THE SUBMARINE REVIEW

OCTOBER 2009

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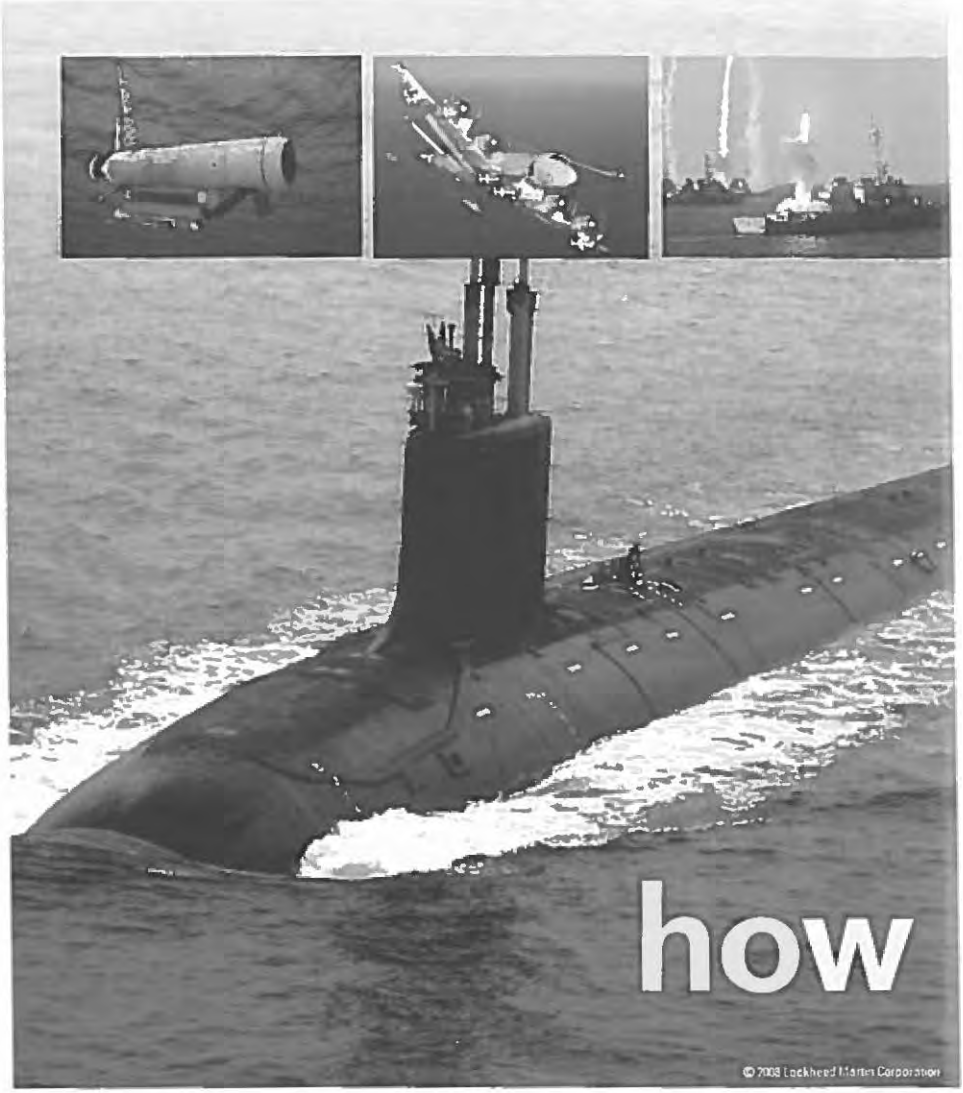

EDITOR'S COMMENTS

This October 2009 issue of THE SUBMARINE REVIEW foregoes the usual set of FEATURES, normally of policy issues and statements by policy makers, to headline several articles about allied submariners and their forces, past and present.

The first article, German Submarines: The Myth Does Not Explain Success is by a currently active-duty distinguished German submarine officer. He gives us an enlightening history of the development of post-World War II German submarines, including the strategic imperatives which have driven the designs. Particularly interesting are his comments about the changes in those strategic considerations since the end of the Cold War. The importance to the Germans of the export market in non-nuclear submarines is well explained, as is the several variations of the production models required by their customer navies.

A description of the origins and development of Norway's submarines is given in the second of these four *allied submariner* articles by Captain Sam Tangredi. He is a recognized author in political-military matters, particularly in *globalization* issues, and has utilized an invitation to Norway by their Navy to describe for us the past and present concerns of Norwegian submariners and how they fit into their national strategic considerations.

A completely different consideration of *allied submarining* is given in Mark Jones' Experiment at Dundee about the Royal Navy's 9th Submarine Flotilla during World War II. Part I of his two-part article illustrates how little political-military academic and professional exposition has been given to the *integrated operation* of individual submarines of differing navies. The 9th Flotilla at Dundee faced such a task as those submarines arrived in the UK as their countries were being taken over by invading Nazi armies. The task of the Royal Navy in handling that problem was not particularly simple in terms of either organization or logistics, but it was made to work, and it was effective. Mr. Jones does cite several later Cold War examples of integrated operations such as the NATO Standing Naval Force, but long term submarine integration problems would seem to be a bit more complex, and

are deserving of some modern consideration.

The story of The Real X-Men is in the nature of a warm paean to Max Shean, an Australian Submariner by a friend, CAPT Timothy Brown RAN, a fellow submariner. Max Shean was in a special class of undersea warrior who took the very small RN X-craft boats into *harms way,* and he did so in both the Atlantic and Pacific theaters during World War II. It's a great story of an indomitable sailor and THE SUBMARINE REVIEW is proud to publish it to his American cousins.

For a bit of US submarine history in the more recent past, but at the height of the Cold War, we have Recollections of Regulus by CAPT Pete Fullinwider, who was there when deterrent patrols were made back-to-back and the seas were not at all that calm. For the SSBN side of remembrances we have the story of a real piano on board a real submarine by Dr. Ed Monroe-Jones with THOMAS EDISON and STEINWAY. Another bit of specialized history, as with the story of the RN 9th Flotilla it is from the World War II era, is a personalized description of the development of the Mk 9 Torpedo Exploder Mechanism by the son of one of the key scientists. Along with the technical story there are results data which are rather surprising to most of us who thought we knew the exploder story.

The Japanese War Crimes Trials by Master Chief Everitt is of more than academic interest to the submarine community because it notes that the main American victims of Japanese atrocities were captured flyers and submarine crewmen. There is a recent book about the treatment of US submarine POWs by the Japanese, Presumed Lost which will be reviewed in these pages in the near future.

Jim Hay
Editor

FROM THE PRESIDENT

I hope you all had a wonderful summer. During this period the Submarine Force fared well. The deployment of USS GEORGIA (SSGN 729) completed the SSGN conversion program. Four of these magnificent ships are now at sea. The proposed 2010 DoD budget has advanced procurement funds for two VIRGINIA Class Submarines in the program for 2011, a major milestone for the Submarine Force. The Submarine Force leadership remains in place. The Naval Submarine League (NSL) has maintained their programs and initiatives and is looking forward to an outstanding Annual Symposium.

The NSL FY 2009 Annual Report was distributed in the Symposium mailing. It reported a modest gain for the year with record revenues because of your support. Increasing costs were offset by the success of the every member donation campaign and the generosity of the Corporate Benefactors sponsoring the Annual Symposium and Corporate Benefactor Recognition Days. The audit results are contained in this issue of the *Review*. We have taken action to improve our accountability for spending these resources in support of NSL events. Your Board of Directors will continue to monitor NSL's financial performance.

The Annual Symposium will be held 28-29 October. We are pleased that Admiral Kirk Donald has agreed to be the keynote speaker. The highlights of the symposium will be honoring the 2009 Awardees. There is a full slate with seven Fleet awards, Mr. Mike Toner is the Distinguished Civilian and the Distinguished Submariner is Team Submarine being recognized for their superior service in support of submarine acquisition, logistics support and technology development programs.

The 2010 calendar has Corporate Benefactor Recognition Days scheduled for 3-4 February 2010. Corporate Benefactors continue to be the foundation of League support. Seventy-one corporations actively support League initiatives and activities.

The Submarine History Seminar is planned for early April 2010 at a venue to be determined. RADM Jerry Holland continues to bring interesting submarine history programs to this event.

Preparations are underway for the 2010 Submarine Technology Symposium (STS) which will be held at The Johns Hopkins University Applied Physics Laboratory on 11-13 May 2010. The theme is ***"Increasing the Submarines' Value in Theater Operations & Irregular Warfare."*** VADM George Emery has identified all the session chairs and many of the plenary speakers. The Call for Papers and Exhibits has been released. Additional information about STS will be on the NSL webpage www.navalsubleague.com.

The 2010 Annual Symposium and Submarine Fall Cocktail Party will be held 20-21 October 2010, at the Hilton McLean Tysons Corner. I ask that you put all these dates on your calendars.

I welcome your comments and suggestions on what the League can do to fulfill its mission of educating the public on the importance of submarines to our national defense. I urge you to submit your ideas in the form of an article for *The Submarine Review*. League members are uniquely qualified to contribute papers in support of the Submarine Force. The *Review* is widely read outside the Submarine Force by Congressional members and staff and Defense Department leadership.

Finally, Jan and I wish you and yours a wonderful holiday season and ask you to continue to pray for the safety of our troops deployed all over the world. I am pleased to represent you in the leadership of the League and encourage you to recommend membership to your shipmates and friends.

J. Guy Reynolds
President

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INTERNATIONAL SUBMARINE FORCES

GERMAN SUBMARINES – MYTH ALONE DOES NOT EXPLAIN SUCCESS

by Captain Raimund Wallner, German Navy

Captain Raimund Wallner, German Navy, currently is the submarine project supervisor at the German MoD, Armaments Directorate. Earlier in his career he had command of Submarine Squadron Three and submarines U-20 and U-30. Before his present assignment he was his country's Defense Attaché to Japan. CAPT Wallner holds a masters degree in Computer Systems Management from the U.S. Naval Postgraduate School.

For more than 30 years, no new submarine had been commissioned by the German Navy until 19 October 2005, when ensign and pennant were ceremonially hoisted on the first two U212A class submarines U31 and U32. However, in this period the German maritime defense industry succeeded in establishing itself as the world market leader for non-nuclear submarines. This phenomenon can be attributed to four reasons:

- the post-war tonnage restrictions of the WEU[1] for submarines of the new Federal German Navy and the requirements for correspondingly compact and capable platforms for underwater warfare, especially in the shallow littoral waters of the Baltic Sea;
- the high performance and innovation potential of the German industry in connection with the support provided by the German Navy and the armaments sector with respect to training, quality control and testing;
- the high professionalism and international reputation that German submariners gained over the four decades following the establishment of the post-war submarine flotilla;

[1] Western European Union

- and, last but not least, the myth of the *Grey Wolves*, the U-boats of the Second World War.

Figure 1 U-31 Aerial View: GeSUBFLOT

From Tonnage War to Maritime Forward Defense

During the two world wars, Germany waged a *guerre de course* with submarines. From 1940 on, the German Navy countered the convoys of the allies with wolf-pack tactics in which groups of submarines were vectored to convoys via radio and then tried to penetrate the screen and sink as much cargo space as possible. In March 1943, the Battle of the Atlantic had reached its peak. For the first time, Admiral Dönitz had the desired number of 100 submarines deployed in the areas of operation. In this month, the Allies lost the record number of 105 ships with approximately 600,000 tons in all theaters, compared to 15 German U-boats sunk.

The German submarine command scored its "greatest success so far", but as a critical evaluation revealed, the initial surprise attacks on the convoys were followed by an increasingly stronger airborne and sea-based response, most of the submarines were forced underwater by aircraft and were then harassed by escorts with extended depth charging.

Figure 2 U31 u. U32 commissioned: Author

In April 1943, 16 submarines were lost, in May the immense number of 41 - this was one U-boat per merchantman sunk. At the end of May, Admiral Dönitz withdrew all submarines from the North Atlantic. The Battle of the Atlantic was lost for the rest of the war. How did it get this far? The reasons are manifold: From 1943 on, submarine construction had been given absolute priority. However, the number of allied new-built ships started to outnumber the vessels sunk by U-boats. The rate of submarines lost increased in proportion to the production of replacements, because now the hopeless technological backwardness in comparison to the allied anti submarine warfare (ASW) became drastically apparent. The enemy was engaged with U-boats optimized for high surface cruising speed, with their design status

of the nineteen-thirties. Under water, a maximum speed of 7 knots could be sustained for 30 minutes at best. Since these submarines were only capable of submerging for short periods and were dependent on the surface, they had little in stock to counter the modern electromagnetic detection methods and the cryptanalytic break-throughs of the enemy. Now it proved fatal that little had been done to gradually enhance the old U-boat types.

The first measure really worth mentioning, the upgrading of the standard VII C type with the snorkel, was introduced to the front not until February 1944. For the next submarine generation, a technological quantum leap was planned: the *total submarine*, driven by a Walter turbine with a maximum speed of 25 knots submerged. Only when it became apparent that a version ready for the front could not be built within an acceptable time frame, Dönitz would shift to an interim solution: by using the hydro-dynamically optimized hull of a pre-series Walter submarine[2] and installing large-capacity batteries, the ocean-going type XXI with a maximum underwater speed of 17 knots and, as the smaller derivative, the coastal type XXIII were developed. In an unparalleled construction program, 170 of these boats were completed between June 1944 and April 1945 and for a large part underwent sea-acceptance testing. For the front, however, they came too late. During the last two years of the war, the old boats carried the burden of a hopeless battle with unwavering fighting spirit in spite of immense losses, thus substantiating the myth of the *Grey Wolves* down to the bitter end. Irrespective of his criticism of the overall German conduct of war, British historian Peter Padfield expressed his appreciation for the German submariners in his book War Beneath the Sea that they fought an incredibly stoical, brave and altogether clean war with no more brutal exceptions than those which also marred the annals of their British or American counterparts.

[2] Type XVIII

Figure 3 type XXIII recovered: Eberhard Rössler, Ubootbau

Submarine technology of the victorious powers, which was lagging far behind these revolutionary U-boat types, benefited from their spoils of war and gained know-how. The Soviet and also Western submarine designs of the early post-war period clearly show the influence of the German type XXI submarine.

The U-boats had borne the brunt of the war at sea, there was no other naval asset which the Germans knew to employ better. For this reason, the submarine was included in the military planning when rearmament of the Federal Republic of Germany was prepared to take effect by 1955. The year of 1957 saw the salvage and refurbishment of a type XXI oceangoing submarine sunk by the Germans themselves as well as of two type XXIII coastal submarines[3]. Thus the nascent Federal German Navy benefitted from the ingenuity of the last World War II submarine types and could become familiar with their technology and handling. Against the background of the completely new strategic situation of West Germany as a frontline state of NATO, the submarine could no longer be a platform for an oceanic *guerre de course*. In the case of an attack by the Warsaw Pact, the task of the

[3]The "Wilhelm Bauer", the "Hai" and the "Hecht"

Navy now would have been to deny the enemy the unhindered use of the Baltic Sea as a taxiway in support of its land front and to prevent landing operations. In sea areas with a clear enemy superiority like the central and eastern Baltic, small compact submarines with high combat power were considered the appropriate means for maritime forward defense. In the North Sea and adjacent waters, the mission of the submarines was to contribute to area defense by engaging enemy submarines and surface forces. In the typical mission profile of the Cold War it was important to maintain the advantage of invisibility and covertness of the submarine until and beyond weapon release and to take the enemy by surprise.

The New German Submarine Force

... was characterized by the restriction to 500 tons imposed on Germany by the WEU, the build-up of an industrial base, and the search for a submarine type which could meet the tremendous challenge of the mission requirements. In the Baltic Sea with its shallow waters and its limited extent, the navies of the Warsaw Pact had the complete southern coast at their disposal, from the Gulf of Finland to Lübeck Bight; ASW forces were capable to be in theater within just a few hours, land-based airborne ASW even within a few minutes. German submarines therefore had to meet special requirements for operations under these conditions, which to this extent were not applicable to most other navies.

Professor Ulrich Gabler with his Ingenieurkontor Lübeck (IKL) found a design solution based on the wartime type XXIII coastal submarine. The U206 class submarine developed from the previous designs U201 and U205 was commissioned between 1973 and 1975. The invitation for tender issued in 1969 for the first time involved the selection of a prime contractor who was responsible for system integration, logistic support, and had to conduct acceptance testing. This was the decisive step to bring about the performance and efficiency of today's industrial base. Naturally, shipyards able to meet this challenge successfully would also have the capability to deliver operational submarines independent from the German Navy in the future. In the late

sixties, there were first successful exports of U205 class derivatives to the NATO countries Norway and Denmark.

The German U206 series consisted of 18 boats of this class. Since the late nineteen-eighties, 12 of these boats were upgraded to class U206 A. The modernization accelerated information processing and thus reduced reaction time. With their improved capabilities that allowed attacks to be launched earlier and at greater ranges, the upgraded boats improved mission accomplishment and increased their survivability. A remainder of six of these units is still in service today.

The U206 A class submarines are conventional single-hull boats optimized for missions in the Baltic Sea. The boat's main battery – powerful relative to displacement – allows a maximum submerged speed of 18 knots which can be maintained over several hours. At very low speeds, the discharge time is several days before the boat has to snorkel to recharge batteries. With a length of just 50 m, the boat has excellent maneuvering and depth keeping capabilities, enabling submerged operation in less than 20 m water depths. The end of the Cold War, so to speak, opened the window towards new horizons for this unique design. While up to then their training area was limited to the northern and western European waters, in the third decade of their in-service-time, i.e. since the middle of the nineties, they operate now routinely in the entire Mediterranean. Several times already they faced the U.S. Navy as demanding exercise partners in the littorals from New England to the Caribbean. Meanwhile, German submarines are in their sixth year of deployment to *Operation Active Endeavor* in the eastern Mediterranean as a contribution to the fight against terrorism. Long since, they have proved to be not just coastal submarines.

Further special features of the U206 A submarines are their nonmagnetic construction of austenitic stainless steel and their low own-noise signatures. This results in a high insusceptibility to sea mines with magnetic fuzes as well as to airborne magnetic anomaly detection (MAD). Their small size of only 500 tons offers active sonar detection an extremely low target strength. With their wire-guided, dual-purpose heavyweight DM 2 A3-

torpedoes in 8 torpedo tubes, the boats can carry a relatively high anti-surface and anti-submarine weapon load.

The assessment on the part of the enemy at the climax of the Cold War is documented as follows:

> *"The danger of these modern ... submarines does not only lie in their tactical and technical capabilities but is even increased by the fact that this offensive weapon is manned by crews educated in the spirit of the fascist submarine elitism, who have a relatively stable and well paid imperialistic military motivation, and can rely on sound skills and capabilities. In the end, these crews are prepared to risk their life for imperialistic interests of power. They are not impressed by the fact that, for example, only ten percent of the submariners manipulated in the spirit of fascism survived the Second World War..."*[4]

In spite of the upgrading measures, the more than 30 year old boats have three major deficiencies which could only be overcome by a new design:

- limited low-frequency acoustic and optical detection capabilities
- air dependence, i.e. the need to snorkel makes them susceptible to detection
- their signatures are vulnerable to modern counter-detection methods in the areas of low-frequency acoustics and infrared, particularly when snorkeling

Already in the Staff Target of December 1987, the Navy initiated the U212 project to remove all these deficiencies by introducing far-reaching innovations. I will revisit this below.

Only Export Success Can Safeguard the Industrial Base

It was foreseeable that the newly established submarine

[4] Fregattenkapitän Dipl.-Mil. Fuchs in the East German journal "Militärwesen", GDR 1985

industry with the two competing shipyards Howaldtswerke Deutsche Werft (HDW) and Rheinstahl Nordseewerke (RNSW) would face a severe utilization gap after the completion of the U206 series. Meanwhile, the WEU had granted Germany a contingent of 6 submarines with a displacement of 1000 tons each which could also be used for export. At the end of the sixties, Professor Gabler and his IKL team had the far-sightedness to transfer the design characteristics of the small German boats to the parallel design of an export version with an initial displacement of 1000 tons which from 1971 on, under the name U209, became the quintessence of the diesel-electric submarine of German origin, and the mainstay of export for more than three decades. The prime contractor principle applied to the U206 program proved to be a success formula. After approval by the Federal Security Council, companies IKL, HDW and Ferrostaal formed a consortium and investigated export opportunities for the NATO members Greece and Turkey. Customer Argentina facilitated the leap onto the South American continent, where all large littoral states meanwhile operate German class U209 submarines. In 1973, the WEU extended the tonnage restriction for German submarine construction to 1800 tons and unlimited quantity, in 1980 the limitations were lifted altogether. The next customers were important states in South and Southeast Asia and, with South Korea at the end of the eighties, in East Asia as well. Transfer of know-how and technology became more and more the established method for licensed assembly in respective countries. Examples are Turkey and South Korea, where series production of German submarines – on the basis of material packages shipped from Kiel – became routine for the respective domestic shipyards. In 2002, HDW purchased *Hellenic Shipyards*, where the series numbers 2 to 4 of the Hellenic Navy's class U214 have been built; I will revisit this point below. For the time being, the three units built for South Africa since 2000 were the last U209 boats. In spring 2008 the program was completed with the third boat's 50 day home-bound transit to Simon's Town.

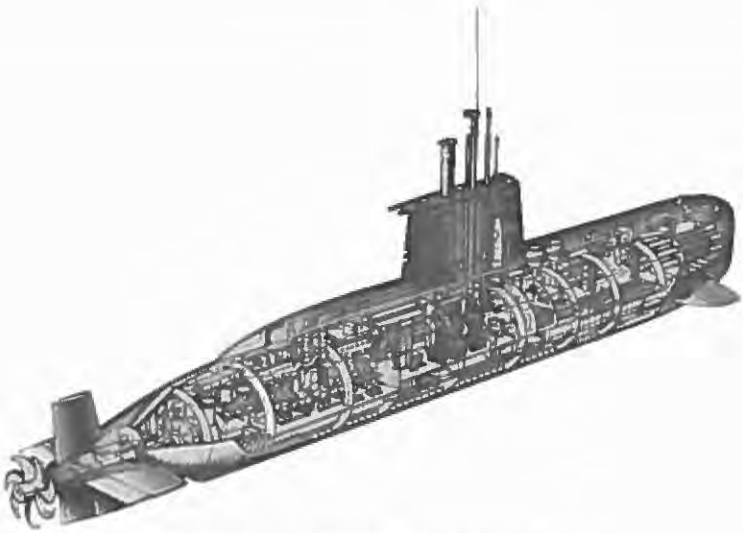


Figure 4 U209 cutaway: TKMS/HDW

In comparison to class U206, the larger displacement of between 1000 and 1500 tons was consequently used in the U209 to increase redundancies, to improve air conditioning and crew habitability, and to extend weapon load-out, cruising range and capabilities, while maintaining the German hallmarks of absolute compactness and low signatures. Nonmagnetic construction, however, remained an exclusive feature of the German Navy. In the seventies, the IKL design for a U206 derivate to be built for Israel in Great Britain laid the ground for the high esteem the Israeli Navy attaches to submarines *"Made in Germany"* ever since. After funding had been made available from the German state budget in the course of the second Gulf War, construction of the Dolphin class started with an initial two units. The third boat was delivered in 1999. The type developed since the mid-eighties exclusively according to Israeli requirements is a special design with a displacement of 1700 tons. A second batch, Dolphin-AIP, under contract since 2006 is being built with two units at HDW, featuring a stretched hull.

Successful exports of the 1000 ton-class U210, which initially had also been planned for the German Navy, went to Norway as ULA class between 1989 and 1992. The delivery coincided with the radical changes induced by the end of the Cold War.

Figure 5 U206A at PD: GeSUBFLOT

Figure 6 U-31 aerial view: GeSUBFLOT

The demanding military requirements of the German Navy for the extreme operational conditions in the northern European border seas had internationally become the benchmark for non-nuclear submarines. This fact contributed decisively to the German submarine industry's rise to world market leader with its product

U209. At the end of the 1980's, already more than 100 submarines of German origin were roaming the world's oceans.

The Nordseewerke yard of Emden, which in the seventies and the early eighties still operated independently in the export sector, developed the type TR 1700 for Argentina, in competition with the U209. This design did no longer follow the basic Gabler pattern, but was a completely novel concept with characteristics that should later be adopted by the U212 as well: a hydrodynamically optimized two-decker with a forwardly located sail and trim-neutral fairwater planes. With a maximum speed of 25 knots, this boat was faster than all previous conventional submarines and, with a standard displacement of 1770 tons, also was the largest submarine ever built in Germany after the War.[5]

During the Falklands War, the only maritime war since 1945, an Argentine U209, the SAN LUIS, kept the British fleet under pressure for more than six weeks. More than 100 light-weight torpedoes were expended against real and supposed enemy contacts by the Battle Group of Admiral Sandy Woodward. The submarine launched four torpedo attacks against the carrier INVINCIBLE and its escorts, but these were unsuccessful as well. As it turned out, faulty wiring between the fire control system and the torpedo tube set of the SAN LUIS had caused the misses. The British were spared the disaster of the sinking of their flagship. Nevertheless, a single enemy submarine with an inexperienced crew proved the *force multiplier* effect: the capability to build up tremendous threat through stealth.

The Revolutionary Fuel Cell AIP with U212

Thus far, German export submarines – with the exception of the TR 1700 – were not characterized by major innovative leaps but were the result of step by step modernizations based on previous designs. This conservative approach built confidence,

[5] The transits (in 1984/85) of the first two units built in Emden were very impressive: During the submerged cruise over 6900 nautical miles, the average transit speed was 11 knots, at a tactically acceptable indiscretion rate. This was made possible by a huge battery, four Diesel engines and a 6.6 megawatt propulsion motor.

especially in Third World Navies; however, it also proved to be a handicap which could be exploited for propaganda purposes by competitors. "*The 209 sells like Japanese cars*"[6] wote *Jane's Defense Weekly*, just before a billion-dollar-contract with Australia for the COLLINS program was lost to the competitive Swedish design in 1987. When the "bestseller" U209 would run out of steam one day, an alternative had to be available in due time. Just as the U205/U206 had set the ground for the success of the U209, now again a new domestic construction project was required to ensure the further success and sustained existence of the German submarine industry.

But the Navy, too, badly needed a successor when the U206 A class would have reached the limits of its life cycle at the end of the millennium. At first, this was to be a platform optimized for ASW, the U211, which the Navy intended as a considerable improvement to area and SLOC[7] protection against the Soviet submarine threat. In a competitive design contest at the beginning of 1986 in which IKL, HDW and TNSW participated with 4 contributions, the so-called TR 1600 design of TNSW was selected for further improvement. Since the budget available for ship construction did not allow two major projects to be pursued in parallel, the Chief of Staff German Navy opted in favor of closing the ASW capability gap with the new frigate F123, and the U211 program was canceled.

[6] At that time, Japanese cars were still perceived as cheap mass-production goods.

[7] Sea Lines of Communication

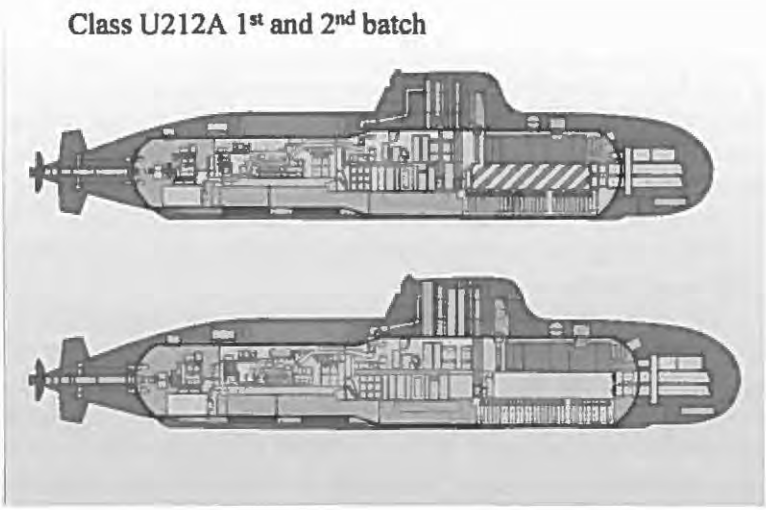


Figure 7 U212A batches 1 and 2: TKMS/HDW

Figure 8 U212A cutaway: TKMS/HDW

This decision, however, resulted in an accelerated planning of the new U212 class. The fact that this boat was still an offspring of the Cold War becomes obvious from the Staff Target of December 1987. It states that the boat be employed flexibly and without limitations in all parts of the area of operations, with priority in the Baltic Sea. This implied the capability for submerged shallow-water passage from the base at Eckernförde through the just 17 m deep Kadet Fairway south of the Danish isle of Falster, combat against landing forces in the Gulf of Gdansk as well as maritime interdiction operations in the Norwegian Sea up to ASW in the Arctic Ocean. Above all, however, this involved the requirement for air independence and low acoustic, magnetic, hydrodynamic and thermal signatures. The first of the 12 boats was planned to be handed over to the Navy in the mid-nineties, the last in 2005. Today we know that the project suffered a ten year delay with regard to the Staff Target, was drastically reduced in platform numbers due to budget shortfalls, and – out of necessity – went along with a lifetime extension of the remaining U206 A class boats.

