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Audit Report No.22 2013–14
Performance Audit

Air Warfare Destroyer Program

Department of Defence

Defence Materiel Organisation

Australian National Audit Office

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Canberra ACT
6 March 2014

Dear Mr President
Dear Madam Speaker

The Australian National Audit Office has undertaken an independent performance audit in the Department of Defence and the Defence Materiel Organisation titled *Air Warfare Destroyer Program.* The audit was conducted in accordance with the authority contained in the *Auditor-General Act 1997*. I present the report of this audit to the Parliament.

Following its presentation and receipt, the report will be placed on the Australian National Audit Office's website—http://www.anao.gov.au.

Yours sincerely

Ian McPhee
Auditor-General

The Honourable the President of the Senate
The Honourable the Speaker of the House of Representatives
Parliament House
Canberra ACT

AUDITING FOR AUSTRALIA

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Contents

Tables

Figures

Abbreviations

ADF	Australian Defence Force
ASC	ASC AWD Shipbuilder Pty Ltd
ASIST	Aircraft Ship Integrated Secure and Traverse
AWD	Air Warfare Destroyer
CAD	Computer Aided Design
CPI	Cost Performance Index
DDG	Guided Missile Destroyer
DMO	Defence Materiel Organisation
EVMS	Earned Value Management System
FFG	Guided Missile Frigate
FMS	US Government Foreign Military Sales
LHD	Landing Helicopter Dock amphibious assault ship
NPOC	Net Personnel and Operating Cost
PSD	Platform System Design
RAN	Royal Australian Navy
SPI	Schedule Performance Index
TCE	Target Cost Estimate
TDP	Technical Data Package

Summary and Recommendations

Summary

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 They are to replace the RAN's six Adelaide-class guided missile frigates (FFGs), two of which were withdrawn from service in 2005 and 2008.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.[1]

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[2]; 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

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.

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

Source: Defence.

capability requirements.[3] The DDGs are highly complex platforms, which combine advanced sensors and weapons to achieve extensive air, surface, and subsurface mission requirements.

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[4]), 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.[5]

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

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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.

- 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.[6]

Shipbuilding alliance

7. In October 2007, the Australian Government announced the signing of two contracts for the design, construction and delivery of the DDGs.[7] A contract for the Platform System Design was awarded to Navantia.[8] 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

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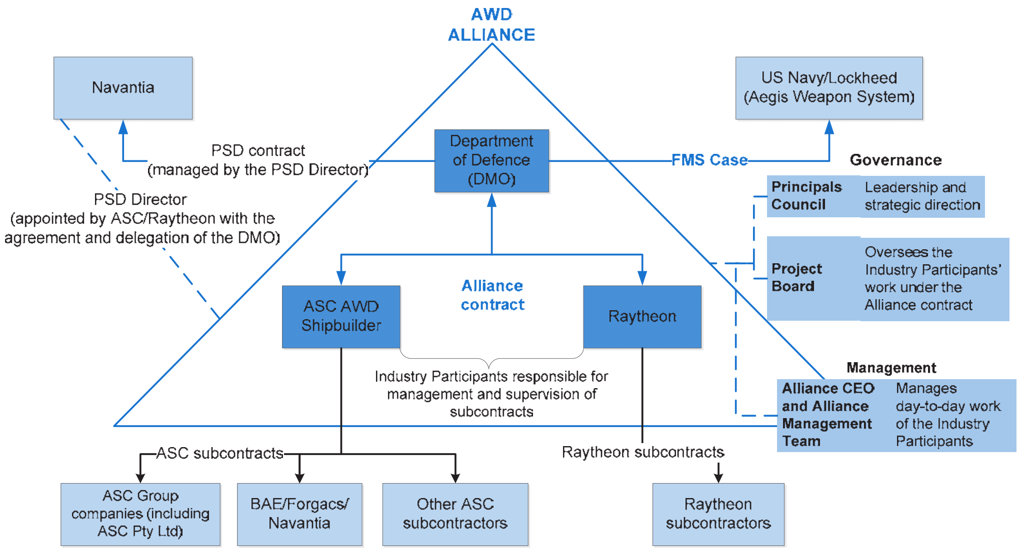
6 Minister for Finance and Minister for Defence, *Coalition committed to the efficient delivery of the Air Warfare Destroyer Program*, media release, 17 December 2013.

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.

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

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).[9] 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

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.

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[10] 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[11] 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

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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.

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[12], 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.[13] 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.[14] 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

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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.

independent review is to be commissioned to identify factors contributing to cost growth and delays, and to recommend remediations and mitigation.[15,16]

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

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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.

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.[17]

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.[18] 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.[19] 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'

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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.

form.[20] Experience shows that assessments about the quality of design supplies were overoptimistic during Phase 2 of the AWD Program.[21] 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

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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.

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.[22] 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.[23] The volume and timing of design change have been significant, at times saturating the Alliance's engineering and planning departments,

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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.

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.[24]

- 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.[25]
- 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.[26] 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

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.

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.[27]

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[28], 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

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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.

actual productivity of the Australian DDG block builders between 2010 and 2012.

34. In 2010, FMI found that core productivity[29] 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[30], and the link between stable or mature design data and shipbuilding productivity continues to be emphasised in the media.[31] 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.[32] 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

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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.

work, production defects, rework and cost estimation errors.[33] 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.[34] However, in September 2013 an Integrated Baseline Review Report[35] 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[36] 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.[37] 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

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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.

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.[38]

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[39] and the warranties they provided

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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).

to deliver the DDGs based on their work during Phase 2.[40] 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 reinvigorate 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.[41]

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.[42]

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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.

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.[43] 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

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.

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.[44]

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.

Key findings by chapter

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.[45]

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.

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.

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.[46] 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.[47] 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.[48] Informed by external advice, the provisions of the Alliance contract were intended to strike a reasonable balance in promoting a collaborative management approach

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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.

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.[49]

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[50] 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[51], including planning and production support intended to ensure, as

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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.

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.[52] 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

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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, *2012–13 Major Projects Report*, p. 157.

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.[53]

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.

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.[54] 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

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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.

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.[55] 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

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

reallocation of some BAE Systems blocks to Forgacs, and to Navantia's shipyard in Ferrol, Spain.[56] 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

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.

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.[57] 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.[58] 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.[59] 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

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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.

assumptions) and production productivity not achieving the levels assumed in development of the TCE.[60]

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.[61]

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.

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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.

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.[62]
>
> 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

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.

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.[63] 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.[64]

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.

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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.

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.[65]
>
> 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, cranage 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.

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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.

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

Recommendation No.1

Para 3.44

The ANAO recommends that the DMO:

- reinvigorate the AWD Alliance Principals Council, as a source of additional leadership, insight and strategic advice on key issues facing the Alliance participants; and
- raise with the Minister for Defence the appointment of a suitably experienced and independent AWD Alliance Principals Council Chair.

Defence's response: *Agreed*

Recommendation No.2

Para 6.12

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.

Defence's response: *Agreed*

Recommendation No.3

Para 6.132

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.

Defence's response: *Agreed*

Audit Findings

1. Introduction

This chapter outlines the SEA 4000–Air Warfare Destroyer Program, which is to deliver three Hobart-class Guided Missile Destroyers to the Royal Australian Navy. It places the program in the Australian Defence Force's capability management context, and sets out the audit's objective and scope.

Background

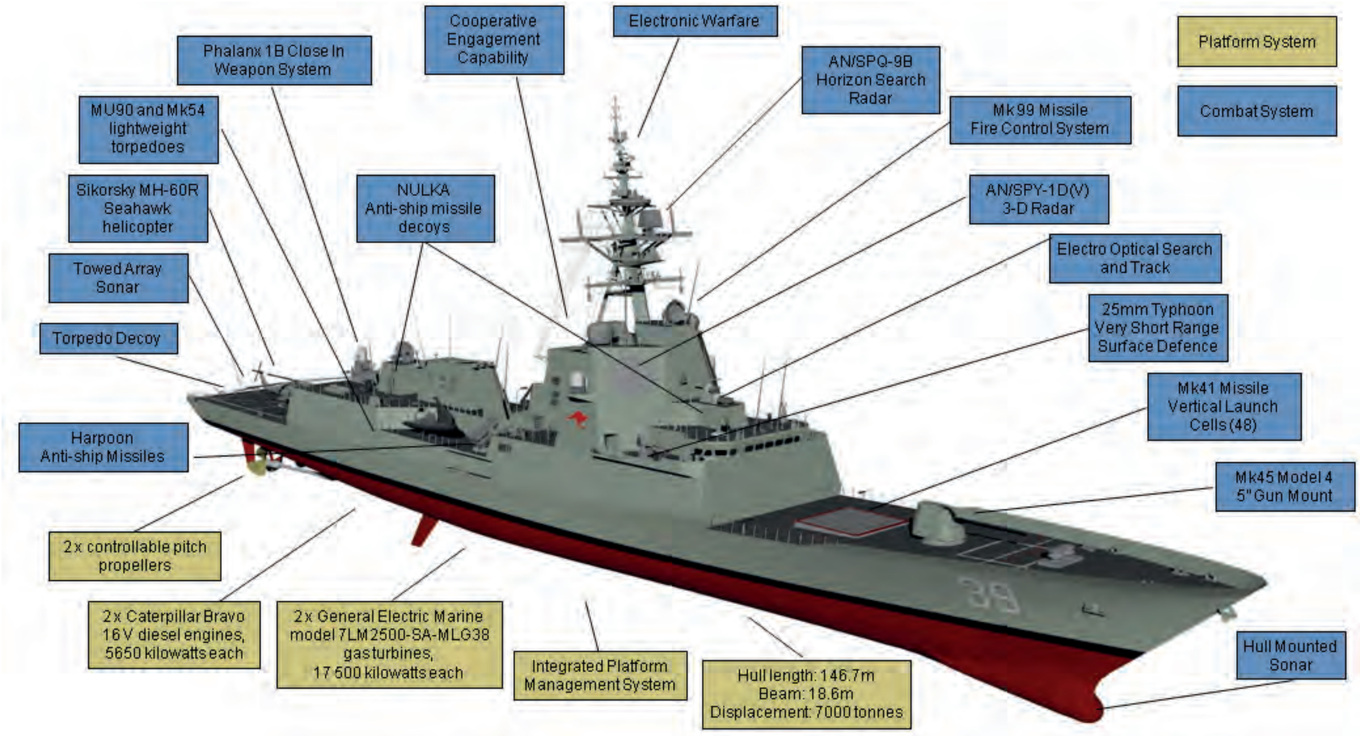
1.1 At a budgeted cost of $8.455 billion for all phases, the SEA 4000–Air Warfare Destroyer (AWD) Program is to design, build and deliver three Hobart-class guided missile destroyers (DDGs) and their Support System to the Royal Australian Navy (RAN). These DDGs are to be named and are scheduled for delivery 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.[66]

1.2 The Hobart-class DDGs are highly complex platforms, which combine advanced sensors and weapons to achieve extensive air, surface, and subsurface mission requirements. Figure 1.1 shows the DDGs' platform and combat-system configuration. Each ship is comprised of 31 blocks (or ship sections) constructed via a distributed-build process at four shipyards. ASC AWD Shipbuilder Pty Ltd (ASC[67]) is responsible for all block construction through its own shipyard and those of its subcontractors. Block consolidation is conducted by ASC, at the Government of South Australia's Common User Facility, Techport Australia, Osborne. The DDGs' platform, sensors and weapons systems will be integrated, set-to-work and harbour-tested at Osborne. At the time of the audit, the AWD Program was in its construction

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

67 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.

Figure 1.1: Hobart-class DDG Platform System and Combat System



Source: Air Warfare Destroyer Program Management Office.

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.[68]

1.3 The DDGs' concept of operations includes defending a naval force (comprising for instance, the Landing Helicopter Dock (LHD) heavy lift and amphibious assault vessels and forces ashore) from aircraft and missile attack, as well as operating independently against other ships and submarines and providing naval gunfire support.

1.4 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.

Design and shipbuilding strategy

1.5 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[69] and additional Australian elements to meet specific

68 In parallel, work was progressing on Ships 2 and 3.

69 The US Navy's Aegis Weapon System was selected in August 2004 as the preferred combat system for the yet-to-be-selected DDG platform system.

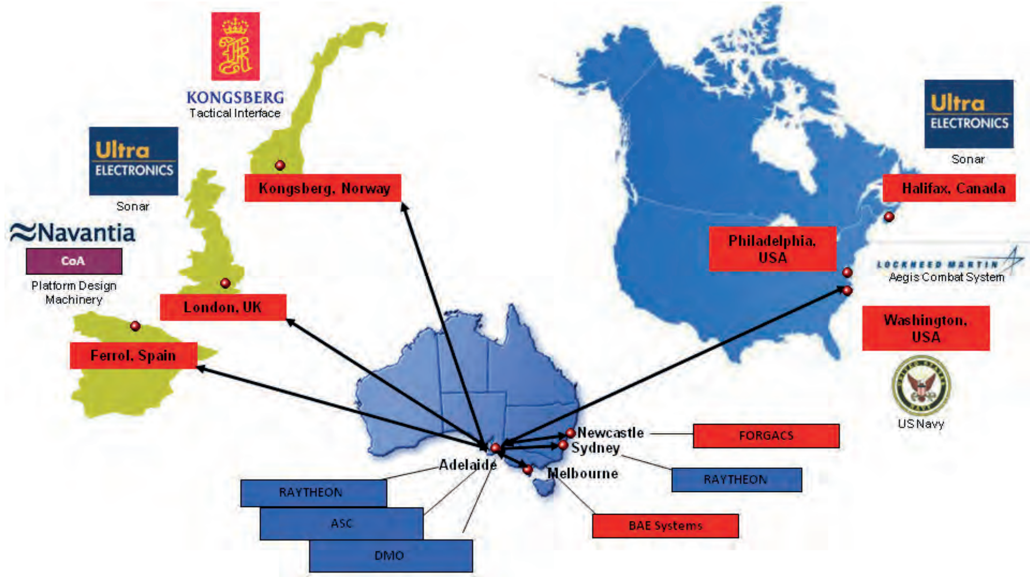
capability requirements.[70] Navantia is responsible for designing the Platform System indicated in Figure 1.1, and for providing the AWD Alliance with the technical data needed to construct the ships. Navantia is also responsible for providing a warranty that the Hobart-class DDG Platform System will, if constructed in accordance with its Category 1 Technical Data Package, achieve the function and performance requirements specified in the Hobart Class Platform System Specification. The Platform System, for a warship, includes all elements of the ship other than the Combat System, including the hull system, propulsion system, electrical system, auxiliary system, outfit, furnishings, explosive ordnance handling and storage.

1.6 As discussed above, the AWD Program is based on a highly distributed model which draws its designs and equipment from international and domestic suppliers (Figure 1.2 shows some elements of the supply chain). The Platform System Design and some elements of the Combat System are being produced in Europe and in the United States of America (US) respectively. Software development is also occurring at those locations and in Australia. Block construction is occurring in three Australian states and at Ferrol in Spain, with block consolidation, systems integration, and test and evaluation occurring in South Australia.

1.7 While the three DDGs will be completed and commissioned sequentially, significant construction work, such as block building and consolidation, as well as the integration of platform-system and combat-system elements, are occurring in parallel. This places a premium on the effective sequencing and coordination of activity and the maintenance of effective relationships between the parties, in the context of a highly distributed project model. An alliance contract model, discussed below, has been adopted to address such issues and attendant risks.

70 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. 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.

Figure 1.2: Elements of the Hobart-class DDG supply chain



Source: AWD Program Management Office.

Shipbuilding alliance

1.8 In October 2007, the Australian Government announced the signing of two contracts for the design, construction and delivery of the DDGs.[71] A contract for the Platform System Design was awarded to Navantia (where appropriate referred to in this report as the Platform System Designer). 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.

