

Flinders University
Australian Industrial
Transformation
Institute

Prime location
Optimising submarine
sustainment in Australia



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Prime location

**Optimising submarine
sustainment in Australia**

Australian Industrial Transformation Institute

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Executive summary

Naval Shipbuilding in Australia

The Australian Government is currently considering the optimal strategy and location for ongoing sustainment of the Collins Class submarines. To align with the Naval Shipbuilding Plan any decision must focus on building and sustaining the country's naval and industrial capabilities, to generate economic growth and provide local jobs into the future. It must ensure all risks to the enterprise are mitigated, costs are managed, and availability of the Collins Class submarines is not compromised over the medium-to-long term during the transition to the Attack Class submarines.

The final Collins Class submarine was commissioned in 2003, with ASC awarded the 15 year Through-Life Support contract. In 2012, John Coles reported on the poor performance of the Collins Class, resulting in a major restructure of the submarine's usage and upkeep cycle of maintenance and sustainment and the implementation of two-year full cycle docking (FCD). Resolution of early concerns about the performance of the Collins Class submarines led Coles (2016) to conclude that the sustainment program had moved from a project of concern in 2012 to an exemplar in 2016. In October 2019, ASC reported the ongoing success of Collins Class sustainment activities, with performance continuing to exceed international benchmarks.

It is the responsibility of ASC to ensure that sustainment is undertaken productively, cost-effectively and in accordance with exacting standards. Significantly, large scale naval shipbuilding, deep maintenance and sustainment has been located at the Osborne facility in South Australia since the 1980s when ASC won the contract to build the Collins Class submarine. The submarine's strategic base is located in Western Australia, with the Henderson Shipyard playing a role in some sustainment activities.

An argument often put forward is that maintenance should be performed as close as practical to the operating base. However, Life of Type Extension (LOTE) is not a maintenance activity, but a major upgrade involving the replacement of several systems, altering the fundamental characteristics of the submarine. Previous experience with aging platforms, such as the Guided Missile Frigates (FFG), has shown that these upgrades inevitably uncover unforeseen problems.

Even without the LOTE, submarine FCD is a particularly complex activity. During this process, the submarine is removed from the water and the hull is cut in two (with re-welding on completion) allowing for the main propulsion motor and three diesel engines to be removed. Completion of a submarine FCD involves planning, engineering, supply, production and certification, and requires an estimated 780,000 skilled person hours.

Managing and mitigating risk

Coles established that a world class FCD submarine sustainment capability exists at the Osborne facility in South Australia. The case for moving FCD to Henderson in Western Australia would need to assemble compelling evidence that Osborne's world class delivery of FCD would be surpassed - without *any* disruption to submarine capability and availability. Risks are magnified at sites where a critical mass of advanced naval shipbuilding skills and a mature supply chain are not in place. Assembling the necessary capability to effectively execute major naval ship and submarine upgrades is challenging.

Much has been learnt from the execution of major naval shipbuilding and submarine projects at Osborne. Modernisation of the Osborne shipyard is also improving the efficiency and

effectiveness of shipbuilding and sustainment operations at the site. A critical mass of world class sustainment capabilities and an extensive local sustainment supply chain has emerged at Osborne due to years of experience. There is a high risk that relocation of submarine FCD and LOTE to Western Australia would lead to fragmentation and potential dissipation of these capabilities.

Submarine FCD requires continuous problem solving and is subject to substantial constraints. To ensure timely and effective outcomes for the Australian Navy, FCD requires a highly experienced workforce which has developed from years of challenging work building and sustaining submarines. The ASC have been clear that experienced South Australian workers are integral to the success of FCD, regardless of the location. If FCD were to move to Western Australia, a significant proportion of the South Australian workforce would need to relocate to Perth, and some would be required for extended fly-in fly-out (FIFO) work. Critically, to obviate risks, a core FCD workforce of approximately 600 will need to be retained in South Australia until engineering competency and capability is *available, tested and proven* in Western Australia. Early indications suggest that only a small proportion of the South Australian FCD workforce is willing to relocate to Western Australia.

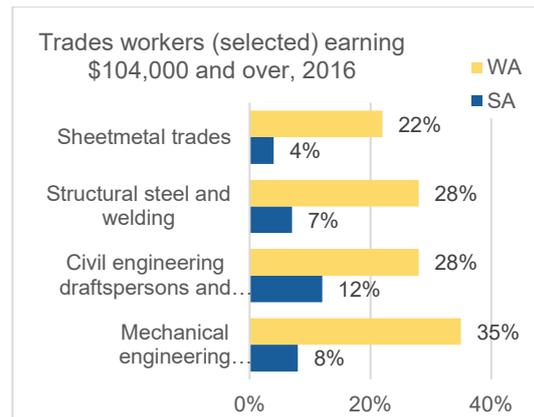
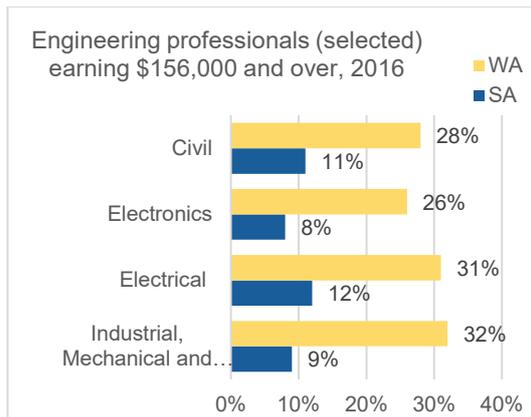
The costs of moving FCD to WA

While the over-riding concern of the Australian Navy and Government in relation to sustainment of Collins Class submarines is the delivery of an effective and reliable submarine capability, any major change to the location of sustainment functions will have significant financial implications for South Australian, Western Australian, and Federal Governments. Relocation of FCD capabilities from South Australia to Western Australia would necessitate a significant duplication of resources, personnel and infrastructure with substantial implications for submarine reliability, availability, and cost.

An estimated \$293.3 million (CAPEX and wages) is required for construction on the Henderson site to accommodate FCD. This estimate (\$, real 2019) *excludes* any costs associated with purchasing the site, site remediation, geological and engineering surveying, concept design work and council approvals to determine the site is available and fit-for-purpose. The Western Australian government has indicated willingness to invest in infrastructure requirements, although the dollar value of this commitment is currently unclear, as is the cost to the Australian government.

An estimated \$251 million is required in duplicate wages. This will pay for the additional 600 workers required to build FCD capability in Western Australia whilst maintaining it in South Australia, and the additional operations staff required in Western Australia. However, salaries for critical engineering jobs in Western Australia will be higher than those in South Australia, given the high base established during the resources boom, as evident below.





Other significant costs will include an estimated \$29 million for 100 scholarships to upskill the workforce, relocation and moving expenses, estimated at \$1 million per 100 workers, and FIFO expenses, estimated at \$16.5 million per 100 workers over 3 years.

Maturity of the naval shipbuilding ecosystem

South Australia has a mature naval shipbuilding and skills ecosystem which has evolved over many years. This ecosystem enables the Osborne facility to tackle the added complexity associated with FCD. South Australia also has a dense network of institutions that contribute to excellence in all elements of naval shipbuilding and sustainment. Additionally, the co-location of submarine build and FCD functions at Osborne is highly beneficial as a self-reinforcing learning and doing system. ASC shipbuilding and sustainment is at the centre of this ecosystem, with support from an extensive South Australian supply chain of some two hundred and fifty companies - augmented by suppliers from other states.

Elements of the 'Industry 4.0' industrial transformation agenda have been increasingly embraced by naval shipyards, the training and education sector, and supply chains, accelerating the uptake and diffusion of advanced manufacturing and digital technologies. In South Australia, the Government is pursuing this through implementation of various 'digital shipyard' initiatives designed to help realise the goal of a world class digital shipyard at Osborne. Programs supporting this include the Virtual Shipyard Training Program and the Defence Industry Pathways Program, along with the establishment of a Joint Cyber-Physical Systems Laboratory and Factory of the Future facility at the Tonsley Innovation District in Adelaide.

Defence SA has collaborated with the Department of Education, Department for Innovation and Skills and TAFE SA along with other significant stakeholders on workforce and skills development. Most recently this has involved the development of the *Defence Industry Workforce and Skills Strategy 2018-2022* to future proof develop and maintain a skilled defence and security workforce. For many years, TAFE SA has led from the front, working closely with naval shipbuilders and the supply chain to align trade, administration and management curricula and courses to meet their needs. The sector has supported strong pathways from secondary schools, into TAFE SA, and onto tertiary education.

Skilled migration has played a pivotal role in driving growth in the Australian engineering workforce for many years, supplementing industry demand which has exceeded the supply from the education system. Today, a large component of Australia's engineering workforce is comprised of skilled migrants. Challenges resulting from changes to the 457 Skilled Migration Visa have been managed in South Australia through two new Designated Area Migration Agreements (DAMA) - the *Adelaide City Technology and Innovation Advancement Agreement* and the *South Australian Regional Workforce Agreement*. The South Australian Government has

also signed an *Adelaide City Deal*; designed to attract and retain skilled workers, quality students, entrepreneurs and to build Adelaide's population. Western Australia has only implemented one DAMA (*Goldfields Designated Area Migration Agreement*) and has been unable to reach agreement with the Australian Government for its proposed *Perth City Deal*.

Competition for skills

The Collins Class sustainment workforce in South Australia is mature and stable. Much of the workforce were involved in the construction of the submarines and have acquired knowledge and skills that are essential to the successful execution of FCD and LOTE. Estimates suggest that the combined naval shipbuilding and sustainment programs in South Australia will require an additional workforce of approximately 1,200 over the next five years. Additional workers will be required within the decade, depending on the extent to which new technologies and automation are introduced into the Osborne shipyard. South Australia has managed similar workforce ramp-ups in the past through the Australian Warfare Destroyer program. Significantly, the labour market in South Australia is better positioned than Western Australia to absorb additional supply, as there is less competition from the mining and resources industry. The benefit of this experience, combined with the mature naval shipbuilding ecosystem, positions South Australia to best support continuous naval shipbuilding alongside sustainment functions.

Both the South Australian and Western Australian naval shipbuilding workforces and supply chains have evolved to support the current division of sustainment responsibilities, and both states need to contend with challenges and pressures for their naval shipbuilding workforce going forward – albeit from different industries. While South Australia has experienced modest growth in mining and is still absorbing the impact of the closure of the automotive industry, Western Australia has seen employment in mining return to near resource boom levels. The total value of engineering construction projects in Western Australia is set to double from around \$16 billion in 2019 to \$31 billion over the next four years, while it will remain relatively static at around \$6 billion for South Australia. There is a high risk that competition for engineering and trades skills in Western Australia will make it more difficult to recruit and retain critical engineering and trades skills both now and in the future.

A common workforce challenge facing businesses manufacturing complex defence equipment such as submarines is finding suitably experienced engineering applicants to fill advertised vacancies. This is more acutely felt during upswings in the commodity cycle when the demand for engineering and trades skills increases, sometimes sharply as it did in Western Australia during the mining boom. A strong recovery in demand for engineering and trades skills is now evident in Western Australia. Demand in South Australia will be more subdued given the smaller scale of the minerals and energy sector in the State. Also of significance is the larger scale of investment in major infrastructure projects in Western Australia relative to South Australia.

Conclusion

A mature naval shipbuilding and sustainment ecosystem like Osborne in South Australia is of enormous strategic value to the nation. Its importance to Australia's sovereign capability cannot be understated.

ASC has accrued a wealth of experience and achieved high level recognition over its many years of engagement at Osborne. Problem solving undertaken during the Collins Class build and sustainment program has resulted in a world class FCD capability at Osborne. Collins Class sustainment at Osborne has proven itself as an exemplar project - exceeding international benchmarks in quality and performance. South Australia's mature naval



shipbuilding and skills ecosystem has evolved over many years and supports an extensive supply chain across Australia.

Sustainment capability like that found at Osborne cannot easily be recreated in other sites given the extensive sunk investment in workforce development and critical infrastructure. This is a product of years of investment, and the development and fostering of relationships. As such it is largely immobile. The South Australian naval shipbuilding workforce has unique capabilities drawn from its longevity, years of challenging work, and deep localised knowledge, skills and experience. This workforce is critical for the ongoing success of the FCD, risk mitigation of the LOTE and ultimately the Collins Class and has demonstrated no appetite for moving from South Australia.

The case for relocation of Collins Class FCD to Western Australia has not been accompanied by evidence of any benefit to the nation. Relocation is likely to erode significant operational gains achieved by the FCD program at Osborne. The evidence available suggests that risks associated with relocation are unacceptable and that the costs would be substantially higher. A prudent course of action would be to strengthen the existing division of sustainment responsibilities between Osborne and Henderson. The case for maintaining all FCD at Osborne is overwhelming and the case for relocation to Henderson is unfounded.

1 Naval shipbuilding in Australia

The Australian Government is currently considering what the optimal strategy for sustainment of the Collins Class submarines might be. This includes an examination of the location of sustainment functions in Australia in the context of naval shipbuilding in general. It also involves examination of options for Life of Type Extension (LOTE) for Collins Class, designed to extend the operational life and capability of the existing submarine fleet to help enable a smooth transition to the new Attack Class Submarines. Access to skills and infrastructure to support the full range of sustainment requirements for the Collins Class submarines are among the key matters under discussion. These same considerations are relevant to the future sustainment requirements of the new Attack Class submarines.

This report addresses these considerations in the context of the maturity of the industrial and skills ecosystems in which submarine sustainment is taking place, principally the Osborne Naval Shipyard in South Australia and the Henderson Marine Precinct in Western Australia. It focuses attention on what sustainment model is likely to optimise availability and reliability of the existing Collins Class and future Attack Class submarine fleets in support of world class sustainment and enhanced sovereign defence capability. The report has been prepared for the South Australia Government to inform deliberations about the location of submarine sustainment in Australia.

In the 2016 Defence White Paper the Federal Government outlined its commitment to naval shipbuilding confirming investment of \$89 billion in new naval ships and submarines. This “generations-long national endeavour” was “aimed at building and sustaining Australia’s naval capabilities creating economic growth through maximising industry participation, and securing Australian jobs that will endure for decades to come” (cited by Department of Defence, 2017, p. 11). The Naval Shipbuilding Plan (NSP), released in 2017, outlined the need for transformational change to underpin the modernisation of naval shipbuilding in Australia. It set out the need for a ‘national shipbuilding enterprise’ based on close partnerships between government, industry and the workforce. It stressed the importance of harnessing the commitment of Australia’s industrial, scientific and research and development communities.

Australia is embarking on a program of continuous naval shipbuilding with 30 years of construction followed by 30 years of sustainment. The NSP focuses on building and sustaining the country’s naval and industrial capabilities, generating economic growth and local jobs into the future (Department of Defence, 2017). The plan includes programs for minor naval vessels, major surface combatants and submarines along with required infrastructure upgrades. It will take advantage of cutting-edge research, technology and industrial capability incorporating heavy engineering, advanced manufacturing and complex systems integration along with skills transfer to Australian industry.

The NSP confirmed commitment to the Attack Class future submarine (SEA 1000) and Hunter Class future frigate (SEA 5000) projects being located at the Osborne Naval Shipyard in Adelaide, South Australia. It also confirmed that the Pacific Patrol Boat (SEA 3036) and the Arafura Class offshore patrol vessel (SEA 1180) build programs would be based at the Henderson Maritime Precinct in Western Australia¹.

