

Submarine Fleet Reliability, Availability – Australia’s Collins Experience

Abstract — The business of sustaining (maintaining and upgrading) Australia’s Collins Class Submarines has undergone tremendous changes. Maintenance strategies have been redesigned; the value chain streamlined; a Submarine Enterprise model has been adopted; and investments have been made in specialised infrastructure, materials and stocking of spares. This has resulted in a tremendous increase in availability and overall reduction in time and cost of maintenance.

1 Introduction

Australia’s fleet of Collins Class Submarines are one of the first of the modern era conventional submarines “figure 1”. They are highly stealthy submarines able to transit long ranges whilst submerged before reaching their area of patrol. The Collins acquisition program was a fundamentally successful bespoke design and construction program by Kockums AB and ASC Pty Ltd., with the fleet of vessels designed, built and commissioned in 16 years.



Fig. 1. Collins Class Submarines

Once the sustainment phase of the fleet got underway factors emerged that impacted submarine availability and cost of ownership. They included unclear roles and responsibilities in the value stream, supply chain, spare part pool, weak alignment between submarine usage models and availability aspirations.

2 Sustainment Phase and Review

In 2011 the Australian Government commissioned a study lead by Dr. John Coles^[1] into the end-to-end business of sustainment of the submarine fleet. Following collaboration with stakeholders, the Coles Team characterised what it meant to be the parent of a unique asset such as the Collins submarines and made key recommendations that subsequently reformed the management of the fleet.

The Coles team defined benchmarks for availability and recommended transferring responsibility for engineering and supply chain management to Australian industry. An Australian Submarine Enterprise was established which included an Enterprise steering group comprising the Royal Australian Navy (RAN), Defence’s

Capability Acquisition and Sustainment Group (CASG, formerly the DMO) and ASC. Arrangements included a redesigned submarine Usage and Upkeep Cycle (UUC - planned maintenance cycle), streamlined materials management arrangements, specialised infrastructure, greater stock of spares and a funded plan to transition the Submarine Enterprise to the new UUC and Integrated Master Schedule for the maintenance of the fleet.

3 An Exemplar Sovereign Submarine Capability

3.1 Usage Upkeep Cycle

The benchmark availabilities proposed by the Coles Study^[2] team required a change in the UUC from the extant 8+3 years to a 10+2 years model. Each submarine would be in-service for 10 years before it enters a 2 year Full Cycle Docking (refit).

To realise the proposed UUC ASC established a program focused on the critical factors necessary to assure a 10+2 UUC. They included a re-design of critical factors of the UUC, rationalisation of the maintenance package, new infrastructure, submarine hull cuts and increase in stock of materials. Separate projects were funded to develop each factor in a transition to the new UUC.

3.2 Maintenance Support Towers

A critical factor in shortening the FCD timeframe was to increase the portion of the workforce’s available time in progressing maintenance tasks. Production personnel spend a proportion of their time travelling to source tools and materials, seek engineering or supervisory advice or to rest areas for meal breaks. Keeping the work force close to the submarine would reduce time spent travelling and improve the utilisation of the effort.

Multi-storey Maintenance Support Towers (MST) “figure 2” were designed and installed to provide the necessary facilities alongside the submarine and surrounds the submarine at all levels. The MST has contributed significantly to the overall reduction in effort required to conduct an FCD.



Fig. 2. Maintenance Support Tower in use during a Full Cycle Docking

3.3 Supply Chain and Materials

Supply chain responsibilities and the availability of spare parts are significant drivers of submarine availability.

Supply chain management responsibilities had been split between Defence's Stores system and ASC. Both organisations dealt with the same suppliers for materials for different planned maintenance periods.

Material procurement and stock management was consolidated at ASC's existing facilities.

To improve the availability of spare parts Defence funded the stocking of spares separate from the funding of individual maintenance availabilities. This included the procurement of additional spares and an increase in a rotatable pool.

The result of these initiatives increased material availability considerably during the first 2 year FCD to over 90%, providing greater certainty and ability to execute production work against plan.

3.4 Shortening the Critical path

Particular maintenance routines had the greatest impact on the FCD critical path and its duration. Metal loss (corrosion) repairs during an FCD make the conduct of concurrent maintenance activities in many compartments difficult. De-conflicting metal loss repairs with Diesel Generators and Main Electric Motor refurbishment work was critical.

The Diesel Generator sets and Main Motor had to be removed from the submarine for refurbishment and set-to-work off-boat, thereby allowing concurrent metal loss repairs in the vacated compartments. The solution was to make cuts in the pressure hull structure to enable their removal "figure 3".

3.5 Effort

Under the existing 8+3 year UUC arrangements an FCD required in excess of 1 million production man hours for all maintenance tasks. A key to reducing the duration of FCDs would be to reduce the number of production hours. As part of the migration to the 10+2 UUC, key innovations reduced the FCD production effort by over 25% whilst maintaining the integrity of the maintenance package. In 2016 ASC successfully completed the first the 2 year FCD. The cost of the MST was recovered with the savings



Fig. 3. Diesel engine being removed via a hull opening

4 Outcomes

The new arrangements have seen tremendous improvements in the outcomes of the overall business of Collins Class Submarine sustainment and upgrades. The sustainment of Australia's submarines has gone from being a project of concern for the Australian Government to an exemplar^[3]. The Australian Submarine Enterprise is now delivering submarine maintenance and upgrades to the Australian Navy's submarine force at and beyond international benchmarks, and evolving towards supporting a growing multiclass fleet.

References

- [1] J. Coles, F. Scourse, P. Greenfield, A. Fisher, Collins Class Sustainment Review, Phase 1 Report, Nov 2011.
- [2] J. Coles, P. Greenfield, A. Fisher, Study into the Business of sustaining Australia's Strategic Collins Class Submarine Capability, Nov 2012.
- [3] J. Coles, P. Greenfield, M. Spark, H. Savage, A. Fisher, Study into the Business of sustaining Australia's Strategic Collins Class Submarine Capability: Beyond Benchmark, May 2016.

Speaker Biography

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Martin's over 30 years in major naval shipbuilding and sustainment include his roles as Chief Operating Officer of ASC Shipbuilding business unit and the Air Warfare Destroyer (AWD) Project, role in Collins Class design, project and business development management roles, including General Manager – ASC Shipbuilding.