The 1983 Memorandum of Understanding (MoU) with Norway for the development of a basic command and weapons control system originally intended for both ULA and U211 class was transferred to the U212 program. The U212 components with the greatest development risk were the propulsion motor with permanent magnet excitation[8] and the solid electrolyte fuel cell module to ensure air independence. Since the early eighties, industry supported by government funding had been working on the development of a fuel cell feasible for submarine propulsion. The operational feasibility of this system had been extensively tested ashore and on board of a submarine using a liquid electrolyte version.

Since the approval of the Staff Target in 1987, the world has undergone fundamental changes: the security environment, the strategic situation of the reunified Germany, the mission and strength of the forces, the focus of armaments and the defense

[8] Permasyn motor by Siemens, Erlangen

budget – nothing was as it used to be. In combination with the technological problems of the development, these determining factors complicated the realization of a demanding project like the U212. They required adaptive and corrective measures which resulted in a delay, until finally the building contract for the first batch of an initial four units was signed in 1994.

Now, the Baltic Sea was no longer quoted in the mission need document of May 1994; instead, "the European maritime areas and the North Atlantic" are defined as theater of operations. For U212, the following main tasks are listed:

- independent, covert and sustained presence in the area of operation without regional restrictions;
- undetected reconnaissance and monitoring of maritime areas in which other naval forces cannot or are not intended to be employed;
- containment of enemy naval forces;
- securing maritime areas and key positions against attacks from surface and sub-surface enemy forces and denial of unhindered enemy use of maritime areas and SLOCs by:
- engaging surface targets in the littorals as well as in blue water environments;
- engaging submarines either alone or in cooperation with other sea- and airborne ASW forces.

For this purpose, long-range low-frequency acoustic sensors in the form of towed array and flank array systems were required to complement the cylindrical array sonar; this additional equipment provides the boat with a multiple detection range compared to that of the U206 A. The torpedo weapon system had to be adapted to this new technology in a separate project, i.e. the heavy-weight torpedo DM 2 A4, which significantly tops the previous model DM 2 A3 with respect to speed and range.

Nine fuel cell modules of 34 kW each provide the boat with its most outstanding capability: submerged operation over several weeks with air-independent propulsion (AIP). This means that snorkel operations for battery recharging can be limited to those phases of a mission when a reduced threat by ASW forces is

anticipated, e.g. the transit to the patrol area. In other words: the submarine skipper no longer has to take risks of being detected with optical or electromagnetic sensors due to technical necessities. Only tactical reasons, e.g. periscope sweeps or radio communications, will force him to take the high risk of exposing hoistable masts. To reduce signatures, the proven nonmagnetic design was maintained. The Diesel generator system and other noise sources were mounted under an absorption capsule on a *floating deck* in the rear cylinder of the pressure hull. The oxygen for the fuel cell system is stored in liquid form in two tanks in the external hull, the hydrogen in metal hydride tanks located outside the lower rear pressure hull. The fuel cell is not yet capable of providing enough performance for high speeds, and the size of the oxygen tanks is a limiting factor in terms of energy supply. A conventional submarine battery is therefore still necessary. U212 is a hybrid submarine.

Additional sensors for the U212's efficient mission accomplishment are improved non-acoustic reconnaissance capacities realized with modern periscopes with a laser range finder and thermal imaging system, an ESM system, mine avoidance sonar, sonar intercept, an own-noise measuring system and passive sonar ranging. An expert system facilitates acoustic passive classification. UHF-Satellite communication and Inmarsat C complement the conventional communications facilities for the VLF, HF and VHF range as well as line of sight UHF.

In 1996, Italy joined the U212 program via a MoU and an Industrial Cooperation Agreement (ICA) between the HDW and Fincantieri shipyards. The now bilateral program was consequently renamed U212 A. Within the scope of a corresponding construction contract, two nearly identical submarines were built in La Spezia with the well-proven package delivery method. The cooperation led to design modifications necessary to comply with the Italian requirement for an increased diving depth, from which also the German submarines benefited. Detailed design progress was already too far advanced to allow Italian industry a larger component share. For part of the hoistable masts and the steering station, however, Italian manufacturers were awarded the contract

for all six submarines to be built. Germany commissioned the last of her four, U34, by 2007, Italy followed with her second boat, SCIRÉ in 2008. After TODARO in 2008, SCIRÉ is presently exercising with the U.S. Navy off the American east coast in CONUS '09.

U214 synthesized from U209 and U212

Like the export submarine U209 with its evolutionary derivatives had once emerged from the German U205/U206 design, a completely novel design could now – nearly 30 years later – arise on the basis of the U212. Boiled down to the handy formula "U209 + U212 = U214", the development of an export submarine with a fuel cell propulsion system started in 1996. In February 2000, the first building contract was signed with the Hellenic Navy, and the construction of the first-of-class started one year later in Kiel. The boat, completed in 2006 already, still awaits delivery since a row over payment and alleged technical deficiencies between HDW and the Greek government remains unsettled. The rest of the four-boat program was assembled at Hellenic Shipyards in Skaramanga near Athens. A contract of three U214 boats to be built exclusively in South Korea was also signed in 2000; the first two were commissioned in 2007 and 2008 respectively. A December 2008 follow-on contract for the delivery of material packages for a six-boat second batch U214 underscores the continued trust of the Korean Navy in their German industrial partner. Two Portuguese boats classified as 209PN – but actually having more in common with U214 – were contracted in 2004 to be built in Kiel and are scheduled for commissioning in 2010 and 2011 respectively. The latest success for the U214 design came in July 2009, when the Turkish procurement agency SSM signed another six-boat contract to be built at the Gölcük Naval Shipyard that had assembled the Navy's 209s ever since the late 1970s.

The 1700 ton U214 design, 250 tons larger than the U212 A, is as compact as all submarines of German origin. Featuring a superb cruising range and high combat power, this submarine possesses an excellent indiscretion rate, enabled by its relatively large main battery and the two high-performance Diesel engines.

AIP is provided by two 120 kW fuel cell modules. The characteristics of a relatively long one-decker, the ferromagnetic construction, the eight swim-out torpedo tubes and the bow diving planes show the affinity with the U209. The Permasyn motor, a high automation level, the reduced signature, the towed and flank array sonar systems and the torpedo defense system are features which the design has in common with the U212 A.

The standard U214 with its development having started about ten years later than that of the German U212 incorporates the integration of a number of state-of-the-art components which the German Navy can implement no sooner than with the second batch of the U212 A. These include the replacement of one of the two periscopes with an optronic mast, the tactical data link system, the active sonar system as well as a special swimmer lock-out chamber. Furthermore, the U214 comes with a *Sub-Harpoon* launch capability.

U212 A Second Batch and the Potential for the Future

The 1990s saw the German Navy employed in peacekeeping missions in the Adriatic, entirely new challenges compared to Cold War decades of exercising for a relatively unlikely all-out war on the northern flank. Throughout the seven years since the start of the fight against terrorism, the German Navy has been continuously operating together with allied and coalition partners in remote theaters, from the Mediterranean to the Arabian Sea, also with submarines. Improving the strengths which have always distinguished the German Navy as a valuable alliance partner, particularly in littoral warfare, became an undisputed necessity – but no longer just on its own doorstep but with the capacity for worldwide deployment. This meant more sustainability and robustness, including better precision and weapons with stand-off capability, also for land attack. In addition, the capability of Network Centric Warfare (NCW) is indispensable for interoperability with own and allied forces of all services.

When the four boats of the first batch of the U212 A were designed at the beginning of the nineties and their mission was defined, NCW was a vision at best. Their capabilities to participate

in such operations at present are therefore only limited. Thus, it is planned to retrofit them with Tactical Data Link, Collaboration At Sea, Battle Force E-Mail and MCCIS[9] systems. The building contract for the second batch of the class U212 A boats with two more units was signed in September 2006 with delivery scheduled in 2012 and 2013 respectively. In August 2008, the Italian Navy followed suit with its own second batch of two more U212 A boats.

The German second batch will be significantly improved relative to the first batch. Besides NCW capability, the boats will be upgraded with additional systems and technically improved components such as:

- the towed communication buoy *Callisto* to provide communication from the deep;
- a new command and weapons control system;
- replacement of the present flank array by a newly developed EFA (Expanded Flank Array) to further improve detection range and reconnaissance capability;
- replacement of one of the two periscopes by an optronic mast;
- integration of a 4-man swimmer lock-out chamber to improve safety and efficiency for the deployment of special forces;
- full tropicalization for worldwide deployment.

In terms of their structural design, the second batch will be largely identical, only in the sail area will they be slightly elongated to provide growth potential, to accommodate an additional hoistable mast for SHF SatCom, and more fuel for range extension.

The strength of the submarine will remain its invisibility. The detection of a submarine's presence – let alone its identification or even its engagement – requires an enormous ASW effort in all three dimensions. Just a handful of navies is able to take on a submarine with the combat power and the stealth characteristics of

[9] Maritime Command, Control and Information System

the U212 A. The British failure in the fight against the SAN LUIS during the Falklands War reflects the strength of the submarine as did the spectacular sinking of the Argentine cruiser BELGRANO by the British nuclear submarine HMS CONQUEROR, which was enough to contain the Argentine surface fleet for the rest of the war.

A submarine already begins to have an effect, when its presence is only suspected in the theater of operations. Depending on the tactical situation or political guidelines, the skipper can deliberately reveal his presence as a measure of escalation. He denies the enemy the unimpeded use of maritime areas and sea lines of communication and is capable to launch devastating strikes against enemy surface and submarine forces. The submarine represents an enormous force multiplier because it can tie up a multitude of ASW platforms or even neutralize whole fleets. Especially relatively small air-independent submarines like the U212 A can successfully assume this role in enemy littoral waters where own or allied surface naval assets – due to superior enemy forces – or other submarines – due to their size – cannot be employed.

Combat against naval forces is, and will remain, the primary task of the submarine. As an ASW platform it reaches its highest efficiency in combination with surface and airborne ASW systems. Within the foreseeable future, the torpedo will remain the weapon of the U212 A. The new fiber-optically guided, highly agile DM 2 A4 has a combat range extending far beyond the horizon and has become a true *stand-off weapon* as compared to the previous model. However, this torpedo is only suitable for engaging surface and submarine targets and always results in the highest level of escalation, i.e. the *unit kill*, the sinking of the enemy.

Anti-ship missiles, by contrast, are weapons normally facilitating *mission kill*, i.e. the continuation of the enemy's mission is disrupted by a hit, without necessarily sinking the platform. Six nations operating German export submarines are equipped with *Subharpoon*, some with land-attack capability. No question that the U212 A also has the potential for being equipped with this missile, or a similarly efficient one.

The feasibility of IDAS[10] was successfully proven in an experimental study and will go into full scale development soon. By 2015 it will provide the U212 A with capabilities so far not available for submarines around the world. IDAS is a light fiber-optically guided missile which can engage ASW-helicopters as well as surface and close-to-shore land targets. Although being a fire-and-forget weapon, the guidance achieved by the man in the loop in combination with the IR seeker-head will provide a multitude of options, including point of impact selection or the targeting of moving land objects. Further weapon options for U212 A are being tested. This includes the integration of a 30 mm machine gun or a light unmanned aerial vehicle (UAV) both mounted in a hoistable multi-purpose mast as payload alternatives. This could provide previously unimaginable engagement capabilities for non-nuclear submarines in asymmetric scenarios.

A second role increasingly gaining importance for submarines is that of covert reconnaissance and intelligence gathering. Surveillance and securing of sea areas, especially when a secure environment is required for follow-on operations, contributions to the early detection of crises, the determination of military and mission-relevant non-military activities, the reconnaissance of objects near the coast and in port - this list of tasks could be continued infinitely. In very shallow littoral waters, where German submarines can already exploit their full freedom of movement, bigger and in particular nuclear-powered units are not even capable of diving. High performance acoustic but also non-acoustic sensors hold enormous potential for compact submarine platforms. Further enhancement in the field of reconnaissance can be expected from submarine launched UUVs and the above mentioned UAVs.

A third role in which German submarines have always excelled, and which becomes more and more important, is that of covert landing, support and recovery of special forces. While on the current boats SEALs have to swim out through the torpedo tubes, the second batch of the U212 A will allow them to use a

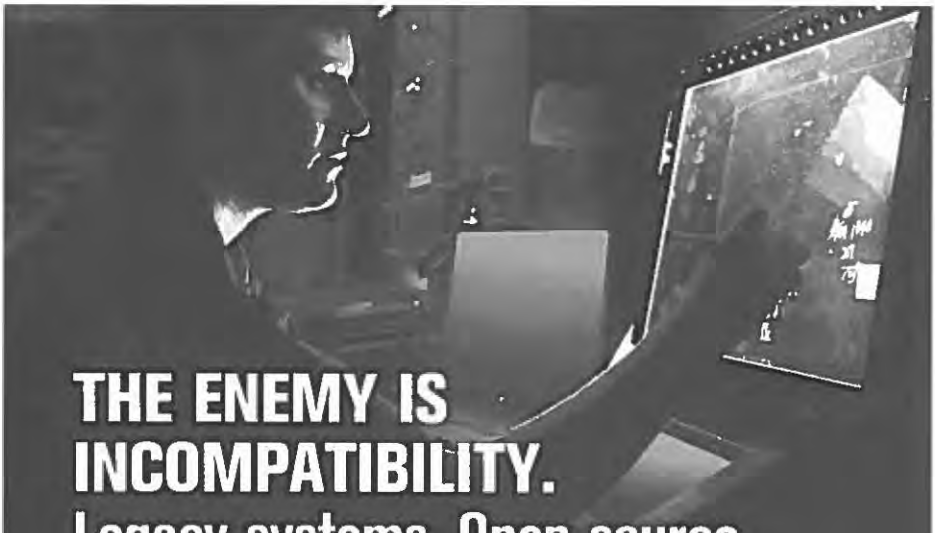
[10] Interactive Defense and Attack System for Submarines

four-man lock-out chamber and an innovative delivery vehicle, as well as to carry along extensive equipment in pressure-tight dry shelters.

To sum up, one may say that due to their characteristics of compactness, covertness, sustainability and high combat power, submarines *Made in Germany* are already able to fulfill the majority of missions that today's and future scenarios hold in stock for underwater platforms. They do have their price, but they expand the maritime capability spectrum of armed forces in a unique way, and thus the military options in the hands of the political leaders of countries operating these submarines. There is no doubt that *readiness* and *responsiveness* are the prerequisites for *relevance*, and that this also applies to these submarines. They are *ready* as long as their high-tech equipment is matched by a high-quality training of their crews. In the case of the German Navy's U212 A this combination is ensured and results in a second to none combat readiness. They are *responsive* because – backed up by a superb industrial base – they have the necessary growth potential to be able to react flexibly to changes that today's and future missions will undergo. And as naval assets they are *relevant* because their capabilities are recognized and understood by the leaders of their own nation, by the Alliance, and by potential enemies, thus increasing the international reputation and the influence of the German Navy to a considerable extent.

The success story of German post-war submarines has been going on for more than 40 years. Germany has one of the best non-nuclear submarines in the world. The German Navy has every right to be proud of the men and, for quite some time also of the women, who operate these units. They have long since stepped out of the shadow cast by the *Grey Wolves*. ■

Figure 9 U214 Artist Impression: TKMS/HDW



DYKK! DYKK! DYKK! (Dive! Dive! Dive!): AN HISTORICAL PERSPECTIVE OF THE ROYAL NORWEGIAN NAVY SUBMARINE FORCE

by Dr. Sam J. Tangredi, CAPT, USN (Ret)

Editor's Note: Invited to make a presentation at the Norwegian Seapower Symposium at the Royal Norwegian Naval Academy, Bergen, Norway, 27-28 August 2009, Captain Tangredi talked with a number of Norwegian submarine officers and took the opportunity to visit an exhibit marking the 100th anniversary of the Norwegian Submarine Force at Bergen's public Maritime Museum. The following article was inspired by the conversations and this visit. Dykk! Dykk! Dykk! is also the title of the exhibit.

Dr. Tangredi is a retired surface warfare officer and a frequent contributor to THE SUBMARINE REVIEW. He is currently the Director, San Diego Operations for the Arlington, VA-based planning-consulting firm Strategic Insight.

The 100th anniversary of the establishment of the Royal Norwegian Navy Submarine Force has provided an opportunity for Norway's naval service to publicize its pride in the vital role it plays in its nation's defense. To the Navy's leaders, this is particularly important because they have concerns that events of recent years have caused *sea blindness* among their nation's citizens—an inability to perceive the full importance of the maritime world to Norway's survival. Although most Norwegians still regard themselves as a sea faring nation, debates on whether to join the European Union and whether to continue to participate in NATO operations in Afghanistan make it easy to forget that--given Norway's political and geographic situation--the Navy and its close partnership with the U.S. Navy remains their primary national life insurance.

Attitudes and the Geopolitical Situation

Norway is unique in Western Europe in that it has decided—at least for now—*not* to join the EU. To some extent, this reflects a lingering *Atlantic mindset* in which ties to the United Kingdom, U.S. and Canada are perceived to be as important as those with continental Europe. There is a cultural basis: the Norwegians claim Leifr Errikkson (Leif Eriksson) as their own and recognize the fact that in the 19th and 20th centuries, over 750,000 Norwegian emigrants settled in the United States and Canada. That number is equivalent to nearly 20 percent of Norway's current population of roughly 4.5 million. To put that size in further perspective, some sources maintain there are 6 million Americans who claim to have Norwegian ancestry.

The Atlantic mindset is also related to the perception (at least until recently) that Norway is dependent on the sea for so many resources—particularly fish and North Sea oil--and for its traditionally strong merchant shipping industry.

It is also sustained by the fact that Norway is the only Scandinavian country with an open Atlantic coastline, and one adjourning that of Russia, making Norway a significant member of NATO's naval defenses during the Cold War, and perhaps in case of the continued Putin-ization of Russia. The Royal Norwegian Navy's ties to the U.S. Navy are perhaps the strongest of all European allies save the U.K. (another nation with a traditional Atlantic mindset). This is especially true between the respective Submarine Forces.

Unfortunately, Norwegians—at least judging by their media—seem to feel some guilt at their good fortune, a sensitivity that appears common to most Western Europeans today. Exactly who *are* the destitute people who require Norway's membership in the EU to order to be helped is not very clear. Norway was never terribly successful in the race for colonial empires and Norwegians seemed to be pretty poor imperialists—at least since the 13th century or so. So by rights it should not be tarred by the imperialist brush. Meanwhile Norway quietly provides a high percentage of their gross national product (GNP) to foreign aid.

Contributing to the potential sea blindness of the Norwegian

populace is that a significant number of Norwegian owned or partly-owned merchant ships sail under flags of convenience. While Norwegian-owned ships still make up over 10 percent of the world's merchant fleet, this is not always apparent at home. All Norwegians are aware of their benefits from North Sea oil, but that does not necessarily translate to an appreciation that the sea is their primary access to markets and other raw materials. Despite recent acquisition of AEGIS-equipped frigates, the Royal Norwegian Navy (RNoN) is concerned for its future parliamentary support, and particularly for its Submarine Branch. Neighboring Denmark has recently announced it will completely eliminate its own submarine capabilities.

Initial Interest in Submarines

Norway's political history largely consists of being forced into unions and alliances it did not necessarily favor (NATO being the exception). In 1808, as part of the Kingdom of Denmark, Norway was an ally of Napoleon. Throughout its struggle against Napoleon, Great Britain maintained a blockade of Norwegian ports.

An inventor, Mikkel Hallstein-Lofthus (1782-1850) come forward with detailed plans and a wooden model of a submarine designed to attack the British fleet. In principal, it was similar to David Bushnell's TURTLE of the American Revolutionary War (it also planned to bore holes in the Royal Navy ships), but Hallstein-Lofthus' design was larger and propelled by oars. There is no indication that the Norwegian was aware of TURTLE. The design was carefully considered by a scientific association, the king's representative, and military authorities in the port of Bergen. But it was decided that the design was too risky and an actual submarine was never built.

In 1901, while Norway was still in union with Sweden, the RNoN sent Captain Victor A. Geelmuyden to the United States to investigate the Holland Type VI submarine. Although unable to observe much in the way of actual operations and pointing out technical problems in his report, Captain Geelmuyden warmly endorsed submarine capabilities as critical for Norway and its

naval strategy: "...submarines are on the agenda of all navies, but seem most of all to be a coastal defense weapon, which will, with reasonable expenses, make a smaller state both strong and dangerous to a bigger attacker. I think that submarines will be the best and most powerful defense for our fjords and key cities, and the most dangerous and the best weapon against blockades or attempts to land troops and occupation of harbors, as the moral value of the boat alone will provide the armed forces with strength and immeasurable advantages."[1]

Apparently the Norwegian Navy command was able to get a good offer *with reasonable expenses* from the Electric Boat Company, and recommended purchase of the submarine despite the technical issues.[2] The recommendation was supported by the Defense Minister and the Prime Minister, but no money was provided by the Storting (Parliament) for the state budget of 1902. Before the union with Sweden was dissolved in 1905, the Swedish Navy had already acquired a submarine in 1904, the HAJEN (*Shark*). With tension between the two countries, HAJEN patrolled near Norway.

The presence of HAJEN prompted the Norwegian Storting to allow for the establishment of a Submarine Force. But instead of the Electric Boat Company, the Norwegian government went to Germaniawerft in Kiel, Germany for its first purchase. On 28 November 1909, the Royal Norwegian Navy's Submarine Branch was officially activated with the commissioning of KOBBEN (*Seal*). It is unclear whether the name was chosen to appear more peaceful than the Swedish *Shark*.

The choice of a German submarine presaged future operations of more advanced German subs, including captured Second World War U-Boats, Type 207s, and Type 210s today (with Norwegian combat systems), along with Second World War-era Royal Navy (UK) subs. In the 1920s, Norway also built submarines of US design in Norway, licensed from the Electric Boat Company.

Kobben and her Role in Establishing the Norwegian Air Force

Like most submarines of her era, KOBBEN, at 259 tons submerged displacement, operated primarily on the surface. She could make 12 knots surfaced on her gasoline engine and 9 knots submerged on batteries, but was not seaworthy in bad weather. Her armament consisted of three torpedo tubes with room for a single spare torpedo. Homeport was the main RNoN base, *Karljohansvern* in Horton on the Oslo fjord, suitable for defense of the capital, but a long distance from the ports on the Norwegian Sea/Atlantic Ocean, where she probably could not operate anyway.

During the First World War, KOBBEN maintained a neutrality patrol in the vicinity, but could do nothing about the great losses of Norwegian merchant ships in their effort to resupply the United Kingdom after Imperial German declared unrestricted submarine warfare.[3] There is no indication that KOBBEN--whose name was changed to AL in 1913--was ever used in combat, and it was decommissioned in 1919.

However, KOBBEN's crew played an inspirational role in establishing Norway's naval aviation and air forces. KOBBEN's commanding officer, Captain Carsten Tank-Nielsen read in a newspaper that a Swedish air pioneer, Lieutenant Olle Dahlbeck, threatened to demonstrate Swedish air superiority by over-flying the Norwegian Holden base and bombarding it with oranges. At the time there were no aircraft in Norway. CAPT Tank-Nielsen and the rest of the wardroom agreed that something needed to be done, and formed *Kobben's flying boat committee* to publicly solicit funds to buy a plane. Meanwhile, the executive officer, Lieutenant H.F. Dons traveled to Germany to take flight lessons. LT Don expressed the typical submariner's bravado about his task: "As experienced sea and submarine officers with solid technical education we should be well prepared to quickly learn how to fly. In a couple of weeks we should thus be able to learn enough to act, under favorable conditions, as pilots."[4]

Response to the solicitation was overwhelming; even the King of Norway contributed. LT Dons purchased the best aeroplane (with pontoon floats) he could find in Berlin. But the

flight school was full, so he took a few individual lessons and decided he had learned enough even if he did not qualify for a German license. KOBBEN's second engineer arrived on the scene to learn how to maintain and reassemble the plane because it would be shipped to Norway in pieces.

On 7 June 1912, the seventh anniversary of Norway's separation from Sweden, LT Dons was the first to fly a Norwegian aircraft, flying across the Oslo fjord with KOBBEN cruising below in case he crashed. In 1913, the Norwegian Navy established a pilot school in Horton, and in 1915, a flying boat factory.

The A-Class

While KOBBEN's crew took to the air, the Storting decided the submarine was a proven experiment and voted to buy four more submarines in Germany in 1911. This was to be the A-class, and KOBBEN was renamed A 1. It may be recalled that the U.S. Navy also named submarines by numbers in the 1920s.

It was decided to buy submarines similar to KOBBEN's design, also to be built by Germaniawerft. A 2, A 3, and A 4 were delivered in 1914, but with the outbreak of the First World War, A 5 was kept by Germany. All had diesel instead of gasoline engines, with crew size of sixteen. As coastal defenses, none of the submarines saw combat in the war. They could not protect the significant number of Norwegian ships sunk by U-Boats on the high seas. But being on alert wore down the submarines' batteries, which were unobtainable during the war. Because of this, Norway built a battery factory in 1923. After the war, the A-Class was placed in reserve for the oncoming B-Class.

The B-Class

In 1915, the Storting voted to purchase six more submarines. Since the war prevented purchase from Germany or the Netherlands, the Norwegian government obtained a design and building license from the Electric Boat Company.

But construction did not begin until the 1920s, at which point the design was already obsolete. Nevertheless, the class of six was

built. B 1 was commissioned in 1923 with now-Captain Dons in command. The B-class carried two spare torpedoes and had a crew of 23. In 1929, the *Submarine Inspection* was established. As its head, Captain Tank-Nielsen was effectively the commander of the Submarine Force.

The Nazi Invasion

Like much of the Norwegian military, the Submarine Branch was overwhelmed in the Nazi attack on 9 April 1940. B 4, B 5, and B 6 were seized in port without resistance.[5] In Oslo fjord, A 2 surrendered under fire, and A 3 and A 4 were scuttled by their own crews to prevent capture.

Meanwhile, B 1 and B 3 were in Northern Norway. When the German army closed on their positions, B 3 sailed for the U.K., but a battery explosion forced her back. She was scuttled by her crew. B 1 was trapped by German naval forces and was also scuttled by her crew on 13 April 1940, but the crew remained intact in the city of Tromso.

When a British landing force combined with the Norwegian Army to push the Germans back, the crew returned to raise B 1 on 13 May, repaired her in Tromso and returned to patrol. But the British forces were recalled to fight in France, and on 7 June, the King of Norway flew to London to form a government-in-exile. On 8 June, B 1 departed from Norwegian waters to continue the fight from the U.K. The remnants of Norwegian Army and Navy—less ships and personnel who managed to escape--surrendered on 10 June 1940.

Fighting On from Scotland

B 1 was assigned to the Royal Navy's 9th Submarine Flotilla based at Dundee, Scotland, which comprised British, Polish, Free French, Norwegian, and Dutch submarines. Along with other tasking, the 9th Submarine Flotilla was to monitor and attack enemy shipping along the coast of occupied Norway, as well as land commandos and agents. This would seem a natural mission for the Norwegian Submarine Branch, but the outdated B 1 was moved to Rothesay on the Western Coast of Scotland to train new

submarine crews and to act as a target for exercising British warships. To fulfill both missions, she was equipped with ASDIC (the initial version of SONAR) in the summer of 1940, but also suffered a battery explosion that killed two sailors.

At the same time, a steady current of refugee Norwegian sailors and merchant mariners arrived in the U.K., many volunteering for submarine duty. A military agreement was reached by which the Norwegians took over three Royal Navy submarines: UREDD (originally designated as P 41 by the British, but transferred before completion) in 1941, ULA (originally designated HMS VARNE, but also transferred before completion) in 1943, and UTSIRA (originally designated HMS VARIANCE, but transferred upon completion) in 1944.

UREDD was commissioned into the RNoN on Pearl Harbor day, 7 December 1941. Like other submarines of the British U-class, she was 191 feet in length, had a submerged displacement of 730 tons, and was armed with 4 torpedo tubes and a 3" deck gun. Torpedo complement was 8-10, and crew size was 32 with room for special forces. UREDD completed seven war patrols and sank several vessels including a German Navy supply ship carrying parts for U-Boats operating from occupied Norway.

On 5 February 1943, UREDD left Dundee to land six Norwegian commandos and one Norwegian agent of British Secret Intelligence on the coast near Bodo. She neither completed the mission nor returned. In 1985, she was finally found and designated a war grave, an apparent victim of an unknown German minefield. UREDD is Norway's sole submarine loss.

ULA, another British U-class sub, was commissioned immediately after the apparent loss of UREDD. Built as the HMS VARNE, she was intended for the Royal Dutch Navy, but the Dutch crew—being transferred from a decommissioned Dutch submarine in Sydney, Australia—were lost when their transport was sunk by a U-Boat. ULA completed fourteen war patrols. At least one source claims she sunk more tonnage than any other Allied submarine operating in the Atlantic.[6] Her most notable victim was U-974, cut in two by a torpedo hitting just aft of the conning tower off Stavanger, Norway. The commanding officer,

Captain Sigurd Valvatne later became the post-war head of the Submarine Branch.

UTSIRA was a British V-class submarine. Similar to the U-class, V-class submarines were slightly longer (207 feet in length), and had a bigger crew (37), more powerful engines and could dive deeper. During her three war patrols she sank a German Navy patrol vessel and a Norwegian merchant ship sailing under German control.

Both ULA and UTSIRA remained in commission until 1965.

U- and K-Class

In 1945, B 1 was decommissioned. In 1946, Norway purchased three more submarines from the UK. All were British V-class like UTSIRA: UTSTEIN (ex-HMS VENTURER), UTVAER (appropriately ex-HMS VIKING) and UTHAUG (ex-HMS VOTARY). Some sources refer to the British V-class as the *Vampire*-class since HMS VAMPIRE was the lead sub.[7]

Somewhat confusingly, the Royal Norwegian Navy refers to their British V-class submarines as the (Norwegian) U-class.

