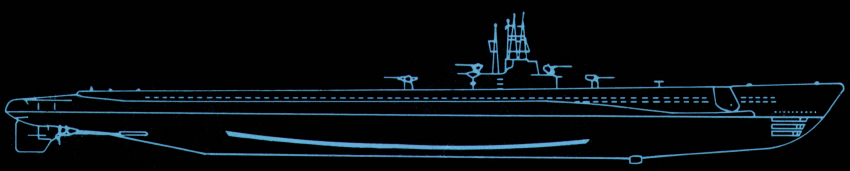
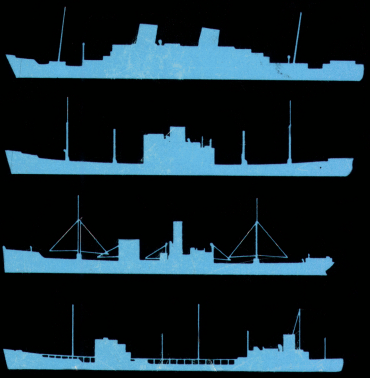




SUBMARINE ACTION IN THE SOUTH PACIFIC

UP PERISCOPE!

SUBMARINE ACTION IN THE PACIFIC

by
John Patten,
Captain USN (Ret.)

NOTICE: THIS MANUAL COVERS SUBMARINE HISTORY, STRATEGY, AND TACTICS. TO OPERATE THE UP PERISCOPE! PROGRAM, READ THE *"SUBMARINE OPERATIONS HANDBOOK"*.

First Edition
First Printing

ActionSoft Corporation
122 South Race Street, Suite 4
P.O. Box 1500
Urbana, IL 61801
(217) 367-1024

TABLE OF CONTENTS

TABLE OF CONTENTS

INTRODUCTION

Shortly after joining SubLOGIC Corporation in May 1986, I was delighted to learn that I would have an opportunity to assist in the development of a World War II submarine simulation. As the result of an agreement with ActionSoft, a new software company, SubLOGIC would provide technical assistance in developing and marketing a line of action/strategy simulation software. This product, Up Periscope!, is the first in this new product line. I am delighted to participate in this project because I regard it as an opportunity to tell at least some of the American people about the tremendous courage, skill, and sacrifices of a small group of U.S. Navy officers and men during World War II.

On the afternoon of December 7, 1941 the Chief of Naval Operations issued the following directive: "EXECUTE UNRESTRICTED AIR AND SUBMARINE WAR AGAINST JAPAN." During the subsequent war years, the American people became well aware of the air war but the role of the submariner was not well publicized. In my own case, even after four years at the Naval Academy, I had little appreciation of just how effective American submarines had been in the war against Japan. Then in April 1961, nearly two years after graduating from the Naval Academy, I reported to Submarine School in New London, Connecticut for submarine training. During the six months at Submarine School and the more than twenty years of service aboard or in support of submarines that followed, I have learned and re-learned of the tremendous accomplishments of U.S. submarines during World War II. Even though more than 40 years have elapsed since the end of the war, the submarine story is still worth telling and one that we can learn from today. It is my sincere desire that this manual and my input to the strategic and tactical aspects of Up Periscope! will help the American people learn of this magnificent heritage.

As you read through this manual, two points may help avoid some confusion. The first is that submarines are combatant ships in the truest sense of the word. However, the first submarines were so small and limited in range, speed, and weaponry that they were called "boats." This tradition has continued to the present day - even Trident submarines are called boats. Secondly, any officer in command of a ship is called "Captain" regardless of his (or her) rank.

Most submarine commanding officers in World War II held the rank of Lieutenant Commander (equivalent to major in the Army, Air Force or Marines), and some were promoted to the rank of Commander while they were in command. Regardless of their rank, they had all the classic responsibilities of a commanding officer of a ship at sea, and were called "Captain." In some cases in this manual, I will refer to a submarine as a "boat" and will sometimes refer to an individual commanding officer as "Captain" even though his military rank was Lieutenant Commander or Commander.

U.S. SUBMARINE OPERATIONS IN THE PACIFIC IN WORLD WAR II

Strategy deals with the big picture - where and with what missions will forces be deployed - while tactics are the techniques used in the actual engagements. In a very simplified sense, strategy is the goal you have set out to accomplish and tactics are how you are going to do it. American national strategy in World War II was to win the war in Europe first, then drive on to victory in the Pacific. This meant that the American and Allied forces in the Pacific were to harass and resist Japanese advances until the American forces could be rebuilt and become strong enough to go on the offensive. Initially, this meant retreat from the Philippines, the Marianas, Wake, and the Netherlands East Indies. Admiral Ernest J. King, Commander in Chief of the U.S. Fleet, instructed Admiral Nimitz to maintain sea lines of communication between Hawaii and the West Coast, maintain control of the Hawaii-Midway line, and maintain sea lines of communication between the west coast and Australia. For American submarines, this meant cutting the Japanese sea lanes to (1) restrict Japan's ability to reinforce and resupply their troops in captured territory, and (2) weaken Japan's ability to wage war so they would be less able to resist the eventual Allied offensive.

World War II in the Pacific was a naval war; success or failure depended to a large extent on which side controlled the sea. In the early days of the war, the Imperial Japanese Navy controlled huge expanses of the Pacific Ocean in which American and Allied surface ships and aircraft could not operate. The extent of Japanese control is shown In Figure 1. The U.S. submarines, however, could, and did, operate in enemy-controlled waters. They started immediately. On the afternoon of December 7, 1941, Admiral King, Commander in Chief of the United States Fleet (later called the Chief of Naval Operations), sent the following message to all Pacific submarines, "EXECUTE UNRESTRICTED AIR AND SUBMARINE WARFARE AGAINST JAPAN." The submariners wasted no time in responding to the order. During 1942 and 1943 they were the only force that could carry the war to the seas surrounding the Japanese homeland. They did so with exceptional courage and valor.

Overwhelming success did not come immediately. The submariners, though neither afraid nor the least bit hesitant to go anywhere, had to

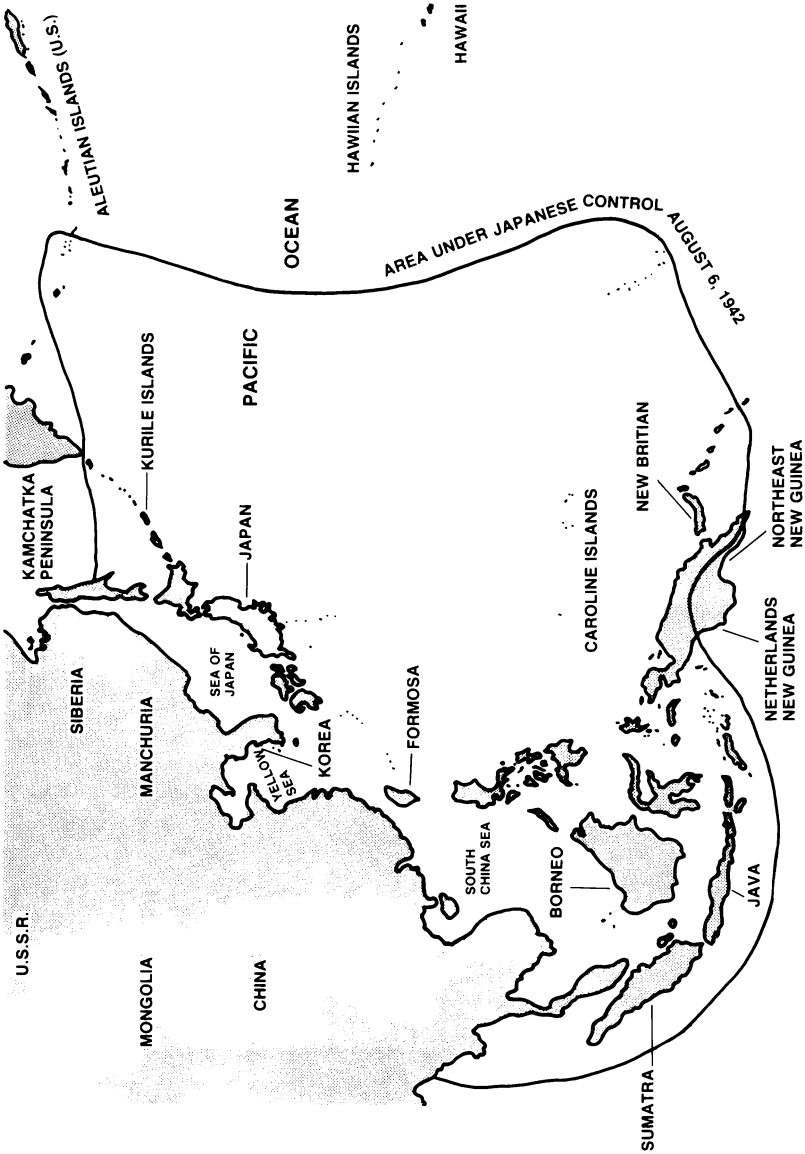


Figure 1. Japanese domination of the Pacific early in WWII

first overcome two major obstacles: these were a very conservative attack doctrine and faulty torpedoes.

During the 1920's and 1930's, submariners came to believe that a submarine at periscope depth was very vulnerable to detection and attack by aircraft. They concluded that the best way to conduct an attack was to remain deep, below the depth at which a periscope could be used, and shoot their torpedoes using only information obtained from sound equipment. This doctrine was proven false in the early months of the war; periscope depth attacks soon became routine during daylight and surface attacks were common at night.

The torpedo problem was not corrected as easily. In fact, it took two years to completely solve the problem. These two years were terribly frustrating for the submarine crews. They routinely risked their lives penetrating enemy controlled waters to conduct daring attacks on valuable targets. All too frequently these daring attacks came to naught because their torpedoes either ran too deep or failed to explode even though they hit the target.

Two wartime experiences illustrate the terrible frustrations caused by torpedo problems. In April, 1943 USS Tunny made a textbook approach on a Japanese task force and maneuvered into position between two aircraft carriers. The skipper, Lieutenant Commander J. A. Scott, was able to fire both bow and stern torpedo tubes at both targets under almost perfect conditions. Three torpedoes were seen to explode but only a little damage was done to one of the two targets. The observed explosions were undoubtedly premature due to improper exploder operation. At least some of the others probably hit their targets but failed to explode. Then in July, 1943, USS Tinosa, commanded by Lieutenant Commander L. R. Daspit, fired at a 19,000 ton tanker and got hits with two torpedoes. The ship didn't sink but lost all power and was unable to maneuver. She was a sitting duck. Lieutenant Commander Daspit took Tinosa to the optimum firing position - 875 yards abeam of the target. He fired nine more torpedoes and all hit but none exploded! Evidence like this helped Admiral Lockwood, COMSUBPAC, attack the problem. Before long, progress was being made due to Admiral Lockwood's determined efforts to find the solution.

TORPEDO DESIGNS, PROBLEMS AND SOLUTIONS

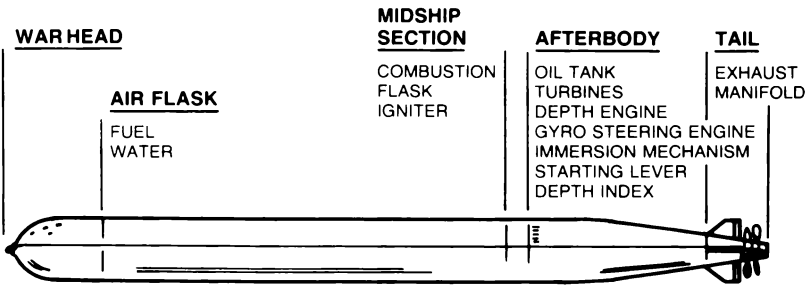


Figure 2. Typical torpedo design

Figure 3. Ship's magnetic field used to activate "Magnetic Influence Exploder" in the Mark 14 torpedo

TYPE	CHARACTERISTICS
MARK 10	STEAM POWERED OBSOLETE AT BEGINNING OF WAR SMALL WARHEAD SLOW BUT RELIABLE
MARK 14	FASTER THAN MARK 10 STEAM POWERED USED NEW "MARK 6" EXPLODER MANY PROBLEMS INITIALLY (erratic depth and duds)
MARK 18	USED NEAR END OF WAR ELECTRIC POWERED SLOWER THAN MARK 14, BUT MADE NO TELL-TALE WAKE TO GIVE SUB POSITION AWAY

Figure 4. Torpedoes of WWII

At the beginning of the war, U.S. submarines carried two types of torpedoes, the officially obsolete Mark 10, and the new and more powerful Mark 14 (see Figures 2 and 4). The Mark 10 was a proven weapon, though slower than the Mark 14 and armed with a smaller, less powerful warhead. The Mark 14 had been developed in the period between the World Wars when money for national defense was severely limited. The Naval Torpedo Station at Newport, Rhode Island - responsible for testing torpedoes - had an annual budget of $70,000! The Mark 14 torpedo test program was conducted as much to save money as to accurately test torpedo performance. As a result, there was little data on torpedo depth control or on the highly secret, very complicated Mark 6 exploder.

Both torpedoes had a tendency to run deeper than the depth set by the submarine. In January 1942, the Mark 10 was found to run four feet deeper than the set depth. Submarine skippers could easily fix this problem by setting the torpedo to run four feet shallow. The Mark 14 was another story. At first the technical bureau that designed the torpedo refused to believe that it's depth control was in error. Only after Admiral Lockwood, Commander Submarines Pacific (COMSUBPAC), provided undeniable proof of erratic depth performance, was the problem finally corrected in August 1942.

Fixing the depth control problem was only a partial solution. Even more difficult to explain was the problem of duds. These were torpedoes that hit the target but failed to explode. TNT and other explosives used in torpedo warheads do not explode easily. An exploder mechanism must be used to start the explosive chain. The Mark 6 exploder used in the Mark 14 torpedo was designed to explode when it entered, or was "influenced" by the magnetic field surrounding the target. (A magnetic field surrounds any iron or steel ship. See Figure 3.) Because of this feature, it was known as a "magnetic influence exploder." It was also designed to explode if the torpedo hit the side of a ship -- to explode "on contact." Unfortunately, problems existed in both the influence and contact features. These problems caused many torpedoes to either (1) explode prematurely, that is, before they were close enough to the target to cause damage, or (2) to actually hit the target but not explode.

Finally, in November 1943 - almost two years after the attack on Pearl Harbor - the torpedo problems were solved. Many submariners have wondered how the character of the war might have been changed if the Mark 14 torpedo had performed properly right from the beginning of the war.

Despite many problems, not all torpedoes malfunctioned and some very successful attacks were made. There were some notable successes in 1942. Between 4 May and 30 December, USS Greenling, under the command of Lieutenant Commander H. C. Burton, sank 10 ships totalling 47,500 tons. USS Guardfish sank five ships totalling 46,700 tons, including three in one day! This patrol, conducted off the coast of Honshu in August and September, demonstrated how effectively the submarines were carrying the war to the enemy's own backyard. They brazenly entered areas totally closed to surface ships and aircraft. In fact, the Guardfish crew watched a Japanese horse race through the periscope and even took pictures to prove it!

Other notable patrols in 1942 were conducted by USS Seawolf commanded by the legendary "Fearless Freddie" Warder, by USS Seadragon, Tautog, Triton, and Drum among others. In all, 133 merchant ships totalling over 560,000 tons were sunk in 1942. Despite the torpedo problems, the United States submarines succeeded in making their presence felt. In many respects, it was the beginning of the end for the Japanese industrial war machine (see Figure 5).

These early submarine patrols marked the beginning of the end because Japan is an island nation and depends on her merchant ships and tankers for the food and raw materials necessary to feed, clothe, and support her population. In 1941, 3,000,000 tons of merchant ships and tankers were necessary to sustain the civilian population. In addition, another 3,000,000 tons of shipping were required to support the war effort. The raw materials used to build military equipment were carried to the home islands by ship. Then the military supplies and ammunition built in the Japanese factories were transported by ship to the Japanese forces stationed throughout Southeast Asia. Oil was a particularly critical item. Japanese tanks, trucks, and planes had to be supplied with oil and gasoline. Their source was the oil fields and refineries in the Netherlands East Indies - Java, Sumatra, and Borneo (see Figure 6). The oil and gasoline had to be carried by seagoing tankers. For Japan to continue to prosecute the war, at least 6,000,000 tons of cargo ships and tankers were needed. 560,000 tons of shipping were sunk by submarines in 1942 but the Japanese shipyards could only build 260,000 tons. At no time during the course of the war were they able to build ships faster than the submarines were sinking them.

1942 - The Noose Tightens

Month	Ships Sunk	Gross Tonnage
January	7	28,351
February	5	15,975
March	7	26,183
April	5	26,886
May	20	86,110
June	6	20,021
July	8	39,356
August	17	76,652
September	11	39,382
October	25	118,920
November	8	35,358
December	14	48,271
	133	561,465

Figure 5. Japanese ships sunk by U.S. submarines in 1942

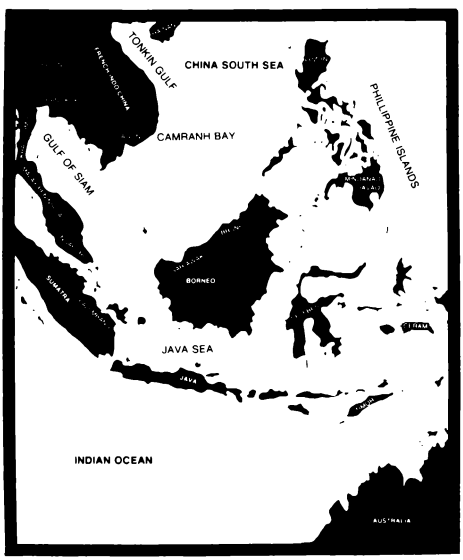


Figure 6. The Netherlands East Indies area; source of Japanese raw materials

Although there were some very bleak and terrible times when the U.S. Navy was outnumbered and fighting against terrible odds, 1942 also marked the turning point of the whole Pacific war. Early 1942 was a period of Japanese conquest and Allied retreat; retreat from Wake Island, the Philippines, from Java and the Marianas. It was a period of retreat up to the line that Admiral King had said must be held, and then the tide began to turn. The first turning point was the Battle of the Coral Sea, a tactical victory for the Imperial Japanese Navy, but a strategic defeat because it caused the Japanese to call off their plans to invade Port Moresby and stopped their southward expansion.

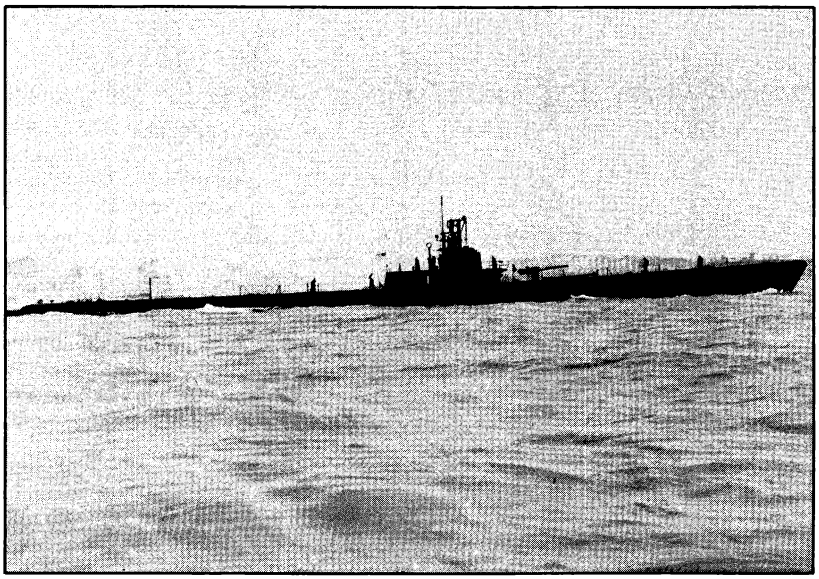
There were two other turning points in 1942; the Battle of Midway, which marked the end of Japanese expansion in the Central Pacific, and Guadalcanal. Midway was a clear U.S. victory since the Japanese lost four aircraft carriers and hundreds of experienced pilots. Replacement pilots had to be trained, and training required aviation gasoline. There was never enough gasoline to train enough pilots and Japanese naval aviation never recovered from the Battle of Midway. Guadalcanal was the first Japanese territory taken by Allied Forces, specifically by the United States Marine Corps and the U.S. Navy. 1942 did not mark the beginning of the Allied offensive push, but it did mark the end of Japanese expansion.

Just based on the fact that sinkings exceeded the Japanese capacity to build ships, 1942 was a successful year for the United States Submarine Force. But if 1942 was a good year, 1943 was excellent. 35 new submarines had been built and commissioned in 1942 and a new boat was arriving in the Pacific almost every other week. The torpedo problem was recognized, if not completely solved, and the skippers were becoming more skilled at conducting attacks. And for the Japanese merchant fleet, 1943 was a disaster. At the beginning of the year nearly 7,000,000 tons of Japanese shipping was afloat, more than enough ships to sustain her war economy. At the end of the year, just over five million tons were afloat, one million tons less than the minimum needed to support the war. The noose on the Japanese war economy was slowly but surely being tightened.

FAMOUS PATROLS OF 1943

1943 featured many highly successful patrols; USS Silversides, Tautog, Trigger, and Seahorse, to name just a few. In addition, 1943 was the year that submarines entered the Sea of Japan, which might be comparable to an enemy submarine entering Long Island Sound! It was also the year in which wolf-packs became common.

A wolf-pack was a group of two, three, or four submarines patrolling together and conducting coordinated attacks. One of the submarine skippers or a senior officer from the COMSUBPAC staff was assigned as the wolf-pack commander. This was also the year when two legendary skippers made their first patrols in command -- Dudley "Mush" Morton in USS Wahoo and Sam Dealey in USS Harder. The Wahoo's exploits are perfect examples of both the frustrations and the successes of the Submarine Force in 1943. No other submarine sank more shipping in 1943 or attacked more relentlessly or aggressively than Wahoo (see Figure 7). Her story is worth repeating.



Courtesy U.S. Naval Institute

Figure 7. USS Wahoo, commanded by "Mush" Morton - a legendary Skipper of WWII

RE-LIVING FAMOUS PATROLS AND HISTORICAL SITUATIONS WITH UP PERISCOPE!

The historical situations and famous patrols described in the following pages can be acted out with the Up Periscope! program.

PACIFIC PATROL - These are long games where your goal is to trace the path of the patrol as shown on the chart and engage enemies as encountered. Use the Big Chart to navigate along the course and go into normal simulation mode when battle areas are reached.

HISTORICAL SITUATIONS - These are short games. Your submarine is placed in the middle of the battle shown on the situations's chart. The goal is to try to do as well as the famous skipper did in the tight situation he encountered.

1. When starting the program (or ending a previous game) select PACIFIC PATROL or HISTORICAL SITUATION from the Scenario Menu. Select either Pacific Patrol or Historical Situation by looking at the upper left corner of the page on which the situation is described.

2. Depending on your selection, either the Pacific Patrol Menu or the Historical Situation Menu will appear. Match up the menu situation to the situation of interest in the manual and select it.

3. The Features Menu appears next. The patrol or situation selection automatically sets the features (date, equipment, rank, etc.) to match the real scenario as closely as possible. Enemy ships are placed accordingly. You can change some of the features if you want, but the more you change, the less realistic the scenario becomes. For no changes, simply type [C] to exit the menu and continue the game.

Five patrols and four situations are described in this section. The descriptions make good reading, and you might enjoy reading the entire WWII history section including descriptions before trying the situations on the computer. Two more patrols and three more situations are presented in the *Additional Patrols and Situations* section of this manual.

Historical Situation

USS WAHOO'S SECOND ENCOUNTER UNDER CAPTAIN MORTON: THE SINKING OF A CONVOY

Lieutenant Commander Morton made one patrol as a Prospective Commanding Officer (PCO) on Wahoo and then "fleeted up" to skipper in January 1943. The ship had not had an illustrious history, sinking only one ship through the first year of the war, but that was about to change. Her first action with Captain Morton occurred when they penetrated nine miles into an enemy-controlled harbor and damaged a Japanese destroyer. Two days later Wahoo met and attacked a convoy of four ships (see Figure 8). The Wahoo skipper sent the following message:

> "IN TEN HOUR RUNNING GUN AND TORPEDO BATTLE DESTROYED ENTIRE CONVOY OF TWO FREIGHTERS ONE TRANSPORT ONE TANKER . . . ALL TORPEDOES EXPENDED . . . RETURNING HOME."

Admiral Lockwood responded with the following message:

> "COME ON HOME, MUSH. YOUR PICTURE'S ON THE PIANO."

In the post-war assessment of inflicted damage, the sinking of the tanker could not be confirmed so Wahoo was officially credited with only three sinkings. The tanker was probably damaged but was able to return to port. In any event, this was an auspicious beginning for the new commanding officer of USS Wahoo!

