Submission to the Senate Economics References Committee:

Inquiry into the future of Australia's naval shipbuilding industry – Future Submarine Program

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Introduction

This brief is based on a career in the operations, maintenance and acquisition programs of ships and submarines. Relevant highlights include a focus on trials and major contracting and procurement programs:

- Submarine qualified weapons and electrical engineer – responsible for all electrical systems including combat system, sonars, communications, power generation, main storage batteries and main propulsion equipment including switchgear
- Operations of Oberon class submarines, and maintenance and post-overhaul trials
- Supervision of contract ship repair in WA, 1987-1992: ~500 contracts/year from $100 non-destructive tests to multimillion dollar refits and dockings
- Project Director's Representative at ASC for the first of class sea trials for the submarines *Collins* and *Farncomb* in 1995-97
- Head of Secretariat for the McIntosh/Prescott Report on the Collins Submarine and Related Matters 1999
- Project Director for the modification and delivery of the two Fast Track submarines *Sheean* and *Dechaineux* in 2000, replacement combat system and heavyweight torpedo projects
- Director General Maritime Development in Capability Development Group 2002-2004, to establish the AWD, LHD, ANZAC ASMD and Armidale Class Patrol Boat projects
- Principal of the Coles Review into the Business of Sustaining Australia's Strategic Collins Class Submarine Capability
- Independent consultant to defence industry from 2005. Past and present clients include Australian Customs, Defence, Pacific Marine Batteries, ASC, Saab, Thales, CEA Technologies and BMT. All contracts prohibit representation of the client.

Summary

Australia's submarines are meant to be sent into harm's way, well placed "up-threat". They must travel long distances at speed, safely and discreetly, to get there and back. We want our submarine crews to be able to do their job and return home safely. To achieve this, our submarines must have technical superiority against likely adversaries. Innovative Australian industries can help achieve this for the Future Submarines as they have in the past for Collins.

Australia's Future Submarines should be the most capable vessels possible within a reasonable and affordable price. The international construction cost/tonne for modern conventional submarines varies around US$400,000. The Collins build program

matches this number. Using Collins as the benchmark, the sail away cost for 12 vessels of about 4,000 tonnes surfaced displacement, built in Australia, would come to just under $20 billion (not including design, infrastructure and project costs). An overall project budget would be more than this, depending on Defence's project arrangements, requirements and risk appetite.

As long as work begins immediately, with the assistance of a carefully chosen overseas design/build partner, Australian industry can build a fleet of submarines to world class quality standards, within a period from contract award for the first of class to avoid a capability gap.

The Collins program was far from perfect. Everyone knows this. NO submarine program has ever been perfect. But the Collins program was much better than the press would have you believe. We are in a much stronger position now than for our last submarine acquisition and can build on this to good effect, if we learn the lessons from the past.

A Military Off-The-Shelf submarine will not suit Australia

To quote a retired submarine engineer officer, "Australia has the <u>only</u> navy in the world which "flogs" its diesel electric submarines thousands of miles across the ocean – dived - and THEN sends them on patrol."

This is an accurate description of what many people refer to as "Australia's unique submarine requirements". Think of a diagram shaped like a tennis racket – the handle represents the transit, the frame represents the patrol.

- This is the unique operational requirement for which no conventional MOTS submarines are designed; not European, not Japanese. The transit is the truly unique part and is a primary source of stress and wear on our submarines (and the crews). It is one of the most significant design drivers and brings with it specific engineering challenges for stealth and reliability in a very punishing environment.
- There is no other country motivated to solve these challenges – Australia is on its own. Collins is designed for this – no other conventional submarine is.
- Collins is the nearest submarine to what Australia needs. Any other submarine must be heavily re-designed to suit this need.
- A submarine design is very tightly coupled – as one thing is changed, nearly everything else has to change. Just a "small" change will negate all Military-Off-The-Shelf (MOTS) assumptions. The lesson here is: a MOTS, even slightly modified, ain't MOTS.
- The surfaced displacement is the number that counts. Australia needs a large submarine - for long range - large as defined by its surfaced displacement which is an indication of usable volume. At 3050 tonnes surfaced displacement the Collins is slightly larger than the much publicised Soryu class, at 2950 tonnes surfaced.
- The transit requires very high installed power generation to ensure a reasonable speed of advance while being stealthy, described in part by low noise and indiscretion ratio (when exposed at the surface charging batteries). An example: Collins has some 30% greater installed generating power than the Soryu and its range at 10 knots is likely to be more than two-three times that of the Soryu.

