Operating US Subs in WW2

**What was the primary mission of our submarines in WW2?**

The primary mission for our submarines was to sink Japanese shipping of all types. The early emphasis was on sinking Japanese warships and troopships, but captains were always happy to sink cargo ships and tankers as well.

As mentioned in the preceding section, the original assumption was that submarines would operate with the fleet. They would be scouts and they would attack the enemy first and do as much damage as they could before the main battle fleets engaged each other. However, in hindsight, that was rather naïve. At a maximum speed of 20 or 21 knots, submarines couldn’t keep up with carriers, new battleships and destroyers. Even if they could keep up, they would have to be on the surface and give away stealth, their greatest advantage and defense. Once carrier battles were fought with opponents hundreds of miles from each other, there was no practical way to have submarines accompany the fleet.

**NOTE:** The Japanese held the same view of submarines as part of the fleet. In fact, some Japanese submarines carried aircraft (float planes) in hangars that would be launched as scouts and recovered. The Japanese never really gave up the idea of submarines as scouts for the fleet. Late in the war, they used many of their larger boats to resupply their bases that we had simply bypassed. We were fortunate that they did not use their boats with their superb torpedoes as effectively as they could have.

As the war progressed, we realized that tankers were the most important ships for the Japanese. If we could sink those ships, their warships and aircraft would be starved of fuel and wouldn’t be able to operate effectively. Therefore, the emphasis shifted and we did sink many of the Japanese tankers.

US submarines comprised only about 3% of the Navy in WW2. Yet they sank about 55% of the Japanese shipping. They did so at a cost of 52 boats. The 23% loss rate was the highest of any major American service during the war.

**Did they do anything other than attacking enemy ships?**

Certainly. Submarines are very versatile ships. The fact that they can submerge and approach an assignment without being seen makes them the best vessel for many other types of missions.

One of the more common missions was what was called “lifeguard duty.” Early in the war, someone suggested that submarines might be used to rescue our airmen whose planes were damaged in attacks on Japanese bases. Tests were successful and in 1943 we began to put submarines near Japanese bases when we attacked. Submarine captains did not like lifeguard duty. They thought they should be out sinking ships rather than hanging around on the surface in dangerous waters for a few days at a time. Naturally, the pilots had a different view.

Pilots were told that, if they could not safely get back to their carriers or bases, they should try to get close to the submarines. There they would have to ditch (crash land in the water) or bail out of the plane. If they couldn’t get close to the boats, the subs would try to come to them. It was helpful if a wingman could circle over the downed pilot for protection and to direct the submarine to the aviator.

Lifeguard operations were very successful. Over the course of the war in the Pacific, our submarines rescued more than 500 airmen. The most famous rescued airman was a young LTJG torpedo bomber pilot by the name of George Herbert Walker Bush. He was rescued by the *USS* *Finback* in September of 1944 off the island of Chichi Jima. His crewman had been killed, and Mr. Bush was in the water for about 30 minutes before being rescued. The result was that submarines were responsible for two American presidents. (George W. Bush wasn’t born until 1947.)

Pampanito did lifeguard duty on her first war patrol near Yap Island. This was during the build-up to the invasion of the Mariana Islands. However, no pilots needed assistance from Pampanito on that mission.

Other missions included:

* Intelligence gathering, which is one of the primary missions of our submarines today. In some cases, during WW2, we needed better charts (maps). As part of their patrols, we sent submarines to certain areas to fill in gaps in our knowledge. In other cases, we needed information about the movements of Japanese ships. The most famous examples of these were the Battles of Midway, The Philippine Sea and Leyte Gulf. Submarines were able to provide critical information for the fleet and, sometimes, sink a couple enemy ships before the big battles.
* Rescue of the crews of our four submarines that had run aground.
* Insertion, resupply and extraction of coast watchers or guerillas on isolated islands in the Pacific. In a few instances, submarines inserted raiding parties onto Japanese held islands. Later in the war, this became more common for boats stationed at Perth, Australia. Commandoes there were anxious to carry out these raids, and found a sympathetic ear in Admiral Christie, the commander of submarines in the Southwest Pacific. Caution was the order of the day and there were concerns about intelligence losses. Many of the raids were successful.
* Shelling of Japanese installations. We originally had three older submarines with two six-inch guns each, the *Argonaut*, *Nautilus* and *Narwhal* and they could be more effective on these missions. The USS *Barb* (SS-220), under the command of Gene Fluckey, had rocket launchers installed for one patrol and attacked factories, a communications hub and a shipyard which built wooden transports. The hub was hit and the shipyard was duly set ablaze.
* *Barb* was also responsible for a very creative commando style attack which destroyed a train and did serious damage to the railroad track. The train was added to the *Barb’s* battle flag.
* Minelaying. Any submarine could be used for these missions, but the size of the USS *Argonaut* (SS-166), USS *Narwhal* (SS-167) and USS *Nautilus* (SS-168) allowed them to be more effective at this task.
* Shortly after the war started, we sent a couple of submarines to the Philippines with ammunition for MacArthur and his troops. One of the boats, the USS *Trout* (SS-202), then took much of the gold and silver from the Philippine treasury off the islands to safety in the US. This resulted in a humorous story when the inventory at Pearl Harbor came up one g)old brick short. The brick was found in the galley, where the cook was using it as a paperweight holding his cookbooks open. The cook proclaimed his innocence, saying that he didn’t realize what the brick was. (Of course, he didn’t!)