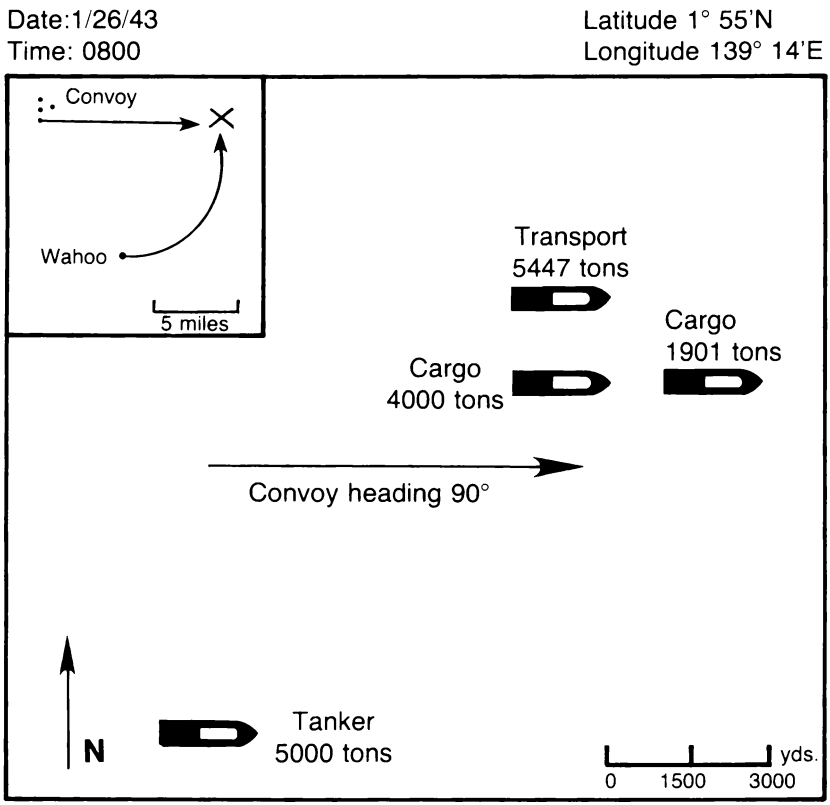


Figure 8. Tactical chart of Wahoo's second encounter

Famous Patrol

USS WAHOO'S SECOND PATROL UNDER CAPTAIN MORTON: TEN DAYS - NINE SHIPS SUNK!

Wahoo departed Pearl Harbor for her second patrol under Captain Morton in February 1943. This patrol was conducted in the Yellow Sea, a relatively shallow body of water between Korea and the Asian mainland considered to be solidly under Japanese control and safe for all Japanese ships (see Figure 9). It was no longer safe after March 19, 1943, the day that Wahoo started sinking targets. In ten days nine Japanese ships were sunk.

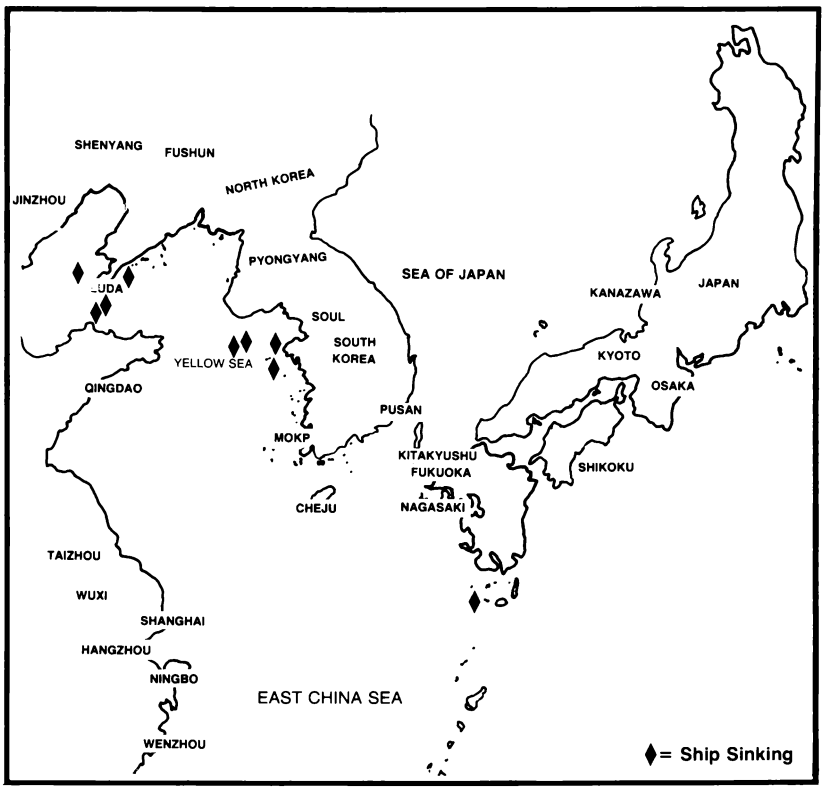


Figure 9. Wahoo's second patrol. Sail from Pearl Harbor to Korea and sink ships in the Yellow Sea.

Famous Patrol

USS WAHOO'S SIXTH PATROL UNDER CAPTAIN MORTON:
A PATROL IN THE SEA OF JAPAN

Following Wahoo's comparatively disappointing fifth patrol, the third under Captain Morton (only three ships were sunk), the ship returned to the West Coast for overhaul and returned to Pearl Harbor to prepare for her sixth patrol, which was to be conducted in the dangerous Sea of Japan.

Patrols in the Sea of Japan were particularly hazardous because the subs had to transit a very narrow and restricted channel both on entering and leaving. The area is diagrammed in Figure 10 and the entry and exit lanes are also shown. This dangerous transit was through the La Perouse Strait, an easily defended "choke point." Other passages could not be used because they were mined and the submarines had no way to detect mines. The first patrols in the Sea of Japan were conducted in July by three submarines, Plunger, Permit, and Lapon. The operation was intentionally held to only three days to prevent the Japanese Navy from closing the La Perouse and bottling up the submarines. The results were disappointing because only three ships were sunk, but it was a successful operation since it proved that submarines could operate in the body of water called "The Emperor's Private Ocean."

In company with USS Plunger, a veteran of the first foray into the Sea of Japan, "Mush" Morton and Wahoo departed Pearl Harbor on August 8, 1943 with orders to conduct patrols in the emperor's backyard. Both ships safely entered their assigned areas but both were plagued with torpedo problems. In four days Wahoo attacked nine ships but all escaped due to malfunctioning torpedoes. In disgust, Morton sent a radio message to COMSUBPAC and Wahoo was recalled to Pearl Harbor to get a fresh load of torpedoes.

Wahoo returned to the Sea of Japan on September 20 with a load of the new Mark 18 electric torpedoes. Their orders were to depart the area on October 21 and send a message to Pearl Harbor when they were once again in the broad Pacific. This message was never received, and on November 9 USS Wahoo was declared "Overdue and presumed lost." Admiral Lockwood concluded that Wahoo had been sunk by a Japanese mine and he decided that it was too

dangerous to send more submarines to the Sea of Japan. They did not return until 1945 when they were equipped with mine detection equipment. After the war, examination of Japanese records revealed that a submarine had been attacked in the La Perouse Strait on October 11, 1943. This was probably Wahoo. Japanese records also revealed that a series of attacks were conducted in Wahoo's patrol area beginning on the 29th of September and four ships, totalling 13,429 tons were sunk. The loss of Wahoo and her courageous skipper and crew was a severe blow, but they left behind a gallant heritage (see Figure 11).

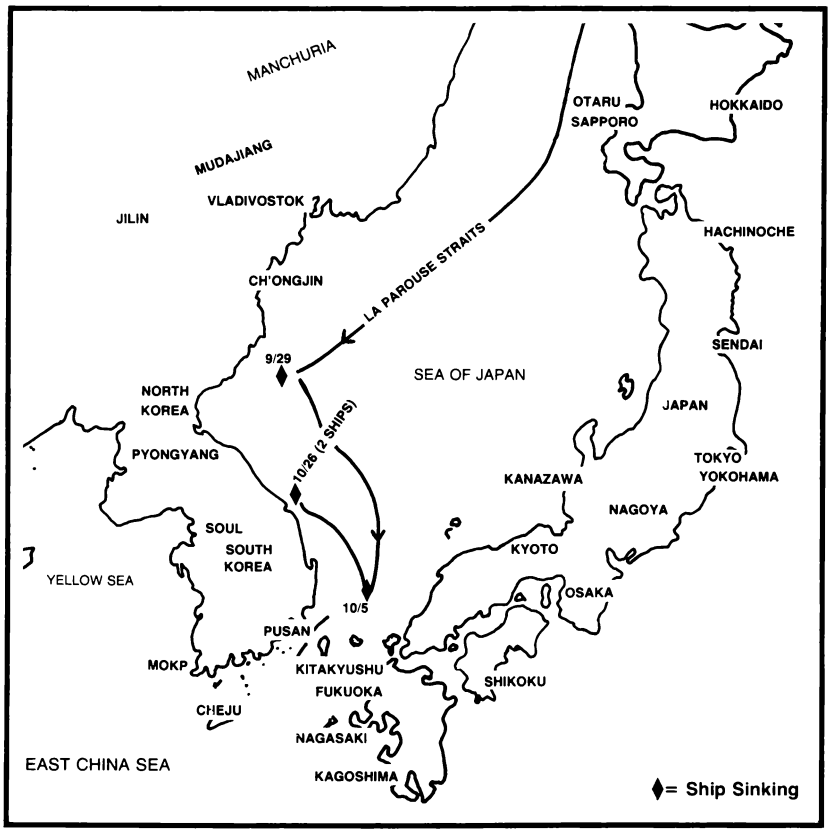


Figure 10. Wahoo's sixth and final patrol. Sail from Pearl Harbor to the Sea of Japan.

DATE	NAME OF SHIP	TYPE	TONNAGE	LOCATION	
26 JAN 1943	UNKNOWN	CARGO	4,000 (EST)	2-37N, 139-42E	SOUTH PACIFIC OFF NEW GUINEA
26 JAN 1943	BUYO MARU	TRANSPORT	5,447	1-55N, 139-14E	
26 JAN 1943	FUKUEI MARU NO.2	CARGO	1,901	1-55N, 139-14E	
19 MARCH 1943	ZOGEN MARU	CARGO	1,428	38-29N, 122-19E	YELLOW SEA
19 MARCH 1943	KOWA MARU	TRANSPORT	3,217	38-27N, 122-18E	
21 MARCH 1943	NITTSU MARU	CARGO	2,183	38-05N, 124-33E	
23 MARCH 1943	UNKNOWN	CARGO	2,427 (EST)	38-37N, 121-01E	
24 MARCH 1943	TAKAOSAN MARU	CARGO	2,076	39-01N, 122-25E	
25 MARCH 1943	SATSUKI MARU	CARGO	827	38-10N, 123-26E	
25 MARCH 1943	UNKOWN	CARGO	2,556 (EST)	38-13N, 123-24E	
29 MARCH 1943	YAMABATO MARU	CARGO	2,556	30-26N, 129-41E	
7 MAY 1943	TAMON MARU NO.5	PASSENGER CARGO	5,260	40-05N, 141-53E	CENTRAL PACIFIC
9 MAY 1943	TAKAO MARU	PASSENGER CARGO	3,204	38-57N, 141-49E	
9 MAY 1943	JINMA MARU	CARGO	1,912	38-57N, 141-49E	
29 SEPT 1943	MASAKI MARU NO.2	CARGO	1,238	40-00N, 130-00E	SEA OF JAPAN
5 OCT 1943	KOMON MARU	TRANSPORT	7,908	34-00N, 130-00E	
6 OCT 1943	UNKNOWN	PASSENGER CARGO	1,228	37-18N, 129-33E	
9 OCT 1943	KANKO MARU	CARGO	2,995	37-18N, 129-33E	
		19 SHIPS	54,683		

Figure 11. USS Wahoo's scorecard

By all standards, United States submarines had an excellent year in 1943. The Japanese war economy was feeling the pinch (see Figure 12). Although they had more tanker tonnage available than they had on December 7, 1941, oil and and gasoline were in short supply. It should also be emphasized that the casualties that resulted were not innocent civilian passengers but were troop reinforcements and cargoes of war materials. These losses were significant and undoubtedly saved many American lives. But all this was not accomplished without cost. Seventeen American submarines were lost in 1943.

1943 - The Japanese War Economy Feels the Pinch

Month	Ships Sunk	Gross Tonnage
January	18	80,572
February	10	54,276
March	26	109,447
April	19	105,345
May	29	122,319
June	25	101,581
July	20	82,784
August	19	80,799
September	38	157,002
October	27	119,623
November	44	231,683
December	32	121,531
	307	1,366,962

Figure 12. Japanese ships sunk in 1943

1943 also was the year when the United States and her allies began a two-pronged offensive. The island-hopping campaign across the central Pacific and General MacArthur's drive toward the Philippines started pushing the Japanese back from the territory they had conquered in the early months of the war. In 1943 the Allies were no longer on the defensive and their offense was in full swing. The general scheme of the two-pronged strategy is shown in Figure 13.

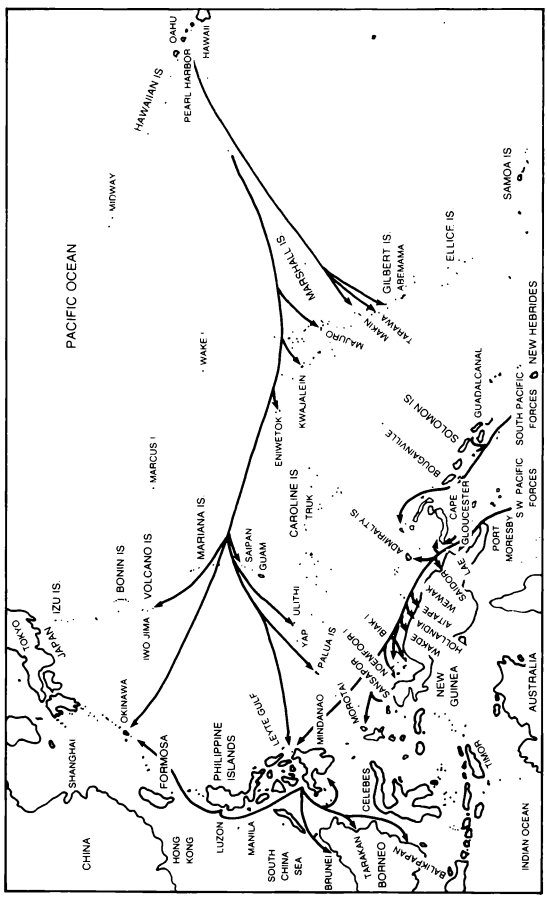


Figure 13. The two-pronged offensive

FAMOUS PATROLS OF 1944

If 1942 was a good year and 1943 excellent, 1944 was spectacular! In January alone, submarines sank more tonnage than in the first seven months of the war. The February tonnage was even better - over 240,000 tons! Almost half of it was sunk by six submarines; Tang, Snook, Pogy, Rasher, Puffer, and Grayback. When the year was over, 2,450,000 tons of shipping had been sent to the bottom by U.S. submarines. Less than 2 million tons of cargo ships and 861,000 tons of tankers were still afloat. The empire was rapidly becoming a hollow shell. In fact, by the end of the year the rate of sinkings was decreasing because there was a lack of targets! By the end of 1944, Japan's merchant and tanker fleet was less than half what it was at the beginning of the war. Lack of ships was only part of the story - many ships that were still afloat were unable to go to sea. They either lacked fuel or were unable to repair damaged machinery because they lacked the required parts.

For the submariners, 1944 was a year of many outstanding patrols, some of them legendary. Albacore and Archerfish each sank an aircraft carrier! Archerfish, commanded by Joe Enright, sank the Shinano, largest ship in the world at that time. 1944 was the year when Eugene B. Fluckey took command of USS Barb and sank ten ships in four patrols. USS Flasher, first commanded by Reuben I. Whitaker and then by G. W. Grider, sank 20 ships totalling more than 99,000 tons! USS Harder under Sam Dealey sank four destroyers and two frigates and became known as the destroyer killer. Her war cry was like a football cheer - "Hit 'em Harder!" USS Jack sank 12 ships including five tankers. Lapon sank ten for 51,537 tons. "Red" Ramage won a Congressional Medal of Honor for a daring surface attack on a convoy in which he fired 19 torpedoes in 46 minutes! Fourteen ships were sent to the bottom by Rasher. USS Seahorse accounted for 15 ships, 14 of them while commanded by Slade Cutter. USS Spadefish didn't leave on her first patrol until late July but still managed to sink ten ships before the year was over.

Famous Patrol

USS TANG'S FIRST PATROL UNDER LIEUTENANT COMMANDER DICK O'KANE: SINK A FEW SHIPS HERE, AND A FEW SHIPS THERE!

No single submarine or skipper can be singled out as "the best," but few can compare with USS Tang under Lieutenant Commander Dick O'Kane. The skipper had been Executive Officer on Wahoo and learned his trade from "Mush" Morton. He was a good student. Tang departed Pearl Harbor on January 22, 1944 for her first patrol and made her first contact with the enemy near Truk on February 17 (see Figure 14). The contact was a two ship convoy escorted by a destroyer and five smaller anti-submarine vessels - an unusually strong escort for such a small convoy. Evading the escorts, Tang sank one of the ships, a 6,854 ton freighter. Five days later, near Saipan, Tang met a three ship convoy with four escorts. Two of the three ships were sunk. A few days later, a freighter and a tanker escorted by one destroyer came into Tang's area. Both ships were destroyed by Tang torpedoes. In her first patrol, Tang fired all 24 torpedoes, got hits with 16, and sank five ships. Not bad for a "rookie!"

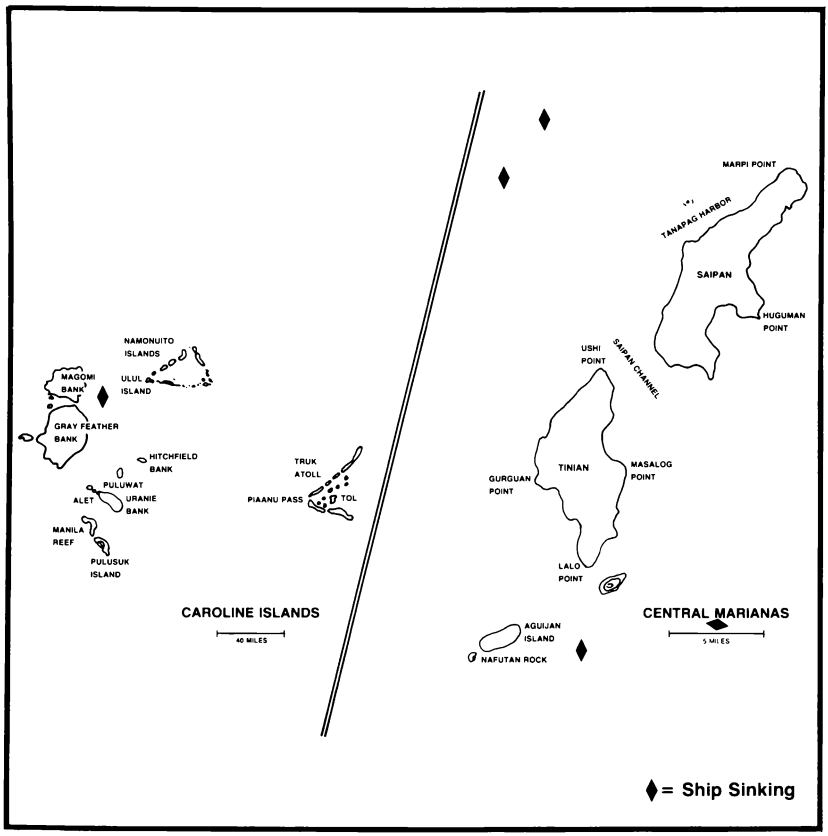


Figure 14. USS Tang's first patrol

Tang's second patrol was notable for two things: (1) no ships were sunk, and (2) Tang rescued 22 downed aviators. Her mission was to be a lifeguard for a carrier air strike on the large Japanese naval base at Truk. 35 planes were shot down during the raid and Tang rescued 22 of the pilots. The 13 who were not picked up crashed either on the island or inside the reef. Not even Dick O'Kane and Tang could climb over a reef!

Famous Patrol

USS TANG'S THIRD PATROL UNDER LIEUTENANT COMMANDER DICK O'KANE: A RECORD-SETTING PATROL

Tang's third patrol was a record-setter. The patrol was conducted in the East China Sea and in the Yellow Sea (see Figure 15). First contact with the enemy was on June 24. A convoy of six large ships, accompanied by an unusually large number of escorts, was detected. O'Kane made a daring but calculated penetration of the escort screen on the surface and fired six torpedoes. The skipper was confident that two ships had been sunk but post-war evaluation confirmed that four ships totalling 16,292 tons had been sent to the bottom! Then on June 30, a 5,705 ton freighter was sunk and the next day, July 1, a small freighter and a small tanker were destroyed. Tang celebrated Independence Day by sinking two more cargo ships totalling nearly 14,000 tons. On the 6th of July she used her last two torpedoes to sink a cargo ship. The score for this patrol was ten ships. It set a record for number of merchant ships and total merchant tonnage sunk in one patrol.

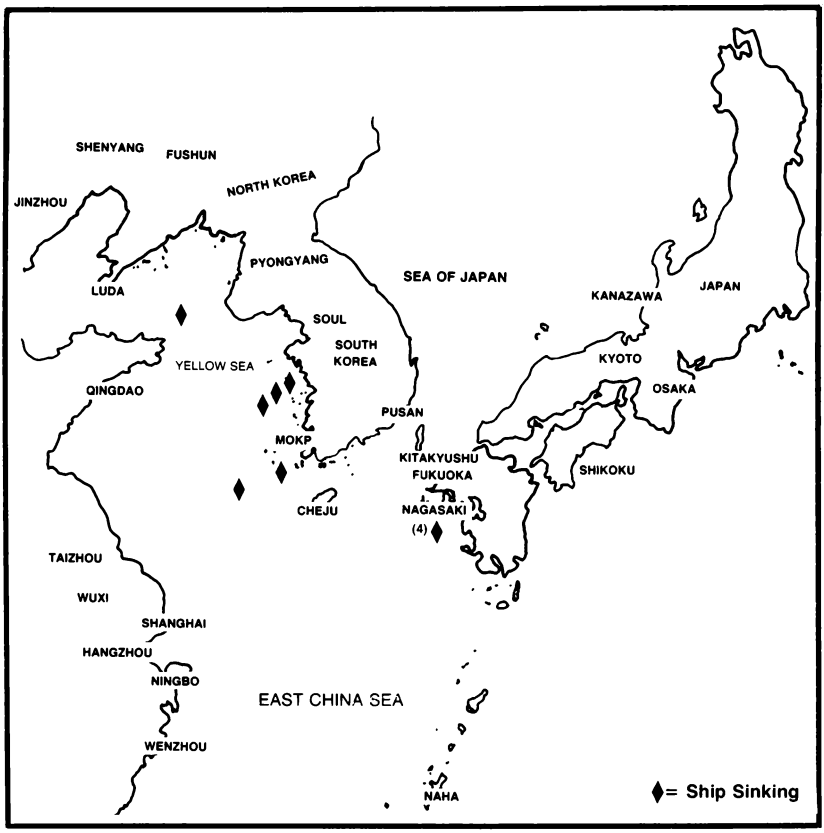


Figure 15. USS Tang's third patrol

The fourth patrol of USS Tang was a disappointment. Conducted off the coast of Honshu, torpedo problems caused some attacks to fail. Only two ships are officially listed as sunk, though others were damaged.

Famous Patrol

USS TANG'S FIFTH AND FINAL PATROL: THE MOST OUTSTANDING PATROL OF THE WAR

The fifth and final war patrol was both a masterpiece and a tragedy. It was conducted in the Formosa Strait, a chokepoint on a shipping lane that was vital to the Japanese war effort. The area is shown in Figure 16. Many of the supply ships needed to reinforce the Philippines came through this strait. After the war, Commander Yamaguchi, Staff Operations Officer, 2nd Japanese Air Fleet, was questioned about the mission and effectiveness of Japanese naval air in late 1944, specifically in defense of the Philippines. The gist of his testimony was that their effectiveness was minimal because they had too few planes and a scarcity of repair parts for those that were available. In his opinion, the scarcity of repair parts was due to submarine attacks on the shipping. He also stated that reinforcements were too few and too late and the reason was the same - submarine attacks. The Formosa Strait was essential to the Japanese defense of the Philippines, but for a period in October, 1944 USS Tang was like a cork in the bottle.

On the night of October 10-11, 1944 the cork was put in place and Tang sank two freighters. For the next 12 days no traffic was found so O'Kane analyzed the shipping lanes and selected an area where hunting would probably be better. He made a good choice. On October 23 a five ship convoy with two escorts was detected and attacked. Captain O'Kane cooly drove Tang into the middle of the convoy and then started shooting torpedoes. The night scene was soon illuminated by burning and sinking ships. O'Kane reported sinking or damaging all five ships but post-war Japanese records only reported three ships sunk and Tang is officially credited with these three sinkings. If the other two ships survived, they were probably severely damaged. The actual torpedo firings took place in less than ten minutes!