- The Main Storage Battery is lead acid – just like a car battery – except that there are some 400 twin-cells each weighing about a tonne. They have been specifically designed for Collins and need to meet a wide temperature range – the high temperatures of the Australian operational sea-water environment have an effect on life. This is not an issue for submarine designs for the Northern hemisphere.
- The Collins was designed as a low speed stealthy boat and acoustic trials with the US Navy in Alaska in 2000 proved it. Its levels of stealth have evolved significantly since the commissioning of the first boat. And a more hydrodynamic hull shape will have reduced flow noise at higher speeds.
- The least risky pathway is to re-design the Collins – we know what works well and what doesn't.
- Australia has been through the lessons and they have been learned well. There is no point in going through the whole learning process again.
- But the design process cannot be short-circuited or truncated – it needs to be done properly. While the risks of redesigning the Collins will be reduced because of the re-use of design and other artefacts, it will be a new design and must be managed as such.

Australia can build its own submarines – and should

Collins was built to world class quality. The weld defect records at ASC stand as testament to just one aspect of this. Senior visitors from the US Navy during the build program were astonished with the quality of the construction.

- To support, maintain and modify a submarine requires a vast library of information from first build. This would include design information such as calculations, dimensions, materials and objective quality evidence – examples are radiographs of welds for pressure hull, tanks and deep diving piping systems, batch numbers and locations of hydraulic T-pieces, mill certificates of materials used in the pressure hull boundary, test certificates of critical systems required to dive and surface the boat and so on.
- Full access to the hundreds of thousands of records is necessary for proper and rigorous maintenance throughout the service life of the submarines.
- In order to be able to effectively modify, upgrade and enhance our submarines our industry must be intimately involved with the design, philosophy and designer's intent, to truly understand the submarine and what can and cannot be done to it. Industry needs to be able to sustain this capability for the full service life of the class. We have it today for Collins class.
- Economic and other spin-offs have result from large sophisticated projects like these. For ANZAC and Collins, spin-offs included the introduction of major project management techniques, quality management systems, and improved exports for industry. Many suppliers were forced to lift their game re quality and corporate organisation and their non-Defence business improved markedly as a direct result.
- From firsthand experience, submarine crews need confidence (blind faith) that all systems will work "as advertised" when called upon, whether it be a fire, flood, battle damage or other emergency. Systems and procedures simply have to work the first time. In these situations, our crews need absolute confidence in the

supporting contractors, suppliers and maintainers. In effect, they've put their lives in the hands of others. Better to have Australian builders and maintainers than rely on far-off countries.

There does not have to be a capability gap

Design and build duration

The first of class Collins submarine was delivered nine years after contract award (1987 – 1996), and this included the construction of the shipyard from a Greenfield site.

- The shipyard quickly grew from 20 to 800 people – an impressive undertaking.
- We are in a far stronger "start" position today than we were in 1987.
- There is no reason why this can't be repeated if we get started now.

Delivery date for the First of Class – see Figure 1

The Coles Review showed how best practice cost-effectiveness, availability and sustainment performance of a fleet of submarines can be achieved by using a repeatable pattern to the sustainment program. This helps the Navy, DMO and Industry alike. For Collins, it was called the 10+2 Usage and Upkeep profile.

- Changes to this profile introduce interruptions which reduce availability, cost-effectiveness of the sustainment program, the ability of Navy to meet crewing dates, and spikes and troughs in expenditure which become difficult to manage.
- To avoid interruptions to the pattern, the launch of the first of class Future Submarine should be two years after the date at which the first Collins submarine is planned to be withdrawn from service.
- This timing is equivalent to the Collins being returned to service from a two year refit. It merely replaces the first-to-retire Collins with the first of class Future Submarine.
- This approach allows an extra two years for the Future Submarine design and build program than has previously been acknowledged.

There is no premium for an Australian built submarine – that is a myth

A reasonable sail away cost for an Australian build of 12 submarines of 4,000 tonnes would be about $20Bn.