¹ SEA 1180 would be initially based at Osborne, transferring to Henderson when SEA 5000 begins construction in 2020

The development of the national naval shipbuilding enterprise outlined by the NSP included four key enablers:

- A modern, innovative and secure naval shipbuilding and sustainment infrastructure;
- A highly capable, productive and skilled naval shipbuilding and sustainment workforce;
- A motivated, innovative, cost-competitive and sustainable Australian industrial base, underpinned initially by experienced international ship designers and builders who would transfer these attributes to Australian industry, and
- A national approach to delivering the NSP.

The NSP states that “a productive Australian naval shipbuilding and sustainment industry that is able to deliver affordable and achievable naval capability is a strategic national asset”, an outcome that the Government is committed to achieving through the development of ‘sovereign capability’ (Department of Defence, 2017, p. 18). Investments by the Federal Government in naval shipbuilding capability at Osborne and Henderson are foundational to the achievement of this.

An ambitious naval shipbuilding program is being undertaken over decades in parallel with the sustainment of the existing fleet of naval ships and submarines. Sustainment of sub-surface vessels like the Australian Collins Class submarine fleet is a complex and demanding undertaking, requiring a highly skilled and experienced workforce and fit-for-purpose infrastructure. This capability can be found in mature naval shipbuilding environments like the Osborne Naval Shipyard, where sophisticated problem-solving skills and world class technological infrastructure combine to modernise shipbuilding processes.

Ensuring that sustainment is undertaken productively, cost-effectively and in accordance with exacting standards is the responsibility of ASC, which is located at dedicated facilities based in South Australia at the Osborne Naval Shipyard and in Western Australia at the Henderson Shipyard. Significantly, large scale naval shipbuilding and deep maintenance including Full Cycle Docking (FCD) has been located at the Osborne facility since the 1980s, resulting in the establishment of a mature naval shipbuilding and sustainment industrial ecosystem. The Henderson Shipyard has historically played a complementary role in relation to Collins Class submarines, acting as their strategic base and an important site for other sustainment activities including Mid Cycle Docking (MCD).

The construction and sustainment of maritime ships and submarines cannot be compared with other forms of large-scale manufacturing which are typically high volume, heavily automated and routinised operations. Submarine sustainment is a particularly complex exercise that involves continuous problem solving within substantial constraints. To ensure timely and effective outcomes for the Navy, this requires a highly experienced workforce that has benefited from years of challenging work building and sustaining submarines. It also requires highly effective localised knowledge and skills transfer from experienced personnel to new workers to continue the critical mass of capability required to execute construction and sustainment of vessels over very long periods of time. Such capabilities evolve where the work is undertaken, embedding critical knowledge and skills in local skill eco-systems and supply chains characterised by high levels of tacit knowledge. In other words, engineers and skilled tradespeople working in these local environments learn a great deal from each other, exchanging high level knowledge and skills essential to successful sustainment. It is very important that policymakers are provided with insights into the evolution of highly functioning industrial ecosystems like those established at Osborne and Henderson. They evolve as sites where high-level problem solving must be undertaken on short-run, high complexity naval vessels.



1.1 Capability and maturity in South Australia

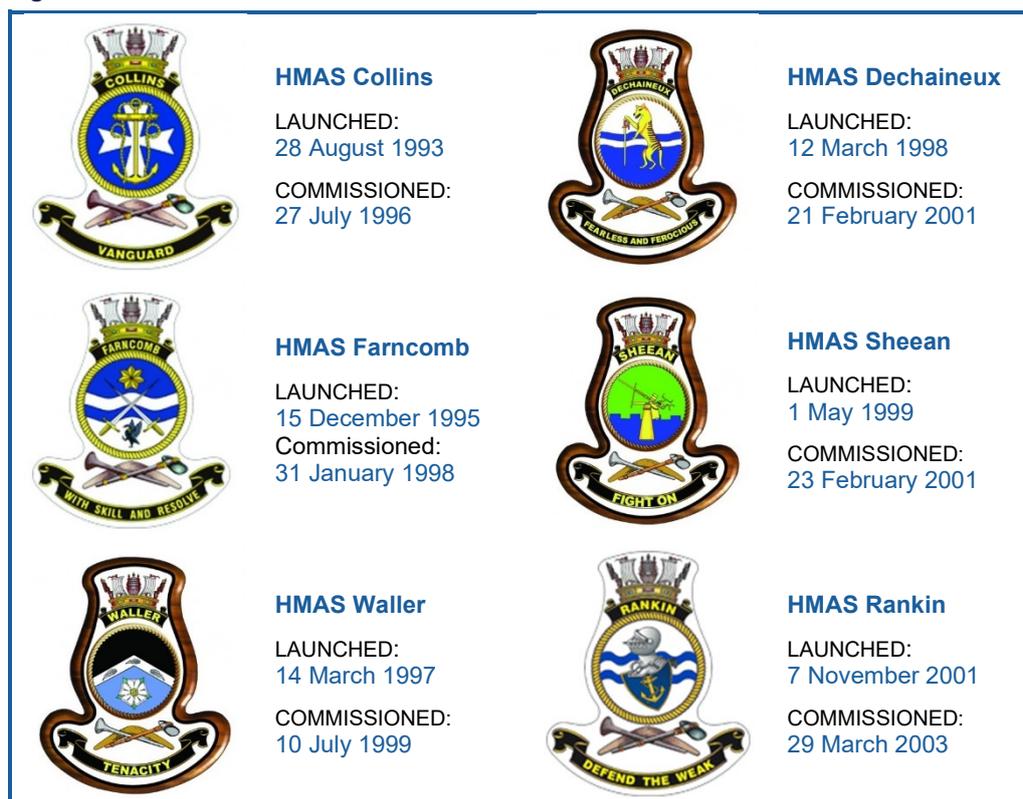
Full Cycle Docking (FCD) of the Collins Class submarines requires a highly experienced and skilled workforce and mature supply chain. This takes many years to develop and emerges in locations where large scale naval shipbuilding has existed for a long period of time, like South Australia. Continuous manufacture of large naval vessels at the Osborne Naval Shipyard has resulted in the development of a highly skilled and experienced workforce and the establishment of critical physical infrastructure. Combined, these human and physical assets have been foundational to the longevity of naval shipbuilding in South Australia and Australia. Many lessons have been learnt over the last thirty years, the result of which is the development of a world class large-scale naval shipbuilding and sustainment enterprise at Osborne.

A mature naval shipbuilding and sustainment ecosystem like that at Osborne has enormous strategic value to the nation. Excellence in sustainment is made possible by the agglomeration of shipbuilding and sustainment functions, bringing together the advanced human and technological capabilities required to solve the complex challenges and problems associated with FCD operations. This critical mass of infrastructure, expertise and skills must be sustained for decades to come in support of sustainment of the Collins Class and Attack Class Submarine fleets.

It is important to appreciate the evolution of large-scale naval shipbuilding in South Australia. The Australian Submarine Corporation (ASC) was created in 1985² to tender for the build of the six Collins Class submarines for the Royal Australian Navy. When signed, the defence contract was the largest to date at \$5 billion. The Osborne facility was opened in 1989 and became the headquarters of ASC and the site for building the Collins Class submarines. Australia's six Collins Class submarines were built from 1990 to 2003 in Adelaide by ASC. Details of their names, launch and commission dates are shown in Figure 1.

² While always majority Australian owned, from 2000 until recently ASC Pty Ltd was wholly owned by the Australian Government with a single shareholder – the Minister for Finance and the Public Service. In October 2016, ASC was separated into three companies, one focusing on the Air Warfare Destroyers, one on submarine sustainment and the other on infrastructure development (Department of Defence, 2017). ASC Shipbuilding was later separated from ASC Pty Ltd and transferred to BAE Systems Australia for the duration of the Hunter Class Frigate program, it is referred to here as ASC Shipbuilding (BAE Systems Subsidiary).

Figure 1: Collins Class submarines



In December 2003, ASC was awarded a 15 year Through-Life Support contract to provide maintenance and upgrades during the operational life of the Collins Class³. Undertaken across three years, the first FCD was completed at Osborne Naval Shipyard in purpose-built facilities in 2004⁴. In 2008 after ongoing problems, the Collins Class submarine sustainment project was added to the Department of Defence's Projects of Concern list. How this was resolved to the satisfaction of all stakeholders is of great relevance to the current discussion about the location of FCD and LOTE.

In his first major report on the topic of Collins Class concerns, John Coles et al., noted submarines from the 1980s and 1990s "conducting distant and long patrols such as the Collins Class are maintenance heavy and will spend around half their lives in extended and preventative maintenance and repairing operational defects" (2012, p. i). However, international benchmarking with comparable programs (assessed for the five years from 2006/07 to 2010/11) found the Collins Class submarines were performing poorly. At that time, availability of the Collins Class was half that of expected benchmarks, the submarines were in planned maintenance around one third longer, maintenance overruns and operational days lost to defects were double, and cost effectiveness⁵ of the sustainment program was approximately half that of international comparators (Coles et al., 2012). Five root causes were proposed to be driving poor

³ The agreement was superseded by an In Service Support Contract (ISSC) signed in 2012.

⁴ ASC West at Henderson was officially opened in 2008, with the first submarine maintenance activity undertaken there in 2010.

⁵ This refers to all costs of the Collins Class sustainment program - it is not limited to the ASC contract or maintenance.

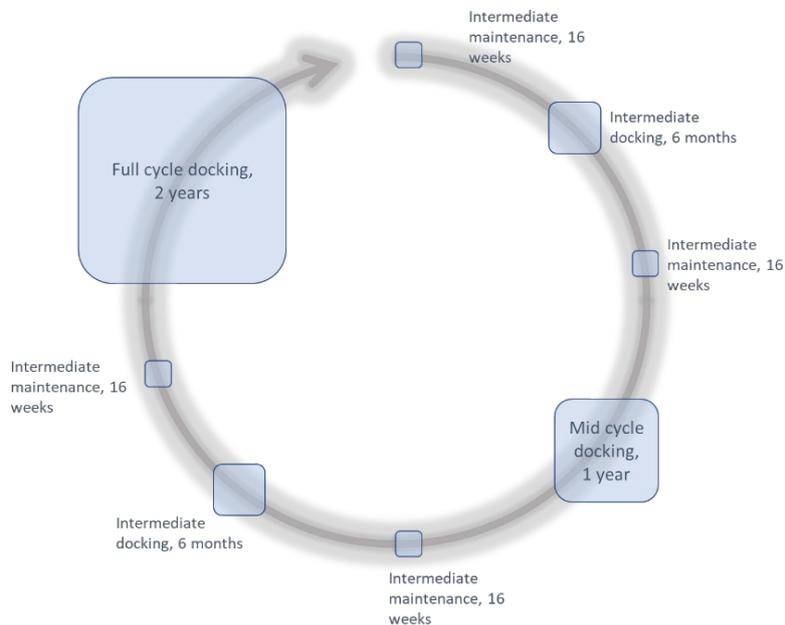


performance of the enterprise at that time: 1) unclear requirements from the Collins Class program; 2) lack of a performance-based ethos; 3) unclear lines of responsibility; 4) poor planning; and 5) the lack of a single set of accurate information to inform decision-making.

A Transformation Office was subsequently established to address the findings of the Coles report and to ensure the ongoing availability of the submarines. Fundamental to this was the change of the Usage and Upkeep Cycle (UUC) of maintenance and sustainment from '8+3' to '10+2'. This was made possible by the introduction of the hull cut and a Maintenance Support Tower creating significant efficiencies. The current 10+2 schedule involves design enhancements, maintenance and support across 12 years - ten years in-service and two years in FCD (see Figure 2):

- 1 Full Cycle Docking (FCD) of two-year duration
- 1 Mid Cycle Docking (MCD) of one-year duration
- 2 Intermediate Dockings (ID) of six-month duration
- 4 Intermediate Maintenance Periods (IMPS) of 16-week duration

Figure 2: Collins Class 10+2 Usage and Upkeep cycle



Each Collins Class submarine is subject to a major platform and systems overhaul and refurbishment after 10 years' operation. The complex two-year FCD maintenance and sustainment work involves planning, engineering, supply, production and certification, and requires an estimated 780,000 person hours to complete. During this process, the submarine is taken out of the water and the hull is cut in two (re-welding on completion) allowing for the main propulsion motor and three diesel engines to be removed⁶. Major hydraulics, power distribution, air services and fluid systems are decommissioned before recommissioning⁷ when the FCD is complete. Work is undertaken in extremely constrained environments (ASC, 2018b).

Troubleshooting problems during FCDs, particularly during the STW [set to work] phase requires a workforce with many years of FCD experience and the ability to balance problem resolution against schedule demands. This presents much greater complexity than that required for MCDs (ASC, 2018b, p. 8).

⁶ This approach has improved the efficiency of maintenance and availability of the submarine fleet by reducing the time for undertaking the FCD from three to two years.

⁷ Auxiliary dockyard systems are required to support critical services during this period.

HMAS Farncomb was the first submarine to undergo two-year FCD at Osborne commencing July 2014. HMAS Collins, the second to undergo the process, was completed successfully on 7 June 2018. HMAS Waller commenced in June 2018 with completion due June 2020. HMAS Waller will be the first submarine to have the new sonar system installed, with ASC working closely with Raytheon Australia⁸ and Thales Australia. Other sustainment activities of shorter duration with lower volume of work and significantly less complexity (ASC, 2018b) are now undertaken at ASC West (Henderson, WA) and the adjacent Fleet Base West (Garden Island, WA). In 2018, HMAS Sheean was the first MCD completed at ASC West in the post-Coles report environment.

Resolution of early concerns about the performance of the Collins Class submarines led John Coles to conclude the sustainment program had moved from a project of concern in 2012 to an exemplar in 2016 at the same time it moved from a three-year FCD program to a two-year program:

There are few including myself, who would have confidently predicted in 2012 that the performance now delivered by the Collins Class would graduate from mediocre to excellent in less than four years at almost level funding. In particular, the Submarine Enterprise ensured that “two submarines were consistently available” while conducting the first two-year Full Cycle Docking and at a time when two submarines were in long term planned maintenance in Adelaide and a third suffered from a debilitating fire and was temporarily out of service. For the Submarine Enterprise to reach this level of performance is a significant achievement that has not received the attention that it merits. If there were unit citation medals to be awarded, the Submarine Enterprise would surely qualify. A program once that was considered a “Project of Concern” should perhaps now be treated as an “Exemplar Project” if such a category existed. In short, the Collins now has a sustainment program arrangement that can deliver the required output with some built-in resilience that as a Strategic System it should have had when it entered service. (Coles, Greenfield, Spark, & Savage, 2016, p. ii)

The Collins Class sustainment program was formally removed from the Federal Government’s project of concern list in 2017 in recognition of its high performance and the success of the program of innovation and reform. Coles and his review team’s confidence in the sustainment capabilities of ASC was reinforced in 2018 when the ASC was awarded Certified Asset Management (global standard ISO 55001) which is considered to be “international best practice for the management of complex physical assets” (“Best practice standard for Collins sustainment,” 2018). The ASC is the first defence company in Australia to implement this standard which is encouraged by the Australian Government. Following this, the ASC and the Asset Management Council of Australia announced a partnership to lead the way for naval shipbuilding in Australia and strengthen the life-cycle management of the Collins Class submarines. The partnership supports “continuous improvement in ASC’s submarine sustainment, upgrade and life-of-type extension for the entire fleet, using the life-cycle management principles” (ASC, 2018a).

In his 22 October 2019 report to the Senate Finance and Public Administration Legislation Committee, the ASC Chief Executive Officer and Managing Director Stuart Whiley confirmed the ongoing success of the Collins Class sustainment activities, with performance continuing to exceed international benchmarks (Hansard, 2019). Along with achieving international benchmarks, improvements have been observed in planning, productivity, inventory investment

⁸ Raytheon is the largest US owned defence contractor in Australia. Most of its combat systems workforce is situated at Techport, South Australia providing services to FCD at Osborne.



and performance monitoring. Coles further suggests that as benchmark performance has been achieved, the focus going forward should be on cost reductions through efficiency measures.