1.9 The Alliance contract binds three diverse organisations: the Commonwealth's Department of Defence, represented by the Defence Materiel Organisation (DMO), as the owner-participant[72]; and two non-owner participants, namely ASC AWD Shipbuilder Pty Ltd, the subsidiary of a (Commonwealth) Government Business Enterprise (GBE) and Raytheon, a

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

72 Various contracts and documents referred to in this audit report name the Commonwealth as the contracting entity. In order to identify the responsible part of the Commonwealth, the ANAO has referred to the DMO as the contracting entity, rather than to the Commonwealth.

public company. Under the Alliance 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 and are responsible for delivering the DDGs and other Supplies in accordance with the contract.

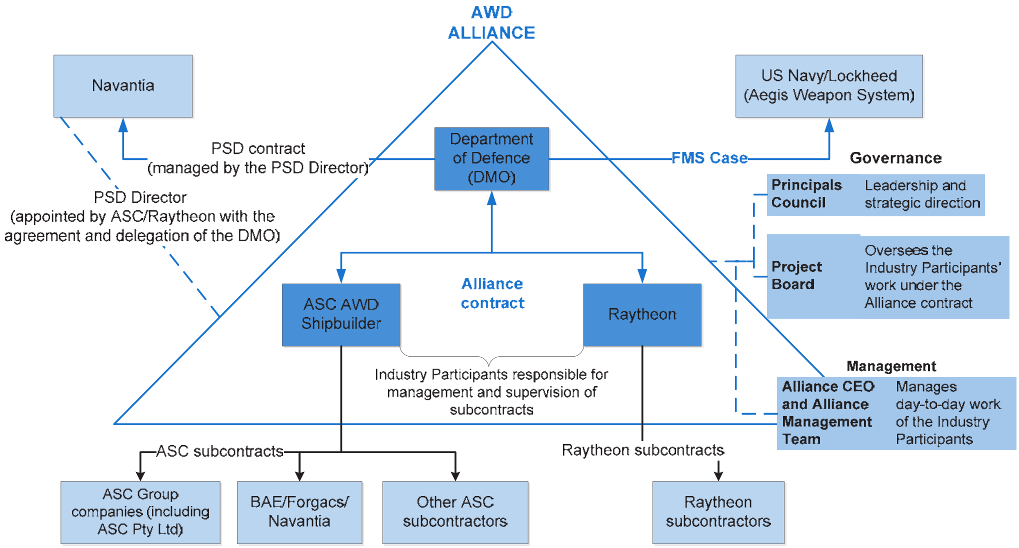
1.10 The three Alliance participants are aligned in a managerial and financial sense by the need to deliver the three DDGs within cost and schedule parameters, and to meet capability specifications, under the Alliance contract. Further, the Alliance contract formally requires openness, mutual trust and honest dealing, and the sharing of data across the Alliance organisation.

1.11 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 Navantia and the DMO) contain obligations for all parties to carry out their respective roles in a spirit of collaboration and cooperation.

1.12 The three Alliance participants are responsible, under the Alliance contract, for the outcomes of all work conducted to meet the contract requirements. The successful delivery of contract requirements depends on the work of the Alliance Industry Participants (ASC and Raytheon), Defence, all related subcontractors, Navantia, and the US Navy and its subcontractors in delivering the core Aegis Weapon System. One exception to these accountability arrangements is that Defence warrants the performance and fitness for purpose of all mandated Government Furnished Material and mandated equipment solutions, including the Aegis Weapon System. However, the Alliance Industry Participants are responsible for all other aspects of project execution involving such capabilities.

1.13 Figure 1.3 shows the AWD Alliance's key contractual and governance relationships.

Figure 1.3: AWD Alliance key contractual and governance relationships



Source: Defence Materiel Organisation.

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

1.14 As the Commonwealth representative on 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.[73]

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73 Within the Alliance contract context, Provisional Acceptance of a DDG is achieved by the DMO issuing a Certificate of Provisional Acceptance if the DDG, as delivered, complies with the requirements of the Alliance contract, subject only to Minor Defects. At this point, responsibility for the management and maintenance of the DDG transitions from the Alliance to the DMO. AWD Alliance, *Phase 3 Project Management Plan*, 18 January 2008, pp. 21, A-8.

Within Navy's Technical Regulations context, the DDG must then transition from the DMO to the RAN. This occurs through two milestones: at Initial Materiel Release (IMR), the DMO advises the RAN that the acquisition requirements have been met and the capability is ready to be transitioned to the in-service phase, and at Initial Operational Release (IOR), the Chief of Navy accepts all technical and operational risks, on the advice and recommendation of the Fleet Commander, being satisfied that the operational and materiel state of the equipment, including deficiencies, training and supportability elements, are such that it is safe to proceed into Operational Test and Evaluation.

Footnote continued on the next page…

1.15 The DMO is also the supplier to the Alliance Industry Participants of the DDGs' Platform System Design, and the Aegis Weapon System and other systems and subsystems, including elements of the DDGs' Support System. Further, the DMO manages the interactions between the Alliance contractors and foreign governments; and engages the RAN's certification agency, which is to provide the Chief of Navy with assessments concerning the safety and suitability for service of the DDGs when they are offered by the DMO to the RAN for Acceptance into Naval Service.

1.16 ASC, as the Shipbuilder, is responsible for building the DDGs, and for the distributed-build arrangements involving DDG block (section) construction, which has been subcontracted to three firms: Forgacs Engineering Pty Ltd (Forgacs); BAE Systems Australia (BAE Systems); and Navantia.

1.17 Raytheon, as the Combat System–Systems Engineer, is responsible for the DDGs' Combat System engineering, which involves integration into the DDGs of the US Navy's Aegis Weapon System[74], acquired by Defence through the US Government's Foreign Military Sales program.[75] The Combat System engineering task also involves the integration of several off-the-shelf elements, acquired from their Original Equipment Manufacturers, with the Aegis Weapon System. These systems communicate with the Aegis core through the newly designed Australian Tactical Interface.[76] The US Navy has an important role in reducing the risks of the combat and weapon systems by managing the delivery of tested and qualified systems, and assisting with systems integration

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At Initial Operational Release, management and security oversight of the equipment is transferred from the DMO's Chief Executive Officer to the Chief of Navy and to the operational authority of the Navy's Fleet Commander. Royal Australian Navy, ABR 6205, *Naval Operational Test and Evaluation Manual (NOTEMAN)*, Edition 4, 2011, Chapter 5.

74 The air warfare component of the DDGs' combat system is based on the Aegis Weapon System Version 7.1, which includes the AN/SPY-1D(V) phased array radar and the SM-2 missile system. The underwater warfare component is based on the Ultra sonar system and the surface-launched MU-90 lightweight torpedo system, and the surface and air-launched Mk54 torpedo system.

75 The US Department of Defense's Foreign Military Sales (FMS) program allows foreign governments to purchase defence articles, services, and training, as well as design and construction services, from the US Government. This program is operated on a 'no profit/no loss' basis by the US Government, and requires an authorised representative to submit a Letter of Request (LOR) to the US Government for desired defence articles and services. Acquisition by FMS purchasers will be in accordance with US Department of Defense regulations and procedures. This affords the foreign purchaser the same benefits and protection that apply to US Department of Defense procurement, and is one of the principal reasons why foreign governments and international organisations prefer to procure through FMS channels. FMS requirements may be consolidated with US Government requirements or placed on separate contract, whichever is more expedient and cost effective.

76 For discussion of the Australian Tactical Interface, see paragraphs 6.69 to 6.70.

testing involving elements of the Aegis Weapon System and the Australian Tactical Interface.

1.18 Although the Platform System Design contract is between the DMO and Navantia, the AWD Alliance Industry Participants manage the contract on a day-to-day basis. The Industry Participants have appointed a Platform System Design Director following the approval of the AWD Alliance Project Board. Under a delegation from the DMO's AWD Program Manager, the Platform System Design Director carries out the general supervision, direction and management of the Platform System Designer under the contract, and accepts or may reject supplies from Navantia on behalf of the Commonwealth.[77] To the extent of his delegation, the Platform System Design Director carries out the Commonwealth's roles and responsibilities under the Platform System Design contract.[78]

AWD Program progress and expenditure

1.19 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. In 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.

1.20 At the time of Government Second Pass approval in 2007[79], the expectation was that the three DDGs would be delivered in December 2014, March 2016 and June 2017 respectively. However, by May 2011 the AWD Program was reporting that difficulties with initial block production and shipyard capacity[80] had affected the schedule to the extent that, if no action

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77 Air Warfare Destroyer Program Manager, Defence Materiel Organisation, *Commonwealth Representative Delegations to PSD Director*, 24 February 2010.

78 Commonwealth of Australia, ASC AWD Shipbuilder, Raytheon Australia, *Air Warfare Destroyer (SEA 4000) Alliance Based Target Incentive Agreement, General Conditions of Contract,* clause 65.2.3. For further detail, see paragraphs 3.71 to 3.82.

79 The First and Second Pass approval process is discussed at paragraphs 2.2 and 2.3.

80 See the chronology in Table 1.2, and Chapter 6.

were taken, the first ship would be two years late, with a flow-on effect for the subsequent ships. Action taken by the AWD Alliance included a one-year delay in the overall schedule, as well as reallocation of blocks between shipyards, with the intention of reducing the overall delay by up to 12 months.[81]

1.21 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. At the time of the audit, the revised delivery schedule was: March 2016 (HMAS *Hobart*), September 2017 (HMAS *Brisbane*) and March 2019 (HMAS *Sydney*).[82] 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.[83]

1.22 The rescheduling of ship delivery dates since the signing of the Alliance contract in October 2007 is shown in Table 1.1.

Table 1.1: Rescheduling of ship delivery dates, 2007–12

Schedule as at	Ship 1 (HMAS *Hobart*)	Ship 2 (HMAS *Brisbane*)	Ship 3 (HMAS *Sydney*)
October 2007	December 2014	March 2016	June 2017
May 2011	Expected two-year delay reduced 'by up to 12 months' through reallocation of blocks.		
September 2012	March 2016	September 2017	March 2019

Source: Ministerial media releases; Alliance contract.

Note: The May 2011 reschedule was not incorporated into the Alliance contract.

81 The Hon Stephen Smith MP, Minister for Defence, *Changes to Air Warfare Destroyer construction program*, media release, Canberra, 26 May 2011; ANAO Report No.20, 2011–12, *2010–2011 Major Projects Report*, p. 190.

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

83 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.

1.23 The September 2012 revised delivery schedule was intended to support the following objectives:

(a) a substantially reduced demand on the Commonwealth budget across the Forward Estimates;

(b) avoidance of the need for further significant recruitment in what was then anticipated to be a tight Australian labour market, and removal of the sharp peak in employment that would subsequently require a large workforce reduction in Australian shipyards[84];

(c) an extension of the work profile of the AWD Program to avoid a sharp decline in naval shipbuilding before the next projects commence, and hence foster a sustainable naval shipbuilding industry in Australia[85]; and

(d) an extension of the time interval between the delivery of the Landing Helicopter Dock (LHDs) and DDGs to Navy, reducing the challenges and risks associated with accepting into naval service these two major capabilities.[86]

1.24 Table 1.2 presents a chronology of key AWD Program events.

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84 In January 2014, Forgacs informed the ANAO that 'AWD and ASC program rescheduling of ship delivery dates has not manifested itself in a full reduction or relief in Forgacs schedule delivery dates. On the contrary, as the costs of delivering the capability increased, Forgacs has been required to direct its efforts to truncate the schedule and thus reduce project overhead. This had exactly the opposite effect intended by the rescheduling initiative of the AWD Alliance. Additionally, as schedule pressures increased, the resource histogram also increased; to meet the demand, marginally skilled labour was recruited and quality reduced accordingly, resulting in a demand for yet more labour. Once completed the consequent rapid reduction of the workforce as a result of the compressed schedule will also contradict the aim of the AWD reschedule to provide resource levelling'.

85 For some time, there has been public discussion of a so-called 'valley of death' between existing and future projects for the Australian naval shipbuilding industry. For example, the *Australian Financial Review* has described 'an expected gap of two years that threatens job losses after the end of the current air warfare destroyer [AWD] and troop transport projects [LHD] being completed'. John Kerin, 'Coalition to tackle China on cyber theft', *Australian Financial Review*, 30 August 2013, p. 9. For a different perspective, see also 'Fourth AWD would be strategic folly: ASPI', *AAP General News Wire*, 19 October 2013.

86 Defence, ministerial submission, *Air Warfare Destroyer Program Rebaseline*, 31 August 2012.

At the time of the audit, the two Canberra Class LHDs (Landing Helicopter Dock), to be known as HMAS *Canberra* and HMAS *Adelaide*, were undergoing construction under JP 2048 Phase 4A/B, and were scheduled to achieve Initial Operational Capability in December 2014 and November 2016 respectively.

Table 1.2: Chronology of key program events

Date	Event
December 2000	Defence White Paper announces decision to acquire 'at least three air-defence capable ships', and states that the 'Government's strong preference is to build these ships in Australia, which will provide significant work for Australia's shipbuilding industry.'
October 2001	The RAN retires the last of its three Perth-class DDGs.
May 2002	AWD Program, SEA 4000, officially commences, Phase 1–Preliminary Design and Build Strategy.
May 2004	Government announces that the DDGs will be built by an alliance.
August 2004	Government selects the Aegis Weapon System.
October 2004	Government states that the DDGs will be built in Australia by an Australian company.
April 2005	Raytheon selected as Combat System–Systems Engineer.
May 2005	First Pass approval. ASC AWD Shipbuilder Pty Ltd selected as Shipbuilder. Commencement of Phase 2–Design.
August 2005	Government selects Gibbs & Cox as 'preferred designer', to further develop its 'Evolved Design'. Navantia to remain in the design competition with its 'Existing Design'.
December 2005	AWD Alliance Principals Council established.
June 2007	Second Pass approval. Commencement of Phase 3–Build. The AWD design approved at Second Pass was an Australianised Combat System integrated into Navantia's F-104 platform system, with certain modifications to meet Australian capability requirements.
4 October 2007	AWD Alliance contract and Platform System Design contract signed for the build phase.
5 October 2007	Effective Date (commencement) of the Alliance contract.
December 2009	DDG block construction commences at ASC and at the ASC subcontractor, BAE Systems.
March 2010	DDG block construction commences at the ASC subcontractor, Forgacs.
May 2010	Standard quality assurance procedures detect defects in Ship 1's (HMAS *Hobart*'s) Block 107, constructed at BAE Systems. These defects are well outside the normal range of defects and require specialist skills to correct.
August 2010	BAE Systems informs ASC of a likely delay due to block construction issues.
November 2010	Block reallocation process begins in response to construction difficulties at BAE Systems.
December 2010	New AWD Systems Centre opens at Techport Australia, Osborne, South Australia.

Date	Event
May 2011	Announcement of two-year production delay, and steps taken to reduce the delay by up to 12 months.
June 2011	Navantia is allocated construction responsibility for Ship 2 (HMAS *Brisbane*) keel blocks, with Navantia, BAE Systems and Forgacs invited to compete for Ship 3 (HMAS *Sydney*) keel blocks.
July 2012	Ship 3 construction commences.
September 2012	Keel is laid for HMAS *Hobart*, beginning the block consolidation phase. Announcement of an AWD Program schedule rebaseline.
January 2013	BAE Systems delivers its final set of blocks for Ship 2 under its original subcontract.
May 2013	Four blocks are reallocated from Forgacs to BAE Systems. Project Board discusses block building difficulties at Forgacs and potential for further block reallocations.
June 2013	Last blocks for HMAS *Hobart* are delivered from Newcastle to Adelaide.
December 2013	Hull integration of HMAS *Hobart* due to be completed under September 2012 reschedule. Three blocks are reallocated from Forgacs to BAE Systems.
February 2014	Hull integration of HMAS *Hobart* forecast to be completed. Keel laid for HMAS *Brisbane*.

Source: ANAO analysis of Defence and DMO documentation.

1.25 In 2001, the SEA 4000 entry in the *Defence Capability Plan 2001–2010* contained an initial cost estimate of $3.5 to $4.5 billion.[87] By June 2007, the cost analysis for design and acquisition of SEA 4000 was complete, and the cost of the overall three-ship AWD Program, based on the Existing Design, was $7.207 billion, with the first ship to be delivered no later than 2014. As at December 2013, the estimated cost of all phases of the entire three-ship program was $8.455 billion.[88] At the same time, Defence's expenditure on the AWD Program totalled $5.370 billion. Expenditure on the build phase (Phase 3) totalled $4.920 billion, of which $3.325 billion had been paid to the AWD Alliance Industry Participants, through the Alliance contract, and $0.390 billion had been paid to Navantia.

