

The **Right Submarine** for Lurking in the Littorals

By Milan Vego

SSKs are better designed for narrow, shallow seas than fast attack submarines.





Nuclear-powered attack submarines (SSNs) are capable of operating in shallow, confined waters—but the smaller, quieter, more maneuverable antisubmarine subs (SSKs) are better suited for operations in such waters. The U.S. Navy should acquire a relatively small number of SSKs for operations in the littorals. SSNs, which can conduct long-range operations submerged and at high sustained speed, should be used primarily in deep water.

The Littoral Operating Environment

The characteristics of the physical environment and weather/climate considerably affect the employment of surface ships and submarines. An ocean's open, deep water poses different challenges than areas close to the landmass, or littorals. (The strict definition of "littoral" refers to a coastline of land and near-shore waters, particularly the area between extreme high and low tides. More broadly, the term designates a coastal region.)

These waters encompass the continental shelf bordering the open-ocean and semi-enclosed and enclosed seas popularly called narrow seas. Littoral waters can be very deep or as shallow as 200 meters or less. A typical narrow sea is characterized by short distances and correspondingly small maneuvering space, many offshore islands, specific hydrography and oceanography, variable weather and climate, and the proximity of the landmass. The sea area close to the coast typically is crowded with warships and commercial vessels, tugboats, barges, fishing trawlers, boats, and pleasure craft.

Because of the short distances, high sustained speed for a submarine is not as critical a factor as it is in the open ocean. In shallow water, a fast-moving sub would have little time to take corrective action should anything go wrong. The proximity of the seabed creates an area of reduced pressure, called the squat (suction), under the

keel.¹ This can lead to handling difficulties and even grounding. Movement through the water also generates on the sea surface a distinctive hump, which is much more easily detectable in shallow water.²

Normally, an SSN must have at least 50–60 feet of water under its keel for navigational safety; the corresponding depth for an SSK is 30–40 feet. A submarine must sail relatively close to the sea surface to use its periscope or snorkel for communications. For example, the periscope depth for a U.S. SSN is about 50 feet. For the German Type 212A SSK, it is about 40 feet. To avoid pursuit, the boat must have much greater depth under its keel so that it can conduct quick vertical maneuvers.

Sound transmission in shallow water is highly unpredictable because of the seabed's proximity, great variations in sea temperature and salinity, freshwater influx from rivers, and the effect of tides, currents, ice, wind, and waves. Natural and human-made ambient noise adversely affect the work of both passive and active sonars. Antisubmarine sensors designed to operate in deep waters of an ocean are ill-suited for detecting quiet submarines in shallow waters. They usually have limited search rate, while those that have high search rates are generally ineffective against slow and deep targets.³

Passive sonars are not very effective against quiet SSKs because of the frequent lack of data on the target signature. Active sonars are impeded by the environmental clutter and the inability to reliably check the entire search area. Most of the noise signature of SSKs is in broadband (flow noise over the hull), while SSNs' signature is in narrow band (or tonal).

In the shallow waters of an archipelago, the problem of using passive sonar is compounded by strong reverberations caused by sound reflection from the seabed, the surface, and the nearby islands.⁴ Many sonar contacts are false, due to high irregularity of the sea bottom. Because of the mod-

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The German type U212A class (here the *U31*) is among the advanced, modern SSKs with the characteristics that make them best suited for operations in the littorals.

ern SSK's quietness, detection ranges are generally short. This, in turn, requires a much shorter reaction time by ASW forces compared with their detection of a submarine in open waters.⁵

The Smaller SSKs

SSKs are primarily designed for operations in the littorals and shallow waters. They are much smaller in size than SSNs and do not need to carry large reserves of fuel.



SSNs have multiple types of sensors and weapons, but modern SSKs have more sensors than the older versions and are better armed. The Dutch HNLMS *Walrus* participated in exercises off Cape Cod to evaluate U.S. capabilities against a modern SSK in a challenging environment.

