Sonar Room

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What is the difference between RADAR and SONAR?

Both systems bounce energy off an object to measure its distance from you, but the difference is that **radar** uses radio waves, and **sonar** uses sound waves. **Radar** is used on land, and **sonar** is used underwater.

Why can't radar be used underwater?

Radio waves are a frequency of light, and like light, they travel through the air at 186,000 miles per second. Also, like light, radio waves get absorbed when they travel through water, and although they travel very well, they don't travel very far.

How fast do sound waves travel?

The speed of sound depends upon the density of the medium it is traveling through. The denser the medium is, the faster the sound will travel. (Compare the speed of sound traveling through the air with it traveling through a copper wire). Sound travels at about 750 MPH through the air, and underwater it goes about 3,350 MPH.

When was sonar first invented?

The first patent for an underwater echo ranging device was filed in 1912, just one month after the sinking of the Titanic. They believed that this would be the best method of detecting hidden icebergs from a distance. Soon afterward, America entered WWI, and they worked feverishly on ways to analyze the data received on the sonar screen so they could differentiate between an iceberg and a submarine. The first use of this device was to divert enemy submarines away from our merchant supply ships.

Was sonar used during WWII?

Sonar was in its infancy during WWII, but was capable of detecting and repelling enemy submarines.

What kind of weapons did we use during WWII?

A *Hedgehog* was a forward-launching, anti-submarine cluster bomb used to repel submarines. It could launch 12 to 24 mortar shells ahead of a convoy of supply ships. A single direct hit was enough to sink a submarine, but direct hits were rare, because targeting methods were so primitive.

Did we have undersea bombs during WWII?

The Navy used the *depth charge* bomb. It carried 300 pounds of TNT, and it could detonate at a depth of up to 300 feet. The bomb was dropped off the stern of a destroyer, and was triggered by pre-set water pressure, and not by contact with the submarine. The depth charge was the primary defense against submarines during WWII, but was discontinued soon afterward in favor of remote controlled rockets.

What type of sonar did the Hornet have during WWII?

True sonar means that a ship transmits a ***ping*** sound, and by watching the reflection of that sound appear as a wavy line on an oscilloscope, they can actually read the size, shape, and distance away that object is. What the Hornet had during WWII was a system called **acoustic location.** This system uses *cavitation* produced by the submarine's propeller to identify the location and size of the submarine.

What is cavitation?

When a ship or submarine moves through the water, the propeller creates reduced water pressure in front of the blades, and increased water pressure behind the blades. The lower pressure in the water in front of the blades causes small bubbles of water vapor to form. These bubbles grow in size as they approach the blade. The size of the bubbles is determined by the size of the propeller, the type of ship it is, the number of propellers it has, how fast it is traveling, how deep in the water it is, and other variables. As soon as these marble-size bubbles pass the blade edge, they enter the high-pressure zone, and they burst abruptly making a very loud roar in the water. This underwater rumble can be analyzed to determine a submarine's distance and direction from you.

When did the Hornet get a regulation sonar room?

In 1965, the Hornet completed her final rehabilitation overhaul, which included a brand-new, fully-equipped sonar room, refitting the bow with a sonar dome to house the ping transducer, relocating the port-side anchor to centerline so it wouldn't interfere with the sonar dome, installing a new ASCAC Room to analyze the data coming from the Sonar Room,

installing a sonar station in CIC to monitor all sonar contacts, installing a sonobuoy station in CIC to chart all sonobuoy input data, and installing a new AEW Room to relay radar data from the sonobuoys back to the ASCAC Room on the Hornet.

Where on the ship is our Sonar Room?

The Sonar Room, (referred to by our crew as the *Sonar Shack*), is located way up at the front of the ship, one deck below the Anchor Room. To get there, take the passage to the right of Elevator 1, then the passage between the Ladies Room and the Emergency Generator. You will pass a Battle Dressing Station, the Anchor Brake Room, and the Officers Barber Shop. The last door on your left will lead to the Sonar Room.

What is the first thing you notice when entering this room?

Right in the center of the Sonar Room, you see the Sonarman's repeater console. *Sonarman* is the title given to operator who reads the oscilloscope. His job is to watch the screen and listen to the pings and determine whether a contact is a natural disturbance or a possible submarine contact. If he determines that the contact is solid, he reports this information to the Bridge to see if there are any surface contacts on that bearing. If the Bridge reports that the bearing is clear, and there are no other ships reported in that area, ASCAC will do a Doppler reading on the target to see if it is moving toward them or away from them. If it is confirmed that the object is suspicious, the OOD will sound General Quarters, and the whole ship will be on Battle Standby.

Why does the operator's seat have a safety belt on it?

The belt is not there for crashes, as it is in your automobile. It is there because this seat is situated in the roughest possible location on the ship. All ships during WWII were built with a pointed bow to reduce friction in the water. The problem with the pointed bow is that every wave you cross will raise the front of the ship by the size of the wave. When the ship crashes through a 10-foot breaker during a strong storm, the front of the ship can be lifted 10 feet into the air, then come crashing down just in time to hit the next 10-foot breaker. Modern ships come equipped with a *bulbous bow,* which is a heavy iron ball which protrudes several feet ahead of the hull at a level just below the waterline. When the ship crashes into a giant wave, tons of fast-moving water will flow over that ball and keep the bow from lifting out of the water. The Hornet was built about 10 years before the bulbous bow was invented, so the safety belt was an absolute necessity for the radar operator.

What is in the small room just forward of the Sonar Room?

That small room contains a heat exchanger, which was used to cool the machinery for the air conditioner and all the electronic equipment in the Sonar Room.