87 Department of Defence, *Defence Capability Plan 2001–2010. Public Version*, Canberra, 2001, p. 264.

88 See Table 2.1 for details. The estimates over time are based on different price indices.

The inputs to Australian Defence Force capability

1.26 Australian Defence Force (ADF) capability is formed by combining eight 'Fundamental Inputs to Capability' (FIC), categorised and broadly defined in Table 1.3.

Table 1.3: The Fundamental Inputs to Capability (FIC)

Input	Key Provider
1. Personnel. All people within Defence, both military (permanent and Reserves) and civilian. The input incorporates recruiting, individual training and all conditions of service and employment, including entitlements, salaries and wages, superannuation and allowances.	**Capability Manager**
2. Organisation. Flexible functional groupings with an appropriate balance of competency, structure and command and control to accomplish their tasks. This input also includes critical organisations that directly support the ADF effort.	**Capability Manager**
3. Collective training. A defined training regime undertaken by organisations, which is validated against the preparedness requirements for operations, derived from government guidance. The regime is to include frequency and depth of competency in skills, with a particular emphasis on long-term readiness critical warfighting skills.	**Capability Manager and Chief Joint Operations Command**
4. Major Systems. Systems that have a unit cost of $1 million or more or have significant Defence policy or joint service implications, which are designed to enhance Defence's ability to engage military power. Input includes, but is not limited to, ships, tanks, missile systems, armoured personnel carriers, major surveillance or electronic systems and aircraft.	**DMO**
5. Supplies. Supplies needed for Defence to operate, including stock holdings, provisioning lead times, serviceability and configuration status.	**DMO**
6. Facilities and training areas. Buildings, structures, property, plant, equipment, training areas, civil engineering works, through-life maintenance and utilities necessary to support capabilities, both at the home base and at a deployed location. Input may involve direct ownership or leasing.	**DMO** for equipment and systems, **Defence Support Group** for facilities
7. Support. Infrastructure and services from the wider national support base in Australia or offshore, which are integral to the maintenance of Defence effort. This input encompasses and originates from civil/private industry/contractors, other government agencies and international support base agencies.	Suppliers to DMO for Mission and Support Systems

Input	Key Provider
8. Command and Management. Written guidance such as regulations, instructions, publications, directions, doctrine, tactical level procedures and preparedness documents required for Defence to support decision-making, administration and operations. Input also includes funding not readily attributable to any other FIC elements, (e.g. discretionary funding).	**Capability Manager**, for regulations and service-specific command and management. **DMO** for system acquisition and logistics management

Source: ANAO, adapted from Defence Materiel Organisation, *DMO Acquisition and Sustainment Manual*, 2007, pp. 74–5.

1.27 This audit focuses primarily on the FIC elements shaded in blue. The acquisition of Major Systems (FIC 4), namely the DDGs, and the establishment of the industry, contractor and government agencies that support them (FIC 7) are examined in the first six chapters. Chapter 7 examines the establishment of the DDG Supplies and Facilities (FIC 5 and 6) needed to ensure that the DDGs remain in a serviceable state once they are placed into operational service.

1.28 Defence's Capability Manager for the AWD Program is the Chief of Navy, who is responsible for overseeing and coordinating all elements necessary to achieve the DDGs' full level of operational capability by the date agreed to by government. The RAN has established an AWD Capability Implementation Team (AWD CIT) to assist the Chief of Navy in that role.

1.29 Contractual delivery of the first DDG by the Industry Participants to the Program Management Office and, subsequently, from the Program Management Office to the RAN is identified as Initial Materiel Release, or Provisional Acceptance in Alliance contract terms. The Chief of Navy is responsible for the achievement of Initial Operational Capability.

1.30 Initial Operational Capability is the point in time at which the first subset of a capability system that can be operationally employed is realised. Initial Operational Capability will be achieved when the first Hobart-class DDG has successfully completed a Unit Ready Work Up, prior to deploying for Combat System Ship Qualification Trials (see paragraph 2.34) and SM-2 and ESSM missile firings.

1.31 The DMO is responsible for delivering the major systems (the DDGs) and also the supplies and facilities needed to sustain the DDGs' capabilities, as defined in the SEA 4000 Phase 3 Materiel Acquisition Agreement and the Materiel Sustainment Agreement between the DMO and Defence. These agreements set out, in broadly defined terms, the materiel acquisition and sustainment services that the DMO is to deliver to the Chief of Navy. The SEA

4000 Phase 3 Materiel Acquisition Agreement was signed in September 2007, and was revised in June 2011.

Audit objective and scope

1.32 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.[89]

1.33 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.

1.34 The period discussed in this audit extends from the commencement of requirements definition in 2000 to the status of the build phase in late 2013. The audit includes the planning necessary for the three DDGs to receive Operational Release into naval service, which is currently scheduled for 2019, and the transition from the current FFG capability to the new DDG capability, which is also to occur by 2019.

1.35 Phase 2 of the AWD Program, the design phase, ended in June 2007. Phase 2 is addressed in this report in terms of its role in reducing risks in Phase 3. Phases 3.2 and 4, which are to acquire the DDGs' guided missiles, are discussed only briefly in Chapter 2.

1.36 The ANAO did not intend, nor was it in a position, to conduct a detailed analysis of the full range of engineering or contracting issues being managed within the AWD Program, or to resolve issues between the Alliance

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89 AWD Alliance, *Engineering Management Plan*, Issue 6, May 2012, p. 2.

Participants and the Platform System Designer. Where relevant, the ANAO has set out some of the views of the Alliance Industry Participants and the Platform System Designer so as to provide a more complete picture of issues affecting the AWD Program.

1.37 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.

1.38 The audit was conducted in accordance with ANAO audit standards at an approximate cost to the ANAO of $797 000.

Structure of this Audit Report

1.39 The remainder of this Audit Report is arranged as follows:

Table 1.4: Structure of the Audit Report

Chapter	Overview
2. The AWD Program	Examines the acquisition strategies, program phases, governance and management structures, and processes for the design, development and construction of the DDGs.
3. The AWD Alliance and the Design Contract	Examines the development and operation of the AWD Program's alliance arrangements, and the extent to which they effectively support the resolution of AWD acquisition issues. Also examines the alignment of the Platform System Design contract with the Alliance contract.
4. Engineering, Regulation, and Test and Evaluation	Examines the AWD build phase from the perspectives of definition of systems engineering requirements, technical regulation, and test and evaluation.
5. Design Progress	Examines the Hobart-class DDG design, design and construction risk reduction, and the incorporation of design changes into the Hobart-class.
6. Build Progress	Examines the progress achieved in building the DDGs, and the impact of design change. Also considers the build program's overall cost and schedule performance.
7. Support System and Transition from Guided Missile Frigates	Examines Defence's development of the Support System arrangements required to ensure that the Hobart-class DDGs remain operational once they have been placed into service. Also examines Defence's management of the transition from the Guided Missile Frigates (FFGs) to the DDGs, and the associated risks.

2. Development of the AWD Program

This chapter examines the acquisition strategies, program phases, governance and management structures, and processes for the design, development and construction of the DDGs.

Introduction

2.1 The Defence White Paper 2000 outlined the then Government's decision to acquire 'at least three air-defence capable ships', which were to replace the RAN's FFGs from 2013.[90] The 2001 Defence Capability Plan (DCP) described SEA 4000 as a multi-stage project costing from $3.5 to $4.5 billion.[91]

2.2 Since the 2003 Defence Procurement Review[92], Defence has been required to gain approval to acquire major capital equipment through a strengthened two-pass approval process. The First Pass process provides government with an opportunity to narrow the alternative solutions being examined by Defence to meet an agreed defence capability gap. The government may then approve the allocation of funds from Defence's government-endorsed Capital Investment Program to allow Defence to analyse the options in more detail, with respect to costs, schedule and technical risks.

2.3 The Second Pass process is the final milestone in the approval of a major capital equipment program's requirements and acquisition phase. Defence's Second Pass submission to government is to provide more detailed and rigorous analysis of the options endorsed by government at First Pass, with further emphasis on cost, schedule and technical risk. At Second Pass, the government endorses a specific capability solution, and approves funding for the acquisition phase and for Defence to proceed to tender.

2.4 To assist in managing the AWD Program's cost, schedule, and technical risks, the program is now divided into six phases: Phase 1—Preliminary Design and Build Strategy; Phase 2—Design; Phase 3—Build; Phase 3.2—SM-2

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90 Department of Defence, *Defence 2000: our future defence force*, Defence White Paper, Canberra, 2000, p. 90. In 2003, the number of ships to be acquired was confirmed as three. Senator the Hon. Robert Hill, Minister for Defence, *Defence Capability Review*, media release, Canberra, 7 November 2003.

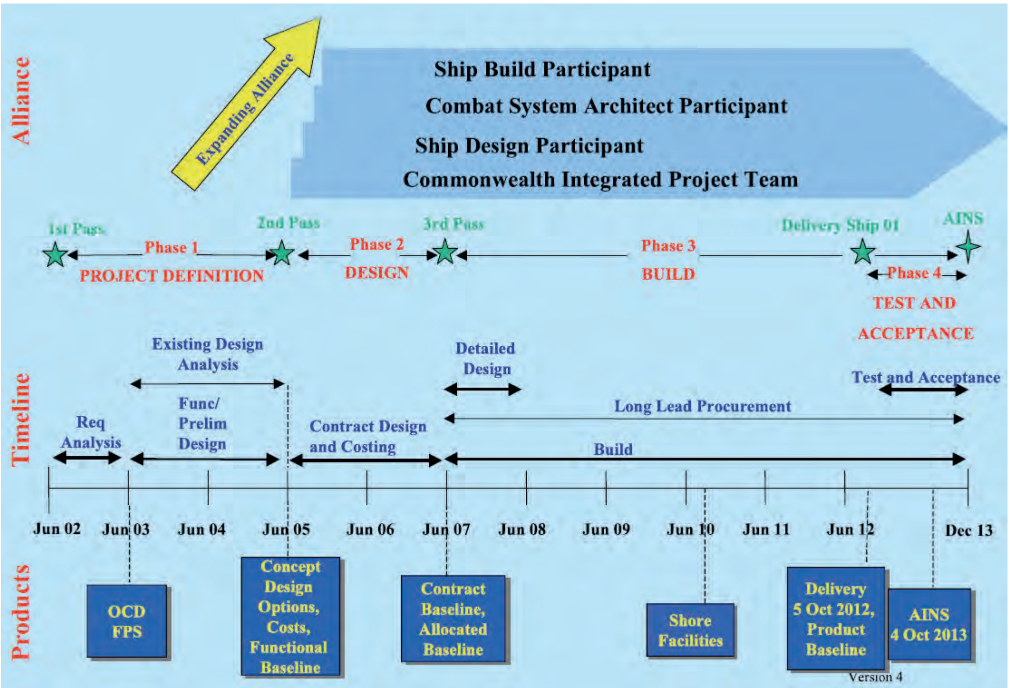
91 Department of Defence, *Defence Capability Plan 2001–2010. Public Version*, Canberra, 2001, p. 263.

92 Department of Defence, *Defence Procurement Review 2003* (Kinnaird Review), August 2003, pp. iv, v, 11.

Missile Upgrade; Phase 3.3—DDG Test and Evaluation (not approved); and Phase 4—Cruise Missile Acquisition (not approved).[93] The initial phases have allowed alternative solutions to be examined in successively greater detail in terms of DDG platform and combat system selection, contracting strategies, and the program's implications for Australia's shipbuilding industry.

2.5 Figure 2.1 shows the DMO's approved 2002 strategy and timeline for the DDGs' acquisition.

Figure 2.1: SEA 4000 acquisition strategy and timeline, as at July 2002



Source: Defence Materiel Organisation, *SEA 4000 Air Warfare Destroyer: Acquisition and Contracting Strategy*, 4 July 2002.

Notes: AINS—Acceptance into Naval Service; OCD—Operational Concept Document; FPS—Function and Performance Specification; Req—Requirements

2.6 Defence informed the ANAO that the total expenditure on Phases 1 and 2 was $262.501 million. This constitutes 3.1 per cent of the current

93 SEA 4000 Phase 4, the acquisition of a maritime-based land-attack cruise missile for the DDGs, is scheduled for the period 2016 to 2025. The previous SEA 4000 Phase 5, which was a joint Australia/US research and development program into advanced Phased Array Technology for the Anzac frigates, was renamed in 2011 as SEA 1448 Phase 3 (approved). These two projects are beyond the scope of this audit. As noted in paragraph 1.32, this audit focuses principally on SEA 4000 Phase 3–Build.

$8.455 billion budget for all project phases identified in Table 2.1 (see page 95). At the time of the audit, Phase 3 was underway and its expenditure had reached $4.920 billion.

2.7 The following sections provide a general outline of five of SEA 4000's phases, Australian industry engagement in the AWD Program, the program's budgets and expenditure, and Defence's organisational arrangements for DDG capability development oversight.[94]

SEA 4000 Phase 1–Preliminary Design and Build Strategy, 2000–05

2.8 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 the major contractors for the project.

2.9 In July 2002, the Defence Capability and Investment Committee approved the AWD Program's Acquisition and Contracting Strategy, which at the time had four options: separate contracts for design and construction; direct foreign purchase; combined design-and-build; and an international joint project.[95] The first option was selected because Defence was confident that the risk that ships built to the design might not perform as required was manageable, and it aligned with the then Government's strong preference for the ships to be built in Australia. However, that option meant accepting a need to delay the contracting of a shipbuilder until after the design activities were complete, to provide the shipbuilder and the naval shipbuilding sector time to rationalise and develop a strategic alliance with the Commonwealth before a contract to construct the DDGs was released.[96]

2.10 These factors were considered as part of the draft August 2002 *Australian Naval Shipbuilding and Repair Sector Strategic Plan*, which recognised a need to establish and sustain naval ship repair, upgrade and construction skills, as required in-country, to meet the RAN's current and future capability

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94 The first two phases of SEA 4000 (Phases 1 and 2) ended in May 2005 and June 2007 respectively, and are generally not within the scope of this audit. However, they are outlined in this chapter and in Chapter 3, in terms of their role in Defence gaining government approval to acquire the DDGs, and their role in reducing the program's risks.

95 Defence Materiel Organisation, *SEA 4000 Air Warfare Destroyer: Acquisition and Contracting Strategy*, version 1.5, 4 July 2002, Annex A.

96 Defence Materiel Organisation, *SEA 4000 Air Warfare Destroyer: Acquisition and Contracting Strategy*, version 1.5, 4 July 2002, Annex A.

and whole-of-life support requirements for major surface ships. This strategy was seen as requiring a design capability in Australia that could responsively and cost-effectively support the evolution of the ships in service.[97]

2.11 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.[98]

2.12 The process of selecting a Shipbuilder took place during late 2004–early 2005. In October 2004, five days before the 2004 federal election, the then Government announced that the DDGs would be built in Australia by an Australian company, and stated the criteria, chiefly pertaining to performance and cost, by which the company would be selected.[99] This decision set the ground rules for the Shipbuilder tender process, which took place from October to December 2004. Three responses to the Shipbuilder tender were received, and two of these underwent extensive analysis and interaction with the respondents. While both responses were considered to provide a satisfactory basis for selection as the AWD Shipbuilder, Defence assessed ASC's response as having demonstrable and significant advantages in all three key areas of technical, commercial and financial evaluation. At First Pass in May 2005, the then Government selected ASC AWD Shipbuilder Pty Ltd, an Australian shipbuilder, to build the ships to the design that was to be

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97 Defence Materiel Organisation, *Australian Naval Shipbuilding and Repair Sector Strategic Plan* (draft), Canberra, September 2002, pp. 22, 32; Defence Materiel Organisation, *SEA 4000 Air Warfare Destroyer: Acquisition and Contracting Strategy*, version 1.5, 4 July 2002, p. 1. While released for public comment, the plan was ultimately not approved by the then Government.

