derived from:

$$P = 1-\left[1-\frac{(N\pi Q^2)}{A}\right]\cdot e^{\left[\frac{-2QVTN}{A-\pi NQ^2}\right]}$$

where N = number of enemy searchers
Q = their detection radius
V = U.S. SSBN's speed
T = enemy search time
A = area being searched

In CASE 2, "Ping and Listen", an enemy searcher is assumed to ping every half hour. If the U.S. SSBN happens to be within the "active" sonar detection radius, it is assumed that the SSBN is detected. The probability of active detection is thus given by:

$$P\ (\text{time of search}) = 1 - \left(1 - \frac{N\pi Q^2}{A}\right)^{2T}$$

In the case of a Soviet BADGER being within the distance to abort a missile launch by the SSBN, since detection is considered to be virtually certain, the relevant question becomes "how soon can an armed BADGER get to the launching submarine?"

It seemed that compared to the war game described in the SUBMARINE REVIEW, our analysis was more straightforward, unambiguous, and compelling. By varying the POLARIS op area and the assumed capabilities of the searchers, absurdly pessimistic (long range) detection capabilities could be tried and the POLARIS survivability still be shown to be very high. Wargaming is too time consuming to permit many variations and with a fixed scenario does not allow this freedom. We also varied the time to E-hour (missile launch time) and SSBN speed.

In one case, model results showed that the SSBN would not be detected by the trawlers and was vulnerable to SAG detection if it's at very slow speeds. Additionally, we were able to see how fast the probability of SSBN survival decreased, as the time to E-hour increased.

For the "Ping and Listen" scenario, results indicated overall lower probabilities of SSBN survival than the passive model. As before, we were able to see how much more susceptible the SSBN was to Red Force detection as time to E-hour increased.

The versatility or flexibility of our approach showed up again while analyzing the question of how long it would take an armed BADGER to attack a launching submarine. Analysis showed that the expected number of missiles launched by an SSBN before the nearest BADGER could get there was 15 -- all but one missile. This was independent of the aircraft's ability to localize and conduct an attack with some unnamed weapon -- probably a nuclear depth bomb.

The second advantage to our analysis was the short time involved. The SUBMARINE REVIEW article stated that it took six weeks to play the game and derive the results. Our three man team, on the other hand, took one week for research, model generation, and analysis. In six weeks the wargame undertook one case. In 1/6th the time every question thought to be interesting was explored in our analysis.

Our findings could have been expanded by incorporating other variables, as specified by the JSTPS staff into the analysis. It is clear that we could supply more quality information to the decision-maker to answer the question of survivability of POLARIS. The ability to vary parameters, time involved and flexibility all illustrate this point.

This is not an argument against all war gaming. Sometimes human decision-making so dominates the analysis that players (of the right professional background) are mandatory. It is always wise, given the time, to check analysis with several games. Moreover, the art of gaming

has progressed since the 1960's.

Still, the game described in the SUBMARINE REVIEW shows that in striving for "realism" and the "human element" you can create more doubt than conviction, more confusion than clarity, and more astonishment than confidence.

LT Benjamin F. Breux
LT Joseph A. Horn, Jr.
LT Robert L. Foster, Jr.

SUBMARINE ATMOSPHERIC HABITABILITY

In 1945 the submarine was a surface torpedo boat which could submerge for protection. There is at least one World War II submarine patrol report which described a remarkable 38-hour dive to escape a depth charge attack. But routine dives lasted only 12 to 18 hours. Moreover, during daily surfacing, the submarine's engines were started and within five minutes the boat would be full of fresh air. Except as an emergency consideration, no one worried about carbon dioxide removal, the replenishment of oxygen, or the control of air contamination. Heat was also of little concern. Calculations indicated that a fleet submarine needed about 20 tons of air conditioning. Yet, the Bureau of Ships saw fit to provide only 8 tons of capacity -- and everything seemed to work fine.

