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Nuclear Submarines for Australia? When?

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Nuclear Submarines for Australia? When?

A Taskforce will roll out its "optimal pathway" in March 2023

The AUKUS trilateral pact has been in the news of late. It involves Australia, the United Kingdom, and the United States and focuses on security for the Indo-Pacific region. At the core of the AUKUS agreement is a plan to provide Australia with the capability and technology to deploy conventionally armed, nuclear-powered submarines.[1]

Australia established a Nuclear-Powered Submarine Taskforce in September 2021. The mission of this "whole of government" effort is to work closely with the two partners — United Kingdom and the United States — to identify the "optimal pathway" to acquire a fleet of eight conventionally armed, nuclear-powered submarines for the Royal Australian Navy.[2]

These are momentous developments, and it is understandable that they have been the subject of much media excitement. What has often been missing in media reports, however, are basic facts regarding realistic options and resource constraints. What follows is an analysis of what I think is plausible with respect to Australia's desire to obtain a nuclear submarine capability.

In a statement on the one-year anniversary of the AUKUS pact, leaders of the three countries stated that they had made "significant progress". "We are steadfast in our commitment to Australia acquiring this capability at the earliest possible date," the statement said.[3]

Although I have no insight into the ongoing work of the Taskforce, I think certain stubborn facts and realities make the options rather limited. I contend that, although the possibilities are many, there are few pathways that will result in deployment of a fleet of Australian nuclear submarines within the coming two decades.

To better understand the Taskforce's proper mission, it is important to clarify the meaning of "optimal pathway".[4] Based on official statements, it can be concluded that the Taskforce has the goal of identifying the most *expeditious* manner by which the RAN can safely deploy eight nuclear powered submarines.

Australia's existing submarine capability comprises six Collins class diesel boats. The first in this class was launched nearly 30 years ago and the class had originally been planned for retirement in the

[1] See, for example, Alessio Patalano, 'Understanding AUKUS', *ASPI: The Strategist*, 19 September 2022 < https://www.aspistrategist.org.au/understanding-aukus/>

[2] 'AUKUS: Trilateral Security Partnership', *Factsheet*, Department of Defence < https://www.defence.gov.au/about/taskforces/nuclear-powered-submarine-task-force/australian-uk-and-us-partnership>

[3] 'Joint Leaders Statement to Mark One Year of AUKUS', *Prime Minister of Australia*, 24 September 2022 < https://www.pm.gov.au/media/joint-leaders-statement-mark-one-year-aukus>

[4] See, for example, Andrew Nicholls, Jackson Downie, and Marcus Hellyer. 'Implementing Australia's nuclear submarine program', *ASPI*, 14 December 2021 < https://www.aspi.org.au/report/implementing-australias-nuclear-submarine-program>

2020s. Life of Type Extension (LOTE) efforts are now underway to keep them in service as Australia's potent submarine capability until the late 2030s. This investment in the Collins class includes an upgrade in sonar and communications capability.[5]

With the extended Collins capability in mind, the term "expeditious" becomes clearer. Australia must strive to put a small fleet of nuclear submarines to sea prior to the superannuation of its existing undersea capability. Let's call this THE GOAL — to acquire a fleet of eight nuclear boats with experienced RAN crews by 2040.

A nuclear attack submarine, whether a US Virginia class[6] or a UK Astute class[7], consists of a pressurized water reactor with an associated primary and secondary power plant. The nuclear reactor uses highly enriched uranium to propel an advanced and potent platform that consists of technologically advanced sensors and weapons, such as torpedoes and Tomahawk cruise missiles. Both classes are fast and can dive deep. Neither requires refueling during its 35-year life. As capable military platforms, each consists of the latest in stealth technology — flow jet propulsion, sound silencing, and advanced sonar systems. Considerable resources were expended by each country over many years to design and construct these impressive subs.

A modern nuclear attack submarine is amazingly complex and takes decades to design. Consider the design effort in the US for the Virginia class submarine. From 1990 to 2006, over 35 million labor hours were spent in designing this improved class of boat.[8] A similarly monumental effort was put forth by UK experts in designing the Astute class.[9] These efforts were by scientists and engineers who had experience with previous nuclear propulsion designs.

Will Australia design its own nuclear sub? Possibly, yes, but completion of such a design would take decades. Without experience, Australia would be starting low on the learning curve. I imagine that the time and resources required to design such an advanced technological marvel would be staggering. Australia has much to offer the partnership, but nuclear design is not its competitive advantage.