Industry has <u>never been asked</u> about the well-publicised budget of $36Bn or more.

The cost/tonne for modern conventional submarines is about $400,000.

Referring to Figure 2, the cost/tonne at the final Collins contract amendment was slightly less than the median for the current era (reference Kokoda Foundation "Sub Judice". I refer to the Kokoda paper because it is the <u>only</u> Future Submarine related analysis published and available in the public domain that was prepared through collaborative work with a group of experts from industry and defence (see the acknowledgements page). All other papers that I know of have been the personal opinions of authors.

Referring to the cost estimates for conventional submarines in general:

- Sail away cost does not include design, infrastructure, weapons, and project costs.

- Labour costs are about 1/3 of the build, and material costs about 2/3.
- When taking into account the factors for rise and fall in material costs, labour costs, changes in architecture and technology, and foreign exchange, the estimated sail away cost for 12 submarines of 4,000 tonnes is about $20Bn.
- It is not magic that overseas designers have come up with $20Bn – it is entirely consistent.
- But the submarine doesn't necessarily need to be 4,000 tonnes – that is just a number that seems to be in common use in the press.
- A total project cost would be more depending on Defence project costs.
- On this basis, the $36Bn as routinely represented in the media translates to nearly $700,000/tonne and has no credible basis. (See the "star" in Figure 2).

Learn the lessons from the past – don't invent new ones.

The engineering lessons from scaling up a smaller submarine to the Collins size were difficult, but learned well – the McIntosh/Prescott review listed the major ones.

- These have largely been solved (the most difficult were the diesels and the combat system).
- Propulsion system technology continues to advance however, and Australia must take advantage quickly of the very small market in modern submarine diesel generators.
- The electric propulsion motor may be more difficult, although the Japanese motor for the Soryu might be suitable.
- The large submarine that Australia needs must have STEALTH as a priority. And the size should be exploited by using large sonar arrays for maximum detection ranges.

Some major issues still need to be dealt with

Recognition of shortfalls in existing and past programs is both crucial in resolving them to the benefit of the next program and enhancing the achievability of the positives associated with an Australian build program. If we don't recognise our mistakes of the past, we're unlikely to do a great deal better next time around.

- There are penalties with an overly-bureaucratic and intrusive DMO inserted into the design, build and sustainment phases (Coles Review, Winter/White Review).
- Some as-yet unresolved issues with Collins – e.g. strong and skilled workforce across the enterprise including crew numbers, training, enterprise-wide IT systems, and understanding cost drivers (Coles Review Phase 4).
- The Future Submarine program should not be allowed to become an experiment in contracting methods – use a well-understood and well-established recipe.
- Don't allow this strategic, highly sensitive and high capital value investment to become a political football – it is too important for our national security for that.

Looking after the submarines

The Coles Phase 4 Progress Review in March 2014 reveals a tremendous and astonishing improvement in sustainment performance by the Submarine Enterprise, which shows what Australians can do under good leadership when energy, innovation and teamwork are unleashed.

- The Coles Review released in November 2012 was initiated by the Government to determine what was wrong with the Collins sustainment program, with poor availability, poor reliability, high costs and a lack of crews.
- The report showed what had to be done by the Navy, DMO, ASC and the Finance Department to achieve international benchmark performance in availability. Mr Coles believed this was achievable within four to five years.

Australian Industry can and must be called upon

Australian industry is already in place for Collins and has a large part to play into the future.

- During the Collins build program the Australian content was 75%.
- Under the Collins sustainment program the local content is over 90%.
- For a future Australian build, most standard equipment should be procured from overseas suppliers as "state of the market", not "state of the art", thus reducing development risk to the integration of the overall design itself.
- However, some sensitive and important equipment should be sourced here, to the extent that they can. Some examples from Collins are: composite casings (streamlining of the hull), main storage batteries, ultra quiet pumps, specialised high-strength steel with matching welding techniques, machining of propellers to exceptional quality and accuracy standards, anechoic tiles and the glue that won't come off, etc.
- There is a sound recipe for transfer of technology and design skills to Australia, extolled recently by TKMS and DCNS at the ASPI conference. The recipe echoed the Australian industry participation in the design of Collins, under guidance of the designer in Sweden. When the designer and the Australians returned to Australia they transferred the design, tools, and processes back to the country. This recipe for technology transfer and design skills should be repeated for the Future Submarine.