(continued on following page)

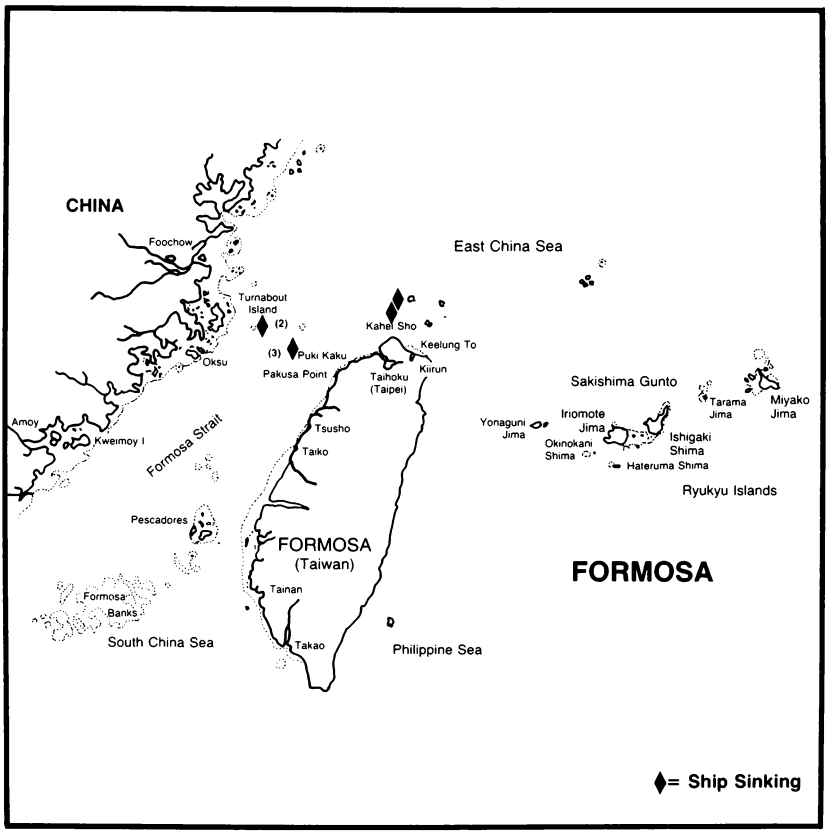


Figure 16. USS Tang's fifth and final patrol

Famous Patrol *(continued)*

The next night, October 24, Tang intercepted another convoy. There were many cargo ships, tankers and troop transports loaded with planes, vital supplies, oil and gasoline, and troops desperately needed by the Japanese garrisons on the Philippine island of Leyte. Once again, Dick O'Kane drove Tang into the convoy on the surface and fired six torpedoes, two at a tanker and four at two transports. All six were observed to hit, and in the resulting melee, Tang fired three more torpedoes as he avoided the escorts and withdrew. Tang had two torpedoes left so O'Kane cleared the convoy to recheck these last two fish, planning to go back to finish off any damaged ships or stragglers. When all was ready, O'Kane carefully took Tang back to a transport which had been damaged earlier. The target was dead in the water but was protected by two escorts. O'Kane was able to slip by the screen and close to within 900 yards. Tang was in perfect position. The first torpedo was launched and was seen to run "hot, straight and normal" toward the middle of the damaged ship. The second was fired a few seconds later but immediately broached, began to porpoise, and circled to the left. Captain O'Kane immediately ordered flank speed and desperately tried to get away from the errant torpedo. He almost succeeded, but the torpedo struck Tang at the after torpedo room.

Nine personnel, including Commander O'Kane, were on the bridge when the torpedo struck and they were thrown into the water. One officer escaped from the conning tower as the submarine was sinking. Thirteen men managed to escape from the forward torpedo room using Momsen lungs. Nine of the 23 survived through the night and were picked up by a Japanese patrol boat the next morning. They spent the rest of the war in a Japanese prison camp.

Following the war, this fifth patrol of USS Tang was officially described as the most outstanding patrol of the war. Commander O'Kane, later promoted to Rear Admiral, was awarded the Congressional Medal of Honor and Tang was awarded her second Presidential Unit Citation. (Only three ships were awarded two Presidential Unit Citations, and two of them were submarines!) Thus ended the brief life of one of the fightingest ships to ever go to sea in any time or in any navy.

1944 - The Destruction of the Japanese Merchant Fleet

Month	Ships Sunk	Gross Tonnage
January	50	240,840
February	54	256,797
March	26	106,529
April	23	95,242
May	63	264,713
June	48	195,020
July	48	212,907
August	49	245,348
September	47	181,363
October	68	328,843
November	53	220,476
December	18	103,836
	547	2,451,914

Figure 17. Japanese ships sunk in 1944

1944 was the year in which U.S. submarines essentially destroyed the Japanese merchant marine and totally crippled her war economy (see Figure 17). In October, more than 328 thousand tons of shipping were sunk, the highest number of any month of the war. They steadily declined thereafter because there simply weren't many targets to shoot at!

Although there were still a large number of Japanese tankers afloat, oil shortages became very critical for the Japanese in 1944. Tanker losses had been replaced by a frantic building program and conversion of other types of ships to allow them to carry oil. In fact, Japan had more tanker tonnage afloat on December 1, 1944 than she did on December 1, 1941. Despite the availability of tankers, the oil lifeline between Japanese home islands and the Netherlands East Indies had been cut and oil deliveries were far less than the minimum needed to support the war effort. Beginning in December, 1944 this situation rapidly grew worse for the Japanese.

The final destruction of Japan's tanker fleet was started by USS Flasher in December. Flasher was one of the great ships of the war. She is officially credited with sinking 100,231 tons of merchant and naval shipping, more tonnage than any other U.S. submarine. Her first skipper was Lieutenant Commander Reuben Whitaker, and the ship had some outstanding patrols under his leadership. Then in December, now commanded by Commander George Grider, Flasher started to work on Japanese tankers.

Historical Situation

USS FLASHER IN THE SOUTH CHINA SEA: A BATTLE IN A STORM

On December 4, 1944 Flasher was in the South China Sea operating as part of a wolf-pack with USS Hawkbill and USS Becuna. About 8 o'clock in the morning Flasher detected a tanker convoy and headed in to the attack (see Figure 18). The weather was poor, with rain squalls and low visibility. Grider took periscope observations as the weather permitted. At one point a cloudburst obscured all targets and when it cleared Grider spotted a Japanese destroyer between Flasher and the tankers. He fired four torpedoes at the destroyer and two hit, causing extensive damage but not sinking her. He then quickly fired four torpedoes at a large oiler but couldn't wait to see the results because a second destroyer was bearing down on him. Flasher went deep to avoid the second destroyer but heard two torpedoes hit the tanker. Sixteen depth charges were dropped on Flasher, many of them close, but Flasher successfully evaded. Returning to periscope depth, Grider found the tanker was still afloat but dead in the water. A destroyer was standing by, about 500 yards from the damaged ship. Flasher closed the range and fired four torpedoes, two set to run shallow and get the destroyer and two set to run under the destroyer and hit the tanker. All four torpedoes performed according to plan and all four hit. Flasher was again subjected to a severe depth charging but was able to evade her attackers. About 2:00 PM she was again at periscope depth. The tanker was still afloat but on fire. Both destroyers were nowhere to be seen. Three small escorts were in the vicinity. Captain Grider took Flasher in close to the burning tanker and finished her off with one more torpedo. Her score for the day was two large destroyers and one large 10,000 ton tanker.

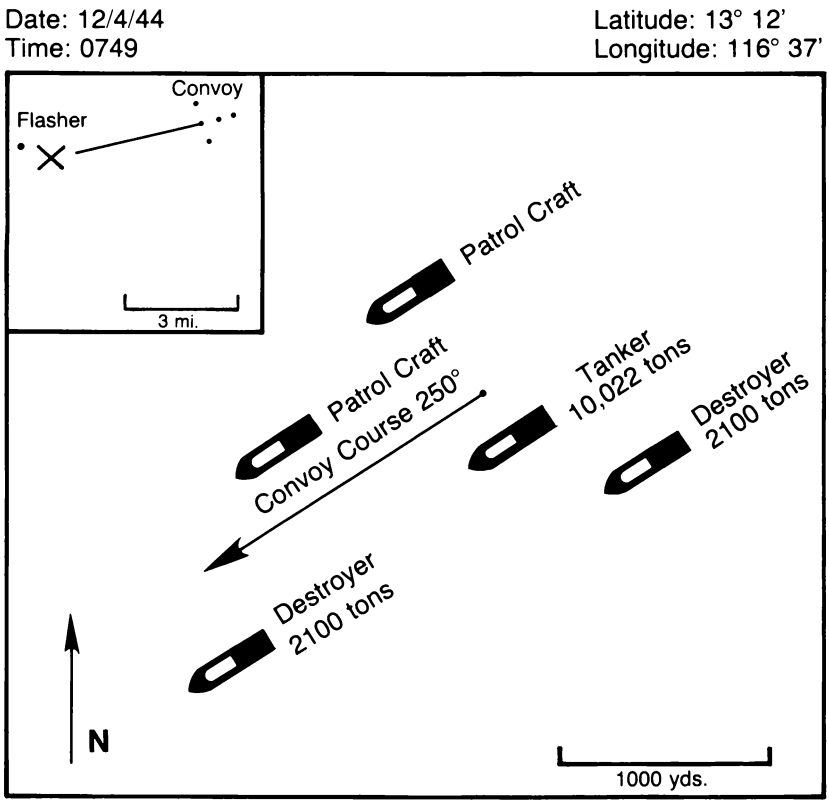


Figure 18. Tactical chart of USS Flasher's battle in the South China Sea

Historical Situation

USS FLASHER ALONG THE INDO-CHINA COAST:
ATTACKING TANKERS NEAR THE COAST

Bad weather persisted for two weeks and hunting was not good. But on December 20 another convoy was detected heading north along the Indo-China coast (see Figure 19). The seas were so rough that Grider figured that torpedoes would not be able to perform properly so he moved to seaward and tracked the convoy until the weather improved. Two days later the seas had abated sufficiently so that an attack was possible. The convoy consisted of five tankers, three escorts and one destroyer. They were hugging the coastline with the tankers close to shore and the escorts patrolling to seaward. Captain Grider decided to attack on the surface, from the shoreward side. He skillfully avoided the screening escorts and moved into position between the tankers and the coast. He fired three bow torpedoes at the leading tanker, three more at the second, and then swung the boat around and fired four torpedoes from his stern tubes at the third ship. All three targets were hit and blew up, covering the water with burning oil and gasoline. Flasher withdrew on the surface at flank speed without being detected.

In this one patrol Flasher sank two destroyers totalling 4200 tons and four tankers totalling 38,668 tons - the best "tanker shoot" of the war.

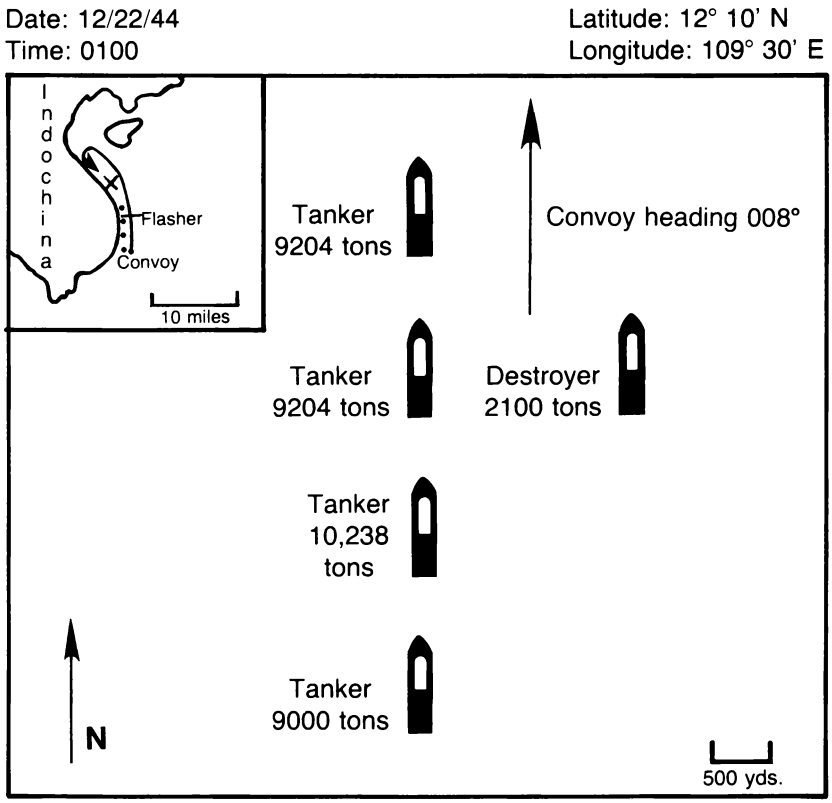


Figure 19. USS Flasher attacking tankers near the coast of Indo-China

Historical Situation

USS BARB INTERCEPTS A CONVOY BOUND FOR TAKAO

As 1945 began, submarine skippers became more innovative at locating and sinking targets. Commander Gene Fluckey, skipper of USS Barb, concluded that convoys were proceeding in very shallow water along the coast during the day and anchoring in protected, mined anchorages at night. When near the coast, submarines could not conduct submerged attacks because the water was too shallow, and at night they couldn't conduct a surface attack because the targets were safely anchored inside a protected harbor. Two submarine skippers, Gene Fluckey in Barb and George Street in Tirante, were awarded Congressional Medals of Honor for attacking convoys while they were anchored.

No convoy could remain in shallow water forever - sooner or later they would have to transit across a body of deep water. In these cases, the submarines would track the convoy while it was in shallow water and then attack ferociously when the targets ventured into deep water. This was a natural situation for coordinated wolf-pack attacks, as was done on 8 January 1945 by Barb, Queenfish, and Picuda.

The convoy was first detected by Barb in the Formosa Straight, apparently headed for Takao on the southwest coast of Formosa. Captain Fluckey informed the rest of the wolf-pack and made an end around in order to attack from the west. This would accomplish two things; (1) prevent the convoy from escaping into the shallow water along the China coast, and (2) cause the convoy to evade toward the waiting Picuda and Queenfish. Barb made a submerged periscope approach and fired all six bow tubes at two targets, and was swinging around to fire the stern tubes when both targets were hit. One blew up with a tremendous explosion. Barb went deep to evade a counter-attacking destroyer and reload her bow tubes.

When the reload was completed it was dark so Captain Fluckey surfaced and chased the remnants of the convoy. He fired three tubes at one ship and observed two hits, but post-war analysis did not confirm the sinking. He then attacked another ship, a 9256 ton passenger-cargo ship which blew up. Queenfish also sank a tanker from this convoy. the net result was four ships sunk and at least two others damaged, out of the eight ships that tried to make it to Takao.

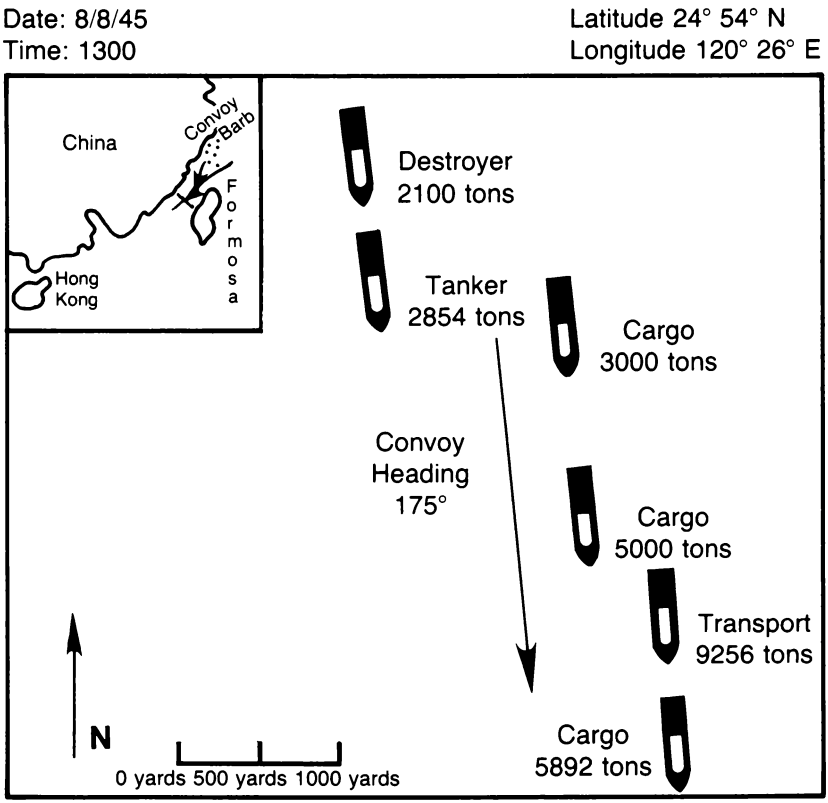


Figure 20. USS Barb intercepts a convoy

In March, 1945, 150,000 barrels of oil were imported into Japan from the south. It was the last oil to reach the home islands from the southern oil fields for the duration of the war.

Then in June, 1945, the Sea of Japan was once again entered by U.S. submarines. No American submarine had entered the "Emperor's private ocean" since the loss of USS Wahoo in 1943. The decision to stay out of the Sea of Japan was made by Admiral Lockwood because he felt that Wahoo had probably hit a mine. This time the boats were equipped with a new mine detecting sonar system and were able to safely transit the Tsushima straits between Japan and Korea. In twelve days 27 Japanese ships and one submarine were sunk, totalling 57,000 tons. Without the ability to safely import food and raw materials from the Asian mainland, Japan was doomed and the end of the war was obviously drawing near. Continuation of hostilities was no longer the only issue -- feeding and sustaining the population, both military and civilian, was equally important. Figure 21 shows the drop in raw material imports as the war came to a close.

Japanese Imports of Raw Materials (does not include oil)

Year	Metric Tons
1940	22,039,600
1941	20,004,430
1942	19,402,090
1943	16,411,880
1944	10,129,610
1945	2,743,200

Figure 21. Japanese imports of raw materials

Cargo ships, troop ships and tankers were not the only submarine targets during the war. Ships of the Imperial Japanese Navy (IJN) were also attacked with notable success. In January, 1942, USS Gudgeon sank a Japanese submarine, the first warship sunk by a U.S. submarine. At the Battle of Midway, generally considered to be the turning point of the war, USS Nautilus sank the IJN carrier Soryu which had already been heavily damaged by American planes operating from U.S. aircraft carriers. Following the Battle of Savo Island, (a severe defeat for the U.S. Navy), an old S-boat, USS S-44, sank the heavy cruiser Kako as she was returning from the battle. This was a case of an 8,000 ton warship being sunk by an 850 ton obsolete submarine! It was also the last major warship sunk by a U.S. submarine for 16 months! The reason for the long dry spell was the Mark 6 torpedo exploder. When the exploder was fixed, the sinking of major Japanese warships rose dramatically, beginning with the sinking of the escort carrier Chuyo by USS Sailfish on 3 December 1943. The results are shown in Figure 22.

In November, 1944, USS Sealion, commanded by Commander Eli Reich, intercepted two IJN battleships, Haruna and Kongo. He shot torpedoes at both and scored three hits on Kongo. Haruna escaped, but Kongo was mortally wounded, and while Sealion was maneuvering into position for another attack, Kongo blew up and sank. Six days later, USS Archerfish, commanded by Commander Joe Enright, detected the largest aircraft carrier in the world, the 59,000 ton supercarrier Shinano. With four torpedoes, Enright turned Shinano into the largest carrier on the bottom of the ocean! In all, American submarines sank 214 Japanese warships, including a battleship and eight carriers.

No history of the United States Submarine Force is complete without relating the stories of Captain John P. Cromwell and Commander Howard Gilmore. Captain Cromwell was aboard Sculpin as a wolf-pack commander when she departed Pearl Harbor on 5 November 1943. On November 18 the ship began an approach on a Japanese convoy but was detected and attacked by a destroyer. Receiving a severe depth charging, the ship was badly damaged and had to surface. The crew tried to "fight it out" with the destroyer but was no match for the destroyer's superior firepower. The Commanding Officer, Commander Fred Connaway was killed in the gunfire exchange. The order was given to scuttle the ship. Captain Cromwell had intimate knowledge of upcoming operations. He feared that if he was

US Submarines vs. the Imperial Japanese Navy:
December 1943 -- August 1945

Month		Ships Sunk	Tonnage
December	1943	3	22,120
January	1944	3	9,230
February		4	12,092
March		5	8,322
April		9	12,203
May		6	6,960
June		11	76,570
July		8	15,689
August		11	41,089
September		7	26,905
October		9	27,662
November		18	125,877
December		13	43,047
January	1945	8	5,703
February		9	7,085
March		4	3,086
April		12	13,336
May		5	4,550
June		7	12,582
July		11	7,896
August		4	3,900

Figure 22. US Submarines vs. the Imperial Japanese Navy

captured and tortured he might not be able to safeguard the vital information that he possessed. He thus elected to go down with the ship rather than risk the lives of the men who were soon to go into action against the Japanese. For this courageous action, Captain Cromwell was posthumously awarded the Congressional Medal of Honor.

Commander Howard W. Gilmore was commanding officer of USS Growler on patrol in February, 1943. In the early morning hours Growler commenced a surface attack on a 2,500 ton Japanese gunboat. As the range closed, the submarine was detected and the gunboat reversed course and tried to ram Growler. In the darkness, Commander Gilmore did not detect the course change until the ships were very close. He ordered "left full rudder" and managed to avoid being rammed by the gun boat but the ships collided. The gunboat raked Growler's bridge with machine gun fire, killing two men and wounding Commander Gilmore. Clinging to the bridge, Commander Gilmore ordered the bridge cleared. When the Officer of the Deck, the Quartermaster, and two wounded lookouts were safely below, Commander Gilmore ordered "Take her down," deliberately sacrificing his own life in order that Growler could submerge and escape. Commander Gilmore was posthumously awarded the Congressional Medal of Honor and the words "Take Her Down" have become immortal in the United States Navy, taking their place with "Don't give up the ship!" and "I have not yet begun to fight!"

On August 15, 1945 the greatest naval war in history ended. The United States Navy and the naval forces of our allies had gained complete control of the waters surrounding Japan. The Imperial Japanese Navy and the Japanese merchant fleet had been destroyed. They virtually ceased to exist. 288 United States submarines were responsible for the lion's share of this destruction (see Figure 23). They had destroyed 1,178 merchant ships totalling more than 5 million tons of shipping and 214 naval warships totalling 577,600 tons. To put the magnitude of this achievement in another perspective, 56% of the Japanese merchant shipping destroyed during during the war was sunk by American submarines and 28% of all Japanese naval tonnage sunk during the war was sent to the bottom by submarine torpedoes. No other force sank more ships and only U.S. Navy planes from aircraft carriers sank more naval ships. These accomplishments become even more incredible when you consider that less than 2% of the U.S. Navy's personnel served in

submarines during the war. In all of naval history, never has such a Herculean task been so well done by such a small group of men.

The submariners' remarkable achievements were not done without cost (see Figure 24). 52 U.S. submarines were lost. 14,750 men served in submarines during the war, and 3,505 are "still on patrol." This ratio is almost one in four. No other service suffered such a casualty rate. They were all volunteers. They knew what they were getting into, but they valued their freedom, they loved their country, and they wanted to serve. In 1942 and 1943, when the rest of the Allied Forces were "holding the line," the submariners took the war to the enemy. They have left us a heritage of incredible bravery and sacrifice.

Eternal Father, strong to save,
Whose arm hath bound the restless wave,
Who bidst the mighty ocean deep
Its own appointed limits keep.
Oh, hear us, when we cry to thee,
For those in peril on the sea.

God of the deep's eternal flow,
wherein thy sons to battle go,
And fearful paths of ocean brave,
Our shores to guard, our ships to save,
In thy vast mercy may they be,
Who vigil keep beneath the sea.