In 1956 the NAUTILUS made an 11-day dive. And by 1959 the U.S. had a true submersible. Dives of two week durations were routine, there had been several 30-day dives, and one 60-day dive. It was the SEAWOLF in October 1958 which completed the 60-day dive. To evaluate the state of "atmospheric control now requires about 60 pieces of equipment". A presentation included the following report:

"In October 1958 SEAWOLF completed a submerged cruise of 60 days, completely divorced from the earth's atmosphere. The cruise was made by a highly motivated crew using jury rig equipment; however, ostensibly it was quite successful. No one died or became ill, everyone apparently performed at peak efficiency and there have been no reported after-effects."

In reality, by 1959, carbon dioxide removal was a routine problem which was being taken care of on a continuous basis by a CO_2 scrubber while the oxygen supply was no longer an emergency consideration but a commodity routinely supplied -- like food.

Work on the CO_2 scrubber was started during World War II by the National Defense Research Council. By 1940 Mare Island Naval Shipyard had developed a scrubber for use on the PERCH and SEA LION -- two battery powered submarines converted to troop carriers.

By 1959 the M. H. Treadwell Company was supplying the Submarine Force with high pressure, mono-polar, electrolytic oxygen generators. The oxygen generator concept was conceived in 1953 when it was established that the nuclear submarine, with its extremely long submergence periods, was nearing a reality. At that time, three general methods for making oxygen were available: air distillation, chemicals, and electrolysis. The first method, while the most efficient, was not practical due to the limited amount of air in the submarine; and the second was considered unattractive since it made the submarine dependent upon logistic support. The third method, production of oxygen and hydrogen by electrolyzing distilled water was selected as the best method since the required inputs -- water and electric power -- were readily available on nuclear submarines.

Because of the high pressure of 3000 psi used in the electrolysis of water process, and because of the possibly explosive nature of the products, oxygen and hydrogen, the early system was protected by 56 safety devices and would shutdown and blanket itself with nitrogen at the detection of any malfunction. The Treadwell oxygen generator, now improved but still recognizable to old hands, continues to provide oxygen to submarine crews today.

What does the future hold for submarine life support? New technology may totally change the methods of oxygen supply and carbon dioxide control while additionally providing a significant improvement in overall operational capability.

Aquanautics Corporation, a biotechnology company, has demonstrated the feasibility of extracting dissolved oxygen from sea water. Their process is based primarily on the way biological systems remove oxygen from air or water. The difference is that the oxygen is produced by an electro-chemical process in much the same way as hemoglobin is unloaded from blood. The Defense Advanced Research Project Agency is currently funding Aquanautics to produce a simple underwater vehicle propelled by a fuel-cell which uses oxygen extracted from the seawater through which the vehicle moves. The demonstration, scheduled for the fall of 1987, will demonstrate energy efficiency and compactness.

The technology will likely reach fruition -- the real question is when.

Military applications for underwater power, propulsion, and life support are limited only by the imagination. As to the source of oxygen for submarine life support, there has been only modest interest to date, primarily because there is no operational requirement, i.e., a workable system exists. Some interest has been shown by those

concerned with submarine security who worry about discharging the hydrogen by-product of electrolysis. It may be timely for imaginative Navy people to consider this new technology and investigate its many possibilities.

Aquanautics Corporation has also developed a scheme to remove carbon dioxide from the air and change carbon dioxide gas to carbonic acid for discharge overboard as a fluid. This scheme might in time be used to discharge combustion gases -- as a liquid -- significantly reducing the back pressure of discharge and the noise of underwater systems which use thermal combustion for propulsion.

What might the environmental control systems of a submarine look like in the 21st Century? Oxygen for breathing might be removed directly from sea water much as fish do it. There may no longer be hydrogen to worry about with its high pressure purges and potential explosions. The carbon dioxide concentration could be held constant to 0.03 percent by volume -- for an entire patrol, and its discharge as a liquid would be quiet and simple. Atmosphere control will not only have come full circle -- with no one worrying about it -- but the Navy may start getting complaints from submarine sailors who worry about the effects of the foul air they breathe while on liberty.