Build continuously, don't boom and bust

The current replacement approach to naval ships and submarines follows a boom/bust model. Much has been written about this over the decades – it is a recipe for poor cost-effectiveness, poor cost-efficiency and perpetuates block obsolescence.

There is a well-known and well-understood learning curve for shipbuilding programs which has decreasing costs for each successive vessel build. The curve falls steeply until at least #3 and #4 and flattens out at about #9.

- With start/stop or short-run programs, no advantage can be gained from the learning curve by subsequent programs. Subsequent programs start again.

- It also means the equipment and systems on the vessels will suffer from block obsolescence, as will the vessels themselves, thus contributing to an endless cycle of boom/bust or crash programs to avoid the next capability gap. This is exactly what is happening now.
- With 10 or 12 Future Submarines, there is ample opportunity to take advantage of the long run and adopt a continuing submarine build program. It doesn't need to be 12 for this to work. A Future Submarine delivery every two years will dovetail neatly into the Collins sustainment program, which as the Coles Review showed, must follow a regular pattern for best cost-effectiveness and availability performance.
- With the economic spin-offs and the return on investments, building and repair and maintenance should be viewed as essential industries supported by a bipartisan Government policy. Australia will be rewarded with a cost-effective industry, supporting very capable, leading edge submarines.

References:

A. *Report to the Minister for Defence on the Collins Class Submarine and Related Matters*, McIntosh, M. K., Prescott, J.B, June 1999.

B. *Steel, Spies and Spin - The Collins Class Submarine Story,* Yule P and Woolner D, 2008.

C. *Study into the Business of Sustaining Australia's Strategic Collins Class Submarine Capability*, Coles et al, November 2012.

D. *Sub Judice: Australia's Future Submarine*, Kokoda Foundation, Pacey, Brice, January 2012.

E. *Study into the Business of Sustaining Australia's Strategic Collins Class Submarine Capability, Progress Review*, Coles et al, March 2014.