Considerable work is now underway to upgrade and modernise the Osborne shipyard to support the Hunter Class Frigate and Attack Class build programs. The world class facilities established at Osborne including the highly experienced and skilled workforce and well-established supply chain, represents a mature industrial ecosystem that would be very costly and extremely difficult to reproduce elsewhere. There is also a high risk that major disruption of existing sustainment arrangements could compromise Collins Class operational objectives, depriving the Australian Navy of essential submarine capability. This is not an acceptable outcome.

1.2 Life of Type Extension (LOTE)

Australia is committed to building and maintaining a world class submarine fleet for many decades to come. This will be achieved by a combination of major refits of Collins Class and the construction of the new Attack Class submarine fleet. The experienced workforce and world class facilities at Osborne are currently foundational to the successful execution of this commitment.

In 2016 the Australian Government awarded the Attack Class submarine contract to Naval Group (formerly DCNS). Construction of these future submarines is to be undertaken at Osborne. The first Attack Class submarine is expected to be delivered in the early 2030s (with trials not expected to be complete until the mid-2030s). The sixth submarine will not be delivered until the mid-2040s. For Australia to maintain a fleet of at least six active submarines during the rollout of the Attack Class submarines, Collins Class submarines must remain in active and productive service. Accordingly, a Collins Class Life of Type Extension (LOTE) project will be required to continue until at least then. A costed LOTE proposal for the main motor, diesel and control equipment⁹ is being developed by ASC and is due to be delivered to the Department of Defence in March 2020 (Hansard, 2019).

Hellyer suggests consideration needs to be given to the extent to which LOTE refers to enhanced capability within the Collins Class submarines or extension of their service life (Hellyer, 2018a, 2018b). He suggests there are some opportunities for Collins Class LOTE to be used as a testbed to help de-risk systems planned for installation in the Attack Class submarines. Sweden provides a benchmark for this, having installed key systems designated for their new submarines in their existing fleet. Such an approach could be adopted in South Australia to help maximise the successful integration and use of new technologies in Collins Class and the Attack Class. The co-location of submarine FCD, LOTE and build functions at Osborne helps to maximise this opportunity given the highly experienced workforce and established supply chain. It also helps to minimise and mitigate risk.

1.3 Workforce overview

The sustainment enterprise of ASC is a significant undertaking. As of February 2019, ASC employed 923 personnel in South Australia and 431 in Western Australia on Collins Class submarine sustainment activities along with contractors at each site to augment the permanent workforce (ASC, 2019). It is notable that the FCD workforce at Osborne includes many highly skilled personnel who have remained with the program since the original build. ASC acknowledge the value of this workforce in terms of their existing corporate knowledge spanning

⁹ Degaussing and firefighting have been removed by Defence from the current packages of work under consideration as part of the LOTE.

their skills, knowledge and understanding of, as well as planning and conducting the FCD for the Collins Class submarine.

This takes place in the context of the build programs for the Attack Class submarine and Hunter Class Frigates. The Attack Class submarine build program is due to commence in 2022/23 and continue over 30 years with the final Attack Class submarine expected in the early 2050s. Across the entire build it is estimated that an average of 1,100 direct jobs will be required - peaking at around 2,300 in the early 2030s (Australian Government, 2019; Hansard, 2019). An additional 1,700 Australian supply chain jobs¹⁰ are expected to be associated with Attack Class submarines (Department of Defence, 2017). The build of the Hunter Class frigates is anticipated to follow a similar trajectory with an estimated average of 1,500 jobs across the build. By 2028, around 2,200 direct jobs in South Australia are expected to be involved in the construction of the frigates (Hansard, 2019), with approximately 2,500 indirect supply chain and associated jobs (Australian Government, 2019).

ASC (2019) has indicated that shifting sustainment activities from South Australia to Western Australia would initially require the recruitment, training and certification of an additional 500 employees. However, this number will only increase the Western Australian maintenance sustainment workforce to 900 employees, sufficient to deliver the FCD, but insufficient to also deliver the MCD, unscheduled docking (USD) and other sustainment activities required concurrently. To deliver all maintenance and sustainment requirements, Western Australia would require a total of 1,300 employees (ACIL Allen Consulting, 2019; ASC, 2019). Nine hundred of this workforce would need to be upskilled and retrained in Western Australia, be seconded, fly-in fly-out (FIFO) or move from South Australia in order to deliver the work associated with FCD which is considerably more technically complex than the current program of work delivered in Western Australia.

As ASC have noted, it is critical to ensure that ongoing capability is available in South Australia until engineering competency and capability is *available, tested and proven* in Western Australia. This means that South Australia would have to maintain FCD skills and capacity to mitigate risk. This duplication of effort comes at a significant cost. ASC (2019) has developed estimates of the minimum skills and capability of the 600 personnel required in South Australia to ensure delivery on their future work commitments for Collins Class sustainment. They estimate approximately 300 people (primarily engineers with some trades) have critical skills and capabilities required to maintain the required knowledge for the Authorised Engineering Authority (AEO), while another 300 are important support personnel (ASC, 2019; Hansard, 2019b). These staff are necessary for compliance with the Defence Seaworthiness and Technical Regulations required for the certification and licensing of boats. Although some loss could be managed through skill sharing, if necessary, it is critical that meaningful work is available for all 600 staff in order to avoid losses that would jeopardise the ability of the Collins Class to be certified as seaworthy.

¹⁰ Many of these workers having previously been employed building components for Collins Class FCD in South Australia.



2 Managing and mitigating risk

Successful execution of FCD and LOTE for Collins Class requires proven ability to manage and mitigate the risks associated with such complex work. The conclusions of the Coles review confirm that the ASC workforce at Osborne has risen to this challenge. Central to this has been developing a critical mass of submarine sustainment capability, which takes many years to develop and considerable effort to maintain and retain. The core workforce required for successful execution of FCD or LOTE must have extensive naval shipbuilding experience and advanced technical problem-solving skills. Capability must also be drawn from a mature and reliable sustainment supply chain. Such a capability has evolved in South Australia where continuous large-scale naval shipbuilding has been undertaken for decades alongside FCD for Collins Class.

In evidence to the Senate Economics Reference Committee, Stuart Whiley, Chief Executive Officer and Managing Director, ASC, referred to the value of the existing sustainment workforce in the following terms:

We need Collins available for the nation, in the 2030s and the 2040s. The expertise to support that platform is unique in my company—absolutely unique. It doesn't exist anywhere else in the world. And I can't afford to let that go. So, I need those people focusing on that job. They understand that job, and they understand the importance to the nation in doing that job (Hansard, 2018, p. 45)

Much has been learnt from the execution of major naval shipbuilding and submarine projects at Osborne, including the Collins Class build and sustainment program. The significant investment in the modernisation of the Osborne shipyard by the Federal Government is now helping to underpin further improvement in the efficiency and effectiveness of shipbuilding and sustainment operations at the site. Having established a critical mass of world class sustainment capability at Osborne and in the local sustainment supply chain, there is a high risk that relocation of submarine FCD and LOTE to Western Australia would lead to fragmentation and potential dissipation of capability.

Such fragmentation has previously been seen to increase the risk of significant technical faults and delays in project execution (Department of Defence, 2007). The upgrade of the Guided Missile Frigates (FFGs) is illustrative of the challenges, risks and delays associated with the relocation of complex upgrade and deep maintenance functions required in naval shipbuilding, maintenance and LOTE. The first four of the FFGs were built in the United States and the second two at Williamstown in Melbourne. The site for the upgrade of four of the FFGs was Garden Island Dock in Sydney which proved to be highly problematic for a range of reasons.

The Australia National Audit Office report on management of the FFG capability upgrade described significant deficiencies in the effective management of the upgrade program, caused in part by “difficulties recruiting suitably qualified and experienced staff with expertise in maritime combat systems, software engineering and tests and trials” (Department of Defence, 2007, p. 42). The factors contributing to this difficulty included:

- Location of FFG System Program Office at Garden Island
- Sydney's high cost of living; and
- The levels of APS remuneration that can be offered to the specialist personnel it needs to attract and retain.

Assembling the necessary capability to effectively execute major naval ship and submarine upgrades is challenging. Risks are magnified at sites where a critical mass of advanced naval shipbuilding skills and a mature supply chain are not in place. Problems experienced in the past with complex upgrades of naval vessels suggest that risk can be mitigated or at least significantly

reduced by ensuring that the core skill sets and experienced personnel required for successful project execution are available at the site and moreover can be sustained and reproduced over long periods of time. This must be possible in the face of various competitive pressures in the labour market and the local and national economy.

2.1 Location, relocation and risk

Coles (2016) established that a world class FCD submarine sustainment capability exists at Osborne. There are significant risks associated with disrupting this, particularly given that existing arrangements have been described as an exemplar. For it to be a compelling one, the case for moving FCD to Henderson in Western Australia would need to assemble evidence that Osborne's world class delivery of FCD would be surpassed - without *any* disruption to submarine capability and availability. Evidence suggests this would require a seamless transfer of capability from South Australia to Western Australia, which is an unrealistic expectation given the complexities involved in establishing world class submarine sustainment facilities (ASC, 2019).

In December 2018, ASC was commissioned to investigate options for shifting FCD of the Collins Class submarine to Western Australia by June 2024. An interim report was released in February 2019. This was subject to a Freedom of Information request from Senator Rex Patrick and subsequently released in redacted form on 29 July 2019. Two options were posited for investigation:

- Option 1a: The last FCD in South Australia to be in financial year 2022/24 (for HMAS Sheean); with MCD in 2023 and FCD docking in 2024/26 (HMAS Rankin) to be in Western Australia.
- Option 1b: The last FCD in South Australia to be in financial year 2020/22 (for HMAS Dechaineux) with MCD in 2023 to also be in Osborne; and FCD docking in 2022/24 (HMAS Sheean) to be in Western Australia.

Four additional options were subsequently included for consideration:

- FCD to commence in Western Australia in 2022/23
- FCD to commence in Western Australia in 2024/25
- FCD to commence in Western Australia in 2026/27
- FCD to remain in South Australia.

Key considerations for the investigation include minimising risk to the availability and capability of the Collins Class submarine; minimising the transition costs of a move to Henderson for FCD; and the safe and efficient delivery of the submarines for seaworthiness testing. Although specific details were redacted and therefore unavailable for this review, the report identified several key risks requiring careful management to avoid loss of Collins Class availability and capability.

The ASC (2019) report argued if FCD was to transition to Western Australia, a phased approach was considered best to avoid risks. This would involve:

- The core Western Australian workforce team to participate in the final South Australian FCD.
- The off-boat work for the first Western Australian FCD, along with any MCD or IDs during this period, to be undertaken in South Australia (pending a Western Australian workforce with suitable skills being in place).
- The South Australian workforce providing fly-in fly-out (FIFO) support to Western Australia.



- The second FCD would be undertaken in Western Australia with significant FIFO support continuing until the local workforce skills reached maturity.
- Suitable docking infrastructure would be maintained in South Australia until all competency and capacity can be delivered in Western Australia.
- Ongoing capability would be available from South Australia until engineering competency and capability is available, tested and proven in Western Australia.
- The ASC business in South Australia continuing to support the transition to FCD in Western Australia.

Critically the report notes that:

The magnitude and complexity of the proposed transition has little historical precedent and has significant potential to disrupt the CCSM [Collins Class submarine] program following a period where much effort has been made by the entire Enterprise to achieve international benchmark performance. The FCD transition schedule cannot be viewed in isolation and instead should be considered in the context of the entire CCSM program and the Enterprise. It is unlikely that the transition can be achieved without some impact to MRDs [material ready days]. (ASC, 2019)

This conclusion indicates that the relocation of FCD to Western Australia is likely to impact availability of the Collins Class fleet, an outcome which is clearly unacceptable. Relocation of FCD in this context is imprudent.

In August 2019 the Western Australian government commissioned PwC to prepare a Positioning Paper to encourage moving FCD of the Collins Class submarines from South Australia to Western Australia (PWC, 2019). Accompanying this paper was an economic impact analysis of such a move (ACIL Allen Consulting, 2019). The reports and the Western Australian Government (McGowan & Papalia, 2019a; PWC, 2019) claim that moving FCD to Henderson is more efficient for Defence and in the national interest. They assert that a Western Australian base for all maintenance and sustainment is optimal due to its proximity to Fleet Base West, and access to the Western Australian workforce and local research and technology. They argue, without supporting evidence, that South Australia cannot provide a workforce of sufficient numbers or capacity to meet the needs of the Collins Class submarine FCD concurrent with the building of the Attack Class submarines and Hunter Class frigate. They suggest the FCD workforce is at higher risk of 'jumping ship' at Osborne due to the appeal of competing projects at the site. The veracity of these assumptions will be tested in following section where the likely costs of moving FCD to Western Australia are identified.

3 The costs of moving FCD to WA

While the over-riding concern of the Australian Navy and Government in relation to sustainment of Collins Class is the delivery of an effective and reliable submarine capability, any major change to the location of sustainment functions will have significant financial implications for South Australian, Western Australian and Federal Governments. Moving FCD to Western Australia will generate economic benefit for Western Australia, however, it will result in a corresponding economic loss to South Australia (ACIL Allen Consulting, 2019). A move to Western Australia will also incur significant additional costs for the Australian and state governments - including the need for duplication of infrastructure and personnel in each State. The following sections detail some of the costs that need to be considered in any deliberations about potential relocation.

3.1 Site development costs

Transition of FCD capabilities from South Australia to Western Australia would involve significant duplication of resources, personnel and infrastructure with substantial potential implications for submarine reliability, availability and cost. In their report for the Western Australian government, ACIL Allen Consulting (2019) estimates a three-year build is required to prepare for FCD in Western Australia. This includes capital expenditure (CAPEX) of \$220 million (\$, real 2019). In addition, they estimate 244.4 FTE construction workers are required per annum to build the facility. Assuming an average construction worker wage of \$100,000 per annum (\$, real 2019) is applied, this equates to a total construction worker wage bill of \$73.3 million. Accordingly, an estimate of \$293.3 million (CAPEX and wages) is required for building on the Henderson site to accommodate FCD. This estimate *excludes* costs associated with purchasing the site, site remediation, geological and engineering surveying, concept design work and council approvals to determine the site is available and fit-for-purpose¹¹.

3.2 Personnel costs

If transition were to occur, a total Collins Class sustainment workforce of 1,933 persons would be required in South Australia and Western Australia for the duration of the transition period - 600 more than currently required. Assuming average real wages per annum of \$100,000 for the Collins Class sustainment workers¹² we conservatively estimate an additional \$60 million per annum in wages (\$, real 2019) will be required to support sustainment and maintenance for a minimum of four years - \$240 million more than retaining the FCD in South Australia. With the conservative estimates presented in Figure 3, the increase in wages associated with the additional FCD and construction workforce is \$324.6 million (\$, real 2019) as a direct result of any move. Noting this is in addition to the \$220m CAPEX required.