The construction of a nuclear sub is also a significant undertaking. Even with existing experience and shipbuilding capability, it takes several years to build, test and commission a single boat. Again, consider the effort by the Americans to build a Virginia class boat. Construction of a single Virginia-class submarine requires about 9-10 million labor hours.[10] This is what is needed from a shipyard

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[5] 'Collins Life of Type Extension (LOTE)', *ASC* < https://www.asc.com.au/what-we-do/collins-life-of-type-extension-lote/>

[6] 'Virginia class Nuclear-powered attack submarine', *Military-Today,com* <https://www.military-today.com/navy/virginia_class.htm>; 'Virginia Class Attack Submarine – SSN', *Military.com* <https://www.military.com/equipment/virginia-class-attack-submarine-ssn>

[7] 'Astute Class Attack Submarine', Royal Navy <https://www.royalnavy.mod.uk/the-equipment/submarines/attack-submarines/astute-class>

[8] John F. Schank et al, *Sustaining U.S. Nuclear Submarine Design Capabilities*, RAND, 2007, p32 <https://www.rand.org/content/dam/rand/pubs/monographs/2007/RAND_MG608.pdf>

[9] 'Astute SSN Program History', *Global-Security.org* <https://www.globalsecurity.org/military/world/europe/hms-astute-history.htm>

[10] See, for example, Sean Flynn, 'General Dynamics lands $22.2B submarine contract', *The Providence Journal*, 02 December 2019 < https://www.providencejournal.com/story/news/2019/12/02/general-dynamics-lands-222-billion-submarine-contract/2166168007/>

that has been doing such work for decades. After years of gains in efficiency, the US Navy estimates that the marginal cost of each new boat is about $US 3.6 billion.[11]

Will a nuclear submarine be built in Australia? Again, it may be possible eventually. Australia has no commercial nuclear industry, and its limited shipbuilding capability has no nuclear experience. Any plan to design submarine reactors domestically, or to build nuclear boats in South Australia, would be a very long-term endeavor. In addition, attempts at design modification or even limited domestic construction are at odds with THE GOAL. It would be cost prohibitive and involve excessive delays.

There is nothing wrong with long-range planning and far-fetched goals. Today, however, Australia should be laser focused on obtaining the capability to sail a small fleet of nuclear submarines by 2040. More fanciful ideas involving domestic submarine design and construction, although attractive to many self-interested parties, would undoubtedly result in an unfortunate and dangerous undersea capability gap. Longer range plans for domestic design and construction should be reserved for mid-century or beyond.

There are two main hurdles in navigating the transition from diesel to nuclear submarines in Australia. Both must be overcome simultaneously in the coming transition period. The first is related to hardware. Nuclear boats must be procured — built, launched, and commissioned.

The second hurdle is related to human resources. The RAN must recruit, train, and provide crucial experience to many officers and sailors to operate these complex platforms effectively and safely. Both are crucially important, and either of these two hurdles could be the longest pole in the tent.

Let's consider recruitment, training and experience.

A nuclear attack submarine has a complement of at least 12 officers and 100 enlisted personnel.[12] It is therefore estimated that a RAN fleet of eight nuclear attack submarines will require a minimum complement of 100 officers and 800 enlisted. To afford periodic shore assignments, however, the RAN would have to increase these numbers; there would eventually need to be at least 150 officers and 1200 enlisted to operate the eight boats.

Sailors on a nuclear submarine are unofficially divided into those who work forward and aft (nuclear). Approximately half of the enlisted (or 600) would have to be nuclear trained. These numbers represent what will be required in a snapshot in time — they are the minimum complement needed to sustain the planned nuclear fleet.

The RAN currently has over 10,000 permanent, full-time personnel, but fewer than 600 serve in submarines. A substantial increase in submarine staffing will be needed.

Personnel Selection

[11] For a review of the US Submarine construction program in general, see US Congressional Research Service, *Navy Virginia (SSN774) Class Attack Submarine Procurement: Background and Issues for Congress*, 21 December 2022 <https://crsreports.congress.gov RL32418>

[12] 'Attack Submarines – SSN', US Navy, 08 October 2021 <https://www.navy.mil/Resources/Fact-Files/Display-FactFiles/Article/2169558/attack-submarines-ssn/>

A continuous flow of volunteers will be needed for the personnel pipeline. Submarine duty is not for everyone, and measures must be taken to select judiciously. Officer candidates will have to be recruited from the ranks of distinguished university graduates in the STEM fields. Enlisted must be vetted to ensure they have the necessary technical potential.

Initial Training

After acceptance into the submarine program, candidates undergo a very demanding training schedule. All officers and enlisted undergo rigorous technical training in specialty areas. All undergo advanced training in nuclear theory (six months), then nuclear prototype training and qualification (six months). Experience shows that not all candidates are able to complete this training.