UTSTEIN, in particular, had a distinguished legacy since HMS VENTURER sunk U-864 off Norway in 1945 while both subs were submerged, a rare feat for the Second World War. Today, the wreck of U-864 is considered an environmental hazard since it carried a cargo of 67 tons of metallic mercury.[8]

After all of the U-class subs underwent modernization in the 1950s, UTSTEIN again distinguished itself (in 1962) by accidentally going 225 feet below its maximum depth of 300 feet.

After liberation, the Norwegian government also realized that it had inherited over 15 Type VIIC long-range German U-Boats as well as a few nearly indestructible U-Boat bunkers. The British Royal Navy had established a policy that all captured U-Boats should be sunk, and the Norwegians complied out of gratitude. However, Sigurd Valvatne, now head of the Submarine Branch, convinced the political leadership to retain three U-Boats which were recommissioned in 1948 into Norwegian service as the K-class: KYA (ex-U 926), KAURA (ex-U 995), and KINN (ex-U 1202).

The subs of the K-class were decommissioned between 1961 and 1964. KAURA (ex-U-995) was returned to Germany as a display at the U-Boat Memorial at Laboe, near Kiel.[9] The U-class was decommissioned 1964-1965.

Cold War and the Move to Bergen

Based on the lessons of the Second World War, a Norwegian Defense Commission recommended that the main submarine base be moved from Horton in the Oslo fjord to near Bergen on the Atlantic coast. In 1949, Norway became a founding member of NATO which provided further impetus for a base in Western Norway. The submarines were moved to Bergen (which is the second-largest Norwegian city) in 1954, although their base was actually not fully completed until 1963.

The move greatly facilitated the superb cooperation between the U.S. Navy and Marine Corps and the Norwegian armed forces, cooperation that was a hallmark of the Cold War, even during the academic and propaganda assault on *The Maritime Strategy* of the 1980s. The focus of the Royal Norwegian Navy was anti-Soviet operations off North Cape and in the Arctic, with the RNoN submarines being critical players. Norway retains this capability; after all it is their territory. However the number of submarines in the force has shrunk considerably.

An alternative submarine base in Tromso, north of the Arctic Circle was activated in 1968, but closed in 2008 amidst controversy.[10]

KOBBEN-Class/Type 207 and the "Grand Age"

In 1960, a Naval Fleet Plan was drafted calling for a construction of 15 small but more modern submarines to be built for defense against a Soviet invasion. RNoN was lent a German Type 201 built by Rheinstahl Nordseewerk (now part of HDW) in Emden for evaluation. The result was a design combining features of the Type 201and Type 205, designated Type 207. Type 207 is 155 feet in length, with a submerged displacement of 485 tons and a crew of 24. Its eight 21.0 inch torpedo tubes are capable of a variety of torpedoes, including US-built.

The 15 submarines, designated the KOBBEN-class (RNoN routinely reuses sub names), were built 1963-1966, and partially financed by the US.[11] Their primary operating areas were off Northern Norway and in the Barents Sea. RNoN took pride in having an average of 10 operational at any given time.[12] Between 1985-1993, six boats were modernized and were lengthened by 2 meters (6 ft. 7 in.). Four others were sold to the Royal Danish Navy, where three served as the Tumleren-class until 2004 (the fourth was used for spare parts). In 2002-2003, five of the modernized subs were given to Poland, where four remain in commission and one is used for spares. The rest were scrapped by 2001.

Because of the number of operational submarines, the 1963-2001 period has been referred to as the *grand age* of the RNoN Submarine Branch.[13]

Ula-Class/Type 210

In the 1970s, the RNoN already started planning for replacements for the Kobben-class. Six Type 210 submarines were built in 1989-1992, and designated the ULA-class. These constitute Norway's current Submarine Force.

At 190 feet and 1150 tons submerged displacement, the Ula-class is substantially bigger and more capable than was the Kobben-class. The combat systems and the boats' sections were built in Norway, but assembled in Emden. The Ula-class is also much faster, capable of making 23 knots submerged and with a range of 5000 miles at 8 knots.[14]

Although primarily used for territorial defense, the Ula-class is a deployable submarine, and has operated in the Mediterranean in support of *Operation Active Endeavor*, primarily conducting intelligence gathering.[15]

As the result of this experience, the ULA (S 300) itself was *tropicalized* for more efficient operations in warm water (especially cooling for the crew). Two more of the class are slated for *tropicalization*. Going through a series of modernizations, the RNoN expect to maintain the Ula-class in service until 2020.

Voyage to the Future, Echoes of the Past

The geography of Norway and its commitment to NATO would appear to require the maintenance of an effective Submarine Force. This is currently recognized by the major political parties, and the commitment to NATO is reflected in the *tropicalization* efforts to support out-of-area submarine operations. The Royal family is very supportive of the Norwegian military (the King is commander-in-chief of the armed forces), and the Crown Prince is a Norwegian Naval Academy graduate.

The Norwegian government is not sanguine about developments in Russia, but there is a significant degree of elite opinion looking to the EU rather than to the Atlantic. In 2005, the government of Norway pulled out its forces from the U.S.-led *Operation Enduring Freedom* in Afghanistan (and from Iraq), reassigning them to the NATO-led International Security Assistance Forces (ISAF) instead.[16] Interestingly enough, there are a number of Norwegian combat soldiers from *Operation Enduring Freedom* who are now RNoN Naval Academy midshipmen or graduates.

Within the RNoN, the Submarine Force maintains considerable prestige; however, the RNoN is a naval service in which most officers know of each other, so reputation is personal rather than derived by specialty. Flag ranks in the Royal Norwegian Navy tend to be dominated by qualified submariners, but most have held at least one surface command as well, often more than one. Being qualified in submarines does not mean one stays in submarines, and the most prestigious commands afloat are now the three new AEGIS-frigates: FRIDTJOF NANSEN (F310), ROALD AMUNDSEN (F311), and OTTO SVERDRUP (F312). Two more are under construction.

As before, RNoN submarines remain largely a territorial defense for the same reasons identified in Captain Geelmuyden's report, with underway periods averaging three weeks. But this appears to be changing given the NATO deployments to the Mediterranean and elsewhere. Women have been integrated into the submarine crews (the fact that most underways are three weeks or so may or may not have influenced this decision), and the

RNoN boasts the world's first female submarine commanding officer.

The decision to proceed with AEGIS surface ships is actually a defensive complement to the Submarine Force in the sense they should eventually be able to provide a national ballistic missile defense (BMD)--at least of cities--while the subs provide local sea control and coastal protection. There has been little if any talk in Norway about AEGIS BMD, but most other nations obtaining AEGIS ships appear to be looking forward to that capability. Given the globalization of ballistic missiles and trends in Russia, it would be a mistake for Norway not to consider AEGIS BMD. At the same time, the AEGIS frigates and the tropicalized submarines give the RNoN a deployment capability unequaled by nations of equivalent population.

There is no indication that Norway would follow Denmark in the elimination of its Submarine Force. But then again, given the narrow straits of Denmark—the perfect geography for diesel-electric submarines--who would have thought that the Danes would make such a decision without simply disarming completely? In the meantime, the Russian Baltic Fleet is bringing tactical nuclear weapons back on to their attack subs and surface ships. But I suppose Denmark's decision reflects either an absolute faith in NATO or a belief that world peace is just around the corner.

In any event, the Norwegians are proud of not being Danes or Swedes and have no problem making their own independent choices as to how they see the world. But sea blindness is an illness that affects even many Americans, and no nation is necessarily immune without being frequently reminded of their naval and maritime traditions. Today that is exactly what the Royal Norwegian Navy is doing.■

ENDNOTES

1. Quoted in *Dykk! Dykk! Dykk!": Undervannsbatvapenet gjennom 100 ar* (Bergen, No: Bergens Sjofartsmuseum, 2009), p. 12. This is the program for the Bergen exhibit.
2. Ibid.

3. Britain referred to Norway as its "neutral ally" during the First World War as Norway refused to submit to the German blockade.
4. Quoted in "Start"-the first Norwegian aeroplane," by Karl L. Kleve, retrieved from http://www.luftfart.museum.no/100/en/txt/txt_norge.htm.
5. One source maintains that B 6 surrendered due to the German threat to otherwise bombard Floro city. See http://www.bookrags.com/wiki/List_of_Royal_Norwegian_Navy_ships.
6. http://en.wikipedia.org/wiki/HNoMS_Ula_(1943).
7. A complete list of the V/Vampire class can be found at www.battleships-cruisers.co.uk/v_class.htm.
8. *Dykk! Dykk! Dykk!": Undervannsbatvapenet gjennom 100 ar*, p. 42.
9. When the author visited Laboe in 1977, he was told that it was the only place in Germany that a swastika flag could be flown, a German Naval ensign from a sub lost with all hands.
10. *Dykk! Dykk! Dykk!": Undervannsbatvapenet gjennom 100 ar*, p. 48.
11. Ibid, p. 54.
12. Ibid, p. 55.
13. Ibid, p. 54.
14. http://en.wikipedia.org/wiki/Ula_class_submarine
15. Ibid.
16. ISAF is often derided (for its operational restraints) as "I Saw Americans Fight" by the Norwegian military members, among others.

ETERNAL PATROL

CAPT Zeb D. Alford, USN(Ret)
CAPT Stephen R. Cleal, USN(Ret)
Mr. Don Dougher
CAPT Bradford S. Granum, USN(Ret)
CDR David R. Hinkle, USN(Ret)
RADM John H. Maurer, USN (Ret)
CAPT Bernard R. McLaughlin, USN(Ret)
RADM Corwin Guy Mendenhall, Jr., USN(Ret)
LT James V. Ragano, USN(Ret)
RADM Alexander M. Sinclair, USN(Ret)
Mr. John J. Stevens, Jr.
CDR Connelly D. Stevenson, USN(Ret)
Mr. John S. Wise

EXPERIMENT AT DUNDEE: THE ROYAL NAVY'S 9TH SUBMARINE FLOTILLA AND MULTINATIONAL NAVAL COOPERATION DURING WORLD WAR II PART I of II

by Mr. Mark C. Jones

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Ed. Note: This article is being published in two parts. Part I, in this issue, is an introduction and a literature review. It also includes a description of the RN system for multi-national naval cooperation. Part II will appear in the January 2010 issue and cover the missions and forces and the operations highlights of Submarine Flotilla 9. It will present the post-war departures from Dundee and some conclusions to be considered.

Mark C. Jones lives in Morristown, New Jersey and writes on the armed forces of the smaller European Allied countries of World War II that were operationally integrated into the British armed forces after being driven from the continent (Czechoslovakia, Poland, Norway, Netherlands, Belgium, France, Yugoslavia, and Greece).

Introduction

Multinational naval operations have been a common occurrence in naval affairs over the last quarter century, yet the origins of multinational naval cooperation are not well documented. Many members of the North Atlantic Treaty Organization (NATO) began their military cooperation during World War II when the armed forces of the smaller European Allies (Czechoslovakia, Poland, Norway, Netherlands, Belgium, Free France, Yugoslavia, and Greece) were driven from the continent and reconstituted with British assistance.

This article seeks to contribute to a greater understanding of how the post-World War II era of multinational naval cooperation grew out of British wartime collaboration with the Allied navies-in-exile of Poland, Norway, Netherlands, Belgium, Free France, Yugoslavia, and Greece. Small numbers of exile naval units operated as part of Royal Navy (RN) formations virtually everywhere the RN deployed forces, including the Battle of the Atlantic, convoys to the Soviet Union, the invasions of North Africa, Sicily, Italy, Normandy and southern France, as well as part of operations of the Eastern Fleet in the Indian Ocean. These vessels were often British-built escort vessels such as destroyers and corvettes on loan to the Allied navies, but also included small craft such as trawlers converted to minesweepers or patrol craft as well as motor torpedo boats. One of the best examples of the naval relationship between Britain and the exile militaries is a little known submarine unit, the 9th Submarine Flotilla (hereafter S9). This submarine flotilla regularly included ships from the British, Polish, Free French, Norwegian and most commonly Dutch navies, and can be seen as a microcosm of the Allied naval cooperation system created by the RN.

This article begins with a review of the extant literature on the history of multinational naval operations, the British political and military relationship with the European exile militaries of World War II, and the RN submarine force during the war. It then turns to an examination of how the RN developed a system to integrate the exile navies into the British fleet. A short section describes the operational highlights (important sinkings, lost submarines) of this unit's war record before turning to an analysis of S9 as an example of a smoothly working multinational naval unit. The article concludes with an analysis of why S9 proved to be a successful multinational naval unit, and suggestions about how the literature on the history of multinational naval operations might be more fully developed.

Literature Review

The literature on multinational naval operations is rather small, and much of it concerns specific examples of Cold War era

operations under the sponsorship of NATO or more recently the two United States-led interventions in Iraq (1990-91 and 2003-present). These sources, generally articles in professional magazines such as the U.S. Naval Institute's *Proceedings*, give a nuts and bolts description of a particular exercise or operation but do not treat the larger history of how it became possible for ships of many Western navies to operate together effectively. What is needed, but which apparently does not exist, is a major historical study of how the Western navies learned to gradually coordinate their defense policies, command and control systems, tactical procedures, and even hardware purchases to create the largely compatible standing and ad hoc naval forces deployed during the Cold War and various subsequent world crises.

The existing literature on multinational naval operations is a mix of short articles and monographs, mostly the former. These various sources are either contemporary accounts of multinational naval operations[1], or demonstrate the need for multinational naval operations given the political, economic, and environmental circumstances that navies operate in.[2] Of the wars and crises where multinational naval operations have taken place, the Spanish Civil War (1936-39) and the first Gulf War (1991) account for the bulk of publications.[3] One account even looks at the multinational naval effort taken to the level of combining men from several navies aboard the same ship.[4]

There are a few sources that seek to provide an historical overview of how navies gradually began to work closely with each other. *Multinational Naval Cooperation* by Robert H. Thomas provides a brief historical review of the topic beginning with the post-World War I era and continuing through the mid-1990s. Thomas points out that prior to World War I, the major naval powers considered each other rivals, which consequently inhibited naval cooperation.[5] Treatment of multinational naval operations during World War II is necessarily brief, but the author states that the first major attempt by the Allies to operate ships jointly led to a decisive defeat. A mixed squadron of Dutch, British, U.S., and Australian warships commanded by a Dutch admiral was shattered by the Imperial Japanese Navy during the Battle of the Java Sea in

February 1942. While Allied forces under the ABDA Command (American, British, Dutch, Australian) had little chance of containing the powerful Japanese forces deployed in the invasion of the Netherlands East Indies, the ABDA naval striking force was handicapped by the ad hoc nature of the unit and the differing languages and communications systems used. This chapter does not contain any analysis of how the World War II experiences of the Allied navies influenced post-war collaboration. A second source, the article "Multinationality: the way ahead for Western maritime power" written by an Italian naval officer emphasizes the efforts of NATO to create standing multinational naval forces beginning in the mid-1960s.[6] However, this article does not go beyond specifying what countries provided ships to specific standing commands for particular security purposes. It does not state what challenges had to be overcome to achieve a smoothly working multinational unit.

Only a few sources offer specific reasons why ships from various navies were or were not able to work together successfully, or attribute successful present day cooperation to World War II era ties. One author argued that the successful international cooperation demonstrated by foreign (British, French, American, German, Italian, etc.) warships during the Spanish Civil War was due to five reasons. These were 1) the shared sense of confusion about conditions in Spanish coastal cities; 2) similar missions of humanitarian rescue; 3) hostile attitudes towards the Republican forces due to reports of atrocities committed against military officers; 4) the common dangers of submarine and air attack due to misidentification by Republican or Nationalist forces; 5) the desire of the German and Italian commanders to be treated as equals by their British and French counterparts.[7] Thirty years later during the NATO attempt to crew the American guided missile destroyer USS CLAUDE V. RICKETTS (DDG-5) using men from six different navies, initial difficulties were experienced due to differences in language, pay scales, operational procedures, training levels, religion, and discipline. Ultimately, the ship was able to surmount these challenges and performed as well or better than other U.S. warships of the same type.[8] One author attributes

successful present day multinational naval operations in the Persian (or Arabian) Gulf to World War II era ties. This author, a commodore in the Royal Australian Navy, commanded in 2002 a mixed nationality task force with headquarters on a U.S. Navy vessel during the blockade of Iraq. This officer wrote, "Six decades of alliance and close interaction with the U.S. Navy has born fruit in the way we can operate together so easily today. This year is the 60th anniversary of the Battle of the Coral Sea. Throughout the Pacific campaign, and in Korea, Vietnam, and the Arabian Gulf, the Royal Australian Navy and the U.S. Navy have operated alongside other allied navies."[9]

The literature on multinational naval cooperation is not sizeable in number of publications, and emphasizes naval operations of the past two decades as well as justifications for multinational operations due to political, economic, or environmental circumstances. There are few sources to provide an historical assessment for how the smoothly running multinational naval operations of today were achieved, or specify particular issues that complicate multinational naval efforts.

While there is not much of a literature on multinational naval operations, there is even less that documents how the British armed forces of World War II were able to incorporate the remnants of the various European Allied militaries. Most of the articles and books about the exile militaries are specific to the land, sea or air forces of a particular country. So while a source about the Polish Air Force in Britain, the Czechoslovak Army in Britain, or the Royal Netherlands Navy in Australia might contain a few observations about the military relationship between a particular European country and the British, these observations are included only as needed to tell the larger story of combat operations. What is needed is a study that combines the diplomacy between governments, the liaison between armed forces commanders, and the operational history of each country's armed forces.[10]

The sole published source to do this for more than one country is a study of the exile squadrons in the Royal Air Force (RAF), *Airmen in Exile*.[11] The author first explains how the

remnants of the various European armed forces arrived in Britain, and then demonstrates how the British came to change their attitude from displeasure at playing host to a ragtag polyglot army to serious attempts to incorporate these exile aviators into the RAF. Most of the chapters of this book are treatments of individual countries including Czechoslovakia, Poland, Belgium and the Netherlands, Denmark and Norway, and France.

While *Airmen in Exile* does a fine job of describing and analyzing the exile air forces, there is no corresponding study of the ground or naval forces of the small European Allies. One wartime book on the European naval forces, *Navies in Exile*, published in 1944 and current through mid to late 1943, has chapters on the several exile navies, but the content is fairly general and no sources are given. There are brief descriptions of the major operational achievements and losses of each of the exile navies, but no attempt is made to explain how the RN incorporated the various Polish, Free French, Norwegian, Dutch or Greek ships into the larger Allied fleet. Likewise, there is no explanation of the efforts necessary for a foreign warship to operate primarily with British ships in mixed flotillas or task forces. Curiously, the only reference to S9 is to the Free French submarine MINERVE. "Early in the Spring of 1941 she was operating with that extraordinary 'Flotilla of the United Nations' which works from a northern base, a base where the notices are posted in five languages and the depot ships are polyglot."[12]

The British submarine service during World War II has been widely written about, either in the form of technical publications about specific classes of submarines, overviews of the entire submarine service, or the war memoirs of officers who commanded individual British submarines. Unfortunately, while there are numerous books and articles about the submarine service, few of these pertain to the 9th Submarine Flotilla. There are two likely reasons for this. First, the unit initially had quite a few British submarines but as more Allied boats were commissioned, British boats could be withdrawn and sent to other flotillas. By early 1945 there were very few British personnel assigned to S9, mostly officers with staff assignments. Second, many of the British

submarine personnel who served with the unit at some point, particularly early in the war, were later killed in action either in the North Sea or the Mediterranean Sea. Losses of men and ships in the submarine service were extremely high. An officer who commanded or served in a British submarine assigned to S9 in 1940-41 thus may have perished before he had an opportunity to write his memoirs after the war.[13]

One source that does provide operational details of S9 as well as lists of assigned submarines at various points during the war is the three-volume naval staff history of the submarine service during the war, written during the 1950s.[14] However, this study concentrates on summarizing the operational history of individual boats and situating the British submarine campaign in the context of British naval operations as a whole. It does not explain much about individual flotillas, except to explain why they were shifted to particular ports as the war progressed or to state the patrol areas each was responsible for.

Studies of individual British submarine flotillas are also scarce. The best example appears to be a description of the famous 10th Submarine Flotilla (S10) stationed at Malta from 1941-44.[15] The book combines the larger strategic role of Malta with the significant details of each boat's patrols, the personal observations of officers and enlisted men who served on the individual boats, and the administrative side (command, supply, maintenance, communications, etc.) of the flotilla ashore. The author sought out contributions from the Polish, Dutch, and French veterans who crewed 'U' class boats on loan from the Royal Navy, but unfortunately there is minimal material on the Greek submarines that operated in the Mediterranean from Alexandria, Beirut, and Malta. This book is supplemented by the memoirs of the officer who commanded S10 for much of its time at Malta.[16] One unpublished source is a study of the 6th Submarine Flotilla at Blyth, England.[17] This study focuses on the first two years of the war when S6 was a combat unit, and makes extensive use of memoirs and interviews to paint a vivid picture of life aboard the submarines and ashore. Other than these two books and one manuscript, there seem to be no other studies of British submarine

flotillas, including S9, during World War II.

It appears that none of the published memoirs of service in the British submarine force during the war were written by an officer who served for any length of time in S9.[18] This includes the four officers who commanded S9 during the war in Europe.[19] The first Captain S9, James G. Roper, was killed in an air crash in Australia in July 1945 while serving as a staff officer in the British Pacific Fleet's supply train. His successor as Captain S9, Hugh V. King, died in 1947. The other two officers apparently did not write about their careers and left no known papers in government or university archives. An alternative to sources written by the commanding officers of S9 would be a memoir by one of the officers commanding the entire British submarine service. As with the Captains S9, none of these flag officers left memoirs or known paper collections that pertain to S9.[20] As stated above, the lack of published accounts of experiences in S9 was likely due to the declining number of British submarines assigned to the unit and the high casualty rate among British submarine personnel during the first three years of the war.

The literature that relates to the topic of multinational naval operations during World War II is rather sparse, even less has been written on the British/exile government military relationship as a whole, and studies of the British submarine service do not provide much information about S9. The article draws upon primary sources from the Royal Navy Submarine Museum, National Archives, and Imperial War Museum, a wide variety of secondary sources published in English, Dutch, French or Norwegian, and letters and photographs from veterans of the 9th Submarine Flotilla from several countries. The next section of the article will explain how the RN integrated the exile navies into the British fleet.

The British Establish a System for Multinational Naval Cooperation

The first exile naval units arrived in Britain just as the German invasion of Poland began. Recognizing that German naval and air forces would quickly eliminate their small navy, the Poles sent three of their four destroyers (GROM, BLYSKAWICA,

BURZA) out of the Baltic before the war started and the submarines ORZEL and WILK later escaped to Britain after further resistance in the Baltic became futile.[21]

Following the end of the Polish campaign in October 1939, a large number of ground and aviation personnel from Poland (and a few from Czechoslovakia) arrived in France via Hungary and Romania, and operated from there until the collapse of France in June 1940.[22] Limited numbers of Polish aviators, generally those trained for bombing squadrons, were transferred to Britain before the French collapse under an Anglo-French agreement about how to reconstitute the Polish Air Force. So prior to the German western offensives in Scandinavia (April 1940) and the Low Counties and France (May-June 1940), exile military personnel in Britain were limited to a handful of Polish naval vessels and several hundred Polish aviators being readied for service as bomber pilots and crews as part of the RAF.

With the success of the German western offensives, considerable numbers of military personnel from the land, air, and naval forces of Norway, Netherlands, Belgium, and France began to arrive in Britain.[23] These forces were sometimes evacuated directly to Britain from their home countries, as was the case with a handful of Norwegian naval vessels and much larger numbers of Dutch and French ships. The evacuation of ground forces from Dunkirk in northern France resulted in substantial numbers of Belgian and French ground troops arriving, and many Polish ground and aviation personnel were disembarked from separate evacuations of French ports farther south than the Channel. In addition to the mass arrivals that occurred as the Germans reached the North Sea and English Channel, small but steady numbers of military personnel began to reach Britain, British territories in the Mediterranean, and several neutral countries. These escapees were determined to join their countrymen in exile in resisting the German occupation, and many were successful in joining the Allied forces though just as many failed in their escape attempts and were either imprisoned or executed for their efforts.

Britain was initially reluctant to host foreign military personnel due to legal, security, organizational and cultural complica-

tions as well as the financial burden it would impose.[24] However, Britain very much needed the additional ships, squadrons, and battalions that the exile militaries could contribute to the Allied cause. As indicated in the above literature review, a prime motivation for multinational naval operations is the need to assemble forces greater than any one country can supply individually. In the case of the RN in 1940, losses of destroyers, submarines and escort vessels during the first nine months of the war had been severe, and the emergency ship building programs had not yet begun to produce the vast quantity of ships needed. So the arrival of foreign warships, while small in number and of varying degrees of utility, were a helpful reinforcement at a time of great need. Generally each exile government concluded a separate agreement with Britain about the nature of its military cooperation with the British armed forces.[25]

In addition to purely military considerations, incorporating the exile militaries into the British armed forces and establishing close diplomatic ties to their respective governments now based in London would offer considerable political advantage to the British government. The struggle between Britain and Germany could now be portrayed as the free world versus Fascism, and not just a war between major powers.

The presence of naval attachés assigned to London by the several governments-in-exile formed the initial basis for communication between the RN and each exile navy. The Dutch, Greeks, Poles, and Norwegians had assigned an officer as naval attaché before their countries were invaded. The Belgians had effectively abolished their navy between the wars, so no naval attaché was present.[26] As for the French, they had a large liaison office with the RN headed by a vice admiral to coordinate operations at sea, such as task forces seeking out German raiders and capital ships. The Greeks had a particularly strong relationship with the RN as the Greek government had asked for the establishment of a British Naval Mission to Greece in 1911. This advisory group of RN officers guided the development and training of the Royal Hellenic Navy until it was finally withdrawn in 1955. As the exile navies regrouped in Britain, they established headquar-

ters in London. The exception to this was the Greeks who set up headquarters in Alexandria, Egypt, the main base of the British Mediterranean Fleet.

When the Germans turned their attention to the Balkans in 1941, the number of exile navies incorporated into the RN grew with the addition of Yugoslav and Greek ships. In the case of Yugoslavia, only two motor torpedo boats and an elderly submarine escaped the Italian blockade of the Adriatic Sea to reach Greece and subsequently a British port in the Mediterranean.[27] Much larger numbers of Greek ships escaped the German air assault in April 1941 to reach first Crete and then Alexandria. Yugoslavia's navy was too small to warrant much attention by the RN, particularly as that country was engulfed by a brutal civil war between different ethnic and political groups. However, the Royal Hellenic Navy was able to contribute significantly to the Allied war effort, especially once its antiquated ships were replaced with newly built British vessels.[28]

For foreign ships to operate as part of the RN, the exile ships usually needed to rearm with British weapons as well as adopt British tactics and communications procedures. Foreign ships were trained as part of the units or commands they belonged to, and uniform communications procedures were guaranteed by assigning a liaison detachment to each ship. Generally the detachment assigned consisted of a junior officer with the rank of Sub-Lieutenant or Lieutenant, often part of the Royal Navy Volunteer Reserve (RNVR), and several ratings for signals and radio communications purposes. "British Liaison Officers, Signalmen and Telegraphists were embarked in Allied boats not to assist in their operation, let alone give advice, but to ensure the security of British signal procedures and ensure that orders and signals in English were properly understood."[29] One retired Polish naval officer who served on destroyers in British waters for much of the war said that upon the arrival of the Polish Destroyer Division in Britain in September 1939 that British Naval Liaison Officers (hereafter BNLOs) in the rank of Lieutenant Commander were assigned to each Polish ship. These were regular navy officers with much professional experience. This Polish veteran is of the

opinion that the initial BNLOs were assigned to the ship not just for communications reasons, but also to evaluate the ship's technical characteristics, the armament, the crew's fighting spirit, and most importantly the captains of each ship. These BNLOs were later replaced by more junior officers as the war progressed. Liaison detachments were shifted from ship to ship; as one ship began a refitting period, the detachment was reassigned to another ship finishing refit.[30]

One detailed account of service as a BNLO was written by an officer who coincidentally served on a submarine assigned to S9. The late Ruari McLean was the BNLO on the Free French minelaying submarine RUBIS between August 1941 and mid-July 1942. McLean was a Sub-Lieutenant RNVR who earned his commission after a few months as an enlisted man on an old destroyer. His vision was poor in one eye, so he was in the Special Branch whose personnel could not stand watch. Many of these Special Branch officers served ashore, while McLean wanted to go to sea. Upon learning that BNLOs to Allied warships could be from the Special Branch, he applied and was accepted. McLean was sent to submarine school and then posted to the RUBIS, which operated from Dundee as part of S9. He spoke French having studied the subject in school, though BNLOs were not expected to be able to speak the language of the ship they were assigned to. His duties were to make sure signals received in English were understood by the captain, and to transmit the captain's patrol report to the Admiral (Submarines) immediately upon arriving in port. The rest of the liaison detachment consisted of a leading signalman and a leading telegraphist.[31]

Much of what McLean says about the duties and experiences of a BNLO on an Allied submarine is confirmed by another account. The late Douglas Sinclair was assigned as BNLO to the Dutch submarine O-21 in 1944. His description reads, "The duty of the liaison party was to assist the C.O. in all departments when in a British port; to organize the recognition signals, ciphers and codes. All S.B.s (secret books) were under the care of the B.N.L.O. We did not speak Dutch which did not seem to matter as they all spoke very good English."[32]

While very junior officers handled communications matters and no doubt answered questions about RN procedure and British culture to facilitate multinational naval operations at the individual ship level, a very senior officer was appointed to facilitate the broader relationship between the RN and the exile navies. Retired Vice Admiral Sir Gerald C. Dickens, RN (1879-1962) was appointed to the newly created position of Naval Assistant (Foreign) to the Second Sea Lord in early July 1940. This position was renamed Principal Naval Liaison Officer (hereafter PNLO) in March 1942. Information about the duties of the PNLO is scarce, as the records of this office are not filed in one consolidated group in the National Archives (formerly the Public Record Office) at Kew outside London. Admiral Dickens kept a diary during the war. The diary is not complete, and much of it concerns the admiral's personal life. Still, there are some brief references to his PNLO duties such as accompanying the senior officers of the several Allied exile navies to social events and naval ceremonies. A few other bits of information about Admiral Dickens' duties appear in an incomplete, unpublished memoir he was writing shortly before his death. The senior officers of the exile navies labored under heavy strain due to their duties. To help these officers deal with the stress of their positions, he arranged for them to take tours of important British cultural sites such as cathedrals, castles and universities.[33] Dickens also apparently spent some time attempting to persuade British security authorities to release from prison foreign nationals who managed to reach Britain. These men, who risked death in order to join their country's military forces in Britain, were often considered possible spies by British security.[34]

Admiral Dickens was relieved in mid-January 1943 by Vice Admiral Edward L.S. King (1889-1971) who served as PNLO from March 20, 1943 until March 1946. Unlike Admiral Dickens, Vice Admiral King left no known collection of papers. While the documentary record for these two senior officers is limited, and PNLO records do not have their own file numbers in the National Archives, it can be assumed that the PNLO was informed of all significant matters concerning the exile navies, from personnel

shortages and awarding of decorations to transfers of newly built British ships and official inquiries seeking explanation of British diplomatic and naval policy. The office of PNLO did not make policy decisions which were handled by the appropriate office within the Admiralty. Instead, the PNLO was to be a point of contact for the exile navies in their dealings with the RN.

