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Feasible but Unrealistic

The Quixotic Quest for a Canadian Nuclear Submarine

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In April 2024, Canada released its long-awaited Defence Policy Update. Entitled *Our North, Strong and Free*, this plan sought to update the Liberals' 2017 defence policy in light of growing Chinese aggression and Russia's ongoing war in Ukraine. One of the most anticipated elements of this refresh was the urgently needed submarine replacement program. There was little of substance in the update – with the document committing only to "exploring options for renewing and expanding Canada's submarine fleet"[1] – yet, the Prime Minister turned heads in a press conference when stated that "we are looking at all types" [of submarines], implying that the government may be considering a nuclear propulsion option.[2] It is widely believed that the Prime Minister misspoke, nonetheless, Foreign Affairs Minister Joly made a similar remark in June, in announcing the country's Arctic policy refresh.[3] The result has been a small – but noticeable – resurgence of interest in a Canadian nuclear submarine capability to replace the Victoria-class, which will reach the end of its service life in the 2030s.[4]

The allure of the nuclear option is easy to comprehend. Larger vessels with near-infinite range (limited only by food supplies), greater speed, and the ability to operate deep under the Arctic ice-cap, a nuclear attack submarine (SSN) would suit many of Canada's vital submarine requirements. Yet, the attractions are a mirage, and the pursuit of an SSN program at this time would be folly.

Here, history is a guide. Canada has seriously considered acquiring SSNs twice before and both times found the costs to be unaffordable and long-term government support impossible to guarantee.[5] On the critical issue of expense, the issue is not only the submarines themselves but the total enterprise cost: the infrastructure, the maintenance, regulatory requirements, the education and training associated with nuclear power, and the eventual decommissioning and safe disposal of the submarines' reactors.[6]

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[1] On July 10, 2024, during the 2024 NATO summit, there was a subsequent announcement on the submarine replacement project by the Minister of National Defence clarifying that Canada was launching a process to acquire up to 12 conventionally powered submarines. Government of Canada, News Release, "Canada launching process to acquire up to 12 conventionally-powered submarines" (July 10, 2024).

[2] Department of National Defence, *Our North Strong and Free* (April 2024).

[3] Danielle Bochove, "Canada Readies New Arctic Foreign Policy as Russia Threat Looms," *Bloomberg* (June 12, 2024).

[4] David Pugliese, "Royal Canadian Navy not considering nuclear-powered subs despite Trudeau claim," *Ottawa Citizen* (May 29, 2024).

[5] Jason Delaney, "The One Class of Vessel that is Impossible to Build in ~~Australia~~ Canada" *The Northern Mariner* 3-4 (July and October 2014)

[6] Peter Kenter, "Canada has a responsibility to safely manage nuclear waste for generations — here's the plan," *National Post* (November 25, 2022).

The timelines involved in procuring an SSN are also a critical component. Simply put, these vessels take a long time to build – time that Canada does not have if it wants to retain the Navy's ability to operate submarines. In dreaming of a fleet of SSNs, proponents risk setting Canada on a path that is not only destined to end without SSNs – but without any submarines at all.

Technology and intellectual property (IP) rights

Broad sweeping statements about the need for the capabilities brought by an SSN are simple and seductive. To fully comprehend the scope of the enterprise, it is worthwhile to examine the critically important – but underappreciated – details that make that vision an illusion.

As one of the most advanced weapons platforms in the world, naval nuclear propulsion technology is a closely held national secret. Today, there are two western nations that own the intellectual property (IP) for naval nuclear propulsion: the United States and France. The Americans are Canada's closest allies and own the IP for not only their own fleet but also the British (and in the future Australian) SSNs. Suggestions have been made that Canada gain access to this technology by joining the US and Australia in the AUKUS agreement (Pillar One). Yet, this is a far bigger step than commentators understand – more than an agreement with the President of the United States, this would require US congressional approval, as well as the agreement of the two other AUKUS partners.[7] Moreover, there is no reason to believe that the United States Congress or the US Navy would be supportive of this move.

The most recent precedent was set by the Mulroney government's outreach to the Reagan administration in the late 1980s to secure that IP transfer. Despite their friendly relations with the Conservative government, the US Navy reacted to this proposal with a combination of suspicion and derision, with Ambassador Allan Gotlieb describing it as having provoked more American interest than any Canadian defence initiative since [Pierre Elliott] Trudeau's 'peace proposal.'[8] Today, the American reaction is unknowable. It is possible that it may be welcomed as evidence of a new commitment, though, with Canada struggling to maintain and expand its current military capabilities, the American reaction might also be similar to that of the 1980s.