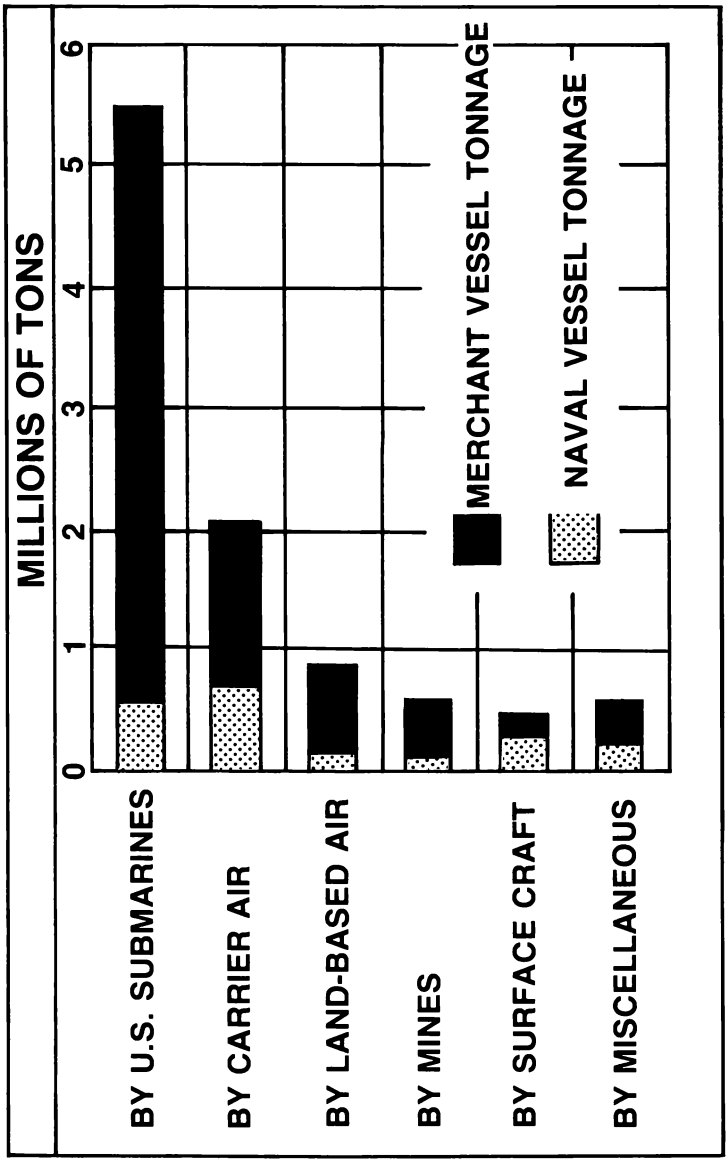


Figure 23. Submarines' contributions to ship sinkings

US Submarine Losses in World War II

Name	Date	Name	Date
1. Sealion	10 December, 1941	27. Grayback	26 February, 1944
2. S-3	20 January, 1942	28. Trout	29 February, 1944
3. S-26	24 January, 1942	29. Tullibee	27 March, 1944
4. Shark	February, 1942	30. Gudgeon	May, 1944
5. Perch	3 March, 1942	31. Herring	June, 1944
6. S-27	19 June, 1942	32. Golet	14 June, 1944
7. Grunion	August, 1942	33. S-28	4 July, 1944
8. S-39	14 August, 1942	34. Robalo	26 July, 1944
9. Argonaut	10 January, 1943	35. Flier	13 August, 1944
10. Amberjack	16 February, 1943	36. Harder	24 August, 1944
11. Grampus	6 March, 1943	37. Escolar	October, 1944
12. Triton	15 March, 1943	38. Seawolf	3 October, 1944
13. Pickerel	3 April, 1943	39. Darter	24 October, 1944
14. Grenadier	22 April, 1943	40. Shark II	24 October, 1944
15. Runner	June, 1943	41. Tang	24 October, 1944
16. R-12	12 June, 1943	42. Scamp	November, 1944
17. Pompano	September, 1943	43. Albacore	7 November, 1944
18. Grayling	12 September, 1943	44. Growler	8 November, 1944
19. Cisco	28 September, 1943	45. Swordfish	12 January, 1945
20. S-44	7 October, 1943	46. Barbel	4 February, 1945
21. Wahoo	11 October, 1943	47. Kete	March, 1945
22. Dorado	12 October, 1943	48. Trigger	28 March, 1945
23. Corvina	16 November, 1943	49. Snook	April, 1945
24. Sculpin	19 November, 1943	50. Lagarto	3 May, 1945
25. Capelin	9 December, 1943	51. Bonefish	18 June, 1945
26. Scorpion	Jan. - Feb., 1944	52. Bullhead	6 August, 1945

Figure 24. US submarine losses in World War II

SUBMARINE STRATEGY AND BATTLE TACTICS

GENERAL

As we have seen, the principal strategy for U.S. submarines during World War II was the severing of Japanese sea lines of communications. These were routes used by the Japanese to resupply and reinforce their troops in the captured territories and to carry oil and raw materials to the home islands. In addition, submarines were to attack and destroy warships according to a priority list from Admiral King. Submarines were also assigned to support fleet operations by rescuing aviators, conducting photo reconnaissance of prospective invasion sites, landing and supporting special agents and commandos, and attacking Japanese ships and naval units as they proceeded to or from battle areas. This strategy was summed up very clearly in the directive issued by Admiral King on 7 December 1941, "EXECUTE UNRESTRICTED AIR AND SUBMARINE WARFARE AGAINST JAPAN."

In order to understand the fundamentals of World War II submarine tactics, one must understand submarine capabilities and limitations. The most important characteristic to always remember is that these boats were essentially surface ships that could submerge for limited periods of time, and while submerged they were limited in speed, endurance and maneuverability.

Prior to the development of nuclear propulsion, all submarines had to use outside air to run their diesel engines, and they all used lead acid storage batteries to drive their propulsion motors when submerged. Just as a car battery must be recharged when the lights are left on, the submarine batteries had to be recharged after a few hours of submerged operation. The length of time that the battery could be used depended on two factors: (1) how close it was to being fully charged when the ship submerged, and (2) how fast the submarine operated while submerged. The batteries discharged much faster at high speed.

Submarine submergence was also limited by the air in the boat. The crew needed oxygen, and it was slowly used up while the ship was submerged. As the oxygen was being used, carbon dioxide was

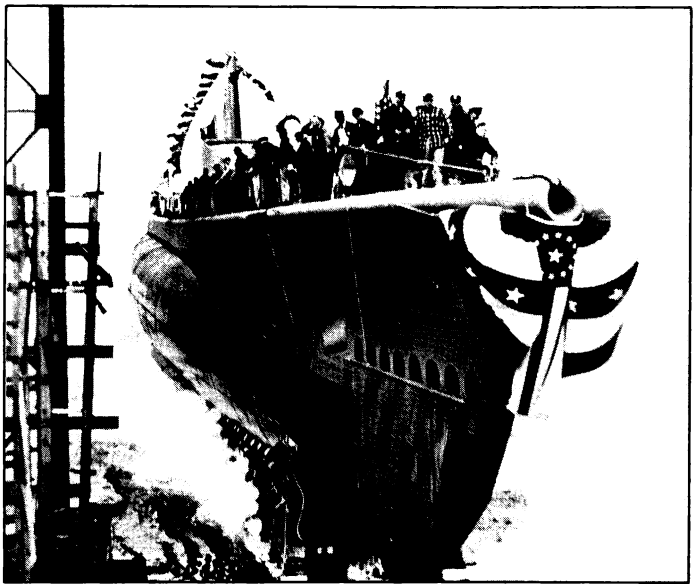


Figure 25. Fleet submarine being launched at Groton Connecticut

The Three Phases of Submarine Attack

I. Classification Phase:	Initial target detection. Ends when direction of target motion is known.
II. Approach Phase:	Closing the target, remaining undetected. Ends when target is within range of torpedoes.
III. Attack Phase:	Maneuvering to reach optimum firing position, still remaining undetected. Ends when target sinks or submarine has to withdraw.

Figure 26. The three phases of a submarine attack

being exhaled by the crew and it gradually built up in the boat. If the air was not replenished, eventually the oxygen would get so low and the carbon dioxide so high, that people could not survive. If the boat proceeded slowly, the time of submergence was usually limited by the need to replenish the atmosphere. At high submerged speeds, the battery capacity was the limiting factor.

Most of the United States submarines of World War II were "fleet boats." Figure 25 shows the launching of a fleet boat. They were given this nickname because they were the first American submarines with the speed and fuel capacity needed to operate "with the fleet." Most earlier boats were much smaller, slower, and simply could not keep up with the main fleet units. Some of these older boats, known as "S-boats," were deployed in the early stages of the war, but for the most part, all World War II U.S. submarines were "fleet boats." They were specifically designed to operate with the fleet. Pre-war doctrine considered that the submarines would operate in direct support of the main battle fleet, principally as scouts in advance of the aircraft carriers and battle ships. They would detect the enemy ships and inform the fleet commander of the enemy's location. In fact, at the time of the attack on Pearl Harbor, the Pacific fleet submarine organization was called "Submarines, Scouting Force, Pacific Fleet," reflecting fleet doctrine. Shortly after the attack on Pearl Harbor, the submarines were transferred from the Scouting Force to the direct control of Commander in Chief, Pacific (CINCPAC).

Prior to the war, it was unthinkable that the United States would ever wage unrestricted submarine warfare. After all, we had entered World War I partly in response to the sinking of merchant ships by German submarines. However, since the attack on Pearl Harbor violated all military and diplomatic protocol, the U.S. submarines were ordered to conduct unrestricted submarine warfare against Japan. As we saw in the section on World War II submarine operations, they responded immediately.

Conducting an approach and attack on a target, whether a single ship or a convoy, is traditionally done in three phases (Figure 26). These are (1) the contact phase, (2) the approach phase, and (3) the attack phase. These phases are not always clearly separated like the periods in a football game, but frequently overlap. In some cases, the attack phase reverts back to the approach phase if the target changes course or the tactical situation changes in some way. In

other instances, a submarine skipper may find himself in the attack phase sooner than he had expected. Submariners must be ready to adapt to rapidly changing circumstances.

In World War II, there were two general types of approach and attack; the periscope attack and the surface attack. In general, periscope attacks were made during daylight hours and surface attacks were made at night. Each has its advantages and limitations and the submarine commanding officer must make his decision on how to proceed based on the tactical situation.

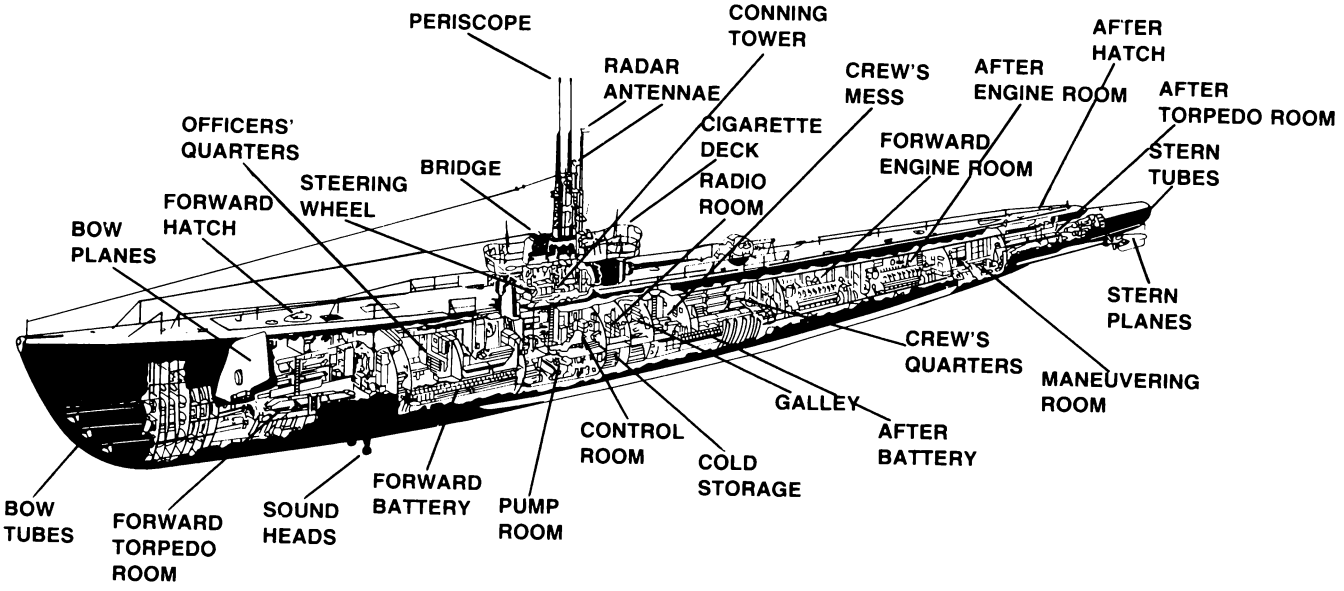
Before we discuss the three phases of an approach and attack and the techniques used in each, we should review submarine characteristics, the equipment used and how the submarine crew was organized during an attack. Not all the equipment described was available on all submarines at the beginning of the war, but is typical of what was carried by most fleet boats in 1943 and later.

SUBMARINE CHARACTERISTICS

A World War II fleet type submarine was a small, maneuverable surface ship that was capable of operating submerged for limited periods of time. They were 310 feet in length, had a maximum beam of 27 feet, and displaced 1,500 tons. (Every Naval Academy plebe knows that a ship doesn't "weigh" 1,500 tons - it displaces tons and "weighs" its anchor !)

The boats had four 1600 horsepower diesel engines, each engine driving a direct current generator able to deliver 1100 kilowatts at 415 volts. The generators could be connected to the main motors which drove the propellors, or they could be connected to charge the batteries. The main motors were connected to the propellor shafts through reduction gears. The diesels could not be connected directly to the propellor shafts; only the main motors drove the propellors. Figure 27 illustrates the components of a submarine.

Each submarine had two lead-acid storage batteries, each with 126 cells and a nominal voltage of 250 volts. Just like a car battery, submarine battery capacity, or state of charge, was measured by the specific gravity of the electrolyte. A fully charged battery had a specific gravity of 1.250, and could deliver 5,320 amperes for one



Courtesy U.S. Naval Institute

Figure 27. Cutaway view of a fleet class submarine

hour. The battery discharge rate was expressed in hours, such as the six-hour rate, meaning that a fully charged battery could maintain this discharge rate for six hours. At the end of six hours, the battery was not completely discharged, but the current had to be reduced.

Submerged endurance, starting with a fully charged battery, is summarized in the following table:

Speed (knots)	Time (hours)	Range (miles)
2.1	48	101
3.1	24	74
4.9	10	49
5.9	6	35
6.8	3	20
8.0	1	8
9.0	0.5	4.5

When submerged, a fleet submarine's maneuverability was severely limited. The hull, unlike modern nuclear submarines, was not designed for optimum submerged operations. It turned and accelerated much slower than it did on the surface. The tactical diameter was 467 yards, but she turned slowly. At four knots, it could turn at about 0.45 degrees per second with full rudder. The turning rate increases as submarine speed increases, and will be about 1.0 degree per second at eight knots. The maneuverability characteristics are very important when making a submerged approach on a target.

EQUIPMENT

Information about the target is gathered by "sensors." These include visual sensors such as the periscopes, and electronic sensors such as radar and sonar. They are used for initial detection of targets and for gathering data during the approach and attack phases. The data is used to first determine the target's position, and then to calculate its course and speed and where torpedoes should be aimed.

In a tactical situation, the position of a target is described by its range and bearing as shown in Figure 28. The range is simply the horizontal distance from the submarine to the target. Bearing is a position on a circle with the submarine at the center. There are 360 degrees in a circle, and target bearing is simply the number of degrees measured clockwise from a reference point on the circle. If the reference point is true north (as opposed to magnetic north), the bearing is called true bearing. If the reference point is the bow of the submarine, the bearing is called a relative bearing. In an approach and attack, true bearing is always used, if possible. If target bearing and range are both measured accurately, the position of the target is very precisely known, and can be considered as a point on a circle with the submarine at the center and the radius equal to the range.

Periscopes

World War II fleet submarines carried two periscopes. One was called the search scope because it had a larger barrel and better light transmission characteristics. The other, called the attack scope, was much narrower and thus less likely to be detected. Because it transmitted more light, targets could be detected at longer range with the search scope. Both periscopes were monocular, that is, they had a single eyepiece, unlike binoculars. Also, both scopes provided both high power and low power magnification: 1.5X in low power and 6.0X in high power (see Figure 29). The person using the periscope could switch back and forth between high and low power very easily.

The target's relative bearing could be read directly from a dial on the scope barrel. It was also transmitted electrically to the fire control equipment where it would be combined with the submarine heading to calculate true bearing. When the periscope cross hairs were centered on the target, the true bearing could be read on dials in the conning tower or from the fire control equipment.

Target range could also be determined from the periscope, but the measurement was not as precise as the bearing. One method of range determination was called "telemetering" and could be used with either scope. Another method used a stadimeter built into the attack scope. Both methods will be described in detail later.

Target Bearing Transmitter

Lookouts aboard U.S. Navy ships and submarines used (and still use) standard 7X50 binoculars for visual search. These very fine

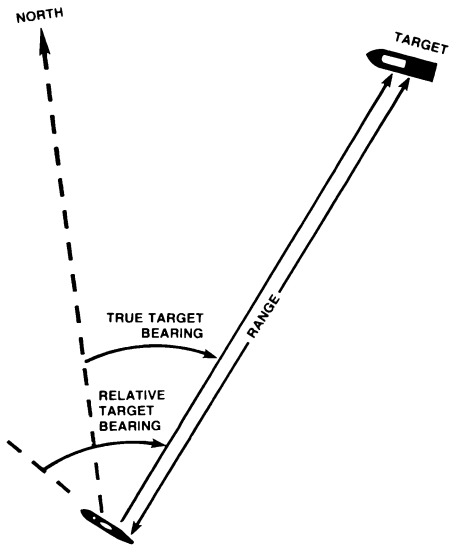


Figure 28. Definition of Range and Bearing

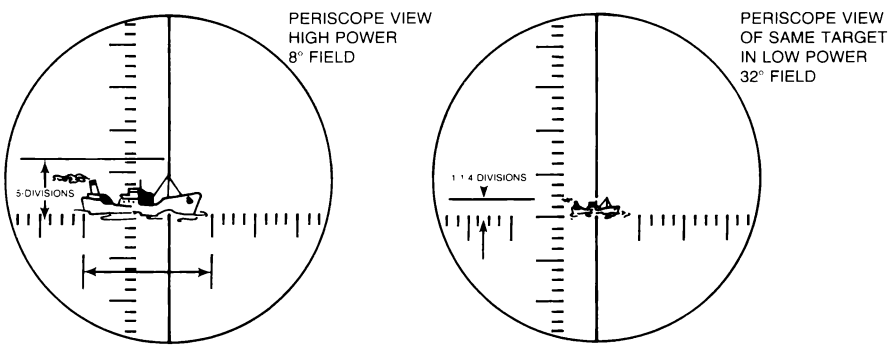


Figure 29. Periscope zoom levels

instruments are excellent for initial detection of a target. However when a World War II submarine skipper wanted to make a surface approach and attack, he could not use a pair of binoculars to measure target bearing. Early in the war a device known as a Target Bearing Transmitter was installed on submarines. Known as the TBT, this device held a special pair of binoculars with cross hairs on the lenses that could be used to line up with the target. The TBT could electrically transmit very accurate target bearing information to the fire control system just like the periscope did. The TBT was a relatively simple addition but it was a tremendous help in conducting surface attacks.

Radar

Today we take radar for granted. It is used to control aircraft taking off and landing at commercial airports and is used by law enforcement officers to measure the speed of automobiles. Many of us probably carry radar detectors in our cars. But in 1942, radar was quite new and one of the most closely guarded secrets of World War II. Japanese escorts did not employ radar until late in the war, but U.S. submarines carried a rudimentary model, known as the "SD radar" in 1942. It was designed to detect aircraft and was not particularly useful in detecting targets. In the summer of 1942, a new model known as the "SJ" was installed on submarines as fast as it could be manufactured. It was specifically designed to detect ships and was a major tactical advantage. It provided accurate range information and fairly accurate bearings in any weather conditions, day or night. Ships were usually detected at an initial range of 5 to 10 miles and sometimes even longer ranges were obtained. Through 1943 and much of 1944 its primary limitation was that it could only be used when the submarine was surfaced or broached. Later in the war another limitation developed when the Japanese were sometimes able to detect the radar signals and were alerted to the presence of a submarine.

Sonar

Sonar is an acronym for SOund NAvigation and Ranging. It was the only sensor available when the ship was submerged below periscope depth. There are two basic modes of sonar operation, active and passive.

In the active mode, called "echo-ranging," the sonar equipment transmits a pulse of high frequency sound energy into the water and listens for an echo, or sound reflected from the target (as shown in

Figure 30). By measuring the time required for the sound signal to travel to the target and return to the submarine, the sonar equipment calculates the range to the target. It can also determine a reasonably accurate bearing. World War II vintage active sonar had two major drawbacks; (1) it could be detected by an enemy warship and warn him of the submarine's presence, and (2) it was not usually effective at very long range. Seldom could an "echo" be received from a target more than two or three thousand yards away. Most skippers who used active sonar at all used it to get a final check on target range during a periscope attack.

In the passive mode, the sonar equipment is used to listen to the various sounds in the ocean. The operators were trained to recognize the sounds made by ships and differentiate them from the sounds of fish, weather, or various forms of marine life. By training the hydrophones in varying directions, the sonar operator can determine an accurate target bearing. By listening to the sounds of a target, a skilled operator is able to determine the type of ship, estimate his speed, and detect course or speed changes.

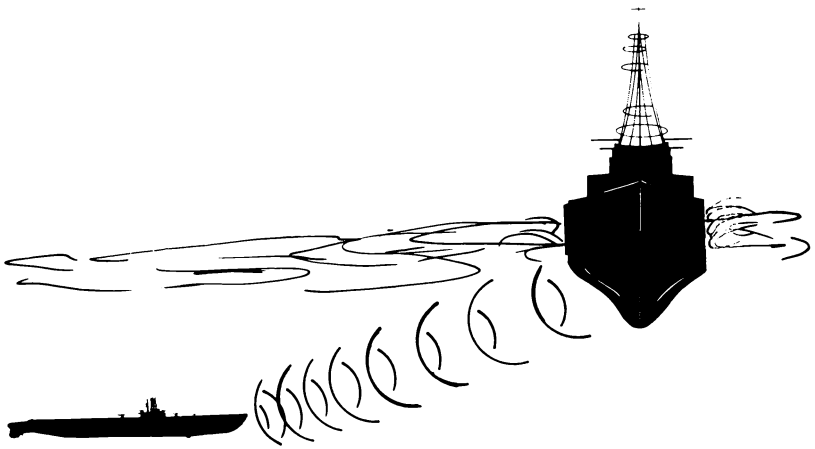


Figure 30. Sonar echoes

Fire Control Equipment

The "fire control solution" is target bearing, range, course, speed, and the torpedo course needed for the torpedo to hit the target. The term "Fire Control Equipment" refers to both manually operated and electrical equipment used to display the relative position between the submarine and the target, update the positions based on assumed target course and speed, and compute the correct torpedo course. The major piece of fire control equipment was the Mark 4 Torpedo Data Computer, called the "TDC." It was, in comparison with today's digital equipment, a very simple analog computer, but in its day it was a state of the art, sophisticated device. It constantly displayed the present target position, and could be updated as necessary to correct or update the fire control solution or to display the new situation if the target changed course or speed. The TDC also computed the torpedo course needed to intersect the target, refined this solution to account for torpedo characteristics, and transmitted a torpedo gyro angle to the torpedo rooms where it was inserted into the torpedo. When the torpedo was launched, it turned to the preset gyro course and then ran straight by using the rapidly spinning gyroscope as a reference. A picture of the main section of the TDC is shown in Figure 31.

Two officers were usually assigned to the TDC. One was responsible for inserting target information and analyzing the accuracy of the fire control solution. The other officer was responsible for updating the torpedo information so that the torpedo parameters were correct for the torpedo being fired.

The torpedo firing panel was also part of the fire control system and was located in the conning tower. The selected torpedo tube was fired by an electrical signal sent from the firing panel. Torpedoes were launched from the designated torpedo tube by compressed air. As the torpedo left the tube, a latch on the torpedo was tripped, causing it to start running.

LINE OF SIGHT DIAGRAMS AND TERMINOLOGY

The tactical situation between a submarine and its target can best be shown by a "Line of Sight" (LOS) diagram. A vertical line is drawn on a piece of paper and arrows at each end are used to show submarine and target course and speed. Submarine officers routinely used LOS

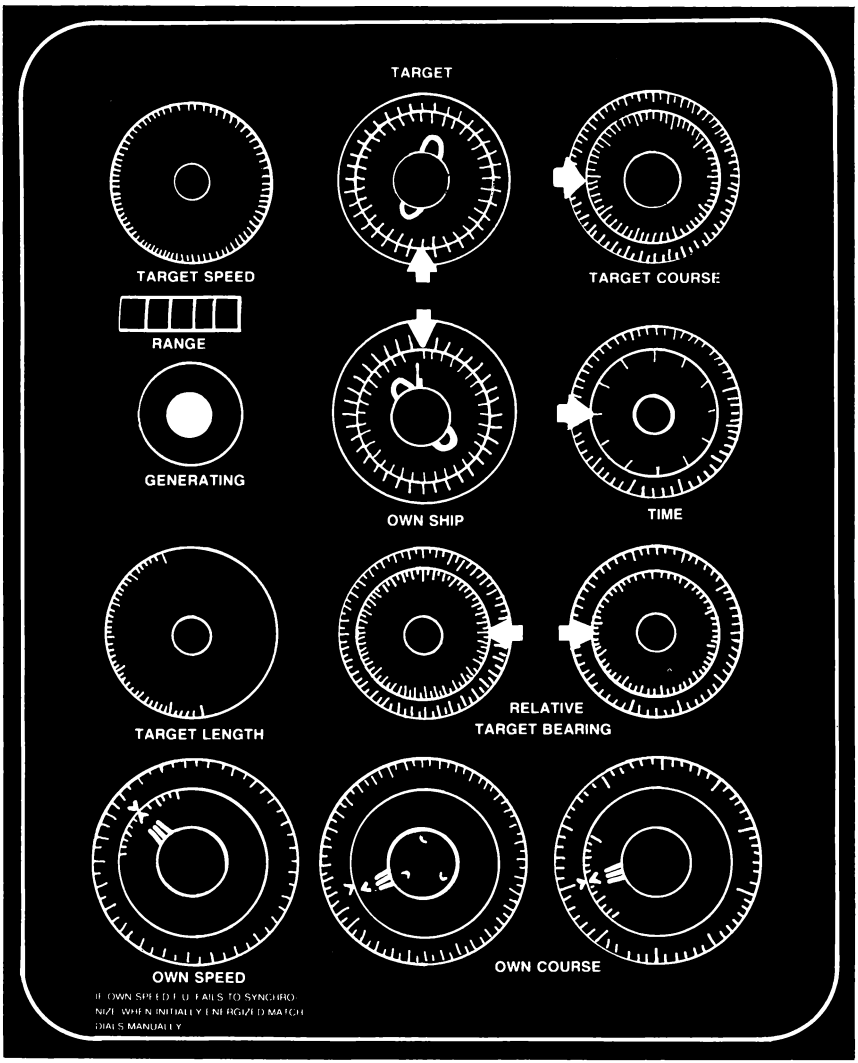


Figure 31. The main section of a Torpedo Data Computer (TDC)

diagrams to analyze a tactical situation, and they became very skilled in their use. In fact, most officers could mentally visualize a LOS diagram and do rapid calculations or approximations. Figure 32 shows a line of sight diagram.

THE SUBMARINE ORGANIZATION DURING AN ATTACK

A submarine crew was divided into three groups called watch sections. Each section included all the personnel needed to operate the ship during normal cruising conditions, surfaced or submerged. A section normally was on watch for four hours, and then was off-watch for eight hours while the other sections were on watch. A commissioned officer was assigned as "Officer of the Deck" (OOD) and was on the bridge when the ship was surfaced, and in the conning tower while submerged. The OOD gave course and speed orders and directed the activities of all personnel on watch. Other personnel were assigned to operate equipment in each compartment or carry out special duties, such as serve as lookouts.