In May 2013, the then Government released a new shipbuilding strategy, the *Future Submarine Industry Skills Plan: A Plan for the Naval Shipbuilding Industry*, and announced its intention to implement it, in order to address key issues in the long-term management of this industry. The Government stated its goal of assuring 'Australia's maritime security capability while providing more certainty to Australian industry through consideration of a smoother, coordinated shipbuilding program that will provide a more stable pattern of work for the industry and retain critical skills for the future through a range of specific measures'. Prime Minister, Minister for Defence, Minister for Climate Change, Industry and Innovation and Minister for Defence Materiel, *2013 Defence White Paper, Naval Shipbuilding, Release of the Future Submarine Industry Skills Plan*, joint media release, 3 May 2013.

98 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.

99 Senator the Hon. Robert Hill, Minister for Defence, *Australian ship builders to build air warfare destroyers*, media release, Canberra, 4 October 2004; and *Doorstop interview—AWDs to be built in Australia*, 4 October 2004.

approved at Second Pass.[100] A subsequent probity inquiry found that the shipbuilding selection process did not inevitably favour ASC, and there were no breaches of the probity process.[101]

2.13 During this same period of late 2004–early 2005, Defence was analysing and evaluating an existing ship design offered by Navantia, and three evolved designs being developed by Blohm+Voss of Germany, Gibbs & Cox of the United States, and Navantia.

2.14 In May 2005, the AWD Program received First Pass government approval to proceed into Phase 2, with the following principal objectives:

(a) to deliver an affordable Maritime Air Warfare capability to meet ADF requirements, within established schedule and cost constraints;

(b) to markedly improve the overall capability of the RAN's surface combatant force;

(c) to build the ships in Australia, thereby providing significant work for Australia's shipbuilding industry; and

(d) to establish and sustain a design capability in Australia that could support the evolution of the ships in service in a responsive and cost-effective manner.[102]

2.15 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.

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100 ASC Pty Ltd is a wholly Commonwealth-owned and controlled Government Business Enterprise (GBE) subject to the *Corporations Act 2001* and the *Commonwealth Authorities and Companies Act 1997*. The Australian Submarine Corporation was originally established in 1985 as a joint venture between Swedish ship designer Kockums, Chicago Bridge & Iron (CBI), Wormald, and the Commonwealth, through the Australian Industry Development Corporation. In 1987, it was chosen to build the Collins Class submarines. During 1990, both CBI and Wormald sold their shares in the Australian Submarine Corporation, leaving the Commonwealth and Kockums as the remaining shareholders. In 2000 the Australian Government bought out Kockums, taking full ownership of the company. The Government announced that its acquisition was the 'first stage of a reform process that is expected to lead to ASC's onward sale to the private sector.'

At the time the Shipbuilder role was awarded to ASC, therefore, it had been government policy for seven years that it would privatise ASC. In March 2004, Defence's external adviser 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.

101 The Hon. De-Anne Kelly MP, Answer to Question in Writing: 'Sir Laurence Street', *House of Representatives Hansard*, 12 September 2005, p. 183.

102 This objective is not included in the Alliance or Platform System Design contracts, or in the scope of this audit.

2.16 At First Pass, Defence advised government that building the DDGs in Australia would cost $680 million—or some 33 per cent—more than the cost of building them overseas. This premium for an Australian build was justified by Defence on the grounds of retaining critical project management and design skills, and experience with sophisticated naval combat systems, which would enable through-life support of the DDGs in Australia and a continuing naval shipbuilding industry. For the 2007 Second Pass estimate of the premium, see paragraph 2.26.

SEA 4000 Phase 2–Design, 2005–07

2.17 The objective of Phase 2 was to further analyse the Navantia and Gibbs & Cox ship and Support System designs, so that the Government could rely upon 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. During Phase 2, Defence substantively completed the AWD Program's Capability Definition Documents, and finalised the Capability Options Document and the AWD Program's Business Case for Phase 3.[103]

Platform design

2.18 To arrive at the preferred AWD design, ASC, Raytheon, Navantia and Gibbs & Cox were engaged by Defence under individual contracts. In May 2005, Navantia was engaged as the Platform System Designer for its Existing Design, and in August 2005, Gibbs & Cox was engaged as the Platform System Designer for its Evolved Design.[104] Both platform designers were required to work with ASC and with Raytheon to arrive at an overall Hobart-class DDG design. In mid to late 2006, formal Phase 2 Design Agreements were signed by ASC and Raytheon. ASC had the US defence firm General Dynamics Bath Iron Works as its Technology Partner, and Raytheon remained the Combat System–Systems Engineer.[105] Bath Iron Works was selected to provide ASC with professional services, in view of its wide-ranging experience in the design and construction of Aegis-equipped destroyers.

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103 AWD Alliance, *Air Warfare Destroyer Test and Evaluation Master Plan*, September 2007.

104 The Existing Design option was for a modified F-100 design from Navantia, while the Evolved Design option was to be developed from Gibbs & Cox's Arleigh Burke-class DDG-51 design.

105 General Dynamics Bath Iron Works and Raytheon are US-based firms foremost engaged in naval ship and submarine design and construction, and integrated defence systems.

2.19 In late 2004, when bidding during Phase 1 for the role of Shipbuilder, ASC advised Defence that it was confident that its offsite block construction plan was practical and efficient, and that it had demonstrated a contingency of excess capacity and ability to deliver blocks in a cost-efficient manner and to the required quality.[106]

2.20 By April 2007, near the end of Phase 2, the DMO was confident that the Existing Design contained considerable design-for-production features, and that Navantia had thoroughly documented the design and production data package. The DMO's confidence was reflected in a finding that there was acceptable risk in the systems integration strategy and the architecture of the Australianised Combat System, centred on the Aegis Weapon System. The overall level of confidence led to the belief that the first DDG would be delivered in December 2014, and possibly sooner.[107]

Program management risk mitigation

2.21 The business model selected by the then Government in 2004 for the AWD Program was an alliance. At the outset of Phase 2, the Commonwealth intended to establish a long-term strategic relationship through a four-way alliance with the Shipbuilder, Combat System–Systems Engineer and Platform System Designer during the construction phase.

2.22 Phase 2 was directed toward reducing Phase 3's program management risks, by developing the cooperative relationships needed to effectively implement the Phase 3 business model. The Phase 2 contract terms and conditions incorporated key principles of cooperation and collaboration central to an alliance, while their pricing mechanism was a cost-reimbursement model. The contractors were required to cooperate with the Commonwealth, and with each other, in carrying out their platform and combat-system design work.

2.23 While the Phase 2 contracts did not share risks and outcomes among the contractors, as occurred in the later alliance-based contract model adopted in Phase 3, they did have the following alliance features:

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106 ASC Shipbuilding Proposal, 2004, paragraph 3.1.1.4.3, quoted in DMO, *SEA 4000 Program Air Warfare Destroyer: Phase 2 Overall Program Report*, April 2007, p. 95.

107 DMO, *SEA 4000 Program Air Warfare Destroyer: Phase 2 Overall Program Report*, April 2007, pp. 6–7.

(a) they recognised the role of the governance bodies established for the project, such as a Principals Council, a Project Board, Integrated Product Teams and Cross Product Teams; but the contracts did not give those bodies a direct governance function[108];

(b) they required the Industry Participants to contribute personnel under protocols that governed their work[109];

(c) they required the Industry Participants to warrant their work;

(d) they incorporated 'good faith' obligations; and

(e) they provided for Commonwealth Directions.

2.24 Following the work undertaken in Phase 2 and the then Government's approval of Phase 3 at Second Pass, the Commonwealth (represented by the DMO), ASC and Raytheon formed a three-way strategic alliance that remains in place. This arrangement provides for a long-term strategic relationship, and is intended to promote a collaborative approach to managing risks. However, the original intention to include Navantia as part of the alliance did not eventuate, and this has contributed to difficulties associated with exporting the design to Australia.[110]

Second Pass submission to Government

2.25 SEA 4000 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 ship 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 (this option was referred to as the Existing Design).[111] The

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108 The AWD Program's Principals Council, Project Board, Integrated Product Teams and Cross Product Teams are discussed in paragraphs 3.37 to 3.52.

109 Broadly speaking, 'corporate governance' refers to the processes by which organisations are directed, controlled and held to account. It encompasses authority, accountability, stewardship, leadership, direction and control exercised in the organisation. ANAO Better Practice Guide—*Public Sector Governance*, Canberra, July 2003, p. 6.

110 For further discussion, see paragraphs 3.72 and 3.73.

111 In 2005, Defence was advised of a risk that the United States' Aegis production line would begin to shut down if further orders were not received, and that reopening the production line would come at considerable additional cost. In line with its August 2004 decision to adopt the Aegis Weapon System, the Government agreed to commence early acquisition, in order to avoid the considerable cost premium associated with reopening the production line.

Footnote continued on the next page…

Government selected Navantia's Existing Design over the Gibbs & Cox Evolved Design, on the basis that Navantia's design was less developmental and therefore contained less risk. At this stage, the DDGs were to be delivered in December 2014, March 2016 and June 2017 respectively, at an aggregate cost in the order of $8 billion.[112]

Premium for building the DDGs in Australia

2.26 In 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.[113] To Treasury, this appeared disproportionate to any critical defence industry capabilities to be achieved as a consequence of a local build. Treasury also commented that it expected that the lessons to be learned from the AWD project—including the importance of not pre-committing to an Australian ship build—would be reflected in the (then) forthcoming Industry Self-Reliance Plan.[114] The Department of Finance noted that the premium for an Australian build was much higher than anticipated, and that almost half the project by value would still be sourced from overseas.

Design risk assessments

2.27 As indicated in paragraph 2.3, the Second Pass submission to government was intended to provide detailed and rigorous analysis of options, including technical risk. At the time, Defence advised the 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;

In 2006, Defence entered into a Foreign Military Sales case with the US Government (represented by the US Navy) to acquire the Aegis Weapon System. Funding was separated from SEA 4000 Phase 3 to fund the Aegis acquisition under a new project phase, Phase 3.1. However, to better align the Aegis acquisition with the acquisitions of the platform system and residual elements of the combat system, Defence notified the Government of its intention to recombine Phase 3.1 with Phase 3 at Second Pass approval, in 2007.

112 The Hon. John Howard MP, Prime Minister, *Transcript of the Prime Minister The Hon. John Howard MP, Defence Announcement, Russell Offices, Canberra*, media release, Canberra, 20 June 2007.

113 An earlier estimate of $680 million is discussed at paragraph 2.16.

114 The Government's March 2007 *Defence and Industry Policy Statement* had stated that a Defence Industry Self-Reliance Plan would be developed that would outline the essential security role of industry in equipping, re-supplying and maintaining the ADF, and that priority local industry capabilities, identified as necessary for Australia's essential security, would be detailed in the public version of the Defence Capability Plan. No Defence Industry Self-Reliance Plan was produced.

- 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 (Defence had high confidence in the Existing Design 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.

2.28 Defence assessed the overall risk of adopting the Existing Design as medium.[115] Defence advised the Government that it had consulted widely with industry and assessed that industry would be competitive for the work in a number of locations.[116] Defence advised government that Navantia's Existing Design was mature, and that about seven per cent of the project risk in the Navantia design was due to lack of maturity of the design. Defence advised that for the Evolved Design from Gibbs & Cox, about 50 per cent of the project risk was related to lack of maturity of the design.

2.29 Defence also advised government that the Existing Design incorporated two types of design change: changes permitted by government direction (at First Pass in 2005) to address Australian capability requirements, and changes that Navantia and the Spanish Government had agreed for the latest of the F-100 class (F-105)[117], because of limitations discovered by the Spanish Navy while operating its F-100 fleet.[118] Together, these two types of design change—

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115 In its coordination comments on Defence's advice to Government, Finance pointed out that there was a tension between Defence's assessments of high technical risk, medium cost risk and low schedule risk.

116 The difficulties facing the shipyards participating in the AWD Program are discussed in Chapter 6.

117 The F-104, *Méndez Núñez*, was laid down in 2003, launched in 2004, and commissioned in 2006. The F-105, *Cristóbal Colón*, was laid down in June 2007, launched in November 2010, and commissioned in October 2012.

118 In its January 2014 response to an extract from this audit report, ASC stated that 'While the ABTIA and PSD contract define the design baseline as the F-104, it is ASC's view that the Alliance is being delivered a production design derived from the F-105. The F-105 has evolved from the much earlier F-104 design and as a result, significant additional design risk has been driven into the AWD program due [to] the extensive nature of the design evolution from the F-104 to the F-105. This has manifested itself as substantial rework driven by design immaturity issues, which run across many aspects of the AWD program and have caused considerable cost and delay to date.' See page 3 of ASC's letter to the ANAO, reproduced in Appendix 3.

Navantia, in its own 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.

for Australian requirements and to address operational shortcomings—were stated to be low-risk and relatively low-cost, and were to improve the Existing Design's range, speed, gun, sonar and other residual capability issues.[119] The effect of these design changes had been taken into account when developing the Second Pass cost estimate, schedule and risk summary for the Existing Design. The cost of the additional design changes was estimated at $122 million.

2.30 In commenting on the Second Pass submission in June 2007, the then Department of Finance and Administration 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.

2.31 However, halfway into the build phase of the AWD Program, there are strong indications 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 not fully understood at the time of the June 2007 Second Pass submission to government.[120] The design change and distributed build issues are examined in Chapters 5 and 6.

SEA 4000 Phase 3–Build, post-2007

2.32 The key activities in Phase 3 are finalisation of the design development, and the construction, test and delivery of the lead Hobart-class DDG and its two follow-on DDGs. Phase 3 also includes the provision of RAN crew training, the development of shore facilities, and the establishment of the DDGs' logistic management infrastructure. This phase is to culminate in the Provisional Acceptance by the DMO of three Hobart-class DDGs[121], the Acceptance of DDG Support System elements in accordance with the Alliance

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119 These and other design changes were analysed during Phase 2, with the objective that they would achieve the then Government's core AWD capability requirements without compromising the existing platform design, while also avoiding extensive and expensive changes to broader fleet equipment and tactics.

120 In its January 2014 response to an extract from this audit report, ASC stated that 'ASC's experience in the Collins and the AWD programs continues to highlight the challenge of transferring a design to production in a new country with differing cultures, technical processes, facilities, supply chains and customers.' See page 2 of ASC's letter to the ANAO, reproduced in Appendix 3.

121 Provisional Acceptance is defined in footnote 73.

contract, and the delivery of the DDG capability to Defence in accordance with the Materiel Acquisition Agreement.[122]

SEA 4000 Phase 3.2–Missiles, post-2011

2.33 In August 2011, the Government approved SEA 4000 Phase 3.2, to convert Defence's stock of SM-2 missiles from rail-launch configuration (as used on the RAN FFGs) to vertical-launch configuration for the DDGs, and to replace some SM-2 missiles with more capable missiles.[123] A separate project, SEA 1360, is proposed to equip the DDGs with the long-range Standard Missile 6 (SM-6) during 2021–24.[124] The SM-2 and SM-6 missile projects are not examined in this audit.

SEA 4000 Phase 3.3–Trials

2.34 At the time of the audit, SEA 4000 Phase 3.3 involved the planning of Combat System Ship Qualification Trials, to be conducted by the RAN on each of the Hobart-class DDGs as part of their Operational Test and Evaluation process. This phase is expected to lead to a recommendation to the Chief of Navy concerning the Operational Release of each DDG.

2.35 The trials focus on operational evaluation of the ships, and on collecting data needed to assess system performance and operator proficiency. This involves live target tracking and firing all onboard weapon systems, and is conducted primarily off the US West Coast or off Hawaii.

2.36 To date, most ships fitted with an Aegis Weapon System, regardless of country of origin, have completed a US Navy Combat System Ship Qualification Trials program.[125] These trials are intended to 'verify and validate that an individual ship's combat/weapons systems have been installed correctly and can be operated and maintained in a safe and effective manner'.[126] This is accomplished by assisting the Aegis-fitted ship in achieving:

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122 AWD Alliance, *Air Warfare Destroyer Test and Evaluation Master Plan*, September 2007.