Richard R. Pariseau

THE TECHNOLOGY FALLACY

The concept that technological superiority can solve our military problems and particularly that it can solve political problems is naive and totally unjustified by recent history.

In World War II both Japan and Germany were

initially technically superior to the United States. I cite the Japanese ZERO fighter aircraft and the LONG LANCE torpedo. While eventually U.S. planes were equal or superior to the Japanese, their torpedo was always far better than anything we were able to build.

German technology remained superior throughout the war.

The Allied Victory was attained through the superiority of the high command, better strategy, the tremendous industrial power and resources of the United States, and by the exploitation of Allied Maritime power.

Technology has the ironic paradox that the technological revolution that makes exotic defenses possible also insures that those defenses can be penetrated or otherwise defeated. This has two aspects: One in the field of weapons development and use; the other is the area of sabotage and information security.

Thus the concept of invulnerability through technical superiority is a dangerous fallacy, a delusion! Technological ingenuity is a two-edged sword; it cuts both ways. The more the requirement for perfect performance, the more this paradox applies. The larger the system and the more people involved, the less the security. The greater the emphasis on its importance or dependence on its performance, the greater the incentive to defeat or to penetrate the System.

the late Henry E. Eccles
Rear Admiral, USN(Ret.)
(Naval War College Review, May-June, 1986)

SUBMARINING -- AN ART OR SCIENCE?

The Editor's musings over submarining as art or science brings to mind one passage in my book, FLEET TACTICS: THEORY AND PRACTICE. "Some people focus on the science of war, others on its art. I would rather approach the study of war from a different perspective, highlighting 'command mystique'; that is, the quality of spirit that distinguished brave, wise, and inspiring leaders. If this third element is given its due, I doubt that any remaining differences between tactical science and art will seem very important. What will abide is a sharper appreciation of the fact that good practice grows out of good theory, and that both are necessary, but not sufficient for consistent success in battle."

Combat, unlike policy or strategy, is in the domain of physical activity. The distinction is important. Victory comes from superior behavior, to which scientific and artistic thinking make a small, but vital contribution.

The science and art of combat is much closer to that of coach and quarterback than to the artistic scientific drawings of Leonardo De Vinci. Reading Miyamoto Musashi (A Book of Five Rings) is better preparation for combat than reading Mahan.

The debate which is important is the one that divides an officer's time between study and reflection on one hand and planning and activity on the other. Personally I think the U.S. Navy's balance is about right. But the time devoted to study could be more productively employed.

Wayne P. Hughes, Jr.

ARTIFICIAL INTELLIGENCE IN WAR-CAMPAIGN MANAGEMENT

The article in the October issue on Artificial Intelligence was typically fine as we have come to expect of anything associated with Jon Boyes. I hope these comments are relevant additions to the thoughts he has expressed.

Running a war campaign is in many respects like running a scientific experiment; a set of hypotheses is used to construct a set of tests which confirm or refute some of the hypotheses. In war, intelligence gaps being inevitable, the uncertainties are greatest at the beginning, thus doctrine must be most tentative then. The rate of doctrinal change can be very swift with the technological complexity existing today and with potential high rates of change in technical things and tactics of the enemy.

It appears then, that the part of an artificial intelligence system used to store tactical doctrine should be so designed as to allow rapid change by a Force Commander message as lessons are learned. This has implications in hardware and in software design including the provision for transmission of encrypted and varifiable patches to hard disc memories. The need for crypto security becomes greater than ever.

A further implication is that the Force Commander will need on his staff, operations experts to work with 'knowledge engineers' in the formulation of up-to-date doctrine for patching into the 'expert' memories. It will also be vital that on some ships there be a few people sufficiently knowledgeable to recognize the need for doctrine changes.

