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## Air Warfare Destroyer Program

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### Introduction

1. At a budgeted cost of \$8.455 billion for all phases, the SEA 4000—Air Warfare Destroyer (AWD) Program is to design, build and deliver three Hobart-class guided missile destroyers (DDGs) and their Support System to the Royal Australian Navy (RAN). These DDGs are to be named and are scheduled for delivery as follows: HMAS *Hobart*—March 2016; HMAS *Brisbane*—September 2017; and HMAS *Sydney*—March 2019. They are to replace the RAN's six Adelaide-class guided missile frigates (FFGs), two of which were withdrawn from service in 2005 and 2008. The remaining four FFGs are scheduled for withdrawal from service by June 2019.<sup>1</sup>

2. The AWD Program has four principal objectives: deliver an affordable Maritime Air Warfare capability to meet Australian Defence Force (ADF) requirements, within established schedule and cost constraints; markedly improve the overall capability of the RAN's surface combatant force; build the ships in Australia, thereby sustaining and providing significant work for Australia's shipbuilding industry<sup>2</sup>; and establish and sustain a design capability in Australia that can support the evolution of the ships in service in a responsive and cost-effective manner.

3. Figure S.1 shows the future HMAS *Hobart* under construction in December 2013. The three Australian Hobart-class DDGs are to be based on the F-104 platform design from Navantia S.A. of Spain (Navantia), with specified F-105 modifications, and additional modifications primarily to accommodate the Australianised Combat System, which comprises an upgraded United States Aegis Weapon System and additional Australian elements to meet specific capability requirements.<sup>3</sup> The DDGs are highly complex platforms, which combine advanced sensors and weapons to achieve extensive air, surface, and subsurface mission requirements.

**Figure S.1: The future HMAS *Hobart* under construction, December 2013**



Source: Defence.

4. Each DDG is comprised of 31 blocks (or ship sections) constructed via a distributed-build process at four shipyards in Australia and overseas: ASC AWD Shipbuilder Pty Ltd (ASC<sup>4</sup>), at Osborne, South Australia; Forgacs Pty Ltd (Forgacs), in Newcastle, New South Wales; BAE Systems Australia (BAE Systems), in Williamstown, Victoria; and Navantia, in Ferrol, Spain. Block consolidation is conducted by ASC at Osborne, and the DDGs' platform, sensors and weapons systems will also be integrated, set-to-work and harbour-tested at Osborne. At the time of the audit, the AWD Program was in its construction phase; by January 2014, block production was well advanced at all four shipyards, with consolidation of blocks in the form of a hull nearing completion on Ship 1.<sup>5</sup>

5. During the audit, the AWD Program was dealing with a range of challenges related to the construction and governance strategy adopted for the program and the advanced technologies used in this type of warship. The challenges include:

- re-establishing Australia’s capability to build warships;
- implementing a distributed shipbuilding strategy across Australia and in Spain, for a small production run of ships based on an evolution of an existing European design;
- installing into those ships an advanced state-of-the-art Combat System based principally on a US Navy combat information and weapons system, and integrated with a wide variety of equipment commercially procured from various Original Equipment Manufacturers; and
- managing an alliance contracting model which includes most, but not all, of the principal industry partners in the project.

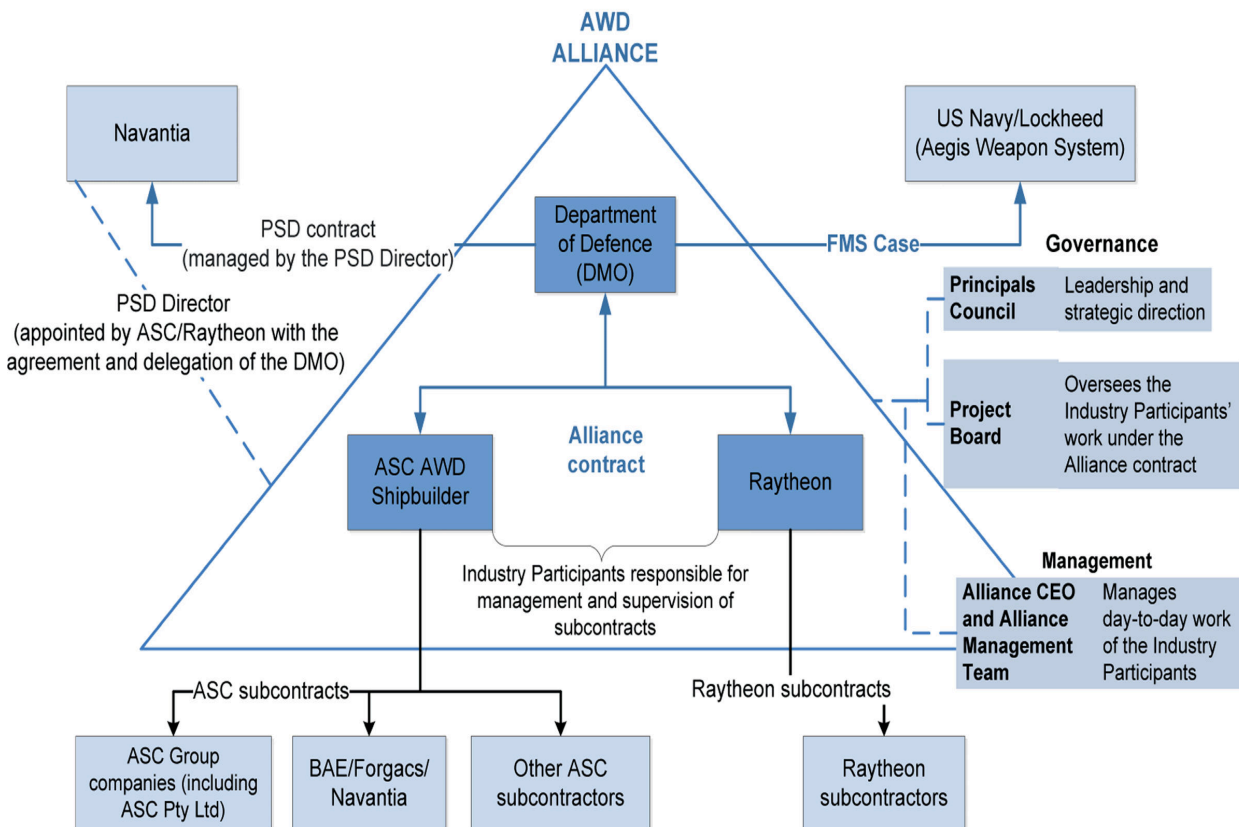
6. The Ministers for Defence and Finance announced on 17 December 2013 that the Government would establish an independent review to address ‘unresolved issues’ associated with the AWD Program, with terms of reference to be finalised in early 2014.<sup>6</sup>

**Shipbuilding alliance**

7. In October 2007, the Australian Government announced the signing of two contracts for the design, construction and delivery of the DDGs.<sup>7</sup> A contract for the Platform System Design was awarded to Navantia.<sup>8</sup> A second contract, for the construction of the ships, and involving a three-way Alliance Based Target Incentive Agreement (ABTIA), was awarded to ASC AWD Shipbuilder Pty Ltd and Raytheon Australia Pty Ltd (Raytheon). This report refers to the ABTIA as the Alliance contract. Under this contract, ASC is the Shipbuilder, and Raytheon is the Combat System–Systems Engineer, responsible for designing the Combat System and integrating it into the Platform System. Together, ASC and Raytheon are referred to as the Industry Participants in the AWD Alliance. Figure S.2 shows the AWD Alliance’s key contractual and governance relationships.

8. The Alliance contract binds three diverse organisations: the Commonwealth’s Department of Defence, represented by the Defence Materiel Organisation (DMO), as the owner-participant; and two non-owner participants, namely ASC AWD Shipbuilder Pty Ltd, the subsidiary of a (Commonwealth) Government Business Enterprise (GBE) and Raytheon, a public company. The three Alliance participants are aligned in a managerial and financial sense by the need to deliver the three DDGs within cost and schedule parameters, and to meet capability specifications, under the Alliance contract. Further, the Alliance contract formally requires openness, mutual trust and honest dealing, and the sharing of data across the Alliance organisation.

**Figure S.2: AWD Alliance key contractual and governance relationships**



Source: Defence Materiel Organisation.

Notes: FMS—Foreign Military Sale (US). PSD—Platform System Design.

9. The Alliance contract’s cost-plus-incentive-fee arrangement provides ASC and Raytheon with monthly payments for their Direct Project Costs, and incentive fees which vary according to the Industry Participants’ collective cost and schedule performance relative to a Target Cost Estimate. Known as the pain-share gain-share arrangement, the incentive fees decrease toward zero as the Direct Project Costs exceed the Target Cost Estimate, or increase when the Direct Project Costs fall below the Target Cost Estimate. This arrangement differs from most DMO major projects,

which have contractors delivering highly-defined supplies for a fixed price.

10. Navantia is not party to the Alliance contract. However, in recognition that Navantia will play an important part in the success of the AWD Program, both the Alliance contract and the Platform System Design contract (between the DMO and Navantia) contain obligations for all parties to carry out their respective roles in a spirit of collaboration and cooperation. The AWD Alliance Industry Participants manage the Platform System Design contract on a day-to-day basis, and have appointed a Platform System Design Director who, under a delegation from the DMO's AWD Program Manager, accepts or may reject contract supplies from Navantia.

11. As the Commonwealth representative in the Alliance, the DMO has a number of roles and responsibilities. The DMO is responsible, via its Materiel Acquisition Agreement with Defence, for the overall management of the AWD Program. In its role of project customer, the DMO seeks a compliant design and the on-time delivery of the DDGs and their Support System. This includes bringing to the Alliance an understanding of Defence's requirements through its reach into the Australian Defence Organisation, and granting Provisional Acceptance of products delivered through the Alliance contract.

### Audit objective and scope

12. The objective of the audit was to report on the progress of the current phase of the AWD Program, which is known as SEA 4000 Phase 3—Build. This phase commenced in June 2007, and covers the finalisation of the detailed design, the signing of the Alliance and Platform System Design contracts, and the construction and delivery of the ships by the Industry Participants to the DMO.

13. Phase 2 of the AWD Program was the design phase, and ended in June 2007. Phase 2 is addressed in this report in terms of its role in reducing risks in Phase 3.

14. The audit focused primarily on Defence's administration of the AWD Program. It examined Defence's progress thus far in establishing and working through the management structures and processes used to deliver the DDGs within approved cost, schedule and performance parameters. The audit considered the Hobart-class DDGs' design and construction in terms of: the achievement of key engineering and construction milestones, based on systems engineering criteria; the management of cost, schedule and their attendant risks; and the effectiveness of the Alliance contract.

15. The high-level criteria used in the audit to assess Defence's administration were as follows:

- contract management processes should be in accordance with internal Defence procedures and contractual provisions;
- appropriate project governance, financial controls, and reporting mechanisms should be in place;
- delivery and acceptance arrangements should assure conformance with technical regulatory requirements; and
- the program should adhere to agreed systems engineering procedures.