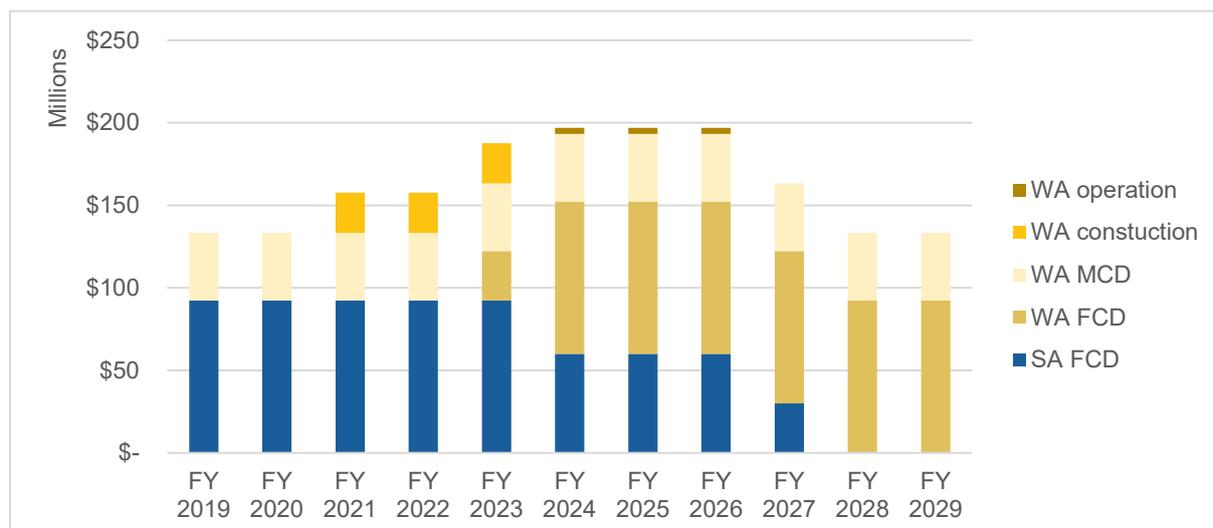
ACIL Allen Consulting (2019) have also estimated Henderson will need 37.7 FTE for operations activity for the duration of the transition, replicating capability available in South Australia. It is estimated that this will be required for at least three years after construction. Applying an average wage of \$100,000, this equates an additional \$11.3 million in salaries in Western Australia for this period.

¹¹ In the event FCD moves to Western Australian, the state government has indicated willingness to build a new wharf, upgrade support facilities, improve traffic flows, and invest in new infrastructure such as a ship lift and graving dock (McGowan & Papalia, 2019b). The dollar value of this commitment is currently unclear.

¹² The figure used by ACIL Allen Consulting (2019) in their recent report for the Western Australian Government for construction and operations workers.



Figure 3: Estimated cost of transition to WA (\$, real 2019)



Other direct workforce costs associated with the relocation of FCD to Western Australia include the cost of upskilling the local workforce in time for the transition. In 2018, ASC estimated the cost of 100 scholarships for submarine capability improvement in the areas of operations management, CAD design, engineering and supply chain/procurement to be \$29.4 million¹³ scheduled across a 3-year period from 2018 to 2020. Along with salaries for the duration of the training program, the costs were inclusive of mobilisation and preparation, course development and facilitation and facility, IT and infrastructure. Although this was proposed in the context of the Future Submarines program, it provides an estimate of the cost of similar scholarships and upskilling required if FCD was to move to Western Australia.

The costs of relocation of South Australian sustainment workers to Western Australia are non-trivial. A range of factors influence this including:

- the cost of the move
- the impact on career opportunities for one's spouse or partner
- existing childcare and school arrangements
- familial and friend support structures

Relocation expenses for moving from Adelaide to Perth can include the reimbursement of the costs of moving. This encompasses packing, moving and storing belongings, freight of cars and short-term rental accommodation in Perth. It also involves transport of the employee, their dependent family members and pets including accommodation and meals associated with the move. It can include the costs associated with turning utilities on and off, cancelled school fees, reimbursement of property transactions (i.e. the real estate commission for selling property in Adelaide). It can also include job finding support for spouses or partners.

With moving costs for a 3-bedroom home from Adelaide to Perth estimated at \$5,000¹⁴, relocation costs are likely to exceed \$10,000 per employee with the additional costs referred to above. It is also likely that relocating the South Australian workforce would involve an increase of salary to align with equivalent Western Australian rates. It is anecdotally estimated that around 5 percent of the workforce may relocate in order to retain their jobs. While this may be a benefit to Western Australia it poses a risk to the South Australian naval shipbuilding workforce that needs to retain skilled workers.

¹³ Email correspondence FOI 494/17/18

¹⁴ <https://www.transcorpremovalsandstorage.com.au/estimate-tool/>

ASC (2019) reported that for a successful transition of FCD to Western Australia, their existing skilled South Australian workforce would also be needed to provide FIFO support for an extended period¹⁵. We have estimated FIFO costs based on publicly available data for return flights (every two weeks) and accommodation, and an estimate for per diem and ground transport resulting in a total of \$200 per day per person. If we apply a discount of 25% (due to the potential size and frequency of the business) we conservatively estimate the cost to be around \$150 per person per day. Assuming 100 FIFO workers are available in Western Australia on any given day, the annual cost would be \$5.5 million. Over three years the cost of FIFO equates to around \$16.5 million.

However, FIFO costs are not limited to dollars alone. A recent report in the Medical Journal of Australia (Bowers, Lo, Miller, Mawren, & Jones, 2018) surveyed 1124 mining and construction workers in Australia. They found a very high level of psychological distress¹⁶ with 28% of respondents showing high to very high levels of psychological distress, compared with 10.8% found in the general Australian population. Key stressors include missing significant events, relationships with partners, financial stress, shift rosters and social isolation common amongst FIFO workers.

3.3 Salary pressures

There are clear differences between South Australia and Western Australian engineering salaries. Salaries for critical engineering jobs remain high in Western Australia in the wake of the resources boom which had significant inflationary impact on engineering and trades occupational salaries. The current Defence Salary Survey (Kinexus, 2019) reports a 1.8% increase overall in defence industry salaries in Australia in the last year. Average increases range from 2.2% in Victoria and 2.1% in South Australia and the Australian Capital Territory through to a low of 1.0% increase in Western Australia, which has had higher defence salaries for a number of years due to competition from the resources sector. The Kinexus report indicates New South Wales and Western Australia have struggled in recent times to meet demand in the defence sector, with pressures set to increase across Australia over the next year.

In their current annual salary guide, Hays (2018) paints a similar picture, with significant investment in infrastructure continuing to drive skill shortages in civil engineering across Australia. They note that Western Australian employment conditions in both engineering and construction are likely to be significantly affected once Metronet¹⁷ and major mining projects ramp up in late 2019¹⁸, coinciding with the ramp-up of naval shipbuilding in Australia. Currently, project managers and contract administrators are in demand placing upward pressure on salaries over the next year. At the same time, expectations are for salary increases in Perth, driven by regional locations adjusting engineering salaries upward to attract and retain staff. While modest increases are expected to continue in South Australia, Hays note that Civil and

¹⁵ Industries engaging FIFO workers do not tend to report the costs of this activity. It is also unlikely that costs would be comparable between those providing workers to remote locations or to cities.

¹⁶ As measured by the Kessler 10 scale.

¹⁷ Metronet has been designed to future proof Perth involving significant rail infrastructure (72 km of passenger line and 18 new stations) and provide a plan and development for an additional 5,000 hectares of housing near the new stations.

¹⁸ Procurement for initial work is underway with construction due to commence late 2019.

<https://www.metronet.wa.gov.au/news-info/latest-news/construction-industry-engagement-survey-october-2019>

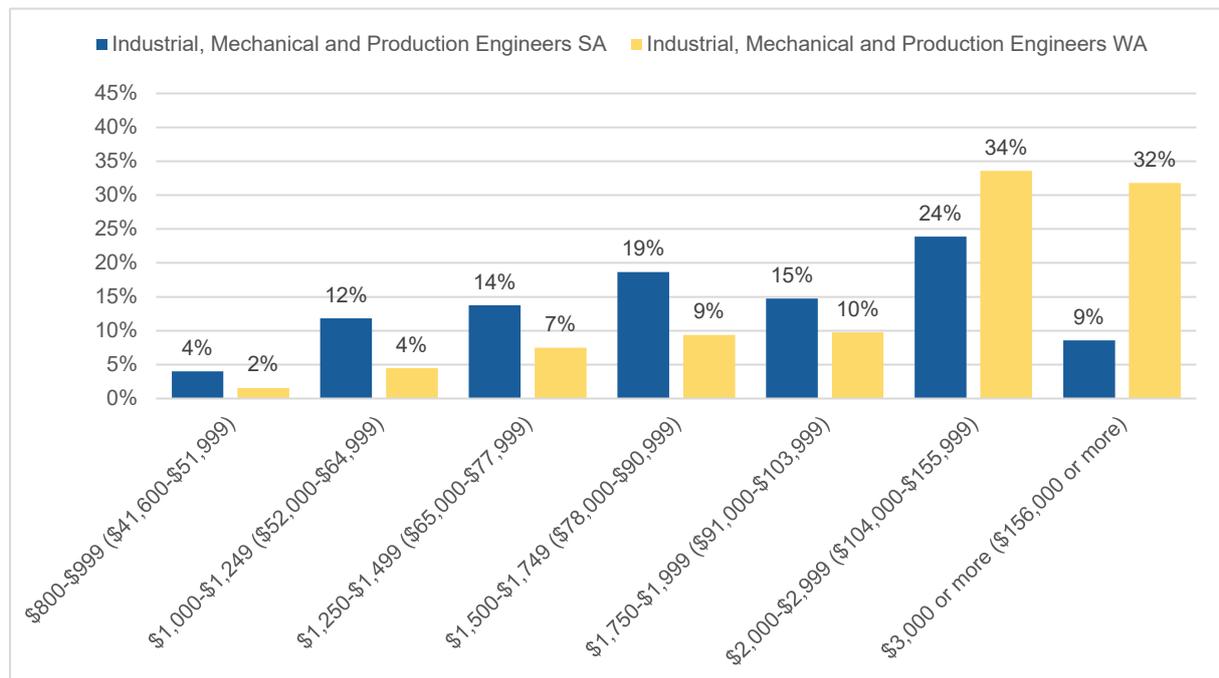


Structural Engineer salaries are \$10,000 to \$20,000 higher in Perth than Adelaide where they start from a lower base and peak at a lower point.

A recent report (BDO Australia, 2019; Ker, 2019) also found that Western Australian salaries for critical roles in mining had increased beyond the peak of the resources boom in 2014. They reported workers that had left Western Australia at the end of the mining boom were unlikely to return as they had now found work elsewhere in Australia. As a result, they expected Western Australia will need to increase salaries to attract the skills they require. They will also need to source workers from related industries which will impact on efforts in Western Australia to attract and retain workers to naval ship building and sustainment.

The most compelling evidence of the salary differential between South Australia and Western Australia across a range of engineering professions is derived from the last Census (Australian Bureau of Statistics, 2019c). The proportion of workers in the highest salary band - \$156,000 per annum and over – is up to four times higher in Western Australia than in South Australia. Almost one-third (32%) of Western Australian Industrial, Mechanical and Production Engineers were on salaries greater than \$156,000 per annum, compared with fewer than one in ten (9%) in South Australia (see Figure 4). In Western Australia and South Australia, respectively, the proportion of Engineers on a salary greater than \$156,000 was 31% compared with 12% of Electrical Engineers (see Figure 5), 26% compared with 8% of Electronics Engineers (see Figure 6), 28% compared with 11% of Civil Engineers (see Figure 7), 20% compared with 8% of other Engineering Professionals (see Figure 8), and 36% compared with 13% of Engineering Professionals - not further defined (nfd; see Figure 9).

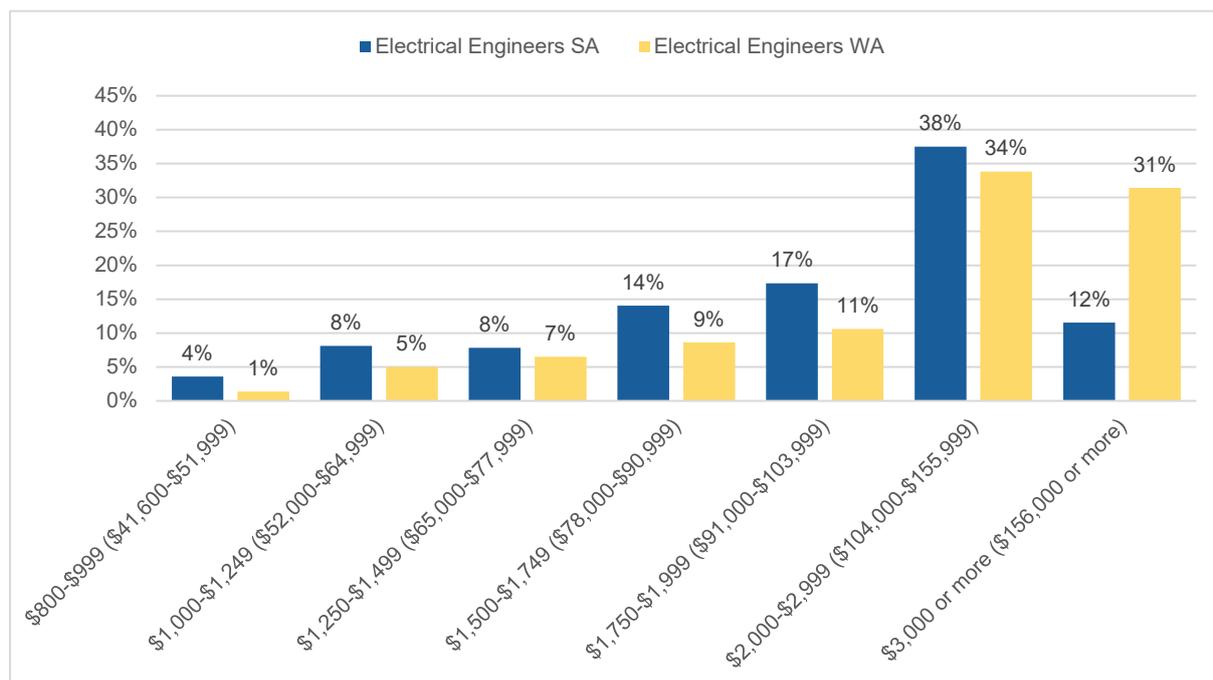
Figure 4: Industrial, Mechanical and Production Engineer salary ranges (%), SA & WA, 2016



Source: Australian Bureau of Statistics (2019c)

Note, salaries less than \$41,600 p.a. and those not stated or applicable have been included in the calculations but are not shown in the figure. These comprise fewer than 5% of salaries.

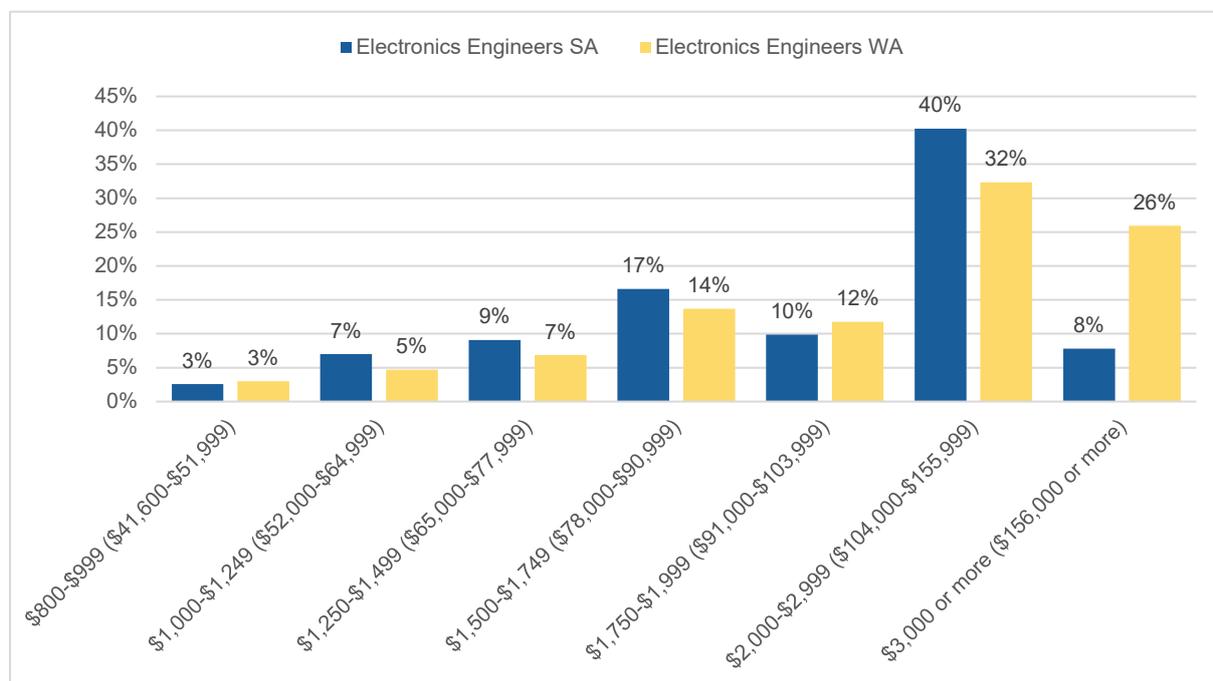
Figure 5: Electrical Engineer salary ranges (%), SA & WA, 2016



Source: Australian Bureau of Statistics (2019c)

Note, salaries less than \$41,600 p.a. and those not stated or applicable have been included in the calculations but are not shown in the figure. These comprise fewer than 5% of salaries.