Career Development

Australian submarines will be manned by members of the RAN. This means that senior crew must be sufficiently experienced and knowledgeable. Consider what is required to become qualified for command.

In the US, it takes at least six years for an officer to become department head qualified and about 14 years to become qualified for command. Similarly, senior petty officers require extensive training and at sea experience.

Keep in mind that Australia's existing Collins class must continue to operate while the RAN nuclear contingent is developed; this means that the pipeline to nuclear must be an effort that is *additional to* the existing diesel boat capability. The existing undersea diesel capability must be preserved during the period when Australia pursues its nuclear goal.

A viable way in which RAN officers and enlisted will be able to gain the requisite experience in nuclear propulsion is to have them serve with their counterparts on US or UK boats. New recruits would receive their initial training at overseas facilities alongside their counterparts. RAN personnel completing their initial nuclear training (15 or so months for officers, a bit longer for enlisted) would then perform one or more tours of duty on a foreign nuclear submarine. The most expeditious way for this to occur would be to acculturate RAN nuclear trained personnel into the US or UK submarine force for a transition period of 14–16 years. RAN enlisted would obtain the experience and skills by working shoulder-to-shoulder (literally, on a submarine) with their US or UK shipmates. During the transition period, there would be no need to stand up new Australian bodies or agencies — the existing US or UK naval nuclear infrastructure would suffice.

I estimate that the pipeline should contain about 25 junior officers and 250 enlisted annually for the first few years. Overseas experience shows that retention will be a challenge. The life of a nuclear submariner is difficult, with grueling work hours and long deployments. I estimate that the retention rate will be low; only about half will extend their initial commitment to the program and fewer than a quarter will remain in the program long enough to qualify for command (or advance to senior enlisted). This retention rate must be considered when supplying candidates for the career pipeline.

The RAN should take advantage of the existing US or UK pipeline. The US is the logical choice due to size — there are tens of thousands of officers and enlisted actively serving America's 50 attack and 14 ballistic and guided missile submarines. Thousands of officers and sailors are trained in nuclear power schools and at prototype reactors every year in the US Navy. Accommodation of an Australian contingent would be rather straightforward.

The staffing numbers previously mentioned may seem large, but they are “ships force” only. That is, these are the numbers of RAN personnel who will take the boats to sea. If Australia were to create its own infrastructure to support a nuclear submarine program, many additional personnel would be needed for ancillary and support roles. Personnel with responsibility for key technical work in a variety of facilities (regulation, national laboratories, training prototypes, shipyards, maintenance facilities) would be needed. I contend that Australia would be wise to “piggyback” with the US or UK in coming years for the provision of such key support work.

As an example, consider the need for maintenance facilities such as deployed tenders and support facilities at major bases. These perform maintenance and repair on nuclear-powered boats outside of major shipyard availability periods. The ability of an Australian nuclear boat to remain forward deployed would be greatly facilitated by using existing US intermediate maintenance facilities in the Pacific theatre. In similar fashion, I would expect to see more US and UK nuclear boats in Australian ports in coming years.

In the US, there is a centralized program with cradle-to-grave responsibility for all naval nuclear propulsion matters.[13] This centralized program includes civilian and military personnel who design, build, operate, maintain, and manage the nuclear-powered vessels and other facilities of the US naval fleet. All major technical decisions are made by these nuclear experts. They set standards and specifications for all work, while onsite representatives monitor the work at the shipyards, laboratories, prototypes, and contractors.[14] To achieve THE GOAL, Australia should take advantage of existing capabilities and expertise by piggybacking with the US Naval Nuclear Propulsion Program, or its UK equivalent. I believe attempts during the transition to stand up a national authority to set and oversee standards and regulations would result in exorbitant costs and unnecessary delays.

One more key consideration involves the ultimate disposition of used nuclear fuel as waste. Australia’s proposed national waste facility[15], whose fate is less than certain[16], will not accept spent fuel. With about 45% of its warships being nuclear powered, the Americans have the capability of defueling, transporting, and disposing of spent fuel safely. Australia would be wise to keep this issue in mind during discussions with the US.

I think it is clear — only by taking advantage of existing overseas capabilities and infrastructure can Australia achieve THE GOAL.