With the complexity of uncertainties which will exist at the beginning of a campaign, it could well be that convergence on the best

doctrine will best be achieved by starting with part of the force using one doctrine and other parts using others. This would require rapid analysis of results and transmission of changes to the force. This is an area where Artificial Intelligence offers a new and unique advantage to the force commander and his units.

What is foreseen above is not meant to reduce command discretion, but definitely to inform and bias it. It's my guess that in the next war-campaign the rate of interaction and change will be a hundred times as fast as anything we've seen in the past. Artificial Intelligence, if it meets its promise may arrive just in time. I wish I knew enough about it to be really useful.

Dick Laning

IN THE NEWS

o Jane's Defense Weekly of 1 November, 1986, reports that Canada is looking at the possibility of buying a conventionally powered submarine with an under-ice capability provided by an air-independent propulsion system. Such a system, which would function as an auxiliary to the main battery could use nuclear propulsion. Two types of nuclear systems are under development in Canada, an Autonomous (Nuclear) Marine Propulsion System by Energy Conservation Systems Inc. and a nuclear battery from the Atomic Energy Commission. These nuclear systems could be used by a generator to produce 400 kw of energy -- theoretically providing unlimited under-ice endurance.

o The Baltimore Sun of November 17 reports that "suspected incursions by Soviet submarines into Norway's deep fjords to test coastal defenses are increasingly worrying military officials in this NATO country. The Norwegians are convinced

Soviet submarines, operating from their base in Kola peninsula, are staging regular forays into their (Norwegian) waters. So far this year, they have reacted to 20 submarine alerts from fishermen, coast guards and civilians."

o Jane's Defense Weekly of 25 October reports that six European governments have been approved to meet a Saudi Arabian requirement for between six and eight ocean-going submarines. Such a submarine force would make the Saudi Navy the dominant Middle East force by the mid-1990s. Bids on these submarines are due to be lodged with the government in Riyadh by mid-December. Iran is also seeking to re-establish contracts for the supply of submarines signed with West Germany at the time of the Shah's downfall.

o According to press reports, the German U-507, sunk on the day before V.E. day in 1945 in the Skagerrak, has been found by divers. Denmark has announced it will lay claim to the reported treasure aboard. The U-507 at over 300 ft. length was one of the largest subs in the U-boat fleet. It was supposed to be carrying many of the top Nazis and was loaded with treasures of gold, jewelry, art and so forth. It was on its way to South America from Kiel, Germany, when it was sunk by British bombers.

o Sub Notes of September, 1986, says that "there is a disturbing rumor that Libya is shopping for small submarines. The Soviets are thought to have nearly 200 minisubs of about 65 ft. length, launched from a mother sub and capable of crawling along the bottom."

o Sub Notes of September, 1986, also reports that the U.S. has gotten a DOLPHIN ROV -- a remotely operated vehicle built by ISE of England initially for the Bedford Institute of Oceanography -- which has been named SEA LION. This small radio-controlled submarine is powered

by a 120 hp diesel engine and can make 15-20 knots. The DOLPHINS are used today for hydrographic and bathymetric survey, as described in a previous issue of the SUBMARINE REVIEW. The Office of Naval Technology intends to evaluate SEA LION for naval applications, including operations at sea by blimps and other aircraft.

o Navy Times of 17 November reports that "an accident during underway operations has left the nuclear powered attack submarine AUGUSTA with $1.5 million in hull damage," according to Navy officials. "The submarine's external ballast tank plating and sonar dome covering were damaged in the accident -- repairs will take several weeks."

o The Underwater Letter of 1 November says that the Submarine Advanced Combat System (SUBACS) -- an integrated combat control system for the nuclear-powered SSN-751 -- is being reviewed by the Draper Laboratory, Cambridge, MA. SUBACS, initiated in 1980 and approved for full-scale development in December, 1983, has undergone restructuring because of problems in developing a revolutionary fiber optics data bus to connect the system's computers.