123 The Hon. Stephen Smith MP, Minister for Defence, *Defence capability projects approved*, media release, 30 August 2011.

124 *Defending Australia in the Asia Pacific Century: Force 2030*, Defence White Paper 2009, Canberra, 2009, p. 71; Department of Defence, *Defence Capability Guide 2012*, Canberra, 2012, p. 39.

125 Royal Australian Navy, *Capability Realisation Plan for the Acceptance into Operational Service of the Hobart Class Destroyer (DDG)*, Version 1, October 2012, p. 10.

126 US Department of Defense, Department of the Navy, Naval Sea Systems Command Instruction 9093.1c, *Combat System Ship Qualification Trials for Surface Ships*, 30 August 2006.

- a sustainable level of combat/weapon system operational readiness; and
- a maintainable level of materiel readiness.

2.37 At the time of the audit, the Combat System Ship Qualification Trials were being planned. SEA 4000 Phase 3.3 was included in the Defence Capability Plan 2012 with an estimated cost of less than $100 million[127], and a feasibility study was being prepared in early 2014. However, these trials were yet to reach the stage of First Pass approval by government. Phase 3.3 is not examined in this audit.

Australian industry engagement in Phase 3

2.38 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.

2.39 Using a similar measure, Figure 2.2 shows, in percentage terms, the overall SEA 4000 Phase 3 expenditure by currency, as at December 2013. In summary, at that time, 51.1 per cent of AWD Program expenditure had occurred overseas, and 48.9 per cent of expenditure had occurred in Australia.

2.40 Figure 2.3 shows, for Phase 3 Australian dollar expenditure, the percentage spent in each state, with the principal beneficiaries being South Australia (60 per cent), New South Wales (27 per cent) and Victoria (10 per cent).

2.41 As at February 2013, ASC had some 200 subcontracts, totalling $1.195 billion. Of these, the Australian industry content amounted to $617 million, or 52 per cent.[128]

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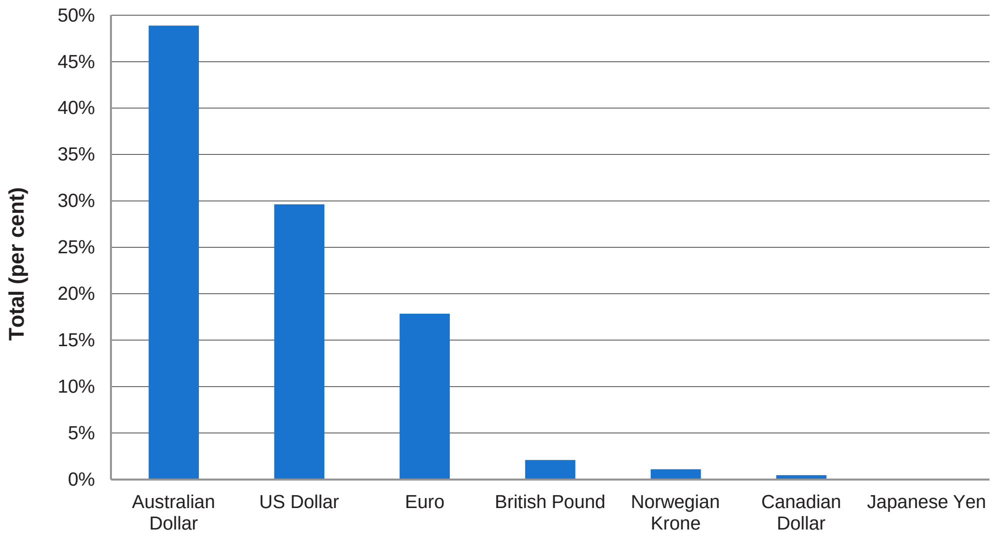
127 *Defence Capability Plan 2012*, pp. 248–9.

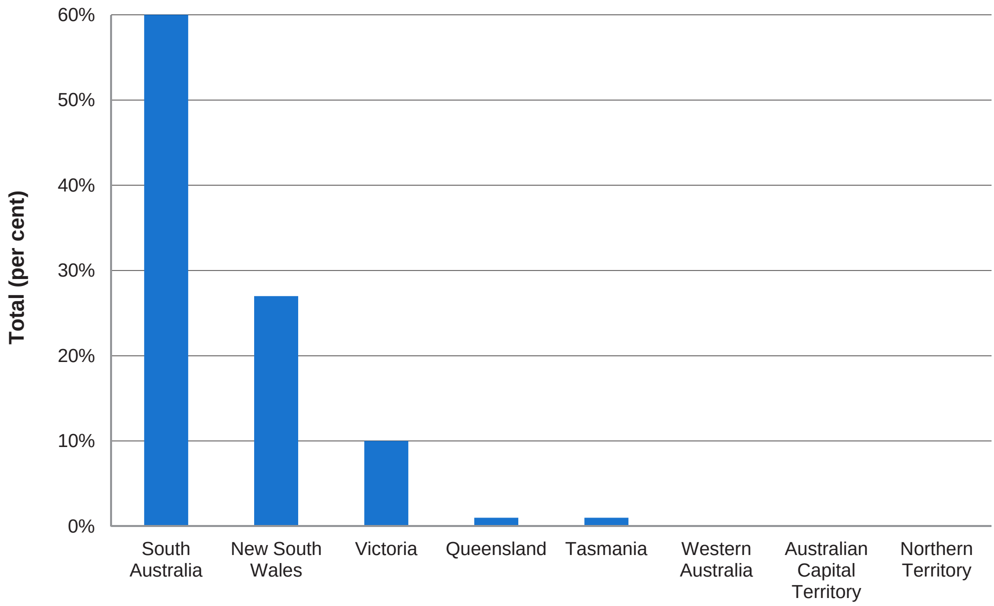
128 February 2013 Raytheon data indicated that it had 22 subcontracts to a value of $476 million (December 2006 prices). While six of these contracts, to a value of $80 million (17 per cent), were with Australian firms or subsidiaries, no exact figure was available for Australian industry content.

Figure 2.2: Expenditure on SEA 4000 Phase 3 in percentage terms, by currency, as at December 2013



Source: Air Warfare Destroyer Program Management Office, information provided to the ANAO, January 2014.

Figure 2.3: AUD expenditure on SEA 4000 Phase 3 in percentage terms, by state and territory, as at December 2013



Source: Air Warfare Destroyer Program Management Office, information provided to the ANAO, January 2014.

Workforce recruitment targets

2.42 The AWD Alliance's Australian Industry Capability Plan, formulated in 2008, included workforce development plans that aimed to build a new shipbuilding workforce. Under this plan, the workforce recruitment targets for ASC were set at a total of: 370 technical, engineering, project management and general management personnel (non-trade personnel); and 491 trades personnel. Both targets were met. Non-trade personnel peaked at 780 in July 2013. Trade personnel met and exceeded the target in September 2012, when 584 trades personnel were employed. As at 30 October 2013, the ASC workforce consisted of 604 engineering/management personnel and 894 trades personnel.

2.43 The workforce recruitment target for Raytheon Australia was set at 230 in the 2008 plan. This target was met, with numbers peaking at 464 in December 2012. As at 30 October 2013, the Raytheon Australia workforce consisted of 354 personnel.[129]

Block construction target

2.44 Under the Alliance contract, the Industry Participants have been set a target of 70 per cent—or 65 of the 93 DDG blocks—to be built by Australian industry other than ASC (located in South Australia). This was to enable a spread of acquisition expenditure to shipyards in other states. However, block construction reallocations resulting from difficulties with initial block production at an Australian shipyard mean that only 58 blocks (62 per cent of all blocks) are being built by Australian industry other than ASC. This shortfall of seven blocks results from ASC being allocated 25 ship blocks (27 per cent of all blocks) and Navantia in Spain being allocated 13 ship blocks (14 per cent of all blocks).[130]

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129 Air Warfare Destroyer Alliance, *Australian Industry Capability Plan*, 29 August 2008; Air Warfare Destroyer Alliance, *Australian Industry Capability Progress Report (May–October 2013)*, 25 November 2013.

130 As stated in paragraph 1.2, the DDGs are being built using a distributed-build construction method, with the hull blocks of the three destroyers being constructed at four shipyards. For an outline of block reallocations among shipyards, and the current distribution of blocks, see paragraphs 6.48–6.51, Figure 6.5 and Figure 6.6.

Phase 3 approved budgets and expenditure

2.45 The approved budgets and expenditure of the various phases of SEA 4000 are shown in Table 2.1.

SEA 4000 Phase 3 budget, expenditure and contracts

2.46 In June 2007, at Second Pass approval, the budget for SEA 4000 Phase 3 was $7.207 billion. In order to maintain the project's approved value relative to the original approved amount over the project's lifetime, the approved budget was adjusted annually for labour and material cost indexation changes using a government-approved price indexation factor. From June 2010 these annual adjustments were replaced by the 'outturn budgeting' concept, whereby the approved budget was updated with a life-of-project price index. As at June 2013, the cost estimates for SEA 4000 Phase 3 had increased by a total of $1.173 billion since June 2007, due to inflation-related price indexation.[131]

2.47 In addition, every six months, the approved budgets of DMO's major projects are adjusted to take account of foreign-exchange fluctuations. Between June 2007 and December 2013, the appreciation in the Australian dollar resulted in the AWD Program's foreign-currency requirements for Phase 3 decreasing by $451 million as at December 2013.[132]

2.48 Between June 2007 and December 2013, the combined effects of price indexation and foreign-exchange variations resulted in the approved budget for SEA 4000 Phase 3 increasing by $722 million to $7.929 billion.

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131 However, in the *2012–13 Major Projects Report*, the DMO also acknowledged that indexation shortfall had contributed to its 2012–13 overspend of $106 million. ANAO Report No.12, 2013–14, *2012–13 Major Projects Report*, p. 151.

132 ANAO Report No.12, 2013–14, *2012–13 Major Projects Report*, p. 151.

Table 2.1: SEA 4000 approved budgets and expenditure, as at December 2013

Phase	Duration	Original approved budget ($m)	Original approval date	Current or last approved budget ($m)	Expenditure to end Dec 2013 ($m)	Price Basis
0, Capability Studies	2000–02	0.250	May 2002	0.256	0.252	Jan 2004
1A, Non-design-related Studies	2002–07	4.450	Jan 2003	4.576	3.673	Jan 2010
1B, Combat System Design Studies	2003–10	7.600	Jul 2003	9.966	7.782	Jan 2010
1C, Platform Design Studies	2004–05	13.940	Apr 2004	14.894	13.016	Jan 2010
1D, Combat System Integration and Risk Reduction	2004–15	14.800	Sep 2004	17.665	11.476	Jan 2014
2, Design *	2005–07	455.000	May 2005	226.302	226.302	Jan 2008
3, Acquisition and Build	2007–19	7207.369	Jun 2007	7929.546	4920.167	Jan 2014
3.1, Aegis Weapon System *	2005–07	1267.273	Dec 2005	150.128	150.128	Dec 2007
3.2, Standard Missile-2 (SM-2) conversion and upgrade	2011–20	93.761	Nov 2011	101.681	37.473	Jan 2014
3.3, Naval Operational Test and Evaluation/Combat System Ship Qualification Trials	2008–19	Not yet approved, but estimated as less than $100 million in the Defence Capability Plan 2012				
Total		* 7664.443		**8455.014**	**5370.269**	**Various**

Source: AWD Program Management Office.

Notes: * Phase 2 funding of $252 million and Phase 3.1 funding of $1148 million was transferred and included in the Phase 3 budget provided in 2007. The total for original approved budgets therefore subtracts these amounts from the sum of that column. For further discussion of Phase 3.1, see footnote 111. Totals do not include Phase 3.3.

AWD Alliance cost changes

2.49 From the signing of the AWD Alliance contract in October 2007 to 31 December 2013, the Target Cost Estimate has increased from $4.319 billion to $4.443 billion (December 2006 prices), an increase of $124 million, or 2.9 per cent.[133] This increase is the result of DMO's acceptance of 19 Contract Amendment Proposals that have increased the Target Cost Estimate.[134] Table 2.2 lists 21 Contract Amendment Proposals, including two that reduced the Target Cost Estimate. The increase in the Target Cost Estimate has been funded from within the program's current approved budget.

Table 2.2: Cost changes in the AWD Alliance contract

Contract Amendment Proposal	Purpose	Cost ($m, Dec 2006)
1	Addition of bowthrusters to the DDG design	13.149
2	Addition of the helicopter Aircraft Ship Integrated Secure and Traverse (ASIST) system, which replaced the helicopter Recovery Assist, Securing and Traversing (RAST) system[135]	-0.557
4	Addition of AWD Systems Centre	45.871
10	Addition of AWD insurance	40.789
12	NECORA (Navantia Manufacturing Resource Planning System)	0.069
15	Amendments to the Hobart Class Platform System Specification relating to the power distribution system	6.771

133 The Target Cost Estimate is the agreed estimate of the Direct Project Costs involved in the work under the Alliance contract and the Platform System Design contract. The Target Cost Estimate is discussed further in paragraphs 3.15 to 3.16 and 3.29 to 3.32.

134 Altogether, to 31 December 2013 there had been 54 approved Contract Amendment Proposals.

135 The ASIST system assists helicopters to land on ships at sea, and on landing secures them to the landing pad and traverses them into their hangars. ASIST was designed to replace the RAST system, which is used by the RAN and by other naval forces, including the US Navy and the Royal Navy. The ASIST system provides a similar, but not compatible, operating capability to that provided by the RAST system, as ASIST does not have a recovery-assist haul-down cable, which the RAST system provides to reduce the risk of damage to the helicopters caused by hard landings in heavy sea swells. Fitting the ASIST system to the DDGs requires the AIR 9000 Phase 8 Program to modify the Sikorsky Romeos' RAST panel to incorporate ASIST functions.
The current helicopter recovery system fitted to the RAN surface fleet is the RAST Mk IV, which is also fitted to the F-100 Class and was originally selected for the Hobart-class DDGs. The choice of this system, in view of possible future RAN aircraft selections, was discussed in various forums during SEA 4000 Phase 2, including on several occasions in Alliance briefings to the Chief of Navy. At the start of Phase 3, the RAN advised the AWD Program Management Office that the preferred helicopter recovery system for the DDGs was the ASIST system, because it might meet future capability requirements. According to the RAN, not proceeding with the change to ASIST would impact on the capability available, and the Hobart-class DDGs might fail to meet future capability requirements.

Contract Amendment Proposal	Purpose	Cost ($m, Dec 2006)
16	Personnel training for the ASIST system	1.250
36	Design changes to the Magazine Fire-fighting Measures	2.859
39	Financial Security[136]	-2.769
41	440 VAC Residual Current Devices	0.031
47	Platform System Design Consultancy	0.047
65	Supply Chain Study funding	0.750
68	Command Team Trainer additional funding	2.000
69	Adjustment for the insurance costs required by the Insurance Wrap Policy	9.336
74	Sonar Dome Insurance Spare	1.502
78	Changes to the Provisions Handling Crane to remove the potential hazard of the crane impacting the superstructure of the ship	0.104
83	Supply Chain Development Planning Phase 2a-2	0.553
84	Commander Task Group Command Team Trainer	0.329
87	Guard Rail Stanchions	0.288
92	Supply Chain Development Sourcing (Phase 2B)	1.687
96	Command Team Trainer Temporary Integration Facility (TIF) Preliminary Design	0.339
	Total	**124.398**

Source: Defence Materiel Organisation, and ANAO analysis of Contract Amendment Proposals.

Notes: Contract Amendment Proposals 2 and 39 reduced the Target Cost Estimate. Contract Amendment Proposals 20, 22, 50, 51, 63, 64 and 89 involved the transfer of funds from the Alliance contract to the Platform System Design contract, and so did not increase or decrease the Target Cost Estimate. Contract Amendment Proposals 12 and 47 also involved the transfer of funds from the Alliance contract to the Platform System Design contract, but additionally incurred minor Alliance contract cost for their preparation.