Figure 6: Electronics Engineer salary ranges (%), SA & WA, 2016

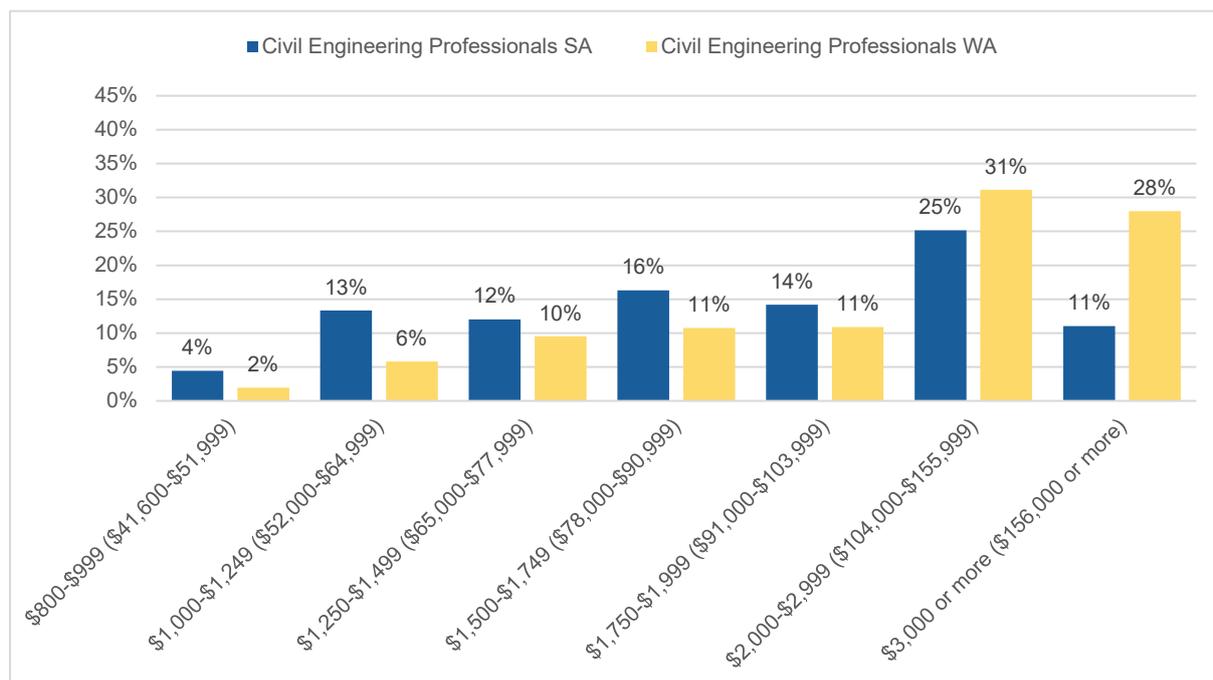


Source: Australian Bureau of Statistics (2019c)

Note, salaries less than \$41,600 p.a. and those not stated or applicable have been included in the calculations but are not shown in the figure. These comprise fewer than 5% of salaries.



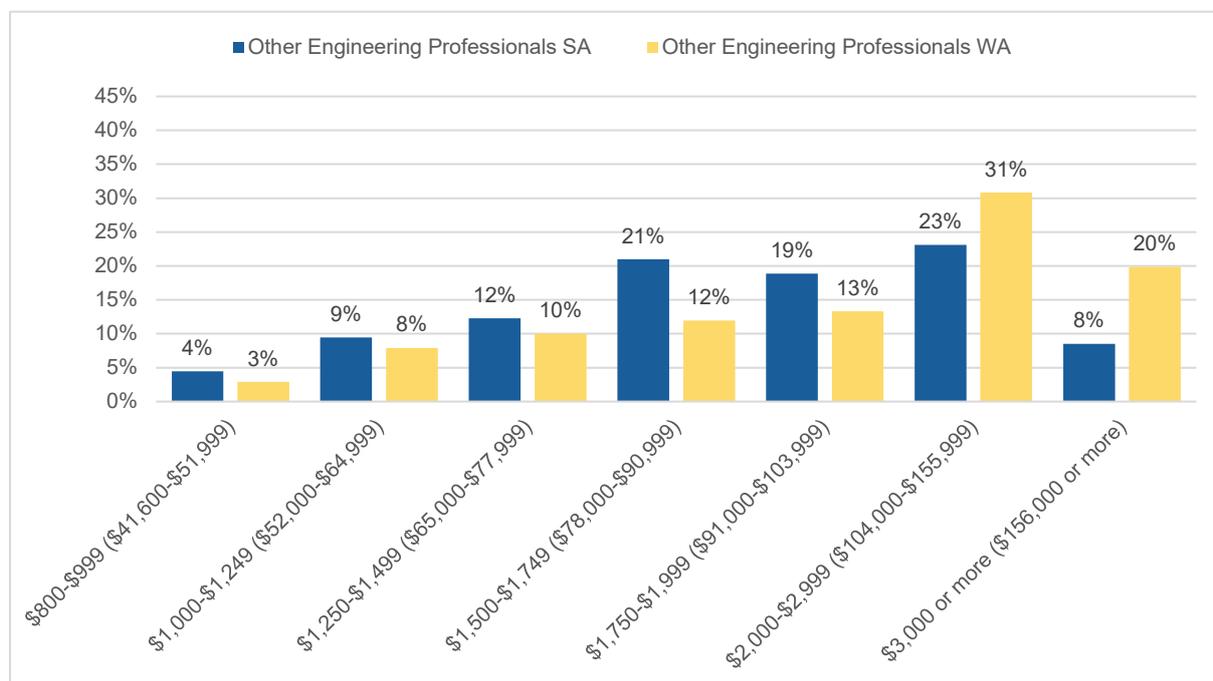
Figure 7: Civil Engineer salary ranges (%), SA & WA, 2016



Source: Australian Bureau of Statistics (2019c)

Note, salaries less than \$41,600 p.a. and those not stated or applicable have been included in the calculations but are not shown in the figure. These comprise fewer than 5% of salaries.

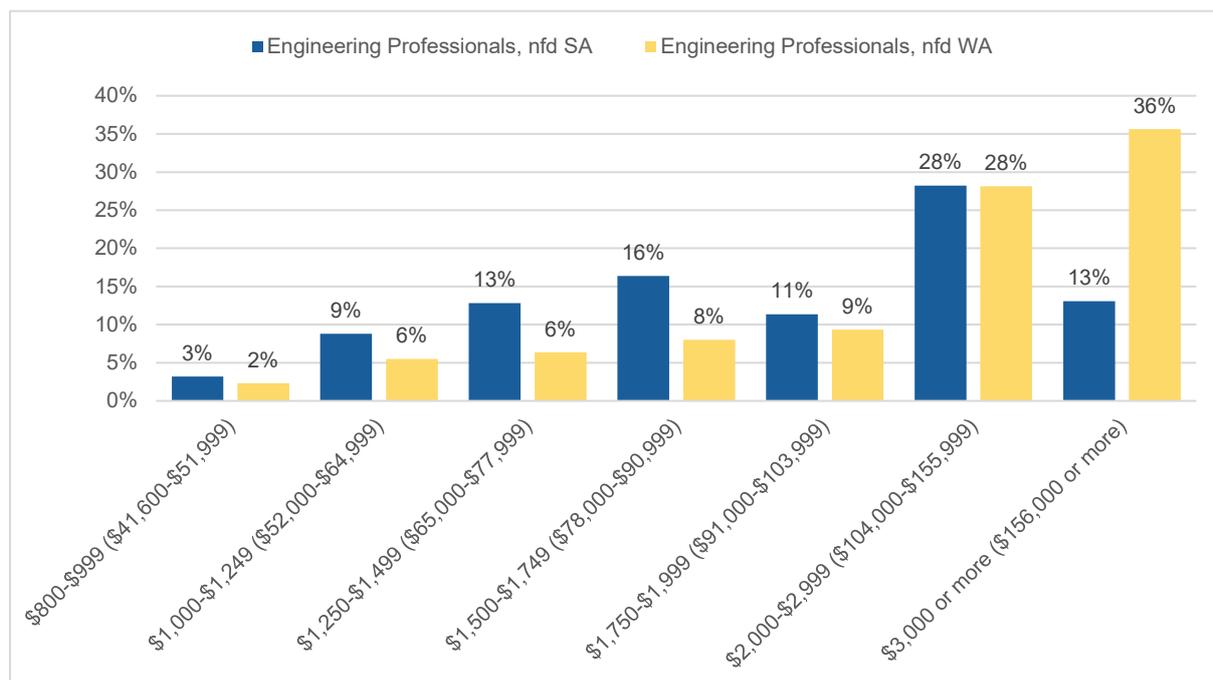
Figure 8: Other Engineer salary ranges (%), SA & WA, 2016



Source: Australian Bureau of Statistics (2019c)

Note, salaries less than \$41,600 p.a. and those not stated or applicable have been included in the calculations but are not shown in the figure. These comprise fewer than 5% of salaries.

Figure 9: Engineering professionals (nfd) salary range (%), SA & WA, 2016



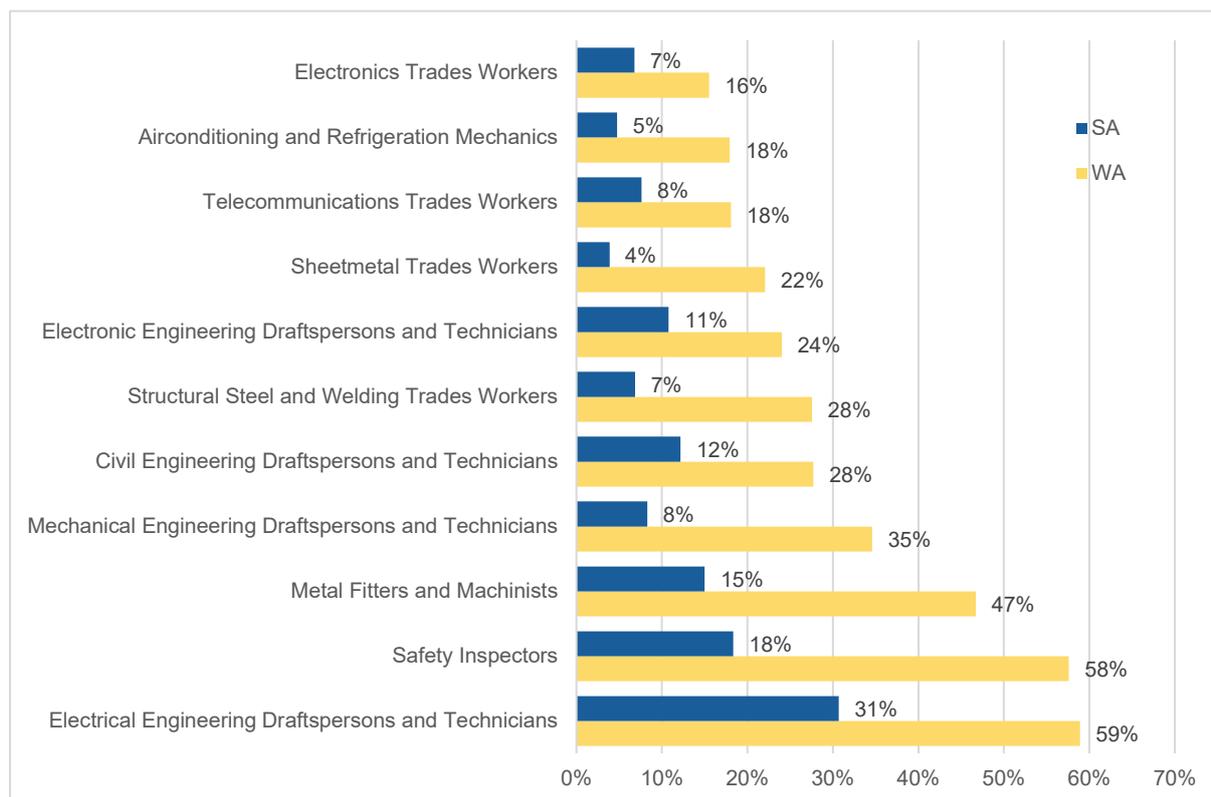
Source: Australian Bureau of Statistics (2019c)

Note, salaries less than \$41,600 p.a. and those not stated or applicable have been included in the calculations but are not shown in the figure. These comprise fewer than 5% of salaries.

A similar differential is evident for trades workers in occupations associated with naval shipbuilding (see Figure 10). Compared with South Australia, more than double the proportion of Western Australian trades workers were receiving annual salaries in excess \$104,000. Notably, well over half (59%) of Western Australian Electrical Engineering Draftspersons and Technicians earned over \$104,000, compared with 31% of the equivalent South Australian workforce. Structural Steel and Welding Trades are in very high demand in naval shipbuilding. In this case Western Australian workers were four times more likely (28%) to receive a salary in excess of \$104,000 than South Australian workers (7%).



Figure 10: Proportion of Engineering trades workers with salaries \$104,000 and over p.a., SA & WA, 2016



Source: Australian Bureau of Statistics (2019c)

3.4 Security clearances

Increasingly, businesses working with defence - and specifically in naval shipbuilding - are required to ensure that access to information is secure and protected in line with Australian Government requirements. Correspondingly, more workers in naval shipyards are required to hold a security clearance, with higher level clearances required by those working on more sensitive tasks (Australian Government, 2019).

Australia's submarines and major surface combatants include some of the most sensitive and secure technologies in the Australian Defence Force and in our partner countries. The construction of these platforms and the integration of communication, combat and weapon systems into them, some elements of which involve classified foreign technologies and systems, must have the highest levels of security. (Department of Defence, 2017, p. 57)

The requirement for security clearances has significant implications for naval shipbuilders including a reduction in the pool of workers available (because of restrictions related to some nations of origin), increased costs and prolonged recruitment processes. The Australian Government has made a number of changes to their security program to better support the defence industry and provide more streamlined access to security clearances. However, as per the *International Treaty in Arms Regulations* this does not change the requirement for most of the naval shipbuilding workforce to be Australian citizens (Department of Defence, 2017).