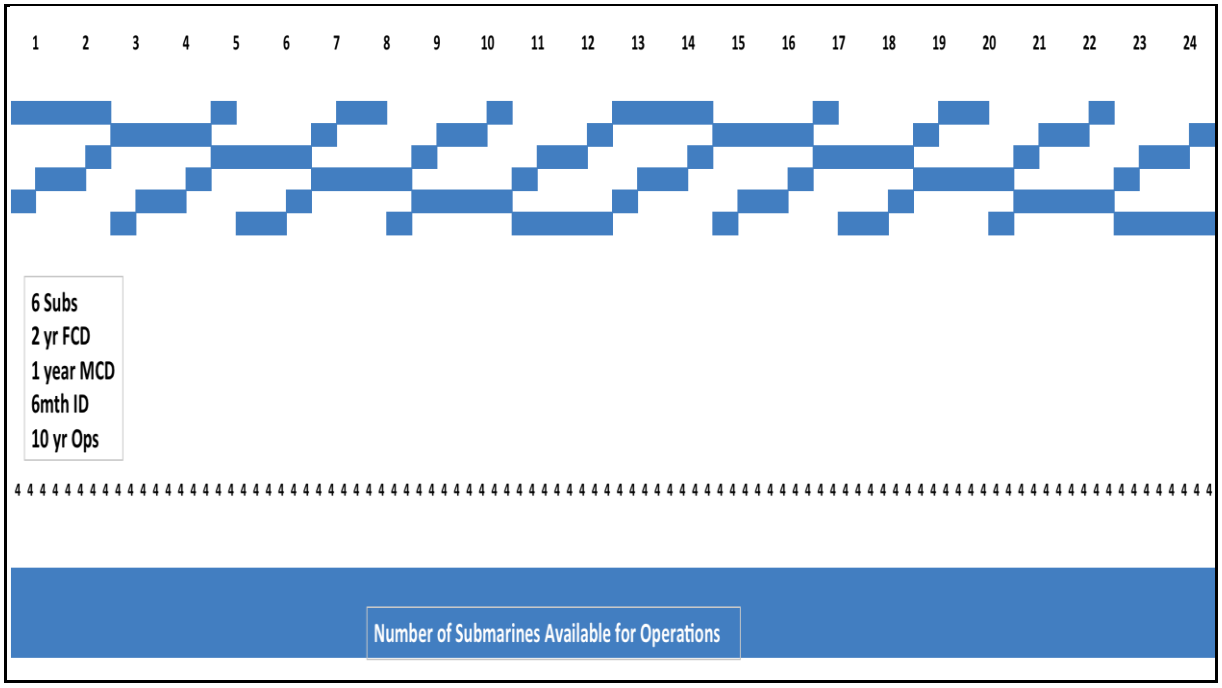

Figure 1: The 10+2 Usage and Upkeep Cycle for Collins (Coles et al, 2012).

Delivery date for first of class - a Collins being withdrawn from service is substituted with the first of class Future Submarine. This avoids disruption to the Navy, DMO and Industry. If the first Collins is withdrawn from service in 2026, the first of class Future Submarine should be launched in 2028, as if it was a Collins returning to service following a refit.

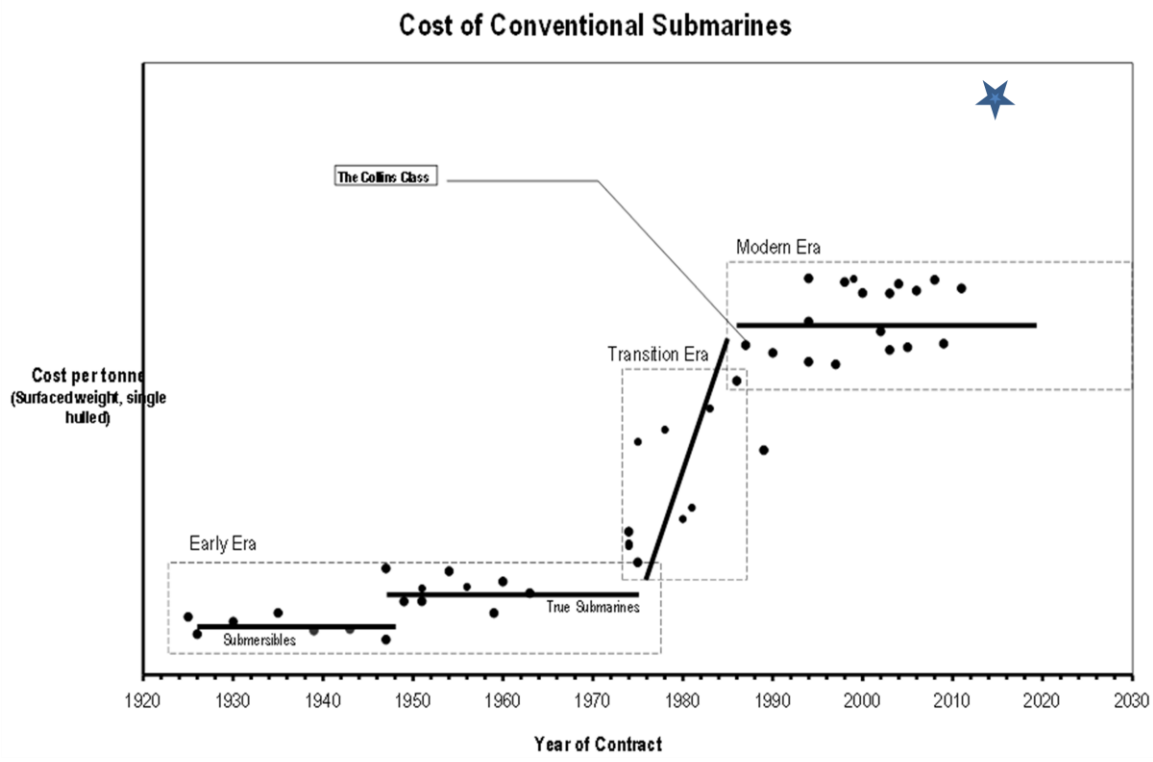

Figure 2: Cost/tonne of conventional submarines (Sub Judice, Kokoda, 2012).

The Collins is slightly below the median cost/tonne for the modern era. The star represents the $36Bn "media" number. But there have been no factors since Collins which would alter the cost/tonne for the Future Submarine.