**What was “Ultra”?**

For most of the war, we had broken some of the Japanese naval codes. This often allowed us to know Japanese ship movements and we could deploy our submarines – and other warships – to attack. (Sometimes their messages were decoded too late for us to respond.) These messages were classified as top secret or “ultra” sensitive. If the Japanese learned that we had broken their codes, they would have changed their coding systems and we would have lost a significant advantage.

**How did we find out that submarines had been sunk?**

Since submarines were frequently operating alone, it would often take a while before their loss was recorded. If the boat was part of a wolfpack, the other members of the pack would likely figure out relatively soon that something was wrong. However, since there was still a chance that the problem was a communications issue, we did not immediately give up hope.

The usual procedure was to identify the submarine as overdue about three weeks after it was scheduled to return to a base. After a few months, it would be declared missing and presumed lost. Families would then be notified.

We might also get confirmation from the Japanese. Both sides were required to notify the other of the prisoners of war in their custody. However, the Japanese chose not to notify the U. S. of POWs in their worst and most punitive camps. These were the camps where submariners and pilots were initially assigned for interrogation and sometimes for lengthy detention. We might not know about survivors until they were transferred to less punitive camps. That could take a long time. In the worst case, we did not know about most survivors from the USS *Perch* (SS-176) until the end of the war, 1,297 days after the boat had been sunk in 1942.

A reason that we withheld the information about our losses for some time was so that we were not providing useful information to the enemy. Japan claimed to have sunk more submarines than we actually had. There was no reason to provide the actual information any sooner than we had to.

**Is it possible to escape from a sunken U. S. submarine?**

Yes, it is possible but only in limited circumstances. There are two escape trunks on the WW2 era boats, one in each torpedo room. The escape procedure was generally thought to be workable down to 200 feet. Experienced divers could escape from as much as 300 feet down. However, most sailors had only had experience in the 100-foot Escape Towers in New London or Pearl Harbor. Even that is in controlled circumstances with Navy divers available in case of problems. In addition, during the war, not all submarine sailors went to Sub School where they would have gone through an escape tower.

Another limitation is that, inconveniently, most of the ocean is far deeper than 200 feet. Only 1 or 2% is less than 250 feet deep. The average depth of the Pacific Ocean is around 13,000 feet deep. The greatest depth is the Challenger Deep in the Mariana Trench at about 36,000 feet, or seven miles.

**Has anyone escaped from a submarine, of the types we built in WW2, that had sunk?**

The forward escape trunk has been used twice on boats similar to the *Pampanito*. The first time was before the war when the USS *Squalus* (SS-192) went down off the East Coast in 1939. She was quickly found by her sister ship, the USS *Sculpin* (SS-191), in about 200 feet of water. The *Sculpin* radioed for help and the Navy rushed the submarine rescue ship *USS Falcon* (ASR-2) to the scene. They then used a McCann rescue bell to bring the surviving crew to the surface through the forward escape trunk. The crew in the after part of the boat died in the initial flooding. It took four trips and, despite a frayed lifting cable on the last trip, everyone else made it out.

It is unclear how the flooding actually happened. When the boat was salvaged, the main induction valve was found to be open. That would certainly be enough to flood the boat. However, when the *Squalus* dove, the main induction indicator was green, showing a closed valve. In addition, in those days, submarines didn’t do crash dives as was done during and after WW2. Instead, they closed up everything until they had a green board on the Christmas tree – everything was secured. Then they would add a little pressure to the air in the boat. Only after they verified that the pressure held, confirming that everything was closed, would they actually open vents and start the dive. The *Squalus* appears to have been buttoned up for the dive. No one knows how the main induction on the *Squalus* opened after the pressure test.

Because of this incident, valves were added to the air induction piping in the engine rooms. These were flapper valves that held any unwanted water in that piping and out of the engine rooms. A locking mechanism was added to the main induction to ensure it stayed closed. In addition, the divider between the engine rooms would be a hard bulkhead on future boats, instead of a soft divider. That way, flooding could be isolated to just one compartment. These upgrades would matter to the *Pampanito* on her first war patrol.

**NOTE:**  The *Squalus* and *Sculpin* were sister ships, built and often maintained at about the same time. Their histories in WW2 were tragically intertwined. (**See the Appendix XX**.)

The other time the forward escape trunk was used somewhat successfully was in 1944 when the USS *Tang* (SS-306) was sunk by a circular run of her own torpedo. *Tang* was on the surface in the South China Sea and had just fired the last torpedo she had on board. In spite of drastic turns to try to get the boat out of the way, that torpedo hit *Tang* around the after torpedo room or maneuvering.

Similar to the *Squalus*, everyone aft of the control room died in the initial explosion and flooding. Of the crew on the bridge or in the conning tower, about five managed to get clear of the boat. One officer decided to swim to relatively nearby China but was never seen again. The rest of the surviving crew gathered in the forward torpedo room. Due to the severe up-angle, it was difficult to do anything about an escape. One of the survivors made it back to the control room and opened the vents on the forward ballast tanks. This put the whole boat fairly level on the bottom at around 200 feet, so the remaining crew could move about and try to escape.

Only about 13 of the men actually tried to get out via the escape trunk. Some went into the escape trunk but couldn’t bring themselves to try the free ascent to the surface. (Not everyone had gone through the escape tower training in New London or Pearl Harbor.) The first one out was a young ensign who, unfortunately, went too far aft of the escape door, got trapped under the deck in the superstructure and drowned. At least two others ascended too quickly and didn’t get enough air out of their lungs. They died at the surface of ruptured lungs. Only six of the 13 made it to the surface safely. For some reason, the Japanese only picked up five of them.