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Praeger, 2003). For just the Belgian Army, see Robert W. Allen, "Britain revives the Belgain Army 1940-45," *Journal of Strategic Studies* 21(4): 78-96, 1998. One source that directly studies the exiles, though with separate chapters for civilians and military forces, is Martin Conway and José Gotovitch, eds., *Europe in Exile: European Exile Communities in Britain 1940-45* (New York: Berghahn, 2001).

11. Alan C. Brown, *Airmen in Exile: the Allied Air Forces in the Second World War* (Phoenix Mill, UK: Sutton Publishing, 2000).

12. Arthur D. Divine, Navies in Exile (New York: Dutton and London: J. Murray, 1944), p. 193.

13. As copies of the RN's Navy List, which gives details of officer assignments and careers, are often hard to find and particularly so in the United States, one source for RN officer information is Hans Houtermans's fine website "Royal Navy (RN) Officers 1939-1945." This source does not list all RN, RNR, and RNVR officers, but does have many of the high-ranking officers. Site is available at ww.unithistories.com/officers/RN_officersR.html, last accessed 22 June 2007.

14. Naval Staff History (Submarines), vol. 1 *Operations in Home, Northern, and Atlantic Waters including the Operations of Allied Submarines* (London: Admiralty Historical Section, 1953). Volume 2 concerns the Mediterranean Sea while volume 3 covers the Indian and Pacific Oceans. This item was never commercially published, and so copies are generally only found in government libraries and archives including the Royal Navy Submarine Museum (hereafter RNSM) at Gosport, England.

15. John Wingate, *The Fighting Tenth: the Tenth Submarine Flotilla and the Siege of Malta* (Hamden, CT: Shoestring Press and London: Leo Cooper, 1991). The author was the executive officer of one of the 'U' class submarines assigned to the flotilla and has written a number of books about British submarine history.

16. George W.G. Simpson, *Periscope View: a Professional Autobiography* (London: Macmillan, 1972).

17. Pamela Armstrong, *Fight and Abide Fortune: the Story of the Blyth Submarines* (unpublished manuscript, 1995, partial copy in author's possession).

18. Among the memoirs examined are Edward P. Young, *One of Our Submarines* (New York: McGraw-Hill and London: Hart-Davis, 1953), William D.E. King, *The Stick and the Stars* (New York: Norton and London: Hutchinson, 1958), Alastair C.G. Mars, *British Submarines at War 1939-1945* (London: William Kimber, 1971), Ben Bryant, *Submarine Commander* (New York: Ballantine, 1974), John O. Coote, Submariner (New York: Norton, 1991).

19. The four officers who commanded S9 during the war in Europe were Commander, later Captain James Gregson Roper (1901-1945) 14 February 1940-21 January 1942; Commander (Acting Captain) Hugh Valentine King (1901-1947) 21 January 1942-1 September 1942; Captain Lancelot Milman Shadwell (1901-1959) 1 September 1942-January 1944; Commander (Acting Captain) Robert Michael Gore Gambier (1904-?) January 1944-10 May 1945. Gambier had a considerable amount of experience with the exile submarines prior to being appointed Captain S9. He served with S9 as a liaison officer from 27 May 1940-10 July 1940 before being assigned to S7 at Rothesay where the Dutch O-9,O-10

and Norwegian B-1 were stationed. He later joined the Dutch submarine tender COLOMBIA in December 1941 before it left Dundee for Ceylon where it became part of S4. Gambier was the executive officer of S4 from March 1942-February 1943, and then Captain S4 from February 1943-December 1943. S4 had several Dutch submarines assigned to it at any given time. Upon the end of the war in Europe, Gambier was suddenly posted away from the flotilla so one of the staff officers, Lieutenant Commander Ronald Hill Balfour, was made Acting Commander and placed in charge of the flotilla.

20. Three officers commanded the RN's submarine branch during the time S9 existed. These men, known as Admiral (Submarines), were Vice Admiral Sir Max K. Horton (1883-1951) who held the position 9 January 1940-9 November 1942, Rear Admiral Claude B. Barry (1891-1951) from 9 November 1942-12 September 1944, and Rear Admiral George E. Creasy (1895-1972) from 12 September 1944-31 October 1946. A book about Horton was written but it focuses almost entirely on his later service as the flag officer for the Western Approaches Command, which fought the Battle of the Atlantic.

21. The best source in English on the Polish Navy during World War II is Michael A. Peszke, *Poland's Navy 1918-1945* (New York: Hippocrene, 1999). Peszke has written extensively in English about all aspects of the Polish armed forces between 1918-1945, particularly its air force. See also the fine web site "Polish navy Portal 1918-1947" by Andrzej Bartelski, www.polishnavy.pl/index.html, last accessed 22 June 2007.

22. When Germany occupied Czechoslovakia, some Czechoslovak forces managed to escape the country and head to France. Some of these men took part in the defense of France in 1940 and then were evacuated to Britain.

23. There were very few Danish military personnel in Britain because the rapid conquest of Denmark of Germny in April 1940 resulted in the Danish government accepting a German occupation. The Danish armed forces remained intact though under German-imposed restrictions. It was not until 1943 when the Danish armed forces were disbanded by the occupying power that Danish military personnel, in very small numbers began to escape to Sweden. Additional Danes living outside Denmark at the time of the invasion joined the British Royal Navy and eventually a Danish section of the RN was formed with several small minesweepers. A good general reference in English on the history of the Royal Danish Navy is Johnny E. Balsved's website "Danish Naval History", www.navalhistory.dk/indexUS.htm, last accessed 22 June 2007.

24. Brown, *Airmen in Exile*, chapter 1.

25. For example, the full text of the Anglo-Polish Naval agreement of 18 November 1939 can be found in Peszke, *Poland's Navy*, pp. 179-180.

26. For information about the Belgian navy during World War II, see the websites by Ivan Sache, "Belgium: History of the Navy" http://www.crwflags.com/fotw/flags/be~his.html, last accessed 22 June 2007, and Johnny Geldhof's "Royal Navy Section Belge"

27. Sources in English on the Royal Yugoslavian Navy are scarce. The best accounts of this navy's history during the pre-war and war periods are Robert

Gardiner, ed., Conway's All the World's Fighting Ships 1922-1946 (Annapolis, MD: U.S. Naval Institute Press, 1980), pp. 355-358; Z.V. Adamich, "Royal Yugoslav Navy in World War II," U.S. Naval Institute Proceedings, April 1963, pp. 138-141; Milan Vego, "The Yugoslav Navy 1918-1941," Warship International 1982 issue 4: 342-361.

28. Procopis Papastratis, "A fighting navy in exile: the Greek fleet in the Mediterranean and beyond." In J. Sweetman, ed., New Interpretations in Naval History (*Tenth Naval History Symposium*). pp. 363-373.

(Annapolis, MD: Naval Institute Press, 1991); Mark C. Jones, "Misunderstood and forgotten: the Greek naval mutiny of April 1944" *Journal of Modern Greek Studies* 20(2): 367-397, 2002.

29. Richard Compton-Hall, *The Underwater War*, 1939-1945 (Poole, UK: Blandford, 1982), p. 35.

30. E-mail message of 1 June 2005 from retired Lieutenant Commander Zbigniew Weglarz, Polish Navy to the author. A regular officer, Weglarz escaped to the UK when his destroyer was sent out of the Baltic before hostilities began. As a Lieutenant, he spent most of the war at sea in Polish destroyers.

31. Ruari McLean, *Half Seas Under: Seaman, Submariner, Canoeist* (Bradford on Avon, UK: Thomas Reed, 2001).

32. Douglas Sinclair, "A B.N.L.O. in Dutch and French submarines." *Submarine Memories*, pages 75-79, published by the Gatwick (UK) branch of the Submarine Association, a submarine veterans group. Publication date is unknown, but the article is dated 24 January 1994.

33. Admiral Sir Gerald C. Dickens, RN, manuscript war diary held by the Liddell Hart Centre for Military Archives at King's College London under the file number GB99 KCLMA Dickens. See the archive web page www.kcl.ac.uk/lhcma/summary/di20-001.shtml. Photocopy supplied by the archive with permission of the admiral's grandson, Commander Mark C. Dickens, RN retired. See also Imperial War Museum, London, Department of Documents, Papers of Admiral Sir Gerald Dickens, 90/35/Box 2.

34. Admiral Sir Gerald C. Dickens, RN, "The Royal Netherlands Navy at War and After", *The Naval Review* 34(4): 387-399, 1946, quote on p. 396. Dickens was a former Director of Naval Intelligence and so was assigned to be naval attaché to The Hague from mid-February 1940 until the Dutch surrender in mid-May 1940. This experience working closely with the Royal Netherland Navy and the fact that Dickens spoke French may have contributed to the Admiralty's decision to make Dickens the first PNLO.

THE REAL X-MEN

by CAPT. Timothy Brown, RAN

Timothy Brown is a serving submarine officer in the Royal Australian Navy.

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NEARLY 66 years ago, a flotilla of mini-submarines set off to sink or cripple the mighty German battleship TIRPITZ. Among the men behind this attack was Max Shean from Perth, a volunteer for one of World War II's most daring and hazardous naval missions.

Figure 1 Max Shean

Shean's courage in command of the X-craft submarines in Europe and the Pacific earned him an unrivalled reputation as a leader whose aggressive instincts were always tempered by concern for his crew. He died on June 15, aged 90.

Born in July 1918, Shean was in his third year of an engineering degree when news of the Dunkirk evacuation inspired him to join the Royal Australian Naval Volunteer Reserves. A man of slender build, Shean was no swashbuckler. He was a man of quiet purpose, optimism and integrity. He was a meticulous planner. Shean trained in anti-submarine warfare in Sydney before serving on a British corvette, HMS BLUEBELL, on Atlantic convoy escort duty. When the British admiralty called for volunteers for "special and hazardous service", he volunteered without hesitation. After 15 months crossing the U-boat infested North Atlantic, Shean thought this special service couldn't be more hazardous than what he had been doing. Unaware that his new job meant manning top-

secret X-craft submarines, he joined 12 other volunteers and began training at the submarine base HMS Dolphin, Gosport, in 1942. They soon learned that their mission was to penetrate German harbour defences with a crew of three. Each had to be competent divers, so they could cut their way through anti-submarine nets to lay a pair of two tonne explosive charges under the TIRPITZ, an awesome machine of war that threatened Britain's trans-Atlantic supply lines. They had six months to prepare for the attack, which was initially planned for April 1943. Conditions were cramped on the X-craft. These submarines were developed to penetrate the most heavily defended waterways and survive unrealistic odds. Shean's engineering skills proved crucial during the X-craft sea trials. The X-craft became part of him for the rest of his life.

He was the perfect choice for such a mission. With his energy and friendly nature he became a popular member of the young group of submariners. In an effort to maintain secrecy, the British navy applied strict rules, but Shean wanted to capture the moment and smuggled a small Box Brownie camera in with him. As a result, he developed a unique record of the X-craft world. However, the biggest obstacle to their mission was developing a means to cut the anti-submarine nets protecting TIRPITZ at its anchorage in a Norwegian fjord. In early training attempts to cut a submarine through a net, all divers had had great difficulty and one unfortunately drowned in the process. It fell on Shean to devise a solution.

Figure 2 Max Shean and Ian McIntosh sitting on HMS SCEPTRE preparing for Operation Guidance.

Typical of a man who grew up playing around with boats on the Swan River, Shean found a way. He felt this to be his greatest contribution to the war effort.

In September 1943, Shean set sail with six X-craft submarines to carry out Operation Source, the sinking of the TIRPITZ in Kaa Fjord. Although qualified as an X-craft commanding officer, Shean was appointed as the diving officer of X-9.

To reach the operations area, the X-craft had to be towed by an ocean-going submarine. Shean was on board the towing submarine, HMS SYRTIS, with the rest of X-9's operational crew when it was discovered that X-9 had broken the tow and disappeared. The shredded towline had become caught in SYRTIS's port propeller and Shean was sent out to clear the snag. Working without his diving suit, which was in X-9, he dived into the freezing Arctic waters and managed to clear the line. However, the X-9, which was being manned at the time by another crew, was lost with all hands. The operation was over and, with it, Shean's chance to take part. The X-craft eventually achieved their mission and TIRPITZ was so severely damaged that it never put to sea again. But none of the X-craft survived the raid and nine men were lost. Soon after returning from Operation Source, the British had built more X-craft, and in April 1944 Shean was appointed in command of the X-24 for Operation Guidance. The Germans had been using Bergen in Norway as a U-boat base, with a floating dock for maintenance and repair. It was Shean's task to destroy the dock, an almost impossible task given that the approach was 40 nautical miles from the open sea through busy and confined waterways patrolled by German vessels and protected by two minefields and anti-torpedo nets.

The X-24 was towed to the drop-off point by HMS SCEPTRE, commanded by another Australian submariner, Ian McIntosh. At dusk on April 13, McIntosh slipped Shean's submarine and X-24 dived. Before departing, the two Australians coordinated a rendezvous. This mission was perilous from its inception and never before had only one X-craft been considered for such an operation. Reflecting on Shean's selection as the submarine's captain, his engineer Vernon *Ginger* Coles said: "Max

was the only captain I would sail with. When we went into Bergen the demeanour of Max was such that one would have thought we were going on exercise. He was cheerful, confident and pleased that we were doing something useful with no thought of not coming back." Shean was just 25.

The X-24 negotiated the minefields and, on returning to periscope depth, passed so close to a patrolling German patrol boat that Shean could see its swastika flag. Shean calmly ducked directly underneath. The X-24 slowly crept up to the target area, where Shean manoeuvred the X-24 close to the Bergen docks. As he approached his target, Shean could see the wharf facilities looming out of the haze. The basin, however, was full of busy marine traffic. Later, he confided that it was at this point he was overcome with fear, but his sense of responsibility for his crew forced him to keep a steady head. He had to do the job. He had to get his crew home safely. He took the X-24 deep and made his run to the target. The underwater picture was confused but the X-24 laid the charges, set with a four-hour time delay. Exhausted and starved of fresh air, Shean and his crew steered back through the heavily defended waters to the rendezvous with SCEPTRE. In the dark night that awaited them, a relieved McIntosh greeted Shean with a submariner's nonchalance, but through their exploits the young Australians forged a deep bond and remained close friends for the rest of their lives.

On their return to Scotland, Shean was to learn that faulty intelligence and incorrect charts had led him to lay the charges on a large enemy ammunition ship, the BARENFELS, which was destroyed. Shean asked to be sent back for a second attack, a request that was refused. The British claimed the attack as a success; a significant target was sunk and the X-craft returned unscathed. After the previous TIRPITZ raid, when all six boats were lost, morale in the flotilla was low. The mere fact Shean had penetrated a heavily defended fjord and harbour 40 nautical miles deep and returned home was a great morale booster. It was the first time an enemy ship had been sunk at its berth without any loss to Allied navy personnel. More significantly, the attack proved to be a strategic success and the Admiralty gained great

confidence in the ability of the X-craft in the war effort. This would later prove vital in the Pacific.

Shean was awarded the Distinguished Service Order for his leadership. But a new threat had arisen and, following D-Day, the X-craft were required in the Pacific. Leaving his new bride in Scotland, Shean was posted to a submarine depot ship and sailed to the Pacific. He was again selected to command a special mission in which he was given the job of cutting two submarine telegraph cables that were part of the Japanese communications network linking Singapore, Saigon, Hong Kong and Tokyo. The Allies could not intercept and listen to Japanese communications sent via these underwater cables. If the X-craft men could sever this link, then the Japanese would have to revert to their secondary radio communications, which the Allies had the means to decipher.

Figure 3 The late Vice-Admiral Sir Ian McIntosh

At that stage it was vital for the war effort to understand the Japanese intentions, for it would be the cue to the Allies on whether to drop the atomic bomb. The mission was no easy task and Shean's engineering background again proved most useful. He developed a special flat grapnel for XE4 that was eventually used for the X-craft mission. After training in Hervey Bay in Queensland, Shean sailed to Borneo in July 1945, then to The Philippines where the X-craft were launched on their mission to Saigon. He almost drowned en route after being swept overboard but was able to swim back and climb aboard after swimming the fastest few strokes of his life. On July 31, the cable was cut. For his efforts in the Pacific, Shean was awarded a bar to his DSO and a US Bronze Star.

On completion of the war, Shean graduated with honours in engineering before a career in the West Australian power industry. He was an avid sailor and in 1978 sailed his yacht Bluebell from Fremantle to Britain in the 150-year celebration Parmelia race, in

the open division, which he won. Shean was a proud submariner until his final days. He maintained close links with his X-craft comrades; Coles and he wrote to each other every three months. McIntosh and Shean together were patrons of the submarine museum in Fremantle. Shean is survived by his wife of 65 years, Mary; two daughters, Ruth and Heather; five grandchildren; and three great-grandchildren.

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ARTICLES

RECOLLECTIONS OF REGULUS

by Capt Peter L. Fullinwider, USN (Ret)

A presentation by Peter L Fullinwider, Captain, USN (Ret), Panel Member, at the 2009 Submarine History Seminar, sponsored by the Naval Historical Foundation and the Submarine League at the United States Navy Memorial, Washington, D.C., 15 April 2009.

Captain Fullinwider was graduated from the U.S. Naval Academy in 1949 and entered submarines in 1951 after serving two years in Atlantic Destroyers. He served in the commissioning crew of the first post war attack submarine TANG (SS563) and later as executive officer of the REGULUS I guided missile submarine TUNNY (SSG282) in 1959 and 1960. Other tours included Staff, Commander Submarine Squadron One; briefly at The REGULUS I Guided Missile Unit 50 and then as the first Officer in Charge of The Research and Development Guided Missile Unit 55 specifically for the Mach Two Aircraft REGULUS II follow on missile then under testing at Edwards Air Force Base.

A very historically significant assignment occurring after patrols in TUNNY was assignment as a member of the first Joint Strategic Target Planning Staff at Sac Headquarters Omaha in 1960 to 1962, responsible for the preparation of the Single Integrated Operation Plan for all U.S. nuclear weapons.

Captain Fullinwider received a Master's Degree in International Affairs while attending the Naval War College at Newport, R.I. and thereafter commanded USS COBBLER (SS344) in New London. Subsequent to his command he was assigned as the Submarine Operations Officer on the Staff of Commander in Chief, U.S. Naval Forces, Europe, in London.

In 1967 he served as the Chief Staff Officer for Commander Submarine Squadron SEVEN in Pearl

Harbor prior to assuming command of the nuclear Submarine Division Seventy One in July of 1968. Captain Fullinwider then went to the Pentagon as Assistant to the Director OP O7 for International Research and Development Cooperation and thence to Command of the USS AJAX (AR-6) a repair ship in San Diego and the Far East and finally returning in 1976 to the CNO Staff as Deputy Director Undersea, Strategic, and Nuclear Weapons Development Division which among other things handled the Tomahawk Cruise Missile development funding. Captain Fullinwider retired 1 January 1978.

Today, we know about Trident, Poseidon and Polaris missiles as the backbone of our Strategic Missile Force, and now, newspapers and the TV spell out even more about the wonders of Tomahawk. After WWII, the Air Force and the Strategic Air Command were perceived as the main players–but would the Navy be left out?

In 1944, a small group of submariners and technical design people saw an opportunity to use the German V-1 unguided buzz bomb as the baseline vehicle to develop a full submarine capability. An Americanized version named LOON soon came into production and in 1946 the DERBY program was formalized to prove the concept and develop the Regulus submarine weapon system at the then new Naval Air Missile Test Center at Point Mugu, California. The Navy wanted something more than the LOON promised. In just two years, Chance Vought Aircraft won a contract for a missile aircraft carrying a 3000 pound warhead for up to 500 miles. This was to be the Navy's sea based deterrent, essentially a high performance 42 foot long unmanned turbojet aircraft weighing 7 tons at speeds up to Mach 0.91 (550 kts) and guided by radar in the submarine version. It would carry a 40-50 kton nuclear warhead or a 1-2 Megaton thermonuclear warhead when available.

The speed of development was a tribute to those involved, and in 1950 Chance Vought delivered the first of the 10 contract

test vehicles to Edward's AFB for flight testing. An innovation by Chance Vought was the addition of retractable landing gear so that training missiles could be recovered for reuse, thus saving tons of money. Most flew multiple times (3 each were hoped for) some as high as 10 and I believe one flew 21 times.

The World War II fleet submarine TUNNY (SS282) was brought out of mothballs and recommissioned as SSG 282. Her main modification beyond a snorkel and streamlined sail was the addition of a huge hangar fifteen feet in diameter just aft of the sail and a set of launch rails which would be elevated to launch the missile. The Hangar would hold two missiles. One of the four main engines and the auxiliary engine were also removed. TUNNY launched the first Regulus submarine missile in July 1953 as the 58th launch overall and would be the primary test and training platform for the next several years. USS BARBERO (SSG 317) was recommissioned shortly after with essentially the same modifications, however they did not get the streamlined sail and ended up with only two main engines and an auxiliary. These shortcomings would haunt and hazard her during transit and on station.

The Navy added two new construction diesel conversions, USS GRAYBACK (SSG 574) and USS GROWLER (SSG 577) built to carry four Regulus I or two Regulus II and a year later in 1960, the nuclear powered USS HALIBUT (SSGN 587) whose enormous hangar could carry 5 Reg I or 4 Reg II. GRAYBACK and GROWLER had design limitations, even though new construction, specifically hull design, which limited operational speed and mobility, but also their new lightweight design high speed engines which gave them headaches from failure of crankshafts, cracked cylinders, piston, and other fatigue failures due to the light weight construction.

The Navy planned some three more SSNs and 7 Cruisers for a future program, but these were either not converted or never really participated in on station deterrent roles. There were, however, to the best of my memory, many training and test firings from cruisers and carriers.

The last Submarine Regulus patrol was carried out in 1964,

just twenty years from the first inspiration in 1944. Slightly over 1000 Regulus launches took place in the combined developmental, training, cruiser and submarine programs. TUNNY fired her 100th missile which was the last from a submarine in 1964. The remaining inventory of Regulus I and II airframes were expended in the next few years as target drones.

Regulus was a highly successful program from start to finish but was phased out prematurely due to the speed with which POLARIS moved in turn from concept to operational status in 1960 and to the flexibility of the nuclear submarine as a platform plus the superb performance of the Special Projects Office in developing the launch and navigation system, the guidance system, the missile and fire control systems and integrating them into the launch platform.

Regulus II, well into its flight test program, and following 8 successful flights in a row was cancelled because of the success of Polaris. Its cancellation incidentally allowed $100 Million to be reprogrammed into the Polaris program which was being funded out of the existing Navy budget. An anecdote I might mention is that the CNO, Admiral Arleigh Burke, told his former aide after watching a nationally televised launch of Reg II, that Regulus II would be cancelled over his dead body. One week later on 12 Dec 1958 SecDef Gates cancelled the program. Contrary to public opinion, even the CNO can be wrong (on occasion).

OPERATIONS

I entered the Regulus program for a relatively short three year period in 1957 by way of a Nuclear Weapon familiarization course at Albuquerque, NM and a few months training in Reg I procedures at GMU 50 as a prelude to becoming the first Officer in Charge of GMU 55 for flight testing and development of the Regulus II. As you know, that program was cancelled in 1958 and I moved on to Executive Officer of TUNNY in spring 1959. Regulus II was designed as a state of the art Mach 2, 65,000 foot flying machine doubling the capability of Reg I out to 1000 miles and guided by an inertial navigation system to its target. Awesome in those days. One navy flight was scheduled for

maximum altitude and speed and a problem developed in which the snap lock fasteners would not snap to secure the 1½ by 3 ft electronic panel smoothly to the fuselage. What to do? The crew chief working the problem said forget the fasteners, we'll use duct tape (Submariner make do/ingenuity). As missile officer that seemed a rather questionable procedure, but by the time I might have said NO and cancel, it was done, and I felt we had to move on. Oh well, trust the chief, I had been taught, so we did and it worked beautifully. I was pleased as you may imagine. In retrospect, "Thank you LORD."

By 1958 and '59 the Regulus program was entering its Strategic Deterrent Operational Phase which would last for five more years. It was really a story of the men who made up the crews of 5 submarines struggling to meet their commitments of maintaining four missiles on station, all the while feeling great pride that they were essential to the safety of their country and the free world. The reality in looking back over the years is that the Submarine Force always operated on a war footing the entire Cold War. The Sea itself was a main adversary with our operating area being a region of the roughest weather in the Pacific and our ships all had shortcomings which the long and repeated patrols brought to the surface with wear and tear. Some had unreliable main engines, aluminum superstructures that could not stand the pounding and poor hull design that made depth control marginal in the high sea states. Our men were remarkable and innovative and they took the hardships and continuous patrols in stride and we never embarrassed our nation in those long years with an international incident of detection by the Russians.

Briefly, deployment on our Regulus patrols involved sailing from Pearl Harbor in a northerly direction to ADAK in the Aleutian Islands, the site of a small port and a Navy airfield for long range patrol Aircraft. After a brief stop to top off fuel, the boat then would sail pretty much Westerly, until in the vicinity of the Kamchatka Peninsula, the eastern end of Siberia where one would cease the difficult transit period, dive and commence a 45 to 60 day deterrent patrol. We would then return via Adak to Pearl or proceed to Yokosuka for a 20-30 day refit and recreation

interim then back on patrol and return to Pearl. As a side, the next to last TUNNY patrol, in 1963, lasted 82 days (13 July to 3 October).

The performance criteria required of the boats on patrol were: (1) copy the fleet radio broadcast 24 hours a day to be able to receive almost instantly any Presidential decision to launch against the enemy. (2) Maintain readiness of the ship and missiles such that the first missile could be launched within 15 Minutes of receiving the EAM, emergency action message. (3) Maintain knowledge of one's navigational position such that a missile would be guided to target at any time, and (4) Remain undetected from all forces, friendly, enemy or neutral while in transit or on station.

Unfortunately, navigation aids were almost nonexistent, consisting of a single Loran A line at the fringes of reception, sparsely charted mountains on the Peninsula which were often obscured by ever changing fog and/or clouds. I do recall one chart with a depth recorded as having been taken by Captain Cook the explorer in 1776 and taken by Lead Line. Big Deal for navigation as you will quickly surmise, every yard of inaccuracy in the SSGN position would be added to target miss distance. Admiral Blount shared recently that BARBARO on one Patrol did not know where they were for 17 straight days. So much for 15 minute launch accuracy. I am not prepared to remember or discuss TUNNY performance, thank you very much! Polaris would have multiple equipments, unknown to the diesel navy, to facilitate their navigation tasking.

Regulus patrols were indeed *Hard Labor* considering the submarines, the sea conditions, facing Cold War conditions 100% of the time and the reality of a single crew often making 3 patrols in a year, and many having to endure hot bunking, too little water for showers and the monotony of the operations. The families were superb in putting up with their deprivation and having a total lack of knowledge as to where their men were or how long they would be gone. Consider that all four diesels made trips of 80-82 days in the latter years, and HALIBUT (SGN) made one of 102 days in '61/'62. Not for sissies, man or family.