*Now, what is the difference between **active sonar** and **passive sonar**?*

With *active sonar* your submarine produces a "ping" (sonar noise), and then listens for it to bounce off an undersea obstacle. The *transducer* is the instrument which converts the sound waves into an electronic signal that shows up as a wavy line on the sonar screen. A good sonarman can read that pattern and determine the size and shape of a submarine. It should be easy for him to distinguish between an American, German, Japanese or Russian submarine. The Hornet did not use active sonar because it would reveal to the enemy its location. Instead, we used passive sonar, and let our destroyers make the ping noises.

If two different ships are targeting the same submarine, can the two ping signals cause confusion?

One ship is able to receive the echo of a signal from another ship, but their transducers are set at a different frequency, so the timing would be out of phase and would not cause confusion.

After your sonar screen has determined the existence of a submarine, how do you locate it?

After your sonar has determined the submarine's size and shape, and what kind of sub it is, and the cavitation bubbles have indicated how deep it is and how many propellers it has, and the Doppler reading shows us what direction it is going and how fast it is moving, the next step is to drop three sonobuoys in the water forming a triangle around the submarine. Each unit will determine a straight line between itself and the submarine, and where all three lines converge, you have found your target.

After they know the submarine's location, how is this information radioed back to the Hornet?

To explain this to our visitors, take them up to the Airborne Early Warning Room (called the AEW Room). This room is on the Gallery Deck, directly above the Security Desk. Starting from Security, go up the ladder to the first landing. On the port side of the landing, you will find the Conflag Station for Hangar Bay 2. On the starboard side you will find the AEW Room. Inside this room you will find photographs of the planes that would collect data from the sonobuoys, convert the data to electronic protocol, and relay this information by radar directly to ASCAC for analysis. The larger plane in the photo is a

Tracker, and it carries its radar dome above the plane's wings. The smaller plane is called a Guppy, which carries its dome below the wings, thereby giving the plane the shape of a guppy. By flying these planes high above the water, Hornet's visual horizon is increased by more than 400 miles.

Is there any way that a submarine can hide from acoustical locator detection?

If a submarine hears cavitation noise coming from another ship, they know that the ship can also detect the submarine's cavitation bubbles. They can easily hide from detection by simply shutting down their engines, or by running at a slower speed.

Is there any way that a submarine can hide from sonar detection?

A submarine can hide from sonar detection by submerging below the *thermocline.* The **thermocline** is a layer of water with a temperature differential which separates the warm, circulating water near the surface and the cold, deep water below. This temperature differential creates a barrier which can reflect or distort sonar soundings and shield an enemy submarine from discovery. It is similar to a window in your house, if it is light inside and dark outside, the window becomes a mirror. Similarly, the thermocline becomes a mirror which reflects sonar soundings and hides the submarine.

*What is that device in the Sonar Room that is called **Gertrude**?*

That box on the forward bulkhead called Gertrude is a 2-way radio that can be used to communicate with a friendly submarine. Sound waves travel much better below the water than do radio waves. Gertrude operates by a hull-mounted transducer, and messages can be sent several miles from a ship to a submarine, or from one submarine to another. These devices are never used in a war zone. If one submarine needs to communicate with another or with a ship, it will surface briefly, and send an encoded message by radio waves, and quickly submerge again afterward.

What is that other strange device on the after bulkhead?

That is another useless device for the Hornet. It is a targeting device that could be used for submarine-launched or ship-launched torpedoes. Hornet never launched torpedoes from the ship, but rather dropped them by airplane.

What is the difference between a water-launched torpedo and an air-dropped torpedo?

To understand this clearly, let's go to the Torpedo Shack on Second Deck, just aft of Sick Bay. There, you will find two torpedoes: a gray one, and a green one. The gray one is a Mark 13, air-drop model. They were used during WWII, but they had numerous design flaws which left them very ineffective. They were contact-detonated, so if you missed the submarine, the shot was wasted. They were dropped by low-flying, and slow-moving aircraft, which exposed the pilot to extreme danger. They had no self-guidance system to correct their heading if they go off course, and although they had a ring stabilizer around the propeller, they were still prone to skim over the water surface which would throw them off target. The Mark 13 failed 80 out of every 100 launches, and was discontinued in 1953.

The green torpedo is a Mark 45, water-launched torpedo. It had 2 counter-rotating propellers to reduce cavitation noise, and it had an electric-powered motor with a maximum speed of 40 knots, which could outrun most submarines. The guidance system was remote-controlled by a wire running between the launching submarine and the torpedo. The only way it could be detonated was by the launching submarine pushing the "red button." It had a nuclear warhead with overkill power of 11 kilotons of TNT.

This model of torpedo was manufactured from 1960 to 1976.

Did the Hornet also carry nuclear bombs during the 1960s?

The Mark 101 (Lulu), was a nuclear depth charge. It weighed 1,200 pounds, and yielded 11 kilotons of TNT. It was deliverable from a Tracker airplane, or from a Sea King helicopter.

The B57 was a nuclear bomb. It weighed 500 pounds, and it had a variable yield of 5-20 kilotons of TNT. It could be delivered as a nuclear depth charge or a tactical weapon. It had an aerodynamic shape, which made it suitable for high-speed attack aircraft. One delivery option was by parachute from an aircraft, or if it was delivered by helicopter, the fins were collapsed to fit on the hard point.

Is there anywhere on the ship where we can see a brief explanation of the units in the ASW Division?

On Second Deck, near Ready Room 4, in Stateroom 243, you will find a brief summary of the various units that support the **Anti-Submarine Warfare Division**. Storyboards describe the Search & Attack unit, Sonar Room, Sonobuoys, AEW Room (Airborne Early Warning), and ASCAC Room (Anti-Submarine Classification and Analysis Center). Be sure your tour includes a visit to this room.