A key change to security clearance management was the reformation of the Defence Industry Security Program (DISP) to provide access to voluntary membership for businesses without a Defence contract. DISP was designed to monitor and mitigate security risks associated with outsourcing services, functions and capabilities. It is mandatory in certain circumstances,

including when it is specified in a defence contract or when industry is working on classified information or assets. This change increased industry opportunities to work with Defence¹⁹.

Through DISP, business entities receive guidance and services to help them secure and protect their information and assets and understand and manage the security of their supply chains. Entities are also able to sponsor security clearances for their personnel - in certain circumstances²⁰. Notably, where personnel are expected to have access to classified resources, they are required to be eligible and suitable, with business entities expected to manage this and report on any issues of concern. There are four categories of membership (governance, personnel security, physical security and information and cyber security) each aligned with current security classifications from unclassified/DLM (entry level), Protected (Level 1), Secret (Level 2) through to Top Secret (Level 3).

Australian citizenship is required²¹ for an Australian security clearance and DISP members are financially responsible for the costs associated with the security clearances for their staff. Fees and charges for security vetting are dependent on the clearance level sought and are updated annually. Rates from 1 February 2018 are presented in Table 1. Australia has four levels of security vetting²². The clearance level applied for each individual depends on the specific needs of their position. Security clearances are a specific issue for the defence industry due to the need to gainfully employ workers during the clearance process, which usually takes between one and six months to process - but can take considerably longer.

Table 1: Security vetting access fees and charges, 2018

Level	Access	Total charge
Baseline Vetting	Permits access to PROTECTED information and resources.	\$637.67
Negative Vetting 1	Permits access to SECRET information and resources.	\$1,327.37
Negative Vetting 2	Permits access to TOP SECRET information and resources.	\$2,267.54
Positive Vetting	Permits access to information and resources at all classification levels.	\$10,713.95

Any FCD relocation to Western Australia would necessarily require security clearances for the new workforce (up to 900 people), and/or possible upgrades to the level of security clearances required for the existing Collins Class workforce in Perth. While the costs of obtaining clearances is non-trivial, the challenge of securing experienced personnel with a clearance is not insignificant in a competitive market as we examine the next section of this report.

4 Maturity of the naval shipbuilding ecosystem

This section examines the importance of mature naval shipbuilding and skills ecosystems. It discusses the relative maturity of the South Australian and Western Australian naval shipbuilding ecosystems and the significance of this for optimisation of FCD and MCD outcomes in Australia. It is important to note that the South Australian and Western Australian sites have different but

¹⁹ <https://www.defence.gov.au/dsvs/industry/default.asp>

²⁰ The business is required to have Personnel Security DISP membership at Level 1 and their Security Officer has Negative Vetting 1 clearance.

²¹ This requirement is waived in exceptional circumstances only.

²² <https://www.defence.gov.au/AGSVA/FAQ/clearance-subject.asp>



complementary functions, evolving to perform FCD in the former and MCD at the latter. This is a very important functional distinction that is fundamental to consideration of the relative merits of the two sites as locations for sustainment. The co-location of submarine build and FCD functions at Osborne represents a self-reinforcing system and capability. Today, complex problem-solving capability and skills are embedded in the South Australian naval shipbuilding ecosystem. ASC naval shipbuilding and sustainment has been at the centre of this ecosystem with support from an extensive South Australian supply chain of some two hundred and fifty companies - augmented by suppliers from other states (Gailberger, 2019).

4.1 Modernising naval shipbuilding – the digital shipyard

Naval shipyards, supply chains and the skills, training and education sectors are increasingly embracing the opportunities associated with accelerating the uptake and diffusion of advanced manufacturing and digital technologies - elements of the 'Industry 4.0' industrial transformation agenda. In South Australia, the Government is pursuing this through implementation of various 'digital shipyard' initiatives designed to help realise the vision of a world class digital shipyard at Osborne. One such initiative includes the *Virtual Shipyard Training Program* delivered over six months in collaboration with Dassault Systemes at TAFE SA in partnership with the South Australian Government and the Advanced Manufacturing Growth Centre. In the first phase, SME participants are provided with digital interfaces and industry scenarios to introduce them to the modern and automated digital shipyard and its processes including supply chain and cost management, production planning and scheduling, quality management and IP security. The second phase provides support for implementation of digital processes within participating business.

Established in 2007, the *Defence Industry Pathways Program (DIPP)* is a long-term collaboration between TAFE SA, ASC and the Education Department. DIPP focuses on advanced manufacturing and design with the aim that young people (who undertake the program during Year 10 or 11) will select educational pathways to jobs in the defence industries. Students selected on the basis of their STEM and team-working skills as well as their ability to be resourceful learners are able to undertake SACE Stage 1 accredited Design and Technology courses including CAD design and 3D printing. By the end of 2019, 16 courses will have been completed with approximately 200 students from approximately 40 South Australian schools across all three educational sectors (Government, Catholic and Independent). Students are able to see first-hand how the new technologies are translated into practice through site visits to ASC facilities at Osborne including tours of the Collins Class submarine and Air Warfare Destroyers. This program is successfully attracting females who make up 25% of the student cohort - double the proportion of women in engineering (Engineers Australia, 2019b). The success of the DIPP program delivered at Regency TAFE has led the state's education department to explore opportunities for delivering the course (open to all schools) at Cardijn College in Southern Adelaide from 2020.

Further demonstrating the collaborative approach undertaken in South Australia, Naval Group will be training apprentice welders at ASC. This will expose apprentices to over 30 years of experience gained through the building and sustainment of the Collins Class submarines. Of note, welding apprentices now also have access to augmented and virtual reality training which provide a simulation of welding, supporting skill development in a risk-free environment.

BAE Systems and Naval Group are also working closely with Flinders University on testing and trialing advanced manufacturing technologies and processes in support of the digitalisation of the Osborne shipyard. The digital transformation of naval shipbuilding in South Australia will be supported by the establishment of a Joint Cyber-Physical Systems Laboratory and Factory of the

Future facility at the Tonsley Innovation District in Adelaide. This advanced manufacturing test and trial facility is being established by Flinders University and BAE Systems to accelerate the uptake and diffusion of advanced manufacturing technologies in naval shipbuilding.

4.2 Defence industry workforce development

South Australia has a mature naval shipbuilding and skills ecosystem, one that has evolved over many years, enabling it to tackle the added complexity associated with FCD. Many lessons have been learnt from the Collins Class FCD program²³ - augmented by suppliers from other states. South Australia also has a dense network of institutions that contribute to excellence in all elements of naval shipbuilding and sustainment with leadership from the Defence Teaming Centre (DTC), the Naval Shipbuilding College (NSC) and the Centre of Defence Industry Capability (CDIC).

Considerable work has been undertaken in South Australia to support the development of the defence workforce with a particular focus on the naval shipbuilding workforce. Over many years Defence SA has collaborated with the Department of Education, Department for Innovation and Skills and TAFE SA and other significant stakeholders on workforce and skills development. Most recently this has involved the development of a comprehensive *Defence Industry Workforce and Skills Strategy 2018-2022* to future proof, develop and maintain a skilled defence and security workforce (South Australian Government, 2019). The Strategy has three key prongs:

1. **Collaboration** between the Australian and South Australian Governments and industry stakeholders to develop the defence industry workforce, and align study and career pathways.
2. **Build capability** that is flexible and fit-for-purpose with investment in defence sector education and training, embed STEM in learning and increase awareness about opportunities in defence with a focus on veterans and skilled migrants.
3. **Shared responsibility** encourages defence industry co-design and co-investment in building their workforce, and supporting access and sharing of innovations, techniques and technologies required by the new defence workforce.

Five key initiatives are now underway involving a mix of recruitment, training and migration - engaging youth, developing skills, building workers, reengaging veterans and attracting professions (see Figure 11). Critical to this work is a strong and collaborative engagement with the Defence Primes (head contractors) to support skills development and growth in naval shipbuilding supply chains, particularly in support of the uptake and diffusion of advanced manufacturing and digital technologies.

²³ Personal communication with ASC.



Figure 11: Defence Industry Workforce and Skills Strategy current initiatives



Source: <https://www.defencesa.com/domains/maritime/naval-shipbuilding-plan/workforce>

The Defence, Aerospace, IT and Cybersecurity Industry Skills Council is one of eight councils established as part of the Skills South Australia initiative. This Council was established to ensure skills and workforce development are specifically aligned to industry needs and priorities. This approach was designed so South Australia could take advantage of opportunities and support the defence industry.

4.2.1 Education and training capability

TAFE SA has partnered with ASC since its inception, providing training for the Collins Class submarine and AWD workforces. Recent reports indicate it has trained and/or tested around 85% of the local ASC workforce (TAFE SA, n.d.). The TAFE SA approach has been to develop and align trade, administration and management curriculum and courses to the needs of naval shipbuilders and their supply chain. As such they are more than simply a training provider. TAFE SA has mapped workforce skills against the VET quality framework to identify, develop or modify courses to align graduates with the requirements of the naval shipbuilding workforce, ensuring they have the right skills and capabilities for shipbuilding, working in a naval environment and in a shipyard. Naval shipbuilding careers underpinned by TAFE SA certificates and diplomas include those with more generalist skills such as project management, team leadership, accounting, information technology, procurement and cyber security, through to CAD design skills and production (including boilermakers, welders, pipefitters, machinists, mechanical fitters, industrial electricians and electronics technicians)²⁴.

TAFE SA supports educational pathways both in and out of the institution. Pathway programs flow from Certificate I and II achieved through VET in Schools programs specialising in engineering, electrotechnology and construction which lead to higher level certificates, diplomas, advanced diplomas and associate degrees in TAFE SA. South Australia has 44 Engineering Pathway programs designed to prepare school students for metal trades. Le Fevre High School has hosted the Maritime High School of South Australia program since its establishment in 2011. The School works closely with the Australian Maritime College in Tasmania. STEM courses focus on naval architecture and engineering, while the VET Certificate courses at the Trade Training Centre provide pathways to apprenticeships. Dual offers²⁵ and credit transfer are available for entry to the three South Australian universities which recognise TAFE SA qualifications in electronics engineering, computer systems engineering, electrical engineering, communications engineering, engineering design, work health and safety and leadership and management.

*Skilling South Australia*²⁶ provides employers, industry associations and training providers with funding to deliver projects to grow a skilled workforce in South Australia designed to meet the needs of growth industries including defence. Of note, the *Ai Group Higher Apprenticeships Program* was launched in October 2018 to create 100 engineering technician apprenticeships within four years. On completion of trade units including mechanical engineering, and emerging technologies - robotic systems, cloud-based data and computer-aided design tools - graduates receive a Diploma in Applied Technologies. The *South Australian Defence Industry Leadership Program* is currently underway providing professional development to help build professional, behavioural and management leadership skills. Over eight months, participants from the defence and manufacturing industries complete either an Advance Diploma or a Diploma of Leadership and Management.

Current projects of relevance to naval shipbuilding also funded under the Skilling South Australia program include pre-apprenticeship programs in electrical engineering (National Electrical and Communications Association), mechanical engineering (Adelaide Training and Employment

²⁴ tafesa.edu.au/defence-industries

²⁵ Whereby students are required to apply only once for admission to the TAFE and university qualifications.

²⁶ <https://www.skilling.sa.gov.au/about>



Centre) or specifically for Indigenous Australians (Zancott Recruitment). Other projects target technology (PwC), cloud computing (Microsoft) and IT (DXC Technology).

Located at Osborne, the Naval Shipbuilding College (NSC) was established by the Australian Government in April 2018 to support the development of a skilled workforce that helps build sovereign naval shipbuilding capability. The College focuses on partnering with industry to determine workforce requirements; partnering with education and training facilities to build capacity and attendance; and increasing trade qualifications to meet construction demand. In September 2018, TAFE SA was the College's first accredited training partner with endorsement of the welding component of the Engineering – Fabrication Trade Certificate III.

In 2018, TAFE SA signed a memorandum of understanding to partner with their French equivalent, AFPA, to work together to build a pipeline of appropriately skilled workers for the Attack Class submarines. As part of this arrangement TAFE SA staff travelled to France to encourage skills collaborations across key specialties of welding, fabrication, machining, mechanical fitting, engineering design and inspection and measurement.

The South Australian tertiary sector has also had a long engagement supporting the development of a skilled professional workforce. Engineering Australia provides accreditation for university programs across Australia. At January 2019, three South Australian universities were fully accredited to deliver a total of 30 branches of engineering. In addition to providing these degree courses and post-graduate level education, universities have undertaken joint research projects and consultancies with the naval shipbuilding Primes and the supply chain. In recent years that has included a more specific focus on the needs of the defence industry and naval shipbuilding. Flinders University offers a Bachelor of Engineering (Maritime) (Honours) in collaboration with the Australian Maritime College. The University of Adelaide in collaboration with ASC offers a Masters of Marine Engineering while the University of South Australia offers a Masters of Project Management. A new Diploma of Advanced Technologies developed collaboratively by TAFE SA, Flinders University and SAGE has been developed with the support of the South Australian Government.

Other initiatives supporting the growth of the appropriately qualified university student pipeline includes the *Premier's Defence Industry Scholarships* which are designed to develop the skills and knowledge required by the defence industry and provide valuable workplace learning experiences for third year or honours university students undertaking STEM or business degrees. Small and medium size enterprises (SME) in the defence industry can access grants of up to \$4,000 to cover the costs of the students engaging in the placements. The Defence Teaming Centre in collaboration with the University of Adelaide have created two courses to contribute to the *Professional Certificate in Defence Industry Leadership*²⁷ to develop core leadership skills including self-leadership, ethics, teamwork, building networks, collaboration, dealing with complexity and managing change in the defence industry.

The focus on building smaller naval vessels and undertaking submarine MCD in Western Australia has given rise to facilities and institutions that service those functions. Understandably Western Australia is seeking to grow its naval shipbuilding enterprise and is well positioned to do so in relation to its current functional remit. Western Australia has recently sought to explore new approaches to meet the workforce demands of the naval shipbuilding industry with the launch of Defence West in May 2017. Early work focused on the appointment of a Defence Advocate, announced in August 2017, and a Defence and Defence Industries Strategic Plan in 2018 to drive a larger share of the defence industry spend on naval infrastructure. However, planning has

²⁷ <https://dtc.org.au/developing/>

only just commenced with a specific focus on education of the defence industries workforce, which will need significant upskilling to achieve expansion of submarine maintenance and sustainment activities beyond that currently delivered (Defence West, 2018). The only fixed action was the establishment of a Defence Office in South Metropolitan TAFE “to lead a coordinated and collaborative approach to the development of a Western Australian Defence Workforce Development Plan and oversee and advise on defence-related Western Australian skilling matters” (p.22) - with this achieved in May 2019. ASC (2019) recently expressed limited confidence in Western Australia’s ability to undertake FCD without significant support from the existing skilled South Australian workforce.

The education and training system and infrastructure that has evolved in South Australia is very mature in relation to the naval shipbuilding and sustainment functions in operation at Osborne. It is now gearing up to support digitalisation of naval shipbuilding. Moreover, a cluster of research and development initiatives is supporting BAE, ASC and Naval Group to help realise the digital shipyard vision at Osborne for the benefit of the national naval shipbuilding enterprise.

4.2.2 Migration

While local availability plays a key role in meeting demand for skilled workers for naval shipbuilding and sustainment, skilled migration is also a source of supply to mitigate potential shortages and help build capability and capacity. As such, it is important to have a supportive migration and visa system in place to enable the timely transfer of the knowledge and skills necessary for the successful execution of naval shipbuilding projects - particularly where they involve global Primes like BAE and Naval Group.