The nine rescued survivors all lived through their experiences in Japanese prisoner camps to the end of the war. However, it is estimated that the captain, Dick O’Kane, would not have survived another month in the camps. The Japanese reserved particularly harsh treatment for pilots and submariners.

There is no record of anyone escaping successfully from the after torpedo room escape trunk.

**How do the escape trunks work?**

The after escape trunk is one-time use only. The boat must truly be lost since this process makes it almost certain that the submarine will not surface again. In order to use the after escape trunk, the crew must:

* Gather as many crewmen as possible together in the space and close the watertight door to Maneuvering.
* Charge Momsen Hoods with air and distribute them.
* Flood the compartment with water up to the lower lip of the escape trunk.
* Pressurize the compartment to exceed the outside sea pressure if it doesn’t already. At 200 feet, this would be about 90 PSI. The higher pressure in the compartment is needed to be able to open the hatch against the sea.
* Launch the marker buoy.
* Someone climbs up into the trunk to open the hatch (Everyone is treading water already, so no ladder is needed.)
* Each man then ducks and goes out and follows the line up to the buoy.
* Each man needs to exhale most of the way up to get the excess air (up to 90 PSI) out of his lungs. Yell “ho, ho, ho” most of the way up.
* Stop at each knot in the buoy line for a minute to decompress
* Do not ascend faster than your air bubbles.
* At the surface, stay together, preferably near the buoy.

This escape trunk has never been used successfully. The two times that sailors were able to escape from the forward trunk on a boat like this, the after part of the ship was flooded from the initial accident and everyone aft had already died.

The forward escape trunk works on the same principles but holds far fewer people and can be used multiple times. The boat doesn’t have to be sunk. The different steps are:

* After the trunk is full with just a few men, it is flooded to just above the side door. It is pressurized, as above. That door will be used to leave the boat rather than the hatch at the top.
* Exit out this side door and follow the buoy line up.
* The last person out closes the door behind him. If he fails to do this, there is a long lever in the torpedo room that can be used to close the door.
* The escape trunk is then drained into the torpedo room and depressurized so the next group can begin their escape.

Part of the reason that this escape trunk is designed differently is so that it can be used for both exit and reentry. In WW2 divers and UDTs (underwater demolition teams) and, later, Navy SEALs could exit the boat, accomplish their missions and be recovered all without the submarine having to surface. The boat would be much less likely to be discovered. The boat and the divers are therefore safer.

**How fast could these submarines go on the surface?**

Top speed on the surface was 20 or 21 knots, about 23 miles per hour. However, this is an inefficient use of fuel. In WW2, boats departing from Pearl Harbor, Hawaii would usually run at top speed to locations such as Midway Island or Johnston Island. There they would top off fuel and then proceed at efficient speeds (10 to 12 knots per hour) to their assigned patrol area.

**How fast could these submarines go when submerged?**

Top speed submerged was 9 or 9 ½ knots or a bit over 10 miles per hour. However, top speed would be limited to less than an hour before the battery is completely drained of power. The usual speed submerged would be 2 to 3 knots. Higher speeds might be used to gain attack position. Higher speeds could be used to try to escape being attacked but that usually made more noise. Slow, silent and clever might be more effective.

The ship’s battery was usually rated at 48 hours if the boat was going 2 knots. The ratio of speed to power needed was cubic. Generally, if you double the speed, eight times the power was needed. If the speed was doubled from 2 to 4 knots, the battery would last approximately six hours. Double it again, and the battery likely won’t last an hour. It is called the “one-hour rate.”

**How far could these submarines go?**

The range of the boats built during and shortly before the war was about 11,000 nautical miles at a speed of 10 knots. They carried over 90,000 gallons of diesel. That was increased later by converting main ballast tank (MBT) four on the later boats to a fuel ballast tank (FBT), boosting the total to 110,000 gallons.

**What does that mean? How far could they operate from San Francisco?**

Our submarines did not operate from the West Coast all the way to Japan or to the shipping lanes in the South China Sea. It was too far and would have taken too long just to get to the patrol area and back. There wouldn’t be very much time left to find and attack Japanese ships. From the approximate mileage chart, below, you can see that it would have taken 36 days just to get from San Francisco to Japan and back. It would have taken 50 days to get to the South China Sea (using the distance to Hainan Island) and back.

Home port for most of our boats was in Pearl Harbor, Oahu, Hawaii. That shortened the transit time significantly. By creating a refueling stop at Midway Island, the range of the boats was extended even further. Now, instead of taking 18 days to get to Japan from San Francisco or San Diego, it would only take nine from Midway. Instead of 25 days to get to the South China Sea, it would only take 16.

The numbers in the following table are rounded approximations. Some notes regarding the table:

1. San Francisco is used as an approximation for the West Coast. The distance to Hawaii from San Diego is actually a bit greater than that from San Francisco.
2. Hainan Island, China is used as an approximation for the South China Sea. The distances to the Luzon Strait and the Formosa (Taiwan) Strait, where many of our attacks were concentrated, were somewhat shorter.
3. *Pampanito’s* first war patrol was initially to Johnston Island to refuel and then to Yap in the Caroline Islands. Therefore, those distances are included.
4. On *Pampanito’s* third war patrol, she rescued 73 British and Australian soldiers from the South China Sea near Hainan Island. She then proceeded at best surface speed to Saipan in the Mariana Islands where the nearest forward base was located.
5. The number of days required was estimated using 250 nautical miles per day, traveling at about 10 or 11 knots per hour. The journeys from Hawaii to Johnston Island or to Midway, and from Hainan to Saipan assume 400 miles per day. Those transits were at higher speed and an average of 17 knots per hour was used.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| From | To | Miles | Nautical Miles | Days |
| San Francisco | Tokyo | 5140 | 4450 | 18 |
| San Francisco | Hainan Island | 7175 | 6250 | 25 |
| San Francisco | Hawaii | 2400 | 2100 | 9 |
| Hawaii | Midway | 1300 | 1150 | 3 |
| Midway | Tokyo | 2550 | 2200 | 9 |
| Midway | Hainan Island | 4525 | 3900 | 16 |
| Hawaii | Johnston Island | 825 | 725 | 2 |
| Johnston Island | Yap | 3550 | 3100 | 13 |
| Hainan Island | Saipan | 2350 | 2050 | 5 |
| Saipan | Hawaii | 3850 | 3350 | 14 |

**What if you ran out of fuel?**

The boats would be very careful not to. There were no fueling stations other than our forward bases and there were few of those early in the war. There was no plan to refuel at sea. Although there is no apparent documentation of a boat running out of fuel, it would have been possible to rig something up to refuel it or even tow it to the nearest base if necessary.

Inside the boat, there are clusters of small black valves. Those are used to tell how much fuel is left in each of the fuel tanks. The result isn’t an exact number of gallons remaining, but it is a good indication if the crew has been paying attention. They always did. The least bad thing to happen if they weren’t paying attention to fuel levels, and ran out, was serious embarrassment. The worst would be to find themselves stranded, adrift and nearly helpless in hostile territory.

**How long were war patrols?**

These WW2 boats were designed for war patrols of up to 75 days. A few patrols even went a bit longer. However, from what we can tell from the histories, most patrols were between 45 and 60 days each. If fuel was used quickly, because of the need to run at higher but less efficient speeds, the patrol could be shorter. If you used all your torpedoes or suffered significant damage, you would also return to port sooner.

Returning to port early because you used up your torpedoes didn’t always get you all of the usual break. There were instances where skippers found abundant targets and fired all their torpedoes fairly quickly. Occasionally, when those skippers returned to a base, they opted to just reload torpedoes, top off food, fuel and other supplies, and head back out quickly to finish the patrol.

War patrols did appear to get shorter as the war progressed and we pushed the Japanese back to the west. We established advance bases as we defeated the Japanese. After the Battle of Midway, we could be confident enough to do maintenance and resupply at that island rather than just refueling. After defeating the Japanese in the Marianas, we established bases at Saipan and at Guam even while some Japanese soldiers were still fighting. The same was true of the Philippines. Again, there was still fighting in the islands when the tender (support ship) was established in Subic Bay. With the reduction in transit time to the combat zones, and with more and more submarines in commission, the patrols could be shorter.

Generally, *Pampanito’s* war patrols ranged from 42 to 59 days. However, her fifth patrol was only a bit over two weeks. (Sources differ on the exact length.) She was almost out of torpedoes and had a very short transit to her next port, Subic Bay in the Philippines.

**How long can these submarines stay at sea?**

The primary limitations are food and fuel. Other things like spare parts can become an issue, but that would be an unusual case. Hopefully, running out of torpedoes is a good thing, assuming they hit targets, and aren’t part of this question.

Food is loaded out for the expected duration of the patrol, up to 75 days. A few patrols went a bit over 80 days. That requires creativity by the cooks and patience by the crew. The menus for the last few days would likely be strange combinations of whatever is still left on board.

Fuel is the most frequent limitation. These submarines can carry up to 110,000 gallons of diesel fuel. The question then is how efficiently is it being used. A boat may have to run at higher, inefficient speeds to be in a newly assigned area. A boat may have had targets make an unexpected course change and get away. In that case, the boat may choose to make a high-speed “end-around” to get in front of the targets again. These are all appropriate uses of fuel, but they are less efficient. As a result, the fuel may not last as long as planned.

**Did American submarines resupply at sea?**

No, we did not usually refuel submarines or transfer torpedoes at sea. In order to resupply, our submarines returned to a base. Early in the war. this usually meant Hawaii, Midway Island, or in Australia at Brisbane or Fremantle. As we pushed the Japanese back to the west, we were able to add bases so that submarines would have shorter journeys for resupply.

**NOTE:** that the German Navy did sometimes transfer supplies at sea and designed specific submarines for that purpose. Most often this was fuel, but it could include food, torpedoes or spare parts.

**How did submarines receive messages during a patrol?**

Although submarines couldn’t send messages over long distances, messages could be received using a very low frequency which would have a much longer range. The fleet (or Fox) broadcast would be sent from very long antennae and could reach submarines thousands of miles away.

Messages in the Fox broadcast were all transmitted in a sequence and were repeated a couple times during the night. This allowed each submarine to pick off their own messages. Perhaps, they might also

pick out messages for other boats in their wolfpack or in the general area to gain more information about what was going on around them. They would not attempt to acknowledge receipt unless specifically ordered to do so.

Submarines did not broadcast messages using the long, low frequency antennae running along much of the length of the boat. They could only use the higher frequency, medium range radios. Their messages would often have to be relayed in order to reach commanders at Pearl Harbor, Midway or Australia.

There might occasionally be a very limited amount of positive, personal information in these messages. The ship’s office on the *Pampanito* displays one such message regarding the birth of a child. It appears that *Pampanito* was returning from patrol when the message was received. Generally, care was taken not to send messages with bad news since the sailor couldn’t do anything about it at the time. There was no sense in distressing the sailor needlessly.