When a target was detected and an approach and attack started, the crew would be called to their battle stations, or "General Quarters." Every person aboard had an assignment during battle stations, and individuals were assigned where their particular skills were most needed.

The commanding officer was the Approach Officer, responsible for conning the ship to the desired attack position. He was responsible for every facet of the attack. Other personnel were assigned to the "Fire Control Party," the organization responsible for tracking the targets, solving the fire control problem, i.e., determining the target course, speed, and range, making recommendations to the Approach Officer, and operating the fire control equipment.

The Fire Control Coordinator was the officer, usually the Executive Officer, who directed the other members of the fire control party, coordinated efforts to solve the fire control problem, and generally assisted the commanding officer. He would inform the Approach Officer when he had a good solution for target course, speed, and range. He would also announce when the target was "within weapon range," that is, when the distance the torpedo would have to run to

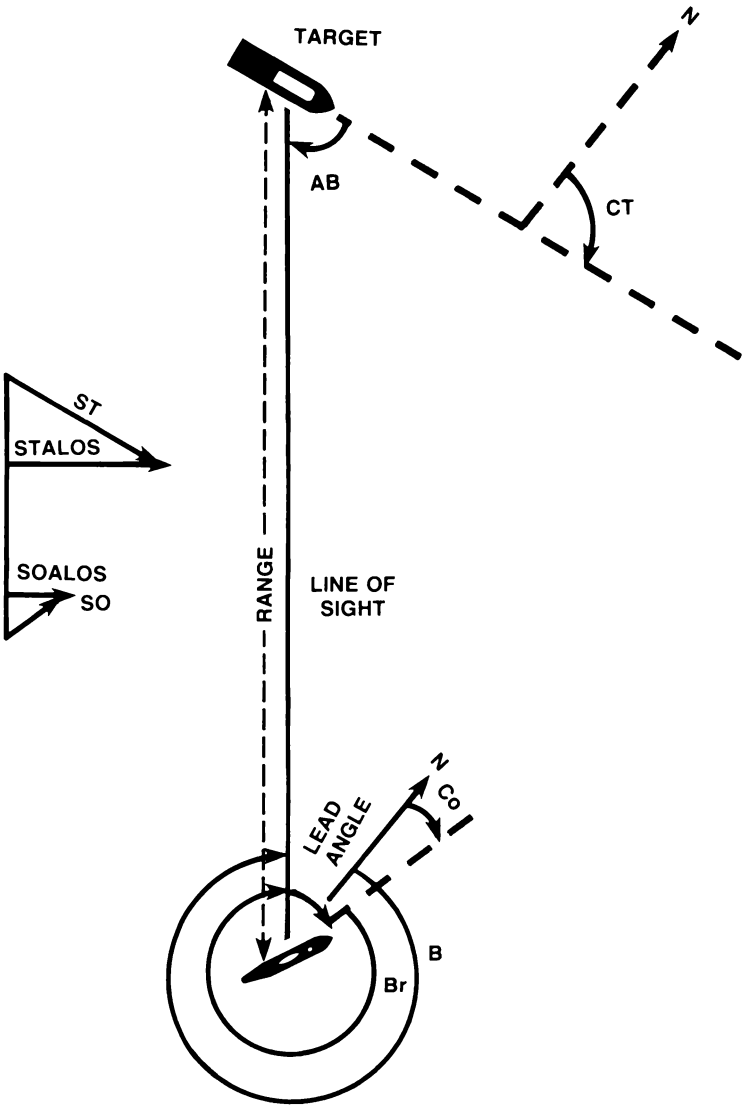


Figure 32. A Line Of Sight (LOS) diagram

Symbol	Name	Definition
Ab	Own ship's course	The angle between the fore and aft axis of the target ship and the line of sight. It is measured from the bow either port or starboard to the LOS. It can never exceed 180°.
B	True target bearing	The angle measure from north clockwise to the line of sight.
Br	Relative target bearing	The angle measured clockwise from the bow of the submarine to the line of sight.
Co	Own ship's course	The angle measured clockwise from true north to the submarine's bow.
Ct	Target course	The angle measured clockwise from true north to the target's bow.
R	Target range	The horizontal distance from the submarine to the target. It is usually measured in yards but can also be in miles.
St	Target speed	The target speed, in knots.
Stalos	Target speed across the line of sight	The component of the target's speed that is perpendicular to the line of sight.
Soalos	Own speed across the line of sight	The component of the submarine's speed that is perpendicular to the line of sight.

hit the target was less than the maximum distance the torpedo was capable of traveling.

THE CLASSIFICATION PHASE

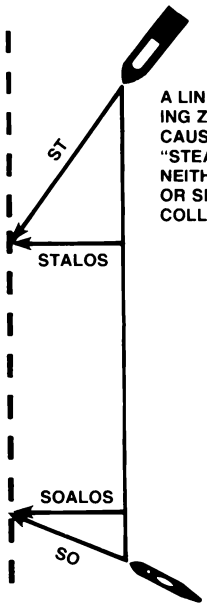
The classification phase is usually the shortest period of an approach and attack. It begins when a target is initially detected and ends when the direction of target motion is determined. The direction of target motion is important because the submarine usually has to "lead" the target to get into a good position to fire torpedoes.

If the target can be easily seen, the direction of target motion can be determined by just observing which way he is headed. Frequently the target is either too far away to be clearly seen or is obscured by bad weather. It is also very difficult to visually determine target motion at night. In these cases, the easiest thing to do is "point the target", that is, steer the submarine so it is headed right at the target. Then any change in the true bearing of the target is an accurate indication of the direction of target motion. The change in true bearing is called the "bearing drift" (see Figure 33). If there is no bearing drift, or the target has a "steady bearing", the target and the submarine are said to be on a collision course; that is, if neither ship changes course or speed, they will collide. If the submarine is not pointing the target, the real direction of target motion may be the opposite to what it appears because your own speed across the line (Soalos) of sight may be greater than the target's speed across the line of sight (Stalos).

THE APPROACH PHASE

As soon as the direction of target motion is determined, the approach phase begins. The objective of this phase is to close the target to within the effective torpedo range while remaining undetected. For a submerged approach, the basic thumb-rule is to lead the target by a lead angle (see Figure 34) that is twice the angle on the bow up to a maximum of 70°. (If you take a lead angle greater than 70°, you will essentially parallel the target and won't close the track.)

There will be times when the target range is so great and his angle on the bow is so large, that you won't be able to close the track to within torpedo range without using high speed. In these cases, you have



A LINE OF SIGHT DIAGRAM SHOWING ZERO BEARING DRIFT BECAUSE STALOS = SOALOS, A "STEADY BEARING" SITUATION. IF NEITHER SHIP CHANGES COURSE OR SPEED, THE SHIPS WILL COLLIDE.

a) Zero bearing drift situation.

A LINE OF SIGHT DIAGRAM SHOWING A TARGET WITH A STARBOARD ANGLE ON THE BOW BUT A LEFT BEARING DRIFT. SOALOS IS GREATER THAN STALOS.

b) Left bearing drift.

Figure 33. Bearing drift and steady bearing

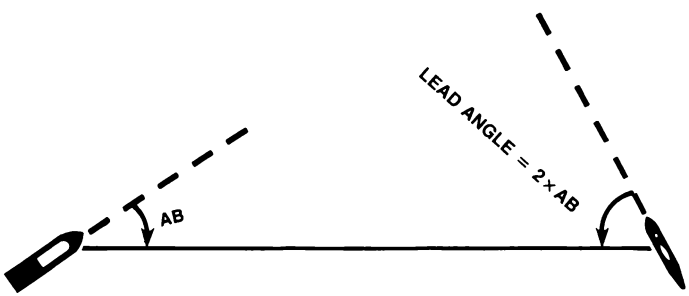


Figure 34. Lead angle

two basic options - (1) surface and try an "end around," or (2) try to close the track with higher submerged speeds. Each has advantages and limitations.

A surfaced "end around" maneuver has the obvious advantages of not using up the battery and getting you in position ahead of the target where you can maneuver into optimum firing position. Another advantage is that you can track the target visually (weather permitting) and on radar and get a very accurate solution for his course, speed, and range. The major disadvantage of a surface approach is that you are much more likely to be detected either by the target, by aircraft, or by an escort. This tactic was most frequently used by World War II skippers at night. Surfaced approaches are much more hazardous during daylight, especially when the target is heavily escorted or when there is the possibility of air cover. (Until the final months of the war, almost every submarine patrol was conducted in enemy controlled waters.)

Conducting the approach submerged is the most conservative method. In many respects it is also the most difficult because of the severe limitations on speed and maneuverability when submerged. Operating at high speed submerged depletes the battery quickly and means you will have less flexibility if you have to evade a depth charge attack. Also, operating at more than three or four knots at periscope depth in calm seas produces a "rooster tail" behind the periscope that is very easy to detect. You can operate at higher speed at periscope depth when seas are rougher; a good thumb rule is two knots plus the sea state. For example, in a sea state four, you can operate at six knots and the scope "rooster tail' will not stand out from the white caps. (Sea state is measured on the Beaufort scale and is described very well in publications such as Knight's Modern Seamanship.)

As the approach phase develops, the submarine captain must constantly evaluate how far away he is from the desired firing position, and calculate if he will be able to get there before the target has gone by. An excellent indication of how well the approach is proceeding is how much the target bearing has changed from the initial bearing. A frequent question during a submerged approach is, "How much true bearing have I lost?" Another thumb rule is that if you are not within weapon range by the time the bearing has changed 60°, then you probably won't catch him. These cases are called

"TGB," or "Target Got By!" When that happens, your only recourses are (1) let him go and hope another submarine gets a shot at him and is more successful, (2) hope that the target changes course toward you, or (3) surface and try an end around. Many times when World War II skippers tracked a convoy or single target during daylight hours without reaching a good firing position, they would let the target(s) go by, then surface after dark, catch up with them, and either make a night surface attack or be lying in wait at periscope depth early in the morning.

Early in the approach phase, the Approach Officer will decide how many torpedoes he will shoot, what torpedo tube(s) he will use, and what running depth he wants set in the torpedoes. He will also develop contingency plans in case the situation changes. Ideally, all ten torpedo tubes, six forward and four aft, will be loaded with torpedoes that are ready to go. Of course, late in the patrol he may not have enough torpedoes left to have all tubes loaded. Any tube that may be used must be flooded and equalized with sea pressure early in the approach phase. The outer, or muzzle doors, must be opened on the selected tubes before reaching the firing point, preferably before beginning the attack phase.

Tracking the Target(s)

During the approach phase, the target is tracked and data is used to determine his course, speed, and range and arrive at an accurate fire control solution. If radar is used, a very accurate solution can be obtained. At periscope depth, the problem is much more difficult. Use of a periscope is an art. The best skippers could get a very large amount of information in about six or eight seconds! At least three items should be given to the fire control party from each periscope observation; bearing, range, and angle on the bow. Getting an accurate bearing is easy if the cross hairs are properly lined up with the target. Measuring the range and accurately estimating the angle on the bow and range are a bit tougher. Angle on the bow is estimated by the Approach Officer, based on his years of experience. Range is measured by either the telemeter or stadimeter.

A telemeter range is an estimate obtained by noting the number of divisions of the vertical cross-hair that cover the target. Figure 35 shows the periscope cross-hairs. In order to calculate the range, the

target "masthead height" (height of the highest mast) must be known. Range is then calculated by the following formula:

$$\frac{76.4 \times \text{target height}}{\text{number of divisions}}$$

The above equation assumes that the periscope is in high power. If the observation is taken in low power, use 19.1 instead of 76.4. In actual practice, most submariners use 80 and 20 instead of 76.4 and 19.1. If the target can be identified, the masthead height is available from intelligence publications. If an identification is not possible, the masthead height can be estimated.

Stadimeter ranging is done using a stadimeter installed in the attack scope. In this method, a "split image" is seen and the images are adjusted to line up the top of one image with the waterline of the other. The range is then read off a dial on the bottom of the scope. The person reading the range must know the target masthead height.

Estimating the angle on the bow is a skill that comes with practice. Some skippers were very good, a few had difficulty. There are a few hints, such as looking at how much of the target's length you really see. For example, if the angle is 30° you will see an apparent target length that is half the actual length. Another aid is to note how much of the forward (or after) part of the superstructure is visible. The only way to get really good at calling angles on the bow is to practice. World War II skippers (and present day submarine officers) practiced constantly both in port and at sea.

A routine for obtaining periscope observations has been developed in the U.S. Navy and has not changed appreciably since World War II. It proceeds in a well-known and very precise format, as follows:

1. The Approach Officer announces, "Observation, number one (two) scope, up scope."

2. The Periscope Assistant operates a hydraulic lever to cause the scope to rise out of the periscope well.

3. The TDC operator announces the generated relative target bearing.

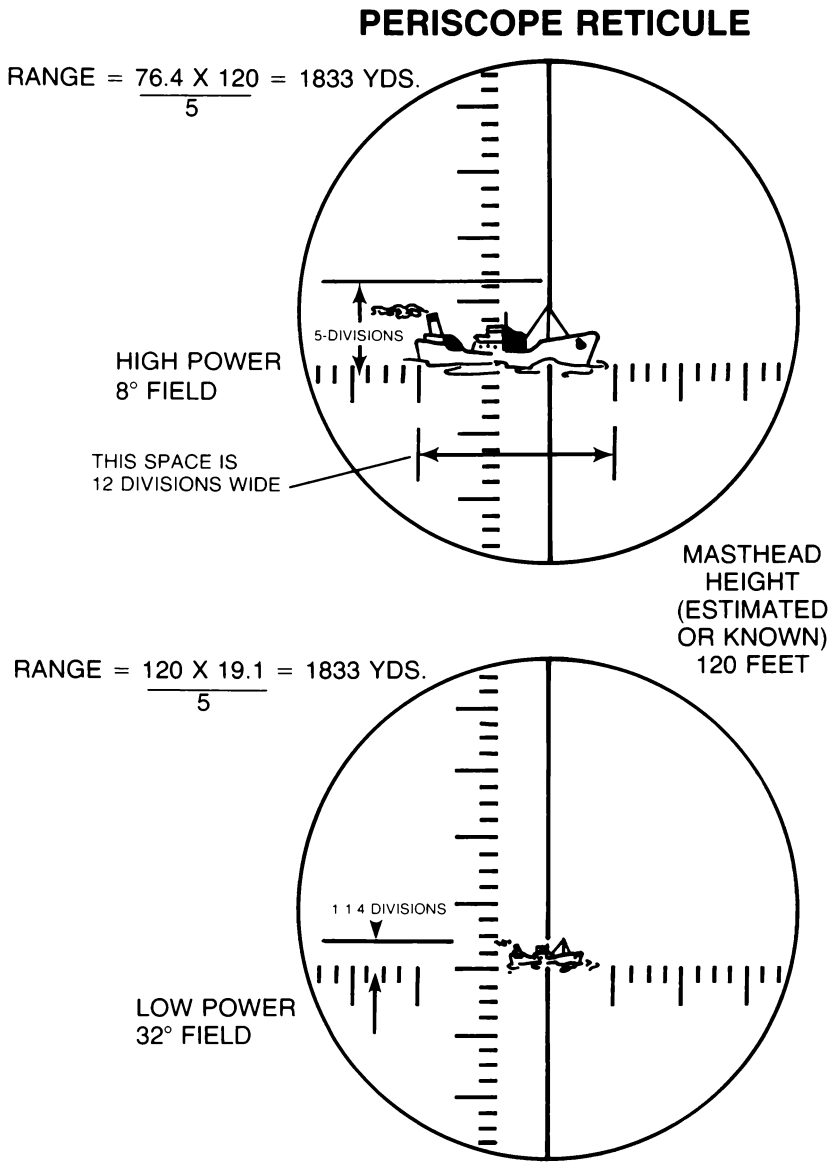


Figure 35. Telemeter ranging

4. The Periscope Assistant lowers the scope handles as they clear the periscope well and turns the scope to the called relative bearing.

5. The Approach Officer lines up the cross-hairs on the target, and says "Bearing, mark!"

6. The Periscope Assistant pushes a button which causes the bearing to be electrically transmitted to the fire control equipment.

7. The Approach Officer then measures the range with either the stadimeter or telemeter and announces, "Range, mark!" If using the stadimeter, the Periscope Assistant calls off the stadimeter range. If using the telemeter, the Approach Officer announces the number of divisions covering the target.

8. The Approach Officer raises the periscope handles and announces "Down scope," and the Periscope Assistant lowers the periscope.

9. As the periscope is being lowered, the Approach Officer calls out the angle on the bow from a mental image he formed during the observation. He may announce any other information that he saw, such as the presence of aircraft, a target zig, unusual cargo, etc.

In a well-trained fire control party, this routine is done crisply, quietly, and with no wasted motion. The scope should be out of the water for about six to eight seconds. If the scope is exposed for longer periods, especially during daylight, you run a much greater risk of being detected by the enemy. Submarines that are detected by the target or its escorts (including planes) end up as the hunted instead of the hunter!

Solving the Fire Control Problem

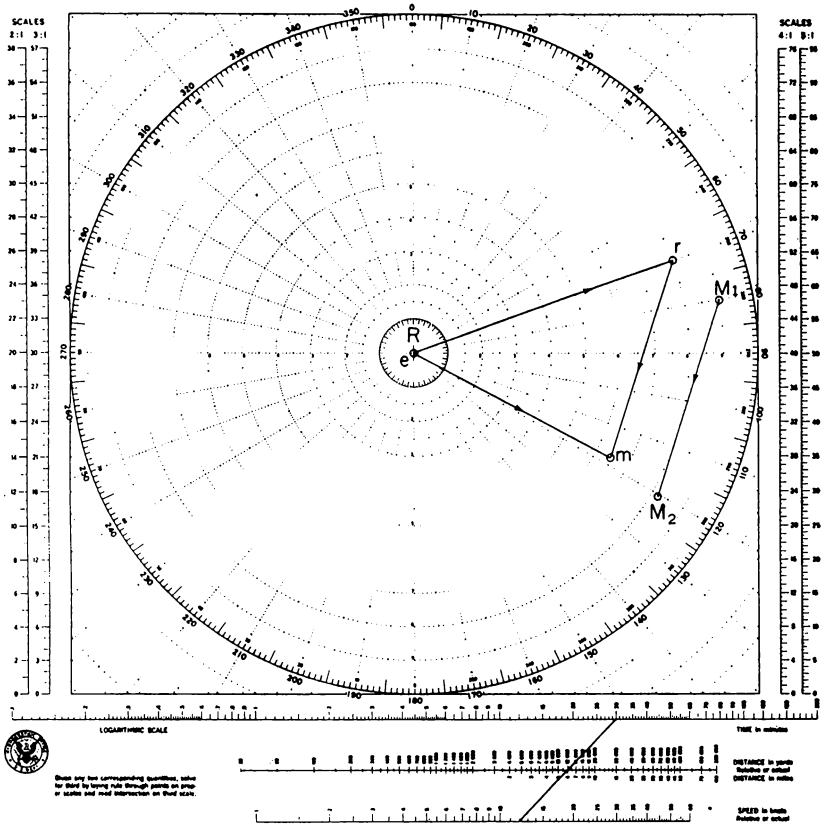
As data is collected on the target, either by the periscope or by radar, it is used to solve the fire control problem. This was done simultaneously in two ways: using the Torpedo Data Computer (TDC), and by manual plots. The Fire Control Coordinator compares the solutions, evaluates available data, and decides on the best

solution. This is then inserted into the TDC and used as the basis for firing the torpedoes.

Shortly after manning battle stations, the Approach Officer makes an "initial observation," if conducting a periscope approach, or announces the initial values of bearing and range if it is a radar approach. These values are inserted into the TDC, along with an initial estimate of angle on the bow and target speed. If the target cannot be seen, an angle on the bow of zero is set. The TDC then continuously generates updated range and bearing. If the solution is in error, the generated values will not agree with the values measured by periscope observation or radar. The TDC operator, working with the Fire Control Coordinator, will adjust target course, speed or range until the solution continuously agrees with the observed bearing and range. This is called a "tracking solution." If a tracking solution is obtained but then fails to "track," it is a good indication that the target has changed course ("zigged"), or changed speed, or both. The process of obtaining a tracking solution then begins all over again.

There are two types of manual plots. One is done on a "Maneuvering Board" (Figure 36), a piece of paper used to plot radar information and solve for target course and speed using vector analysis. It is a tried and true method that is still in use today. The other method plots own ship's track, either automatically or manually. Each periscope observation is plotted and a geographic presentation of each ship's movements is developed. Radar information is also plotted. The navigational plot (Figure 37) is very helpful because it shows the history of the approach and is used to figure out if the target is using a zig pattern. It also can be marked to show navigational constraints such as shoal water, mine fields, or another submarine's operating area, and the Approach Officer can plan his tactics to avoid these restricted areas.

As the approach develops, the fire control solution is continuously refined. Escorts are also tracked and the Approach Officer must decide how he will avoid the escorts and still get close enough to torpedo the main target or targets. He must also have a contingency plan on what to do if he is detected and attacked by an escort. If the target is a convoy, then the Fire Control Party will be constantly recording data and trying to determine the composition, the formation, and the base course and speed. The Approach Officer and all members of the Fire Control Party must always be aware of



Scale: 2:1 in thousands of yards.

Situation: You are on course 070°, speed 16 knots. At 0900 you sight an enemy vessel bearing 080°, distant 18,000 yards. At 0930 the enemy ship bears 120°.5, distant 16,500 yards.

Required: (1) Direction of relative movement of the enemy ship with respect to your ship.

(2) Course of the enemy ship.

(3) Speed of the enemy ship.

Solution: (1) Draw vector *er* for your course, 070°, and speed, 16 knots.

(2) Locate M_1 and M_2, the two given postions of the enemy ship, and draw the relative movement line.

(3) Determine the relative speed using relative distance, M_1M_2, and time. Since the time is just half an hour, the relative speed can be determined mentally, being double the relative distance.

(4) Lay off vector *rm* from *r* in the direction of relative movement, M_1M_2, for the relative speed found in step (3), thus locating *m*. Vector *em* indicates the course and speed of the enemy.

Answers: 91), DRM 197°, (2) C 118°, (3) 13.0 kts.

Courtesy U.S. Naval Institute

Figure 36. Solving a tracking problem on a maneuvering board

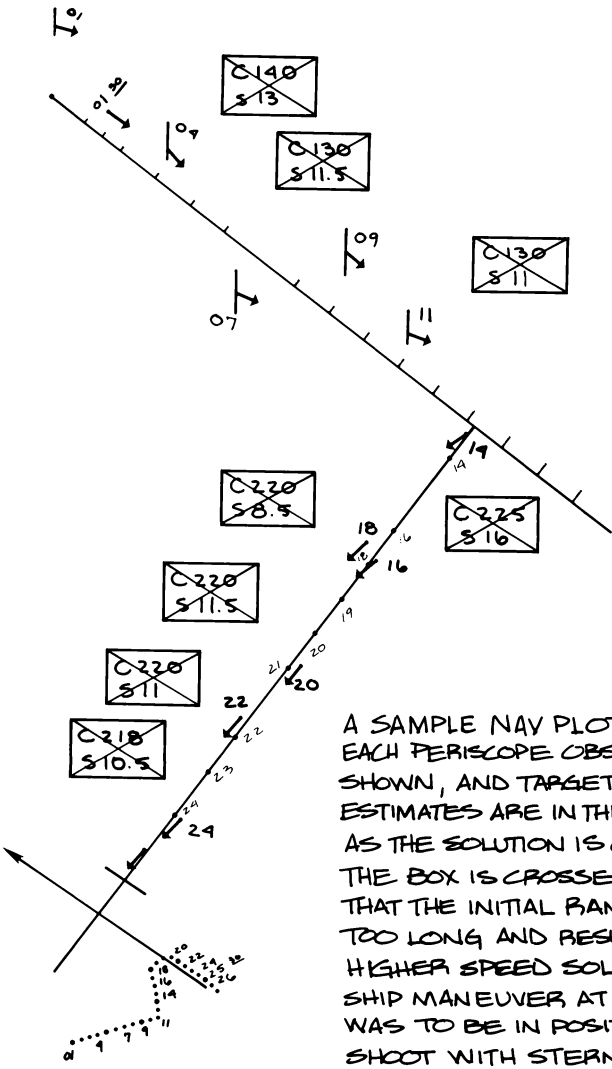


Figure 37. The navigational plot

where the ships are because a submarine at periscope depth is very vulnerable if it gets run over by ship that wasn't detected. (An ancient maritime axiom is "A collision at sea can ruin your whole day!")

Also, what is the depth of water? The Captain and the Navigator must always be aware of how much water is available in case they have to go deep to avoid a close contact or evade a counterattacking escort. A submarine can "run aground" in 300 feet of water if the ordered depth is deeper! Hitting the bottom can be just as fatal as a depth charge. It can also ruin your whole day!

As the approach continues, the TDC is constantly computing torpedo course to hit the target, which may be thought of as the course the torpedo should steer to be on a collision course with the target. The TDC also constantly generates "torpedo run," which is the distance the torpedo has to travel to the point on the target's track where it should hit the target. When this value equals, or is less than, the maximum run for the type of torpedo being used, you are "within weapon range" and are now in the attack phase. Figure 38 shows a submarine "within weapon range" and with torpedo course set.