## Overall conclusion

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16. At a budgeted cost of some \$8.5 billion, the SEA 4000—Air Warfare Destroyer (AWD) Program is one of the largest acquisitions undertaken by the Department of Defence (Defence) for the Royal Australian Navy (RAN).<sup>9</sup> The Program will deliver three Hobart-class Guided Missile Destroyers (DDGs) that will replace the RAN's four remaining Adelaide-class Guided Missile Frigates (FFGs). The DDGs are based on a modified version of an existing design, newly exported by a Spanish designer to a new Australian shipbuilder for construction in a distributed-build environment. The Alliance contract for the construction of the DDGs involves the Commonwealth as the owner-participant; and two non-owner Industry Participants, namely ASC AWD Shipbuilder Pty Ltd, the subsidiary of a (Commonwealth) Government Business Enterprise (GBE) and Raytheon, a public company.

17. The AWD Program's governance and construction arrangements are inherently complex, but seek to strike a reasonable balance between assigning core responsibilities to individual parties and promoting a cooperative relationship between the Alliance participants. The Alliance contract imposes a 'fundamental obligation' on the Industry Participants to deliver the DDGs and other Supplies and to achieve delivery schedule commitments. There is, accordingly, high dependency on the performance of the Industry Participants to manage the project risks in association with the Commonwealth. Any residual risks accrue to the Commonwealth in funding the project, and to the Commonwealth's representative in the Alliance, the Defence Materiel Organisation (DMO), in managing the delivery of this significant capability within cost and to schedule, as the AWD Program manager and project customer on behalf of the RAN.

18. Successive Australian governments have accepted that building the DDGs in Australia would involve a premium over and above the cost of building them overseas. The decision to build locally is based on a desire to retain shipbuilding jobs and facilities, project management and design skills, and experience with sophisticated naval combat systems, so as to enable through-life support of the DDGs in Australia and a continuing naval shipbuilding industry. As part of the June 2007 Second Pass submission to government, the Treasury noted that the premium associated with building the DDGs in Australia was around \$1 billion, representing an effective rate of assistance of over 30 per cent for naval shipbuilding.

19. Since the commencement of the build phase, the AWD Program has developed and maintained a skilled workforce and production facilities, and made significant progress in the construction of the DDGs. As at January 2014, consolidation of blocks in the form of a hull was nearing completion on Ship 1, and zone-level fit-out was well underway. The majority of Ship 2 blocks were structurally complete and production outfitting was underway. In the near future, the build phase will expand into the installation, set-to-work and systems integration of complex state-of-the-art warship platform and combat systems. Nevertheless, under current plans, there is a gap between the DDGs' production and the next design-and-construction program for major surface ships, which would result in a reduction in the naval shipbuilding workforce. A range of Defence stakeholders<sup>10</sup> have observed a risk, which is under consideration by the Australian Government, that the experience and knowledge gained by the shipbuilding sector during the build phase may not be available to meet the RAN's future whole-of-life support and capability requirements.

20. Defence developed the AWD Program ship design options and alliance arrangements through a substantial investment<sup>11</sup> in a competitive design phase and the close involvement of industry during that phase. This resulted in the selection of a modified Existing Design by the then Government in 2007 instead of an Evolved Design. The Evolved Design was considered to be too immature and presented high risk. In developing the Alliance contractual arrangement, Defence combined elements of a typical alliance contract with the more 'standard' risk allocation provisions of a fixed-price contract, with a view to protecting the Commonwealth's interests. The Alliance contract obliges the Industry Participants to deliver



the DDGs and meet schedule commitments. Based on the extensive work undertaken on the design by industry in the design phase, the Alliance contract also includes warranties by the Industry Participants that they had assessed the risks they were assuming; and that they had the resources required to perform their obligations.

21. Despite the contractual arrangements put in place to manage the project, the AWD Program has experienced a range of delivery issues, including significant immaturity in detailed design documentation<sup>12</sup>, major block construction problems and substantially lower than anticipated construction productivity. The design and construction issues have led to extensive, time-consuming and costly rework.

22. The Alliance reported in November 2013 that the contract for the construction of the DDGs would be completed at an estimated cost of some \$302 million or 6.8 per cent in excess of the Target Cost Estimate. The cost overrun is attributable to the shipbuilding elements of the project.<sup>13</sup> As previously reported in the 2012–13 Major Projects Report, the AWD Program exceeded its original budget allocation for 2012–13 by \$106.4 million as a result of increased Direct Project Costs from the Industry Participants for labour, materials and subcontract costs.<sup>14</sup> In the same report, the CEO DMO advised that:

There are emerging concerns from the AWD Alliance around cost overruns and associated delays in shipbuilding aspects of the AWD Program. An independent review is to be commissioned to identify factors contributing to cost growth and delays, and to recommend remediations and mitigation.<sup>15,16</sup>

23. In the light of these concerns about cost overruns, the current estimated cost of \$302 million in excess of the Target Cost Estimate should be treated with caution; the cost increase is likely to be significantly greater.

24. The delivery schedule for the three DDGs was revised in September 2012 and is now some 15 to 21 months later than the original delivery schedule (for Ships 1 to 3). Despite the effect of design and construction issues on the cost and schedule for the DDGs, their materiel capability requirements remain as specified at Second Pass approval. However, Operational Test and Evaluation to validate the specified capability achievement is scheduled to commence in August 2015 for Ship 1, 12 months later than originally scheduled.

25. While Defence did seek to adopt prudent risk mitigation strategies in the design and build phases of the program, drawing heavily on industry input and experience to inform its advice to government, the risks of developing a modified design, exporting the design for construction in distributed Australian shipyards, and re-establishing Australia's shipbuilding capability were underestimated. This is the first time the Spanish designer Navantia has exported a surface ship design for construction by international shipyards, the first time ASC has built a surface ship, and the other Australian shipyards lacked recent experience in complex warship building. While Defence has subsequently sought to address design, construction and productivity issues through DMO involvement in Alliance governance and program management, and the application by the Industry Participants of new strategies during the build phase, substantial performance issues were ongoing in late 2013. As mentioned above, the continuing detailed design, construction and productivity issues present a significant risk of further overruns in the cost of the project, as well as in the delivery schedule, and will require an ongoing management focus. Further, the program is approaching the complex stage of systems integration when, historically, cost and schedule risks tend to rise.<sup>17</sup>

### **Technical and contractual risk mitigation strategies**

26. Defence sought to assess and mitigate design and production risks through a substantial investment in the design phase (Phase 2) of the AWD Program, which drew heavily on industry input and advice, and through the terms and conditions of the Alliance and Platform System Design contracts, which were also intended to harness industry cooperation. During Phase 2, the DMO engaged two teams of shipbuilders and designers to analyse an Existing Design and an Evolved Design and arrive at an overall Hobart-class DDG design.<sup>18</sup> In August 2004, the US Navy's Aegis Weapon System was selected as the preferred combat system for the yet-to-be-selected DDG platform system. In April 2005, Raytheon was selected as the Combat System–Systems Engineer.<sup>19</sup> Phase 2 ended in June 2007 with the then Government's Second Pass approval of the acquisition of three Hobart-class DDGs based on Navantia's existing F-104 platform design, with specified F-105 modifications, and additional modifications primarily to accommodate the Australianised Combat System, which comprises an upgraded Aegis Weapon System and additional Australian elements to meet specific capability requirements. The selection of largely existing platform and combat system designs formed the basis of the DMO's technical risk reduction strategy for the Program, and was considered at the time to provide a high level of comfort.

27. Notwithstanding the risk mitigation strategies applied by the DMO in the program's design phase, the selected design did not exist in an 'as built' form.<sup>20</sup> Experience shows that assessments about the quality of design supplies were overoptimistic during Phase 2 of the AWD Program.<sup>21</sup> Defence and its industry advisers underestimated the risks associated with incorporating the design changes to Navantia's F-104 design, exporting that design to Australia, and adapting the designer's build strategy and processes to accommodate a distributed build at shipyards that lacked recent experience in warship building. Further, this is the first time Navantia has exported one of its ship designs for construction by international shipyards, and the first time ASC has built a surface ship. A better understanding of these risks is likely to have led Defence and the Industry Participants to proceed more cautiously in accepting the detailed design and moving into production, with strengthened design supply management processes to reduce the risks associated with the exported design, and its distribution to the shipbuilding contractors. It is also likely to have led to a stronger focus on the Australian shipbuilders' production engineering processes and shipbuilding productivity from the outset of the build phase, in the context of an ambitious project to re-establish Australia's capability to build warships.

28. Further, Defence sought to mitigate risk in the build phase (Phase 3) of the AWD Program through an alliance arrangement intended to incentivise the Alliance Industry Participants (ASC and Raytheon) to work cooperatively in the pursuit of cost, schedule and performance parameters. The Alliance governance and program management arrangements also enable the DMO, as the owner-participant in the Alliance, to closely monitor the build phase and work through the Alliance to address issues.

29. However, the intention to include Navantia, the Platform System Designer, in the Alliance did not eventuate. The then value of the Platform System Design work (some \$300 million) was low when compared to the then cost of the Alliance contract (some \$4.4 billion), and there was limited incentive for Navantia to put its own profit share at risk by entering an Alliance arrangement with a new shipbuilder, and taking part in the pain-share gain-share regime it imposed on potential profit.<sup>22</sup> While Defence has delegated responsibility for the day-to-day management of the Platform System Design contract to the Industry Participants, by itself this measure has not resulted in effective integration between the designer and the Alliance, and a range of other strategies have been applied over a four-year period to strengthen integration. The non-inclusion of Navantia has detracted from the Alliance's ability to collectively and collaboratively manage risks, which are among the main reasons for establishing such



an arrangement; and there has been incomplete alignment of incentives for sharing of best practices and for reducing costs, from design conception through to shipbuilding and ship acceptance. This experience highlights the challenges in effectively managing the risks when a key industry participant is not party to an alliance contract; and, while accepting that the terms of an alliance contract need to be acceptable to all of the key industry participants, underlines the benefits of establishing arrangements which include all such participants.

### Design and construction progress

30. Since the initial delivery of construction drawings and the completion of design and production readiness reviews in 2009, the build program has experienced:

- Immaturity in the detailed design documentation provided by Navantia, predominantly associated with drawing errors or omissions, contract amendments and late Vendor Furnished Information.<sup>23</sup> The volume and timing of design change have been significant, at times saturating the Alliance's engineering and planning departments, resulting in late releases of design drawings to ship production. There has been an average of 2.75 revisions per drawing (as at March 2013), and revised drawings were still being provided in late 2013. This process has led to costly and out-of-sequence rework in cases where construction work already undertaken no longer matched the design.<sup>24</sup>
- Major block construction issues at block subcontractor level associated with shortcomings in capacity and skills—initially at BAE Systems and more recently at Forgacs. In the case of BAE Systems, this resulted in rework and the reallocation of work between shipyards. The Alliance has noted that during Phase 2, government and industry operated on the shared assumption that potential block subcontractors had the financial capacity, facilities and commercial incentive to complete significant portions of the DDG hull block production. However, it became apparent during the block subcontract and tendering process that none of the tendering shipyards had recently performed work of this type on the scale anticipated, and that each facility required significant capital investment to develop the necessary handling and processing capability.<sup>25</sup>
- A continuing decline in construction productivity. By November 2013, the program's Earned Value Management System revealed that it was costing ASC, the lead shipbuilder, \$1.60 to produce work that was originally estimated to cost \$1.00.<sup>26</sup> As discussed later in paragraph 33, a range of factors have been assessed as contributing to low construction productivity, including the performance of ASC and its Australian block subcontractors, and construction rework arising from both ongoing changes in the detailed design and rectification of block subcontractor work. The Australian shipyards' distributed-build production engineering strategies and build processes continued to evolve into 2013, some four years after block construction began.