2.50 Contract amendments can be expected in a defence program of the size and technological complexity of SEA 4000 Phase 3. Five of the Contract

136 The Alliance contract originally required each Industry Participant to maintain a Financial Security. After the Government announcement in 2009 that ASC would not be privatised, the Alliance Participants agreed to remove the requirement from ASC, and to reduce the Target Cost Estimate accordingly. The requirement is expected to be reimposed if ASC is privatised.

Amendment Proposals—items 1, 2, 15, 36 and 50[137]—relate to scope change for the construction of the ship. These five Contract Amendment Proposals were foreshadowed in the funding submission at Second Pass in 2007, which contained an allowance of $122 million for platform-related changes that were a consequence of F-105 modifications and RAN requirements (see paragraph 2.29). 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. Design and other changes must be communicated effectively to affected parties and changes must be implemented in a coordinated manner, to avoid unnecessary rework and other potential costs and delays. This is particularly important for those aspects of the project that are being progressed in parallel, such as block construction and block consolidation.[138]

Commonwealth Funded Property

2.51 Under the Alliance contract, Defence is funding a large amount of material and equipment that is being used by the Industry Participants and their subcontractors, in accordance with the contract's cost-plus-incentive-fee structure.[139] This includes Commonwealth Funded Property, which is defined as 'plant, equipment and other goods' costing over $1 million, the purchase of which is approved by Defence for reimbursement, and which is to be used in producing the Hobart-class DDGs.[140] After the completion of the contract, this material may be offered for sale to the Industry Participants and their subcontractors, subject to value-for-money considerations.

2.52 As at February 2013, the AWD Program's register of Commonwealth Funded Property included these items:

- a Manitowoc Model 21000 crane, Australia's biggest heavy lift crane and one of only 12 in the world of this size, with a lifting capacity of 900

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137 Contract Amendment Proposal 50 involved change of the Electronic Warfare baseline from the reference design to an alternate solution ($1.311 million transferred to the Platform System Design contract), but did not affect the Target Cost Estimate, and so is not shown in Table 2.2.

138 The issue of contract amendments which affect the baseline design should also be considered in relation to the cost of any rework involved in their implementation; for discussion of rework, see paragraphs 6.55 to 6.65.

139 Discussed in detail in Chapter 3.

140 Commonwealth of Australia, ASC AWD Shipbuilder, Raytheon Australia, *Air Warfare Destroyer (SEA 4000) Alliance Based Target Incentive Agreement—Attachment 1—Glossary, 2007*, p. 10.

tonnes. This crane was acquired in 2009 at a cost of US$11.782 million (inclusive of delivery and assembly)[141], and is being used to support the consolidation of ship blocks on the South Australian Government-owned Common User Facility at the Techport Australia Maritime Precinct; and

- two Outfit Support Towers situated on the Common User Facility. These five-storey buildings are situated directly beside the hard stand where the ships are being consolidated, enabling access for shipbuilding staff. The towers were built in 2010 at a cost of $11.668 million.[142]

2.53 Upon completion of the AWD Program, material costing less than $1 million that has qualified as a Direct Project Cost under the Alliance contract remains the property of the relevant company.[143]

2.54 In February 2011, the Program Management Office considered whether some other high-cost items, such as four self-propelled modular transporters, costing under $1 million each, that are used to move ship blocks[144], should also be classified as Commonwealth Funded Property.

2.55 In May 2011, the Program Management Office sought agreement from the Industry Participants to adopt a number of changes in implementing the Commonwealth Funded Property provisions of the Alliance contract. It also suggested that procurements of plant and equipment be presumed, in the first instance, to be Commonwealth Funded Property, with the onus on the Industry Participants to demonstrate why items were not Commonwealth Funded Property under the Alliance contract (having regard to any agreed methodology). However, the Industry Participants did not share Defence's view, and declined the suggested changes. In February 2012, the AWD Alliance Project Board resolved that the method of acquiring and accounting for Commonwealth Funded Property on the project should be reviewed, with a view to crediting to the Target Cost Estimate the residual value of

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141 ASC, information provided to the ANAO, October 2013.

142 ASC, information provided to the ANAO, October 2013.

143 The principle of Commonwealth Funded Property—that the Commonwealth funds the purchase of items/facilities critical to progressing a project and to be offered for sale at the end of the project—has applied to other Defence contracts, for example, some of the Collins Class submarine-building facilities.

144 Individually, these transporters cost some $625 000 each, but they must be used as a pair, and therefore could be considered to be a system costing more than $1 million.

Commonwealth Funded Property already purchased. In April 2013, the AWD Alliance Project Board agreed that it would assess the potential for returning funds to the Target Cost Estimate by the sale of property purchased by the project at the end of the project.[145]

2.56 In respect of these arrangements, the ANAO notes that the definition of public property set out in section 5 of the *Financial Management and Accountability Act 1997* is drawn broadly to include:

> (a) property in the custody or under the control of the Commonwealth; or
>
> (b) property in the custody or under the control of any person acting for or on behalf of the Commonwealth in respect of the custody or control of the property;
>
> including such property that is held on trust for, or otherwise for the benefit of, a person other than the Commonwealth.

2.57 The application of section 5 in any given circumstance can be complex, and it would accordingly be prudent for the DMO to seek appropriate advice (including legal advice and Department of Finance advice) on the application of the Act to the arrangements described in paragraphs 2.51 to 2.55.

South Australian Government-owned property

2.58 The South Australian Government's Techport Australia Maritime Precinct was constructed between 2008 and 2012.[146] Within that precinct, and adjacent to the ASC Shipyard, is a Common User Facility costing some $254 million, where the building blocks for all three destroyers are to be consolidated and then launched. This facility includes a dry berth, transfer system, a shiplift dock and a wharf. The shiplift dock is 156 metres long, 34 metres wide and can lift 9300 tonnes.

2.59 Techport also contains the Maritime Skills Centre, the AWD Systems Centre, the ASC South shipyard and Raytheon Australia's South Australian headquarters. Figure 2.4 shows the Techport precinct, and highlights the

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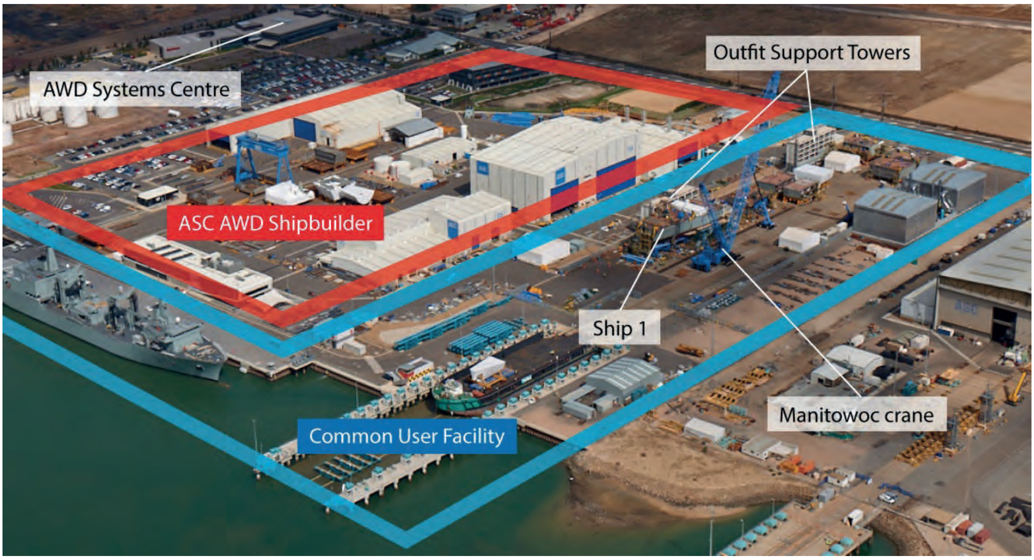
145 For further discussion of the Alliance contract pricing model, see paragraphs 3.29 to 3.32.

146 As part of its support for a South Australian build location for the DDGs, the South Australian Government offered an assistance package, which the Commonwealth accepted in May 2005. The South Australian Government committed to constructing the Techport Australia Maritime Precinct and a purpose-built Common User Facility (CUF), at a cost of some $300 million. In November 2008, the AWD Alliance signed a ten-year lease for the AWD Systems Centre at Techport.

Common User Facility. The Manitowoc crane and the Outfit Support Towers are Commonwealth Funded Property (see paragraph 2.52).

Figure 2.4: Techport Australia Maritime Precinct



Source: AWD Program Management Office, March 2013.

Organisational arrangements for capability development oversight

2.60 Another key aspect of the AWD Program is the Defence management structure used to oversee the delivery of the DDGs, in accordance with the parameters set by government. The Defence management structure shown in Figure 2.5 is responsible for the development of the Fundamental Inputs to Capability (FIC) for the RAN's DDG program.[147] The management structure includes:

- the Capability Manager (the Chief of Navy), advised by the Director-General Navy Capability Transition and Sustainment and the Capability Management Steering Group (CMSG);
- two Program Management Stakeholder Groups (PMSGs)—at three-star and one-star levels;

147 Defence's FIC, and the groups responsible for managing their development, are shown in Table 1.3.

- DMO's AWD Program Management Office (PMO);
- the AWD Capability Implementation Team;
- the AWD Transition and Coordination Management Group; and
- the AWD–LHD (Landing Helicopter Dock) Sustainment Steering Group.[148]

2.61 Further detail on these arrangements is in Appendix 8.

2.62 The Capability Manager for the AWD Program is the Chief of Navy. At the time of the audit, the Chief of Navy's responsibility for overseeing and coordinating all elements necessary to introduce the DDGs' full level of operational capability into service by the date agreed to by government had not been documented into a Joint Project Directive issued by the Secretary of Defence and the Chief of the Defence Force.[149] 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.

2.63 Joint Project Directives are intended to provide top-level direction from the Secretary and the Chief of the Defence Force to the Capability Manager, to facilitate the introduction of full operational capability into service by the date agreed by Government. The directives are meant to articulate the roles of each Defence Group in delivering their respective FIC. This approach is intended to ensure alignment between government decisions and the capability to be delivered.

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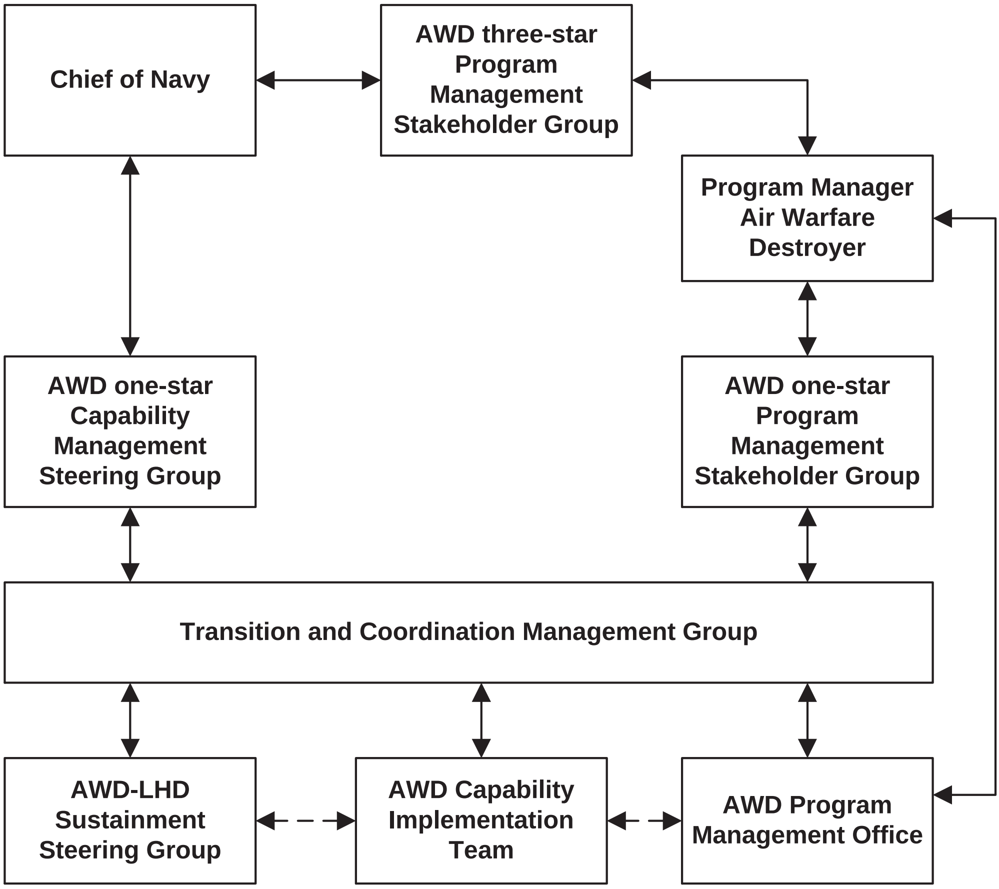
148 The two Canberra-class Landing Helicopter Dock (LHDs), HMAS *Canberra* and HMAS *Adelaide*, are scheduled to achieve Initial Operational Capability (IOC) in December 2014 and November 2016 respectively. The ships will replace one of the Kanimbla-class landing platform amphibious ships and the Tobruk-class Landing Ship Heavy (LSH) vessel.

149 There is a Joint Project Directive for SEA 4000 Phase 3.2–Standard Missile-2 Conversion and Upgrade, but not for SEA 4000 Phase 3–Build.

Figure 2.5: Defence oversight of the AWD Program



Source: RAN, AWD Capability Implementation Team.

2.64 Given the cost and complexity of the AWD Program, there would be benefit in Defence creating a Joint Project Directive for Phase 3–Build. This would help ensure ongoing alignment between government decisions and the contribution required of each part of the Defence organisation. It would also provide a sound basis for seeking a change to the capability being acquired where contingencies arise.[150]

150 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.

Option for a fourth destroyer

2.65 At the AWD Program's Second Pass approval in June 2007, the Government considered the option to acquire a fourth destroyer.[151] The Alliance contract, signed in October 2007, provided an option for an additional Hobart-class DDG, which needed to be exercised by October 2008. Since then, Defence has done further work to assess the viability of acquiring a fourth DDG, should the Government so decide. The Defence White Paper 2013 did not mention an acquisition of a fourth DDG.[152]

2.66 Following the change of government in September 2013, Senator the Hon. David Johnston, the new Minister for Defence, was reported as having stated that a series of options to deal with the future of the naval shipbuilding industry would be presented to the Government, with no option having been ruled out.[153] By November 2013, preparations were being made for a review of the AWD Program. 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.[154]

Conclusion

2.67 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 the 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

151 The Hon. Brendan Nelson, Minister for Defence, *Transcript of doorstop interview, Adelaide*, media release, 4 October 2007.

152 Department of Defence, *Defence White Paper 2013*, Canberra, 2013, p. 83.

153 John Kerin, 'Fourth destroyer on Coalition agenda', *Australian Financial Review*, 20 September 2013, p. 9.

Public discussion of a shipbuilding review and of the possibility of acquiring a fourth DDG continued late in 2013; see, for example, John Kerin, 'Cost fear sets off $8bn warships review', *Australian Financial Review*, 7 October 2013, and Ian McPhedran, 'Shipbuilding companies lobby Government for a fourth Air Warfare Destroyer', News Limited Network, 8 October 2013.

In November 2013, the CEO DMO confirmed that a review of the maritime sector was under way. Senate Foreign Affairs, Defence and Trade Legislation Committee, *Estimates Hansard*, 20 November 2013, pp. 85–6.

154 Senator the Hon. David Johnston, Minister for Defence, and Senator the Hon. Mathias Cormann, Minister for Finance, *Coalition committed to the efficient delivery of the Air Warfare Destroyer Program*, media release, 17 December 2013.

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.

2.68 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.

2.69 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, halfway 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.

2.70 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.

2.71 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.

2.72 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. 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.

3. The AWD Alliance and the Design Contract

This chapter examines the development and operation of the AWD Program's alliance arrangements, and the extent to which they effectively support the resolution of AWD acquisition issues. It also examines the alignment of the Platform System Design contract with the Alliance contract.