Even if the US was amenable to transferring the technology, it would retain an absolute degree of control over the program that many Canadians would chafe at. As the IP owner, the US will set the requirements for the supporting infrastructure and personnel certification requirements. These requirements are incredibly stringent and not subject to debate; they are also the reason that there have been no US Navy nuclear incidents over seven decades of continuous operation.[9] Adhering to these requirements represents an expense and a logistical challenge that most Canadians simply don't understand.[10] The infrastructure in direct support of nuclear-powered submarines must be

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[7] AUKUS Pillar 1 is the sharing of nuclear submarine technology.

[8] Allan Gotlieb, *The Washington Diaries 1981-1989* (Toronto: McClelland & Stewart, 2006), 470.

[9] The loss of the nuclear-powered submarines USS *Thresher* in 1963 and USS *Scorpion* in 1968 were the result of factors not associated with the nuclear propulsion. See: Bruce Rule, *Why the USS Thresher (SSN 593) Was Lost*, (Nimble Books LLC, 2017) and *Why the USS Scorpion (SSN 589) Was Lost*, (Nimble Books LLC, 2011).

[10] At this time, the US Navy is operating approximately 97 reactors, which includes 11 aircraft carriers with two reactors each and approximately 67 submarines and five R&D and training platforms (including moored training

several times more sophisticated and robust than standard dockyard facilities – in case of nuclear emergencies. For example, the synchrolift (ship lifting system) or drydock must be able to fully function in the face of extremely unlikely events – such as a simultaneous major earthquake and hurricane while a naval nuclear reactor is being worked on. Thus, any equipment cost estimates must be from a current nuclear support infrastructure, not necessarily what is available commercially locally.

The alternative to American IP would of course be a partnership with the French. This was one of the options examined in the late 1980s by the Mulroney government. Naturally, the French would also have to approve Canadian access to their IP, as well as the construction of the supporting Canadian infrastructure. In short, while possible, Canada would not be in control of the application of foreign sourced IP, especially infrastructure associated with operations and maintenance.[11]

To avoid the political complexity and logistical hurdles of foreign IP Canada could develop and build an indigenous naval nuclear reactor. The nation certainly has the resident expertise, however, the civilian CANDU reactor is not suitable for naval service and duplicating the maritime technology which has taken our allies generations to refine would be an enormous undertaking and prohibitively expensive.[12]

Infrastructure

Apart from the submarines themselves, the most significant cost of an SSN program would be the accompanying infrastructure. These are massive expenses and commonly underappreciated. As part of AUKUS agreement the Australians are currently spending $8 billion on their modern west coast submarine base HMAS *Stirling*. This expense is simply to upgrade the current submarine support infrastructure on one coast.[13] With two coasts, separated by a continent, Canada could expect to more than double that cost because, for reasons of nuclear safety, neither Esquimalt nor Halifax naval bases could support a fleet of SSNs. These bases are simply too close to major

submarines) with one reactor reach. They also have shore facilities for technology development and training naval nuclear power operators. Therefore, it is difficult to say exactly how many reactors the US Navy is operating at any one time as once a ship is decommissioned, the reactors still exist, and the recycling programme is lengthy. To give an idea of the some of the costs of maintaining a naval nuclear infrastructure in FY 2023 US Congressional Budget Justification for naval nuclear reactors asked for $2.1B USD for FY 2023 but also anticipated outyear funding of $7.6 B USD from FY 2024-2027. Of note there is also the Dept of Energy Working Capital Fund of which Naval Reactors' contribution in FY 2023 was $2.5B. Rough calculation is that for 97 reactors, *supported by a longstanding infrastructure*, the FY 2023 Congressional ask was just short of $5B USD, with major increases anticipated. That is about $50M USD per operating reactor assuming you have a mature infrastructure in place, which Canada does not. Also noting with more reactors operating, the more the overall maintenance costs can be amortized over – a small number of Canadian naval reactors, supported on both coasts, would assuredly be more expensive per reactor than that of the US Navy model. See: US Department of Energy, "Naval Reactors: Proposed Appropriations Language" (2023).

[11] The 1958 agreement between the US and the UK bars the transfer of nuclear technology to a third country. Also, the 1959 agreement between Canada and the US bars Canada from receiving nuclear technology from a third nation. See: Theodore Guillory, *Canada: The Decision to Procure Nuclear Attack Submarines and its Significance for NATO*, Monterey, California: Naval Postgraduate School (September 1988), 48-49.

[12] Both the Americans and the French use pressurized light water reactors (PWR) which are fundamentally different than the Canadian CANDU reactor which is a pressurized heavy water reactor (PHWR).

[13] Australia Ministry of Defence, "Press Conference, HMAS Stirling, WA" (March 22, 2024).

population centres. In the late 1980s the Canadian Submarine Acquisition Program (CASAP-SSN) project calculated that a fleet of 10-12 SSNs would require a base the size of CFB Shearwater in a location on the sea, with air and rail heads, away from high population density – and on both coasts.