31. In responding to this report, the two major subcontractors, BAE Systems and Forgacs, emphasised the significant challenge they faced in re-establishing shipbuilding facilities and skills after a gap in naval shipbuilding.<sup>27</sup>

32. Defence has sought to address the range of program risks in such a major acquisition through DMO involvement in Alliance governance and program management. The Alliance applied a series of strategies between 2009 and 2013 to address immaturity in detailed design documentation, including the purchase and use of 3-D Computer Aided Design (CAD) models of the DDGs<sup>28</sup>, and better leveraging of Navantia's knowledge and experience into the Alliance. These strategies primarily involved the assessment of potential design issues, and the implementation of revised approaches to manage change in the detailed ship design. During the same period, the Alliance progressively reallocated blocks between shipyards in response to capacity and skills issues. Nevertheless, detailed design immaturity and construction performance issues were ongoing in late 2013, and continue to pose a risk to the program's cost and schedule.

33. Defence has also taken steps to examine the construction productivity issues and promote shipbuilding productivity improvements. The DMO has raised productivity at the AWD Principals Council and engaged the internationally recognised shipbuilding advisory firm First Marine International (FMI) to carry out an independent assessment of objective and actual productivity of the Australian DDG block builders between 2010 and 2012.

34. In 2010, FMI found that core productivity<sup>29</sup> was unlikely to be achieved. FMI suggested that the maximum possible attention be given to resolving the issues surrounding the technical information and the transfer of technology from Navantia. It also suggested that a concerted effort be made to move away from project development and to settle into a stable production process as quickly as possible; that effective processes were needed to ensure the maximum productivity improvement was gained from lessons learnt; and that a culture of continuous improvement and cooperation be fostered, supported by some good shipbuilding process metrics, rather than just the EVMS data.

35. However, during the DDG construction program, immaturity in detailed design documentation has tended to overshadow other factors contributing to low shipbuilding productivity<sup>30</sup>, and the link between stable or mature design data and shipbuilding productivity continues to be emphasised in the media.<sup>31</sup> FMI reported mixed progress against the observations and suggestions it made in 2010 and 2011, and made many new observations and suggestions in 2012 to improve shipyard performance.<sup>32</sup> Further, it was not until 2013 that the Alliance put in place extensive key performance measures of productivity, and reported more detailed cost variance analysis on factors contributing to productivity shortfalls, such as design change, out-of-sequence work, production defects, rework and cost estimation errors.<sup>33</sup> Going forward, it is clear that a rigorous focus will be required to address the underlying causes of low shipbuilding productivity so that construction cost overruns are contained over the remainder of the DDG build program, and more broadly so that the AWD Program's four principal objectives (listed in paragraph 2) are achieved.

### Cost and schedule performance

36. The Alliance has estimated that the Alliance contract will be completed for \$4.776 billion (December 2006 prices), which is \$302 million or 6.8 per cent over the Target Cost Estimate.<sup>34</sup> However, in September 2013 an Integrated Baseline Review Report<sup>35</sup> indicated that major corrective actions were necessary to restore confidence in the AWD build program's cost and schedule estimates. The report highlighted problems with the EVMS's Performance Measurement Baseline<sup>36</sup> and that corrective action was required for the EVMS to be considered acceptable for accurate performance measurement. As discussed in paragraph 22, the CEO DMO has also noted that there are emerging concerns about cost overruns and associated delays in shipbuilding aspects of the AWD Program.

37. Following the emergence of block construction issues at the BAE Systems shipyard, in September 2012 the Government announced a plan to extend the AWD Program so that the delivery of the first ship was delayed by 15 months and the interval between the delivery of the ships was

increased from 15 to 18 months.<sup>37</sup> The first DDG is now scheduled to be delivered in March 2016, rather than December 2014 as originally planned. The three DDGs will progress through sea trials and increasing levels of Operational Capability in order to achieve Final Operational Capability in March 2020, when all the Fundamental Inputs to Capability for the DDGs are expected to be in place.<sup>38</sup>

### **Defence's position within the Alliance**

38. As noted in paragraph 28, the Alliance's contractual and governance arrangements have promoted cooperative relations, but cannot be expected to eliminate all tensions between the parties, such as those arising from the erosion of fees due to higher than anticipated costs in constructing the DDGs. Under the Alliance contract, Defence pays all specified direct costs that the Industry Participants incur (reimbursable Direct Project Costs), and if there are cost overruns, the Alliance Industry Participants share reductions in their incentive fees, because these fees are geared to the Alliance contract's Target Cost Estimate and the Industry Participants' collective cost efficiency. In March 2012, the Industry Participants submitted to the AWD Alliance Project Board a \$240.6 million (December 2006 prices) claim for a schedule extension and a Target Cost Estimate adjustment, based on the amount of Platform System Design change they had experienced. The Alliance Project Board could not come to an agreement on the claim, because the DMO member, on advice from DMO Counsel, did not agree to the claim. Within this context, the DMO has not fully utilised the overarching governance body, the Alliance Principals Council, to contribute to the mitigation of risk and the resolution of issues between the parties. Further, the position of the independent chair of the Council—a potential source of additional insight and advice to the Alliance participants, the Defence Minister and the ASC shareholder Minister (the Minister for Finance)—has been left unfilled since August 2011.

39. As noted in paragraph 17, there is high dependency on the performance of the Industry Participants to manage risks with the Commonwealth. The DMO has appropriately reminded the Industry Participants of their contractual obligations<sup>39</sup> and the warranties they provided to deliver the DDGs based on their work during Phase 2.<sup>40</sup> Nevertheless, it remains incumbent on the DMO, as the owner-participant, to make full use of the Alliance structure and framework to inform itself of program risks and take an active role in guiding and gaining assurance about the strategies to be pursued by the Industry Participants to manage and resolve build program issues, which are ongoing. The DMO faces both an immediate, and a continuing challenge, in acting to mitigate the key risks faced by the AWD Program, so as to achieve the timely delivery of capability to the RAN and limit the overall cost to the Commonwealth.

### **Recommendations**

40. In the context of ongoing challenges during the build phase of the AWD Program and a proposed government review of the program, the ANAO has recommended that the DMO reinvigorates the AWD Alliance's Principals Council to provide additional leadership and assist in addressing the serious issues facing the AWD Program, including by raising with the Minister the appointment of a suitably experienced and independent chair.<sup>41</sup>

41. The ANAO has made two further recommendations directed towards future Australian naval construction programs. The first of these recommendations focuses on reducing the risk of detailed design errors from the outset of naval construction, through a fully integrated design review process, supported by contemporary Computer Aided Design technology.

42. The final recommendation focuses on the development and monitoring of a set of productivity metrics from the outset of future Australian naval shipbuilding programs, to gauge the key factors influencing productivity and, where required, help bring about productivity improvements. The ANAO has also made a number of suggestions in the report where there are opportunities to improve the project's management.<sup>42</sup>

### **AWD Program review**

43. The Ministers for Defence and Finance confirmed on 17 December 2013 that the Government would establish an independent review into the AWD Program, with terms of reference to be finalised in early 2014. The independent review presents an opportunity to identify strategies aimed at addressing construction challenges, increasing productivity and mitigating further cost overruns, in a timely manner.

### **Lessons for future naval construction programs**

44. The audit highlights some key lessons for Defence's management of risk, alliance contractual arrangements and naval construction programs. These broadly focus on the effective integration of key industry participants, and the management of maturity in the design and production systems.

45. A common issue that has been experienced in complex state-of-the-art warship building in recent decades has been immaturity in the design and production system.<sup>43</sup> The AWD design phase demonstrated the potential benefits of close industry involvement during the planning phase to inform the management of such risks. It has also become an accepted practice to adopt alliance contractual arrangements where there is project risk and cost sharing between the various parties.

46. Where a key industry participant is not party to an alliance arrangement, a rigorous approach is needed to ensure that the products and services they provide will match the construction strategies applied by the alliance. Alliance governance and operational arrangements should also be explicitly adapted from the outset so as to make up for any contractual shortfall and provide sufficient forums for joint oversight of key issues. This may include regular involvement by the industry participant in alliance board discussions.

47. Looking forward, for programs such as the Future Frigate (SEA 5000) and the Future Submarine (SEA 1000), the design process, and subsequent design and production reviews need to be effective in working through a range of fundamental issues relating to the design and construction. Proposed designs, and construction and delivery schedules, need to be thoroughly assessed to confirm that there is sufficient time to conduct adequate pre-production systems engineering processes, including Preliminary Design Reviews, Critical Design Reviews, Detailed Design Reviews and Production Readiness Reviews. Designers need sufficient time to incorporate design changes that allow an acceptable level of concurrent design and production to proceed. Construction should commence only when the infrastructure, resources and construction data are stable enough to allow production to commence within manageable cost and schedule risk profiles. Shipbuilders need sufficient time to assess, in detail, the overall capability of their shipyards, to ensure that their production engineering management systems, quality systems (including dimensional control systems and workshop skill-levels) and production capacity are prepared for the nature and volume of the construction work that they would be expected to perform. This is particularly the case when shipbuilders do not have recent experience in complex warship building.

48. Building a ship as complex as the Hobart-class DDGs is a significant challenge even with a stable design package. While the construction of the three DDGs will be completed and the ships commissioned sequentially, in practice, significant construction work, such as block building and consolidation, is occurring in parallel with the integration of platform-system and combat-system elements. This places a premium on the effective management of the design, the coordination of engineering activities and the maintenance of effective relationships between the parties. The exporting of a design also creates challenges in terms of different work practices and levels of experience in modern warship building between the designer and the shipbuilder. For future naval construction programs with similar characteristics, a high level of integration should be sought between the designer and shipbuilder throughout the program.<sup>44</sup>

## Key findings by chapter

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### The AWD Program (Chapter 2)

49. The AWD Program's preliminary design phase, known as SEA 4000 Phase 1, commenced in 2002, and involved the selection of the DDGs' combat system and competitive selection of the major contractors for the project. In May 2005, the AWD Program received First Pass government approval to proceed into Phase 2. The then Government's First Pass approval reduced to two the number of alternative solutions to be examined by Defence in Phase 2: the Existing Design offered by Navantia, and the Evolved Design offered by Gibbs & Cox. Following a tender process involving Australian shipbuilders, at First Pass, the then Government also selected ASC AWD Shipbuilder Pty Ltd to build the ships to the design that was to be approved at Second Pass.<sup>45</sup>

50. The objective of SEA 4000 Phase 2 was to further analyse the Navantia and Gibbs & Cox ship and Support System designs, so that the Government could rely on comprehensive analysis of operational capability, cost (acquisition and through-life), schedule and risks when it considered Second Pass approval of SEA 4000's build phase—Phase 3. To arrive at the preferred AWD design, ASC, Raytheon, Navantia and Gibbs & Cox were engaged by Defence under individual contracts. Both platform designers were required to work with ASC and with Raytheon to arrive at an overall Hobart-class DDG design. Phase 2 ended in June 2007 with the then Government's Second Pass approval of the acquisition of three Hobart-class DDGs based on Navantia's existing F-104 platform design, with specified F-105 modifications, and additional modifications primarily to accommodate the Australianised Combat System, which comprises an upgraded Aegis Weapon System and additional Australian elements to meet specific capability requirements. Treasury advised the then Government that the premium associated with building the DDGs in Australia was around \$1 billion, representing an effective rate of assistance of over 30 per cent for naval shipbuilding. Total expenditure on Phases 1 and 2 of the AWD Program was some \$262 million.