o The Portsmouth Herald of August 31, tells of the opening of the ALBACORE to the public at its Albacore Park, Portsmouth, NH. About 2500 visitors went aboard ALBACORE on her first open day. The brochure for this superb tourist attraction, says: "See how a crew of 55 men worked and lived aboard this 205-foot by 27-foot submarine," (with its revolutionary tear-drop shape and high underwater speed).

o Defense Week of November 3 notes that the Navy's financing solution to its low-cost (about $200,000) antiship torpedo program indicates that at least one of the two finalists is a foreign firm. Four contractors are bidding on this program, but several see it as a weak

program "fearing congressional opposition will kill the program next year." However, one contractor's representative said that "Navy Secretary John Lehman, who has personally fostered this program, will find a way to keep it alive." This year Congress zeroed the Navy's request for $17 million to buy 34 torpedoes to start the program, including 7 torpedoes for each of the two finalists. But the Navy received permission to use $7 million from the Submarine Tactical Warfare Support account for test and evaluation only. Whitehead of Italy, Marconi of Great Britain and Gould and Honeywell of America are in contention for this torpedo competition.

o In an interview in the DOLPHIN newspaper of July 11, Captain Harvey, the Head of the Submarine Medical Research Laboratory, Groton, CT, says that the DSRV (the deep submergence rescue vessel) is viewed as the prime method for rescues from a trapped submarine. The second method is the Flyaway McAnn Bell (homeported in San Diego), and free ascent using the Stanke Hood is the third option. Other submarine projects, he noted, were under study including "examining the possibility of running with lowered oxygen levels to decrease fire hazards." Also, "what would happen if we used sudden pressurizations with nitrogen to suppress fires as opposed to the current means for fire suppression."

o A Navy release tells of the commissioning of the USS LOUISVILLE (SSN 724) on 8 November at the SubBase, Groton, CT. Admiral Kinnaird McKee, USN, was the Key Guest Speaker.

o Jane's Defense Weekly of 11 October summarizes the sinking of the Soviet (YANKEE-class) SSBN after an explosion off the U.S. east coast -- 600 n.m. north of Bermuda. The explosion in one of the starboard bank of ballistic missile tubes, while the submarine was submerged, ripped a one-meter hole in the hull. Seemingly, a fire in

the two stage liquid fuel rocket motor of an SS-N-6 missile had generated considerable heat and smoke and set off the explosion. However, it was not believed that a detonation of a nuclear warhead had taken place. Tass confirmed on October 4 that three of the YANKEE's crew had died and that several more were injured. Offers by the U.S. to help the stricken submarine were refused, and after two attempts to limp home under its own power it was taken in tow by a Soviet trawler. But the sub sank on the morning of October 6th. The loss of the YANKEE was not considered to be a setback for the Soviets since the YANKEES are being disposed of to stay within SALT 1 treaty limits. The Red Fleet moreover is converting some YANKEEs to attack and cruise missile capable vessels.

o Milan Vego, writing in the December, 1986 Proceedings says: "Soviet SSNs with the exception of older ECHO-1s and NOVEMBERs, are fitted with two small, twin-bladed propellers on the stern planes, which are powered by an auxiliary (electric) plant for running at a silent speed (5-15 knots). Likewise, some modern SSs, notably the TANGOs and probably KILOs as well, are also equipped with a similar plant to provide a silent speed capability."

o Jane's Defense Weekly of 4 October, 1986, tells of the launching of the 1100-ton VASTERGOTLAND. It is the first of four diesel-electrics to be constructed at the Kockums Malmoe yard for the Swedish Navy. It will use wire-guided homing torpedoes, has a one-man steering and dive control system, and has a complement of 20. Kockums is also offering for export, a tropicalized version, the A 17, an air-independent submarine using Stirling closed-cycle propulsion.

o Defense Week of November 24, in a byline by Frank Elliot, reports on a classified conference on "new ways to find submarines," sponsored by the Defense Advanced Research

