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Nuclear Powered Submarines for the RAN

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The announcement on Thursday 16 September that Australia had cancelled the *Attack* class submarine project in favour of pursuing a nuclear powered option better suited to our nation's strategic interests has sparked a frenzy of reporting in the press and stimulated vigorous discussions throughout the community.

A number of friends and relatives have sought my insights concerning just what a nuclear option means for the navy and the nation. In those discussions it became clear to me that many people don't seem to have a clear understanding of how a nuclear powered vessel works and most were surprised to learn of the part that good old fashioned steam plays in the equation. Some also failed to appreciate the distinction between acquiring nuclear powered vessels and nuclear weapons, the latter of which is not a consideration.

In the minds of most I spoke with, a nuclear power plant was a mysterious piece of glowing green equipment that emits energy that is somehow used to propel a vessel through the water. Notwithstanding the green glow reference, it is not too far from reality and the purpose of this short paper is to provide a simple explanation concerning how a nuclear powered submarine works. It is not my intent to comment on strategic sensitivities except to say that the new AUKUS alliance is central to achieving a nuclear powered submarine option.

Los Angeles 688 Class Submarines

In 1992 I was fortunate to be part of a group of sailors from HMAS *Tobruk* (II) that undertook a tour of the *Los Angeles* class submarine USS *Pasadena,* SSN 752, which at that time was visiting an Australian port.

We were welcomed on board and each of us received an unclassified brochure that served to take much of the mystery out of how and what the vessel was capable of. Of great interest to me was 'how did this nuclear powered vessel work?' and I was delighted to see included in my brochure a simplistic and useful explanation, with an illustration, that I have included in this paper.

The Power Plant

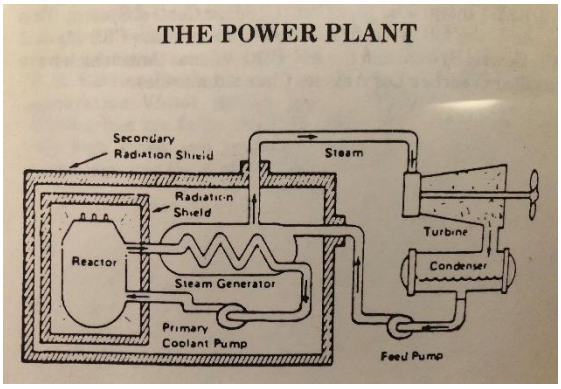
The power plant of a nuclear powered ship or submarine recruits a nuclear reactor to provide heat. The heat comes from the fissioning of nuclear fuel contained within the reactor. Since the fissioning process also produces radiation, shields are placed around the reactor so that the crew is protected.

A typical nuclear propulsion plant, such as those found in the *Los Angeles* class submarines, uses a pressurised water reactor design that has two basic systems; a primary system and a secondary system.

The primary system circulates ordinary water and consists of the reactor, piping loops, pumps and steam generators.

The heat produced in the reactor is transferred to the water under high pressure so it does not boil. This water is pumped through the steam generators and back into the reactor for reheating.

In the secondary system, the steam flows from the steam generators to drive a turbine and generators that supply the vessel with electricity and to the main propulsion turbines that drive the propeller.



A basic diagram of the two separate closed systems that interact to propel a submarine through the water.

After passing through the turbines, the steam is condensed into water that is fed back to the steam generators by the feed pumps. Thus, both the primary and secondary systems are closed systems where water is recirculated and reused.

There is no step in the generation of this power that requires the presence of air or oxygen. This allows the vessel to operate completely

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independent from the earth's atmosphere for extended periods of time.

What does this mean?

In simplistic terms the power plant is a large kettle used to heat water to create high pressure steam that drives the propulsion system and turns the propeller. This concept has been in use for hundreds of years and the steam powered locomotive is perhaps the most recognisable form of transport, that most would be familiar with, that burnt coal in a furnace as a source to create energy.

Ships too have made use of steam for more than a hundred years. The first of these were themselves powered by coal and it was the lament of many a sailor involved in the backbreaking and dirty work of coaling ship.

Later, furnace fuel oil and diesel oil were used as a cleaner alternate energy source to heat boilers and create steam, resulting in greater range, speed and efficiency.

Today of course many of our ships use diesel engines and gas turbine propulsion systems.

Coaling the RAN battle cruiser HMAS Australia (I) was an all ship evolution involving most of the ship's company to bring the vital energy source on board. It was a laborious and frequently undertaken task limiting range and endurance.

Range and Endurance of Nuclear Powered Submarines

Submarines powered by nuclear propulsion enjoy almost unlimited range and endurance meaning they can deploy for long periods of time over great distances. They can attain speeds in excess of 25 knots, which is comparable to many surface ships, enabling them to steam many hundreds of nautical miles in a 24 hour period. They are stealthy and unhindered by the need to replenish at sea or in port as their reactors have a 30-year life span.

This makes this option particularly attractive to Australia as a nation that sits between two of the world's great oceans, the Indian and Pacific, in which it is invested in contributing to and maintaining regional maritime security interests.

HMAS Rankin *and the* Los Angeles *class fast attack submarine USS* Albuquerque *operating together in Australian Waters.*

In order for future Royal Australian Navy submarines to be effective, they will need to have the 'legs' to travel vast distances to get to where they are needed most, the endurance to remain deployed for many months at a time, and be able to carry a payload commensurate with the mission. This is something that is infinitely harder to achieve in conventionally powered diesel-electric submarines.

Conclusion

This Semaphore is not intended to provide a deep understanding of the workings of a modern nuclear powered submarine. It is, however, hoped that it will take some of the mystery out of what makes them work and what the benefits of adopting this class of vessel will be to Australia's future maritime security interests.