THE ATTACK PHASE

Once within weapon range, the Approach Officer will maneuver to obtain the optimum firing position. In general, this position will be slightly forward of the target's beam and on a course so that the torpedo gyro angle will be very small, preferably zero degrees. Small gyro angles are particularly important if the range is not known with a high degree of confidence. As shown in the Figure 39, large gyro angles and a range error usually result in a miss while small gyro angles and the same range error may still result in a hit.

The torpedo track angle, measured from the bow of the target to the torpedo's course, should be in the range of 90-100°. This is known as a broad track angle, and increases the likelihood of a hit because the torpedo "sees" more of the target. For example, consider a ship that is 500 feet long and has a beam (width) of 50 feet. If the track angle is 0°, or "down the throat" (180° is "up the kilt") you are trying to hit a 50 foot target, but if it's 90° you are shooting at a 500 foot target. Hitting the broad side of a barn gets easier if the barn is big!

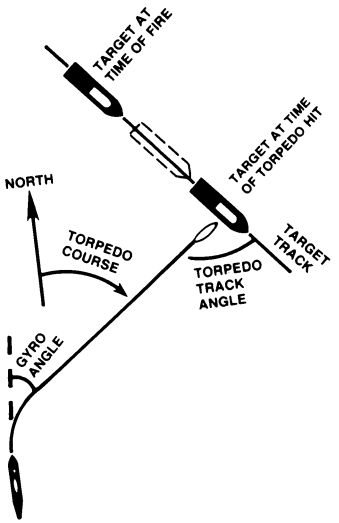


Figure 38. The torpedo's course

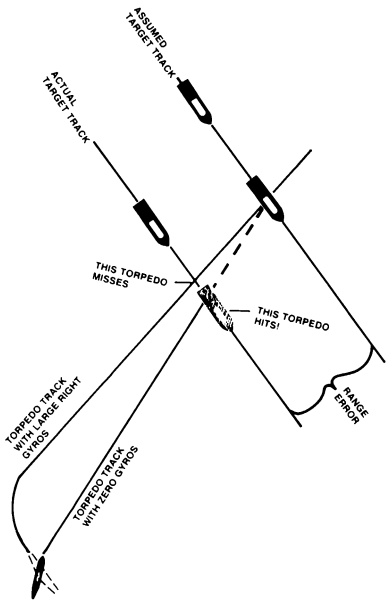


Figure 39. Missed hit caused by large gyro angle and range error

The torpedo exploder, the device that initiates the explosive train, is unarmed when the torpedo is first fired. This is necessary for the protection of the submarine since the shock of being impulsed out of the tube could cause it to explode at a very short, probably fatal, range. As the torpedo travels, a small paddle wheel is turned to line up the explosive train. The exploder is completely armed in about 450 yards of travel. Obviously, if the target is too close, the torpedo won't explode even if it hits the target exactly amidships. In general, the optimum firing position is 900 to 1100 yards from the target's track. This usually results in a torpedo run that is long enough to arm the torpedo but short enough to have a high probability of getting a hit.

Throughout the attack phase, the selected torpedo tubes should be ready to fire, that is, the tubes should be flooded and the outer doors open, and all torpedo settings made and checked. This is important because the situation can change very quickly if the target changes course or if an escort detects the submarine and begins a counter-attack. Many times the best way to handle a counter-attack is to shoot the attacker! -- but you won't be able to do it if your torpedoes aren't ready and if your fire control party isn't able to "shift targets" with little notice.

The Approach Officer has to decide how many torpedoes he will fire at a target. Usually a "spread" is fired to allow for any errors in the fire control solution and improve the odds of getting a hit (see Figure 40). Usually a spread of three is sufficient for a cargo ship or tanker, with the first aimed to hit amidships, the second aimed to hit aft, and the third aimed to hit forward. This type of spread was called "MOT - AFT - FORWARD." (MOT stands for "middle of target.")

The firing point and the few moments preceding it are the most critical time in the whole approach. The situation can change very rapidly if the target is close. This is the time that a well trained, disciplined crew excels and a poorly trained crew's lack of proficiency becomes obvious.

About one minute before the target will reach the desired firing point, the Approach Officer orders "Final bearing and shoot." He also designates a bearing source, either a periscope or the TBT, and the torpedo tubes that will be fired. If a periscope is to be the bearing source, his command will be, "Final bearing and shoot, number

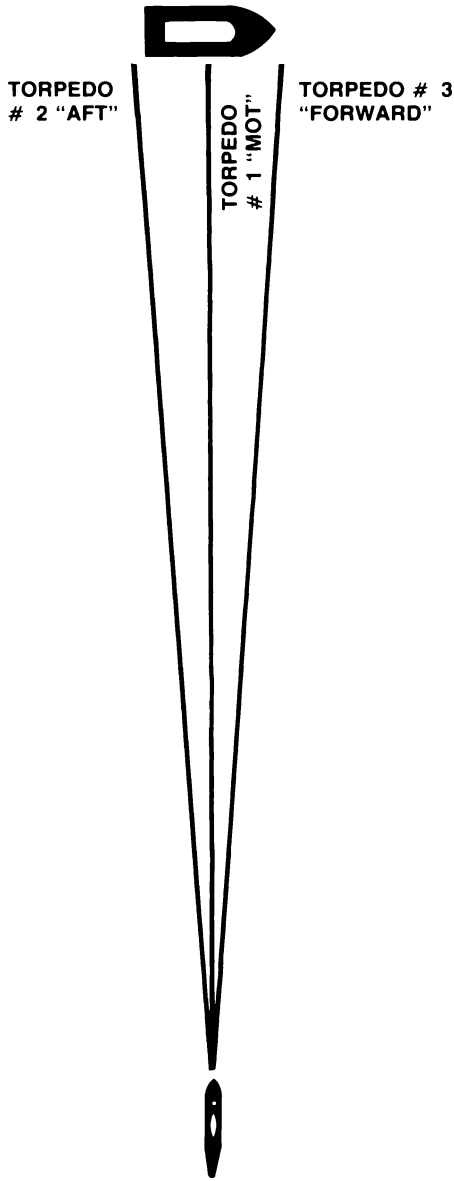


Figure 40. Firing a spread of torpedoes

one(two) scope, up scope." When the scope cross-hairs are on the target, he will say, "Bearing, mark!" The TDC operator inserts the bearing and says, "Set!" If the tactical situation and the fire control solution are satisfactory, the Fire Control Coordinator orders, "Shoot!" The Firing Panel Operator then pushes the remote firing button and the first torpedo will be on its way. The Approach Officer may lower the scope or he may keep it up to check on other targets or escorts. If more than one torpedo will be fired, the TDC Operator repeats the command "Set" and the Fire Control Coordinator orders "Shoot!" for each subsequent torpedo.

If there are multiple targets the attack phase, especially the firing point(s), becomes rather hectic. The fire control party must be able to rapidly shift targets and get a "set up" on the next target. As soon as the first target is hit, the resulting explosions certainly alert the other ships, including the escorts. The Approach Officer and the fire control party must expect and be ready for major course changes. Escorts will head for the submarine's most likely position and start dropping depth charges. The whole tactical situation becomes a melee and a submarine captain's success in this situation depends how well he can maintain a tactical picture and shoot torpedoes and avoid attacking escorts. As related in the World War II history chapter, some skippers were superb in these situations. When mass confusion seems to be everywhere, they remained calm, their crews were superbly trained and disciplined, and they inflicted maximum damage on the enemy.

WITHDRAWAL

When satisfied that all possible attacks have been made, or when the escorts are counter-attacking and getting closer, the prudent submarine skipper will withdraw. In some cases the decision is easy -- such as when there are no more targets to shoot at, or when all your torpedoes have been fired. When all tubes are empty and there are still targets, it is usually best to withdraw to reload the tubes and then come back to finish off the cripples or go after any other targets still afloat.

Successful evasion depends on knowing where the escorts are. During the approach phase, the Approach Office will make frequent "look-arounds" to check on the escorts and get information on how

any other ships are arranged in the convoy formation. A good skipper will always have an evasion route in the back of his mind in case it is necessary to break off. If on the surface, it is almost always best to withdraw at high speed -- get out of there quickly so you can return again on your terms when you are ready. Surface withdrawals are an excellent technique at night or during low visibility since submarines are hard to see even in good weather.

Periscope withdrawal requires a decision -- remain at periscope depth or go deep? Staying at periscope depth permits you to keep track of what is happening but leaves you more vulnerable to detection and limits your speed. Going deep allows more speed if the battery capacity is high enough, but means it will be much more difficult to keep track of escorts and how the remaining ships of the convoy are departing the area. Another advantage to proceeding at a deep depth is that there may be a thermocline, that is, a sharp drop in water temperature that makes it very difficult for an escort's sonar to detect a submarine. A thermal layer, or thermocline essentially reflects the escort's "ping" back toward the surface and it never reaches the deep submarine.

In addition to escort disposition, the submarine skipper must also consider navigational factors in planning his withdrawal. To run aground when angry escorts are hunting for you is to invite almost certain destruction. As described in the history chapter, many World War II patrols were conducted in shallow, restricted waters. ALWAYS KNOW WHERE THE BOTTOM IS!

If there is no clear-cut best way to avoid attacking escorts, sometimes it it best to evade in the least likely direction. Depending on the situation, it may be best to withdraw toward shallow water rather than in the obvious direction. It is best not to be stereotyped and predictable. In any event, successful skippers always see the three phases of an approach and the final withdrawal/evasion as a whole. They form an overall plan of attack as soon as the target is detected, and then put it into motion, modifying it as conditions change. When it is over, if it was a good plan to begin with and if it was well executed, the end result will be enemy ships sunk and a submarine well clear of the scene ready to reload and rejoin the hunt for more targets. Or, if all torpedoes have been fired, it is time to head for home.

ENEMY STRATEGY AND TACTICS

The Japanese began World War II with an apparent belief that their shipping would not be attacked because so great an expanse of the Pacific Ocean was under their control. Throughout 1942, many Japanese ships steamed alone, without escorts. These single ships depended on zig zag plans and strategic routing to protect them from attack. Strategic routing meant directing their voyage so as to avoid submarine operating areas, but it was not successful.

At the beginning of the war the Japanese merchant ships were unarmed which made them vulnerable to being "finished off" by gunfire if a torpedo damaged but did not sink them. After a few months, guns were installed on a few ships, but not until 1944 were almost all ships armed.

SINGLE SHIPS VS. CONVOYS

By refusing to use convoys early in the war, the Japanese were ignoring the lessons of history. In the First World War, German submarines almost caused the defeat of Great Britain since they were sinking ships faster than the Allies could build them. The use of the convoy system, with sufficient escorts, was the single most effective submarine countermeasure in that war. It was also an essential element in winning The Battle of the Atlantic in World War II. This was a lesson that the Japanese chose to ignore, and it cost them dearly.

Although merchant ship convoys were not formed until later, and were generally not well escorted, fleet units were escorted, frequently by very fast and proficient fleet destroyers. However, there was not a consistent plan to provide escorts. At times, large groups of ships or troop transports were lightly escorted and other times a small number of ships were heavily protected (Figure 41).

As the number of successful attacks on Japanese ships mounted, the Japanese finally began to construct escort ships just for convoy protection, but this did not begin until late in 1942 and it was many months before the first of them became available. At no time during the course of the war did the Japanese Navy have enough ships to properly protect their convoys.

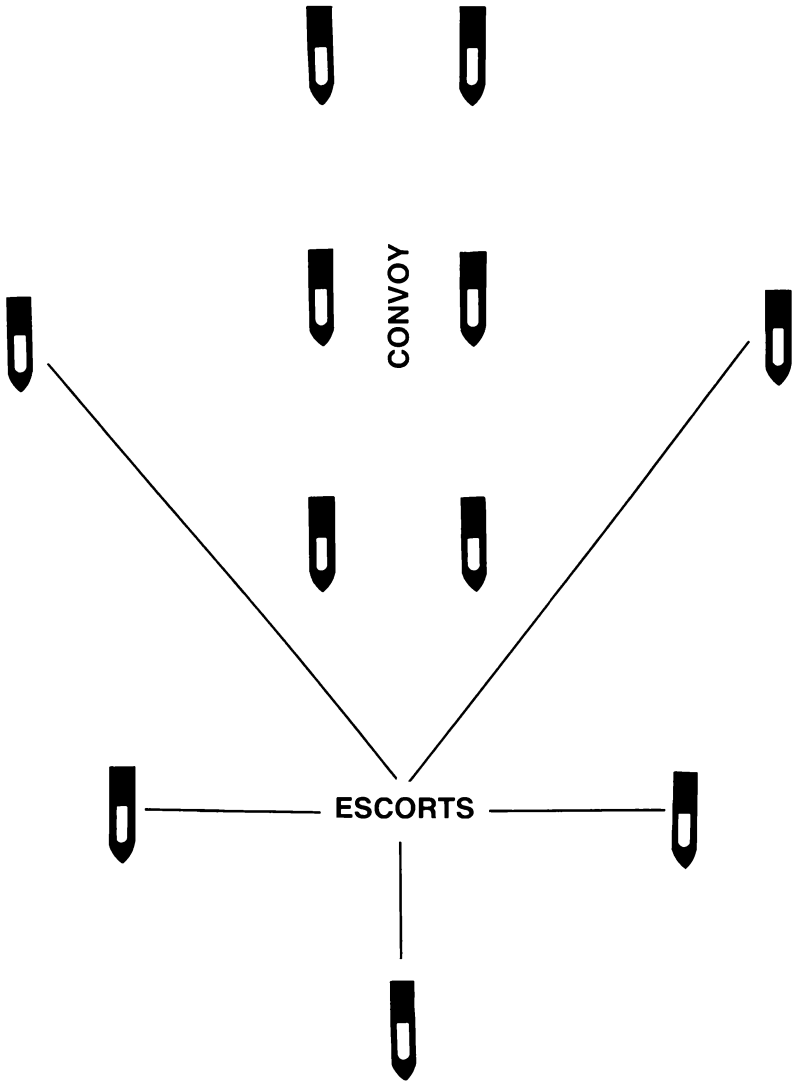


Figure 41. Six-ship convoy with five escorts

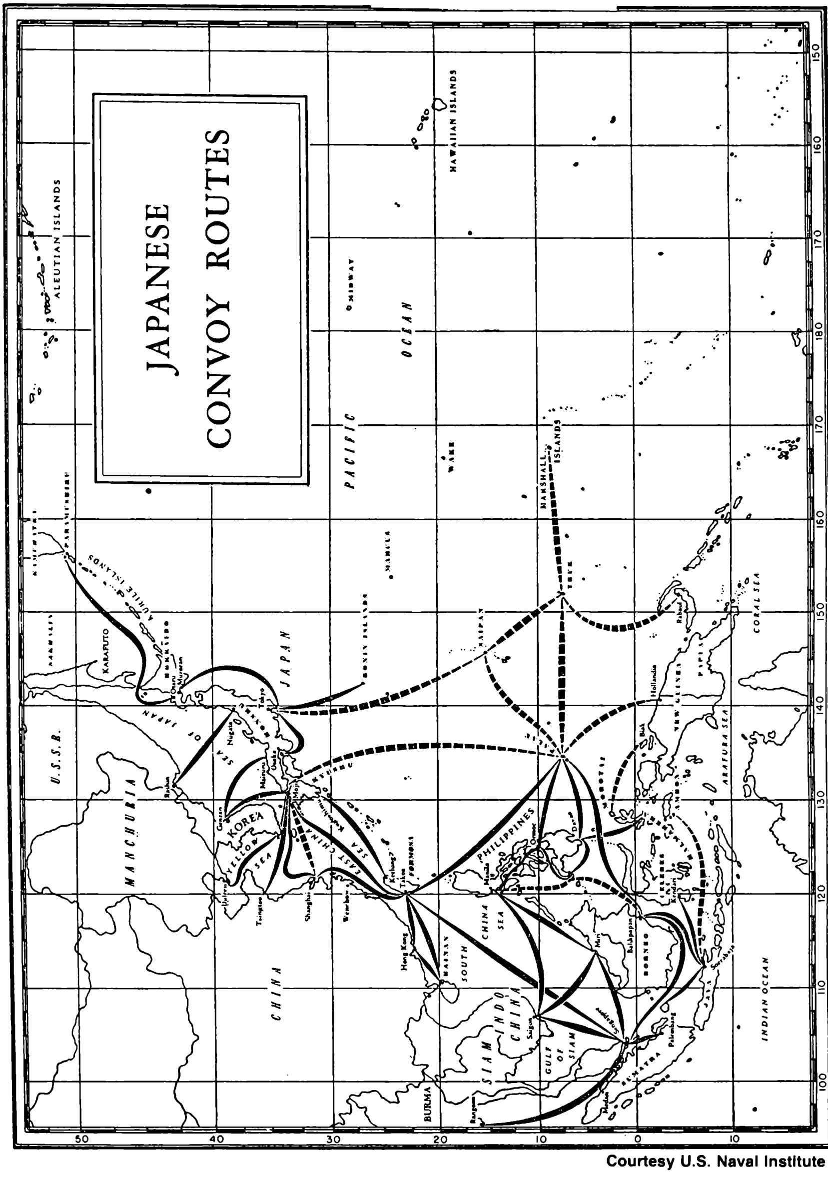
In late 1942, the beginning of a convoy system began to take place as small groups of ships and escorts travelled together. In 1943, as the sinkings continued with greater frequency, a regular convoy system was implemented on the Singapore run. It was not until 1944 that a regular system of convoy routes was finally established. The routes implemented are shown in Figure 42. However, this was much too late. By this time the Japanese-controlled ocean was shrinking and many routes were abandoned shortly after they were created. There was also a severe shortage of escort ships, so even when convoys were formed, they did not have an adequate number of escorts.

EVASIVE TACTICS

Zig-zag plans were simply frequent course changes, usually designed so as to appear random and unpredictable. Some felt that this was a useful technique since it certainly made it more difficult for the submarine to develop an accurate solution to the fire control problem. However, there are definite disadvantages. The principal disadvantage is that it causes the ship to take longer to make its voyage and uses more scarce fuel. Also, if an unescorted vessel escaped an attack by zigging away, the submarine could surface, do an "end around," and make another attack. Also, for every ship that zigged away, another may have zigged toward a submarine. In any event, Japanese ships did use rudimentary zig plans as shown in Figure 43.

When a convoy or single ship detected or suspected that a submarine was in the vicinity, the most effective evasion was to make a major course change away from the submarine's position. Frequently the first indication of a submarine's presence was a torpedoed ship, and it was not always obvious which way the convoy should turn to avoid.

When steaming at night, Japanese ships routinely proceeded with no lights showing, i.e., at "darken ship." This tactic did make it more difficult to track the targets visually but it was largely overcome by the use of radar. Late in the war, the Japanese only steamed during daylight and then stayed very close to shore where the shallow water made it difficult for submarines to get close enough to conduct an attack. The convoy would pull into a port each evening to prevent a



Courtesy U.S. Naval Institute

Figure 42. Japanese convoy routes

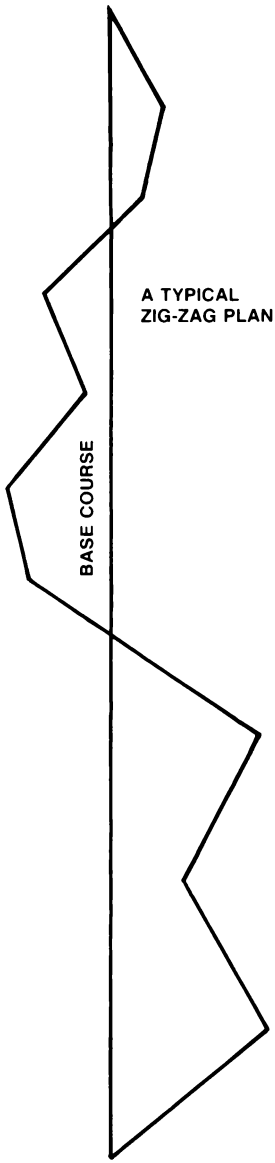


Figure 43. A typical zig-zag plan

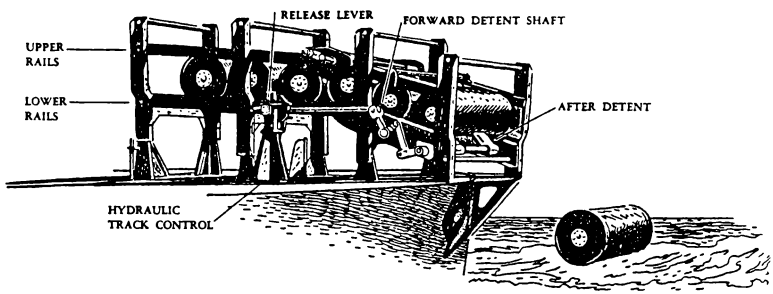
night surface attack. This was a reasonably effective defensive tactic but it greatly lengthened the time of the voyage at a time when speed was critical. It was not 100% effective since skippers such as Gene Fluckey and George Street went right into the harbors after their targets.

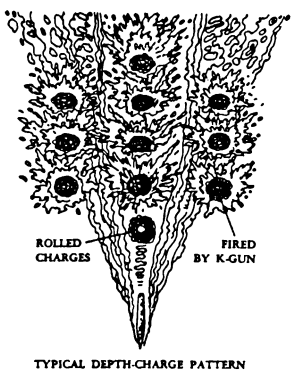
OFFENSIVE TACTICS

U.S. submarines were attacked by both ships and planes. The tactics used by the Japanese were fairly typical - find the submarine and deliver a depth charge or depth bomb right on top of him! It's not as easy as it sounds. First, the submarine must be detected before he can launch a torpedo, and the depth charges or depth bombs must be dropped, not where the submarine is now, but where he will be when the explosion takes place.

Depth charges and bombs were set to explode when they reached a preset depth. For example, assume that the depth charges sink at a rate of 12 feet per second and the submarine is 240 feet deep. It will take the depth charge 20 seconds to sink to that depth. If the submarine is moving at six knots, which is a reasonable speed to use when trying to evade, he will go 600 yards in three minutes, or 200 yards in one minute. (This is the "three minute rule" learned by every plebe!) In the 20 seconds that the depth charge is sinking, the submarine will move 200 feet. Unless the depth charge is dropped ahead of the submarine and set to explode at the correct depth, then lethal damage will probably not occur. Figure 44 shows the release gear used to drop depth charges.

This does not mean that depth charges were not effective -- they were effective and caused the sinking of many of the 52 U.S. submarines that were lost. However, very seldom would one depth charge sink a submarine, but depth charges dropped close to the boat will cause some damage and eventually, with persistence by the escort, a fatal explosion will occur or cumulative damage by many close depth charges will force the boat to surface. Many times, the Japanese would break off an attack too soon, convinced that they had scored a kill when the submarine was "on the ropes" but still alive. I can vividly remember a conversation I had in 1959 with a U.S. destroyer skipper who had served in submarines during World War II. He stated that many times they surfaced after a series of depth





Courtesy U.S. Naval Institute

Figure 44. The depth charge

charges because they had been damaged, or had run out of air or battery capacity and simply could not remain submerged. When they reached the surface, the Japanese ships had ceased attacking and were gone! If they had been more persistent, they would have sunk a submarine. This was a major Japanese weakness during the war.

Another Japanese weakness was the lack of radar on their escorts. By the end of the war a few ships had radar installed, but in general, submariners made night surface attacks with impunity because the surfaced submarine would not be detected. Later in the war some Japanese ships had radar detectors installed which alerted them to the presence of an Allied ship. The submariners countered this development by using their radar at random intervals, usually for just one or two sweeps. This gave enough information to track a target with little likelihood of alerting him.

The initial action of an escort or destroyer conducting an attack on a submerged submarine was to turn directly at the submarine's position, tracking the sub on either active or passive sonar. When steady on the bearing of the contact, the escort would then take a lead angle calculated to pass ahead of the submarine so that he could drop charges that would sink to the proper depth and explode just as the submarine arrived there. (Figure 44 shows a typical depth charge drop pattern.) As noted above, this is not as easy as it sounds. Even if it worked perfectly, there was a very good likelihood that the depth charge would not explode at the proper depth. In general, the Japanese tended to set their depth charges too shallow, while the best skippers set varying depths and greatly increased their chances for a successful attack.

Aircraft were a definite threat that submariners had to guard against. The Japanese were very proud of a system they had developed that could detect a submarine's magnetic field up to 500 feet directly beneath the plane. This was not a good search device but was very good for localizing a submarine. The planes carried two types of bombs, a small one of 150 pounds, and a big one of 625 pounds. A small bomb needed a direct hit to do much damage and the big ones were lethal up to 60 feet. The bombs were set to explode when they reached a preset depth. The only depths that could be set were 80, 150, or 250 feet, which limited their effectiveness against deep submarines but made them very particularly effective against submarines at periscope depth or just going deep.

52 submarines were lost during World War II. Of these 48 were lost in combat operations. Compared to other forces, this is not a large number, but it still represents 18% of all U.S. submarines that saw combat action. By contrast, the Japanese lost 128 boats, and the Germans lost over 700! The American losses would certainly have been higher had the Japanese installed radar on their escorts, developed a convoy system sooner and, most of all, been more persistent in their depth charge attacks. They seemed to believe that an attack had been successful based on the flimsiest evidence. Examination of Japanese records after the war showed they had reported 468 positive sinkings of American submarines, more than 10 times the number they actually sank. Luckily for the United States Navy, the Japanese Navy did not practice what "Mush" Morton taught Dick O'Kane - "Tenacity, Dick. Stay with the bastard till he's on the bottom."