Skilled migration has played a pivotal role in driving growth in the Australian, and particularly Western Australian, engineering workforce for many years supplementing industry demands which exceed that supplied by the education system. Today, a large component of Australia’s engineering workforce is comprised skilled migrants (Engineers Australia, 2019a). In the ten years to 2017-2018, five of the top ten skilled migrant occupations were for engineers with combined inward migration of engineers totalling 41,383 persons representing one in eight (11.9%) of Australia’s total skilled migrants. , Since 2007, engineers have migrated from 166 countries, but more than two thirds have come from only ten countries (Engineers Australia, 2019b). India has comprised one quarter of all skilled engineers during this time, China contributes one in ten and Philippines one in thirteen. England was the only member of the Five Eyes alliance²⁸ in the top ten – providing one in twenty migrant engineers.

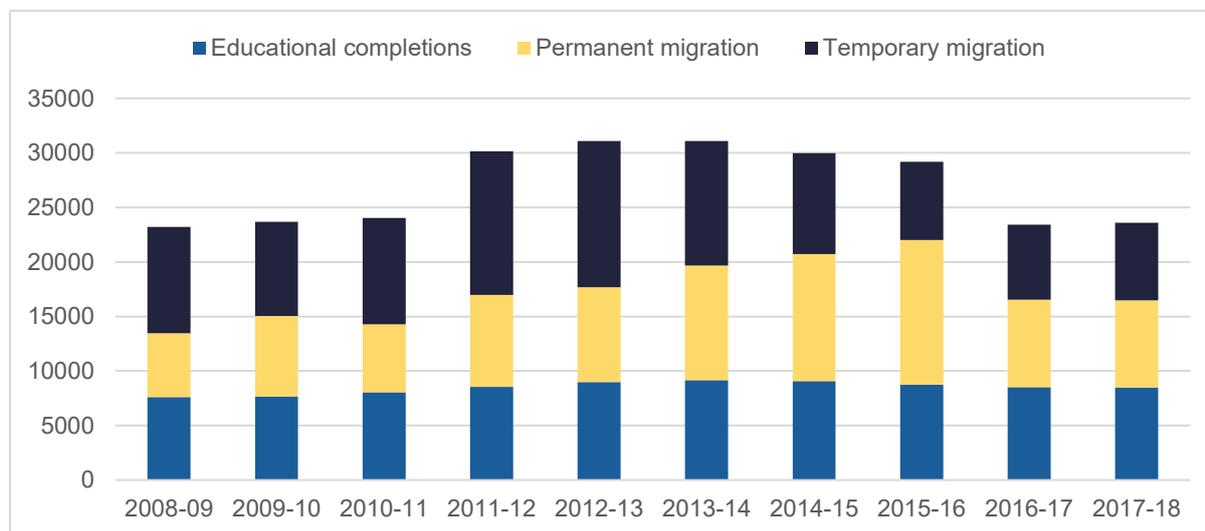
Examination of education and migration data provides a guide to the increased level of individuals engaging in engineering degrees in Australia and the proportion of these completions achieved by domestic and international students (Department of Education and Training, 2019). While overall numbers have grown due to an increased overseas market, commencements of both domestic undergraduate and graduate level engineering students have declined from 2013 - reflected in lower domestic completions since 2015. Issues associated with a high volume of international students and a large migrant workforce present key risks for the sovereign naval shipbuilding industry. These include managing the impact of changes to skilled migrant visas and international tertiary completions and ensuring access to an eligible workforce that meets skills and citizenship requirements for defence security clearances.

²⁸ Parties to the multilateral United Kingdom – United States of America Agreement for cooperation in signals intelligence.



Engineers Australia (2019b) provide details of the relative contribution of tertiary completions and skilled migration (permanent and temporary) to the supply of professional engineers (see Figure 12). This shows that while educational completions have remained fairly consistent across the 10 years, permanent skilled migration peaked in 2015-16, before declining sharply the following year.

Figure 12: Professional engineers: educational completions and skilled migration, 2008-09 to 2017-18



Source: *Engineers Australia (2019b)*

There are significant impacts from the abolition of the 457 Skilled Migration Visa and an increased requirement for security clearances in some sectors (BDO Australia, 2019), however, workers are still able to enter Australia through the Designated Area Migration Agreements (DAMAs). The DAMA is an employer-sponsored visa program which falls under the Temporary Skill Shortage visa (Subclass 482). These visas enable business to attract and retain skilled workers with priority processing from the Department of Home Affairs²⁹. Seven DAMAs are currently in place in Australia. These provide increased access to skilled and semi-skilled overseas workers in regions of recognised need. The DAMA head agreement (first tier) is between the Australian Government and a regional representative. The second-tier agreement is between regions and local employers who are seeking to fill an occupation designated in the head agreement (for a position that due to workforce shortages cannot be filled by an Australian citizen or permanent resident).

The South Australian Government Department of Innovation and Skills and the Australian Government Department of Home Affairs entered into two DAMAs in March 2019. The *Adelaide City Technology and Innovation Advancement Agreement* covers 60 occupations in the Greater Adelaide region with a focus on high-tech growth industries (defence, space, technology and advanced manufacturing). Of particular relevance for defence businesses, this agreement provides for the inclusion of engineering, technical and trades positions relevant to the defence industry, with these eligible for permanent residency via the Employer Nomination Scheme Visa. Restrictions on age have been changed for eligible professions and tradespersons, allowing older applicants. Defence industry occupations are also eligible for the *South Australian Regional*

²⁹ It is noted that the Medium to Long Term Strategic Skills List (MLTSSL) has replaced the Skilled Occupation List (SOL). Criteria for the MLTSSL include long training time leading to specialised skills and high risk of disruption to the labour market and economic if the skills are unavailable or facing shortages (Engineers Australia, 2019b).

Workforce Agreement which covers 114 occupations across whole of South Australia in high growth industries (construction, mining, forestry, health and social services, tourism and hospitality).

The Migration Advisory Council has been set up in South Australia to ensure migration initiatives help drive the State's economic agenda and appropriately respond to the needs of industries and regions. BAE Systems Australia and Naval Group Australia are members of this council and provide an important lens on the needs of naval shipbuilders.

The \$551 million *Adelaide City Deal* is a 10-year plan signed in March 2019 (following a memorandum of understanding in December 2018) to use migration and planning reforms to attract and retain skilled workers, quality students, entrepreneurs and build Adelaide's population³⁰. Central to this are South Australia's defence and innovation precincts including the Osborne Naval Shipyard, Edinburgh Defence Precinct, Tonsley Innovation District, Technology Park and Lot 14. Currently, around 4% of Australia's migrants settle in Adelaide. Under this deal the Australian and South Australian governments will be tailoring new migrant arrangements to attract the right skills to meet Adelaide defence and innovation needs. Adelaide's three universities are key partners in this deal with their focus on attracting and retaining domestic and international students.

The *Supporting Innovation in South Australia (SISA)* visa is a pilot program scheduled to run until November 2021. This program aims to stimulate new and ongoing investment in the innovation economy in South Australia by connecting overseas entrepreneurs with local activity to support the growth of local business and start-ups and create jobs.

Western Australia was successful in securing one DAMA specifically associated with the resources sector - the Goldfields Designated Area Migration Agreement provides for 72 occupations within City of Kalgoorlie-Boulder and the Shires of Coolgardie, Leonora and Menzies. Although the Western Australian Government memorandum of understanding (MOU, 27 April 2018) to negotiate a City Deal for Perth predates the Adelaide MOU by eight months, the Perth City Deal is not yet in place. The Perth City Deal has an aim to invest in new public transport infrastructure and services (METRONET) to connect and plan for new urban communities.

5 Competition for skills

The Collins Class sustainment workforce in South Australia is a mature and stable one. Many have benefited from involvement in the construction of the submarines and have acquired knowledge and skills that are essential to the successful execution of FCD and LOTE.

Estimates suggest that the combined naval shipbuilding and sustainment programs in South Australia is likely to require an additional workforce of approximately 1,200 over the next five years. Beyond that, estimates are less clear, though it is possible that another 1,800 workers will be required within 10 years (see Section 1.3). This will be dependent on the extent to which new technologies and automation are introduced into the Osborne shipyard.

South Australia has managed similar workforce ramp-ups in the past, most recently when the Australian Warfare Destroyer program came online. With the benefit of this experience and the

³⁰ <https://citydeals.infrastructure.gov.au/adelaide>



existence of a mature naval shipbuilding ecosystem (see Section 4), the State is well positioned to support continuous naval shipbuilding of large scale vessels in combination with FCD of the Collins Class and Attack Class in the future. The defence industry has specified its workforce needs and engaged with the South Australian and Federal Governments to ensure skills pathways are suitable and arrangements put in place to support the development of the required workforce (Defence Teaming Centre, 2015). This co-ordinated approach to workforce development is fundamental to the successful execution of the Osborne shipbuilding and FCD enterprises.

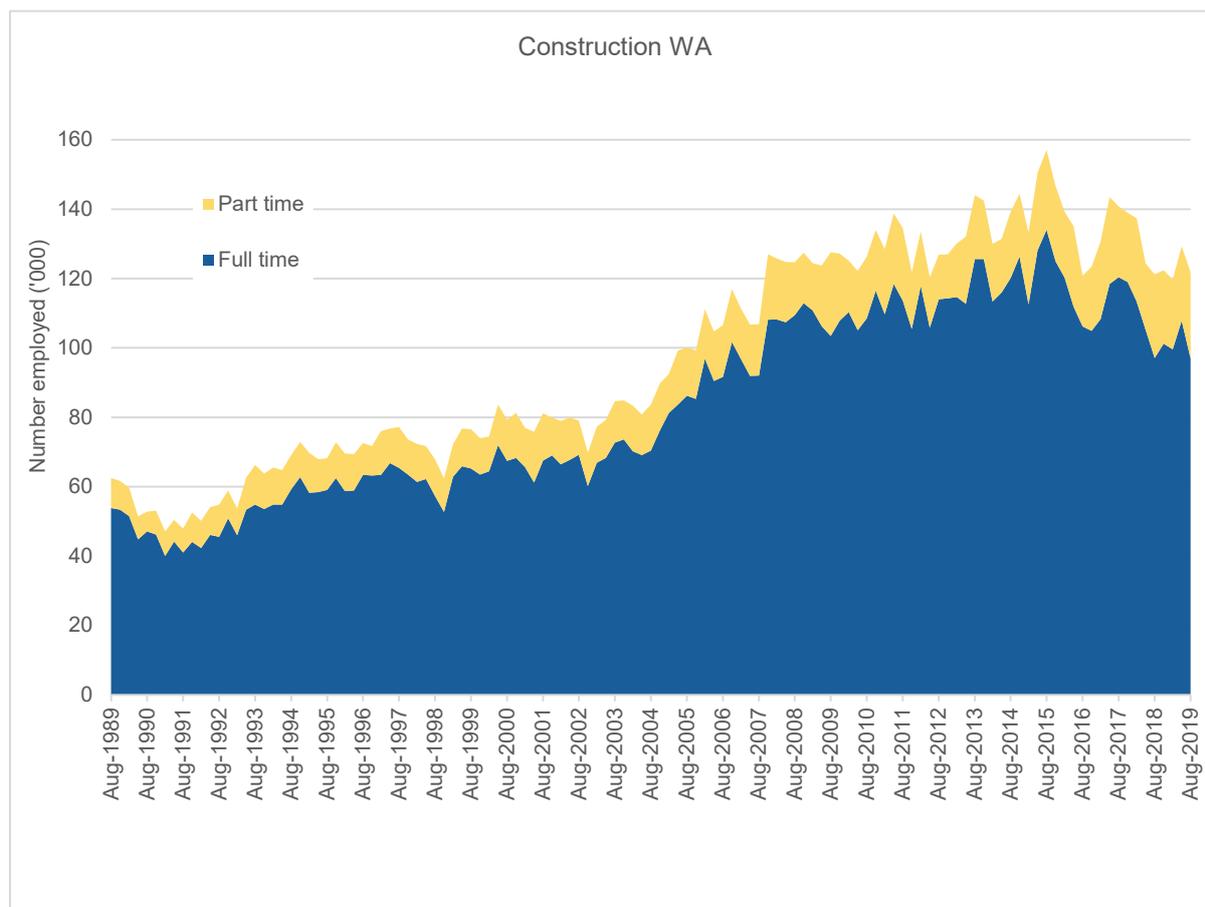
Both the South Australian and Western Australian naval shipbuilding workforces and supply chains have evolved to support the current division of sustainment responsibilities, and both states need to contend with challenges and pressures for their naval shipbuilding workforce going forward – albeit from different industries. However, these challenges are clearly more acute in Western Australia where competition for trades and engineering skills remain extremely intense. It is noted that Western Australia is still dealing with the repercussions of the resources boom where the workforce more than doubled within five years to over 120,000 workers and salaries for in demand occupations rose exponentially (see Section 3.3). Although it is evident that the Western Australian mining workforce dipped after the peak, it has corrected and for the last two years well over 100,000 workers have been employed in the sector (see Figure 13). Increases to the Western Australian construction workforce have followed a slower trajectory extending over the last 15 years (see Figure 14). The workforce in both these sectors are expected to continue to grow as new mining and construction projects come online in Western Australia (see below).

Figure 13: Persons employed in Mining, WA, 1989-2019



Source: Australian Bureau of Statistics (2019a)

Figure 14: Persons employed in Construction, WA, 1989-2019



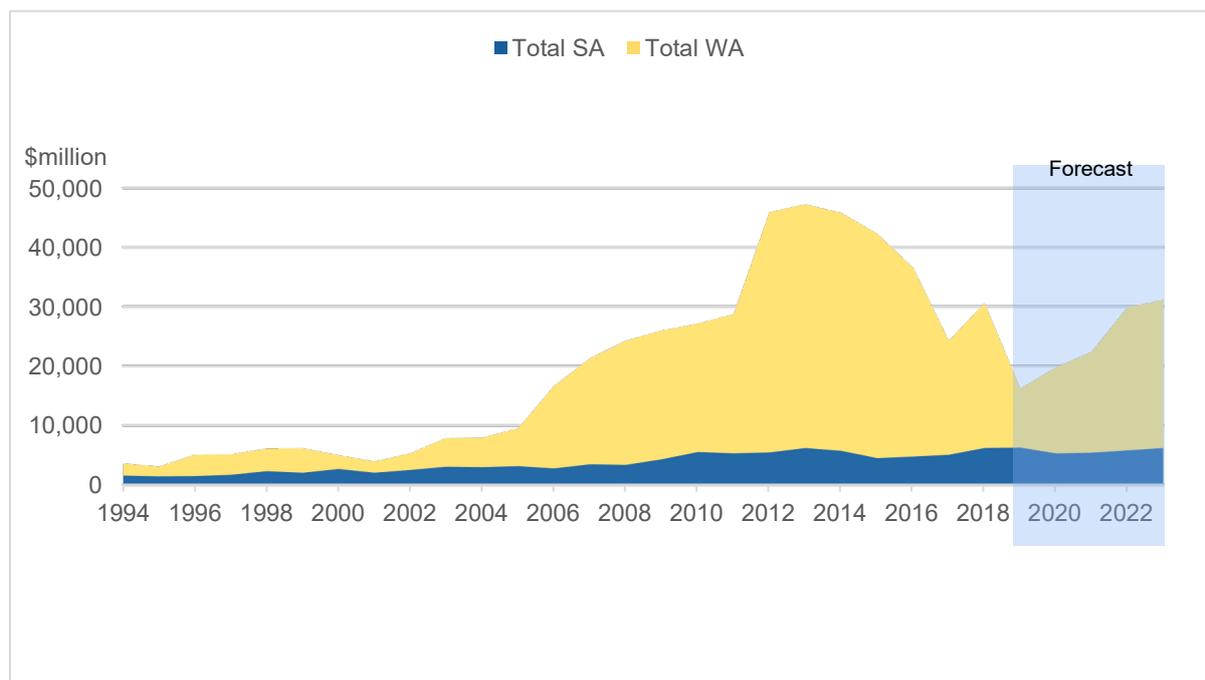
Source: Australian Bureau of Statistics (2019a)

The total value of engineering construction projects in Western Australia is set to double from around \$16 billion in 2019 to \$31 billion over the next four years as Figure 15 illustrates (BIS Shrapnel, 2019a, 2019b). The sharp increase in the value of engineering work undertaken in Western Australia, along with the growth in mining activity in general will intensify competition for engineering and trades skills in Western Australia. This will put further upward pressure on wages and housing costs in the state (see Section 3.3). Aligning with this, the Australian Resources and Energy Group, AMMA (2019) have estimated that around 11,000 new mining workers will be required in Western Australia by 2024. Around half of the occupations specified as ‘in demand’ include engineers, technicians, supervisors, management, and electrical, mechanical and maintenance trades.