Their weapons-reload capability is not critical for performing their assigned missions. An SSK can frequently return to its base or a submarine tender for replenishment of disposable stores. The German Type 212A displaces 1,450 tons on the surface and 1,830 submerged. The Type 214 displaces 1,700 tons on the surface and 1,860 submerged; the French *Agosta* 90B SSK for export has a surfaced displacement of 1,490 tons and submerged of 1,740 tons. Advanced SSKs have small crews because of the high level of automation. The Swedish *Gotland* and the German Type 212A SSKs have crews of only 27–28. This means that watch-keeping is more complicated than it is on board

SSNs. Small crews are also likely to suffer from fatigue during long combat missions.

Because of their small draft and better maneuverability at lower speeds, advanced SSKs are suitable for operations in confined and shallow waters. Some experts contend that the submarine's size plays a minor role in its maneuverability, and that a much more important factor is its handling and stability.⁶ But the submarine's overall length and height play a major role in its ability to ensure navigational safety in shallow water. Also, in case of the loss of depth control, the much longer SSNs have far greater difficulties avoiding the sea bottom.

The Surfacing Challenge

Traditionally, the SSKs' single biggest disadvantage was their frequent need to come to the surface to recharge batteries. The invention of the snorkel greatly reduced this problem, because with it the sub can recharge batteries while sailing at periscope depth. Today, the most advanced SSKs are fitted with air-independent propulsion (AIP), which allows increased submerged endurance.⁷ AIP also considerably reduces the SSK's indiscretion rate (percentage of time spent snorkeling; it varies from 10 to 25 percent). Thereby it enhances survivability during transit to the operating area or when moving to attack. The top submerged speed of most modern SSKs is not more than 20 knots, but they can sail at that speed for only few hours. For example, the *Gotlands* have a maximum speed of 10 knots on the surface and about 20 submerged. The corresponding figures for the Type 212A and the French *Agosta* 90B classes are 12 and 20 knots, respectively. Self-noise above a speed of 20 knots would make it very difficult for an SSK to detect other vessels.

Long range and endurance are not as important for submarines operating in the littorals as for those deployed on the open ocean or needing to transit long distances. Nevertheless, modern SSKs are capable of

transiting long distances at relatively low speed and on the surface. Their submerged range is measured in several hundred nautical miles (nm). Type 212As have a range of 8,000 nm at 8 knots on the surface, or 420 nm at 8 knots submerged. Their endurance is about 30 days. Type 214s have a maximum range of 12,000 nm at a speed of 9 knots. They can sail at the submerged speed between 16 and 20-plus knots for a few hours several times during a 50-day mission.

An SSK can transit to the prospective operating area by using batteries or snorkeling. Once there it can use AIP for long, submerged, quiet patrols at low (4–5 knots) speed.⁸

The Swedish *Gotlands* can operate on AIP for two weeks at 5 knots without snorkeling. Type 212A submarines can sail submerged by using AIP for about 15 days, and Type 214s for more than four weeks. However, an AIP SSK still has the need, from time to time, to come to snorkel depth to take on oxygen for its crew.

Dive, Dive, Dive—And Maneuver

Diving depth is a major factor in avoiding a pursuit, but in the littorals, it does not play as large a role. Because of the prevalence of shallow water in most narrow seas, the minimum operating depth for an SSK should be about 650 feet.⁹ The Type 214 has more than 1,400 feet for this, and the French-Spanish designed S-80 *Scorpène*-class SSK has a maximum operating depth of about 1,000 feet.¹⁰

High maneuverability is also critical in shallow and confined waters. All submarines sailing at less than 165 feet need to have excellent depth control.¹¹ There a submarine can maneuver in a water column of only two to three ship lengths.¹² At periscope depth, it has to operate around a keel depth of 50 to 65 feet, depending on the sea state and periscope and mast extension.