51. In its June 2007 Second Pass submission for the AWD Program, Defence advised government that: the technical risk in the program was high but the platform risk was low, because the design existed and was in service with the Spanish Navy; the schedule risk was low–medium, because Navantia had proven work packages prepared for the Existing Design option, and the industry proposal took a conservative approach to schedule; and cost risk was medium, with the main sources of risk being the non-Aegis elements of the combat system, and possible labour costs. The submission also advised government that the F-100 platform, including the proposed design changes, was based on a mature design and mature production processes, which could be transferred to Australian shipbuilders at relatively low risk. Notwithstanding the resources applied during Phase 2 to develop the designs and mitigate risks, half way into the build phase of the AWD Program, it is apparent that the risks associated with incorporating the design changes to Navantia's F-104 design, exporting that design to Australia, and adapting the designer's build strategy and processes to accommodate a distributed-build construction method in Australia, were underestimated at the time of the June 2007 Second Pass submission to government.

52. Contract amendments are expected and budgeted for in a defence program of the size and technological complexity of SEA 4000 Phase 3. Five Alliance contract amendments relate to scope change for the construction of the ship, and were foreshadowed in the funding submission at Second Pass in 2007. That submission contained an allowance of \$122 million for platform-related changes that were a consequence of F-105 modifications and RAN requirements. As at December 2013, the AWD Alliance's Target Cost Estimate for construction of the DDGs had increased by \$124 million, or 2.9 per cent, as a result of 19 contract amendments. While the value of Alliance contract amendments was largely known at Second Pass, in the context of an exported design and distributed-build strategy, the contract amendments have added to the risks and challenges faced by the Alliance during the build phase of the AWD Program.

53. SEA 4000 Phase 3 includes the objective of achieving expenditure of 50 per cent of the Alliance contract's Target Cost Estimate on products and services provided by Australian industry. By October 2013, 52.3 per cent of Direct Project Costs—or \$1.635 billion of \$3.129 billion—had been spent in Australia. Based on expenditure by currency, as at December 2013, 51.1 per cent of the overall Phase 3 expenditure had occurred overseas, and 48.9 per cent of expenditure had occurred in Australia.

54. Joint Project Directives are intended to provide top-level direction from the Secretary and Chief of the Defence Force to the Capability Manager (in this case the Chief of Navy), to facilitate the introduction of full operational capability into service by the date agreed by Government. SEA 4000 Phase 3 commenced prior to the introduction of Joint Project Directives, and Defence has not retrospectively developed a directive for the AWD Program.<sup>46</sup> Nevertheless, the completion of a Joint Project Directive for the AWD Program would assist to maintain clarity in roles and responsibilities within Defence for the delivery of the DDGs, including in the event of turnover of key Defence personnel, or changes in program parameters as a result of government decisions.

### The AWD Alliance and the Design Contract (Chapter 3)

55. The three-way Alliance between the DMO as owner-participant, and ASC and Raytheon as non-owner participants, binds three diverse organisations in a managerial and financial sense by the need to deliver the three DDGs within cost, schedule and capability specifications.

56. Project alliances offer potential benefits over traditional construction contracting methodology. They also raise new and different risks that have to be managed—in particular, determining the appropriate balance between maintaining the collaborative spirit of the alliance, and protecting the Commonwealth's financial interests and expected outcomes.<sup>47</sup> Under traditional contracts, the parties have specific individual obligations, and risks are generally allocated to the party considered best able to manage them. Under a project alliance, risks and responsibilities are generally shared and managed collectively, rather than allocated to individual parties.<sup>48</sup> Informed by external advice, the provisions of the Alliance contract were intended to strike a reasonable balance in promoting a collaborative management approach while protecting the Commonwealth's interests. In consequence, the Alliance contract combines elements of a typical alliance contract with the more 'standard' risk allocation provisions of a fixed-price contract.



57. The Alliance contract is intended to provide financial incentives to motivate the Industry Participants to work together to mitigate AWD Program risks and to quickly resolve issues. The reimbursement of defined Direct Project Costs and the payment of 'Fee' (profit and Corporate Overhead) are determined by the Industry Participants' collective (not individual) performance against an agreed Target Cost Estimate. The management reserve also enables contingencies to be managed within existing contractual arrangements. The Alliance contract has been instrumental in facilitating the acceptance into the program of a large number of changes in the detailed design documentation provided by Navantia without the need for changes to undergo the contract price and schedule negotiations and adjustments that are normally the case with fixed-price contracts. However, it should be noted that, under the contract's cost-plus-incentive-fee arrangement, the Commonwealth shares the cost of production inefficiency. While the Industry Participants' Fee may reduce to zero, the Commonwealth will continue to be liable for Direct Project Costs.

58. Notwithstanding the financial incentives provided by the Alliance contract, and its other features intended to protect the Commonwealth's interests, such as the 'fundamental obligation' and industry warranties, the underlying design of the Alliance means that significant risk remains with the Commonwealth. While ASC AWD Shipbuilder Pty Ltd is a subsidiary of ASC Pty Ltd, and does not have the legal persona of the Commonwealth, it is nonetheless a subsidiary of a Commonwealth business entity whose board is ultimately responsible to the Australian Government (through the shareholder Minister) and the Parliament, and whose income flows primarily from the Commonwealth. In these circumstances, the fundamental obligations agreed by ASC, and the contractual warranties it has offered to the DMO, may be of limited financial benefit to the Commonwealth. A range of mechanisms is available to the Australian Government, as discussed in its *Commonwealth Government Business Enterprise—Governance and Oversight Guidelines*, for the shareholder Minister to be provided with additional performance information from ASC and its subsidiary about the project, should government wish to receive such information.

59. The Australian Government can reasonably look to the DMO, as the Commonwealth representative in the Alliance and the 'owner-participant', to adopt an active stance within the context of the Alliance, while also encouraging and enabling the Industry Participants to apply their expertise to quickly resolve issues. In this respect, the ANAO noted that the DMO has appointed several experienced officers with relevant industry expertise in shipbuilding to the AWD Program Management Office, and has engaged a firm with major construction contract management expertise to provide day-to-day advice on contractual issues. The DMO has, as part of the Alliance contract, also invested significantly in directly staffing the Alliance, as a risk mitigation strategy. These arrangements assist the DMO in its interactions with the Industry Participants, and in providing advice on risk management approaches.

60. As at November 2013, the Alliance was experiencing a range of difficulties that have cost and schedule implications. Longstanding issues with the maturity of detailed design documentation were ongoing, resulting in significant rework, major construction problems had re-emerged at subcontractor level, and shipbuilding productivity remained well below expectations. In these circumstances, it remains incumbent on the DMO, as the owner-participant, to make full use of the Alliance structure and framework to inform itself and take an active role in guiding and gaining assurance about the strategies to be pursued by the Industry Participants to manage and resolve build program issues.

61. Further, the Alliance operates under three major governance bodies: the Principals Council, the Project Board, and the Alliance Management Team. However, the Alliance governance structure has not been fully utilised to contribute to the mitigation of risk. The Principals Council, consisting of chief executives and an independent chair, has met only eight times since 2007, not achieving the annual frequency envisaged by the Alliance contract (no meetings were held in 2011 or 2013). The Project Board, the working-level governance body, has generally met at least monthly since 2007, and hence has provided the primary decision-making body for the Alliance. The potentially valuable role of the independent chair of the Principals Council remains vacant, and Navantia is outside the Alliance.

62. The original intention to include the Platform System Designer in the Alliance did not eventuate, and this has contributed to difficulties associated with exporting the design to Australia. The DMO's *Phase 2 Overall Program Report* states that Navantia was not prepared to agree to the liability regime that the Alliance contract was to impose. For its part, Navantia informed the ANAO in October 2013 that there was a lack of clarity with respect to the proposed liability regime, and that it preferred a separate contract be established for the Platform System Design. Defence sought to minimise the impact of Navantia's exclusion from the Alliance by incorporating provisions into the Alliance and Platform System Design contracts that provide for cooperation and collaboration between Navantia and the Alliance, including delegation of responsibility for the day-to-day management of the Platform System Design contract to the Industry Participants. Nevertheless, the fact that the Platform System Designer is not part of the Alliance has detracted from the Alliance's ability to collectively and collaboratively manage risks, and to do so in a timely manner—which are among the main reasons for establishing such an arrangement. It has also resulted in an incomplete alignment of incentives for sharing of best practices and for reducing costs, from design conception through to shipbuilding and ship acceptance. The design issues have highlighted that, ideally, an alliance should include all of the key industry contributors to the task being undertaken, as initially envisaged for the AWD Program. When it is not possible to achieve a comprehensive alliance arrangement because of the stance taken by an industry contributor, appropriate governance and operational arrangements should be established to mitigate the associated risks and enable effective integration between the key contributors to the project.

#### **Engineering, Regulation and Test and Evaluation (Chapter 4)**

63. The AWD Program has three key Capability Definition Documents that specify the program's requirements in terms of: the functions that each DDG is to perform, how well each function is to be performed, and the tests and evaluations needed to verify and validate contractor achievement of the specified requirements. Requirements contained within these documents are translated into the AWD Alliance contract in the form of the Hobart Class Platform System Specification (HCPSS) and Hobart Class Systems Specification (HCSS). The AWD Alliance is required to conduct test procedures and produce test reports that verify compliance with these specifications. As at April 2013, the Capability Definition Documents had been fundamentally stable since Second Pass approval in June 2007. The HCPSS has, however, changed many times since contract commencement to account for design changes.

64. The ADF introduced a standardised Technical Regulatory Framework in 2002 to ensure that ADF materiel is fit for service. The AWD Program has complied with those sections of the Technical Regulatory Framework that cover program activities up to midway through the build phase, including the preparation of a Project Certification Plan and Safety Program Requirements. The AWD Alliance achieved the status of an Authorised Engineering Organisation in July 2008, and the regulators have endorsed the Engineering Management Plan and Project Certification Plan.

65. Regulatory structures generally provide for independent assessment of design risks by requiring organisational separation between designers and the individuals responsible for accepting designs, or assessing the risks in accepting the designs. However, the Alliance Technical Director is responsible for the certification of the Hobart-class DDG design, and the Alliance Engineering Director's Design Acceptance Representatives are responsible for providing independent assessments of the technical integrity risk associated with that design. To support the integrity of these risk assessments, the Design Acceptance Representatives report to the General Manager Stakeholder Engagement (GMSE). GMSE is a one-star

Officer of the RAN's Engineering Branch, and reports to DMO's AWD Program Manager on design acceptance issues. GMSE also chairs the RAN's one-star Program Management Stakeholder Group, and reports to the three-star Program Management Stakeholder Group.