Introduction

3.1 In the public sector context, alliance contracting involves an arrangement between a government agency as 'owner-participant', and one or more 'non-owner participants', for the delivery of capital works. Project alliances are characterised by:

- sharing of risks and rewards between the participants;
- a no-fault no-blame arrangement between the participants to resolve most issues;
- payment arrangements whereby contractors receive reimbursement of direct project costs, and a fee for corporate overheads and profit based on a pain-share gain-share arrangement which takes into account project performance against a Target Cost Estimate and other key result areas; and
- a joint leadership arrangement and integrated project team.[155]

3.2 There are a range of potential benefits, issues and risks associated with alliance contracting arrangements. The benefits include the ability to apply a pricing structure which provides a strong incentive to motivate the non-owner participants to deliver the project on time, at cost, and in accordance with requirements; and for the participants to collectively, collaboratively and flexibly manage project risks and issues.[156] Of particular note, circumstances which lead to contract variations under a standard contract may not result in

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155 ANAO Audit Report No.37, 2009–10, *Lightweight Torpedo Replacement Project*; and Victorian Government, Department of Treasury and Finance, *Project Alliancing Practitioners' Guide*, Melbourne, 2006.

156 Victorian Government, Department of Treasury and Finance, *Project Alliancing Practitioners' Guide*, Melbourne, 2006.

variations under an alliance contract. The Target Cost Estimate under an alliance arrangement may include an amount of management reserve, which can be used by the participants to manage various contingencies, with contract variations only needed when there is a substantial change to the scope of the project.[157]

3.3 In establishing an alliance contractual arrangement, there is a need for consideration of the respective skills, capacity and integrity of the potential alliance participants through a tender process. Nevertheless, in contrast to standard contracting, the tender process does not establish the price of the project through the bidding, negotiating and awarding of a contract at an agreed level of remuneration. This can lead to difficulty in demonstrating value for money where the owner and non-owner participants develop and agree the Target Cost Estimate for the project and other performance targets.[158] Another related factor to be considered is that the owner-participants in an alliance contract generally face high administration costs. For example, there is a need to apply expertise to validate the Target Cost Estimate and direct project costs; and regular senior management input and day-to-day staff involvement are necessary to establish and maintain project alliances.

3.4 Reflecting these considerations, the Victorian Government's *Project Alliancing Practitioners' Guide* states that:

> Project alliancing should generally only be considered in the delivery of complex and high risk infrastructure projects, where risks are unpredictable and best managed collectively. The decision to use project alliancing must be based on a robust understanding of the project risk, including risks that cannot yet be determined or scoped. Organisations must also ensure they have the understanding and resources required to deliver projects through project alliancing.[159]

3.5 In July 2002, the DMO identified an alliance contracting model as 'the preferred contracting strategy' for the AWD Program, and characterised an alliance as:

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157 Davies, P.J., *Alliance Contracts and Public Sector Governance*, Griffith Law School, Griffith University, August 2008.

158 Note that, in the case of the AWD Program, in 2004 tenders were called for the roles of Shipbuilder and Combat System–Systems Engineer (CSSE); these tenders were awarded to ASC and Raytheon respectively.

159 Victorian Government, Department of Treasury and Finance, *Project Alliancing Practitioners' Guide*, Melbourne, 2006, p. 3.

> a risk sharing collaborative approach to contracting that is ideally suited to projects that are delivered in an environment of uncertainty, including diverse interests, shifting imperatives and rapid technological change.[160]

3.6 The DMO's September 2002 *Australian Naval Shipbuilding and Repair Sector Strategic Plan* outlined the benefits of a strategic alliance between Defence and a sole-source Australian shipbuilder in order to sustain strategically important industry capabilities during a period of reduced naval shipbuilding expenditure over the following 15 years (2002–17). Beneath the proposed strategic alliance would be a number of project alliances, below which—at the subcontractor level—there would be open competition.[161]

3.7 This chapter examines the development and operation of the AWD Program's alliance arrangements, and the extent to which they effectively support the resolution of DDG acquisition issues. It also examines the alignment of the Platform System Design contract with the Alliance contract.[162]

Development of the Alliance arrangements

3.8 The current edition of the Defence Procurement Policy Manual outlines the prerequisites for the adoption of alliance contracting:

> An alliance contracting approach should only be considered when the risks in a project are such that a traditional contracting approach is unworkable, and a cost–benefit analysis demonstrates that the benefits of managing risks and opportunities in an alliance contracting arrangement outweigh the costs of establishing and supporting the alliance. The costs of establishing an alliance are significant, sometimes prohibitive, and as such an alliance structure is rarely suitable for projects valued at less than $80 million. Before proceeding

160 Defence Materiel Organisation, *SEA 4000 Air Warfare Destroyer: Acquisition and Contracting Strategy*, version 1.5, 4 July 2002, p. 11.

161 The 2002 *Australian Naval Shipbuilding and Repair Sector Strategic Plan*, and the 2003 defence aerospace and defence electronics sector plans, arose from the then Government's 2001 commitment to develop a strategic defence industry. Liberal National Coalition, *Our Future Action Plan: Strengthening Australia's Defences*, 24 October 2001, pp. 44–8. Defence Materiel Organisation, *Australian Naval Shipbuilding and Repair Sector Strategic Plan*, Canberra, September 2002, pp. 9–13, 19, 32; Chapters 10–11. While released for public comment, the plan was ultimately not approved by the then Government.

162 In September 2013, the Australian Strategic Policy Institute raised questions about the effectiveness of the AWD Alliance contract, and in particular about the cost of program delays, the accuracy of the Target Cost Estimate and the potential imposition of liquidated damages. These matters are discussed later in this chapter. Mark Thomson, 'The Air Warfare Destroyer project—how effective is the alliance model?', *ASPI Strategist* blog, 16 September 2013.

with an alliance acquisition strategy, specialist legal advice should be sought.[163]

3.9 In March 2004, an independent advisory firm, Carnegie Wylie, delivered a report to the then Minister for Defence and to the then Minister for Finance and Administration that recommended an alliance-style contract for the AWD Program. This recommendation was made on the basis that an alliance had the potential to offer the Commonwealth a number of advantages. Primary among these was the ability to enter into a contract with a shipbuilder through a competitive tender process, even though the ship design had not been determined, and recognising that the tender process would not itself determine the price of the project.[164] An alliance was also considered to be the most suitable contracting method for a large-scale, lengthy and complex project, which would require modification, change and innovation throughout its life. However, the report also noted government's limited experience in alliance contracting, and the skill and diligence Defence would need to exhibit to successfully deliver the AWD Program through an alliance.

3.10 In May 2004, the then Minister for Defence announced that tenderers for the AWD contract would be asked to bid on the basis of an alliance relationship with the Commonwealth.[165]

3.11 In June 2004, Defence commissioned the independent advisory firm and a second firm to assist it to develop the detailed terms of the AWD Program's alliance relationships. In its subsequent October 2004 report, the advisory firm recommended that the Commonwealth should proceed to establish an alliance-based contract for SEA 4000 with a shipbuilding contractor, with a view to expanding the alliance-based contract to include the combat system engineer and platform designer, if possible. In particular, an alliance was seen as a means of avoiding traditional contracting practice of 'bidding low' and then recovering margin via scope variations. The report also made recommendations on the financial arrangements that should underpin the alliance, and provided a risk and risk-mitigation matrix for alliance-based contracting regimes. The firm also recommended that expert advice be sought

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163 Department of Defence, *Defence Procurement Policy Manual: Mandatory Procurement Guidance for Defence and DMO Staff*, Canberra, 1 July 2011, pp. 2.2 to 2.7.

164 See paragraph 3.3 above.

165 Senator the Hon. Robert Hill, Minister for Defence, and Senator the Hon. Nick Minchin, Minister for Finance, *Naval Shipbuilding: Moving Forward*, media release, 27 May 2004.

from a person skilled at estimating and costing shipbuilding projects, to enable these costs to be accurately defined and commercial terms to be agreed. It also advised that it was vital that the Commonwealth access the best internal expertise and relevant commercial experience in both the contract-letting process and its ongoing implementation and monitoring, and that a capable 'owner's team' with the requisite skills, continuity and institutional memory would be necessary for a successful outcome.

3.12 The advisory firm further recommended that the Commonwealth strike a balance between the beneficial close working relationship inherent in an alliance, and the assumption of legal obligations beyond those the Commonwealth would normally accept (for example, fiduciary obligations). The firm made a number of other recommendations about the need to depart from the traditional or 'pure' alliance model. In particular, the firm raised the question as to whether it was appropriate for the parties to have 'total collective responsibility', having regard to the expected roles of the parties and the limited hands-on technical role that Defence was likely to have. It also made a number of other recommendations, including:

(a) that the Commonwealth retain a number of key rights;

(b) that the alliance not adopt 'no fault, no sue' in all cases;

(c) that the Industry Participants (individually or together) bear particular responsibilities; and

(d) that the alliance arrangements include mechanisms for managing and limiting price variations.

3.13 SEA 4000 Phase 2, the design phase of the project, which received Government approval in May 2005, had alliance-like features, including obligations to cooperate and collaborate, and to work in good faith. Defence intended that the alliance-like arrangements established in Phase 2 would be reconfigured and expanded for the construction contracts in Phase 3. The rationale given for choosing an alliance strategy for Phase 3 was that it would:

- support the 2002 *Australian Naval Shipbuilding and Repair Sector Strategic Plan* by complementing the Commonwealth's proposed strategic alliance partnership with an Australian shipbuilding entity;

- support the achievement of a robust design to a firm build cost; and
- reduce the number of expensive changes that had traditionally arisen in design-and-build contracts.[166]

3.14 The AWD Alliance was mostly designed along the lines suggested by Defence's external advisers. While the Alliance includes ASC and Raytheon, the original intention to also include the Platform System Designer (Navantia) did not eventuate. This matter is discussed in more detail at paragraph 3.72.

Target Cost Estimate development and validation

3.15 Governments may not have the requisite skills or resources to contribute substantively to the development of an alliance Target Cost Estimate. As a consequence, government, as the owner-participant, will generally need to validate the cost estimate, including by auditing and conducting independent cost analysis. For the AWD Program, the Industry Participants developed the Target Cost Estimate (TCE) during SEA 4000 Phase 2.[167] It is comprised of three elements:

- the Direct Project Costs expected to be incurred by the Industry Participants in carrying out their work in accordance with the Alliance contract and the Platform System Design contract;
- the Platform System Design contract price; and
- the Alliance management reserve.[168]

3.16 In relation to the validation of the TCE that was adopted for SEA 4000 Phase 3, Defence informed the ANAO in October 2013 that:

> … the AWD Industry Participants (Shipbuilder and Combat System–Systems Engineer) developed TCEs during Phase 2 for both the Evolved and Existing Design options. The Basis of Estimates (BOEs) for the TCEs were developed using parametric and weight-based estimates based on F-100, DDG-51[169] and other shipbuilding data. Monte Carlo and other probability-based modelling

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166 Defence Materiel Organisation, *SEA 4000 Air Warfare Destroyer: Acquisition and Contracting Strategy*, version 1.5, 4 July 2002, p. 11.

167 The Alliance contract acknowledges that the Industry Participants prepared the Target Cost Estimate and the Commonwealth accepted it. Commonwealth of Australia, ASC AWD Shipbuilder, Raytheon Australia, *Air Warfare Destroyer (SEA 4000) Alliance Based Target Incentive Agreement, General Conditions of Contract,* clause 37.1.1.

168 For detailed discussion of the Alliance pricing model, see paragraphs 3.29 to 3.32.

169 See footnote 104.

uncertainty estimation techniques were applied to the cost elements to determine the most likely outcomes. Navantia, Bath Iron Works, Defence Science and Technology Organisation, the UK Ministry of Defence, the United States Naval Sea Systems Command (NAVSEA), the RAN and contracted cost-estimating experts assisted the two design option teams and the AWD Program Management Office in the development of the final Target Cost Estimate and program cost estimate. Defence, specifically the AWD Program Management Office, was involved in the review of the final Target Cost Estimate development. This review involvement did not constitute 'validation' in a technical sense, because the Australianised AWD design had not been previously built. The review undertook to determine the reasonableness of the pricing and the robustness of the Target Cost Estimate development process for Second Pass consideration. At Second Pass, the then Department of Finance and Administration (Investment Analysis Branch) and Defence (Chief Capability Development Group, the DMO and the RAN) reviewed the Cabinet Submission cost estimates from accuracy and affordability perspectives.

The AWD Alliance

3.17 In October 2007, the then Government announced the signing of the Alliance contract for acquisition of the DDGs. This acquisition contract differs from fixed-price contract arrangements, under which Prime Contractors typically receive progress payments based on a mix of earned value and milestone achievement. Instead, the Alliance contract is based on a cost-plus-incentive-fee arrangement, under which the Industry Participants receive monthly payments of Direct Project Costs, and incentive fees based on their cost performance relative to a Target Cost Estimate.

3.18 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 and scheduled dates for Provisional Acceptance of each DDG).[170] The importance of this obligation to the contract was reinforced by the Chief Executive Officer of the DMO in correspondence to the ANAO.

170 Commonwealth of Australia, ASC AWD Shipbuilder, Raytheon Australia, *Air Warfare Destroyer (SEA 4000) Alliance Based Target Incentive Agreement, General Conditions of Contract*, clauses 7.2.1 and 18.1.

3.19 The Commonwealth has also taken on a number of 'fundamental obligations', which include:

- providing Government Furnished Material (GFM), equipment and information regarding the Aegis Weapon System procured through the US Government Foreign Military Sales Case, and Defence personnel that assist the AWD acquisition program; and
- providing the supplies delivered by Navantia, under the Platform System Design contract.

3.20 The AWD Program utilises a three-way Alliance Based Target Incentive Agreement (the Alliance contract) between the following three Alliance participants, two of which are Australian Government entities:

- The DMO[171], which is responsible, via its Materiel Acquisition Agreement with Defence, for the overall management of the AWD Program. The DMO is supported by the following two Industry Participants:
- ASC AWD Shipbuilder Pty Ltd, a subsidiary of ASC Pty Ltd (formerly the Australian Submarine Corporation), which performs the role of Shipbuilder, and is responsible for:
  - project management;
  - production planning;
  - platform systems and materiel procurement;
  - construction and physical integration of the ships, including block subcontracting[172];
  - combat and platform systems installation;
  - ship test and activation; and

171 The DMO is a non-statutory government agency staffed through the Department of Defence; it exercises a degree of financial and operational independence and is subject to the *Financial Management and Accountability Act 1997*.

172 Block construction has been subcontracted to Forgacs, based in Newcastle, BAE Systems, based in Melbourne, and Navantia, based in Ferrol, Spain. For further discussion of the block allocations, see paragraphs 6.41 and 6.48 to 6.52.

  - development of an integrated-lifecycle-support solution for the platform system, including provision of specified facilities and training.

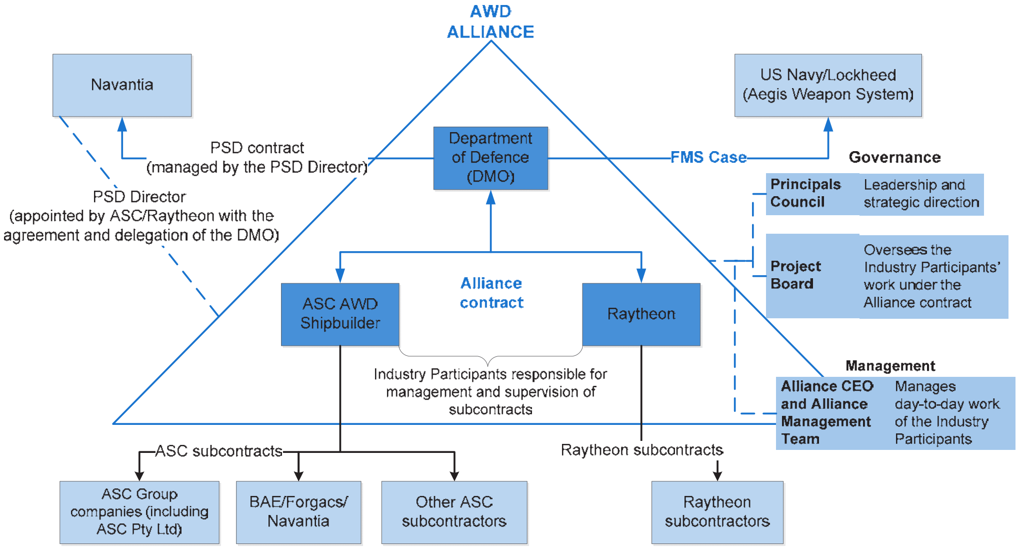
- Raytheon Australia Pty Ltd, a private sector firm, which performs the role of Combat System–Systems Engineer. Raytheon is responsible for:
  - project management;
  - Combat System architecture[173] and design;
  - procurement of Combat System equipment;
  - integration of the Australian elements of the Combat System;
  - Combat System test and activation; and
  - development of an integrated-lifecycle-support solution for the Combat System, including provision of specified facilities and training.

