Submarine Developments: Air-Independent Propulsion

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Although there is a (mis-informed) view within Canada that submarines are yesterday's news, or relics of the Cold War, many countries are rushing to buy modern submarines as a major component of their maritime security force. In this article, I will discuss the air-independent propulsion (AIP) diesel-electric submarine and the ultimate AIP vessel – a modern nuclear-powered attack submarine (SSN).

Nuclear submarines are very expensive, not only to build the boat (yes, submariners refer to their vessels as 'boats'), but the extensive infrastructure required to support them – a nuclear industry with all of the necessary safeguards, advanced training for all members of the crew, isolated high-security bases, etc. At the moment these boats are operated by just five states: USA, Russia, UK, France and China. All five countries possess both ballistic missile submarines (SSBNs) and SSNs, indeed all but Russia and China now operate only nuclear-powered vessels.

Other states are interested in joining this nuclear club, especially India and Brazil. The quickest way of gaining admission to this elite group is by purchasing or leasing a nuclear sub: during the period 1988-91, India leased a *Charlie I*-class SSGN (the 'G' standing for a submerged launch anti-ship missile capability). The expertise gained in operating that submarine must now have been lost, but there are persistent reports that India will lease one or two Russian *Akula*-class SSNs, in order to develop the capability to operate such vessels, while it works on an indigenous design.

A nuclear propulsion system allows a submarine to remain submerged for extended periods. As an example, the USS *Triton* circumnavigated the world submerged in 1960 – travelling a total of 41,500 nautical miles at an average of 18 knots. Most diesel-powered submarines are really submersibles rather than true submarines, and have to put up a snorkel-mast – a WW II German development – to run their diesels when dived if they wish to achieve a faster transit, or recharge their batteries so that they may loiter submerged and silent on electrical power in a given patrol area, and then only for a few days and at speeds of 2-4 knots. Faster submerged speeds would quickly expend all of the stored electrical power in their batteries. For example, a modern diesel-electric submarine, like the Australian HMAS *Collins* or Canada's

U-32, a new German ***Type 212A*** *submarine underway.*

HMCS *Victoria*, is able to achieve a submerged speed of 20 knots, but only for an hour or two.

In recent years there have been a number of experiments with air-independent propulsion (AIP) systems by submarine-building states, principally France, Germany and Sweden, that permit diesel-powered boats to operate submerged and virtually undetectable for as long as two weeks at a continuous speed of five knots. The German *Type 212A*, the most advanced of the current AIP generation, is built of non-magnetic steel which makes it more difficult to detect and impervious to magnetically-initiated mines and torpedoes. It is propelled while in the mission area by hydrogen fuel cells, is highly automated with a crew of 27 including eight officers, and equipped with long-range wire-guided torpedoes and submerged-launch anti-ship missiles. *Type 212A* submarines are being equipped with new communications systems to integrate fully into net-centric operations with other forces, including supporting the deployment of Special Forces.

The *Type 212A*, in comparison with the conventionally-powered *Type 206A* boats which comprise most of the German submarine flotilla, has a greatly increased operational radius. The second of class U-32 set a record in April 2006 when it conducted an uninterrupted dived transit from the Baltic to Rota Spain, a distance of 1,500 nautical miles in two weeks. These vessels are very stealthy by virtue of their lack of a need to snorkel and are much more habitable than their predecessors: the accommodation improvements have enabled the abandonment of

Photo: Internet image

*USS **Virginia** underway.*

the German practice of hot bunking for the first time and there are now dining and working spaces separated from the sleeping quarters.