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[13] ‘Powering the Navy’, *National Nuclear Security Administration, US Department of Energy* <https://www.energy.gov/nnsa/powering-navy>

[14] ‘Naval Nuclear Propulsion Program’, *Naval Nuclear Laboratory* <https://navalnuclearlab.energy.gov/nuclear-propulsion-program/>

[15] Australian Radioactive Waste Agency <https://www.industry.gov.au/australian-radioactive-waste-agency>

[16] Tory Shepherd, ‘Australia’s nuclear waste is growing as battle over dump site heats up’ *The Guardian*, 14 October 2022 < https://www.theguardian.com/australia-news/2022/oct/14/australias-nuclear-waste-is-growing-as-battle-over-dump-site-heats-up#:~:text=Currently%20waste%20is%20stored%20in,facilities%20in%20Lucas%20Heights%2C%20Sydney.>

Where will the hardware — the nuclear subs — come from? The most widely cited option is for Australia to buy its first few boats "off the shelf" from either the UK or the US, or possibly from both.[17]

Soon after the AUKUS announcement in 2021, some pundits weighed in with comparisons of designs. They framed the key question as one of simply choosing between two new, sexy designs — either the US Virginia class design or the UK Astute class. However, both platforms are excellent. The issue is not whether one of these two is superior, the operative question is how each of the two partners can best support THE GOAL.

Consider the UK's Astute class nuclear submarine. A replacement for the Trafalgar class boat, it is the latest class of nuclear-powered fleet submarines in service with the Royal Navy. These boats are being constructed by BAE Systems Submarines at Barrow-in-Furness at a rate of about one every two or three years.[18] The first of this class (Astute) was launched in 2007, commissioned in 2010, and declared fully operational in 2014. There are now five boats operational, with two more in the works. The seventh and final Astute class boat is to be commissioned in 2026.

If the UK were to dedicate its shipyard to building Astute class boats for Australia, it would be unrealistic to expect more than 50% of UK capability to be diverted. At best we might expect production of one Astute class submarine every four to six years to go to Australia. At this cadence, it would be 2046 before half of the planned eight boats are delivered and 2060 until eight could be obtained.

The US Virginia class is the country's newest fast-attack submarine. Virginia class submarines are designed for a broad spectrum of missions, including anti-submarine warfare and intelligence gathering operations. They are replacing the Los Angeles class boats, many of which have already been decommissioned. Virginia class submarines will continue to be built through 2044, and they are expected to remain in service well after 2060. There are now 22 Virginia class boats operational and a total of 66 are planned.[19] To enable this transition from Los Angeles class to Virginia class while maintaining undersea capabilities, the US is building about three Virginia class SSNs every two years.

Although the shipyard capability in the US is much greater than that of the UK, a similar problem exists — the US can't build boats for Australia in the near term without the possibility of it affecting its own submarine program. US national interests require that any diversion of productivity to Australia be managed judiciously. Assuming a 50% capacity diversion, which is considerable, eight boats could be delivered by the mid-2030s.

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[17] See, for example, Sam Goldsmith, 'Astute versus Virginia: which nuclear-powered sub is the best fit for Australia?', *ASPI: The Strategist*, 25 November 2021 <https://www.aspistrategist.org.au/astute-versus-virginia-which-nuclear-powered-sub-is-the-best-fit-for-australia/>

[18] See generally, 'The Royal Navy's Astute class submarines: Part 1 – development and delivery', *Navy Lookout*, 09 January 2023 <https://www.navylookout.com/the-royal-navys-astute-class-submarines-part-1-development-and-delivery/

[19] 'United States Submarine Capabilities', *NTI Factsheet*, 17 February 2021 <https://www.nti.org/analysis/articles/united-states-submarine-capabilities/>

It is unlikely, in my opinion, that the production rate of the Virginia class will be increased in coming years. To help in accommodating the AUKUS demand, one option that the Americans might consider would be to extend the service lives of a few of the remaining 25 or so Los Angeles class SSNs. Suffice it to say there are administrative and operational ways to do this safely and without the need for refueling.

Let's go back to THE GOAL. The obvious path involves careful recruitment and assimilation of RAN personnel into the US or UK nuclear submarine force for the coming decade and a half. During this transition period, more than one thousand RAN officers and enlisted will have to enter this pipeline.

At the same time, hardware must be procured from the Americans or British. Delivery of a few Astute class submarines would be possible by 2040. By then, it is possible that sufficient numbers of RAN personnel could have gained the requisite experience overseas to take them to sea. Procurement of eight new Virginia class boats by 2040 is feasible and, due to size, the US is well positioned to accommodate Australia's timetable.

Australia would be wise to piggyback on existing US or UK submarine support infrastructure (prototype training, regulation, maintenance, etc.), which would free up Australian resources in the coming years. I believe that the establishment of domestic infrastructure, like Australian nuclear design and construction, is best left for the longer term.

The Taskforce is expected to release results in March 2023. I suspect there will be pressure to appeal to a diverse set of stakeholders with competing interests. I look forward to learning what the Taskforce has to say.