This is not an impossible task, but it raises questions of time and cost that are not intuitively obvious. There are obvious political pitfalls as well. Over the decades required to build these submarines, it is inevitable that the government will face serious local resistance pushing back against new SSN bases. Despite their excellent safety record, there will be a concerted environmental campaign that any government will struggle to win over – or push past. To their advantage, the US, the UK, and France put their respective nuclear infrastructure in place in the 1950s and 1960s before much of modern anti-nuclear movements had gained strength, and importantly, before modern environmental assessment regulations were developed. Canada's poor track record executing on major infrastructure projects suggest that it would face a nearly impossible task achieving the permitting and political support needed to actually build these facilities in time to replace the Victoria-class submarines.

It is important to understand that the infrastructure associated with nuclear-powered submarines goes beyond jetties and warehouses. These vessels require considerable support to safely maintain and, if necessary, refuel reactors.[14] Modern US Navy reactors use pressurized light-water reactors (PWR) with highly enriched uranium that provides a core-life lasting the entire service life of the submarine. The French, however, chose low enriched uranium in their reactor, which means they must be refuelled every ten years. Therefore, a French-designed Canadian naval reactor would need that refueling infrastructure, which is both complex and expensive.

Moreover, a clear understanding of costs is important to gaining and maintaining public support – and this is not something that Canada has been adept at, when communicating defence related procurement to the public. In particular, media reporting tends to quote questionable open-source submarine "sail away" costs and not the total cost of the project that is required by Treasury Board. The reality is that buying a submarine is not at all like buying a car. It is more than the production cost of the vehicle; it is also the cost of buying an entirely new garage and service centre – while also convincing the people on whose land you are building it that it's a good idea.

Disposal

Before embarking on the acquisition of nuclear-powered submarines, a country must have a disposal plan for the submarines at the end of their service life. Looking at the UK today, all their decommissioned nuclear submarines remain alongside awaiting disposal and are only now starting to be recycled.[15] Notably the cost to safely store these submarines while awaiting final disposal is

[14] US Nuclear Regulatory Commission, "Refueling PWR," www.nrc.gov/reading-rm/basic-ref/glossary/refueling-pwr.html
[15] "Project to dismantle ex-Royal Navy nuclear submarines inches forward," *Navy Lookout* (February 7, 2024).

significant.[16] The issue is more than the storage of nuclear waste (expended fuel),[17] it is also the reactor compartments themselves. The US Navy recycles decommissioned nuclear vessels at the Puget Sound Naval Shipyard by defueling the reactor and sending the spent nuclear fuel to the Naval Reactors Facility in Idaho for processing. It then cuts out the actual reactor compartment which is then stored in an above ground facility in Hanford in Washington state.[18] This is a multi-billion-dollar effort. Indeed, disposal plans were a significant issue with environmental groups in the late 1980s during the short-lived Canadian SSN project and this will have only become more difficult to manage today.

Building the Submarines

Building an SSN is an extraordinarily difficult and complex process. Unlike surface vessels, it cannot reasonably be done in Canada and our allies have little spare build capacity. Currently, the US, the UK, and the French are all simultaneously rebuilding *both* their attack and ballistic missile submarine (SSBN) fleets. In many cases, the national shipbuilders are years behind schedule and unable to fill even their own navies' orders. In 2024, the US Navy has a stated requirement for 66 SSNs, however, with only 48 currently in commission and current production producing less than two SSNs per year, there is inadequate capacity to meet national demands – this will not change any time soon.[19] This is the conundrum the Australians are facing in the replacement of their Collins-class conventional submarines, challenging the popular misconception that the Americans can quickly ramp up SSN production to meet increased AUKUS demand.

Yet there is a huge difference in building components (including torpedo tubes and outer hull sections) and building entire submarines. Submarine building yards are special compared to other shipyards, including those building warships. Canada has done a good job through the National Shipbuilding Strategy (NSS) of rebuilding its shipyards to construct surface warships. Yet, that success is illustrative of the effort and time that this entails. The NSS has been a multi-decade process and is still not at full strength. Attempting to establish a new NSS for far more complex