66. In August 2013, Defence informed the ANAO that the Naval Technical Regulatory System has assurance mechanisms to provide high levels of confidence that the AWD Program's Design Acceptance Representatives remain independent and impartial in relation to the Hobart-class DDG design process.

67. At the time of the audit, the build program was at the Hull Integration Complete stage. Very few of the DDGs' systems had been installed and set to work. Consequently, it may not be until December 2014—when the combat system of Ship 1 is scheduled to be fully installed—that the AWD Program's system-level tests and evaluations, on board the ship and at sea, will begin to fully verify and validate system performance against function and performance specifications. In January 2014, the AWD Alliance CEO informed the ANAO that, of 1986 Combat System requirements, 864 had been fully completed and are not subject to further validation.<sup>49</sup>

### Design Progress (Chapter 5)

68. No matter how well planned a project has been, if there is inadequate control over changes, this will compromise the likelihood of completing it on schedule and to budget. The AWD Program sought to mitigate design change risks by basing the Hobart-class DDGs on the F-104 platform, which was designed and built by Navantia and is in operation with the Spanish Navy. A number of changes have been included in the Hobart-class DDG platform design, as the schedule for those options was seen as being manageable. Four main reasons for these changes were: the Australianised Combat System (based on the Aegis Weapon System), obsolescence, Australian legislative requirements<sup>50</sup> and lessons learned from the F-105. Platform System design changes may be considered as evolutionary and relatively low-risk when the designers, shipbuilders and technical regulators have a history of working together on the development of the particular class of ship. However, the same design changes can take on a quite different character and level of risk when a shipbuilding program involves a newly exported design, a new shipbuilder and a distributed design-and-build environment of the sort established for the Australian AWD Program.

69. The AWD Program's Critical Design Review, as required by the Alliance contract, focused on the functional design of the DDGs and concluded in late 2009 that 'the team is well positioned to proceed through Detail Design and Construction'. However, the report also noted that a key challenge was 'churn in the design and construction due to changes, holds and revisions'. Nonetheless, construction began as planned within one month of this conclusion.

70. The Alliance formed the view that the design-to-production process could operate effectively without Navantia providing extensive Lead Yard Services<sup>51</sup>, including planning and production support intended to ensure, as far as is reasonably practicable, that the lessons from the initial build are transferred to the follow-on build yard. In light of the problems that have occurred in transferring the design to Australia, ASC informed the ANAO that there was an expectation that production issues commonly captured in 'as built' drawings would have been fed back into the design by Navantia because this is standard shipyard practice. For its part, Navantia noted that some aspects of the design-to-production process adopted for the DDGs were not well aligned with its standard approach for the design. The Alliance was not fully effective in working through a range of fundamental issues relating to the maturity of the baseline design and the design-to-production process, which continue to impact on the program's build phase.

71. During the construction phase, the AWD Program has experienced ongoing immaturity in the detailed design, which has significantly exceeded that expected at the time of Second Pass approval in 2007.<sup>52</sup> This has involved Navantia providing a large number of revised design documents between 2009 and 2013. The extent of this problem is evident from the large number of drawing revisions that have been delivered by the designer, at an average of 2.75 revisions per drawing (as at March 2013), and by design deficiency and design interference accounting for some 5000 records or 46 per cent of all records in the Alliance's Problem and Issue Reports database (as at April 2013). Drawing revisions from Navantia have at times saturated the Alliance's engineering and planning departments, resulting in late releases of design drawings to ship production.

72. AWD Alliance records indicate that drawing revisions and updates have occurred for a variety of reasons, including: drawing errors or omissions, to incorporate design changes required by Defence, and to cater for Vendor Furnished Information (VFI). During the audit, the ANAO was advised by the Industry Participants and Navantia that it is difficult to calculate the contribution of different causes to changes in the detailed design of the DDGs. Further, there has been disagreement over the causes of design changes. The Alliance CEO has estimated, based on management judgement, that over half of detailed design change is due to defects and deficiencies in drawings. On the other hand, Navantia has emphasised that a large majority of drawings were affected by Contract Amendment Proposals, and that Vendor Furnished Information (VFI) caused 700 hold-ups (notices to stop work) that had to be implemented in later drawings. Navantia also emphasised that it invested significant resources to incorporate additional detail into the construction drawings for the less experienced Australian shipyards, as compared to drawings for its own shipyard. Navantia noted that, in its own shipyard, many minor design changes are resolved 'on the spot' by its experienced production workforce, rather than through the revision of design documentation.

73. The Alliance CEO informed the ANAO that, while the volume of detailed design change has been high in shipbuilding terms, it is the timing of the delivery of change that has had the most significant impact on the AWD Program. Alliance data shows that the first set of drawing revisions was typically received between a third and half way through the block construction period for Ship 1. Similarly, the second set of drawing revisions was typically received more than half way through the block construction period for Ship 1 for many blocks. The Alliance CEO estimated that 45 per cent of design change had been implemented in production sequence, and that less than 20 per cent had resulted in rework.

74. Navantia's contract allows for 'maintenance' updates to the Platform System Design, and the incorporation of some updates is necessary to preserve warranties from Navantia as to the DDGs' Platform System function and performance. The cost of incorporating design updates, and the risk of updates continuing, are factored into the Alliance contract's gain-share pain-share regime. To date, design changes have resulted in reduced fees for ASC and Raytheon, and in extra Direct Project Costs for Defence. However, as previously discussed, Navantia is not part of the Alliance. This reduces the contractual incentives on the ship designer to eliminate errors and omissions quickly.

75. Irrespective of the causes of design change, the Alliance contract requires the Industry Participants to work together with the DMO and the Platform System Designer to address design issues. The Alliance has taken a range of actions to mitigate the impact of immaturity in the detailed design.<sup>53</sup> The actions taken have included the application of additional engineering review effort, the purchase and use of Computer Aided Design (CAD) tools, schedule prioritisation, better leveraging of Navantia's knowledge and experience to support the design-to-production process, and developing a Collaborative Change Assessment Process. However, these steps have been taken over a four-year period, during which time design



maturity issues have continued to emerge, and have affected the shipbuilding process. The problems of design change and its consequences were ongoing in 2013, as illustrated by the Alliance CEO's October 2013 advice to the ANAO about emergent issues and the ASC CEO's public warning in October 2013 that ongoing design revisions might disrupt the delivery schedule.<sup>54</sup> The DMO has appropriately reminded the Industry Participants of their contractual obligations, including the 'fundamental obligation' to deliver the DDGs and other Supplies and to achieve certain schedule commitments. As the Commonwealth's representative in the Alliance, the DMO appreciates the need to be actively engaged in monitoring developments, managing the relationships between the parties and ensuring that technical issues are dealt with expeditiously.

## Build Progress (Chapter 6)

76. 3-D Computer Aided Design (CAD) tools are generally used extensively in the design and construction of modern warships. While Navantia used multiple 3-D CAD models, these were not closely integrated, making it more difficult to identify and resolve detailed design issues. Further, under the Platform System Design contract, Navantia was only required to deliver two-dimensional (2-D) engineering drawings in PDF format, which can be difficult to interpret. The Alliance had made the assumption that it did not require a large CAD/modelling capability. In addition, Navantia was unwilling to release its 3-D models for intellectual property reasons. In 2010 and 2013, the Alliance purchased from Navantia basic 3-D models to assist in the resolution of production issues, and in January 2013 Navantia placed a design approval engineer at ASC Osborne. While the 3-D CAD models and increased integration with Navantia are supporting more timely and effective resolution of design and construction issues, it would have been preferable to have applied suitable technology and expertise from the outset of the build program, particularly given the risks associated with Navantia exporting a design for the first time to a third-party shipyard.

77. During the design phase of the AWD Program, SEA 4000 Phase 2, industry and government operated on the shared assumption that potential subcontractors to the AWD Program had the financial capacity, facilities and commercial incentive to develop capabilities necessary to win and execute contracts for significant portions of the DDG hull block production. However, during the subsequent block subcontract tendering and source selection process, it became apparent that none of the tendering shipyards had recently performed work of this type on the scale anticipated, and that each facility where work could potentially be conducted required significant capital investment to develop the necessary handling and processing capability.<sup>55</sup> The allocation of blocks to subcontractors was developed by ASC, approved by the Alliance Project Board and subsequently negotiated by ASC in 2009. BAE Systems was allocated 36 blocks, which included the DDGs' complex keel blocks, and Forgacs was allocated 29 blocks.

78. The Production Readiness Reviews conducted by the Alliance in late 2009 and early 2010 to determine the readiness of block construction contractors to commence production appear now to have been inadequate in ensuring that production enabling products, such as design documentation (discussed in the previous chapter), facilities and personnel were in place and ready to begin production.

79. In May 2010, a routine quality inspection uncovered serious defects in a keel block being constructed by BAE Systems. This placed the block construction schedule in jeopardy, particularly as BAE Systems' simultaneous construction of other blocks for the DDGs and the Landing Helicopter Dock ships stretched its capacity to the point that, without remedial action, the first DDG would have been two years late. Defence advised the then Minister for Defence in October 2010 that 'the poor build quality was largely the result of BAE Systems not having sufficient experienced production supervisors—workshop engineers and foremen—despite being one of Australia's most experienced shipbuilding organisations'. Consequently, there was a reallocation of some BAE Systems blocks to Forgacs, and to Navantia's shipyard in Ferrol, Spain.<sup>56</sup> Defence records show that further reallocation of blocks between shipyards was under discussion by the Alliance during the latter half of 2013, as a result of deteriorating performance and significant cost escalation at Forgacs. In December 2013, three more blocks were reallocated from Forgacs to BAE Systems.

80. The detailed design immaturity issues discussed in Chapter 5 have adversely impacted block production. In 2010, the Alliance Project Board decided that, rather than rejecting Navantia's design documentation until it had reached the anticipated level of maturity, a better strategy would be to continue working and consequently allow some defects and deficiencies in the supplies to progress into production. In October 2013, the Alliance CEO informed the ANAO that the majority of defects and deficiencies were more insidious, and were either discovered in production or identified later by the Platform System Designer in the form of change. The receipt of revised designs—very often after block production was already completed—has resulted in large amounts of costly out-of-sequence rework.

81. The Alliance Industry Participants and Navantia are not directly liable for the cost of the rework they carry out. For Alliance members, these costs are allowed as reimbursable Direct Project Costs. However, as Direct Project Costs, they are subject to the Alliance contract's pain-share gain-share regime. Also, the time taken to conduct rework reduces the Alliance Industry Participants' ability to qualify for incentive payments for delivering the DDGs ahead of schedule, and increases the Industry Participants' exposure to the Alliance contract's liquidated damages for late delivery. While Navantia is not part of the Alliance and is therefore not exposed to reduced incentive payments, it does bear the cost of revisions to rectify errors and omissions in design documentation.