Projects Agency and held at Systems Planning Corp., Arlington, Virginia. The conference was designed "to investigate new and innovative methods of detecting various non-acoustic signatures of submerged submarines," noting that Soviet submarines may soon be too quiet to find by traditional methods. Already the Soviet AKULA-class submarines are able to elude the Navy's SOSUS underwater system. "Much of past Navy effort in this field has been spent in tracking non-acoustic ASW research by the Soviets, who by some estimate have been pursuing the matter for 20 years."

o Defense Week of November 17 has an item telling of the launching on November 3rd of the British Royal Navy's fifth TRAFALGAR-class SSN, the HMS TRENCHANT. These attack boats carry HARPOON missiles and cost $300 million each. Plans are for seven of this class.

o Defense Week showed a box score of the Navy budget for Fiscal Year 1987 as passed by the Congress on October 17. While showing approved administration numbers for Mk 46 torpedoes, HARPOONs, TOMAHAWKs and ASROCs, there were exceptions, to the administration's request, of special note:

- Mk 48 ADCAP torpedoes were reduced to 123 weapons and $255 million cost from the requested 227 units.
- The ASUW antiship torpedo was zeroed from the request of 34 units.
- The Mk 50 lightweight torpedo was reduced from 84 to 67 units.

o Navy News and Undersea Technology of September 26, reports on a drive, spearheaded by the Naval Surface Weapons Center at White Oaks, Maryland, "to develop a new generation of explosives and warheads." The Navy has issued a notice in the September 15 Commerce Business Daily for "fundamental research proposals in energetic

materials (explosives and propellants) technology and in warhead technology." As further defined, the notice hopes to find "if somebody in industry has something that may be of interest to the Navy" but no budget has been established for the warhead technology effort. Five areas of research the Navy wants to pursue are: new energetic materials and their applications to warheads; techniques to safely produce warheads; energetic molecules and ingredients with military applications; the dynamics of failure of high-strength, low weight composites when subjected to high explosive forces; all other aspects with potential warhead application.

o Defense Week of September 29, under the byline of Frank Elliot, reports on a seminar held 25 September, at the SubBase, Groton, CT, and sponsored by the U.S. Naval Institute on "The Future Mix of Submarines and Strategy." Aimed mainly at the SSN-21, the Navy's new attack submarine program, Norman Polmar took the position of the devil's advocate in the seminar -- quoting Benjamin Franklin that "agreement produces very little. Disagreement produces debate, and that leads to progress, invention and innovation." Polmar asserted that the SEA WOLF will not do what was decided by the Navy was necessary to recapture underseas superiority. Of the five goals set for the SSN-21, Polmar felt that only the one for quieting would be met. For speed, below-ice movement capability, depth it can dive, and number of torpedo tubes, the SSN-21 falls short of that desired -- and its cost would more realistically be $1.2 billion rather than the planned $1 billion. Polmar's remarks were denied by several submariners -- without being backed by facts which are necessarily classified in nature. Polmar expressed concern that the "submariners had failed to develop attack submarines that are affordable in the numbers needed." He felt that the Navy needs 150 attack boats, "but given the cost of the SEA WOLF, it is doubtful that the Navy can even

maintain its goal of having 100 operational nuclear attack submarines."

o Armed Forces JOURNAL International, of December, 1986, under the headline "Demise of USAF's Intellectual Forum," in a letter to the editor from a Lt.Col. Baucom, USAF, decries the end of the Air University Review "which has served as the professional journal of the Air Force since 1947." Baucom says, "The death of the Review could not come at a worse time, as the need for fresh, innovative thinking about air power was never greater." As to the changes "that are currently afoot in air warfare," a colleague of Baucom is quoted as saying "that the advent of stealth aircraft and other major changes make this as revolutionary an era in air power development as the period which witnessed the advent of the all-metal multi-engine bombers." The closing of the Review, Baucom concluded, "bodes ill for the intellectual vitality of the Air Force."