**What kinds of messages would submarines send during a patrol?**

Submarines did not often transmit messages because doing so gave away their presence, and could give away their exact location. However, there was still the need to get the most important messages out.

The most important messages were those regarding enemy convoys or warships that got past the submarine. This might allow other boats in the area to find the targets and attack. The message would be brief but would need to include the number and types of ships, last known base course (without zigs and zags) and estimated effective speed.

Other messages could include results of attacks. These would normally be sent when the boat was clear of the attack area or in relatively safe waters. Boats would also report when they were headed back to port because they were out of torpedoes, short of fuel or had serious damage and needed to end the patrol.

Submarines would also communicate with each other. This would normally be done using high frequency radios with limited range so that it would be less likely to be intercepted. Once we started operating in small wolfpacks in the fall of 1943, communications between boats became very important. Boats had to coordinate operations to be more effective. To assist with this, a radar was added to one of the periscopes with a Morse Code (telegraph) key. The radar transmission would be very directional, thus reducing the chances of it being intercepted. Another option would be to rendezvous and discuss tactics verbally.

**Did they spend most of the time submerged?**

No. In fact, overall, they spent the majority of their time on the surface.

When in their patrol area, they may have been submerged slightly more than they were on the surface. Early in the war, they would be up on the surface when it was dark and submerged when it was light. However, as we became better at spotting Japanese planes and ships, some captains tended to stay on the surface longer. Since we are so much faster on the surface, that would provide a better chance of being able to get in front of targets.

However, the transit to and from the patrol areas was done mostly on the surface. There would be a trim dive every day, to get the boat back into neutral buoyancy. Since the transit to and from the assigned area could be a few weeks out of each patrol, mostly on the surface, the majority of the time for the full patrol is now spent on the surface.

**What is a trim dive?**

The actual weight of the submarine matters a great deal when it is submerged. If it is too light, it will tend to rise and broach the surface. If it is too heavy, it will tend to go deeper, possibly to unsafe depths. Therefore, we work to keep the boat in neutral trim which is safer and makes depth control easier. We want to weigh the same as the water we displace.

The challenge is that the weight of an operating submarine is constantly changing. Consuming food and using supplies make the boat lighter. Burning fuel makes the boat heavier. (See the section on diving and surfacing the submarine.) Changes in the temperature or salinity of the water can make the boat seem heavier or lighter.

As a result, at least once each day, the submarine will be submerged so that the Diving Officer can get the boat back into neutral trim. That is the trim dive. It probably takes no more than 10 or 15 minutes. Once the boat is back in trim, it can be surfaced and previous operations resumed. Trim dives were most common during lengthy transits from one location to another.

**How long were they normally submerged in the patrol area?**

These submarines wanted to be on the surface every night for multiple reasons if that was possible. You might come up to the surface at dusk and dive again at dawn. If you are in the tropics, the day/night split would be close to 12 hours each. However, if you were in higher or lower latitudes, the split could be much less even and you might be submerged a few hours longer in summer. That leaves less time to recharge the battery.

**Why was it important to be on the surface at night?**

It was about filling the boat with fresh air, charging the battery, receiving messages and updating the ship’s position – knowing the ship’s location.

The air on the submarine was only intended to last 16 to 18 hours. Since most of the crew smoked, the air was probably only good for about 16 hours. (Cigarettes were given away free to servicemen in WW2.) A primary need, therefore, was to get fresh air in the boat.

The battery also needed to be recharged. Fortunately, running the engines to recharge the battery pulls fresh air into the boat. Most of the air from the main induction goes directly to the engine rooms. However, some of the fresh air is fed to the ends of the boat and is pulled toward the engine rooms. That way, all compartments would get fresh air.

Another task to be completed is to listen for messages on the fleet broadcast. This broadcast is sent to all submarines, and is repeated during the night. It may contain orders for the boat. It may also provide messages to other boats that would be useful for your submarine to know about.

Finally, the boat would want to get a position fix. In WW2 this would be very dependent on the weather. If it were cloudy, there were no stars to shoot, and therefore no updated position fix. Ideally, there would be a clear enough sky at dawn and dusk to see the horizon and find the brightest stars as they appear. The elevations of those stars would be measured with a sextant. The resulting numbers could then be translated into your position.

Sun lines at local apparent noon could help update the boat’s position but wouldn’t usually be as accurate as a star fix. Sun lines could be done through the periscope.

**How long could these submarines stay submerged?**

It depends. Submarines could stay submerged for more than the 16 hours that the fresh air would last, as indicated above, but it takes some extra steps. The short answer is that the practical limit would be around 30 hours. However, the record in WW2 was just short of 38 hours by the USS *Puffer* (SS-268). At that point both the battery and the crew were pretty messed up. (Technical term!) The boat was being depth charged and tracked, and they had no choice. Fortunately, they were eventually able to get away and return to base.

There are two limitations at play here, battery power and air quality. The limits on both depend on how fast you use them.

As discussed above, battery duration depends very much on the speed. At two knots (about 2.3 miles per hour), the battery is rated at 48 hours. Note that you probably walk faster than that. If you double the speed to four knots, you need to divide the time the battery would last by about eight. (The ratio of speed to battery power is cubic, two times two times two.) If you double the speed again to eight knots, you divide the time by eight again and the battery will last less than an hour, and this is called the “one-hour rate”. At maximum speed submerged, about 9 ½ knots, the battery may only last about 30 to 40 minutes. As a result, captains tended to use the battery very conservatively.