82. Based on the forward estimates by the Alliance's Control Account Managers, the AWD Program's Earned Value Management System (EVMS) indicates that the Alliance contract will be completed for \$4.776 billion, which is \$302 million or 6.8 per cent over the Target Cost Estimate. Since late 2010, production engineering issues at ASC and its block subcontractors, and ASC's block rework to address changes in the detailed design and rectify work undertaken by its block subcontractors, have contributed to persistent productivity below planned levels and production cost overruns. By November 2013, it was costing ASC \$1.60 to produce work that was originally estimated to cost \$1.00, or in EVMS terms, production cost efficiency had declined from 1.0 in September 2010 to 0.62 (62 per cent) by November 2013. However combat system development is progressing more satisfactorily. By September 2013, Raytheon had expended 69 per cent of its budget for the DDGs' Combat System engineering work, with the Earned Value Management System showing its cost efficiency at 1.0 or 100 per cent, and schedule performance at 0.99 or 99 per cent.

83. Between 2010 and 2013, the Alliance and ASC did not routinely quantify the various elements that contributed to reduced productivity.<sup>57</sup> ASC and the Alliance CEO noted that isolating costs associated with immaturity in detailed design documentation was difficult, particularly when revised drawings contained multiple changes that were not identified by Navantia.<sup>58</sup> In 2013 the Alliance CEO began presenting more detailed cost-variance data to the Alliance Project Board, drawing on EVMS data and ASC Control Account Manager estimates of the extent to which different factors impacted on shipbuilding productivity.<sup>59</sup> In January 2014, the Alliance CEO informed the ANAO that:

... there are a variety of root-causes for the cost increases and these include: schedule prolongation; block sub-contract outcomes; churn in the detailed design being greater than expected (or allowed for); costs not properly estimated or budgeted in the TCE [Target Cost Estimate] (and/or invalid assumptions) and production productivity not achieving the levels assumed in development of



the TCE.<sup>60</sup>

84. FMI independently assessed the objective and actual productivity of the Australian DDG block builders between 2010 and 2012, producing three reports on the matter. FMI's 2012 update report, released in February 2013, noted that changes made by the shipbuilders had led to improvements in some areas. However, FMI also found that, of the 72 overall observations and suggestions it made in 2010, 2011 and 2012, 49 (68 per cent) were found to be new issues or were issues where little effective action had been taken, 17 (24 per cent) showed some effective action taken, four issues (5 per cent) were largely resolved, and the status of the remaining two issues was not reported. FMI's 72 observations and suggestions were grouped into the following five categories: business processes and communication; personnel; technical information and change; production performance; and planning and control. Issues needing effective action were predominant throughout all these categories.<sup>61</sup>

85. In September 2012, the Government announced a plan to extend the AWD Program so that the delivery of the first ship was delayed by 15 months, and the interval between the delivery of the ships was increased from 15 to 18 months. Defence and the Industry Participants subsequently commenced rebaselining the construction schedule. The September 2013 Integrated Baseline Review report indicated that major corrective actions were necessary to restore confidence in the AWD Program's cost and schedule estimates. The report highlighted problems with the EVMS's Performance Measurement Baseline, and that corrective action was required for the EVMS to be considered acceptable for accurate performance measurement. Consequently, a recalculation of the estimated cost of the Alliance contract (that is, the EVMS Estimate At Completion discussed above) is necessary to ensure that adequate allowance has been made for remaining AWD build risks and issues, such as those relating to construction drawing maturity and future productivity projections.

### Support System and Transition from Guided Missile Frigates (Chapter 7)

86. As the RAN is the 'parent navy' of the Hobart-class DDG, it is required to invest in and manage a cost-effective Support System. This Support System includes: engineering services, configuration control, supply support, training, intellectual property, and the industrial capacity to undertake repairs, upgrades and maintenance. Defence has sought to mitigate risks by commencing the development of the Hobart-class DDG Support System early in the AWD Program's build phase. Progress is being monitored by the RAN, including by the one-star and three-star Program Management Stakeholder Groups (see Appendix 8). While these are positive developments, the sustainment phase of the DDGs' lifecycle is not expected to begin until 2016, and it is too early to assess the adequacy of the Support System arrangements.

87. Public works that cost more than \$15 million must be referred to the Parliamentary Standing Committee on Public Works (Public Works Committee) before work can commence. Defence records show that there was a significant delay in gaining the approval to refer the DDG Support System facilities to the Public Works Committee. Defence initiated the process by seeking ministerial approval in late 2011, but it was not until March 2013 that the referral to the committee was made, and thus the facilities expenditure was not approved by the House of Representatives until May 2013. This has resulted in an overall delay of some 25 months in the delivery of the DDG crew training facilities at Randwick Barracks and the Command Team Trainer facility at HMAS *Watson*. The RAN and the AWD Program will not have permanent, dedicated training facilities for crew and support personnel for the first DDG, and alternative temporary arrangements will need to be established.

88. To budget for the extra lifecycle cost of a new capability, Defence's practice is to estimate the new capability's Net Personnel and Operating Cost (NPOC). NPOC represents the difference between future and current mature operating costs associated with a capability. In 2007, at Second Pass, Defence advised the Government that the estimated NPOC over the 30-year life of the DDG capability was \$3.4 billion, with annual NPOC of \$70.4 million from 2018–19 (Budget 2007–08 Constant Price and Exchange). In December 2012, the RAN revised the estimated NPOC for the DDGs in light of their postponed delivery dates and the consequent delay in withdrawing the FFGs from service. The RAN now estimates the NPOC for the DDGs at \$619 million in the years up to and including 2019–20, and a further \$2.07 billion in the years to 2029–30.

89. The knowledge and experience acquired in the development of the DDGs will form the basis for the DDG Support System necessary to sustain and upgrade this complex capability over its expected service life. However, the Support System work is likely to be undertaken against the background of a decline in work for the Australian shipbuilding sector. There is a risk, observed by Defence stakeholders and under consideration by the Australian Government, that the knowledge and experience gained by the Australian shipbuilding sector during the DDG build phase may not be available to meet future RAN capability and whole-of-life support requirements.

## Summary of agency and program participant responses

### Defence

90. Defence's covering letter in response to this audit report is reproduced at Appendix 1. Defence's response to the audit report is set out below:

Defence welcomes this timely and thorough review of the Air Warfare Destroyer (AWD) program and appreciates the acknowledgement that the AWD project is a very complex undertaking initiated after a downturn in the Australian naval construction sector.

Defence agrees with the ANAO recommendations.

In respect of recommendation one, Defence will re-invigorate the Principals Council and appoint a suitably experienced independent Council Chair.

Defence notes that with respect to Recommendations 2 and 3, the ANAO report recognises that both recommendations are already current practice.<sup>62</sup>

In respect of the report more broadly, it finds that, at the time that the AWD Project was approved by Government, Defence may not have fully appreciated the immaturity of ASC shipbuilding capabilities, or the extent to which the capabilities of BAE Systems and Forgacs shipyards had atrophied since their last major shipbuilding activity. Defence's understanding of the Australian capability to build the AWD was in fact informed by significant investment in studies and preliminary design activities conducted by the industry participants, and relied on the resultant assurances and warranties provided by industry. Defence agrees with the report's assessment that it overestimated the ability of domestic shipyards to 'ramp up' their productivity levels to the required level within a reasonable time. In this context, Defence also agrees with the ANAO commentary that normal levels of design change can take on

a different character and level of risk with an inexperienced shipbuilder, and block building subcontractors which had lost much of its shipbuilding capability.

The audit has identified the potential problems that stem from inconsistent demand. This is particularly important if Australia is to retain an efficient and competent naval shipbuilding capability.

Defence accepts that the report accurately reports the current status and challenges faced by the project. Defence would, however, make the following comments.

Firstly, the report suggests that DMO did not make sufficient allowance for factors such as importing a surface ship design and the inexperience of domestic shipyards. Defence did consider these issues throughout Phases 1 and 2 of the AWD project and made sizeable investments in the shipbuilding industry in studying existing and evolved designs, and comparing these to contemporary projects of similar scale and scope in Australia and overseas. The estimated cost and schedule for the shipbuilding element exceeded all other contemporary examples, including even the original design and build of the F100. Unfortunately even these conservative levels of efficiency have not been achieved and, on present estimates, the shipbuilding delay is anticipated to be at least 49 weeks (or 18 per cent) longer than the period required for the original F100 design and build. Given the uncertainty surrounding the cost estimate at completion (EAC) and Defence's concerns over continued low productivity levels, the report will serve as significant background information for the recently announced Independent Review of the AWD Program.

Secondly, Defence questions the emphasis in the ANAO report on the impact of design change. Defence considers the amount of design change was not excessive for a design of the complexity of the AWD, nor was the level of design change unpredicted at Government approval.<sup>63</sup> The real issue around these changes was in the immaturity of the processes to manage the design change challenge with the designer and the block subcontractors. Defence accepts this is a major concern which must be addressed as a core performance requirement of an effective and efficient shipbuilding industry.

Finally the report suggests Defence did not adequately monitor shipyard performance. Since the commencement of production, Defence has engaged First Marine International, a highly regarded consultant to the international marine industry, to conduct annual benchmark assessments on shipbuilding performance in the AWD project. Defence has made these reports available to each of the shipyards on an annual basis to assist them with identifying key areas for improvement.<sup>64</sup>

91. The other participants in the AWD Program, including ASC and Raytheon Australia as the AWD Alliance Industry Participants, Navantia as the Platform System Designer, and the two major subcontractors BAE Systems and Forgacs, were also provided with the opportunity to comment on relevant extracts from this audit report. Their summary responses are set out below, and their formal covering letters are reproduced at Appendices 2 to 7.

#### **AWD Alliance CEO**

92. The AWD Alliance CEO's covering letter in response to an audit extract is reproduced at Appendix 2. His response to the audit extract is set out below:

ANAO's audit report assembles relevant SEA 4000 historical and performance issues and has delivered related commentary and interpretation. The AWD Alliance construct by its very nature and intent has established a close working relationship between the three formal Alliance Participants. Within that arrangement, each Participant is dependent on the other's performance for a successful program outcome. Industry Participant information regarding the AWD Project was openly shared with the ANAO to support this audit.

The ANAO report gives focus to schedule, cost, ship design, the Alliance contract and the performance of both the 'Owner-Participant' (DMO) and the Industry Participants (ASC and Raytheon) in executing the AWD project. AWD is a large and complex project and unsurprisingly, the related considerations and issues are similarly complex and open to interpretation. ANAO has provided extended commentary on the AWD design process noting that the current AWD cost and schedule pressures have a number of root causes and these include: schedule prolongation; block subcontract outcomes; churn in the detailed design being greater than expected (or allowed for); costs not properly estimated or budgeted in the Target Cost Estimate (and/or invalid assumptions) and production productivity not achieving the levels assumed in development of the Target Cost Estimate.

CEO AWD generally concurs with the primary recommendations made by ANAO and the focussed commentary within the report. Notwithstanding, the majority of the ANAO commentary tends to focus on the issues, and less has been said about the successes, or in fact that the potential impacts of various challenges have been mitigated, and some issues avoided altogether through the cooperative and collaborative approach taken within AWD.

Noteworthy successes include: establishment of the workforce, development of the facilities, achievement of the early design milestones, product quality and utility of the Alliance arrangement in problem resolution on a best-for-program basis. Appropriate credit should be given to the architects of the Alliance arrangement and the participants that work tirelessly to make it successful. There are many positive lessons learnt that should be applied in consideration of future programs of this type.