Because of the highly classified nature of our patrols, Regulus personnel were not authorized to wear the Strategic Deterrent Patrol Pin as was Polaris, at least not until 35 years later in 1995 when The BuPers issued a bulletin authorizing the Polaris pin for those engaged in Regulus patrols. Feeling a little left out by this slight, some of our enterprising people in 1961 (BARBERO), designed a small rather innocuous logo and pin memorializing a group called the North Pacific Yacht Club, had the Japanese make a pin and obtained sufficient quantities for clandestine use by those who had participated, before and thereafter. One wonders in retrospect, if the Regulus had been authorized in the beginning for a Strategic Deterrent Patrol Pin, might the Polaris folks have had to wear a pin in the shape of TUNNY rather than the streamlined Polaris. The "Diesel Boats Forever guys" of the North Pacific Yacht Club would have liked that.

Preparations for a patrol with Regulus were basically the same as for other submarines, notably making sure all equipment and machinery was in tip top shape, a full complement of spares on board. The Supply Officer would personally deliver two extra Movie Projection bulbs to the Captain to put in his safe for emergency use along with his medicinal whiskey. Underway training time was needed for torpedo firings, drills, operation of all equipment and just washing the rust off of crewmen from the time ashore plus integrating new members into the crew. We of course would add missile training, launches and navigation training. Finally there would be an all hands effort to take aboard and stow the supplies and extra food cases in every nook and cranny and the passageways. I don't know how the earlier boats could store that much and still get the men in, much less operate.

As part of pre patrol training for our second patrol, TUNNY launched a missile from the NW corner of Oahu targeted for the next island to the West, Kauai, and for recovery at the Navy airfield at Barking Sands. Shortly after launch it became apparent that the missile was not responding to TUNNY guidance commands, nor shortly, we determined, by either chase plane. We had tested guidance fully effective moments earlier. It appeared that the missile had a mind of its own as it turned over Oahu and

populated areas and headed toward Honolulu proper and Diamond Head by Waikiki. A DISASTER IN THE MAKING!!!!! As it approached the Commander in Chief, Pacific's Headquarters, the missile decided to go in to a vertical climb to 20,000 feet, stalled, flamed out and spun into the rugged mountain terrain just a quarter mile above the headquarters. It is not usually career enhancing to attack either your Commander in Chief or the City in which he lives. The evening paper emblazoned its front page with a picture of TUNNY launching a missile and the first Red Headlines since Dec. 7, 1941. The accompanying story was beautifully crafted as to the perfect safety of the event and that the Navy knew what it was doing when the safety chase planes forced the errant missile to crash in the mountain terrain. Score one for CincPac's Public Affairs people. ISSUE CLOSED, thank you very much and much to the relief of the CO and the DivCom embarked.

We in TUNNY always went by ADAK to refuel, going and coming, at least for my year of Patrols, and we would loiter off of Kamchatka within launch distance of our prime targets the fighter airfields around and the Port of Petropavlosk.

You may ask why the U.S. was concerned with this out of the way place on the globe. Well, Petro just happened to be the one spot in the Pacific which our heavy bombers needed to fly over from whatever airfield in the U.S. in order to reach their targets. The Russians figured this out and put their forces in place to defend themselves. The U.S. mustered the Regulus submarines around as the best way to be ready around the clock to prevent them from doing their job.

TUNNY made the first scheduled Submarine Deterrent Patrol with nuclear weapons 23 October to 16 December 1959. As a matter of fact she had already made the first and only emergency deployment when on return from a West Pac trip in July of '58 she was loaded with Warheads, reprovisioned for patrol and sent to Kamchatka in response to the Lebanon Crisis.

These first year patrols ran 54, 57, and 60 days of highly stressful wartime operations. Our mission was to be on Alert and ready 100% of the time and indeed, on mooring in Pearl at the end of the third in eleven months, the self styled *Black and Blue* crew

of TUNNY expressed their approval of the pending Polaris policy of 2 crews by draping a large banner on the Sail saying "Ok, GOLD CREW, She's All Yours."

The stress of these patrols made them seem much longer in memory and more nearly equivalent to the 65 days on station plus transit time as later reported by other submarines. As we arrived on station for our third and a back to back patrol, a palpable black cloud of silence descended on the crew as the realization of another 45 days of boredom sank in.

We had our share of typical emergencies which threatened our mission as did all the boats, but the ingenious, dedicated and highly motivated crewmen solved them in every instance. For example, en route Adak, we experienced a fire in the cubicle controlling our propulsion, which could have aborted the patrol. It was fixed in a few hours. RAdm Bob Blount, then skipper of the BARBERO told me a few days ago that his two main engines were of a GM design which could not withstand the rigors of snorkeling and many cracked cylinder liners had to be replaced while on station or transiting, sometimes leaving them with only the auxiliary engine to continue. They also had breakdowns on their High Pressure Air Compressors and Stills which made their water, both of which were essential to staying on Patrol and they had to manufacture internal, close tolerance parts on both as there were no spares on board.

Well into the first patrol routine, we were sitting down for a full Thanksgiving Dinner when a loud bump and a heavy lurch brought on the Collision Alarm. The Captain ran aft to the Control Room and I, as the Exec, ran into the Torpedo Room to assess the damage. I arrived just in time to watch the 3" from the shaft Sonar Dome rise into the room and form a beautiful "S". As Navigator, I was happy that the analysis was a playful whale rather than a grounding. We were able to stop the minor sprays caused by stress as the steel shaft bent, then continued the patrol. I guess we went back to a cold turkey dinner, each with our separate thoughts of what might have been.

On our next patrol, a crewman came down with appendicitis and we off loaded him in Adak as we passed. But on arrival at

Yokosuka the Captain took notice and he had the entire Crew, including himself, checked for potentials for Appendicitis. He was assured all were sound. Quite naturally, three weeks into the third patrol Captain Chris disappeared behind his curtain with a severe case of Appendicitis which our Corpsman treated with massive doses of Penicillin and intravenous feeding. I wanted to leave station take him to Adak but he stubbornly declined, sure he would rise up shortly, and he did. The Doctors who operated on him on return to Pearl were not happy over his delayed arrival.

One of our enemies in the winter and spring months were the Bergy-Bit floating ice chunks, silently drifting down from the arctic ice fields. Hard to see with only about 1/3 of them above water, the 2/3 below could be hard on masts or snorkels. One night while snorkeling, a loud bang was followed by engine shutdown. We surfaced and found a 6 inch hole in the snorkel exhaust mast. The Chief Engineer surveyed the damage, repair of which would be critical to staying on station, and astounded us by saying "if you will let me have the Corrosion Resistant steel liner in the After Battery Hatch and the Engine Room cable covers, I can fix it." In some 3 hours he had built the world's biggest band-it patch with layer after layer of gasket material wrapped by the hatchliner and 20 band-it clips. It was rumored that contrary to Navy Regulations, some medicinal whiskey may have been dispensed to those who were topside in the frigid North Pacific weather. Later the shipyard declared the patch the strongest part of the mast.

I think the Cuban Missile Crisis upped the ante for future patrols when President Kennedy warned that the U.S. would respond to any Cuban missile as though it were from the Soviet Union. The Soviets presumably knew that Regulus was there, hence our boats saw more naval activity in our patrol areas, raising the danger of conflict in peacetime. In TUNNY's early patrols, we played the same Alert game of making sure the mouse is never detected. While we rarely saw Soviet Naval Activity as they did later, we were absolutely certain that the 3 masted Schooner which passed through our area twice a day, 2 or 3 times a week had high powered and highly sensitive sonar and they were **after us**. Constant vigilance was our watchword. Periscopes, Electronic

countermeasures, sonar and good ship handling were all on alert to minimize chances of detection. Torpedoes were ready in the tubes against the ever present threat of hostile action from the Soviet Navy, even in peacetime.

The reality to us was that we were at war in the Cold War and for more than 30 years we leaned against the Soviet Union with our mind-set and tempo of operations. The general population didn't know it, but our families did and they were the unsung heroes for their unstinting support. Not just the Submarine Force, but the Army, the Navy and the Air Force felt the high paced tempo and tension of War in the Cold War, until the wall came down, and I suspect, even today.

The final patrol incident on my third and last patrol was in a very heavy willywaw Alaskan Storm and very high seas while proceeding to ADAK after leaving station. To keep up with our speed of advance, we chose to run surfaced under the cover of the seas which we thought would be helpful in keeping us from being detected. A weak ECM contact was detected far away on the starboard beam and moving forward until it disappeared in the direction of Adak, our destination. One of our patrol planes, no doubt, but not a threat. Suddenly, the diving alarm and the officer of the deck with the lookouts swung below. The OOD hastily said, "No Sir He was off in the clouds and didn't see us." And that folks is the name of this picture delivered to us on arrival Adak the next evening in an unmarked envelope. The picture shows no one on the bridge. There are no numbers on the Sail and no flag to identify a nationality. Who could it be? And, why would they deliver the picture to us? If it were TUNNY, it would mark the only unauthorized sighting in four patrols and over the roughly 8 months we had spent defending our country on patrol. Fortunately it was a friendly aircraft crew.

Ladies and Gentlemen, this concludes my thoughts on the subject of Recollections of Regulus. We led the way. Upon mooring in Pearl Harbor, I received orders to proceed on new duty, to arrive in eight days at the Joint Strategic Target Planning Staff, then being formed at SAC Headquarters, Omaha, Nebraska. The where, the what? I wondered. Actually quite related, it turned

out, as the new all service staff was to draft a Single Integrated Operational Plan (SIOP) for efficient targeting of the entire inventory of some 3500 weapons. This we did, publishing the first SIOP two and a half months later about 10 December 1960, almost to the day USS GEORGE WASHINGTON (SSBN 598) pulled into port at completion of the first Polaris patrol. GW was commanded by Commander, later RADM, Jim Osborn, one of the early giants (and there were many) of the Regulus Program and in fact he was the first Commanding Officer of TUNNY (SSG 282). Early Polaris years are replete with the names of those who had cut their teeth on Regulus in the strategic deterrent world and I think many of the lessons learned and experience gained in the Regulus era were carried forward helpfully into the programs that followed. So you see, the Navy would not be left out. Regulus, to Polaris, to Trident plus the Ohio Class SSGN with Tomahawk. The Navy leads the way while The Strategic Air Command (SAC) is no longer with us as the preeminent Strategic Service

Lastly, and as an aside, I would draw your attention to David K. Stumpf's book, Regulus, The Forgotten Weapon as noted below. It is an incredibly detailed summary of everything done or said from start to finish in the program from predevelopment to phase out and is written in a very engaging and almost riveting manner. It is written largely based on the recollections, pictures and records of about 150 participants, plus Navy and Chance Vought Corporation cooperation

The following references were useful in improving my recollection and perceptions for overall program details and dates occurring before and after my participation in the program.

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NATHANIEL BOWDITCH
MARINE NAVIGATOR, MATHEMATICIAN, SCIENTIST, ACTUARY
1773-1838

by Mr. John Merrill

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"Until Bowditch, ships found their way across ocean tracks with no exact calculation of their courses."[1]

In the more than 200 years since the first printing of Bowditch's American Practical Navigator, the story of his life and his lasting contribution to marine navigation has appeared periodically in articles and books. The objective of this essay is to bring attention for perhaps a new audience to consider his admirable and broad accomplishments and fine character. What appears here is a brief reprise of some of his life's highlights as noted over the years by various authors.* The story of his life quickly reveals his determination to learn, know and grow in spite of his circumstances. His life was a full one and his navigation book soon to be known as *Bowditch* was perhaps the most important, but in no sense the only, contribution from his life's work.

* My introduction to Bowditch occurred as a fourth-class deck cadet at the New York State Merchant Marine Academy during a May-September 1936, 100-day 10,000-mile, USS Empire State cadet cruise from New York City to Callao, Peru

A 2002 Bicentennial Edition of this monumental navigation book, first published in 1802, included the latest advances in electronic navigation and digital charting technology and nonelectronic navigation. Starting in 1868, the US Hydrographic Office assumed publication. Over 75 editions and almost a million copies were printed. A 1940 comment about the book stated "...it sells around 300 a month in peace times, and as much as 15,000 in wartimes."[2] *Bowditch* is carried on the bridge of every U. S. Navy ship.

Marine Navigation Pre-Bowditch (1800)

Compass, log, and lead provided most at sea indication of location in the years before 1800. Longitude without the assistance of the newly invented John Harrison chronometer time could have a 30-mile spread. By 1772, Harrison's chronometer provided accuracy to five seconds after an 81-day voyage. Chronometers were scarce, in some instances even a watch was not available, and the chronometer did not come into general use until after the 1820s.[3] Astronomical observations served to support time correction and star sights to support latitude. At that time, some shipmasters did not hold celestial navigation in high regard for keeping a ship on course. "In those days it was not at all unusual for a New England vessel to wander toward her destination..."[4]

Early Days

Reviewing Bowditch and his background and surroundings provides an awareness of living and growing up without ample means at (or near) poverty level during the hardships of the American Revolution and the following period. It is remarkable that in this environment, the pieces needed for his many future contributions fell into place for him. His small stature not withstanding, his unusual drive and intellect were essential factors in his eventual success.

Salem, Massachusetts and the surrounding communities with their strong connection to the sea and particularly the marine

activity during and after the Revolution was the center of Bowditch's world until his first sea voyage at twenty-two as clerk and navigator aboard HENRY, home ported in Salem. It took Bowditch around the Cape of Good Hope to Reunion Island off the southeast coast of Africa not far from Madagascar from January to December 1795. He was well prepared for the dual assignment years at sea.

Learning

Education usually has the connotation of being formal and carefully organized. The opportunities for Bowditch's early learning could best be described as random. It turned out that he never ceased learning and made the time needed even when working ashore and in moments of opportunity on yearlong sea voyages. His mathematical skills, knowledge of science, languages, business matters and insurance, resulted in success in all his ventures. He has also been cited as the first American actuary.

Bowditch's ancestors arrived in Salem almost 100 years before he was born in 1773. Going to sea provided vocations for many of the Bowditch male descendants. At the time of the arrival of Nathaniel (the fourth child with three more to follow), his parents Habakkuk and Mary (nee Ingersoll) frequently found themselves in impoverished circumstances. His father alternated working ashore and going to sea. On shore, he was engaged as a self-employed cooper during Nathaniel's early years. When Nathaniel was three, the family moved a few miles from Salem to Danvers where his father worked at cooperage. It was in such grim pecuniary circumstances that Nathaniel spent his first ten years.

Beginning Education

When he was six, during the Revolution, the family returned from nearby Danvers to live again in Salem. For the next several years, he attended a local school with limited facilities.[5] (Clark p84) Independently, a strong and long-time interest in mathematics

attracted Nathaniel. There is documentation regarding Nathaniel's mathematical skills from his earliest days. The family's poverty brought even this very limited schooling to an end when he was ten. This was the last of his formal education and the beginning of his self-education, driven by his zeal that drove him to new studies all his life.[6]

Continuing Education

At this point, he was apprenticed to Ropes and Hodges, a firm of Salem ship chandlers. This provided him with food, clothing and lodging at the home of Hodges. Surrounded every day by things nautical and in close proximity to ships, navigation (along with other wide-ranging interests) became important to him. Using the time from dawn to the start of work plus the hours after work, his knowledge grew. Salem was a small town, and encouragement came in the form of access to books. His ownership of books at this time came from the copies he made to create his own library.

At 13, he compiled a book on navigation. The next year, he started one on surveying. "The Practical Surveyor, Nathaniel Bowditch, County of Essex And State of Massachusetts, New England, March Seventh, 1787."[7] At the same age during his second year of apprenticeship, he read through four volumes of Chambers' Cyclopedia that was the first English encyclopedia with an initial printing in 1728. Next, he discovered what turned out to be algebra, procured a book on the subject, and expanded his mathematical knowledge.

The Reverend William Bentley, one of Bowditch's older Salem friends and supporter, a minister of exceptional scholarship and a linguist, secured the loan for Bowditch of Newton's *Principia,* comprehensible to an advanced mathematician and written in Latin. In the next four years, Bowditch read it and found an error in it.

Another Salem minister, who befriended Bowditch, was the Reverend John Prince, who kept in his home (the Philosophical Society library) a scientific collection previously owned by a distinguished Irish scientist. He gave Bowditch access to one of the finest scientific libraries in America. In addition to reading and

copying the mathematical papers from the Transactions of the Royal Society, Bowditch knew Shakespeare and the Bible intimately.[8]

Having an interest in the works of French mathematicians and aware of ships leaving Salem for French ports convinced him to learn French. His technique for learning languages was to buy the dictionary of the language and a copy of the New Testament in that language and translate the book. Later, a French elocutionist residing at the time in Salem coached him in French for sixteen months. In exchange for his improved speaking proficiency, Bowditch taught the Parisian English. [9,10]

As he approached his twenty-first year and the end of his apprenticeship with Ropes and Hedges, Bowditch's avid pursuit of knowledge provided him with certainly the equivalency of a full college education. In particular, his deep understanding of mathematics, navigation, and astronomy plus his business knowledge from the ship chandlery made him an asset at sea. During this period on the practical side, he constructed and developed competency with the sextant, a primary tool aboard ship.[11]

After Apprenticeship

Salem Region Survey

In 1794, the Massachusetts Legislature required each town to be accurately surveyed and its exact area be calculated. The town selected the Reverend John Prince, previously mentioned as one of Bowditch's supporters, and John Gibaut, a sea captain to do the work. Prince offered Bowditch the position of calculator for the survey with a salary of $135. His acceptance of the assignment was pivotal as it led to the beginning of Bowditch's nine years at sea. Captain Gibaut, impressed by Bowditch's mathematical skills, offered him the opportunity to go on his next voyage as ship's clerk.

At Sea: Five Voyages 1795-1804

Disagreement developed between the ship's owner and Captain Gibaut. Captain Henry Prince of Salem was designated to the

take the ship HENRY to sea. Bowditch was acceptable to Captain Prince and set sail on his first trip to sea on January 11, 1795. His shipboard duties included standing watches as second mate, navigation, and doing all the ship's paper work for a ship engaged in trade with countries bordering the Indian Ocean. HENRY returned to Salem January 11, 1796. On this first trip, he invented a simpler method of taking lunar observations, which in those days before accurate chronometers was the most practical way of determining longitude. Chronometers were not affordable to ships sailing out of Salem.[12] Voyages took Bowditch around the Cape of Good Hope to the Philippines and other locations in Southeast Asia and into the Mediterranean.

The second passage with Captain Prince was aboard the ASTREA, March 27, 1796 to May 22, 1797. The ASTREA gave Bowditch increased knowledge about navigation and the available tools for determining position. On this second trip, he started compiling notes of errors in The Practical Navigator written by former Royal Navy officer John Hamilton Moore and published in 1772. The Royal Navy placed Moore's book in general use and by 1800 there were 13 editions in print. Bowditch also noted errors in navigation charts and other maritime books. A biographer of Bowditch opined regarding the notes "Unaware that he was doing so, he was slowly compiling a book on navigation."[13, 14]

A ten-month voyage from August 15, 1798 to April 6,1799 with Captain Prince aboard ASTREA, from Salem to the southeast coast of Spain in the Mediterranean, provided Bowditch with ample opportunity to enhance his knowledge and to be aware of existing errors in the available tools for navigation. By this time, Bowditch's mathematical skills were well known in the Salem community and beyond. His recognition included being elected to the American Academy of Arts and Sciences in 1799, later becoming its president.

A local maritime publisher Edmund March Blunt, 1770-1862, was aware of Bowditch's mathematical and navigational skills. Blunt, an entrepreneur from nearby Newburyport, Massachusetts, published charts, papers and books. Blunt was interested in creating an American corrected version of Moore's navigation

book. With assistance from Bowditch, a version of the Moore book with some corrections appeared in 1799. [15, 16]

ASTREA, with Bowditch in his navigator and supercargo role, was scheduled to depart Boston for Manila on July 22, 1799. Shortly before the ship's departure, Blunt went aboard to solicit from Bowditch a complete revision of the Hamilton navigation book and verification of the thousands of figures in the tables. Bowditch accepted the task. The voyage of over one year returning to Massachusetts September 16, 1800, provided opportunity for Bowditch to continue his search for errors in certain navigation publications and tables (2,000 corrections). In Moore's navigation book, he found 8,000 errors.

A table in the Moore navigation book contained an error regarding leap year and the sun's declination. An 1838 book on the life and character of Bowditch points out the incorrect designation of the years 1792, 1796, 1800, and 1804 each being a leap year. The year 1800 was not a leap year. This error by Moore creates a difference of 23 miles in position in some instances and actually caused the loss of ships.[17, 18] "This error was the cause of losing two vessels to the northward of Turk's Island and bringing others in serious difficulties."[19]

It is often cited that on this trip, Bowditch taught every man of the crew of twelve, including the ship's cook to take and calculate lunar observations and to plot the correct position of the ship.[20]

November 21, 1802, Bowditch sailed out of nearby Beverly, Massachusetts to the Indian Ocean on the newly constructed PUTNAM. Bowditch and three other men from Salem jointly owned the ship. He was the master, navigator and in charge of the business transactions of the voyage. This last voyage was a successful financial business venture and upon returning to Beverly from Sumatra December 25, 1803, he was able to retire from the sea.[21,22] Two years after his return, PUTNAM was on a voyage to the Indian Ocean and natives overtook it and massacred entire crew.[23]

Prior to sailing, Edmond March Blunt, Bowditch's associate gave him a copy of *Celestial Mechanics* by the Pierre Simon Laplace (1749-1827) the French mathematician, astronomer, and

physicist. Laplace was best known for investigations into the stability of the sun. Blunt suggested that Bowditch translate it into English. He began the translation on his last voyage and then later devoted about thirty years to it after he came ashore, Bowditch created a multivolume 4,000 page version that was printed and internationally acclaimed.

The New American Practical Navigator: "Bowditch" First Edition 1802

Six hundred pages of remarkably accurate printing, in the original manuscript by Bowditch, included thousands of corrections to the Moore tables and other well-known maritime tables. "*The New American Practical Navigator* was not just another navigation book. It was a tool—as important as sextant or compass." [24]

Regarding the publication of this first edition, followed with approximately 70 editions by 1955, the above-mentioned Edmund March Blunt brought more than encouragement to Bowditch. Starting his bookstore and publishing in 1793, Blunt's interest and experience in manuscript acquisition, including maritime-related material, benefited acceptance of the new book. Further, Blunt was broadly known in maritime circles including England.[25]

The title page describes the book as an "epitome of navigation: containing all the tables necessary to be used with the Nautical Almanac, in determining the latitude, and the longitude by lunar observations: and keeping a complete reckoning at sea; illustrated by proper rules and examples: the whole exemplified in a journal kept from Boston to Madeira, in which all the rules of navigation are introduced...by Nathaniel Bowditch, Fellow of the American Academy of Arts and Sciences." Chapters covered a wide range of material on winds, currents, the obligations of an owner, the duties of a master, a dictionary of sea terms, an explanation of all-possible maneuvers of square-riggers at sea and the appropriate commands for their accomplishment. There are even sections on marine insurance, bills of lading, and bills of exchange. Mathematics is not only included, it is taught including decimals, geometry, algebra, logarithms, trigonometry and

calculus of navigation. The table for relating the distance of visibility of objects at sea is still in use. [26]

The Salem East India Marine Society authenticated the work of Bowditch, and Blunt provided seven separate printings of the first edition, each for a different bookseller on the New England Coast. This edition was so large enough that another was not needed for five years.[27] One hundred years later, a 1903 remembrance in a Naval Institute Proceedings article about Bowditch noted that within several years of initial publication seven thousand copies were sold in the United States.[28] Eventually it became extensively used in the British and French navies.[29]

Matthew Fontaine Maury (1806-1873)

Maury and Bowditch shared self-education and are sometimes compared in their contributions to those who follow the sea. Maury, an outstanding United States Navy officer, was a scientist, chart maker and oceanographer and after his initial nine years at sea he wrote *"A New Theoretical and Practical Treatise on Navigation"* in 1835. His purpose was to provide a more thorough textbook suited to the needs of the US Navy midshipmen. It took the place of Practical Navigator for junior officers in the Navy and by 1837 was on every Navy ship. When the Naval Academy was established at Annapolis in 1845, it was used for several years as the basis for instruction to midshipmen in navigation.[31]

At the time when Maury's book was in final preparation, Bowditch sent him a letter commending his book. In addition to providing satisfaction to Maury, the letter helped the book's acceptance. By this time, Bowditch was well known nationally and internationally beyond the authorship of his navigation book. Maury asserted that a more theoretical navigation book than *Bowditch* was needed. "The ground designed to be covered by this work is unoccupied this is not designed to conflict with Dr. Bowditch's, for by a mere reference to the pages of his, the necessity of a work, more theoretical in its nature becomes obvious" wrote Maury to his publisher of the navigation book.

> Bowditch to Maury: "A work of the kind you are preparing for the press, containing the demonstrations of the formulas of Nautical Astronomy, would be very useful to those who have a taste for the subject and would like to examine the demonstration of the rules." [32]**(Williams p. 108)**

After the Voyages

Bowditch's active participation and contributions in business (insurance), science, and other professional activities brought him to national and international fame in the years after his sea duty. In 1803 he and other men from Salem, organized with his mathematical skills the Essex Fire and Marine Insurance Company, serving as its president for twenty years and actuary. He was the first American actuary. The Company was successful and in addition, Bowditch managed estates and trusts. In 1823, he became actuary of the Massachusetts Hospital Life Insurance Company and moved to Boston from Salem.

Prior to his move, he wrote 23 papers on astronomy and mathematics. His ability in mathematics provided him with teaching opportunities he did not accept. They included: a Harvard mathematics and physics chair, a mathematics chair at the University of Virginia offered by President Thomas Jefferson, and a mathematics chair at West Point offered by Secretary of War John C. Calhoun.

His professional affiliations included the Edinburgh Royal Society, Royal Society of London, Royal Irish Academy, Royal Astronomical Society of London, Royal Academy of Palermo, British Association, Royal Academy of Berlin, American Philosophical Society, Connecticut Academy of Arts and Sciences, and the Literary and Philosophical Society of New York.

From Harvard, he was awarded a Doctor of Law Degree and from 1810-1826 he was on the Board of Overseers. "During 1826-27 he was the leader of a small group of men who saved the school from financial disaster by forcing necessary economies on the college's president."[33]

Regarding the above-mentioned English translation of Laplace's Celestial Mechanics, Bowditch's corrected version removed errors, supplied omitted proofs and included attribution of other scientists. The annotated edition, nearly doubled the size of the original and constituting a major critical work, was well received by European scientists and brought Bowditch to further international fame. Publication at his own expense, Bowditch spent one third of his worth to have the four volumes brought to fruition between 1829 and 1839, the year following his death.

Comments about Bowditch

A Mathematician

Bowditch was considered as primarily a meticulous and exhaustive critic having exceptional mathematical skills. He found his most receptive audience in Europe with few in America who could follow his mathematical work. He died on March 17, 1838.[34]

The Boston Athenaeum - 1838

"His fame is of the most durable kind, resting on the union of the highest genius with the most practical talents, and the application of both to the good of his fellow man."

The Salem Marine Society Eulogy

"...but as long as ships shall sail the needle point to the north, and the stars go through their wonted courses in the heavens the name of Dr. Bowditch will be revered as of one who has helped his fellowmen in time of need, who was and is a guide to them over the pathless oceans, and one who forwarded the great interests of mankind."

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THOMAS EDISON AND STEINWAY THE STORY OF THE THOMAS A. EDISON'S (SSBN-610) PIANO

Dr. Edward Monroe-Jones
Submarine Research Center

This article was prepared with the help of THOMAS EDISON crew members who searched their memories to give specificity to this amazing story. Appreciation is extended to the USSVI office which provided SRC with the names of many EDISON crew members. Assisting in the preparation of the article were crew members Rick Boorman and Terry Pendergast.

The EDISON was an Ethan Allen (SSBN-608) class fleet ballistic missile submarine built at Electric Boat in Groton, Connecticut. She was commissioned on March 10, 1962 with Captain Charles M. Young commanding the Blue crew and Commander Walter Dedrick commanding the Gold crew. Cracking the bottle at the launching on June 15, 1961 was Mrs. John Eyre Sloane, daughter of the famous inventor after whom the boat was named.

All of this sounds like that of any other nuclear powered boat launching and commissioning, but EDISON carried in her crew's mess an upright Steinway piano. While other boats, such as the NATHANIEL GREEN carried more portable, electronic organs, EDISON is the only American submarine to have ever housed a real piano over the life of the submarine. Its story is singular and interesting.

EDISON initially operated in the Atlantic and after a successful shakedown cruise made 17 deterrent patrols out of Holy Loch, Scotland. She then went into overhaul in Charleston, South Carolina from October of 1966 to May of 1968. Ported in Rota, Spain EDISON made another 19 patrols. Transferred to Submarines Pacific, she arrived in San Diego in July of 1973 to join Submarine Group 5. From there she went north to Mare Island and her second overhaul, beginning in August of 1973. After her second overhaul, she operated out of Guam until October of 1980, at which time she was redesignated an SSN in compliance with the SALT I treaty and accordingly was modified at the Puget Sound Naval Shipyard. When EDISON was converted, the piano was moved from crew's mess to the missile control center which was being turned into the crew's lounge with television and library. According to crew member Scott Parr, the piano was partially disassembled and crew members carried the pieces down and aft to the newly created space where it was re-assembled. The boat was decommissioned in November of 1983 at the Puget Sound Naval Shipyard in Bremerton, Washington. During all of the deterrent patrols, the Steinway piano sat in the crew's mess. Its story runs parallel to that of the EDISON and adds a rich texture of life aboard a submarine during the cold war.