Air quality also depends somewhat on how fast you use it, although the differences aren’t as drastic. Again, the air in the boat was intended to last 16 to 18 hours. However, since most of the crew in WW2 smoked, the air would likely last 16 hours. How can you use it more slowly? One way is to put everyone not actively operating the boat in their bunks. Expending less energy uses less oxygen. Another way would be to put the smoking lamp out. That didn’t usually turn out to be practical due to nicotine addiction. Still, it could be done in a real emergency.

Fortunately, there are some other options to extend the air limitation. There are six oxygen bottles on the *Pampanito*, and they could be bled into the boat to drive up the O2 percentage. There are also many cannisters in the overhead marked “Do Not Paint.” These contain lithium hydroxide, soda lime, which is a CO2 absorbent. The cannisters would be opened and spread on bunks or decks. However, the chemicals are caustic. These steps will add a couple hours of habitable air to the boat.

If more time is needed after the above steps, it is possible to bleed air into the boat from the high-pressure air banks. It seems unlikely that any boat had to go to this extreme but it is possible to safely double the air pressure in the boat. The oxygen and CO2 percentages are about half way back to normal and the pressure is not extreme. The pressure would be about the same as swimming at about 25 feet. This wouldn’t be terribly uncomfortable and wouldn’t require decompression.

However, now another challenge arises due to the increased pressure. When the boat surfaces, we want eyes on the bridge as soon as possible. We need to know for sure that there isn’t anything up there that we missed on sonar and periscope sweeps. Although there isn’t a great overpressure in the boat, that increased pressure is in all of the pressure hull that is 16 feet in diameter and about 275 feet long. It all wants to go out the Bridge hatch at once. If you put a man in that small hatch, he could be pushed out much the way a bullet is pushed down the barrel of a gun, albeit more slowly. To keep him from being launched, they would have a big sailor hang on to his ankles as he opens the hatch. Really! The procedure was not uncommon. The overpressure could be an issue just from launching multiple torpedoes which brings more air and water into the boat.

There are some other steps that could be taken to reduce the pressure in the boat such as running the low-pressure blower or the air compressors. However, that would usually take too much time and you don’t want to introduce a vacuum.

**How do you know that oxygen is getting low?**

Even without a gauge of some sort, there are signs that oxygen is getting low. Probably the first would be labored breathing. Men would have to breathe deep in order to get enough oxygen into their lungs. This gets to be the feeling that there is an elephant sitting on your chest. Added to that would be headaches among the crew. They can be pretty intense and painful when oxygen is very low.

Another indicator is that the air no longer supports combustion. It becomes impossible to light a cigarette because the match or lighter can’t burn. This puts the “smoking lamp” out and slows the rate of oxygen consumption ever so slightly. There is still free oxygen in the air, but the level has definitely decreased. It would certainly be time to do something about the poor air in the boat.

**Are there any windows on a submarine?**

This may seem to be a laughable question. However, it isn’t like asking about screen doors on a submarine, which there obviously aren’t. After all, it looks to many people as though there are a whole series of windows along the side of the boat. Those are actually limber holes, not windows, and they are discussed under “Diving, Surfacing and Buoyancy.”

In fact, there is just one small window on the Pampanito. (This is in addition to the periscopes.) It is located in the control room at the Chief of the Watch station. Near the Christmas tree, in the forward port corner, there is a safe and a ladder above it leading up to a hatch. That hatch has a small window in it, about two inches in diameter. The purpose of the window is to let the gun crews know when the water has cleared enough to be able to open the hatch safely and head up on deck.

**Did these submarines always have a window in the Control Room hatch?**

During the war, they did. However, in the early 1950s, most WW2 boats still in service had the guns removed. At that point, there was no need for the window. It would have been removed to make the hatch stronger.

**Were our submarines successful during the war?**

Our submarines were very successful by the end of the war. They comprised only three percent of our ships yet they sank 55% of all the Japanese shipping sunk during the war. By the end of the war, Japan was nearly starved of fuel and short of food and many other supplies.

However, the war didn’t start out that way. There were many issues with submarines that limited our effectiveness. Some of these were specific to submarines and others applied to the Navy in general.

**What were the Navy’s problems at the beginning of the war?**

In no particular order, some of the issues for submarines were a shortage of combat-ready ships; submarine captains who had been trained to be too conservative; significant torpedo problems; a faulty assumption that submarines would sail with the fleet; and the need to learn how to fight a modern war. In more detail:

**The shortage of combat-ready ships of all types**. President Franklin Roosevelt had been walking a tightrope between trying to keep the country out of the war, as most of the public preferred, and preparing to fight in the likely global conflict. Fortunately, he managed to get funding from Congress to start building the ships we would need. Unfortunately, it would take time to complete the ships that were ordered and then to build enough facilities to increase production after the attack on Pearl Harbor. The first submarine of the new Gato designs to be completed, the USS *Drum* (SS-228) *,* had just been commissioned on November 1, 1941, in Kittery, Maine and was still on shakedown, post construction repairs and crew training. She wouldn’t be ready for combat until the spring of 1942.

**Submarine captains had been trained to be conservative.** Pre-war training taught that if your boat was sighted, you were assumed to be sunk. Being sighted in combat wasn’t usually a good thing, but it wasn’t always fatal either. As a result of the conservative approach, captains were taught to fire torpedoes based on sonar bearings rather than risking having the periscope being seen. We quickly established that sonar bearings alone weren’t good enough. Visual bearings to the targets were needed, particularly until we improved the quality of our sonar.

In order to overcome these mistakes in training and procedures, we would wind up replacing about one-third of the officers who were in command of submarines at the beginning of the war.