#### **ASC**

93. ASC's covering letter in response to an audit extract is reproduced at Appendix 3. ASC's response to the audit extract is set out below:

ASC is absolutely committed to the safe delivery of three Hobart Class Air Warfare Destroyers to the satisfaction of all our key stakeholders including the Australian Government, the Department of Defence, the Royal Australian Navy and the Defence Materiel Organisation, our shareholder and our industry partners. ASC will continue our drive on productivity and we will deliver these ships.

As your audit identifies, the risks associated with the design and build strategy were underestimated at the time of the June 2007 Second Pass submission to Government. Further, the governance arrangements in the program have not allowed stakeholders to come to a common view of the root cause of problem issues. Shipbuilding is fundamentally about teamwork, and a view of quality,

cost and schedule performance can only be arrived at by considering the performance of all the members of the team, underpinned by a desire to work collaboratively to improve performance. ASC stands ready to work to a set of program arrangements that adequately address the actual risks in the program.

### Raytheon Australia

94. Raytheon Australia's covering letter in response to an audit extract is reproduced at Appendix 4.

### Navantia

95. Navantia's covering letter in response to an audit extract is reproduced at Appendix 5. Navantia's response to the audit extract is set out below:

AWD, like any other frigate program, is a very complex program, and this requires the shipbuilder to cope with several revisions to the drawings in order to capture the latest technical information available, which comes from many different sources and is often out of the designer's control. This process is natural within the business, and the contractor needs to be prepared to effectively manage revisions so as to minimise cost and schedule impact.

ASC and the Alliance did not and do not have the experience or the skills level to manage revisions in the most effective manner, with the result that revisions have a greater impact than could be expected.

Navantia recommends a comprehensive analysis of the current management procedures to achieve significant improvements in productivity.

### BAE Systems

96. The BAE Systems covering letter in response to an audit extract is reproduced at Appendix 6. The BAE Systems response to the audit extract is set out below:

BAE Systems appreciates the invitation to comment on the extract of audit findings and recommendations. However, we are unable to comment on the ANAO recommendations because none were shared with us in the extract provided. We are also unable to comment on many of the audit findings as only a limited number of them were included in the extract provided. Nevertheless, we agree with the facts as presented in the extract that was shared with us. Reference is made to our full response for elaboration.<sup>95</sup>

BAE Systems fully agrees that all of the Australian naval shipbuilding industry companies that have participated in the AWD Program, our company included, have faced a significant challenge from the need to re-establish capability, capacity and experience after the gap in naval shipbuilding that preceded the start of AWD construction. Over the course of the program to date, BAE Systems has been able to rectify these initial issues through investment, reachback to our global organisation and additional hiring to rapidly build capability. Our performance on the AWD Program has been recognised by the AWD Alliance, as evidenced by the reallocation of additional blocks and by DMO's Directorate of Maritime Safety and Sustainment Assurance, which has assessed the BAE Systems Williamstown Shipyard as performing significantly above DMO's own industry benchmark score. Clearly therefore, in our view, a key Recommendation in this report should be for the Commonwealth to act quickly to ensure that the impending gap in naval shipbuilding currently being faced again by the industry is avoided.

### Forgacs

97. The Forgacs covering letter in response to an audit extract is reproduced at Appendix 7. The Forgacs response to the audit extract is set out below:

The Forgacs shipyard, as at contract signature, had been engaged in building mining 'haul pack' truck bodies for some years, and most of the shipbuilding experience had been lost during the intervening period between construction work on HMAS *Manoora* and *Kanimbla* and the start of the AWD Program. Accordingly, many of the facilities, cranes and general yard facilities were ill prepared to commence block production at the schedule, quality and cost demanded under the contract; and the pilot block allocated to assess capability was too small a sample to be a valid indication of capability or capacity. The subsequent reallocation of the BAE blocks to Forgacs, just as the shipyard commenced to improve in maturity, placed additional stress on the already strained facilities and workforce, and caused further issues with quality and schedule achievement at the Forgacs facilities.

Whilst the imperative of building ships fitted with naval combat systems in Australia is well articulated by the government, the concern of Forgacs is twofold:

- That the costs of ramping back up to a competitive shipyard to maintain the indigenous shipbuilding capability have not been fully appreciated in terms of the magnitude of the investment required in facilities, recruitment, training and retention of the workforce to reach competitive productivity; and
- Once established, the shipbuilding capability will once again dilute and disappear if not utilised in an ongoing shipbuilding program out across the Defence portfolio. Whilst again much discussion has occurred, the time line for the tender evaluation process of the next major Defence project to prevent a gap in work is dangerously close.

## Recommendations

<p>Recommendation No.1</p> <p>Para 3.44</p>	<p>The ANAO recommends that the DMO:</p> <ul style="list-style-type: none"> <li>• reinvigorate the AWD Alliance Principals Council, as a source of additional leadership, insight and strategic advice on key issues facing the Alliance participants; and</li> <li>• raise with the Minister for Defence the appointment of a suitably experienced and</li> </ul>
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	independent AWD Alliance Principals Council Chair.  <b>Defence's response:</b> <i>Agreed.</i>
<b>Recommendation No.2</b>  <b>Para 6.12</b>	The ANAO recommends that, in order to reduce the risk of detailed design errors from the outset of future Australian naval shipbuilding, Defence require and oversee the implementation of a fully-integrated design review process, supported by contemporary Computer Aided Design technology.  <b>Defence's response:</b> <i>Agreed.</i>
<b>Recommendation No.3</b>  <b>Para 6.132</b>	The ANAO recommends that, for future Australian naval construction programs, Defence monitor performance against a set of productivity metrics from the outset, so as to promote productivity, gauge the key factors influencing productivity and, where required, help bring about productivity improvements.  <b>Defence's response:</b> <i>Agreed.</i>

## Contact

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[1] Between 1990 and 2001 the RAN withdrew from service its three former DDGs, known as the Perth class, without replacement.

[2] In 2007, the Treasury noted that the premium associated with building the DDGs in Australia was around \$1 billion.

[3] The terms F-104 and F-105 refer to the Spanish F-104 Méndez Núñez-class FFG and the F-105 Cristóbal Colón-class FFG respectively. The Hobart-class DDG design contains changes to the F-104 design (including specified F-105 modifications) that address: obsolescence, Australian legislative compliance, integration of Australian selected elements into the Combat System, agreed improvements in capability and the mitigation of technical risk.

[4] ASC AWD Shipbuilder Pty Ltd is a subsidiary of the Commonwealth Government Business Enterprise ASC Pty Ltd. For convenience throughout this report, the acronym ASC generally refers to this subsidiary. Where this is not the case, the report makes it clear whether a reference is to the parent company or the subsidiary.

[5] In parallel, work was progressing on Ships 2 and 3.

[6] Minister for Finance and Minister for Defence, *Coalition committed to the efficient delivery of the Air Warfare Destroyer Program*, media release, 17 December 2013.

[7] The Hon. Dr Brendan Nelson MP, Minister for Defence, *Air Warfare Destroyers—The Foundations Laid*, media release, 4 October 2007.

[8] Navantia S.A. is a shipbuilding firm owned by the Spanish Government through its industrial holding company, Sociedad Estatal de Participaciones Industriales (SEPI), which controls all company stock owned by the Spanish State.

[9] Although the acquisition of a fleet of F-35 Joint Strike Fighter aircraft is expected to cost a total of \$13.2 billion, the Government has as yet approved only a small part of this amount. See ANAO Audit Report No.6, 2012–13, *Management of Australia's Air Combat Capability—F-35A Joint Strike Fighter Acquisition*, p. 118.

[10] See, for example, ACIL Allen Consulting, *Naval Shipbuilding & Through Life Support: Economic Value to Australia*, December 2013, which stated (p. ii) that:

A pattern of slowing down and then starting up again imposes large costs. The direct costs of re-opening a closed shipyard are relatively minor compared with the costs of retraining the workforce. [...] In addition, there are very large but unquantifiable costs resulting from the loss of the supply chain expertise gathered over many years.

[11] Total expenditure on Phase 1 (preliminary design and build strategy) and Phase 2 (Design) was \$262 million.

[12] Immaturity can include errors, omissions and changes. For an explanation of different design phases, see footnote 255.

[13] The Alliance CEO informed the ANAO in January 2014 that 'Alliance records also disclose that the [cost] over-run has primarily resulted from an increase of about \$400m in the Estimate At Completion for Ship-building elements of the program primarily during the production period from the end of 2009 until now'. See page 3 of the Alliance CEO's letter to the ANAO, reproduced in Appendix 2.

[14] ANAO Report No.12, 2013–14, *2012–13 Major Projects Report*, pp. 147, 151.

[15] The DMO also acknowledged in the *2012–13 Major Projects Report* that there is some uncertainty in relation to the adequacy of contingency for the AWD Program, and that the program is funding actual cost increases with project contingency funds. Nonetheless, having reviewed the current, financial, contractual obligations of the DMO for this project, current known risks and estimated future expenditure, the DMO considered, as at 30 June 2013, that there was sufficient budget remaining for the project to complete against the agreed scope. ANAO Report No.12, 2013–14, *2012–13 Major Projects Report*, pp. 34, 143, 157.

[16] The Ministers for Defence and Finance confirmed on 17 December 2013 that the Government would establish an independent review into the AWD Program, with terms of reference to be finalised in early 2014.

[17] The ANAO has previously observed that it is not uncommon for major projects, including Defence projects, to experience cost overruns and integration issues. There is a tendency for initial estimates to be optimistic, contingencies to be too low, the severity of risks to be underestimated, delays to be more extensive than anticipated and the complexity of integration issues not to be fully appreciated. See ANAO Audit Report No.41, 2008–09, *The Super Seasprite*, p. 18.

[18] ASC and Raytheon were engaged to work with Navantia on its Existing Design option and with Gibbs & Cox on its Evolved Design option.

[19] The Aegis Weapon System is an advanced air defence system in service with the US Navy, which offers improved precision and shorter reaction times than those that have been previously deployed on Australian vessels. Raytheon is responsible for integrating Aegis and the other combat system equipment. For a fuller description of the Aegis Weapon System, see the section beginning at paragraph 6.66.

[20] Navantia, in its January 2014 response to an extract from this audit report, stated that 'The design of the Australian AWD is very different from that of the existing F-104, incorporating lessons learnt from the Spanish Navy's F-105 (not all known at the time of the contract), implementing Australian regulations, and taking account of obsolescence, Contract Amendment Proposals, etc. All these items, together with the supply chain information modifications in respect to F-104 equipment, imply a very relevant number of revisions/modifications to the existing F-104 design, to be implemented at the time that the information is made available to the designer—in most cases out of the designer's control.' See page 1 of Navantia's comments to the ANAO, reproduced in Appendix 5.

[21] For example, the Second Pass submission to government in 2007 stated that Navantia had proven work packages prepared for the Existing Design option.

[22] The DMO's Phase 2 Overall Program Report states that Navantia was not prepared to agree to the liability regime that the Alliance contract was to impose. For its part, Navantia informed the ANAO in October 2013 that there was a lack of clarity with respect to the proposed liability regime, and stated that:

When the possibility of being part of the AWD Alliance was on the table, it was not clear to the parties how to integrate Navantia into the Alliance. Navantia considered it clearer and more appropriate that the contract be made with DMO (although it could have been made with ASC), and this course of action was quickly agreed with the AWD Alliance.