It is reported that the idea for a piano in a submarine came originally from Mrs. Sloane. EDISON veteran crew member, James LeVangie reports that the piano may have been donated by Mrs. Sloane, but other documentation supports its purchase by Captain Young and his crew for $1,500 as was reported by John Fletcher, officer on board EDISON at its commissioning. Of course, it was to be housed in the crew's mess, but its exact location was left undefined until the boat was completed. Steinway and Sons agreed to construct a Spinet style piano and consulted with Electric Boat on its construction. The piano is defined as serial number 370862, Model 100, in ebonized satin lacquer.

The piano was delivered to the shipyard as EDISON was nearing completion. The boat was in the water, but still had its access patch over control open. The piano was lowered by crane through the soft patch, through radio in control, which had to be

partially disassembled, and onto the mid-level deck of crew's mess. It competed for deck space with mess and serving tables as well as a slot machine which was later installed in Holy Loch. It was eventually located on the forward bulkhead, to the left of centerline on the port side. Unfortunately, its positioning presented a slight problem to ship's cooks, because two supply lockers could not be opened without moving the piano. The cooks solved this problem by devoting the lockers to seldom-used supplies. Besides, they found that the piano's sound board made a good place to store napkins. The piano was bolted to the deck using only its two legs as bolt-down points. The bulkhead provided ample for-and-aft stability.

The crew's mess on EDISON was aft of the operations/torpedo room and forward of officer berthing. The commanding officer's and executive officer's staterooms were immediately aft of the crew's mess. Crew's berthing was on the lower level beneath the piano. Several constraints arose that limited piano playing by crew members. These were voiced by officers aft of the piano and enlisted men below it, who needed sleep between standing watches. Nevertheless, veterans of the EDISON reported that the piano got plenty of use by anyone who thought of himself as a second George Gershwin. EN1 Malcolm Snellgrove, MMC Gordon Wetzel, PN1 Larry Krieger and COB Joe Nichols played the piano as time and conditions allowed. Captain Dedrick of Gold Crew was also an accomplished pianist. Later, in the 1980s, it was played by MM1 Mark Johnson. There was plenty of plunking and key pounding by the less talented, but during Sunday services the piano served a real function as instrument for hymns. The most popular hymns played and sung were *Amazing Grace* and *Rock of Ages.*

Crew members put on *Over the Hump* or *Mid Patrol Frolics* to celebrate the approximate mid-point of a deterrent patrol. Naturally, the piano played a central role, since nearly all the crew's mess performances featured so-called musicals. One such performing group called themselves, *The Velvet Sweat Pig Tabernacle Choir.*

Of course, the piano's use was dependent on the makeup of

the crew. As crew members were transferred on and off the boat, the number of those who had musical talent varied. The piano's heaviest use was during the boat's initial years. But even in the late 1970s, the Gold Crew's executive officer, LCDR Fred Gower, played it frequently and expertly. Additionally, its use depended greatly on the captain's inclination toward music, so it was logical that some EDISON veterans remembered its extensive use while others couldn't remember it ever being played. Several crew members remembered sing-a-longs with traditional favorites such as *Down in the Valley*, *My Old Kentucky Home* and *Home on the Range* being played when conditions allowed the piano's unrestricted use. Those in adjoining compartments could sometimes hear the raucous strains of, *The Man On the Flying Trapeze*. One rock and roll pianist, Richard Schmidt, gave a remarkable imitation of Jerry Lewis hammering out, *Great Balls of Fire.*

The concept of a submarine piano is contradictory to a basic submarine axiom: remain undetected by being quiet. Patrol operations meant a good deal of stealth and during these times the piano's keyboard cover was locked shut. Naturally, there were exceptions. On one patrol a tenacious Soviet boat stuck close to the boat's tail and all of EDISON's cunning couldn't shake it. After weaving and dodging, the captain (who remains anonymous) decided to serenade his Soviet companion. An extended microphone cable to the UQC was run into crew's mess. After several American patriotic songs were played, the performance ended with a blast of the klaxon. It was viewed by the defiant Americans with good natured humor, but the Soviet submarine refused any recognition. Still, men in crew's mess swapped good verbal images of Soviet sonarmen bewildered by their crazy American adversaries.

Because the piano took a beating from so many self-professed musicians, it was necessary to have it tuned during each overhaul. Once into the submarine, the piano remained in the crew's mess during EDISON's subsequent two overhauls. The yard metal shop fabricated a sheet metal cover to protect its ebony finish from the heavy-handed yard workers. The piano shield was removed long

enough for it to be tuned during each overhaul by a professional piano tuner. Crew members tell of a wide-eyed little Scotsman who stumbled through hatches and tripped over cables and air hoses as he made his way down into the boat's bowels to do his specialized work. Once at sea, however, the piano went out of tune. It was found that a 13/14 torpedo wrench fit the string pegs and the sonar techs provided a frequency generator for the proper tone. It was the torpedomen who did the tuning at sea and many plunks were required on each string to get it right. This drove the eating crew members crazy, but piano tuning became as important as missile monitoring.

The Salt conversion required the removal of missiles with some of EDISON's silos weighted with *ballast cans*. It was only a few years thereafter that the boat was decommissioned. The piano's fate was nearly tragic. Damaged on removal from EDISON, it was transported to a Naval Museum warehouse where it reportedly became the home of rats and other creatures. Humid storage damaged the veneer finish and warped keys. In 1992 a few EDISON veterans including James LeVangie undertook to have the piano restored and placed in an appropriate museum, but their efforts to locate the piano had many dead-ends. Only two weeks before the Naval Museum was to destroy the piano, it was discovered. When the EDISON crew members approached Steinway and Sons about the fate of the piano the company was receptive to the concept of restoring it to the condition it was in when placed aboard Edison. At the eleventh hour, the piano was rushed to New York where Steinway and Sons went to work to prepare it as a one-of-a-kind show-piece for its 150th anniversary. The piano now resides in the Steinway Museum in New York. At some point in the future it is destined to be moved to the Naval Museum. It remains as the only piano to be an integral piece of equipment in an American submarine.■

The EDISON piano as it appears in its restored condition as a featured display of the Steinway and Sons New York Museum.

EDISON crew members entertain in the crews mess by putting on an "Over-the-Hump" skit in celebration of a patrol's duration mid-point.

EDISON's crew's mess.

PIANO

Leiutenant Robert Hoke, Medical Corps) plays Chopin on the EDISON Steinway while MM1 Joe Zeoli watches.

THE JAPANESE WAR CRIMES TRIALS

by Master Chief Jay Everitt, USN (Ret)

Master Chief Everitt is a retired submarine Quartermaster with a very broad career in both the Navy and civilian life. He joined the Navy at 17, went to SubSchool after boot camp and qualified on DIODON. As a QM2 he reported to ABRAHAM LINCOLN as a plankowner and did three patrols before shore duty with the NROTC.

During a tour as a Swift Boat LPOL Vietnam he was promoted to QMC then returned to submarines in SCULPIN. He spent two tours as a Warrant Officer before reverting to Master Chief and returning to submarines in GUARDFISH. He retired as Chief of the Boat in 1977.

His post-Navy life included duty with the Federal Protective Service, college and 12 years of space program quality engineering with Martin Marietta.

He and his wife of 53 years reside in Grove, Oklahoma. He is a life member of USSVI.

In early August of 1945, World War II came to an explosive end. Following the explosions of two atomic bombs, *Little Boy* dropped over Hiroshima on 6 August and *Fat Man* dropped over Nagasaki on 9 August, the Japanese surrendered *unconditionally* to the Allied Forces in the Pacific. Immediately following the surrender, the various Allied Governments began rounding up those Japanese they considered war criminals. This activity didn't get as much press exposure as the Nuremberg trials in Germany, and as a result the American public largely ignored the war crimes trials in Tokyo and throughout Asia. Also the Japanese who were accused of being war criminals were not as well known as their German counterparts. Much of this was due to intentional Allied propaganda as the Allies had decided not to charge Emperor Hirohito as a war criminal in order to shorten the war even though there was ample evidence to do so.

In any event, the machinery set in motion by the surrender on 14 August 1945 was not to end for several years. Victor's justice and vengeance for past injuries were the themes. This was no doubt a time for revenge, but this was also a time for justice.

Procedure and Machinery

Unlike the agreement between the Big Four in London, which produced the trials of Nazi war criminals at Nuremberg, the trial of Japanese war criminals was left to the various nations involved. Each would use their country's judicial system and administer punishment according to the will of the court. The allies were held in a loose association by a body called the International Military Tribunal for the Far East (IMTFE). This body was almost entirely the child of General Douglas MacArthur and as such, it had responsibility to the Supreme Commander for the Allied Powers (SCAP), i.e., General MacArthur. The purpose of the IMTFE was to ensure that Japanese war criminals were given a fair and impartial trial. The obvious difficulty in this case came when this body was more or less forced to allow each individual country to conduct its trials based on its own national law (Piccigallo, XIII).

The Australians looked to the United States to lead the way in the trials, and to the British to support the U.S. in any way they could. They nevertheless proceeded to try war criminals under their own jurisdiction. The Dutch to a greater extent conducted trials independently in Indonesia, and the French trials in Indonesia were also conducted with total autonomy. In brief then, the Japanese War Crimes Trials were conducted by the standards and policy objectives of each individual Allied country.

Trials were held at various locations including the following: Batavia on the island of Java in the Netherlands East Indies; Canton, Nanking, Shanghai and Hong Kong in China; Kuala Lumpur, Labuan and Singapore on the Malayan Peninsula; Guam in the Marianas; Makassar on the island of Celebs; Manus Island off New Guinea; the Marshall Islands; Morotai Island west of New Guinea; Port Darwin in Northern Australia; Rabaul, New Britain; Khabarovsk, Russia; and Tokyo and Yokohama in Japan.

The Allied Nations conducting these tribunals were the

United States, Great Britain, Australia, the Netherlands, China, the Philippines, France, Russia, Canada, New Zealand and India. The last three of which played only minor roles in the trials. This then was the international mechanism by which the Allied Powers would mete out justice upon those Japanese accused as war criminals.

Three categories of criminal action were created for prosecution of war criminals:

> Class *C*: individuals who committed crimes against humanity such as murder, extermination or enslavement.
> Class *B*: individuals who committed violations of laws or customs of war, murder, or caused ill-treatment of civilians, POWs, civilian internees or hostages.
> Class *A*: Individuals, who planned, ordered and administered plans for carrying out the acts of war against humanity.

Category *A* trials were of high visibility and were carried out in Tokyo. These lasted 2 ½ years and resulted in the conviction of 25 Japanese out of 28 charged. Two of the 28 died during the trials and one was deemed unfit to continue by reason of insanity. All other trials were of a lesser nature, and they were of the Class *B* and *C* categories. The substantial difference between the *B* and *C* category criminals was the *B* criminal was the person actually performing the act and the *C* criminal was the officer or official who ordered the act or who had authority to prevent the act.

The Yamashita Trial

Before the actual surrender of Japan, the United States had waged war in the Philippines against troops led by General Tomoyuki Yamashita. Yamashita had succeeded to command of all the 14th Army Group and all the Kempeitai (the secret military police, not unlike the German Gestapo) in October 1944. Ten days after his arrival in the Philippines, the U.S. Forces commenced the invasion of Leyte Gulf, and the noose began to tighten. In November control of the Japanese naval forces in the Philippines

passed to him as well when Count Terauchi transferred his headquarters to Saigon giving up his rule as commander in chief of the area.

As U.S Forces advanced on Luzon, the Japanese Forces began a reign of terror directed at the Philippino population. For no truly apparent reason, they systematically brutalized the population of the Islands; killing, torturing and raping hundreds of thousands.

General Yamashita surrendered to U.S. Forces on 3 September 1945, the day after the signing of the Peace Treaty. On 25 September, he was charged as a war criminal and arraigned on 8 October. His trial began three weeks later.

The general comprehensive charge was:

> .....[that] between 9 October 1944 and 2 September 1945, at Manila and other places in the Philippine Islands, while Commander of Armed Forces of Japan at war with the United States of America and its Allies, General Tomoyuki Yamashita unlawfully disregarded and failed to discharge his duty as commander to control the operations of the members of his command, permitting them to commit brutal atrocities and other high crimes against people of the United States and of its Allies and dependencies, particularly the Philippines; and he, General Tomoyuki Yamashita, thereby violated the law of war (Lael, 80).

In addition to the general comprehensive charge there were 123 specific charges lodged against Yamashita. The charges were for acts committed by his troops, and these charges were for their acts as condoned by Yamashita. Defense lawyers put up a spirited defense for Yamashita, but the trial progressed rapidly. Many felt that the court of five generals had begun the trial with Yamashita's fate already sealed. Much testimony was given by survivors of the Japanese brutality, and this testimony was universally condemning of Yamashita (Lael, 82).

The court case was concluded on 5 December 1945, and the President of the Court announced that a verdict would be rendered within 46 hours. The court then reconvened and General Yamashita quickly knew his fate. The findings were that he was criminally liable for the actions of his men, and that he was guilty as charged. The court then sentenced him to death by hanging. True to the sense of theater, Yamashita's sentencing was on 7 December 1945 - 4 years to the day of the attack on Pearl Harbor (Lael, 95).

The defense quickly got the attention of the U.S Supreme Court and while the defense team argued for overruling or overturning the verdict on constitutional grounds, the court ultimately upheld the military court's findings. In so doing, they created a new crime. That crime being the failure of a field commander to control his troops. On 23 February 1946 at 0300 hours, General Yamashita was executed by hanging (Reel, 239)[1].

The question of Yamashita was to come up again and again in the trials that followed. The precedent had been set, and now with precedent making it easy, the U.S. began to move against the Class *A* war criminals in trials held in Tokyo. This same precedent was widely used against the defendants in trials throughout the Far East. Primarily it was applied to the Class *C* defendants who may have ordered murder or torture, or possibly ignored the fact that it was happening.

Other U.S. Trials

The establishment of U.S. Trials in China had been approved by the Chinese Government in Chungking and the U.S. Forces began arresting Japanese in October 1945 for crimes against U.S. Nationals. The principal trials were held in Shanghai, and most involved treatment of downed aviators. Because of the victims, these trials were labeled the Doolittle Fliers Trials. These trials also covered captive submariners who had received harsh treatment when captured. Once again the Japanese were tried by military commission and their sentences were generally upheld by review of the convening authority. The defendants in these trials were given very fair treatment and from the viewpoint of all

observers, the trials were conducted in a most fair manner (Piccigallo, 71).

The Shanghai Trials were considered so important that the chief prosecutor for the IMTFE, Joseph Keenan, and five of his assistants sat as observers at the proceedings. The idea of this group of officials was that the U.S. could attach responsibility for the barbarous treatment of POWs to the highest levels of the Japanese Government and Army. This inhumane treatment question was to underlie many of the remaining trials (Piccigallo, 71).

Naval authorities supervised all of the war crimes trials held in the Pacific Islands. Guam was the administrative headquarters for the trials, and the investigative efforts were wide spread throughout the islands of the Pacific. Investigation, arrest and trial procedures were definitely different from the Army trials. There was close cooperation between naval authorities and the governments of the Pacific Island Groups.

The Navy operated under the procedure set down by the provisions of the Naval Courts and Boards. This court martial system predated the Uniform Code of Military Justice, and was considered more enlightened than the Army's Articles of War. Using the trial procedures set forth, the Navy prosecuted primarily on the charge of murder, using the justification that it is patently unlawful to inflict grievous bodily harm on a combatant who has laid down his arms. Most of the cases in the Navy's jurisdiction were questions of conduct toward prisoners. However, there were some very unusual aspects of the Naval Trials, some of which included charges of cannibalism, atrocity slaying, and punishment as spies without trial, and mutilation of bodies for experimental use. Also as a result of conviction at these trials, it was found that the sentences were more severe. This severity may be from the fact that all of the death sentences, and all but one of the life imprisonment sentences, were from convictions on the charge of murder (Piccigallo, 79-83).

The United States Army was given the task of conducting the war crimes trials of those Japanese on the Main Islands. The Commander of the 8th Army at Yokohama conducted the trials and

was responsible for the appointment of the military commissions that acted as the court. These trials were the largest in number of both trials and individuals charged. Supreme Commander of Allied Powers (SCAP) investigated charges on over 2000 individuals in preparation for the trials.

The Yokohama Trials were thought to be more international in scope. They were to represent the interest of all the Allied Powers in the Home Islands and as such they became *International Tribunals*. Because of their character, these trials involved different types of people than those previously mentioned. Involved were professional military personnel from the highest rank to the lowest, interpreters, farmers, teachers, doctors, nurses, government officials, shinto priests, and college professors. The first women were tried at these trials (Piccigallo, 84-85).

The trials ended in October 1949 and the numbers are astounding (see Table labeled Final Statistics). During this time the United States spared no expense to ensure that the trials were fair and each defendant had sufficient defense. Since these trials were for crimes committed on the Home Islands, they did not involve any non-Japanese civilian victims. Most of these cases involved POWs. Part of the difficulty with trials involving POWs was that within the first three weeks of occupation 23,000 POWs had been embarked on their journey home. This kept face to face testimony at a minimum. Still the question of fair trial has seldom been raised and history has for the most part let these trials slide into obscurity[2].

The British Trials in Southeast Asia

The British War Crimes Trials were based on a royal warrant and were to follow British law as closely as possible. The opening trial in Singapore on 21 January 1946 was to set the tone for all British trials. All standards of fairness that could be observed were established at this trial. Most other trials followed these standards and the accused was not convicted unless his actions had been proved *beyond a reasonable doubt* (Piccigallo, 104-105).

Because of the wide area of the world covered by these trials, The British set up headquarters in Singapore to coordinate the

trials. The trials were processed as rapidly as possible while yet ensuring the accused a fair trial. Just the sheer numbers of accused caused the British to consolidate many of the cases into one trial. When this occurred, there was the possibility of unfair treatment, but through it all, the British judges were thoroughly protective of the accused's rights. Most of the charges were for Japanese actions against POWs. Some trials, however, were for crimes committed against the local native population. The most severe punishment was handed out over the Japaneses' conduct at the Sime Road POW Camp. This trial caused the most controversy in the British press, not because of the findings, but because of the harsh sentences. Still the British were able to complete their trials by December 1948, and the matters were then left to history (Piccigallo, 114).

The Australian Trials

While most of the war crimes trials were well organized, the Australians seemed to have a hard time conducting their investigation and establish procedural matters. The trial started all right, but the Australian Judicial System for the trials could not keep pace and there were no trials conducted in 1949. Although several hundred accused war criminals still remained in jail, the trials suffered from lack of facilities and various support needs. General MacArthur denied the Australians further use of the facilities in Hong Kong, and eventually the trials were moved to Manus Island off the north coast of New Guinea in the Admiralty chain. The trials continued in 1950, and the Australians tried 113 cases at Manus Island between July 1950 and May 1951. All of the defendants were accused of capital crimes. Any others charged with less serious crimes were released (Piccigallo, 135-137).

The Australian Trials came to a temporary halt in 1948. The fact that they were stopped was not the issue. The burning issue was that failure to complete the trial process was a barrier to the final peace treaty with Japan. Finally, the Australian Parliament forced the conclusion of the trials, and one more barrier to peace with Japan was removed.

The Russian Trials

Immediately following the surrender of Japan, information developed that Russia had interned between 400,000 and 500,000 Japanese POWs. Russia's reply was that they were investigating them for alleged war crimes. In December 1949 Russia staged a war crimes trial at Khabarovsk in southern Siberia. This trial accused 12 men of bacteriological warfare and other crimes related to the manufacture of bacteriological agents. The trial was a large show with all of the trappings of a farce. Most of the testimony was directed at current political issues and not at the guilt or innocence of the accused. Naturally, all 12 were found guilty, but the sentences were relatively mild. The longest term given was for 25 years in a labor camp.

The upshot of this trial was that Russia ignored the repatriation issue of the remaining several hundred thousand Japanese POWs. This decision caused quite a stir in international circles and has remained a barrier to amicable relations between Japan and Russia. The Voice of America in October 1951 reported that there were 370,000 Japanese POWs remaining in unaccounted status. As late as 1976 information indicated that 400 or more still remained alive in Siberian Labor Camps (Piccigallo, 157).

The Chinese Government Trials

Japanese authorities in China had allowed more atrocities than anywhere else in Asia. This had been apparent from the start of the Allied occupation. Since Japan had been in control of China in some fashion since 1931 when they invaded Manchuria, much of the dirty work had come before the actual start of hostilities marking the beginning of World War II. Thus, the Chinese people had a lot of ill feelings about the Japanese. However, to their credit, they created several new laws to govern the trial and punishment of accused Japanese and they proceeded into their trials with a goal of justice and not vengeance. As a result, the Chinese had a higher acquittal rate than other nations holding trials.

The Chinese trials were well run and were conducted in an atmosphere of impartiality. Still, the goal was justice, and they

succeeded in meeting this goal. Their law called for specific punishments for specific crimes. The sentence could not be overturned by higher authority. All death sentences had to be approved by Chiang Kai-Shek. If he did not agree with the findings, he could send the case back for retrial, but he could not modify the sentence.

During their incarceration, the Japanese were well treated up until their conviction by the military tribunal. Upon conviction, they then entered the normal Chinese prison system. This system was as humane as was the system set up by the Japanese, but conditions were decidedly worse. Soon the trials were slowed by the ever closer civil war, and as the Nationalist Government lost control of more and more territory, their importance to the Chinese people faded. When the Communist regime took over the government of China, their emphasis toward the Japanese became political. They only addressed the war crimes issues in political rhetoric. The imprisoned war criminals, about 260, were transferred to Tokyo by the Nationalists before the fall of Shanghai, and this became an issue between the U.S and China (Piccigall, 172).

The Remaining Allied Trials

Trials were held in the Netherlands East Indies as well as further trials in the Philippine Islands and French Indo China. The Dutch trials were extremely harsh and resulted in a great number of convictions. If the Dutch trials were harsh, the trials in the Philippines were extremely lenient. After all of the savagery that the Japanese dealt to the people of the Philippines, they still received a remarkably fair trial. There were numerous acquittals if the guilt status was questionable.

The French Trials in Indochina were very small when compared to the rest of the Allies. France seemed to be saying to the world that the trials at Nuremberg were the important issue, not those in Indochina. Also the French seemed content to try accused Japanese in absentia and make no further attempt to apprehend the culprit. The one major factor of the French Trials was their use of municipal law in charging war criminals. By using

municipal law in an international tribunal, the French set numerous precedents in international law. This in effect turned much of the French Municipal Code into law.

The Class "A" War Crimes Trials

During the time that the Allied nations in the Far East were conducting trials on the Class *B* and *C* criminals, the IMTFE was conducting a massive trial of Class *A* war criminals in Tokyo. This was the main thrust of the war crimes issue. An international charter called the Tokyo Charter had been created under the auspices of SCAP, i.e., General Douglas MacArthur. The charter was drawn up by Joseph B. Keenan, the Chief Prosecutor of the IMTFE. This was done by MacArthur under direct orders of the Joint Chiefs of Staff and President Harry Truman. Since the charter followed the form of the Nuremberg Charter, it was acceptable to the Allies.

The Charter called for a trial for those responsible for the war in the Pacific. The accused would be provided concise indictments, a bilingual trial conducted in English and Japanese, the right to freely chosen counsel, freedom to conduct one's own defense and, lastly, aid in the production of evidence. The Tribunal would consist of one judge and one alternate from each member nation of the Far East Commission (FEC). There was one Chief Prosecutor and 10 Assistant Prosecutors. Additionally, 10 American attorneys were assigned to assist the defense. With the machinery and procedures in place, the trials began on 3 May 1946 (Minear, 20-23).

Much has been printed about the legal aspects of the trial, but the most important feature was the use of the Yamashita precedent in finding some of the defendants guilty of violating *command responsibility*. Another important feature was the charge of conspiracy. In many of the countries involved there was no such legal concept as conspiracy. This was an Anglo-Saxon concept which was forced upon the Tribunal.

Eventually the trials ended and the findings were announced on12 November 1948, some 2 ½ years after they had begun. (Minear, 26).

Of the 28 defendants charged for Class *A* war crimes, 25 were convicted of some major war crime. Two died during the trial and one was found insane and excused from the proceedings. Seven of those convicted were sentenced to death. To emphasize the statement at the beginning of this paper, i.e., "the Japanese war criminals were not as well known as their German counterparts", they are listed here along with their charges, only one name of which is recognized by most, Heideki Tojo. They are:

Hideki Tojo: Gendarme Commander and Chief of Staff of the Kwantung Army, Minister of the Army and Prime Minister - accused of launching the Pearl Harbor attack.

Kenji Doihara: Chief of Special Service of the Kwantung Army - accused of being one of the conspirators who engineered the 18 September 1931 incident and kidnapping the ruling emperor of what was to become Manchukuo when Manchuria was over run.

Seishiro Itagaki: Chief of Staff of the Kwantung Army and Minister of the Army - accused of being one of the conspirators of the 18 September 1931 incident.

Iwane Matsui: Chief of Special Service of the Kwantung Army, Commander in Chief of Japanese Central Chinese Army - accused of being the chief instigator of the Rape of Nanking.

Akira Muto: Deputy Chief of Staff of Japanese Central Chinese Army - accused of being responsible for the Rape of Nanking and committing other atrocities in Indonesia.

Heitaro Kimura: Chief of Staff of the Kwantung Army, Deputy Minister of the Army, and Army commander in Bunna - accused of being responsible for the brutalization of Allied POWs especially to build the Bunna Rail-

way (later to be scored for the movie Bridge on the River Kwai).

Koki Hirota: civilian, Foreign Minister and Prime Minister - accused of introducing *Three Principles* of how to deal with China in 1935.

The rest received varying prison sentences ranging from 7 years to life. It is interesting to note that in this group were the only Navy men among the 28, two Admirals. Their particulars were:

Takasumi Oka: Chief of Bureau of Military Affairs and Deputy Minister of the Navy - accused of being responsible for mistreatment of Allied POWs especially the *Hellships*.

Shigetaro Shimada: Vice Chief of Naval General Staff and Minister of the Navy - accused of authorizing the Pearl Harbor attack.

The executions were reviewed by the FEC and approved by General MacArthur. MacArthur then directed that the executions be carried out at 0001 on 23 December 1948.
(Shiroyama, 296-298 and
http://centurychina.com/wiihist/japdeny/tokyo_trial.html)

Justice or Revenge

Was it justice? Clearly many, if not all, of the *B* and *C* defendants were guilty of crimes that would require punishment in any society. In most of the trials, the defendants received a fair hearing and just punishment. What seems to remain in question is the trials of the Class *A* defendants. The author feels it was vengeance pure and simple. The brunt of that vengeance was dealt to the seven men who were executed as a result of the Tokyo Trials. They did their duty to their country and their Emperor as they saw it, and while it caused a war, war per se is not against

international law. Yes, it was a railroad job and it was probably done to pacify General MacArthur and atone for the many men he lost in the Philippines. Yamashita was partially the cause of those losses and it appears he, MacArthur, got his revenge on Yamashita also.

Final Statistics

Place/Trials	Cases Held	Defendants	Convictions	Acquittals	Death Sentences
US Trials:					
Philippines	97	215	195	20	92
China	11	75	67	8	10
Naval Trials:					
Pacific	47	123	113	10	30[1]
8th Army Trials:					
Yokohama	319	996	854	142	124[2]
British Trials	306	920	811	107[3]	279[4]
Australian Trials	296	924	644	280	148
Russian Trials	1	12	12	0	0
Chinese Trials	605	883	504	350[5]	149
Netherlands Trials	448	1038	969	55[6]	236[7]
Philippine Trials	72	169	133	11[8]	17
French Trials	39	230	198	31[9]	63[10]
IMTFE Class A Trials:					
Tokyo	1	28	25	0	7
Totals	2242	5613	4525	1014	1155

Notes on Table

[1] While the Naval Trials in the Pacific Islands were more severe, the actual executions were 10 of the 30 sentenced to hang. The remainder had their sentences commuted to life in prison.

[2] Of the 124 death sentences awarded by the Yokohama Trials, only 51 were carried out.
[3] The results of the two trials were not reported or were not available to researchers.
[4] Of the 279 death sentences awarded in the British Trials, 265 were carried out.
[5] This figure doesn't account for 29 accused which were unaccounted, escaped, not apprehended or indictment withdrawn.
[6] This figure left 14accused unaccounted due to escape, illness, etc.
[7] 10 death sentences were commuted to long term prison terms.
[8] Cases dismissed, trials adjourned, or sentences not approved - 25 cases.
[9] One unaccounted for.
[10] 43 of those condemned or sentenced to harsh prison terms were tried and sentenced in absentia, having eluded capture.

Author's Notes

[1] The book by Adolf F. Reel is an easily read memoir, but most of the factual data about the Yamashita case came from The Yamashita Precedent by Richard Lael. Mr. Reel was an Army Captain in the JAG Corp, and was one of three officers appointed to defend Yamashita.
[2] The author has a personal note in this regard. While serving in Japan, he became acquainted with one of the Japanese Colonels who had been in charge of a POW Camp. At his trial two American Officers came forward and testified on his behalf. Their testimony revealed that the Colonel fed these men from his own meager rations. He received a 5 year sentence of which he served 3 ½. He claimed that his "perfect" English was "kicked" into him by the guards at Leavenworth prison.

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THE MARK 9 TORPEDO EXPLODER MECHANISM: A CONTACT-INFLUENCE SUCCESSOR TO THE MARK 14 MOD 6 DURING WWII

by Victor S. Alpher, Ph.D.