Not every good commanding officer in peace time would be aggressive enough for command in the war. A general rule was that if a captain didn’t produce results within two war patrols, he would likely be reassigned. Some captains who “washed out” of submarines went on to distinguished careers in surface ships.

**We had significant torpedo problems.** These are detailed in the section on torpedoes. Generally speaking, testing was woefully inadequate and the Torpedo Bureau refused to believe that the problems were in the torpedoes. The main issues were that the torpedoes ran too deep; the magnetic exploders generally did not work properly; and the contact exploders didn’t always work either. It would take almost two years to identify, acknowledge and then fix the major problems with our torpedoes. It appears that, even then, no one was held accountable.

**The assumption that submarines would sail with the fleet** and engage the enemy before the big gun battles. That’s why they were called “fleet boats”. In hindsight, there were obvious problems with this theory:

1. After the attack on Pearl Harbor, there wasn’t much of a fleet for submarines to sail with.
2. Even our newest submarines could barely keep up with our oldest and slowest battleships and cruisers. Even then, they would have to sail on the surface and give up their greatest advantage - stealth.
3. It ignored the lessons of the Atlantic War where the German U-boats were beginning to cut the supply routes to England, an island nation. Japan was just as dependent as Britain for the imported supplies needed to fight a war.

**We needed to learn to fight a modern war**. The United States was barely involved in the naval parts of WW1. There was a great deal of new equipment and technology that we needed to learn to use most effectively. Japan had been at war in China for over five years. They had a great deal of combat experience and had been actively training for the war that we still wanted to avoid. It would take us about 18 months for us to catch up and become a truly effective fighting force.

**Why was the submarine service known as the “Silent Service”**

Silence, or being quiet, was a fact of life on submarines. In WW2, it could mean the difference between making it home or being lost at sea. Modern submarines are still designed to be as quiet as possible. That doesn’t mean you can’t talk, but you surely didn’t want to drop a wrench.

The lack of publicity about our submarines was a great advantage. Sailors’ lives could be saved if the enemy was kept in the dark about capabilities and intended operations. Large fleets with frequent communications could be difficult to disguise or hide. It was much easier for submarines. They could submerge and severely limit radio and radar emissions.

When attacking the enemy or evading attack, being quiet was even more important. The enemy’s use of sonar was how submarines could be located. Quiet boats were harder to find. There were routines to run more quietly by shutting off as much equipment as possible. Where possible, hydraulic systems, such as the bow and stern planes, were operated manually to avoid the noise of the pumps. Even fans would be shut off to lower the noise level in the boat as much as possible.

Submarines took various steps to keep hidden when on patrol. They were very aware of the dangers of using radar often. The Japanese were listening and could locate a submarine by listening for their radars. Boats even learned to sink their trash so that it couldn’t be found by the Japanese.

Steps such as these deprived the enemy of a great deal of information. “Silence is golden.”

**Why did submarines limit the use of active sonar and radar?**

The main reason is that they give away your presence and location long before they provide information that is useful to you. For example, let us assume that the effective range of radar was no more than seven miles early in the war. That means that the radar pulse is strong enough to travel 14 miles – to the enemy ship or plane and back. The issue is that all of the radar pulses being sent out, that don’t hit a target and return, are going to travel out 14 miles. That means that the enemy can be aware of your presence when they are still 14 miles away but you won’t be aware of them until are within seven miles.

**Does that mean submarines never used active sonar and radar?**

Not necessarily. It meant that they used it sparingly and cautiously. You would always be listening on sonar, but it has always been very rare to use the active mode, to send out search pulses. That may be even more true today as passive sonar has improved so much. For reference, recall the scene in “The Hunt for Red October” where the captain asks his second in command to send out a second “single ping”. The second in command looks at the captain in total disbelief. The movie is fiction, but that part of it, and much more, is quite accurate.

In WW2, active radar was used by submarines more often than active sonar. Aircraft were a main concern. An air search radar was available early in the war. It didn’t provide much information beyond the presence of an aircraft. It was also on a frequency that the Japanese could easily detect. Since the information was still important, captains would use the air search radar very sparingly. When a new surface search radar became available, and it included some aircraft detection, it was used more often. However, it was still used sparingly and often wasn’t trusted to locate aircraft in the area. (Refer to section 65 on electronics for more information.)

Late in the war, a radar was added to the search periscope to provide accurate range information. This would be a narrow beam and a single pulse making it hard to determine the location of the source. More importantly, it was a different frequency, making it that much less likely that the enemy was listening for it.

**Did loose lips really sink ships?**

There was a saying and many posters during WW2 that “Loose Lips Sink Ships.” It reminded everyone that intelligence matters a great deal during war, and you never know who might be listening. Certainly, information about major fleet and troop movements mattered a great deal. However, does that mean that we may have actually lost ships due to “loose lips?” Admiral Lockwood, commander of submarines in the Central Pacific, believed there was at least one time when we did.

In June of 1943, US Congressman Andrew Jackson May of Kentucky was Chair of the House Military Affairs Committee. He held a press conference on returning from a war zone junket. He let it be known that our boats were able to evade Japanese depth charges because they would explode at shallow depths. Early in the war, the Japanese depth charges had only two settings, 30 meters (98 feet) and 60 meters (197 feet.) Even our pre-war classes, which were 250-foot (depth) boats, could get far enough below that to avoid major damage.