Modern SSNs are fitted with a new computer-controlled autopilot and hovering system that allow them to maintain a specific depth to within 1/10 of a foot at stable depth, even in the roughest weather conditions. They can also penetrate close to shore, where sea-floor contours permit. However, the submarine's size still counts in shallow water. Quiet SSKs also have features that enhance their ability to operate in shallow waters. *Gotlands* are fitted

with four control surfaces in X-configuration and two on the sail, plus a slow-turning, seven-bladed propeller, giving them extremely high maneuverability and operations close to the bottom. Their turning radius is also very small.

Keeping It Down

Modern SSNs are more stealthy than SSKs, because they do not need to come to the surface and are extremely quiet. For example, the *Virginia* class is very quiet, and their non-acoustic signature has been reduced to absolute minimum. But this once-great advantage has been eroded by the technological advances of SSKs operating on AIP.¹³ They are even quieter than nuclear-powered submarines.¹⁴

Gotlands have a very low-noise magnetic and infrared signature. They are vibration-free and reportedly extremely hard to detect. Type 212A is perhaps the quietest SSK today, with its drastically reduced waterborne noise, magnetic, radar, infrared and pressure signature. It has a carefully shaped hull and sail with no straight lines, resulting in low target-echo strength. Type 212A and Type 214 fuel cells work at an operating temperature of 70 to 80 degrees C. This makes the submarine difficult to detect using external heat sensors.

When snorkeling, SSKs may be able to blend into surface shipping, which is predominantly diesel-powered. Some SSKs have specially designed propellers that drastically reduce blade rate.¹⁵ A smooth sea floor allows an SSK to “lie down” during a pursuit, and this sub may be able to use bathymetry, bottom composition, nearby topography, or a shipwreck to hide.¹⁶ An SSK is difficult to detect if it settles on the seabed in less than 100 feet



Littoral waters can be challenging and dangerous for shipping, with their small maneuvering spaces, variable weather, and traffic. The Gulf of Aden is one such perilous area. Here in February 2010, a team from the USS *Farragut* (DDG-99) investigates a Somali skiff. SSKs operate well in this environment.

of water, switches off its engines, and closes all seawater inlets. (In contrast, an SSN cannot sit on the bottom because of the danger of clogging vital inlets to condensers.) However, the SSK is vulnerable to detection and attack because of its need to come up to just beneath the surface at regular intervals, raising its snorkel mast and running its diesel to recharge the batteries.

Modern SSKs Are Well-Armed

Because of their smaller size, SSKs cannot compete with SSNs in terms of number, variety, and sophistication of sensors and weapons. SSKs were previously fitted with only two displays, smaller arrays, simpler single processors, and weaker computers. They lacked the space, power, and people to use towed arrays effectively, as well as the space to mount a large hydrophone for long-range detection and localization.¹⁷ But modern, advanced SSKs have more sensors.

Type 214 submarines have five different sonars: medium-frequency passive sonar, flank array, the very low-frequency towed array, and passive/active sonar for fire control. They also have advanced modular periscopes, an electro-optic mast, torpedo countermeasures, and a fiber-optic communications network. And they have high-bandwidth satellite-communications connectivity using the Callisto towed communications buoy.

Additionally, modern SSKs are much better armed. Type 214s have eight 21-inch bow torpedo tubes (carrying 16 torpedoes) and Sub Harpoon antiship cruise missiles. Type 212As are armed with six 21-inch torpedo tubes. Both they and the 214s can carry mines in lieu of torpedoes. The newest variant of these (Batch 2) will be also armed with the mast-mounted, retractable Murena recoilless 30-mm gun to engage surface targets, and the IDAS (interactive defense and attack system for submarines) missile system facilitating engagement of ASW helicopters. They will have a diver lockout chamber and stowage containers in the casing for special-forces operations.

The *Gotlands* are fitted with the Sesub 940A combat system, a CSU-90 integrated system composed of a medium-frequency hullborne passive search/attack sonar, active search Reson Subac sonar, a low-frequency passive search flank array, and an advanced periscope. They are fitted with 21-inch torpedo tubes (with 12 torpedoes) and two 18-inch torpedo tubes (six antisubmarine torpedoes). They can carry 12 mines in lieu of 21-inch torpedoes, and another 48 mines with an external girdle. The *Gotlands* are equipped with active sonars for mine detection/localization, and a bottom-navigation echo sounder.