TIPS, TECHNIQUES, AND PARTING SHOTS

A few thoughts to bear in mind as you depart on your first patrol:

- A submarine at periscope depth must be constantly alert for surface ships and aircraft. A collision (or being rammed) at periscope depth is far more hazardous than it is on the surface because the ship has no reserve buoyancy.

TIP: Never forget that when at periscope depth you are shallow enough so that a collision with a surface ship will cause damage.

- It is easier for a ship to "sneak up on you" at periscope depth because you have only one or two periscopes searching for contacts. Your field of view is restricted to that of the scope while on the surface you and your lookouts can quickly scan 360°.

TIP: Whenever you are at periscope depth, take frequent periscope sweeps to be sure you are not about to be run over. (Remember that a collision at sea can ruin your whole day, and a collision at periscope depth can ruin your whole life!)

- You are most vulnerable when just below periscope depth because you are still shallow enough to get run over but are "running blind" because your periscope can't be used to locate a dangerously close ship.

TIP: Don't order a depth that is just below periscope depth - be at either periscope depth or deep, at least 90 feet.

- A submarine's sonar system cannot hear most contacts that are within about 20 or 30 degrees of your stern. This area is intentionally baffled in order to prevent your own propellor noise from interfering with the sound of a target. This area astern, roughly relative bearing 150 to 210 degrees, is called the "baffles."

TIP: When proceeding from deep to periscope depth, alter your course 60 degrees to allow your sonar operator to listen to the area that was previously in your baffles. If there is a close contact in that area, you may get run over! (This will ruin your whole day!) This maneuver is known as "clearing the baffles."

A recent Commanding Officer of the Submarine School in Groton, Connecticut, explained that he volunteered for submarine duty because he wanted to serve in the ships with an "unfair advantage." This unfair advantage is the ability to disappear from sight by submerging. You give up your greatest tactical advantage if you get detected by the enemy.

Here are a few TECHNIQUES that will help you remain undetected:

- When making an approach in good visibility, don't leave your scope up for long periods. Keep your looks short.

- Present the minimum target to the enemy, by avoiding a beam aspect. As you get closer, "point the target" by steering a course that is within 20-30° of the target's bearing.

- Avoid high speed at periscope depth because your periscope will create a rooster tail and your propellors will cavitate and make a noise that is easily detected by enemy sonar.

- When making an approach and attack, don't forget that aircraft and escort or destroyers may also be in the area. Periodically, take a "look around" with the scope to make sure you are not being ambushed.

- While transiting to or from your patrol area, be alert for enemy planes and ships. Remember that vast expanses of the Pacific were totally controlled by the Imperial Japanese Navy during the first two years of the war.

When making an attack, you want to make the chances of a hit as large as possible in your favor. Here are a few TIPS:

- Try to shoot with small gyro angles. Remember that small gyros can still result in a hit even with a large error in your solution.

- Always try for a broad torpedo track angle. Keep the side of the barn as broad as possible!

- Short torpedo runs are always more likely to get a hit than a long run. 800 yards is not too short. Even if the target detects your periscope at that range, he probably won't be able to turn fast enough to escape a good shot.

Always know where the bottom is! (Take it from one who knows!)

As a PARTING SHOT, I'd like to encourage you to learn more about the history of the United States Navy, and particularly the Submarine Force, in World War II. Some suggested books and sources are listed in the following paragraphs.

Although U. S. submariners received little publicity during the war, a few excellent books have been written since the war's end. Many are no longer in print but may be available in your local library. Here are some personal recommendations:

Theodore Roscoe, *United States Submarine Operations in World War II*, United States Naval Institute, Annapolis, Md. 1949. This is a most complete and very authoritative work. It was written for the Navy and is based on the official operational history compiled by the ComSubPac staff. This book was a major resource in the writing of this manual.

Clay Blair, Jr. *Silent Victory: The U. S. Submarine War against Japan* , J. B. Lippincott, 1975. This is a very scholarly work. When I was Director of Officer Training at Submarine School, I made this book required reading for all officers in the Submarine Officers Advanced Course.

George Grider, *War Fish*, Little, Brown and Company, 1959. Commander Grider was Commanding Officer of Flasher during the

great tanker shoot. This patrol is described in detail. He also describes patrols he made as an officer in Wahoo with Mush Morton. A paperback edition was published by Pyramid.

Edward L. Beach, *Submarine!*, Henry Holt and Company, 1946. Also available in a Signet paperback edition by New American Library. Captain Beach has written numerous books. This work describes his experiences aboard Trigger, Tirante and Piper and also includes chapters on other notable boats.

Forest J. Sterling, *Wake of the Wahoo*, Chilton, 1960. I found this book in a submarine library many years ago and read it during a Polaris deterrent patrol. The author served on Wahoo with Mush Morton and was transferred off the ship just before the ship's final patrol. It's an excellent account of life and routine aboard a submarine.

Keith Wheeler, *War Under the Pacific*, Time-Life, 1980. This is volume 23 in the Time-Life series on World War II. It includes many photographs and is a very readable book.

Charles A. Lockwood, *Sink 'Em All: Submarine Warfare in the Pacific* , E. P. Dutton, 1951. Admiral Lockwood was ComSubPac during the war. I have not been able to find a copy but if your library has it I'm sure you'll find it interesting.

Many excellent naval histories of World War II have been written. One of the best is *The Two Ocean War: A Short History of the United States Navy in the Second World War* by Samuel Eliot Morison, published by Little, Brown in 1963. It is a summary of his monumental 15-volume *History of United States Naval Operations in World War II* published in 1962 by Little, Brown and available in most libraries. A number of histories are published by the United States Naval Institute, including one edited by E. B. Potter and Admiral Nimitz.

If you only read one book, I recommend *Clear the Bridge!* by Richard H. O'Kane. It is published by Rand McNally and recounts the five patrols of USS Tang. I cannot say enough about this book. It was also required reading at Submarine School when I was in charge of officer training. Four times a year a class graduated from the Submarine Officers Advanced Course. We always had a distinguished submariner, usually a flag officer, as graduation speaker. One class said they wanted to arrange their own speaker, and they wanted

Admiral O'Kane. (They even offered to pay for his plane ticket and played liars' dice at the Officers' Club to raise the money!) Admiral O'Kane spoke at their graduation and it was one of the best graduation addresses I have ever heard. This same quality is in his book.

In addition to books, one of the best sources of information is the Nautilus Memorial Submarine Force Library and Museum located in Groton, Connecticut. It is the newest National Memorial. The museum contains many World War II exhibits, including a TDC, a conning tower mockup, periscopes, models and submarine battle flags. Visitors to the museum may also go aboard USS Nautilus (SSN 571), the world's first nuclear submarine, which is moored nearby. The museum is open from 9 AM to 5 PM every day except Tuesday. The library is open only by appointment, and you may call or write to make arrangements. It contains original copies of World War II patrol reports, technical manuals, and a file on each submarine ever commissioned in the U. S. Navy. The museum is located just outside the main gate of the Submarine Base and adequate parking is available. The address is:

Nautilus Memorial Submarine Force Library & Museum
Box 571
Naval Submarine Base New London
Groton, Connecticut 06349-5000.
Phone (203) 449-3174.

In addition to visiting the museum, why not become a member of the Submarine Force Library & Museum Association and join the growing numbers who are helping to "Preserve Our Proud Heritage?" Members receive the KLAXON, a semi-annual publication containing news and updates of the newest national memorial; a 10% discount at the gift shop and mail order service; a free counted cross stitch pattern of the Association patch and the opportunity to buy the patch, which is available to members only. A coupon to join is included in the Up Periscope! package.

You may have some veterans of World War II submarine patrols in your neighborhood who would be happy to talk about their wartime experiences (this is known as telling sea stories). The United States

Submarine Veterans of World War II is a national organization with many local chapters throughout the country. To find out if there is a chapter in your area, write or call the national headquarters. The address is:

United States Submarine Veterans of World War II
862 Chatham Ave.
Elmhurst, Illinois 60126
Phone (312) 834-2718

Finally, I would like to acknowledge the help of the Submarine Force Library and Museum staff, especially Senior Chief Petty Officer Bob Zollars and the Museum Director, Lieutenant Commander J. M. Crochet. Bob Zollars has been recently reassigned as Chief of the Boat on USS Pittsburgh, a new, quiet, and fast nuclear attack submarine. I'm confident he will be a great COB and I'm sure Pittsburgh will carry on the traditions of excellence and professionalism that marked the World War submariners.

APPENDIX I - ADDITIONAL PATROLS AND SITUATIONS

In the following pages more historical situations and famous patrols are described for you to try, but instead of showing you the convoy formation and describing how the situation was handled in World War II, only the basic scene is set. It's up to you to figure out how to conduct the approach and attack the targets. To compare your success with the World War II skippers, turn the page to learn the actual patrol results. For an historical situation, you will find an accurate reproduction of the situation as recorded in the actual World War II patrol report.

Good hunting! Remember there are just two types of ships, submarines and targets!

Famous Patrol

USS GUARDFISH'S FIRST PATROL: OFF THE COAST OF HONSHU

USS Guardfish, commanded by Lieutenant Commander Thomas B. Klakring, departed Pearl Harbor on August 6, 1942 for her first patrol. She carried 24 Mark 14 torpedoes. Radar had not yet been installed. Her assigned area was off the northern coast of Honshu. The area is shown in Figure 45. Upon completion of patrol, she returned to Midway.

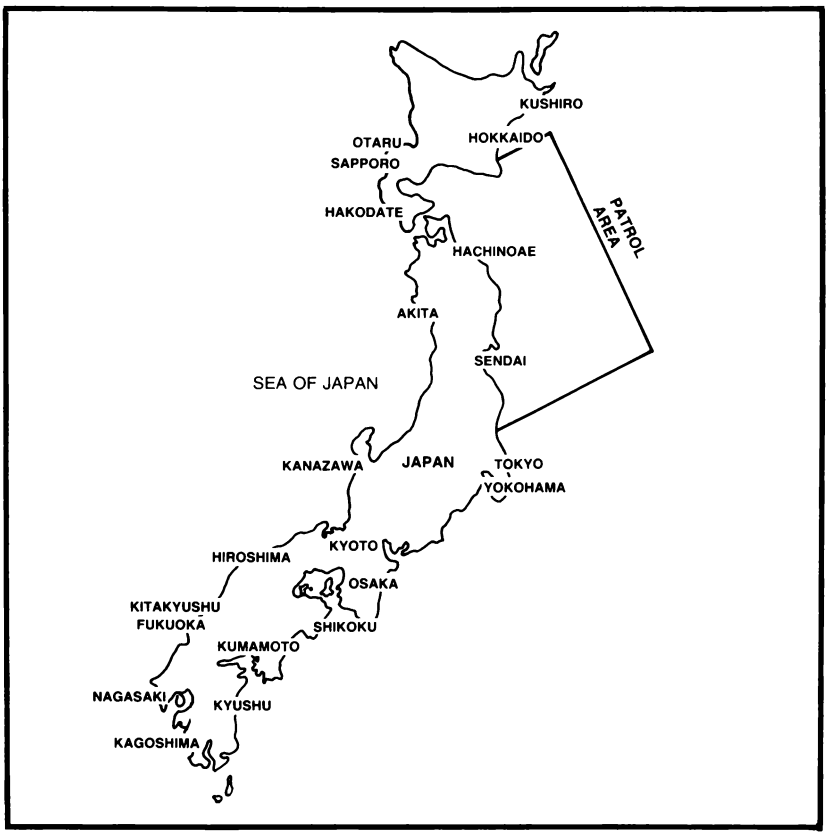


Figure 45. USS Guardfish's first patrol

Results of Guardfish's First Patrol

Guardfish is officially credited with sinking the following ships:

Date	Location	Type of Ship	Tonnage
Aug 24	38-12N, 141-30E	Passenger-Cargo	3,109
Sept 2	42-08N, 141-15E	Cargo	2,332
Sept 4	40-10N, 141-53E	Cargo	2,276
Sept 4	40-14N, 141-51E	Cargo	3,738
Sept 4	40-14N, 141-51E	Cargo	5,254

In addition, on August 19, an attack was made on an 8,000 ton naval auxiliary ship but was unsuccessful, apparently due to premature warhead detonations. On August 22, a small trawler was sunk by gunfire. Three freighters were sighted on August 24 but Captain Klakring was unable to get close enough to attack. This was followed by the successful attack listed above. The next day another ship was attacked but all three torpedoes malfunctioned. On September 4, in addition to the three confirmed sinkings listed above, a transport was damaged but was able to return to port. Another ship was torpedoed while at anchor, was seen to sink but was probably salvaged so Guardfish was not credited with its sinking. On September 9, with three torpedoes left, another ship was attacked but the torpedoes apparently ran too deep.

Famous Patrol

USS HARDER'S SECOND PATROL: OFF THE COAST OF JAPAN

USS Harder, commanded by Sam Dealey, departed Pearl Harbor on August 24, 1943 and topped off with fuel at Midway four days later. Her assigned area was off the coast of Japan and she was authorized to penetrate any vacant area. Harder carried 24 Mark 14 torpedoes and was equipped with radar. After patrol she returned to Pearl Harbor. Her patrol areas are shown in Figure 46.

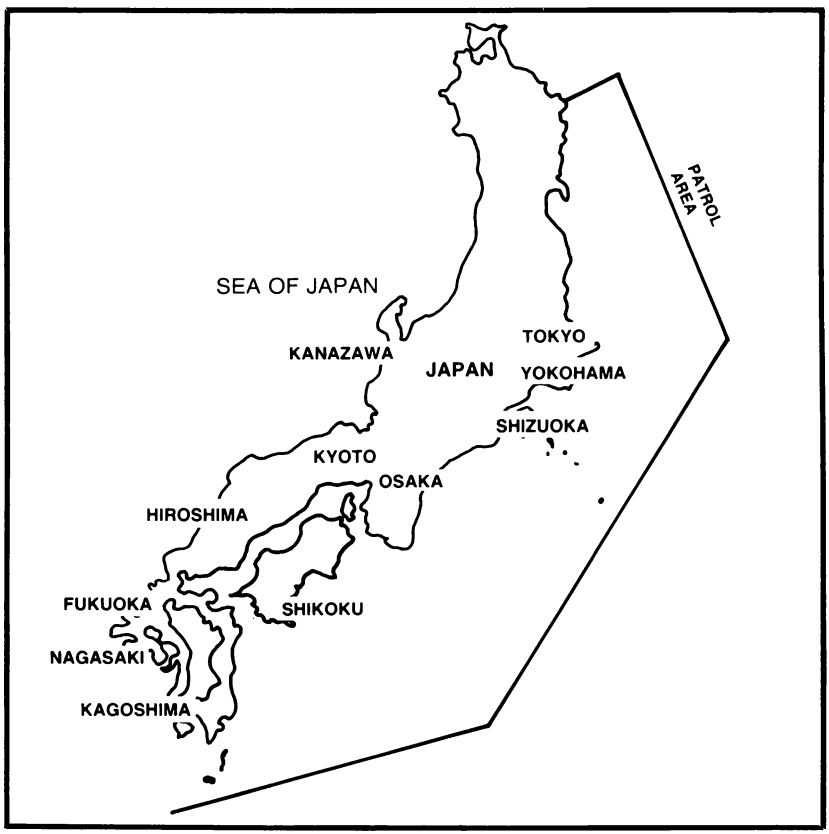


Figure 46. USS Harder's second patrol

Results of USS Harder's Second Patrol

Harder is officially credited with sinking the following ships:

Date	Location	Type of Ship	Tonnage
Sept 9	35-20N, 140-49E	Cargo	3,010
Sept 11	33-50N, 139-33E	Cargo	1,050
Sept 19	33-30N, 135-40E	Cargo	814
Sept 23	34-15N, 137-00E	Cargo	4,520
Sept 23	34-15N, 137-00E	Tanker	5,878

In addition to the confirmed sinkings, Harder also attacked two freighters on September 22 but missed. On September 28, she attacked a convoy with her last two torpedoes and missed, but later surfaced and destroyed two armed trawlers on the 29th. At one point during the patrol, Dealey took Harder so close to the Japanese homeland that highway traffic was clearly visible. As written in his patrol report, "The headlights of many cars moving along the nearby highway remind us of Riverside Drive along the Hudson."

Historical Situation

USS SPADEFISH AGAINST A CONVOY

On September 8, 1944, on her first war patrol, USS Spadefish is patrolling off Formosa. At 0958 in the morning, the following situation, as described in the patrol report, exists:

"Sighted smoke bearing 005. Sound picked up pinging in direction of smoke. Smoke developed into a convoy of 8 ships and at least 3 escorts. All the ships were smoking heavily, intermittently. The convoy came down the NE coast of FORMOSA and took departure off SAMACHO KAKU on course 105, at speed about 8 knots. All that could be seen were masts and stacks. We couldn't close any closer than about 18,000 yards. Set course to trail."

See if you can make a good attack on this convoy. Because of computer memory limitations, only six ships can be programmed so you won't "see" every ship that Spadefish detected, but there will probably be enough to keep you busy. On the next few pages, the rest of the patrol report is reproduced.

8 September
1652: "Surfaced and commenced overtaking convoy whose smoke could still be seen plainly, bearing 083."

1853: "SJ contact on convoy bearing 102, range 17,000 yards. Set a tracking party watch and commenced an end around to south of convoy. Convoy now determined to be zig-zagging 20 to 30 degrees either side of base course 105, at speed 8 knots. There were eight good sized ships from the size of the radar pips. Three small pips were taken for escorts."

1922: "Went to battle stations. Convoy was in sight at range of 9000 yards. SJ encountered interference of a sweeping type, sweeping rate about 20 per minute, similar to that encountered with Jap ships off LUZON. Decided to disregard their radar and make attack on the surface."

2030: "Headed in for an attack on the starboard flank of the convoy. Convoy was arranged in 2 columns of four ships each. One escort was ahead, one on starboard bow and one astern."

2033: "Fired three torpedoes forward at last ship in far column, followed by three torpedoes at last ship in near column. This second target was one of the largest in the convoy. His range on firing was about 2100 yards. He was a long (about 500 feet) split-superstructure AK transport, heavily loaded. It was too dark to see further details. One hit was observed on first target, which seemed to disintegrate, throwing sparks and smoke high in the air. Two hits were observed on second target, one amidship and one aft. He was last seen smoking heavily and settling rapidly."

2035: "Turned to bring stern tubes to bear and at 2036 fired four torpedoes at a target in the middle of the convoy, using radar range and bearings, firing range 3000 yards. Two hits were heard, with times corresponding to 1st and 4th torpedoes. Convoy was now smoking so heavily it was hard to determine where the torpedoes exploded, other than sudden additions to the puffs of smoke.

"SJ radar then reported only 9 pips where there had been 11."

2044: "The depth charges commenced to go off in the vicinity of the attacks. As we were astern of the convoy and crossing to the port side, we could afford to laugh at them."

2120: "In position on port flank of convoy, so headed in for another attack. It was a bit premature as the convoy had not yet settled down in disposition. The base course was now 113, zig-zagging radically at a speed of 8 knots. A small ship astern, taken for an escort, began moving up the port flank. We got in to a range of 1900 yards from this fellow when it was decided to pull out and try again. This ship could be seen to be a small, well-decked, inter-island freighter, about 150 to 200 feet long, probably acting as escort. Two PC type escorts were on the port bow of the convoy. Radar interference was coming from their bearings, but they apparently didn't pick us up as the sweeping didn't stop, although we had closed to 1800 yards of these two. One of the freighters was smoking quite heavily aft. With so many escorts on the port side, decided to go around the stern of the convoy and attack from the starboard side again."

2208: "Headed in for attack from starboard flank. Before firing position was gained, the moon came up. However, we had the convoy between us and the moon, so went on in."

2223: "Picked out two targets silhouetted by the moon and fired three torpedoes at each, with a range of 2300 yards. Two hits were seen in first target. He was later seen to blow up and sink. The second target was missed. Radar had trouble getting on the right target and possibly a faulty range was given."

2224: "Turned to bring stern tubes to bear, and fired four torpedoes at a range of 2450 yards, using TBT bearing and radar ranges. This time radar was on the right target and two hits were observed. Target was low in the water and then obscured by smoke as we withdrew from the vicinity."

2229: "Indiscriminate depth charging was seen and heard in the vicinity of the attack for the next fifteen or so minutes. Some forty or fifty in all. Some gun fire was seen, but no shells came our way. There was much flashing of searchlights, and flames and explosions continued from the vicinity for some time. Radar reported the number of pips had now reduced to seven. We kept within a range of about 10,000 yards as we circled to the south to make an end run down

moon. Visibility was excellent. We could see the dark shapes and smoke plainly. They couldn't see us with our light color."

2241: "The convoy could be plainly seen to consist of only four big ships now. The last in column was having a hard time keeping up and was guarded by two of the escorts. The other two escorts were seen with the leading three ships. The convoy was headed on course 113 at a speed of 6 to 7 knots, headed for NAGURO WAN in ISHIGAKI JIMA."

Historical Situation

USS TRIGGER VS. CONVOY

USS Trigger is on her sixth war patrol off Formosa on September 21, 1943. The ship is submerged at Latitude 26-27N, Longitude 122-40E. The situation, as reported in the patrol report is as follows:

1510: "Sighted masts and smoke bearing 345°T, distance 10 miles. Commenced approach at high speed."

1545: "Convoy in sight, consisting of one very large tanker, two smaller tankers, and three old type freighters, with air coverage. Full speed since sighting, unable to close. Barring a radical and wholly illogical zig, our only hope is a night attack. Convoy is zig-zagging from 030°T to 130°T, speed eight."

The convoy is escorted by an aircraft. Twilight will occur about 1900 (7:00 PM). Can you attack this convoy? After you have completed your attacks, turn the page to see how Dusty Dornin, skipper of Trigger, did it in 1943.

CONTACT #3 - 6 SHIP CONVOY WITH AIR ESCORT
ATTACKS #3, 4, 5, 6, 7, 8, 9
Lat. 26-27N. Long. 122-40E.

21 September, 1943
1510: "Sighted masts and smoke bearing 345°T, distance 10 miles. Commenced approach at high speed."

1545: "Convoy in sight, consisting of one very large tanker, two smaller tankers, and three old type freighters, with air coverage. Full speed since sighting, unable to close. Barring a radical and wholly illogical zig, our only hope is a night attack. Convoy is zig-zagging from 030°T to 130°T, speed eight."

1844: "Lost sight contact."

1923: "Surfaced. Full speed on all engines."

1955: "Radar contact. Commenced working around on starboard side of convoy. It is still fairly light, and lookouts picked up the convoy at about 8000 yards range."

2030: "On starboard beam of the convoy, range 8000. Plot indicates course 080°T, speed 8, not zig-zagging. Disposition from PPI - Two columns of three ships each, 1000 yards apart. From the size and location of the pips, decided the tankers are on our side, hence will attack this side. Waited till it became a little darker."

2045: "Commenced surface approach, planning to fire three torpedoes at the first ship, three at the second, then swing and fire four at the third ship."

2048: "Nearest column of ships in plain sight - THREE TANKERS, with the big one leading. It is still fairly light. They should see us - but they don't."

ATTACK #3 - TANKER, 10,000 TONS - SUNK

2056: "Fired three torpedoes at TANKER #1, 80 S track, GA 10 L, 1600 yards."

ATTACK #4 - TANKER, 7500 TONS AND FREIGHTER, 6700 TONS - SUNK

2057: "Fired three torpedoes at TANKER #2, 60 S track, GA 0, 1200 yards. Came left with full rudder and full speed. During the firing, had TBT bearings, radar bearings, radar ranges, sound bearings, and periscope bearings, all checking."

2057-10: "One hit seen on after part of the TANKER #1. Flame shot five hundred feet into the air, lighting up the whole area as bright as day. All six ships could plainly be seen. Eight seconds later the second torpedo hit her amidships; but nothing could have added to the furious holocaust already taking place. Members of her crew in various stages of dress (most in white uniforms) could be seen running forward ahead of the rapidly spreading flames. She was still driving ahead, a brilliant blazing funeral pyre. The men in the bow manned the bow gun and fired three or four times, but she was soon burning throughout her length. The flames were yellow-red, evidently a gasoline fire."

2058-10: "One hit on TANKER #2. A small flash amidships, a column of smoke and water were seen, and fire immediately broke out. She was turning away from us when hit."

2058-50: "One hit amidships on FREIGHTER #2. in the far column. In the light of the burning tanker she was seen to break in half beneath the stack and sink immediately. Radar was on this target at the time, the operator having expressed a desire to see a ship sink on his screen. His wish was fulfilled.

"During this time we were swinging hard left. Bridge saw FREIGHTER #3 turn away. FREIGHTER #1 was holding on her original course. Both remaining freighters and tankers opened fire. Range was about 1000 yards to the tanker column, 2000 yards to the freighter column. It was so bright they had no difficulty seeing us. Splashes were seen on both sides of us, but not too close. TANKER #3 presented a 50 starboard angle on the bow, and was closing rapidly, firing his bow gun. We seemed to take a year to pick up speed. Finally steadied with our stern toward him, and at

ATTACK #5 - TANKER, 7300 TONS - MISSED

2100: "fired three torpedoes aft at this tanker, 50 S track, GA 0, 1000 yards. All missed,probably because we had not steadied enough, and he was swinging toward us, as we realized in a moment."

ATTACK #6 - SAME TARGET - HIT

2101: "Fired one torpedo aft down the throat, angle on the bow zero, GA 10 R, 800 yards. Hit on the starboard bow, observed from the bridge. We were making full speed by this time, and pulling away. However, he continued firing, and was getting a little better, as was evidenced by shells whistling overhead."