o An item in Insight of December 1, says: "The Brazilian military has begun a nuclear research program separate from the government's civilian program. By 1994, the navy plans to test a small nuclear reactor that will serve as a model for a "compact reactor" intended to propel Brazil's first nuclear submarine -- a small one of about 70 meters length. "The navy plans to complete the submarine by the latter part of the 1990s."

o Sea Technology of November, 1986, notes that RADM J. B. "Brad" Mooney, Jr., as confirmed on October 8th by the U.S. Senate for a second term as Chief of Naval Research. A former Oceanographer of the Navy, Mooney is popular and well known within both the Navy and the oceanic business and academic communities. He is one of only a few non-nuclear-submariners to achieve flag rank.

o Sea Technology of November, 1986, also tells of an advanced sea mine to guard against modern submarines in medium water depths. This sea mine will be the product of a joint development program between the U.S. and Britain. The mine is needed according to the article, by the Royal Navy for deployment along the U.K.'s continental shelf. The cost of the mine -- expected to enter service in the 1990s -- will be shared equally by the two governments.

o A Navy release announces: "LOUISVILLE (SSN 724) formally joined the fleet during commissioning ceremonies November 8th at the U.S. Naval Submarine Base, Groton, CT. "The 360-foot, 6,900-ton submarine is the 16th ship in a row that Electric Boat has delivered early." Also, that "the launching of TENNESSEE (SSBN 734), the nation's ninth OHIO-class ballistic missile firing submarine, is scheduled for December 13th at the Groton, CT Electric Boat shipyard. The wife of Admiral Frank B. Kelso, Commander in Chief, U.S. Atlantic Fleet, will be the sponsor and Admiral Kelso the principal speaker.

o A Navy relese noted the decommissioning of the USS SKATE (SSN 578) at Pearl Harbor on September 12th. SKATE was the first submarine to make a completely submerged Transatlantic crossing, and was the second submarine to reach the North Pole and the first to surface there. ADM J. A. Lyons, Jr., Commander in Chief of the Pacific Fleet said, at the decommissioning, "SKATE and her crew past and present have earned the respect of the entire U.S. Navy."

o Two moves by submarine flag officers were announced in a Navy release. Rear Admiral L. G. Vogt reported for duty as Commander Submarine Group TWO in December and Rear Admiral J. D. Williams reported for duty as Assistant Deputy Chief of Naval Operations, Submarine Warfare, (OP 02B) in January.

BOOK REVIEWS

FRESH WATER SUBMARINES -- THE MANITOWOC STORY

Rear Admiral W. T. Nelson, USN(Ret.) -- Manitowoc, WI: Hoefner Printing 180 pp. Illus. 1986

"THE MANITOWOC STORY" is a fascinating one, unique in submarine history. It is a success story of wartime ingenuity overcoming almost insuperable difficulties to produce and deliver first-line combat submarines from the shores of Lake Michigan to the Pacific submarine forces of World War II. In his prologue to this excellent book Admiral Nelson says:

"In 1940 the Navy Department, through its Bureau of Ships, contracted with the Manitowoc Shipbuilding Company for the construction of ten submarines of the GATO class of fleet submarines. This contract was later expanded to forty-one submarines, of which twenty-eight were completed before the termination of the contract as World War II drew to a successful close.

"How did the Navy Department happen to pick this relatively small shipbuilding company, located so far from salt water and the ocean, to build submarines, the most difficult ship construction job known at that time? How successful was this company in building a type of ship that had not even been seen by company executives, engineers and workers? What was the quality of work on this difficult job, and how successful was the company in meeting the terms of the contract? How were the crews of these submarines trained for their wartime duties at a spot so remote from normal submarine training facilities? And, finally and most importantly, how were these boats taken from the fresh water of Lake Michigan to salt water?

The answers to these questions are a

testimonial to the competency, skill and ingenuity of American industry, as represented by this small Wisconsin company, and demonstrate how workers, management, industry and government working together respond to a challenge in a crisis.