Best Subs for the Mission

SSNs, with their high sustained speed and almost unlimited endurance while submerged, are the best platforms against enemy submarines. They can attack a great variety of targets, both on the surface and deep into the enemy shore. The very presence of an SSN in



SSKs are better suited than SSNs for defending merchant shipping in coastal areas (here Imam Khomeini Port, Iran). They can lay mines covertly off approaches to enemy naval bases and ports, detect enemy mines, and deliver special-operations teams. The effectiveness of the submarine force, the author maintains, will be enhanced through a proper mix of SSNs and SSKs.

certain areas can have not only operational but strategic effects on enemy deployments and movements of merchant shipping.

But SSKs seem much more capable of searching for and destroying enemy submarines operating in shallow waters, and of defending merchant shipping in coastal areas. They are also better suited to lay mines covertly off approaches to enemy naval bases and ports, and in straits and narrows. SSKs can be used for detection and localization of enemy mines, and for delivery of special-operations teams.

Such missions might require a submarine to operate in less than 20 to 30 fathoms (120–180 feet), at speeds of less than 3 knots, for prolonged periods. Such shallow-water operations involve stopping and maneuvering, including backing up and down.¹⁸ But because of their inadequate range, endurance, and low sustained speed, SSKs cannot be employed as part of carrier or expeditionary strike groups on the open ocean. Their need to occasionally use snorkel or come to the surface does not allow them to be effective in intelligence, surveillance, and reconnaissance missions. And, because



of their small size, they cannot carry long-range land-attack missiles.

Optimally, SSKs should be employed as an integral part of a force specifically designed and trained to operate in littoral waters. Such a force should be composed of small surface combatants (light frigates, multi-purpose corvettes, fast attack craft), SSKs, smaller amphibious ships, attack and mine-countermeasures helicopters, and unmanned aerial vehicles. These littoral combat groups would operate under the protective umbrella of carrier strike groups and land-based aircraft.

Political and Financial Considerations

One of the greatest disadvantages of the SSKs is their inability to deploy covertly and quickly from homeports many thousands of miles away from their prospective operating areas. Hence, host-nation support is critical. At the same time, home-porting and port visits by SSKs are less problematic politically than by the more menacing SSNs. Submarine tenders could also be acquired to provide full support for deployed SSKs.

An SSN can be three to five times more expensive than a conventional submarine fitted with AIP. The price of one *Los Angeles*-class submarine is about \$1 billion, a *Virginia* class \$1.6 billion, and a *Seawolf* class about \$2.1 billion. In contrast, the price of one *Gotland*-class AIP submarine is about \$365 million, and one Type 212A about \$500 million.

SSNs are expensive and cannot be easily replaced in the event of loss or severe damages. But SSKs have more than enough range, endurance, and speed to operate in a typical narrow sea. They are more maneuverable in shallow waters, and they are two to three times less expensive. Advanced SSKs are very difficult for enemy ASW sensors to detect.

The Navy's current and projected numerical shortfall in the submarine force can be resolved by acquiring a relatively small number of AIP SSKs from friendly nations. They cannot and should not be considered as an alternative to the SSN force, but only as their complement. The effectiveness of the U.S. submarine force will be greatly enhanced through a proper mix of SSNs and SSKs. Because SSKs can perform some missions in the littorals much more effectively, SSNs can focus primarily on those missions for which they are optimally designed and trained. ⚙️

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Dr. Vego is a professor of operations at the Naval War College. Before coming to the United States in 1976, he served as commanding officer of torpedo boats and gunboats in the former Yugoslav Navy and as 2nd officer (Deck) in the former West German merchant marine. He is the author of *Naval Strategy and Operations in Narrow Seas* (London: Frank Cass Publishers, 1999 and 2nd ed., 2003), and of many articles on littoral warfare.