South Australia on the other hand has experienced only modest growth in mining and is still absorbing the impact of the closure of the automotive industry. The state is set to experience a dip in the value of engineering construction projects from \$6.2 billion in 2018 to \$5.3 billion in 2020, before returning to \$6.2 billion in 2022. Projecting ahead, BIS Shrapnel forecast engineering construction work in Western Australia to continue at four times the level seen in South Australia, growing to five-fold in ten years (see Figure 16). There is a high risk that competition for engineering and trades skills in Western Australia will make it more difficult to recruit and retain critical engineering and trades skills both now and in the future.

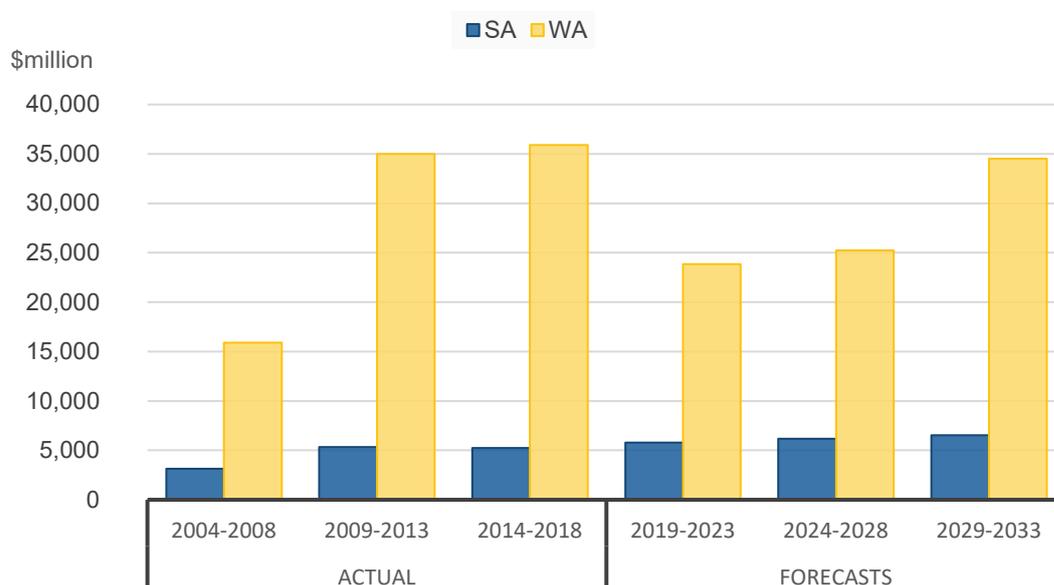


Figure 15: Total engineering construction work done (constant 2016/17 price), SA & WA 1994-2022



Source: (BIS Shrapnel, 2019a, 2019b)

Figure 16: Total engineering construction work done (five year averages, constant 2016/17 prices), SA & WA 2004-2033



Source: (BIS Shrapnel, 2019a, 2019b)

5.1 Engineering personnel in focus

Naval shipbuilding projects require a substantial engineering workforce. Relevant specialist engineers with appropriate skills and experience can be challenging to recruit, despite growth in the engineering workforce as a whole. During periods of growth in the resources sector, competition for engineers intensifies, making it more difficult to attract and retain people,

particularly where there are limitations on salary matching. This is why the existing FCD engineering workforce is of such great strategic value and needs to be sustained and regenerated with care.

The number of Engineers in Australia has grown significantly in recent years (see Section 4.2.2), rising in part in response to the resources boom. Engineers Australia (2018) reported a total of almost 330,000 engineers³¹ in the Australian labour force at the 2016 Census, a 25% increase on the engineer workforce in 2011 – which was a 32% increase on the number of engineers specified in the 2006 Census. In 2016, fewer than two percent of engineers were self-identified as working in the defence sector and these were mainly in the public sector. Notably, across the ten-year period (from 2006 to 2016) the proportion of overseas-born engineers increased by ten percentage points from 48.4% of the engineering workforce in 2006 to 58.5% in 2016 – more than 193,000 engineers.

Government data on engineering workforce shortages tends to be presented as an aggregate of a number of occupations. For example, Civil Engineering Professionals include Civil Engineers, Geotechnical Engineers, Quantity Surveyors, Structural Engineers and Transport Engineers. The aggregation obscures the impact of industry on individual occupations. For example, the national Civil Engineering Professional shortage reported in the four years from 2009 to 2012 runs parallel to the Western Australian resources boom. High salaries commanded as a result of this boom drew many engineers to the West; with the flip side being increasing numbers available to the workforce during the subsequent mining downturn (Labour Economics Office Western Australia, 2018a). Within this professional cohort there was no specified shortage for Structural Engineers - with the mining and resources sector successful in attracting employees to these roles. However as in South Australia, roles requiring experience remained unfilled in many instances (Labour Economics Office South Australia, 2018a).

At the 2016 Census (Australian Bureau of Statistics, 2019b), almost one in five Western Australian Electrical Engineers were employed in the mining industry compared with around one in twenty-five of the South Australian workforce. As with Civil Engineers, a national shortage was reported for Electrical Engineers in the four years from 2009 to 2012. In 2018, South Australia again reported a shortage of Electrical Engineers (Labour Economics Office South Australia, 2018b). The cessation of some large oil and gas projects meant that mining industry employers were able to fill their vacancies with experienced Electrical Engineers, whereas those in other industries reported insufficient skilled applicants. At this time, Western Australia was experiencing regional recruitment difficulties for Electrical Engineers (Labour Economics Office Western Australia, 2018b).

Almost three in ten of the Western Australian Industrial, Mechanical and Production Engineers were employed in the mining industry whereas fewer than one in ten of the South Australian workforce were employed in mining (Australian Bureau of Statistics, 2019b). A shortage of experienced Mechanical Engineers was reported in South Australia in 2018 (Labour Economics Office South Australia, 2018c). As with other professions there was difficulty in attracting experienced applicants. Employers also indicated applicants were seeking remuneration at the heightened level achieved during the resources boom in Western Australian. In South Australia some supply issues relate to the government's budgetary commitments to major civil construction projects from 2016 to 2020. However, it is noted that employment in South Australia's manufacturing industry contracted by 16% in the year to February 2018, with the

³¹ Persons with at least an associate degree or advanced diploma in engineering are included.



closure of Holden and decline in associated supply chain business - there was also a gap in naval shipbuilding in 2017. Western Australian employers seeking specific skill sets in Mechanical Engineers found it difficult to fill vacancies in 2018 (Labour Economics Office Western Australia, 2018c).

A common workforce challenge facing businesses manufacturing complex defence equipment such as submarines is finding suitably experienced engineering applicants to fill advertised vacancies. This is more acutely felt during upswings in the commodity cycle when the demand for engineering and trades skills increases, sometimes sharply as it did in Western Australia during the mining boom. A strong recovery in demand for engineering and trades skills is now expected and evident in Western Australia. Demand in South Australia will be more subdued given the smaller scale of the minerals and energy sector in the State. Also, of significance is the larger scale of investment in major infrastructure projects in Western Australia relative to South Australia.

6 Conclusion

Large scale naval shipbuilding has existed in South Australia for nearly thirty years. It has resulted in the development of a highly skilled and experienced workforce and the establishment of critical physical infrastructure at the Osborne Naval Shipyard. Combined, these human and physical assets have been foundational to the longevity of naval shipbuilding in South Australia and Australia. All of this provides a foundation for successful execution of FCD of the Collins Class submarines at Osborne.

The maturity of the Osborne facility and the naval shipbuilding and sustainment industrial ecosystem that surrounds it, is a national asset. This has evolved over decades to be a highly successful enterprise. ASC was contracted to build Australia's six Collins Class submarines at its Osborne facility from 1990 to 2003. From December 2003, ASC was contracted for a further 15 years to provide maintenance and upgrades to support the operational life of the Collins Class in Adelaide. Transitioning from a problematic '8+3' to a more efficient '10+2' Usage and Upkeep Cycle (UUC) of maintenance and sustainment in 2014, ASC has since completed two two-year FCDs with completion of a third due June 2020. In comparison, Western Australia has completed just one MCD in the post-Coles report environment - in 2018.

Moreover, ASC has accrued a wealth of experience and achieved high level recognition over its many years of engagement at Osborne. Problem-solving undertaken during the Collins build and sustainment program has resulted in the development of a world class FCD capability at Osborne. Implementing a program of innovation and reform, ASC successfully navigated the Collins Class sustainment program to the status of being awarded Certified Asset Management (global standard ISO 55001) - considered to be international best practice for the management of complex physical assets. Collins Class sustainment at Osborne has come to be recognised, and has proven itself as an exemplar project, exceeding international benchmarks in quality and performance.

A mature naval shipbuilding and sustainment ecosystem like Osborne in South Australia is of great strategic value to the nation. Excellence in FCD is made possible by the agglomeration of large-scale shipbuilding and sustainment functions, bringing together the advanced human and technological capabilities required to solve the complex challenges and problems associated with FCD operations. This critical mass of infrastructure, expertise and skills is necessary for decades to come to support the sustainment of both the Collins Class and the Attack Class Submarine fleets. It is a jewel in the crown of Australian sovereign capability.

South Australia's mature naval shipbuilding and skills ecosystem has evolved over many years, enabling it to tackle the added complexity associated with FCD. Many lessons have been learnt from the FCD Collins Class program in particular. Today, complex problem-solving capability and skills are embedded in the South Australian naval shipbuilding ecosystem. ASC shipbuilding and sustainment has been at the centre of this ecosystem with support from an extensive South Australian supply chain of some two hundred and fifty companies - augmented by suppliers from other states. South Australia also has a dense network of institutions that contribute to excellence in all elements of naval shipbuilding and sustainment with leadership from the Defence Teaming Centre (DTC), the Naval Shipbuilding College (NSC) and the Centre of Defence Industry Capability (CDIC).

Sustainment capability like that found at Osborne cannot be easily recreated in other sites given the extensive sunk investment in workforce development and critical infrastructure and the high level of maturity of the sustainment industry ecosystem. This capability, insofar as it is a product of years of investment, development and fostering of relationships, is largely immobile. For example, extensive work has been undertaken in South Australia to support the training and development of the defence workforce with a particular focus on the naval shipbuilding workforce. Over many years Defence SA has collaborated with the Department of Education, Department for Innovation and Skills and TAFE SA and other significant stakeholders on workforce and skills development, resulting in a *Defence Industry Workforce and Skills Strategy 2018-2022* to future proof, develop and maintain a skilled defence and security workforce.

Since ASC were awarded the Collins Class submarine project in the late 1980s, South Australia has been investing in defence industry workforce development. Today, South Australia has a highly mature skills, training and educational ecosystem focusing on providing defence industry, and specifically naval shipbuilding, pathways for school students through trades and academia to the workforce. Much of this productive mature ecosystem, and the benefits it confers, would be lost if FCD sustainment activities were to be relocated to Western Australia.

ASC has identified the unique capability and strength of its Adelaide-based workforce. Years of challenging work building and sustaining submarines has resulted in deep localised knowledge. The Collins workforce assembled at Osborne has developed the fundamental capabilities required to manage the complexity of FCD operations, including considerable variation in the condition of submarines presented at Osborne and the challenge of integrating major technological upgrades. The reality that few of the highly experienced South Australian FCD are likely to choose to relocate to Western Australia, presents a major risk to the successful execution of FCD in support of the Australia Navy's requirements. This in turn risks impacting the availability and reliability of Collins Class submarines, which would undermine the requirement that at least six Collins Class submarines remain in productive and active service during the rollout of the Attack Class submarines.

If relocation of FCD to Western Australia were to be undertaken, the costs associated with it are substantial. The cost (CAPEX and wages) of preparing the Henderson site for FCD is estimated to be around \$293.3 million (\$, real 2019) - an estimate that *excludes* costs associated with purchasing the site, site remediation, geological and engineering surveying, concept design work and council approvals that would determine the site is available and fit-for-purpose. An estimated additional wage bill of \$240 million would support the additional workers required to build FCD capability in Western Australia while maintaining it in South Australia at the same time. The duplication of facilities in Henderson will add a further \$11.3 million to the operations wages bill. In addition, significant inducements would be required to entice South Australians to Western Australia. This is likely to include extensive relocation or fly-in fly-out support along with increased salaries.



ASC have estimated a cost of \$29.4 million for 100 scholarships for submarine capability improvement in the areas of operations management, CAD design, engineering and supply chain/procurement for the Attack Class submarines. This is comparable to the costs of training the Western Australian workforce for Collins Class FCD. This is in addition to trainee salaries for the duration of the three-year program. Traditionally, Western Australia has relied on skilled migration to build significant engineering capability. However, changes to skilled migrant visas and an increased requirement for Australian security clearances mean an increased reliance on domestic Australian workers in naval shipbuilding.

In Western Australia employment conditions in both engineering and construction are likely to be significantly impacted once Metronet and major mining projects begin in earnest in late 2019. Recent reports indicate that Western Australian salaries for critical roles in mining had now increased beyond the peak of the resources boom in 2014. Moreover, it was expected that Western Australia would need to increase salaries in order to attract the skills and workers they require for mining and construction as well as sourcing workers from related industries and sectors.

The total value of engineering construction projects in Western Australia is set to double from around \$16 billion in 2019 to \$31 billion over the next four years. The sharp increase in the value of engineering work undertaken in Western Australia, along with the growth in mining activity in general will intensify competition for engineering and trades skills in Western Australia. This will put upward pressure on wages and housing costs in the State. South Australia on the other hand is set to experience a decline in the value of projects from \$6.2 billion in 2018 to \$5.3 billion in 2020, before returning to \$6.2 billion.

The Australian Resources and Energy Group, AMMA (2019) have estimated that around 11,000 new mining workers will be required in Western Australia by 2024. Around half of the occupations specified as in demand include engineers, technicians, supervisors, management, and electrical, mechanical and maintenance trades. There is now a high risk that competition for engineering and trades skills in Western Australia will make it more difficult to recruit and retain critical engineering and trades skills.

The Coles Review rigorously established that a world class FCD submarine sustainment capability exists at Osborne. Clearly, there are significant downside risks associated with disrupting this arrangement, particularly given that existing arrangements work well, and the expertise has been concentrated at Osborne and in the local and national supply chain to ensure this outcome. For it to be a compelling one, the case for moving FCD to Henderson in Western Australia would need to assemble evidence that the world class benchmark that has been met at Osborne would be surpassed and that there would be no disruption to submarine capability as a consequence of any move. This would require a relatively seamless transfer of capability from South Australia to Western Australia. The evidence available suggests that this is not a realistic expectation given the complexities involved in establishing world class submarine sustainment facilities. A prudent course of action would be to strengthen the existing division of sustainment responsibilities between Osborne and Henderson. The case for maintaining all FCD at Osborne is overwhelming and the case for relocation to Henderson unfounded.

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