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There have been many well-written and documented histories of torpedoes used before and during World War II.[1,2] Overall, torpedo performance was fairly dismal for all forces. One of the greatest problems in writing histories on such topics involves the classified nature of the original documentation. The Atomic Bomb is a good example. A lesser-known but no less decisive ordnance development during the war was the radio-controlled Proximity Fuze. These tremendous advances in military ordnance were developed under the highest possible secrecy within the National Defense Research Committee (NDRC) and the Office of Scientific Research and Development (OSRD) under Vannevar Bush. They were founded by President Roosevelt in 1940.

This paper will demonstrate that torpedo development under the auspices of BuOrd was in fact much more successful than most experts have proposed, using primary documentation not previously considered. These developments were decisive in the Pacific, as were bombs and other ordnance detonated with the Proximity Fuze in Europe.

The Bureau of Ordnance Changes Gears and Adopts Modern Technology

Recruitment of the necessary scientists and engineers to accomplish the task of modernizing the American military occurred by word of mouth (or telephone) beginning on August 17, 1940. The first significant event was the hiring of physicist Dr. Merle Tuve by Vannevar Bush to head Section T. Section T contracts were of the most classified nature, and coveted throughout academia and industry. Employment interviews were held on the sidewalks of Washington, D.C., where "I have a job for you but I can't tell you about it—oh, and you'll need to move to Washington immediately with or without your family" was followed with the statement "I need your answer in two weeks." Astronomer Dr. Ralph Belknap Baldwin was recruited three years after obtaining his doctorate in Astronomy at the University of Michigan (1937). One of his mentors, already working in Washington, Dr. Robley C. Williams, Sr. interviewed him on a sidewalk outside of the Carnegie Institution–the first physical location for Section T (Dr. Ralph Belknap Baldwin, personal communication, January 15, 2009). What Tuve wanted was good problem-solvers. One of the miracles of the War is that about 500-800 scientists and engineers, working under an unusually flexible bureaucratic structure developed by Tuve, were able to revolutionize ordnance provided to our military forces in a remarkably short period of time.[3] Broad brush strokes of the nature of the advanced work were lauded in the years following the war.[4,5,6,] However, some technical details remain unknown or highly classified, even today. Some of the material used for the research documented here was not declassified until late 1996–and I was able to locate important details only because of very brief notes left by my father, who passed away in August, 2007.

The Low Point: The Early War Mark 14 Submarine Torpedo.

The most common torpedo used early in the war was the Mark 14.[7] This torpedo was a dismal failure, especially due to its deficient Influence (magnetic) Exploder Mark 6 which had problems comparable to those that plagued the German Kriegsma-

rine-- inadequate depth control, duds, broaching, and a tendency to make a u-turn and return to the firing vessel. The contact detonator was not much better, particularly at small angles of attack. Karl Dönitz referred to early *German* torpedo testing methods as "criminal".[8] In the U.S. Navy, early failures were typically blamed on the skippers, at least until the nature of the failures were carefully examined.

By early 1943, the Mark 6-equipped Mark 14 torpedo was no longer in use as it was designed. Often, the magnetic influence component of the Mark 6 Torpedo Exploder Mechanism was deliberately disengaged. Frederick J. Milford concluded his mid-1990s series on torpedo development during World War II in *THE SUBMARINE REVIEW* that nearly exclusive focus on development of *homing* (sound-detecting) torpedoes following the Mark 14 debacle was not particularly successful. There was *another* concurrent track of torpedo development, typical of the OSRD, that *was* quite successful, however. In concept, what was needed was influenced significantly by the highly successful Radio-Controlled Proximity Fuze. Its first appearance, as an anti-aircraft detonator was made on January 5, 1943. A Japanese dive bomber attacking USS HELENA was destroyed by a 5"/38 anti-aircraft (AA) shell.[9] (see Figure 1).

Figure 1. (left to right) Photograph of a 1944 Proximity-Fuzed AA shell, along with a prototype given to my father for his work on the Fuze. Also included is the mercury-filled Navy device used to locate personnel in the water at night, which emits a faint blue glow, used by my father when testing torpedoes in the water. From the collection of Ralph A. Alpher.

Part of this new vanguard of scientists was my father, Ralph A. Alpher. From 1940 through 1955, he worked contracts with the Bureau of Ordnance (at the Naval Ordnance Laboratory, at the Carnegie Institution and the Johns Hopkins University Applied Physics Laboratory [JHUAPL] under BuOrd "Section T" contracts).[10,11]

Reappearance of Magentic Influence Exploders in 1944

Under Section T, for example, physicist Dr. Robert C. Herman, JHUAPL's liason to the Navy, became after 1948 a lifelong scientific collaborator with R. Alpher in Cosmology. Astronomer Dr. Robert Belknap Baldwin was the liaison to the Army, which had a dramatic effect on the end of the war in Europe.[12] As a Junior Physicist and Professional Engineer (he earned his Ph.D. in 1948 at George Washington University in Physics), R. A. Alpher was assigned to many different tasks. Because of his extensive experience with magnetism, his services were sought later in the war to assist with a *new influence exploder* for torpedoes. We turn now to that major project.

In April 1944 my father was first approached to move to JHUAPL. In a recommendation letter dated April 10, 1944 Scott Forbush, Ph.D. (on *loan* to the Naval Ordnance Laboratory from the Department of Terrestrial Magnetism of the Carnegie Institution) stated that R. A. Alpher had "far better knowledge of mathematics and physics than the average person with a Master's." He had also by this time acquired his B.S. degree in Physics (as well as the equivalent course work for a B.S. in Mathematics). On April 21, 1944 he received a formal *letter of interest* from the BuOrd Personnel Officer, A. Russell Slagle *and* Commander Arthur L. Wheeler, about an *urgent* task for which they stated, "We believe your qualifications are such that you would be of real value in the organization here." They wanted only personnel who had the highest security clearance, and who would not be drafted, enlist, or in any way be open to enemy compromise.

This task was assigned jointly to the Applied Physics Laboratory of Johns Hopkins University (JHUAPL) and the Applied

Physics Laboratory of the University of Washington (APLUW) which collaborated with the Naval Station at Keyport (Torpedo Town, U.S.A.). A mention of the coveted Section T contract is made in the January 1, 1945 "Lab Oratory" (Vol. 1, No. 1) of the APLUW. Drs. Wilbur Goss and Freeman K. Hill were the JHUAPL group supervisors. Eventually R. A. Alpher became Project Supervisor, Production Problems, during which he was responsible for introduction of any design changes, and production and testing problems. He began working with the group on August 1, 1944. On June 20, 1946, Dr. Wilbur Goss applied for a Patent for "an exploder for a torpedo and more particularly to an improved exploder of the influence operated type." (United States Patent Office, Patent No. 2,968,242 awarded January 17, 1961; interestingly, the patent for the Proximity Fuze involved an extensive legal battle in the 1960s).

That "Special Torpedo"

I will briefly describe the advantages of a newly formulated magnetic influence torpedo exploder, introduced in OP-1365 written by my father and published by the Bureau of Ordnance with the date March 13, 1945. I will confine most of my remarks to the Mark 9 Mod 0, although in 1950 OP-1365 (First Revision) for the Mark 9 Mod 3 was also published, summarizing improvements made following the introduction of the novel and successful Torpedo Exploder Mechanism (TEM) Mark 9. In the Preliminary OP-1365 my father wrote:

> "There are basically two advantages in the use of the influence exploder.
>
> First, the target, as *seen* by the exploder, is effectively increased, since it is unnecessary for the torpedo to actually strike the target. The extent of the target's magnetic field makes exploder operation possible at reasonable depths below keel depth. Second, if the torpedo is run at target keel depth with the proper time delay in the action of the exploder, the explosion will occur either beneath the target, where the maximum damage possible will result, or else a low contact hit will be obtained"

(most vessels of the period were better armed at the side, expecting side contact from shallow-running torpedoes)." (p. 1)

Prior to his passing in 2007, he described many of the dangerous experiences he had experimenting with early versions of the new TEM 9 in tests in waters off the State of Washington (most likely Puget Sound). There, he and his colleagues observed and tested torpedoes in the running, occasionally having to abandon their wooden boat as a torpedo broached out of the water, veered off course, or otherwise threatened the testing crew in some manner. He carried a mercury-filled Navy-issue lamp that emitted a faint blue glow for nighttime rescue (see Figure 1). He remained with this research and development group full-time until September, 1945, but thereafter continued to make further contributions on an as-needed basis.

Magnetic Influence Exploders in Greater Detail

The main design feature of magnetic Torpedo Exploder Mechanisms (TEMs) is the method of detonation (of course, all such torpedoes can also be detonated by direct contact). Several problems attendant to prior torpedoes other than the influence component had to be solved. First, the torpedo must run at a constant depth, preferably under a ship's keel, *breaking its back* in Naval parlance. The Mark 14 had been found to run many fathoms deeper than set, inflicting minimal damage even when detonated. A direct under-keel detonation is magnified by the plume from the explosion, however.

The new TEM included two coiled electromagnets with reverse polarization (providing the information to the gradiometer that initiated the firing sequence). The design was completely novel. It also required a seaworthy battery–activated by seawater after launching-- that would not arm the mechanism until it was a safe distance from the launching vessel (later versions were armed mechanically in such a way that minimal deviations off-track would be insufficient to operate the electric cap). The new gyro had adequately to control yaw, pitch, and roll to control the torpedo's depth and angle of approach.

Second, a new gradiometer was added to the detonation sequence to detect polarity changes. It turned out that deficiencies of the early Mark 14 were due not to human error, but use of the torpedo in equatorial waters far away from its design features—hence, the geomagnetic field was considerably weaker providing insufficient information to arm the torpedo. The use of any such detonator must be calibrated to the effects of the influence of the earth's magnetic field on the target and the torpedo. Even a degaussed target will acquire a new magnetic signature from the pounding of waves, firing of guns, as well as passing through the earth's own magnetic field (Ralph A. Alpher, personal communication, December 3, 2005). The early Mark 14 influence design was not sophisticated enough to account for all of these variables. He described to me an experiment trip made on USS MASSACHUSETTS from Virginia to New York to measure the effects of wave pounding, 16-inch gun firing, AA gun firing, and passing through the Earth's own magnetic field on the ship's *magnetic signature*.

Third, a mechanism was necessary to keep the circuit from accidentally closing if the torpedo was jarred or *flexed* in transit. This would occur, for example, if a German or Japanese magnetic mine exploded as the torpedo passed by. This problem, though complex, was solved by deactivation of the influence feature from shocks of sufficient severity as to *flex* the warhead. This was called a "CC" or ceiling-countermine switch (broaching could also cause sufficient flexing as to cause premature detonation). The firing condenser was bridged with a 10,000 ohm resistor when the torpedo reached the surface, preventing detonation. Further, another set of contacts short circuited the firing condenser when closed by a shock wave or by high pressure. This helped avoid premature firing due to a variety of environmental threats in the ocean.[13]

Fourth, closure of either set of contacts would activate thyratron tubes leading to activation of the firing mechanism (late in the War, Torpex was preferred for underwater explosion). Sufficiently rugged thyratron tubes had been developed for the Proximity Fuze. Activation of the firing sequence could only occur when the

torpedo came close enough to the keel of a ship or submarine, where the magnetic field encountered has sufficient perturbation (measured in gauss).

Fifth, the TEM 9 had many intended applications. This included the Mark 13, 16, and 18 War Heads. The first application was to be on the Mark 13 Torpedo (Bureau of Ordnance OP-1365 ([Preliminary]) TORPEDO EXPLODER MECHANISM MARK 9 MOD 0, 13 March 1945), an air-to surface anti-submarine and anti-ship torpedo. Further applications were anticipated for the War Heads Mark 18 Mod 3 and Mark 16 Mod 5 as stated in the OP and are described in the First Revision. The Mark 13 was the mainstay of the Navy's Avenger torpedo bomber, which was used extensively in both Pacific and European theaters.

In the introduction to OP-1365 (Preliminary) Rear Admiral G.F. Hussey, Jr., Chief of the Bureau of Ordnance stated: "Because of the urgent need for this information, it has been issued in preliminary form." (p. ii). Unique testing devices were developed so that an experienced radioman could regularly monitor the proper operation of the many components of TEM 9 (Supplement to Ordnance Pamphlet 1365, dated August 1, 1945). Because of its unique characteristics, even ship degaussing was an ineffective countermeasure for the TEM 9—the Germans and Japanese were known to have employed degaussing when building ships, when the first magnetic signature is acquired, although neither opponent *required* repeated degaussing at a frequency of six months as required and monitored by BuOrd.

What is the World War II Record of the Mark 9 TEM?

Many reports are silent as to the use of the Mark 9 TEM during World War II.[14] One would have expected it to be used with the Mark 18 Torpedo because the Mark 18 became more popular after the Mark 14 debacle, and because of its deep, wakeless running. In this way the adaptation of the German G7e electric torpedo with U-570 captured by the Royal Navy in 1941, and manufactured first in the U.S. by Westinghouse was well done.[15]

The prototype Mark 9 TEM was first tested against the 10,000 ton German oil tanker AMPETCO (the second of *three* by that name, manufactured in 1926 in Kiel). Off Aruba, the hulk of this tanker which burned in a collision in 1944 sank in 10 minutes.[16] My father's photograph of this test clearly shows a shallow-running torpedo, most likely a Mark 13 fired from a Naval Avenger.

Figure 2. Photograph of a test of the TEM 9 against the disabled German oil tanker AMPETCO (II) sometime in late 1944 or early 1945. From the personal photo collection of Ralph A. Alpher, Ph.D.

There is now convincing information that the Mark 9 TEM made a decisive impact during the final year of the War in the Pacific. On April 7, 1945, barely a month after the publication of the initial OP-1365 for the Mark 13, the largest battleship ever built, the Japanese YAMATO (1941) was sunk along with several other Japanese warships (operation "Ten-Go") after first being sighted by a submarine in an excellent coordination of submarine with Naval Aircraft Carrier Task Groups 58. YAMATO herself was struck by some ten Mark 13 torpedoes launched by TBM Avenger Navy torpedo bombers.[17,18] The improved Mark 13 was probably introduced sometime sooner, but nonetheless, the Japanese fleet was rendered ineffective as an attack force for the remainder of the war. Beginning with the Mk 13 Mod 0 through Mk 13 Mod 13, about 17,000 of these torpedoes were manufactured during the war.[19] The combined magnetic influence-contact Mark 9 Torpedo Exploder Mechanism was designed initially to be used with the Mark 13 Mod 4. Had the intensity of the Pacific Naval campaigns continued, I would think there would be little doubt as to its use in Mark 18 Mod 3 and the Mark 16 Mod 5 as initially intended although primary documentation has not yet been found to support any speculation.

My father received the Naval Ordnance Development Award (with symbol) signed on December 10, 1945 by then Rear Admiral G. F. Hussey, Jr., Chief of the Bureau of Ordnance. In a separate letter with the same date, also personally signed by Admiral Hussey, the Admiral added to the body of various commendations "The congratulations of the Bureau of Ordnance are extended to you for your outstanding performance in connection with the research and development of a ***special torpedo*** [emphasis added; the nature of the reference implies its classification]." The Mark 18 was the preferred torpedo toward the end of the war; during the last 6 months of the war, 65% of the torpedoes used were of the Mark 18 type.[20,21] Gannon, interestingly, does not even list the Mark 18 as being in any stage of development at the end of the War.[22]

In addition, a memorandum dated July 9, 1945 from Admiral Hussey to the Officer in Charge, Naval Ordnance Laboratory,

Navy Yard, Washington 25, D.C. Stated the following:

Subject: Mine Performance

1. This Bureau is in receipt of information from the Pacific indicating that mines developed by the Naval Ordnance Laboratory and planted in Japanese home waters have and are currently taking heavy toll of enemy shipping and have disrupted Japanese industry by blockading large numbers of ships.
2. The Chief of the Bureau of Ordnance notes with pleasure that the Naval Ordnance Laboratory was singled out for congratulations for effective mine designs by the command responsible for laying the mines.

This memorandum, although stamped 9 JUL 1945 had a second half, stamped 10 AUG 1945. It continued:

From: Officer-in-Charge, Naval Ordnance Laboratory.
To: Ralph A. Alpher

3. The achievements cited above represent the culmination of five years of vigorous industry enthusiastically and intelligently applied, carried forward with perseverance in the face of many formidable obstacles, by a superb team of scientists, engineers, technicians, artisans, and administrators.
4. I take great pleasure in congratulating you as a member of that team for your part in bringing about this important contribution to the winning of the Pacific war.

The bottom portion of this combined memorandum was signed W.G. Schindler, Captain, U.S. Navy, Officer-in-Charge, Naval Ordnance Laboratory. It reflects not only Ralph A. Alpher's work on degaussing, the Proximity Fuze, and the Torpedo Exploder Mechanism Mark 9, but work on mines and mine countermeasures as well. Interesting to note is that on May 3, 1946, the Applied Physics Laboratory presented my father with a

second Naval Ordnance Development Award lapel pin (letter of May 3, 1946 signed by D. Luke Hopkins, who was on the Board of Directors of Johns Hopkins University).

Following World War II

On October 28, 1947 (letter from R.E. Gibson, then director JHUAPL) my father was assigned *part time* to the High Altitude Research Group under Dr. John A. Van Allen. From examining the nature of his writing and the actual publications, I have little doubt that Ralph Alpher contributed extensively to the First Revision of OP-1365, TORPEDO EXPLODER MECHANISM MARK 9 MOD 3, dated May 11, 1950. I have not yet located copies of MODS 1 and 2. (This Revision was in a National Archives Record Group Box that was only Declassified December 18, 1996). This version had additional novel components. One made it feasible to "set torpedoes carrying the exploder to run deeper than for contact shots, thus giving better torpedo depth keeping performance against shallow draft targets." (Chapter 1). MOD 3 also permitted installation in combination with several different torpedo War Heads with no modification whatsoever.

The addition of a degaussing loop for the Mark 18 Torpedo, because it was electrically driven, was added as a safety precaution because of fluctuations in amperage in the battery compartment that could cause premature detonation. This was not unlike that used to degauss the cathode ray tube used in early televisions and was situated between the battery compartment and the Torpedo Exploder Mechanism.

As you can see from the cutaway (Figure 3), the full works of the Mark 9 Mod 3 TEM appear present in a photo that was also printed in a 40-year history of the JHUAPL. Following the war, the new principles applied to replace the faulty Mark 14 Mod 6 that led to such havoc in 1941-43 were continued. As is clear from the histories put together by the NDRC of the extensive Anti-Submarine Warfare (ASW) and Submarine Warfare advances

during the war, changes developed by the OSRD during the war continued to flourish. My father, for example, continued to work on these projects for many years at JHUAPL until leaving for the General Electric Company–yet even there, he was extending immediate post-war research (Ram-Jet, Terrier Missile, Shock Tubes) and magnetism (Magnetohydrodynamics) to problems initially identified by BuOrd and given the highest priority for solution during the war. Figure 4 shows application of the Mark 9 Mod 3 in three different torpedo warheads from the OP-1365 of 1950. Readers of this Review, probably more than any other group, will certainly recognize that these principles have been incorporated in subsequent ordnance to this day.

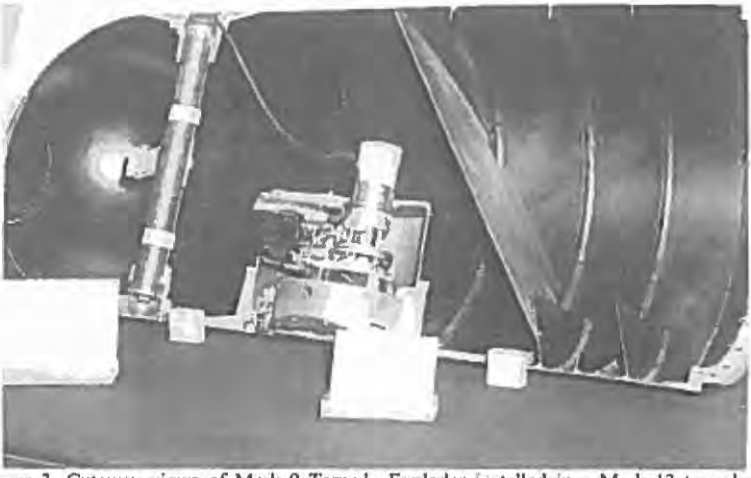

Figure 3. Cutaway views of Mark 9 Torpedo Exploder installed in a Mark 13 torpedo. Personal photo collection of Ralph A. Alpher.

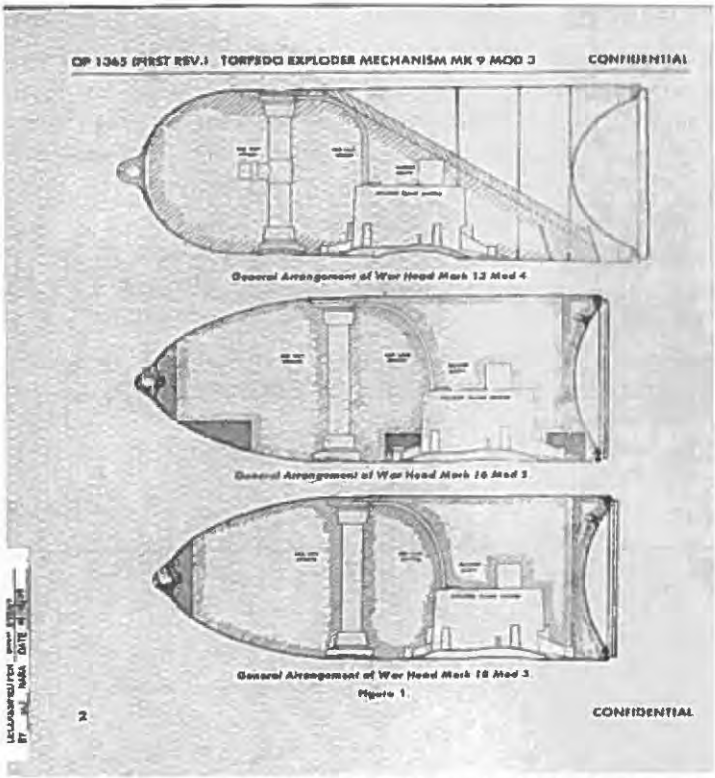

Figure 4. Cutaway views of the Mark 9 TEM for the Mark 13, 16, and 18 Torpedoes from the Mark 9 Mod 3 Torpedo Exploder Mechanism Manual, OP-1365. Note the forward position of the tube containing the electromagnets in reverse polarity in each War Head.

Another Magnetic Influence Exploder, the Mark 10 Mod 3, was introduced prior to April 15, 1945. Reference to it, and to the Mark 9 Mod 0 and Mark 9 Mod 1 appear in the Mine Disposal Handbook, Part II, Chapter 3, U.S. Torpedoes from the United States Underwater Ordnance Bureau. The initial Handbook is dated October 1, 1944, with inserts added April 15, 1945, June 10, 1945, and September 1, 1945–to aid in disarming torpedoes, many models are explained in detail so that they may be rendered safe. The vast amount of information included in this Handbook merely supports the main thesis of this paper, **that Magnetic Influence as**

a detonation device hardly ended with the demise of the Mark 14 Mod 6 Submarine Torpedo of the early war. (Ed. note: emphasis added).

It is my hope that new information about torpedo development under the Bureau of Ordnance will encourage others to delve into the as-yet unwritten history of World War II and post-war torpedo development . We should not forget the dedication of millions, from the smallest hands needed to work on the Proximity Fuze to the brilliant minds that were gathered to solve ordnance and other wartime problems. Our great nation dedicated itself to end that conflict so that our rare system of freedom, democracy, and self-government might survive. Tyrants of the 20th century did not believe a system such as ours could accomplish these tasks. Great dedication in the 21st century will be needed to preserve it.

Acknowledgments

Much of this work would not have been possible without the assistance of many individuals—more than I can possibly name here. Most important was the assistance of Mr. Jack Lopez, USN-Ret., President of Aviation Archives in Potomac, Maryland. The Historic Naval Ships Association (Rich Pekelney in particular) was most helpful. Many articles in *The Submarine Review* have helped me see how the importance of this gap in reported torpedo research and use should be recognized.

Further, support of many relatives, friends, and colleagues have inspired me during long periods of slow going and bursts of activity and enthusiastic progress. Such is the nature of scholarly research. Foremost amongst these is Professor Dwight (Ed) Neuenschwander. Also, I acknowledge Gerard G. Connors, Ph.D., Lt. Col. C. Jay Lyons (U.S.A.F.-Retired), Tatyana Zayeva, Bill Henry, Ph.D., Norman and Deanna Alpher, Rita Alpher, and Gary White (American Institute of Physics and Sigma Pi Sigma). My father's friends and colleagues Drs. James Van Allen, Ralph Belknap Baldwin, Bob Herman, Don White, Bob Johnson, Charlie Muckenfuss, and Samuel Wait, and my longtime friends, Bill Erickson, M. J. Valachovic, Richard B. Hook, Jr. have all helped further this research.

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the National Defense Research Committee) in cooperation with the Office of Naval Research, Washington, D.C. Printed and bound by the Columbia University Press. Salinity, temperature, diurnal and seasonal changes, weather, and ocean currents at various undersea locations had to be taken into account to prevent premature detonations of a torpedo armed with the MARK 9 TEM.

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20. Rowland & Boyd, *op. cit.*
21. Rowland & Boyd, *op. cit.*, p. 115.
22. Gannon, *op. cit.*, p. 201.

SUBMARINE NEWS FROM AROUND THE WORLD

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From the June 2009 Issue

GREECE--FREMMs and Submarines Progressing

In mid-June 2009, AMI received information from its Greek source that the Hellenic Navy (HN) continues to make headway on three of its major programs. Specifically, the frigate, Type 214 class submarine and the Type 209 submarine modernization/replacement programs. The updates are as follows:

Type 214 (Katsonis) Class Submarine: In early June 2009, rumors began to surface regarding the fate of the problem plagued first unit of the class (PAPANKOLIS). Rumors in trade periodicals indicated that the German Navy (GN) would take the submarine because it has been turned down by the HN and that a fourth unit would be built in Greece to replace it. The official position from the Chief of the HN is that the first unit will never be accepted because compared to the other three units, it is now considered old and still has performance problems.

Regarding the GN accepting the submarine, sources close to the HN have stated that the GN will not accept the boat as an operational vessel because it would be the only unit of that type in service and would cause issues with the supply system. A more likely scenario is that the GN may take custody of the submarine to maintain it until it can be sold to a third country.

The rumor of a fourth unit being built in Greece is just that, a rumor. No official word has been given nor has ThyssenKrupp Marine given license to Hellenic Shipyards for the production of a fourth unit. Only time will tell if the class will end with three units, but considering the route being taken with the Type 209s (see below) it is likely that the class will end at three.

As far as the three Greek built units, acceptance of those submarines will be dependent on the results of the sea acceptance trials (SAT) that are scheduled to begin in late August 2009.

C. Type 209/1200 (Poseidon) Class Submarine Modernization/Replacement: In mid-June 2009, AMI received information from sources close to the HN that Hellenic Shipyards had re-implemented the Mid-Life Modernization (MLM) of the first unit (OKEANOS) after a three year delay. The MLM of unit one should be complete by the end of 2011 at which time unit two (PONTOS) will enter the shipyard for its MLM.

Additionally, on 17 June 2009, GDDIA and ThyssenKrupp Marine signed Amendment 7 to the MLM contract that states the final two units of the class (POSEIDON and AMFRITITI) will not receive the modernization. Instead, two new construction Type 209s will be procured to replace those boats.

The two new construction units will be built with the Air Independent Propulsion (AIP) system as part of the build. The new unit will likely be built at Hellenic shipyards and will not begin construction until around 2013, after all of the Type 214s have been commissioned.

INDIA -- Naval Programs Update, Delays Continue

In May and June 2009, AMI continued to receive information from its source on major Indian Navy (IN) projects. Most of the sea service's projects continue to face delays suggesting that India's shipyards are still struggling to build sophisticated ships and submarines in a timely manner. The Akula II submarines and Admiral Gorshkov aircraft carrier delays also suggest that Russia's yards face some of the same dilemmas in refitting and delivering vessels on time and on budget. The following is a list of some of the programs:

A. Scorpene Class Submarines: The delivery schedule for the class continues to slip. The first six units of the class were originally expected to begin delivering to the IN by 2012 with all units in service by 2017. The first unit will now be delivered to the

sea service no earlier than 2014 with the entire program slipping a minimum of two years.

B. Advanced Technology Vessel (ATV): The latest information suggests that the first ATV is scheduled to be launched on 15 August 2009, one year behind schedule. Commissioning will probably also slip at least one year to 2013. The ATV Program, although continuing to slip, is considered a national priority in India as the country is attempting to round out its a nuclear triad with the sea based leg, similar to other major nuclear powers. When the first unit becomes operational, India will enter the exclusive club of having nuclear power ballistic missile submarines (SSBNs).

C. Akula II Class Submarine Lease: The IN is now expecting the first Russian Akula II nuclear attack submarine NERPA to be delivered by the end of 2009. The NERPA, negotiated under a 10-year US$360M lease, is making final repairs following an accident in Russia earlier in the year. A second unit may also be leased with delivery by 2011. These two submarines will be the stop gap measure for nuclear submarine operations and training until the new Indian-built ATVs begin commissioning sometime in 2013.

Various Did You Know?

Singapore: On 16 June 2009, the Republic of Singapore Navy (RSN) submarine, RSS ARCHER, was launched at Kockums in Sweden. The ARCHER is the first of two former ex-Vastergotland class submarines procured by the RSN from Sweden.