The Japanese weren’t nearly as stupid as we wanted to believe early in WW2. They did pick up this information from Congressman May. Then they modified their depth charges to add depth settings for 90 and 120 meters as well. In the next few months, we lost more boats than usual. Admiral Lockwood believed that Congressman May’s “loose lips” cost us as many as ten boats and 800 men.

Representative May did not suffer any serious consequences for his security breach. However, he failed to win reelection in 1946 and spent nine months in prison for unrelated bribery charges. He was pardoned by President Truman in 1952 but was unable to revive his political career.

**How is the trash and sewage removed from the boat?**

In WW2, trash and garbage were usually thrown over the side when at sea for an extended time. The trash would be bagged and weighted so that it would sink to the bottom. The objective was to be sure that the trash didn’t give away the boat’s identity or location. This also meant that someone had to come up on deck the throw the trash over the side. That could be dangerous and in heavy seas the trash would be retained in the boat until the seas calmed.

For sewage, we are talking about the human waste that goes through the heads (toilets). The sanitary tanks for three of the heads were emptied overboard each morning, usually between 05:00 and 06:00. High pressure air is used to blow the tanks dry. This is done by the auxiliaryman who is part of the engineering department. It is critical that the sanitary tanks then be vented to eliminate air pressure. Failure to do so results in a very nasty surprise to the next person flushing the head.

The head in the after torpedo room is different. This head flushes directly overboard since there is no room for a sanitary tank below the deck. (The propellor shafts are below that space.) The challenge is that the water level outside the boat is above the top of the torpedo tubes while the toilet is maybe a foot and a half off the deck. The toilet sits well below the outside water level. The issue then is: how do you flush a head uphill without the contents and seawater coming back into the boat? You do that by first moving the contents to a small intermediate tank.

It is a multi-step process to flush this head. And if you get it wrong, **you** get to clean up the mess. The basic process is:

* Shut the bowl flapper valve
* Add water to the bowl through the sea and stop valves
* Shut both valves
* After using the head, operate the flapper valve to empty the contents of the bowl into the intermediate chamber
* Shut the flapper valve
* Charge the volume tank until the pressure is 10 pounds higher than the sea pressure
* Open the gate and plug valves on the discharge line
* Operate the rocker valve to discharge the contents of the expulsion chamber overboard.
* Shut the gate and plug valves.
* Vent any remaining pressure.

The process works but is not for the faint of heart. By the way, this head would only be used when on the surface and not at all when in port.

Current environmental regulations require that ships no longer discharge waste into harbors. Therefore, modern submarines need to have holding-tanks for all heads and a means to discharge the tanks to a sewage treatment system when in port.

**When would the signal tube in the after torpedo room be used?**

If it were needed for signaling, we would launch flares from that tube. This would be used mostly when doing training exercises with other U. S. ships and planes. The color of the flare contains the message. For example:

* A green flare is fired by the submarine when the boat would have launched torpedoes if this weren’t an exercise. That would mean that the boat had sunk the carrier or tanker, etc.
* A red flare is fired by the submarine when it is in trouble and needs to surface quickly. All surface ships need to get clear of the area as soon as possible.

The signal tube can also be used to launch decoys. Modern decoys are sophisticated and complex. In submarines like the *Pampanito*, the countermeasure is fairly basic. It consists of a bubble generator, much like the German *pillenwerfer*, made of calcium hydride. When it contacts water, it generates a large volume of bubbles. Air bubbles reflect sound (sonar) just as the submarine’s hull would. It is the change in density that reflects the sound. If you are familiar with Alka Seltzer, you know that it reacts with water and creates fizz or bubbles. The countermeasures are similar. (However, Alka Seltzer uses different chemicals, bicarbonates.) A fictional example can be seen in the movie “The Hunt for Red October.” When the Russian aircraft drops a torpedo to try to sink “Red October,” the boat releases a pair of decoys that tumble and generate bubbles in an attempt to confuse the torpedo’s sonar.

Some modern decoys can be much more sophisticated. They would be launched from a torpedo tube and generate noises just like another submarine. That includes the power plant noises as well as propellors, pumps and other sounds that submarines normally make. They do a much better job of providing another “target” and confusing the other guys sonar.

**Was there a specific paint color for submarines?**

There were specific colors and patterns for most Navy ships. For surface ships, this can be fairly complex. Patterns can act as camouflage and can even confuse the eye about which direction the ship is going.

Paint colors also mattered to submarines. They wanted to be less visible on the surface. Initially, submarines were all black. This was thought to be the best color when on the surface at night as well as when submerged. That turned out not to be the case.

Black was the best color for horizontal surfaces. Seen from above, the deck and other surfaces can blend in with the depths of the ocean. Those surfaces remained black in the new paint schemes.

The vertical surfaces of the submarine were a different matter. Someone pointed out that black is actually too dark at night. Submarine captains were skeptical, but experiments were done to determine which shade of dark grey would be less visible. Captains were convinced when they saw that a dark grey submarine was actually harder to spot than a black one.

Submarines were painted all black again once snorkels were added and boats could be submerged most of the time.

**NOTE**: There is an old Navy adage: If something moves, salute it; if it doesn’t move, move it; if you can’t move it, paint it gray.

**Do submarines leak?**

It may be a bit unnerving to learn that submarines do leak and that is intentional. Some parts of the boat that need to extend through the hull may need to move. These include the propellors, the bow and stern planes and the periscopes. It is possible to tighten the packing around these structures so that the leak is stopped entirely. Unfortunately, the devices would be stopped as well; they would no longer rotate. The small amount of water that is leaking into the boat also acts as a lubricant.

The rate of the leak is normally not a concern. It is easy to pump the water out periodically.