"Due to wartime security restrictions, and also, perhaps, because success stories were plentiful in those war years, this story went largely unnoticed at the time and has never been told in its entirety. Much attention today focuses on horror stories involving Government contracts which result in huge cost over-runs, delivery delays and poor workmanship. Today the term "military-industrial complex" so often connotes conditions that are illegal or immoral. By examining the military-industrial relationship that existed between the Navy and the Manitowoc Shipbuilding Company in the early 1940s, a better understanding of the nature, purposes and accomplishments of the relationship can perhaps be reached. An examination of this partnership and the reasons for its success might disclose facts useful in improving performance under contract in today's military-industrial alliances."

The Prologue gives the scope of the story Bill Nelson has to tell and he tells that story masterfully. In fact the prologue is really the outline of the book. The author examines each of the questions in sequence, and in detail only possible by one who was there at the time and intimately involved with those who brought this minor shipbuilding miracle to reality.

The book is factual, comprehensive and fast-paced. The principal characters are well described and the facts and numbers, the costs and construction times and the war records of the submarines built are all broken out for easy reading. The whole book is exceptionally well done but, for me, the chapter on the delivery of the ships down the Mississippi to New Orleans is

the finest. I was privileged to serve with Bill Nelson when he commanded the HOWARD W. GILMORE. He is a superb shiphandler and an accomplished seaman. He obviously observed the entire trip down the river to New Orleans from the "Kibitzer's Bench" in the Pilot House. He established a fine rapport with the pilots and the tug master and his descriptions of the precarious situations which arose and the remarkable ability of the pilots and master to extricate themselves from the jaws of disaster are absolute jewels.

The book is a must, of course, for anyone who had anything to do with those fine boats in World War II. It also should open the eyes of modern submariners whose new construction experience may not have been as rewarding as Admiral Nelson found Manitowoc. Bill Nelson is obviously a great admirer of the Manitowoc Shipbuilding Company and of the late Charles Cameron West who was President of the Company during the program and to whom the book is dedicated. Perhaps time has mellowed some of the memories of those exciting days. However, the facts speak for themselves too clearly for sentiment to hide and they are most impressive in this thoroughly excellent book. What a pity it took forty years to get into print.

Captain Frank D. Walker, Jr.

The Submarine ALLIANCE: the Anatomy of the Ship
By John Lambert and David Hull: Naval Institute Press, Annapolis, MD, 1986.

For the submarine enthusiast, this is a book that should become a collectors item. The author provides a detailed history and documentation of a major submarine design resulting from the British Navy's efforts of World War II. The ALLIANCE is now a memorial exhibit at a museum in Gosport, Portsmouth, England, and it should be on the tour

schedule of anyone who might want to compare it with the NAUTILUS museum in New London, Connecticut.

The author's purpose in this book is to present an example of British Naval power as one of a series of several other "Anatomies." The detailed photographs and engineering drawings will give the serious researcher much authentic material for study and reflection. The narrative history of the "A" class submarine is a relatively brief one -- telling of the evolution of the class during World War II. For those with a desire to relive their submarine qualification days of tracing every pipe and valve in and out of the hull, this book should be of interest. It is profusely adorned with engineering sketches of every significant piece of equipment on the submarine. This reviewer found the overwhelming quantity of detailed drawings just a bit of a distraction from an otherwise interesting story about this class of submarine.

The ALLIANCE was not completed until the very end of WW II, and thus did not see combat operations. However, it embodied many of the innovations resulting from developments prior to the end of WW II. The "Snort" was perhaps the most significant postwar modification to this class of submarine. Experimental submerged cruises in tropical and arctic waters were conducted to learn how effective the underwater breathing system was for long operational patrols.

Other modifications were made to the "A" class in general, as well as the ALLIANCE. These included removal of the guns and streamlining for increased speeds submerged. Having been constructed during a time of rapid changes in technology, these submarines were finally removed from service in the years following 1974. The

only one to escape the "breakers' torch" was the ALLIANCE which in 1979 became a permanent memorial.

Charles Hoke

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