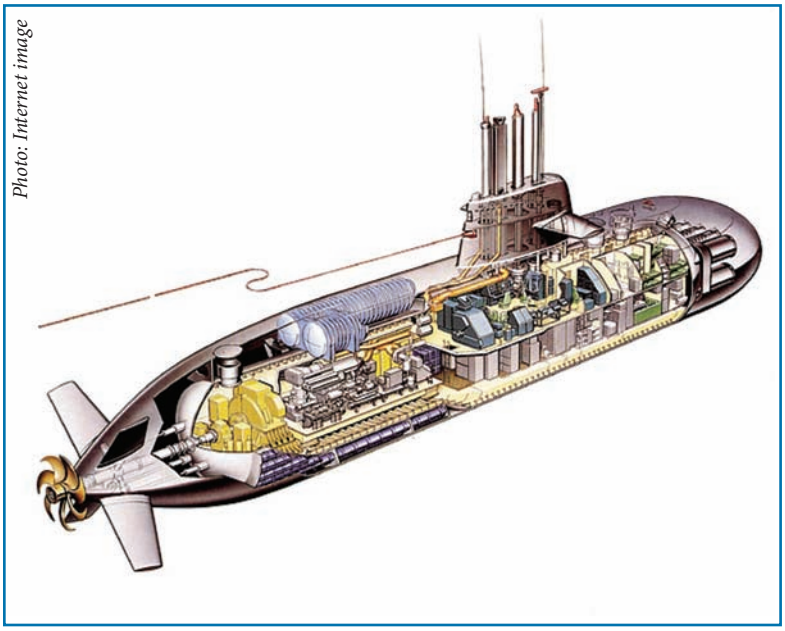
AIP propulsion systems are being installed in new submarines of other navies – at the moment these include Greece, India, Italy, Japan, Malaysia, Pakistan, Spain and South Korea. AIP may be retro-fitted into older submarines as well: some years ago there was discussion about putting an AIP 'plug' into at least two of the Canadian Navy's *Victoria*-class SSKs during their mid-life refit. This now seems very unlikely, but if a new generation of submarines should ever be built for the Canadian Navy, the inclusion of some type of air-independent propulsion system would be included in the design.[1]

The most modern submarine in the US Navy is the *Virginia*-class SSN. It is interesting that these vessels are named after states: *Virginia*, *Texas*, *Hawaii*, etc. For many years, battleships – then the most powerful, prestigious vessels (capital ships) – were named after states. In the past few decades, that honour has been conferred on the *Ohio*-class ballistic missile submarines, arguably modern strategic-deterrent capital ships, and now this powerful new SSN continues that trend.

Virginia-class submarines are capable of submerged speeds of 34 knots, have a reactor designed to last the life of the vessel, are armed with 12 Tomahawk land-attack cruise missiles in launch-tubes outside the pressure hull, and internally with wire-guided torpedoes, anti-ship cruise missiles, and mines. They can also launch and recover unmanned underwater vehicles (UUVs) to conduct reconnaissance, find minefields, etc. Another feature is the ability to reconfigure the torpedo room to carry up to 40 Special Forces personnel and their equipment. They have also been designed to operate as a key element of a fully networked naval force. *Virginia*-class submarines are thus uniquely equipped to wage multi-dimensional warfare in the farthest reaches of the globe, providing the US Navy with continued dominance in coastal waters or the open ocean. These submarines can travel submerged at high speeds, undetected, independent of sea state or logistic support and arrive on station ready for action.

Virginia-class submarines are the US Navy's first major combatant ships designed with the post-Cold War security environment in mind. Approved nearly four years after the fall of the Berlin Wall, they embody war-fighting and operational capabilities required to dominate the littoral areas while maintaining undersea dominance in the open ocean.

These are much bigger submarines than the German *Type 212-A*-class: more than twice as long at 377 feet, more than five times the dived displacement at 7,800 tons, and with a crew of 134 officers and men. From that one could conclude that the German boat will likely operate for shorter periods of time in Baltic or other coastal waters, while the *Virginia*-class could deploy for much longer periods and be more independent of external support. However, both types of submarine represent a formidable deterrent and offensive capability – after a submarine leaves harbour and dives, its position remains a mystery to unfriendly states until it returns to homeport!



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*Cut-away drawing of a **Type 212A** submarine.*

Notes

1. For more details on AIP, see the *CNR* Backgrounder, available at http://naval.review.cfps.dal.ca/pdf/AIP_Backgrounder.pdf.