[23] As discussed in detail in Chapter 5, a number of causes can contribute to any particular design change, and it is difficult to isolate the cause of any one change. As for the impact of design change, all design change received from Navantia generates some level of additional work for the Alliance. This can range from re-review and release of revised drawings, replanning of work packages through to scrapping of material already procured and production rework or development strategies to avoid consequential impacts.

[24] For example, even the five keel blocks built by Navantia in Spain have required rework.

[25] As discussed in detail in Chapter 6, construction difficulties at BAE Systems early in 2010 led to a succession of reallocations of block construction among shipyards, in order to reduce an expected two-year delay. As a result of deteriorating performance and significant cost escalation at Forgacs during the latter half of 2013, a further block reallocation occurred in December 2013.

[26] This amount is based on the Alliance Earned Value Management System (EVMS) data. It includes DDG block construction by ASC and its block subcontractors, block consolidation, production supervision, operations, production management, apprentice and production training. It does not include DDG pre-production, which includes engineering reviews and planning, configuration management, Combat System production support, work orders and materials support.

[27] See paragraphs 96 and 97.

Forgacs, for example, informed the ANAO that its shipyard had been engaged in building 'haul pack' truck bodies for mining operations after the cessation of naval ship construction work in the nine years prior to AWD project signature, and as such had lost much of its shipbuilding capacity, equipment serviceability and knowledge.

[28] 3-D Computer Aided Design (CAD) tools are generally used extensively in the construction of modern warships. CAD-assisted clash and interference checking is performed on structures, equipment, piping systems, cable systems and air-conditioning systems etc to ensure that they are properly spaced for installation, that moving parts such as doors and hatches can move as intended, and that equipment may be installed and operated correctly. The overall aim is to discover and solve design problems in the drafting room rather than during PO1 and PO2, when design changes often become extremely expensive.

While Navantia used multiple 3-D CAD models, these were not closely integrated, making it more difficult to identify and resolve detailed design issues. Further, under the Platform System Design contract, Navantia was only required to deliver two-dimensional (2-D) engineering drawings in PDF format, which can be difficult to interpret. For further discussion, see paragraphs 5.64 and 6.7 to 6.11.

[29] Core productivity is the best productivity a shipyard can achieve given a mature design. Although there are notable exceptions, core productivity is generally not reached before the fourth vessel in a series. Due to first-of-class performance drop-off, which can be as high as 50 per cent in established naval builders, actual productivity achieved early in the series is much lower than core productivity.

[30] In 2012, the AWD Alliance Principals Council discussed productivity, noting that:

productivity needed to improve at both Forgacs and ASC. The Council acknowledged the current issue of lack of a mature TDP and agreed that an increase in productivity would require the design to stabilise and change to cease.

AWD Alliance Principals Council, meeting minutes, 20 February 2012, p. 3.

[31] For example, in September 2013 the Chief Executive Officer (CEO) of ASC was quoted as highlighting that ongoing design revisions might disrupt the delivery schedule. Sarah Martin, 'AWD program "plagued" by design changes', *The Australian*, 18 September 2013, p. 2.

In subsequent correspondence with the ANAO, the ASC confirmed that it regarded design immaturity as having 'caused considerable cost and delay to date'. See page 3 of ASC's letter to the ANAO, reproduced in Appendix 3.

[32] FMI reported that, of the 72 overall observations and suggestions it made in 2010, 2011 and 2012, 49 (68 per cent) were found to be new issues or were issues where little effective action had been taken, 17 (24 per cent) showed some effective action taken, four issues (5 per cent) were largely resolved, and the status of the remaining two issues was not reported.

[33] ASC and the Alliance CEO noted that isolating costs associated with immaturity in detailed design documentation was difficult, particularly when revised drawings contained multiple changes that were not identified by Navantia.

[34] Based on past cost and schedule performance, combined with the Alliance's forward estimates.

[35] An Integrated Baseline Review is a detailed review of a project to ensure that the necessary work is appropriately scheduled, budgeted and resourced.

[36] A Performance Measurement Baseline is a time-phased schedule of all the work planned to be performed, expressed in terms of the budgeted cost of that work—or in other words, the Budgeted Cost of Work Scheduled (BCWS or Planned Value).

[37] The Hon. Stephen Smith MP, Minister for Defence, *Air Warfare Destroyer update*, media release, 6 September 2012.

[38] ADF capability is formed by combining eight Fundamental Inputs to Capability, categorised and broadly defined in Table 1.3. The March 2020 date to achieve Final Operational Capability, reported in the *2012–13 Major Projects Report*, represents a four-month delay over that reported a year earlier. ANAO Report No.12, 2013–14, *2012–13 Major Projects Report*, p. 154; ANAO Report No.15, 2012–13, *2011–12 Major Projects Report*, p. 195.

[39] As discussed in paragraph 17, the Alliance contract imposes a 'fundamental obligation' on the Industry Participants to deliver the DDGs and other Supplies and to achieve certain schedule commitments (such as achieving Key Target Dates for Provisional Acceptance of each DDG).

[40] As part of the Alliance contract, the Industry Participants warranted that: they had assessed, to their own satisfaction, the risks they were assuming; and they had the resources (or sufficient access to resources) required to perform their obligations under the contract. The Industry Participants also acknowledged that the Commonwealth was relying on their skill and judgement.

[41] Clause 8.2.1(e) of the Alliance contract makes provision for the appointment of an independent chair by the Minister for Defence, after consultation with the Industry Participants. Clause 8.3.1(b) of the contract provides that one of the functions of the Principals Council is to provide leadership, oversight and strategic direction for the work under the agreement in seeking to achieve program objectives.

[42] See paragraphs 2.57, 2.64, 5.59 and 6.24.

[43] See, for example, Audit Report No.34 1997–98, *New Submarine Project*, p. xv; and Malcolm McIntosh, *Report to the Minister for Defence on the Collins Class Submarine and related matters*, Canberra, 1999.

[44] In September 2013, the CEO of ASC also publicly suggested lessons learned for Future Submarines, particularly related to the quality of design prior to production. Sarah Martin, 'Coalition facing troubled waters as it prepares to sink \$250bn into naval shipbuilding', *The Weekend Australian*, 28 September 2013, p. 15.

[45] At the time the Shipbuilder role was awarded to ASC, it had been government policy to privatise ASC since the then Government took full public ownership of the company in 2000. In March 2004, Defence's external adviser had recommended that 2006–07 would be a suitable time for privatisation. In February 2009, however, the then Government announced that the sale of ASC would not proceed, citing global financial uncertainty as presenting risks to a successful sale.

[46] For discussion of Joint Project Directives, see ANAO Audit Report No.6, 2013–14, *Capability Development Reform*, Chapter 11. The report noted that Joint Project Directives were first proposed in the response to the Mortimer Review in May 2009, with the prime function of clearly expressing, in a working form, the essence of a government decision and assigning responsibilities to Defence Groups. However, Defence took over two years to begin to produce Joint Project Directives and, contrary to the intent expressed in the original proposal, Joint Project Directives have not been issued immediately after government approval.

[47] ANAO Audit Report No.34, 1999–2000, *Construction of the National Museum of Australia and Australian Institute of Aboriginal and Torres Strait Islander Studies*, p. 13.

[48] Victorian Government, Department of Treasury and Finance, *Project Alliancing Practitioners' Guide*, Melbourne, 2006, p. 9.

[49] See also the overview of the Combat System Design at page 8 of the Alliance CEO's letter to the ANAO, reproduced in Appendix 2.

[50] Such as compliance with requirements for protected fuel tanks, appropriate sewage treatment, and doors that open to 90 degrees.

[51] These services are defined as the collective services that the lead shipbuilder for a class of ships will provide to another shipyard that is building follow-on ships of the same class.

[52] In the *2012–13 Major Projects Report*, the DMO acknowledged design change management as a major project issue, and stated that it will impact cost and possibly schedule. The DMO further stated that the severity of the cost and schedule impacts to the Commonwealth will be



dependent on the scope and timing of the change implementation relative to ship completion. ANAO Report No.12, 2013–14, 2012[53] In January 2014 the Alliance CEO informed the ANAO that, while actions taken by the Alliance have mitigated the impact of design change, only Navantia, as the owner and producer of the platform design, can rectify the design quality issues.

[54] Sarah Martin, 'AWD program "plagued" by design changes', *The Australian*, 18 September 2013, p. 2. Shortly after, the CEO also publicly suggested lessons learned for Future Submarines, particularly related to the quality of design prior to production. Sarah Martin, 'Coalition facing troubled waters as it prepares to sink \$250bn into naval shipbuilding', *The Weekend Australian*, 28 September 2013, p. 15.

[55] AWD Alliance, *Schedule Replan*, Project Board paper, 16 June 2011, p. 2.

[56] In March 2012 and May 2013, BAE Systems was reallocated a total of eight blocks. The reallocation recognised that BAE Systems had the capacity and skill to successfully take on an increased share of the workload.

[57] In 2012, the AWD Alliance Principals Council discussed productivity, noting that:

productivity needed to improve at both Forgacs and ASC. The Council acknowledged the current issue of lack of a mature TDP and agreed that an increase in productivity would require the design to stabilise and change to cease.

AWD Alliance Principals Council, meeting minutes, 20 February 2012, p. 3.

[58] See paragraphs 5.45 and 6.112.

[59] DMO's AWD Program Office analysed the monthly cost variance data for the period August to December 2013. The analysis showed that design change, out-of-sequence work, defects and left-off work, rework, productivity and estimating error, and block subcontractors' performance all directly contributed to monthly cost overruns in shipbuilding. The largest direct contribution to cost increases between August and December 2013 came from subcontractors' performance. It should be noted that design change also has an indirect impact on other factors.

[60] See page 3 of the Alliance CEO's letter to the ANAO, reproduced in Appendix 2.

[61] First Marine International, *Assessment of actual and planned shipbuilding productivity for the AWD project, SEA 4000 Air Warfare Destroyer Program, 2012 update*, 8 February 2013, p. 32.

[62] ANAO comment: Recommendations 2 and 3 address design review and performance monitoring arrangements that should be implemented from the outset of future Australian naval shipbuilding.

[63] ANAO comment: The audit identifies significant immaturity in the detailed design documentation provided by Navantia as a major AWD Program delivery issue. This issue is separate from, but related to, agreed changes in the design of the DDGs, which have led to churn in Navantia's detailed design documentation and contributed to immaturity. The audit identifies drawing errors or omissions, contract amendments and late Vendor Furnished Information as major causes of immaturity in detailed design documentation. The volume and timing of changes in the detailed design documentation have resulted in costly and out-of-sequence rework in cases where construction work already undertaken no longer matched the design.

[64] ANAO comment: While recognising the value of First Marine International's annual assessments of the productivity of the Australian shipyards, the audit report also emphasises the need to monitor productivity metrics from the outset of future naval construction as part of regular project reporting.

[65] ANAO comment: The ANAO provided only a small extract of the draft audit report to BAE Systems because the company is not a member of the AWD Alliance. The parts of the draft audit that were provided to BAE Systems mainly concerned its performance as a block subcontractor.