[16] According to the UK National Accounting Office (NAO) in 2019, the Ministry of Defence had not dismantled any of the submarines it has decommissioned since 1980. In that time, the government has spent an estimated £500m storing the retired vessels in Rosyth, Fife, and Devonport, Devon. The NAO estimated cost of fully disposing of a submarine was £96m. "Nuclear submarines: MoD criticised over submarine disposal," *BBC News* (April 3, 2019).
[17] Peter Kenter, "Canada has a responsibility to safely manage nuclear waste for generations"
[18] US Environmental Protection Agency, "Nuclear Submarines and Aircraft Carriers," https://www.epa.gov/radtown/nuclear-submarines-and-aircraft-carriers
[19] The US Navy has been procuring Virginia (SSN-774) class nuclear-powered attack submarines (SSNs) since FY1998, and a total of 40 have been procured through FY2024. From FY2011 through FY2024, they have been procured at a rate of two per year. When procured at that rate, they have an estimated procurement cost of about $4.5 billion USD each. Although they have been procured at a rate of two boats per year, the actual production rate has fallen short of 2.0 boats per year, and since 2022 has been limited by shipyard and supplier firm workforce and supply chain challenges to about 1.2 to 1.4 boats per year, resulting in a growing backlog of boats procured but not yet built. The Navy and industry are working to increase the Virginia-class production rate to 2.0 boats per year by 2028, and subsequently to 2.33 boats per year, so as to execute the two-per-year procurement rate, replace three to five Virginia-class boats that are to be sold to Australia under the AUKUS submarine (Pillar 1) project, and reduce the accumulated Virginia-class production backlog. Congress has appropriated billions of dollars of submarine industrial-base funding to support this effort. See: US Congressional Research Service, "Navy Virginia-Class Submarine Program and AUKUS Submarine (Pillar 1) Project: Background and Issues for Congress" (July 24, 2024).

nuclear-submarine yards would be a generational undertaking and far from a certain success. In short, whatever industrial expertise that Canada once had in submarine construction no longer exists and is not an expertise that can be rebuilt quickly or easily. This is the main reason that the current Canadian Patrol Submarine Project is looking to a foreign yard to build the next generation of conventional submarines for Canada.

People

The Royal Canadian Navy's most critical deficiency today is not equipment, but people. Specialized occupations, both officer and NCM, are significantly below authorized strength and nuclear certification is a lengthy process. In addition to training and education, what is often not mentioned is the challenge of recruiting sufficient submariners, as there is a significant increase in the size of submarine crews associated with nuclear propulsion. Similar to Canada, the Australians are operating conventional submarines (with a crew of 48 personnel), which will have to increase considerably for an AUKUS SSN, as a British Astute-class SSN crew is 95 and a larger American Virginia-class SSN crew is 130. Notably, the future Canadian patrol submarine project is looking to reduce the current Victoria-class submarine crew size - not increase it.

With regards to nuclear propulsion certification, as the Australians are seeing now with AUKUS, it will take the better part of twenty years to generate the initial submarine crews and support facilities with fully trained, educated, and certified personnel. For Canada, even this multi-decade effort would be uncertain, as it would require the total support of the foreign nation supplying the submarines. This process means building more than crews and supporting military personnel; it includes the entire submarine human resource network. This would include support personnel, maintenance, safety technicians, and contractors. Moreover, once the SSN bases are established, they are likely to be remote – resulting in similar personnel posting issues that are currently being experienced by the Royal Canadian Air Force at CFB Cold Lake in northern Alberta. For a military that is already finding it difficult to recruit and retain uniquely skilled personnel, a lengthy posting to a remote base, far from the comforts of urban life, will not be attractive.

Conclusions

Nuclear-powered attack submarines have a great deal to offer and, in an ideal world, they would be the best solution for the Canadian Navy. Yet, the near-insurmountable challenges surrounding their acquisition and operation must be understood and respected. The costs to acquire, operate, maintain and dispose of this capability is staggering. Because of this, it is also a capability that would be far too tempting to discard should political or economic circumstance change. As was stated in the recent Naval Association of Canada report "*Canada in Extremis – Rebalancing the Canadian Armed Forces and the Canadian Navy*": a programme of this magnitude "would require continuous political support, spanning many governments".[20] Can this be done? Yes, but until such time as Canadians have an epiphany on defence spending, a Canadian nuclear powered submarine capability will remain unaffordable and probably politically impossible to implement.

[20] Naval Association of Canada, *In Extremis* (May 2024).

Embarking on an SSN project would also drag down the RCNs current conventional submarine replacement program. With time, money, and political capital wasted on a quixotic quest for SSNs the current efforts to find a realistic submarine replacement would be sidelined and probably lost following the failure of the more ambitious program. The Mulroney government's decision to cancel the conventional submarine project, as well as the last batch of patrol frigates, in favour of an SSN fleet in the 1980s is a good example of that thinking. The failure to acquire SSNs meant that the navy lost a significant portion of the required surface fleet and was forced to make do with a smaller number of conventional submarines, which are ill-suited to Canada's requirements. In every respect, the search for a nuclear option is a case of the perfect being the enemy of the good.

Instead, Canadians need to accept the realities of nuclear submarine ownership and move on with the immediate replacement of the Victoria-class submarines. Far from a second-tier capability, modern conventional submarines are extremely capable and offer the RCN strategic capabilities for defence, surveillance, and global warfighting, in partnership with the US Navy's SSNs they would make a formidable team in the defence of North America and international allies.

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