Portugal: On 18 June 2009, the second of two Tridente (Type 209PN) Class submarines for the Portuguese Navy (PN), NRP ARPAO, was launched at ThyssenKrupp Marine in Kiel, Germany.

From the July 2009 Issue

INDIA - Naval Projects Update

Advanced Technology Vessel (ATV): In late July 2009, AMI received information that the IN launched its first Advanced Technology Vessel (ATV) from the Vishakapatnam Naval Dockyard (VND), the INS ARIHANT. The launch of the ARIHANT will make Indian the sixth nation to operate nuclear-powered submarines and the potential to possess a sea based nuclear strike option. AMI assesses that India will eventually have the capability, but it has yet to fully test and implement sea based ballistic missiles launched from underwater platforms.

The launch of the 6,500 ton submarine closes the long chapter of construction of the INS ARIHANT, of which first steel was cut at Larsen and Toubro's (L&T) Hazira facility in 1998. AMI's source indicates that the ARIHANT will be commissioned by 2011, although this timeline could be unrealistic as the submarine has yet to complete any type of trials, including one for the K-15 short range ballistic missiles (SRBMs) (submarine launched variant of BrahMos). The ARIHANT will be powered by an indigenous version of the Russian 80MW VM-4 pressurized water reactor (PWR). The strategic weapons load-out is currently envisioned at 12 vertically launched K-15 SRBMs (700km range), each with a single nuclear warhead. The SRBMs will be launched from four triple-tube launchers located in silos behind the sail.

The 12 SRBMs will be replaced at a later date by four K-X submarine launched ballistic missiles (SLBMs) with a 3500km range and employing multiple independent reentry vehicles (MIRVs). The K-X is still in the early stages of development. The four K-X missiles will be launched from the four silos currently containing the triple-tub launchers for the K-15s.

TURKEY - Contract Signed for Six Type 214 Submarines

On 02 July 2009, the Turkish Undersecretariat for Defense Industry (SSM) signed an estimated €2.5B (US$3.52B) contract with ThyssenKrupp Marine (Howaldtswerke-Deutsche Werft - HDW) and Marine Force International LLP (MFI) for six Type 214 AIP submarines. The contract calls for the delivery of six

material packages to Turkey with construction taking place at the Golcuk Naval Shipyard. HDW will preassemble structural and mechanical parts as well as the AIP system in Germany and then ship them to Turkey. The contract also includes an 80% offset agreement, which will primarily be found in technology transfer and local construction agreements.

The contract signing follows the 22 July 2008 announcement that HDW was the preferred supplier. The Type 214 design bested the offers made by DCNS of France and Navantia of Spain. The first unit will enter service in 2015 and begin replacing the Atilay class that was commissioned from 1976 through 1990.

Unlike earlier Type 209/1200s and Type 209/1400s supplied to Turkey, which had very limited Turkish domestic industry involvement, the Type 214 program will include many Turkish companies in a variety of roles:

- Golcuk as the primary builder and integrator
- STM assisting in design and integration
- Havelsan providing the command and control system (foreign candidates being Atlas, Raytheon and Lockheed Martin)
- Koc Savuma Sistemleri providing the torpedo defense system
- Milsoft with the link 11/22 data transfer software
- Tubitak supplying the underwater telephone system and self-noise and other signature measuring systems

The Type 214s will have the traditional German AIP system that employs the polymer electrolyte membrane (PEM) fuel cell technology that was developed jointly by HDW and Siemens AG.

AUSTRALIA - Defence Capability Plan Highlights Near-Term Requirements

In mid-2009, the Department of Defence released the latest Defence Capability Plan (DCP): Public Version 2009. The DCP provides an account of major capital equipment expenditure proposals currently planned for Government consideration (either

first or second pass approval) in the period 2009-2013 (the Forward Estimates period). A number of substantial programs identified in the 2009 Defence White Paper, *Defending Australia in the Asia Pacific Century: Force 2030* are not included in this DCP as they will be presented for Government consideration beyond the Forward Estimates period (2014-2019). They are expected to be included in subsequent DCPs.

Highlights for the Royal Australian Navy (RAN) in the 2009-2013 timeframe include:

- SEA 1000 Phase 1A and Phase 1B Collins Class Submarine Replacement: This project seeks to acquire an increased and enhanced submarine capability beyond the Collins class. Future Submarine Concept Design - Year of Decision (YOD) FY 2009-10 to FY2010-11. Phase 1B Preliminary Design YOD FY2011-12 to FY 2012-13.
- SEA 1439 Phase 3.1 Collins Obsolescence Management, Phase 5B.2 Collins Continuous Improvement Program and Phase 6 Collins Sonar Replacement. Phase 3.1 intends to replace the existing ship control monitoring and management system for the Collins class, Phase 5B.2 will replace the EW and external communications systems and Phase 6 will upgrade the existing sonar system including signal processors. Phase 3.1 First pass approval FY2010-11 to FY 2011-12 and YOD FY2011-12 to FY2012-13. Phase 5B.2 First pass approval is complete and YOD is FY2011-12 to FY2012-13. Phase 6 first pass approval FY2009-10 to FY2010-11 and YOD FY2011-12 to FY 2012-13.

UNITED KINGDOM - Delay in Royal Navy SSBN Replacement Program

In early July 2009, AMI received information that the Royal Navy (RN) was delaying its Initial Gate milestone decision on the Vanguard SSBN replacement submarine by one year. Initially, the decision was scheduled for the end of 2009. The decision will now slip to 2010. Initial Gate approval would have provided a green light to move forward with contract awards for a detailed design

for the new submarine; it would have also committed the government into spending the initial US$4.9B for the program in 2009.

The delay in the program can be attributed to several reasons. The first is that the Ministry of Defence is facing severe budgetary shortfalls and the SSBN is no exception. Other reasons are political. The first is that there is a growing call in the United Kingdom to disestablish the nation's nuclear deterrent capability. Secondly, the British government wishes to await the outcome of the five-year review conference of the Nuclear Non-Proliferation Treaty (NPT) that will take place in the United States next year. The conference on the NPT may indicate a reduction in the nuclear threat and hence less justification to replace the Vanguard class, or even the eventual withdrawal of the United Kingdom from the nuclear club.

Two other major question marks at this time are the recently negotiated nuclear arms reduction talks between the US and Russia and the now pending Nuclear Posture Review (NPR) that is taking place in the US. Both of these issues will probably affect the US Ohio class submarine replacement program and its missile component, the Trident II. As mentioned in the previous article, the US and the UK are joined in these two programs as engineering, technical services, concept studies and design of a Common Missile Compartment (CMC) are being conducted for the US and UK.

Perhaps another reason for this delay is to align their program more closely with the US SSBNX and benefit from significant design commonality.

With so many policy unknowns developing over the next several months and the UK budget scenario getting worse, it makes sense for the MoD and the RN to put the brakes on the Vanguard replacement program for one year in order to clarify the future requirements and establish framework for developing the future US and UK SSBN fleets.

INTERNATIONAL - World Missile Developments

Russia: In July 2009, Russia conducted three tests of submarine launched ballistic missiles (SLBM), two from Delta IV submarines that are part of the Northern Fleet and one from the DMITRY DONSKOI (Typhoon class) in the White Sea.

Various Did You Know?

France: On 26 June 2009, the first plate for the second Barracuda class submarine was cut at DCNS' Cherbourg Shipyard.

Russia: On 24 July 2009, the second Yasen (Project 885) class nuclear-powered attack submarine (SSN), KAZAN, began construction at Sevmash in Russia.

From the August 2009 Issue

AUSTRALIA - Submarine Study Tenders Due on 04 September 2009

On 10 August 2009, the Defense Material Organization (DMO) announced that it would begin taking tenders for the Royal Australian Navy (RAN) Domestic Submarine Design Capability Review for SEA 1000. The Request for Tenders (RfT) will close at 12:00 PM Friday 04 September 2009. AMI first announced this opportunity on 12 August 2009 when it released HOT NEWS FLASH 02 for the Domestic Submarine Design Capability Review. The closing date remains 04 September for all interested parties.

SEA 1000 covers the proposed acquisition of the RAN's future submarine, to replace the Collins class submarines as they are withdrawn from service beginning in 2025. Preliminary work is aimed at supporting future project submissions to the Australian Government. Components of these submissions will address design options for SEA 1000. One option that requires investigation is a possible domestic Australian design.

The contractors shall undertake a comprehensive study of local industry, including the area of conventional submarine design. The outcomes of the study will include:

- A description of the submarine design process.
- Research existing submarine design capability in Australia.
- A gap analysis of the current Australian domestic submarine design capability against a mature submarine design capability.
- Development options to facilitate Australian industry goal to reach a fully mature submarine design capability.

The Future Submarine Program (SEA 1000) currently calls for the acquisition of up to twelve submarines costing an estimated US$22.9B. The first unit will enter service in 2025 suggesting a construction contract for the first unit will need to be in place by 2022. The detailed design phase will start in 2013.

UNITED STATES - US House approves 10 Ships, Waiting for Senate

On 30 July 2009, the US House of Representatives passed its version of the Fiscal Year (FY) 2010 Defense Appropriations Bill (HR3326). The legislation provides US$13B for 10 ships, which is US$949M and two ships above the Administration's budget request. In the accompanying report to the bill, the House appropriators expressed their concern over the Department of Defense's failure to submit a shipbuilding plan that would achieve the current force structure requirement for a 313 ship fleet.

House appropriators also stated their strong desire to increase stability in the nation's shipbuilding industrial base by increasing the quantity of ships being constructed each year. The House bill fully funds the following:

- One Virginia class submarine and the advance procurement to fund the building of two submarines beginning in 2011.
- One Arleigh Burke class destroyer.
- Two Lewis & Clark class dry cargo ships (T-AKE).
- Four Littoral Combat Ships (LCS), one more than the Administration's request.

- Two Joint High Speed vessels (JHSVs), one more than the Administration's request.

The research and development (R&D) account will provide US$495M for the development of the Ohio class ballistic missile submarine (SSBN) replacement.

The US Senate is expected to complete its version of the FY 2010 Defense Appropriations Bill when Congress returns from the August recess.

INDONESIA - Submarine Program Slips to 2011

In late August 2009, AMI received information that the Indonesian Navy (IN) has again delayed its procurement of submarines until at least 2011 due to budget shortfalls. Even considering a 20% increase in the defense budget for 2010, the Minister of Defense stated that the new submarine and jet fighter programs would be put on hold.

Additionally, in what appears to be a step back from the preference for the Russian Kilo design in late 2007, the Minister also stated that the final decision on a supplier is still being considered. South Korea, Germany, Russia and France have offers on the table and Indonesia will probably make a decision on the preferred supplier in 2010, assuming the budget issues have been worked out.

AMI believes that the front runners in the program are probably still Russia and South Korea. Russia and South Korea have historically been involved in counter-trade agreements with Indonesia. Russia has also been a major supplier of air and ground equipment to Indonesia. South Korea has major ties to the IN as the supplier of fast attack craft (FAC), patrol vessels and landing ship programs. Most recently, South Korea was involved in the sale of the Tanjung Dalpele class landing platform, dock (LPD) design, in which the first two units were built at Dae Sun in Korea and the last three to be built at Indonesia's PAL. South Korea has also modernized one of Indonesia's Cakra (Type 209/1300) class submarines, with the second scheduled for the near term if and when funding becomes available.

Various Did You Know?

RUSSIA - On 14 August 2009, the Russian Navy Delta III class nuclear powered ballistic missile submarine (SSBN) RS BORISOGLEBSK (496), was officially decommissioned. The RS BORISOGLEBSK was removed from service in December 2008.

THE SUBMARINE REVIEW

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

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

A stipend of up to $200.00 will be paid for each major article published. **Articles accepted for publication in the REVIEW become the property of the Naval Submarine League**. The views expressed by the authors are their own and are not to be construed to be those of the Naval Submarine League..

Comments on articles and brief discussion items are welcomed to make **THE SUBMARINE REVIEW** a dynamic reflection of the League's interest in submarines.

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

THE SUBMARINE COMMUNITY
THE LAST SKIPPER

by Captain James Patton, USN(Ret)

Captain Patton commanded PARGO (SSN650) and is now President of Submarine Tactics and Technology of North Stonington, CT.

Background

In a previous piece for the NSL THE SUBMARINE REVIEW titled *The First Skipper*, it was stressed just how important that individual was for a young officer on his first submarine, and how fortunate I had been to have had CDR Buz Bessac as that first CO on SCORPION (SSN589). I didn't realize it then, but he was treating me as a PCO – not a bad concept for the care and feeding of all JOs, since that is exactly what they are.

Not mentioned in that first article, but the subject of this one, is the equal if not greater importance of one's *last* Skipper – the one you have as XO – your last opportunity to learn the finer points of the submarine trade before you have to go off and do it without adult supervision–as a CO yourself. I was again very fortunate in this regard in that for me this individual was CDR Bruce DeMars on new construction CAVALLA (SSN684). These two *bookends* to my 13-year submarine apprenticeship served me well when I was given the opportunity to command PARGO, and their entirely different but complementary styles influenced many of the *good* decisions I made in that job. The *bad* decisions were entirely of my own doing.

If *The First Skipper* was really lecturing to COs and JOs about the critical nature of that *initial* submarine experience, than *The Last Skipper* is doing the same for present and future COs and XOs about how that last phase of the apprenticeship–the *residency* if you will – can and should be conducted.

Discussion

The experience didn't start well however. From refueling/decontamination Engineer of DANIEL WEBSTER (SSBN626) at Newport News I had gone to the Pentagon for a year before agreeing to do a year (with 6 month Med deployment) as Third Officer on LAPON (SSN661) – the understanding being that I could then pick the boat/CO in Norfolk for my XO tour, having previously just bought our first home in Newport News.

Upon finishing that tour and calling BuPers, I was told "...sorry about that, but all the XO jobs in Norfolk are filled, and you'll be going to build CAVALLA at EB, homeport Pearl Harbor". This was 1971, and I/we had moved at least once a year since USNA graduation in 1960 and now even had furniture and two small kids – I was not happy.

That evening CDR DeMars called me at home and in his trademarked laid-back and low key manner, said he was happy to have gotten me, that I had a great background – yadayadayada etc. This seemed the final straw – not only had I never heard of this guy, but my previous service with more senior submariners I'd served with had lead me to conclude that the really good ones – Buz Bessac, Yogi Kaufman, Ken Carr, Whitey Mack, Jerry Holland et. al. – were anything *but* laid back and low-key, and even sometimes bordered on boisterous. Now it looked like I was stuck with a Type B Casper Milquetoast for a Skipper.

There was nothing to rent in the New London area, and we had to buy a second house – hoping someday to get back to the one in Newport News. Long-hull 637s were being pumped out like popcorn in those days, running some ten months from launch to delivery. I considered myself an old hand when it came to shipyard tours having earlier built FLASHER and JAMES MONROE and overhauled DANIEL WEBSTER, and as such, was coming in late and going home early – the CO being already there when I arrived and still there when I left.

This went on for three-four weeks until CDR DeMars asked me one day "Jim, can I see you in my office?" My reply was something in the order of "Well Captain, I'm kind of busy, but OK..." In his office he took out a yellow legal pad and, calmly

and without emotion (Yogi used to throw things at me) began running down a long list of my shortcomings and failures – "... I told you to have this finished by so and so, and it's still not done; you told me this and such would happen and it hasn't; thus and such was done wrong - twice" and on and on.

After several pages and many minutes he had gotten my attention, and I had concluded that: one – he's going to fire me, and two – I deserve it. Setting down the legal pad, I got a long and powerfully quiet stare before he said "As XO, I want everyone else in the world to think *you're* running this ship – but don't ever *you* get confused." From that point on things were gangbusters, and I really took aboard the valuable lesson that: no, all the good ones *aren't* loud and extroverted.

The Skipper had a talent for cutting to the quick of an issue and was a master of the "Occam's razor" philosophy – the simplest answer is usually the best. At one point during the precommissioning period he asked me how I was coming on ship's instructions. I told him I was plagiarizing (pre-word processors) as fast as I could, and was thankful that there were more letters in SILVERSIDES than in CAVALLA, but that we were required to have some hundred or so instructions.

> "Like what?" he asked, already knowing where this conversation was going.
>
> "Well, for instance, SECNAV requires us to have an instruction on how we are going to train reservists when they're aboard for active duty." I replied.
>
> "We're not going to have reservists on board for active duty – don't do that one. In fact, you can have as many ship's instructions you want as long as it's not more than twelve. And remember, the importance of doing what your bosses direct in things like this is inversely proportional to their seniority. If SECNAV or the CNO directs something, don't bother – if the Squadron Commander tells us, get right on it."

"Yes sir" I answered with incredible sincerity and gratitude.

"And Jim, tell the Department Heads they can have *one* instruction – their Organization Manual – and if they want Chapter One to be about training, then Chapter One in *all* the Department Organization manuals will be about training – their choice." (before the standardized Engineering Organization Manual)

In my day I have seen more than a little *lip service* given to how one takes care of the people entrusted to them, but few actually did it more sincerely and effectively than Bruce DeMars, and I brought many of his techniques with me to Command. For example, each quarter he would meet in private with each of the paygrades sequentially, ask them what their issues were, and promise to do something about valid complaints if he could. After one such meeting with the Seamen he told me to find at least six bunks in crew's quarters (less the Goat Locker) where there was a locker at either the head or foot of the bunk. I did, and a request was put into EB to extend the bunk 6 inches into the locker, and to fabricate cushioned "extenders" that effectively increased the length of the bunk. It turned out that one exceptionally tall Seaman had told him that he never got a good night's sleep aboard, because he just didn't fit into the standard bunk length. These six bunks were preferentially assigned to tall enlisted crew members regardless of rank.

Analogous to the above was the response to the complaint of junior crew members living aboard that although they understood the need to bunk in the torpedo room while at sea, they didn't understand why better bunking went unused 2/3 of the time when in port. The *fix* in this case was that in port duty sections bunked in one given section of crew's berthing, and that junior personnel living on board were temporarily assigned better berths where no wake-up calls would be being made for others through the night. In all of such fixes to an individual or group problem, there was a parallel issue of *selling* the fix to others affected – again skillfully done on the basis of honest dialogue – "Here's the problem, here's

what I am doing to solve it, the solution is in the best interests of the ship, and I'd like your support in the matter".

When we started going to sea the Skipper told me there was a set of rules he'd like followed – i.e.:

- There would be a movie in the Wardroom *every* night
- The movie would start at *precisely* 2000
- The CO would always watch the whole movie
- The CO would never *pick* the movie
- Whoever picked the movie had to watch the whole thing
- No one could watch the movie standing up

It took a while to decipher the logic behind all this, but it was simply a Command-endorsed and guilt-free two hours of sloth every night after a hard day's work which someone like the Engineer couldn't spoil by waiting till the lights went out, coming into the Wardroom for a cup of coffee, then leaning on the sideboard waiting to leave between reel changes – making everyone else feel bad because he *was working*.

Conclusions

In retrospect, the most extraordinary observation of those almost three years on CAVALLA was that there was only *one* Bruce DeMars. It is extremely difficult to deal with all people in the exactly same manner, but if the CO was on the phone as I passed his office, I could not tell, by the tone and manner of his speaking, whether he was talking to his wife, Admiral Rickover, Seaman Smith, or Seaman Smith's wife – he treated everyone with the same even respect and dignity. Even today, Admiral B. DeMars, USN (Ret) is exactly the same person I knew and served with as CDR B. DeMars.

As is probably true for everyone in our profession (and most others), every CO (and XO) I served under shaped me to some degree, but some more than others. It is almost inescapable that the two that will affect a submariner the most will be his first and last Skipper.■

CHEAP TRANSPORTATION

by CAPT Dave Smith, USN(Ret)

In the November 2008 issue of SHIPMATE, page 63, Dave Cruden commented on how in 1953 he and Tom Murtagh, shipmates on USS QUINCY, had purchased a 1941 Buick in Long Beach for $100. The story reminded me of the ritual at Portsmouth Naval Shipyard in the 1950's, '60's and 70's. Just about the time a submarine entered the shipyard for overhaul, another would be leaving. Thus there were always several *junkers* for sale by the departing wardroom, for the going price of $100. The officers of the incoming submarine would always buy up the lot and keep them in running condition until they departed the shipyard, at which time the $100 sale would continue the tradition.

In the mid-1960's I was XO of JACK precommissioning unit and classmate Herb Tibbetts was Weapons Officer on JOHN ADAMS. One Friday evening, after celebrating T.G.I.F. at the shipyard officer's club, Herb offered to give me a ride home and I accepted. As soon as I got into the passenger's seat of his $100 station wagon, Herb commented that I should "Hold on until I get the car moving." I asked "Why?" and he replied "Because the seat is not fastened to the car." Herb started the car, the forward motion caused the seat and both of us to tilt backward a bit, but holding onto the door and dash we were off on our homeward journey. What can you expect for $100?■

NAVAL SUBMARINE LEAGUE
COMPARATIVE STATEMENT OF FINANCIAL POSITION
As of:

	31-Mar-08	31-Mar-09	Change
ASSETS			
CURRENT ASSETS			
Cash	$ 121,023	$ 182,663	61,640
Cash Equivalents	39,564	24,177	-15,387
Accounts Receivable	24,229	6,379	-17,850
Investments at Market	373,437	274,708	-98,729
Prepaid Expenses	7,447	7,156	-291
			0
Total Current Assets	$ 565,700	$495,083	-70,617
FIXED ASSETS			
Furniture & Computer Equipment	36,359	36,359	0
Office Condominium	251,021	251,021	0
	287,380	287,380	0
Less Accumulated Depreciation	(154,155)	(162,310)	-8155
Total Fixed Assets	133,225	125,070	-8,155
	$ 698,925	$620,153	-78,772
LIABILITIES			
CURRENT LIABILITIES			
Accounts Payable	$ 0	$ 0	0
Accrued Expenses	4,930	4,392	-538
Deferred Income	66,162	87,731	21,569
Deferred Membership Dues	63,160	64,277	1,117
Rental Deposit	675	675	0
	134,927	157,075	22,148
Total Current Liabilities			
LONG-TERM LIABILITIES			
Deferred Membership Dues	210,076	219,579	9,503
			0
TOTAL LIABILITIES	$ 345,003	376,654	31,651
NET ASSETS			
UNRESTRICTED			
Undesignated	332,772	222,349	-110,423
Board Designated for Equipment	21,150	21,150	0
RESTRICTED	0	0	0
	353,922	243,499	-110,423
	$ 698,925	$ 620,153	-78,772

NAVAL SUBMARINE LEAGUE
COMPARATIVE STATEMENT OF ACTIVITIES

For The Year Ended:			31-Mar-08	31-Mar-09	Change
REVENUES	Restricted	Unrestricted	Total	Total	
Contributions			$ 151,839	$230,312	78,473
Dues			64,415	61,275	-3,140
Annual Symposium			138,543	225,510	76,967
Subtech Symposium			269,760	293,913	24,153
History Symposium			3,000	3,653	653
Bank Interest			0	0	0
Interest & Dividends			31,848	15,755	-16,093
Advertisements			24,075	26,100	2,025
Rent			8,640	8,640	0
Realized & Unrealized Market Gain (Loss) On Investment			(39,891)	(112,489)	-72,598
Royalties			194	0	-194
CB Days Receipts			30,480	43,500	13,020
Other			2,114	3,719	1,605
Total Revenue			**685,017**	**789,888**	**104,871**
EXPENDITURES					
Awards and Grant			7,178	28,667	21,489
Publishing			83,230	85,924	2,694
Promotion			63,702	83,064	19,362
Annual Symposium			171,422	224,334	52,912
Subtech Symposium			223,356	230,984	7,628
History Symposium			6,877	6,245	-632
Chapter Support			13,822	16,279	2,457
Total			569,587	675,497	105,910
SUPPORTING SERVICE			208,362	224,814	16,452
Total Expenditures			**777,949**	**900,311**	**122,362**
INCREASE (DECREASE) IN NET ASSETS			**(92,932)**	**(110,423)**	**-17,491**
NET ASSETS, BEGINNING OF YEAR			**$ 446,854**	**353,922**	**-92,932**
NET ASSETS, END OF YEAR			**$ 353,922**	**$243,499**	**-110,423**

NAVAL SUBMARINE LEAGUE

COMPARATIVE STATEMENT OF ACTIVITIES

Detail of expenses for Supporting Services in the Statement of Activities follows:

For The Year Ended:	31-Mar-08	31-Mar-09	Change
SUPPORTING SERVICES			
Accounting/auditing	$ 6,400	$ 6,560	160
Bank Charges	10,404	18,288	7,884
Depreciation	8,155	8,155	0
Equipment rental & repair	10,300	6,409	-3,891
Miscellaneous	1,320	1,877	557
Office Supplies	6,969	6,621	-348
Payroll Taxes	12,920	16,188	3,268
Casual Labor		2,016	2,016
Postage	8,666	9,111	445
Printing	3,685	7,338	3,653
Fees	5,266	7,340	2,074
Telephone	3,216	3,451	235
Transportation	1,331	2,169	838
Wages	110,984	113,667	2,683
Memberships & Subscriptions	1,232	1,522	290
Office occupancy	6,522	7,091	569
Computer install/Training	4,606	1,312	-3,294
Investment expense	2,070	1,383	-687
Insurance	4,316	4,316	
Total	**$ 208,362**	**$224,814**	**$ 16,452**

NAVAL SUBMARINE LEAGUE 2009 AWARD WINNERS

JACK N. DARBY AWARD
CAPT BRADFORD S. NEFF, USN

FRANK A. LISTER AWARD
CMDCM (SS) DAVID W. SMITH, USN

CHARLES A. LOCKWOOD AWARD
LCDR MICHAEL S. ANSLEY, USN

CHARLES A. LOCKWOOD AWARD
MMCS (SS) DAVID JANOWSKI, USN

CHARLES A. LOCKWOOD AWARD
SK1 (SS) BRETT M. ADAMS, USN

FREDERICK B. WARDER AWARD
MMCM (SW) NORMAN T. CREMEANS, USN

LEVERING SMITH AWARD
LCDR PAUL B. SPRACKLEN, USN

GOLD DOLPHIN AWARD
CAPT MICHAEL W. BROWN, USN

SILVER DOLPHIN AWARD
ETCM (SS) ROBERT E. MELTON, USN

DISTINGUISHED CIVILIAN AWARD
MR. MICHAEL W. TONER

DISTINGUISHED SUBMARINER AWARD
TEAM SUBMARINE

NAVAL SUBMARINE LEAGUE

2009 LITERARY AWARD WINNERS

1ST PRIZE: VADM JIM SAGERHOLM, USN(RET)

WHY THE U-BOAT CAMPAIGN FAILED

2ND PRIZE: MASTER CHIEF JAY EVERITT, USN(RET)

JAPANESE WAR CRIMES TRIALS

3RD PRIZE: CAPTAIN RAIMUND WALLNER, GERMAN NAVY (RET)

GERMAN SUBMARINES: MYTH DOES NOT EXPLAIN SUCCESS

ACTIVE DUTY PRIZE: LT. CHRIS BERNOTAVICIUS, USN

THE 0S & 1S OF UNDERSEA WARFARE; COMPUTING IN USW

Naval Submarine League Honor Roll

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American Systems Corporation
Applied Mathematics, Inc.
Booz Allen Hamilton, Inc.
Cortana Corporation
Curtis-Wright Flow Control Corporation
DRS Technologies, Inc.
General Dynamics Advanced Information Systems
General Dynamics Electric Boat
Kollmorgen Corporation, Electro-Optical Division
Lockheed Martin Corporation
Northrop Grumman Shipbuilding
Northrop Grumman Corporation - Sperry Marine Division
Pacific Fleet Submarine Memorial Association, Inc.
Raytheon Company
RIX Industries
SAIC
Sonalysts, Inc.
Systems Planning and Analysis, Inc.
The Babcock & Wilcox Company
The Boeing Company
Treadwell Corporation
Ultra Electronics Ocean Systems, Inc.
URS Corporation, EG&G Division

Benefactors for More Than Ten Years

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AMADIS, Inc.
American Superconductor Corporation
Battelle
Goodrich Corporation, EPP Division
Hamilton Sundstrand Energy, Space & Defense
L-3 Communications Ocean Systems
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McAleese & Associates, P.C.
Northrop Grumman Corporation - Marine Systems
Northrop Grumman Corporation - Undersea Systems
Perot Systems Government Systems
Rolls Royce Naval Marine, Inc.
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OceanWorks International, Inc.
Oil States Industries/Aerospace Products Division
Pinkerton Government Services, Inc.
Progeny Systems Corporation
SSS Clutch Company, Inc.
Superbolt, Inc.
Whitney, Bradley & Brown, Inc.

Additional Benefactors

3 Phoenix, Inc. (New in 2009)
Advanced Technology Institute
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Cunico Corporation
DRS Sonar Systems, LLC (New in 2008)
Dynamic Controls, Ltd. (New in 2008)
Epsilon Systems Solutions, Inc.
Ettem USA, Inc.
IBM Global Business Services, Public Sector
Imes Strategic Support – Ltd.
In-Depth Engineering Corporation (New in 2009)
Imes
iRobot Maritime Systems
L-3 Chesapeake Sciences Corporation (New in 2008)
L-3 Communications, Space and Navigation Division (New in 2009)
Lockheed Martin Corporation - Space Systems Company (New in 2009)
Lockheed Martin UK - Strategic Systems Ltd. (Formerly Imes)
Murray Guard, Inc. (New in 2009)
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