2102: "Dived. Slight confusion in the conning tower. The Commanding Officer fell into the periscope well and the quartermaster began to lower the periscope. Fortunately the Commanding Officer, supporting himself on his elbows, was able to make himself heard in time.

"In the meantime, with lots of down angle and lots of speed, went to 200 feet, figuring TANKER #3 might try to ram or possibly drop some depth charges as he passed over. However, he did not pass over, and in fact, no screws were heard. The situation at this time can best be illustrated by the following sketch:" (Figure 47)

2105: "One violent explosion."

2108: "Another violent explosion. Both sounded like ships sinking. No depth charges were dropped at any time during these attacks."

2120: "Periscope depth. Burning ship still very bright, but nothing else could be seen. Made reload, two torpedoes left forward, four aft. Took periscope pictures and allowed crew to view burning tanker through both periscopes."

2140: "Reload completed."

2141: "Surfaced. Took more pictures of burning ship. Radar reported five contacts, three in the vicinity of the burning tanker, and two others. The situation as clarified by plot and radar was as follows: TANKER #1, stopped, burning. TANKER #2, burning, course east.

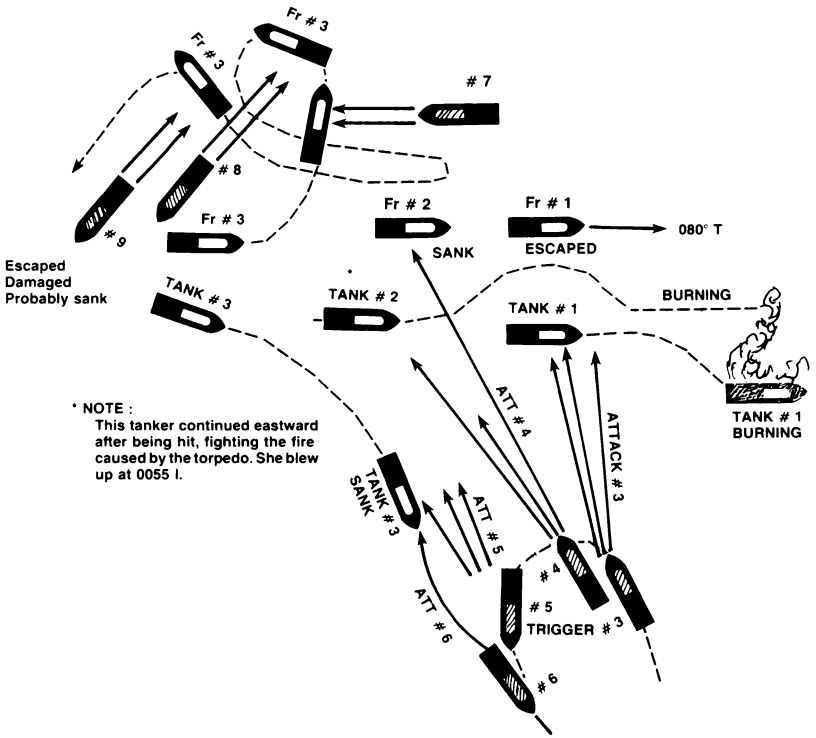


Figure 47. USS Trigger's convoy encounter

TANKER #3, down by bow. FREIGHTER #1, undamaged, stopped near burning ship. FREIGHTER #2, sunk. FREIGHTER #3, undamaged, course north."

2142: "Took off after ship moving north. As we passed the burning NIPPON MARU abeam, the stern of a ship, pointing vertically into the air, drifted between us and was distinctly silhouetted. It is believed that this was the stern of TANKER #3, but it is possible it was the stern of FREIGHTER #2. However, this freighter already had been seen to sink at about 2059."

2147: "The stern went under. At this time the whole hull of TANKER #1 could be seen, red hot."

2210: "Attained surface firing position on FREIGHTER #3. So bright we nearly dived, but decided to ride our luck."

ATTACK #7 - FREIGHTER, 7000 TONS - DAMAGED

2212: "Fired last two bow torpedoes, 90 S track, GA 0, 1400 yards. Two hits in the bow, target immediately went down by the bow, and we left him in an apparently sinking condition. As we swung left he opened fire. A light came on on his bridge and he commenced signalling. With this, FREIGHTER #1 opened fire also. While we circled, it seemed there were flashes of gun fire all around us. Shooting still pretty wild."

2220: "FREIGHTER #3 down to his main deck forward, dead in the water, but still not under. Decided to polish him off, and made surface approach. He was still firing but evidently to wrong side, because we could see no flashes. FREIGHTER #1, several thousand yards beyond him, was shooting back. Score zero for both, as far as we could see."

2235: "Swung to bring stern tubes to bear, range 1500 yards. At this moment he discovered us, and commenced shooting in our direction. Went to full speed and at

ATTACK #8 - SAME TARGET - MISSED (OR DUD)

2236: "fired two stern tubes, 110 port track, GA 0, 2200 yards. Should have got a hit, but nothing happened. Although no definite

proof, from firing data feel sure we must have hit, and hence at least one dud.

"Pulled out again and thought it over. We have only two torpedoes left, both aft, and he is getting pretty handy with his gun."

2242: "Dived for radar approach. Target in meantime had got underway, and we had to go to full speed submerged. Had almost reached favorable position when he reversed course."

2332: "Surfaced. Found ourselves silhouetted against burning TANKER #1. Went to full speed, pulled around FREIGHTER #3 on the dark side.

"Passed too close (2500 yards). Target saw us and opened fire."

22 September, 1943
0010: "Dived. Attained firing position for radar depth approach. Used radar, periscope, and continuous echo ranges."

ATTACK #9 - SAME TARGET - DUDS

0022: "Fired last two torpedoes, 90 port track, GA 0, 1000 yards. One hit, one missed, according to sound. No detonation, but target evidently felt the hit, for he opened fire immediately. The feelings of the Commanding Officer and the control party by this time can be imagined. Held huddle over a battle surface, decided against it. We felt, under the circumstances, that our chances in a gun fight against a fully aroused enemy were not of the best, and that the probability of the target's sinking eventually was still good."

0036: "Surfaced. Three radar contacts. Burning TANKER #1, damaged FREIGHTER #3, and undamaged FREIGHTER #1. The latter was slowly steaming back and forth near the fire, like a moth drawn to a flame. FREIGHTER #3 was still firing aimlessly, forecastle awash, but able to make 4 knots.

"The whole action covered a period of 3 1/2 hours, and took place within a circle of 8000 yards of the burning NIPPON MARU. The light cast by this fire was intense; the flames being, most of the time, a hundred feet over the tops of his masts. Continuous minor explosions took place, throwing up globules of fire even higher. The

smoke emitted covered a third of the sky, and was blown by the wind into a plume twenty miles long.

"It must be admitted that the light of the fire was probably of more benefit to us than to the enemy, however, since we were always able to get around to the dark side and use it to our advantage."

0045: "Set course for edge of area, full speed on all engines."

0050: "Sighted a glow over the horizon, beyond the burning tanker."

0055: "The glow flared up, and burst into brilliant flame, identical to that of the burning tanker. It was TANKER #2, as she blew up. By 0100, two huge fires could be seen. The bow, bridge, and stern of the distant tanker were incandescent. Nothing more could be seen of the hull of the NIPPON MARU, but the place where she had been was still burning fiercely, with flames 50 to 100 feet high.

"Allowed members of the crew, one at a time, to come up on the bridge to see the two burning ships."

0220: "Lost sight of fires, distance 25 miles astern.

"Recapitulation of results of attacks 3, 4, 5, 6, 7, 8, 9 on six-ship convoy:

FREIGHTER #1	(Kohuko Maru type) escaped, undamaged.
FREIGHTER #2	(Argun Maru type) sunk. Broken in half.
FREIGHTER #3	(Lima Maru type) damaged, two hits in bow. Forecastle awash.
TANKER #1	(Nippon Maru type) sunk. Blew up immediately.
TANKER #2	(Syoyo Maru type) sunk. Blew up after burning for several hours.
TANKER #3	(San Pedro Maru type) sunk. The Commanding Officer realizes that proof of the sinking of this vessel is not completely conclusive. However, by reason of the evidence put forward in the narrative, it is felt that the stern which sank at 2147 belonged to this ship."

Historical Situation

USS RASHER TAKES ON A LARGE CONVOY

USS Rasher, commanded by Commander H. G. Munson, is on patrol off the northwest coast of Luzon. Captain Munson was leader of a two ship wolfpack with USS Bluefish. On August 18, Rasher is patrolling alone because Bluefish had left to chase down a damaged tanker. The situation, as described in Captain Munson's patrol report, is as follows:

1905: "Surfaced and headed up coast to make sweep to CAPE BOJEADOR prior to effecting rendezvous with BLUEFISH due to rejoin us tonight."

SHIP CONTACT #18

2009: "Made radar contact dead ahead at 15,000 yards on a 13 (approximately) ship convoy with about 6 escorts. Composition and disposition were never fully determined but the PPI showed them to be in a line of close columns with the escorts around in a conventional screening formation and with a group of four or five more ships well behind. The night was very dark, no moon, completely and thickly overcast with almost continuous rain - absolutely ideal conditions for night attack. Sound gear was of great help in all phases of the action to follow in identifying the escorts by their pinging and was used at this time in 'sorting' the convoy. All attacks were made by radar only. Targets were easily detected and tracked at ranges up to 19,000 yards."

Make your approach and attack on this convoy, then read how Rasher attacked the convoy.

18 August
2009: "Took convoy course and tracked from ahead, determined base course 205°, speed 12 knots, zigging 10 degrees either side."

2108: "Solution completed, started in on starboard bow, unable to see any targets when desired firing point reached 1500 yards ahead of starboard beam escort. Since the multiplicity of targets and side lobes confused the radar operator who could not isolate the desired target, swung out at full power 900 yards ahead of the escort. As we steadied on the outbound course, the radar operator solved the bearing problem, we stopped, and at

2122: "commenced firing a spread of two torpedoes from the stern tubes, on a 125° starboard track, gyro 5° right, spread 2°, range 2800. (Figure 48)

"Drew off and ran up along starboard flank to attack again. As we steadied down both torpedoes were seen, heard, and

2124: "correctly timed to hit a huge tanker, apparently gasoline laden judging from the appalling explosion with a column of flame 1000 feet high. The entire sky was a bright red momentarily and the target and the whole convoy was seen for an instant. Part of the ship blew off and landed about 500 yards from the remainder of the tanker and both parts burned fiercely for about twenty minutes and then disappeared from sight in one grand final explosion. The near escort decided something was wrong, he fired his guns at all points of the compass, reversed course and fiercely depth charged something or other two miles astern of us. Pandemonium reigned in the convoy, lights flashed on and off, side lights turned on, depth charges fell in every direction, gun fire broke out all over and some badly aimed 40mm tracer passed astern of us about 100 yards wrong in deflection and way over. Two ships appeared to indulge in a spirited gun duel for a few moments. We proceeded up the starboard side of the convoy about 4000 yards off reloading and enjoying the spectacle, sending contact to BLUEFISH, who advised us he was 83 miles ahead. The convoy obligingly changed base course to 240° at this time, making the end around much easier."

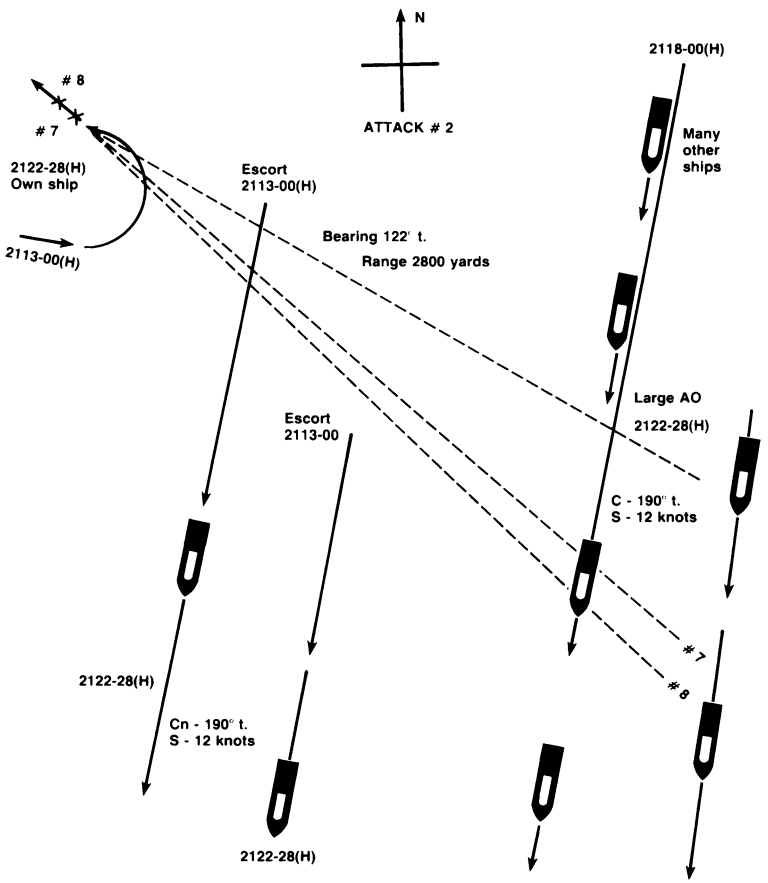


Figure 48. USS Rasher torpedo attack #2

2201: "Took position 5000 yards on starboard bow of convoy and tracked. At

2206: "considered problem solved and started in, selected nearest, and, judging by radar pip, largest target. Headed in around stern of starboard bow escort. At least eleven large targets were seen on the PPI screen beyond and bearing on either side of the chosen target."

TORPEDO ATTACKS #3 AND 4

2211: "Fired six bow tubes, on a 71° starboard track, gyro 8° right, spread 2°, range 3300 yards. Swung left and at

2214: "fired four stern tubes at a large target immediately to the left and a little further out, on a 93° starboard track, gyro 13° right, spread 2°, range 3750 yards." (Figure 49)

2212: "Observed, heard, and timed three hits on the bow tube target. It immediately began burning and smoking heavily, and was seen to be a large transport (AP). Many low power lights, probably lifeboat markers, began to appear.

"The spread used, combined with the run and number of hits, indicates that the target was very long."

2213: "Timed a hit (from the bow nest) on a second target beyond and ahead of the AP."

2216: "Observed, heard, and timed two hits, heard and timed one more, on the stern tube target at the proper interval. These three hits with the large spread indicates that this target was also very long."

2217: "Timed a fourth hit that indicated a stern tube torpedo hit on another unidentified target beyond the stern tube target. One half hour later the first stern tube target was plotted at speed zero, four miles from the attack position. Four hours later, while returning through this same vicinity, passed through a thick layer of oil roughly two and a half miles long, in a location only two miles from the last contact with the target. Three small objects were contacted on radar at close ranges, one of which was blinking a white light, indicating it

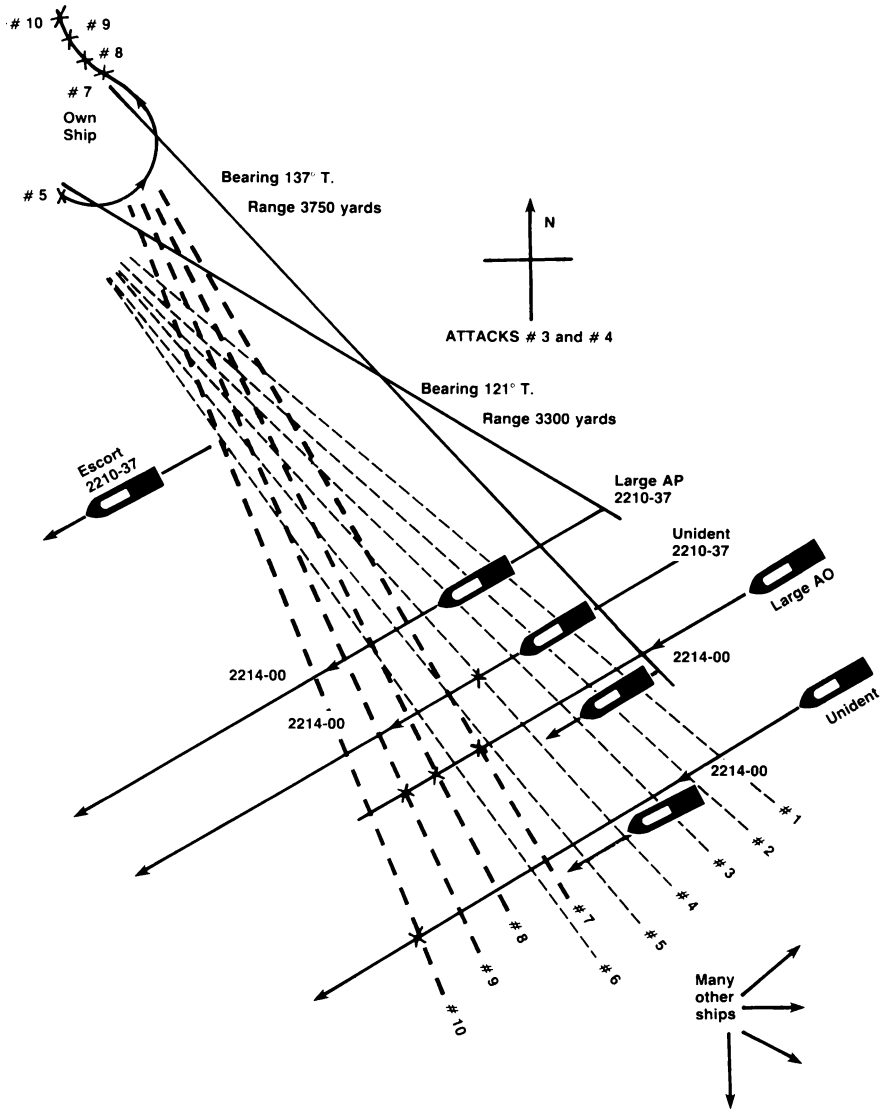


Figure 49. USS Rasher torpedo attacks #3 and #4

was a lifeboat. Two escorts were also detected in the vicinity. It is believed that this target was a large tanker and that it sunk.

"The usual depth charging, gun firing and signalling began anew, with the escorts rushing around like rats in a cage."

2218: "One escort got on our tail at 4000 yards as we opened to end around. We easily shook him off.

"Radar showed the AP dropping out of the formation with two escorts joining the target. The radar pip acted very erratically and kept decreasing in size, and finally disappeared from the radar screen. When returning through this area four hours later, radar contacted three small objects, at close range, one of which was blinking a white light, indicating they were lifeboats or rafts. This target was considered sunk."

2300: "The leading part of the convoy had split into two groups and we picked for our final attack the largest of the two groups remaining which appeared to consist of at least two large ships in column with one very non-hostile escort on their starboard bow and a third large ship on the port quarter. They had changed base course to 270°. We crossed ahead of the convoy."

2327: "Had solution, started in. Targets had zigged right to 290°T."

TORPEDO ATTACK #5

2330: "Fired remaining four bow torpedoes at leading target on a 64° port track, gyro 7° left, spread 2°, range 2200 yards, #1 torpedo hooked right but finally straightened out, swung right and at

TORPEDO ATTACK #6

2333: "fired two remaining stern torpedoes at second target, on an 85° port track, gyro 20° right, spread 2°, range 2100 yards." (Figure 50)

2332: "Observed two hits, heard and timed three hits on leading target and at

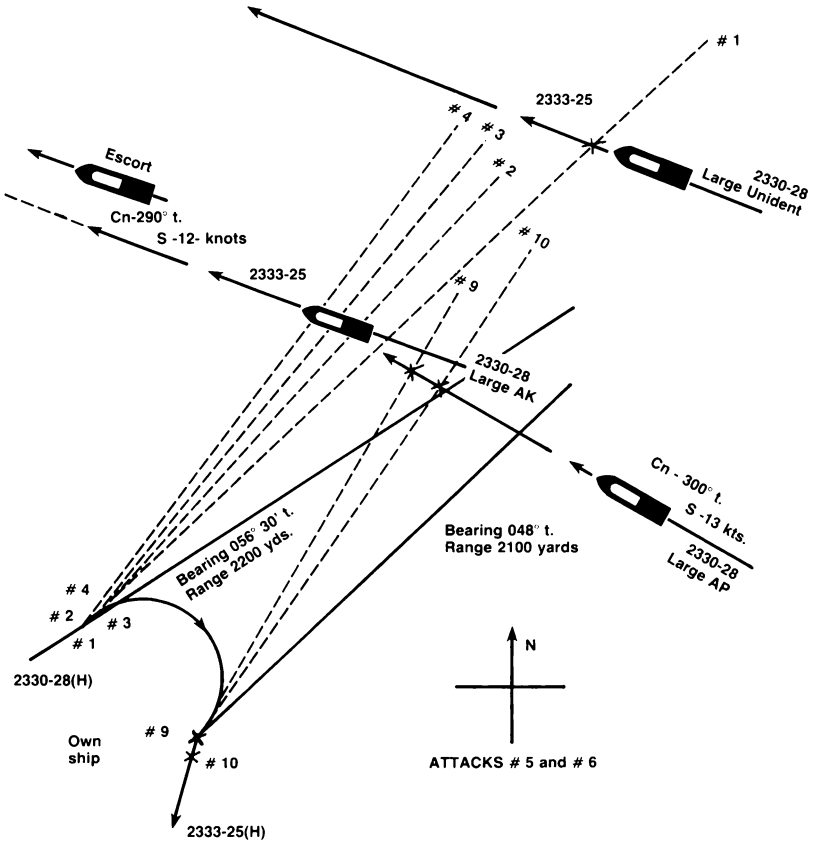


Figure 50. USS Rasher torpedo attacks #5 and #6

2333: "another hit was seen, heard, and timed on a second ship beyond and on the leading target's starboard quarter. This was a lucky hit by #1 torpedo."

2335: "Timed two hits in stern tube target. Leading target stopped, a very pronounced munition explosion occurred a moment or so after it had been hit, it burned for a bit, and at

2346: "disappeared from the radar screen. The escort joined the ship hit with the stray bow torpedo, and they both moved to the south at 12 knots. We hauled out to the west and stopped to collect our wits and estimate the situation."

APPENDIX II - GLOSSARY

Aft - Near or toward the stern (rear) or heading toward the stern. If you are looking aft, you are looking toward the stern.

After - Located toward the stern or behind another. The After Torpedo Room is in the stern, and the After Engine Room is located immediately aft of the Forward Engine Room.

Astern - Behind a ship.

Backing Down - Reversing the propellors so the ship moves in reverse, or has sternway.

Bow - The front of a ship.

Cavitate - To operate your propellor so fast that vapor bubbles are formed at the trailing edges of the propellor blades. These bubbles then collapse and make a distinct sound which can be detected by an enemy's sonar equipment. This condition is called *cavitation*, and can be avoided by going deeper, where the increased water pressure prevents the bubbles from forming.

Chief of Naval Operations - The senior officer of the Navy, abbreviated CNO. During World War II, this was Admiral King. Until 1942 his title was Commander in Chief of the Fleet, or COMINCH.

Course - The compass heading which a ship is steering. It is measured relative to north.

Depth Charge - The principal anti-submarine weapon of World War II. It resembled a trash can, was filled with explosive, and would detonate when it reached a pre-set depth.

Escort - A ship assigned to provide anti-submarine protection for a convoy or major warships. It was usually smaller than a fleet destroyer, equipped with active and passive sonar, and carried many depth charges.

Executive Officer - The officer on a ship who is second in command and principal assistant to the skipper. He was also the Navigator.

Exploder - A device in a torpedo used to initiate the explosive chain needed to detonate the main warhead charge.

Fathom - A measurement for depth of water. One fathom is six feet.

Fathom Curve - A line on a navigational chart showing constant depth. For example, if you are inside the 100 fathom curve, the water depth is less than 100 fathoms (600 feet.)

Flank Speed - The fastest speed possible. All equipment is running at or above its rated speed or load. Ahead flank is faster than ahead full.

Forward - Toward the bow, or ahead of.

Hydrophone - A sonar listening device. When it is squeezed by the pressure of a sound wave, it generates a very small electric voltage that is amplified and converted into an audible sound.

Keel depth - The depth of a submarine's keel below the surface. When a submarine is at 100 feet, its keel is 100 feet below the surface.

Knot - A measure of speed, specifically nautical miles per hour. One knot is one nautical mile per hour. Landlubbers frequently refer to ship's speed as "knots per hour," which is incorrect.

Nautical mile - A measurement of distance equal to one minute of arc on the earth's surface. It is approximately 2000 yards, or about 1.1 times longer than a land mile.

Periscope Depth - A keel depth at which the submarine is fully submerged but still shallow enough so that a periscope can be used.

Port - The side of the ship that is on your left when facing forward.

Starboard - The opposite of port, i.e., the side of the ship that is on your right when facing forward.

Stern - The rear of a ship.

Tactical Diameter - The diameter of the circle that a ship travels when a designated amount of rudder is used. In a submarine, the rudder is full rudder.

Test Depth - The maximum keel depth at which a submarine may operate without exceeding specified safety factors. Most fleet boats had a test depth of 412 feet. Test Depth is NOT the depth at which the hull will crush, but if you exceed test depth your margin of safety is reduced and will be zero at crush depth.

Tonnage - For a merchant ship, tonnage refers to the cargo carrying capacity. It is usually computed by dividing the usable volume, measured in cubic feet, by 100. Thus if a 5000 ton cargo ship is sunk, it does not mean that the material used to build the ship weighs 5000 tons, but that the ship was rated at being able to carry 5000 tons of cargo. For a warship, tonnage is the ship's displacement, or what the ship would weigh if placed on a scale.


ACTIONSoft