3.21 The Industry Participants have agreed to cooperatively manage the platform system and combat system work, and so are collectively responsible to the DMO for DDG block construction and systems integration. The Industry Participants are also jointly responsible, under the Alliance contract, for the day-to-day management of the Platform System Design contract between the DMO and Navantia (see paragraphs 3.77 to 3.82).

3.22 The key contractual and governance relationships in the AWD Alliance are shown in Figure 3.1.

173 A combat system architecture is a logical construct for defining and controlling the physical realisation of a combat system and associated processes for target engagement. It is formed by partitioning the system into subsystems and interconnections so that, over the entire lifecycle of the system, applicable functional, organisational, and physical requirements of combat operations can be met. (US Naval Surface Warfare Center (NAVSWC), *Combat System Architecture: Design Principles and Methodology*, TR 91-795, 1991, p. 2.

Figure 3.1: AWD Alliance key contractual and governance relationships



Source: Defence Materiel Organisation.

Notes: FMS—Foreign Military Sale (US).

PSD—Platform System Design.

3.23 The Alliance is not a legal entity, as it consists of separate Industry Participants (ASC and Raytheon, each responsible under their own existing management structures for the execution of the program), and the DMO. However, the Alliance operates as a 'virtual organisation'. It has a Principals Council, Project Board, Chief Executive Officer, and an Alliance Management Team comprising ASC, Raytheon and Defence personnel, who are responsible for overall project management (see Figure 3.3). Alliance personnel drawn from all of the Alliance participants form the Alliance's functional groups, and they work within Integrated Product Teams and Cross Product Teams (see Figure 3.4 and paragraphs 3.49 to 3.52). Within this structure, the DMO is also the Commonwealth's representative, and so ultimately remains responsible for managing the AWD Program as the 'owner-participant'.

Alliance incentives and risk management

3.24 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.[174] Under traditional contracts, the parties have specific individual obligations, and risks are generally allocated to the party considered best able to manage them.[175] Under a project alliance, risks and responsibilities are generally shared and managed collectively, rather than allocated to individual parties.[176]

3.25 The Alliance participants have contracted to work collaboratively under a 'shared risk and reward' structure, which aims to ensure that all parties are aligned in the common objective of delivering the three DDGs to the specific requirements, within the approved budget and schedule. The Alliance is characterised by:

- a collective responsibility for work conducted, and collective ownership of associated risks;
- collaborative working principles; and
- a remuneration arrangement in which the Industry Participants are paid all direct project expenses, with additional financial return subject to a pain-share gain-share arrangement based on an agreed Target Cost Estimate.[177]

3.26 Informed by external advice, referred to in paragraphs 3.9 to 3.14, 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. As previously discussed in paragraph 3.18, the Alliance contract imposes a fundamental obligation on the Industry Participants to deliver the DDGs and other Supplies and to achieve delivery schedule commitments. Further, the Alliance contract combines elements of a typical alliance contract with the more 'standard' risk-allocation provisions of a fixed-price contract. The specific provisions of the contract reflecting this approach include:

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174 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.

175 This principle is reiterated in Department of Finance and Deregulation, *Commonwealth Procurement Rules*, Canberra, 2012, p. 24.

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

177 Carnegie, Wylie & Company, *Alliance Contracting for SEA 4000 Air Warfare Destroyer,* report for Department of Defence, October 2004, p. 20.

- cooperation between the Commonwealth and the Industry Participants (typical alliance principle);
- a multi-tiered governance framework involving representatives of all contracting parties (typical alliance principle);
- unilateral rights for the Commonwealth, represented by the DMO, to issue directions to ensure that its requirements are met, and to exercise Suspension or Step-in Rights in various circumstances (modified alliance principle);
- the Industry Participants to assume joint and several responsibility for delivering the DDGs and other Supplies (modified alliance principle);
- the parties generally not to have liability to each other for work under the Alliance contract; however, in a limited range of cases, the Industry Participants are jointly and severally liable to the Commonwealth and to each other for delivering specified project outcomes (modified alliance principle);
- the Industry Participants to be entitled to reimbursement of direct project costs incurred in carrying out the work, subject to specified limits, conditions and exclusions (typical alliance principle);
- the Industry Participants' Fee entitlements to be calculated by reference to their joint cost performance against an agreed Target Cost Estimate (typical alliance principle);
- damages to be claimed by the Commonwealth and the Industry Participants in certain instances, subject to specified caps (modified alliance principle)[178]; and
- the Industry Participants to manage the Platform System Design contract, but not its terms and conditions (typical alliance principle).

3.27 One of the risks of an alliance arrangement is that the non-owner participants will have less incentive to perform if all potential incentive payments are lost. In such a situation, these participants may only recover Direct Project Costs, and there may be reduced incentive for them to achieve contracted outcomes. The Alliance contract seeks to mitigate this risk through

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178 Department of Defence, *Summary of the key aspects of the AWD Alliance Based Target Incentive Agreement (ABTIA)*, September 2010, p. 1.

the fundamental obligation of the Industry Participants to deliver the DDGs and other Supplies, their joint and several liability for certain project outcomes, and the Liquidated Damages provisions (see paragraphs 3.63 to 3.67).

3.28 The Alliance contract also contains these warranties by the Industry Participants:

- the Industry Participants warranted that, based on their own investigations, they had assessed, to their own satisfaction, the risks they were assuming;
- the Industry Participants acknowledged that the Commonwealth was relying on their skill and judgement, and their warranties under the contract; and
- the Industry Participants warranted that they had the resources (or sufficient access to resources) required to perform their obligations under the contract.[179,180]

AWD Alliance pricing model

3.29 The Alliance contract is a cost-plus-incentive-fee contract, which seeks to reduce the AWD Program's cost by offering the contractors financial incentives to manage the program's cost risks. The contract provides contractors with cost-reimbursement payments and a progressive Fee payment based on Earned Value data. The Industry Participant Fee (comprised of profit margin and corporate overhead costs) is to be adjusted at the end of the program according to a formula based on the end total cost (see Figure 3.2). Direct Project Costs in excess of the Target Cost Estimate will be fully paid, however the Fee decreases at an agreed ratio when these costs exceed the Target Cost Estimate. If costs fall below the Target Cost Estimate, the Fee increases according to an agreed ratio.

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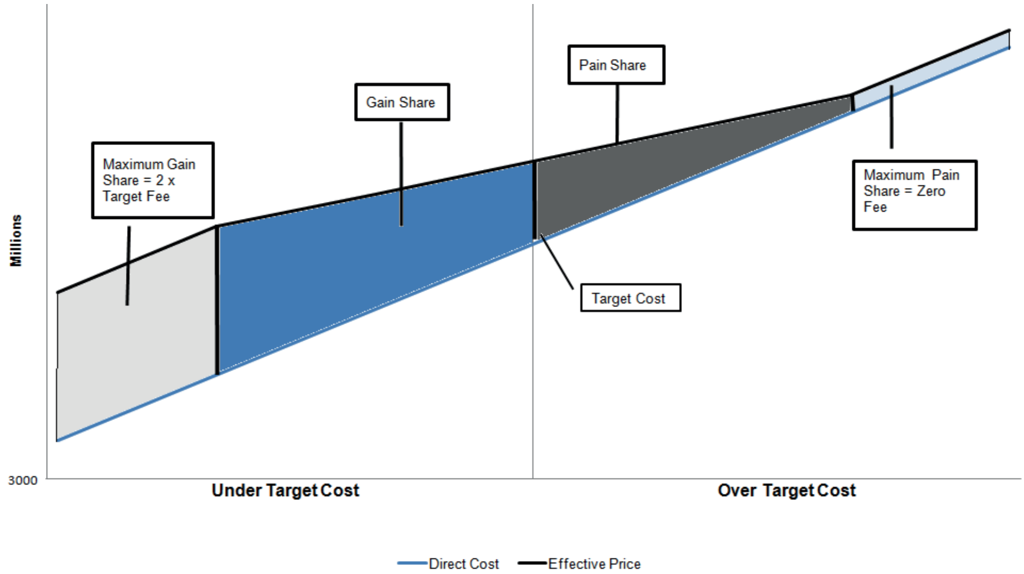
179 Commonwealth of Australia, ASC AWD Shipbuilder, Raytheon Australia, *Air Warfare Destroyer (SEA 4000) Alliance Based Target Incentive Agreement, General Conditions of Contract*, clauses 95.1, 96.2 and 97.1.

180 In its January 2014 response to an extract from this audit report, ASC stated that 'these warranties were given on the basis of the understanding that the Hobart Class was based on an existing and proven design from the Navantia F-100 (and more particularly the F-104 ship). This was reflected in the selection of the F-100 class as the "existing design" under the SEA 4000 Phase 2 arrangements, which drove ASC's expectations moving forward into negotiations and execution of SEA 4000 Phase 3.' See page 3 of ASC's letter to the ANAO, reproduced in Appendix 3.

Figure 3.2: AWD Alliance contract pricing model



Source: AWD Program Management Office, June 2013.

3.30 Figure 3.2 shows the relationship between the actual cost and the effective price paid by the Commonwealth under the Alliance contract. The figure shows that the pain-share gain-share mechanism operates across a range of underspend to overspend scenarios against the Target Cost Estimate. Once the zone of maximum pain-share is reached, Direct Project Costs will continue to be met by the Commonwealth, but zero Fee is payable. The Alliance contract obligates the Industry Participants to continue their contractual requirements, even if the contractors have exhausted their Fee entitlements. Under this scenario, the intention of the pricing model is that the Industry Participants break even on the Direct Project Costs of actual work done, but do not receive profit or reimbursement of Corporate Overhead costs. However, Raytheon Australia continues to be entitled to receive a separate Procurement Fee.[181]

3.31 There are four elements to the Alliance contract's cost-plus-incentive-fee model, and these are summarised below:

- *The Target Cost Estimate*: This is the agreed estimate of the Direct Project Costs involved in the work under the Alliance contract, which sets the benchmark against which the pain-share gain-share arrangements are

181 The Alliance contract was structured differently for ASC, which will not receive a Procurement Fee.

measured. The Industry Participants developed the Target Cost Estimate during SEA 4000 Phase 2[182], and it comprises the Direct Project Costs that were expected to be incurred by the Industry Participants in carrying out their work in accordance with the Alliance contract and the Platform System Design contract. It also includes the Platform System Design contract price, and the Alliance management reserve. The Alliance contract allows for the Target Cost Estimate to be adjusted through contract amendments, but only in limited circumstances. As at December 2013, the Target Cost Estimate had increased by $124 million (to $4.443 billion[183]) since contract signature in October 2007 (see paragraph 2.49 and Table 2.2). During the same period, there has been a proportional adjustment to the Target Fee.

- *Direct Project Costs*: Direct Project Costs represent the direct costs of performing work under the Alliance contract. Specified direct costs that the Industry Participants incur are reimbursed by Defence. The Alliance contract includes a schedule that defines the costs claimable as Reimbursable Direct Project Costs, and in some cases it specifies the amounts able to be claimed as Direct Project Costs (for example, in relation to labour rates), or sets conditions or limits on amounts that can be claimed. The Alliance contract makes provision for a series of advance payments to be made to the Industry Participants, which they can draw down to meet Reimbursable Direct Project Costs. Direct Project Costs also include certain other costs that Defence will pay (but not to the Industry Participants). These are called non-Reimbursable Direct Project Costs, for example, payments under the Platform System Design contract and payments of Defence costs. Both Reimbursable Direct Project Costs and non-Reimbursable Direct Project Costs are included in the calculation of each Industry Participant's entitlement to claim amounts of Fee under the pain-share gain-share model (discussed below). By December 2013, $2.985 billion in Direct Project Costs had been paid by Defence to the Industry Participants.
- *Fee*: Subject to their performance, the Industry Participants have the opportunity to receive payment of a Fee, which represents their Profit

182 See paragraphs 3.15 to 3.16.

183 December 2006 prices.

and Corporate Overheads. The Alliance contract specifies an agreed Target Fee, which is the amount that the Industry Participants would receive if the cost at completion of the work under the Alliance contract equals the Target Cost Estimate. The Industry Participants are entitled to progressive payments, on account of their entitlement to a Fee, at quarterly intervals. The amount of these 'on account' payments is calculated on a 'moderated' Earned Value basis, which is designed to calculate payments for the current quarter by reference to the extent to which the work under the Alliance contract has progressed toward overall completion, and based on an estimate of the final cost of the work. With the exception of Raytheon's separate procurement fee, all of the Industry Participants' Fee entitlements are 'at risk' under the Alliance contract.[184] No Fee has been claimed by the Industry Participants since January 2012.

- *Pain-Share Gain-Share*: The Industry Participants' final Fee entitlements will depend on how the actual cost of work completed compares to the Target Cost Estimate. Defence and the Industry Participants share the impact of actual costs that exceed the Target Cost Estimate. If the Target Cost Estimate is exceeded, each Industry Participant's Target Fee is reduced by 50 per cent of the amount of the excess, until payment of Fee is reduced to zero. If actual costs are less than the Target Cost Estimate, then the Target Fee is increased by 50 per cent of the amount of the saving, to a maximum of double the Target Fee.

3.32 The specified amount of management reserve funds in the Target Cost Estimate enables the Industry Participants to respond flexibly to risks and opportunities. The management reserve is composed of two elements. The Tier 1 management reserve is controlled by unanimous decisions of the Project Board, to allow the Industry Participants to manage risks, including cost estimate uncertainties. The Tier 2 management reserve is controlled by the Alliance CEO, and is managed at the project-team level.[185] At the end of the program, any unallocated management reserve is to be shared among the three Alliance participants in accordance with the pain-share gain-share model. As

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184 Commonwealth of Australia, ASC AWD Shipbuilder, Raytheon Australia, *Air Warfare Destroyer (SEA 4000) Alliance Based Target Incentive Agreement – Attachment 15 – Fee Data*, 2007.

185 The Alliance CEO informed the ANAO that the Tier 2 management reserve was created at the start of the project by 'challenging' the project execution budgets.

at September 2013, 63 per cent of Tier 1 management reserve and 71 per cent of Tier 2 management reserve (which can and does fluctuate) had been expended.

Implications of the Alliance contract for the Commonwealth's risk management approach

3.33 The Alliance contract is designed to provide strong 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 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.[186] However, it should be noted that, under the pricing model, 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.

3.34 Notwithstanding the financial incentives provided by the Alliance contract, and its other features intended to protect the Commonwealth's interests, the fundamental 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 and Parliament through the shareholder Minister.[187] At the end of the day, accountability for the performance of Commonwealth GBEs is shared by entity management and the shareholder Minister(s); as the latter 'exercise strategic control consistent with their accountability to the Parliament and the public', while the entity directors are expected to ensure that 'the GBE's activities are conducted so as to seek to minimise any divergence of interests between the GBE and the shareholders'.[188]

3.35 The Australian Government is reliant on a range of mechanisms to mitigate its AWD Program risks, which include substantial financial and

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186 There are also 'Risk Pool Events' (such as natural disaster or war) and Target Cost Estimate and Schedule adjustment events within the Alliance contract, which are additional risks carried by the Commonwealth, and these are not intended to be covered by the management reserve.

187 The shareholder Minister for ASC Pty Ltd is the Minister for Finance. As indicated in footnote 100, ASC is also subject to legal and compliance frameworks, including the *Corporations Act 2001*.

188 Department of Finance and Deregulation, *Commonwealth Government Business Enterprise—Governance and Oversight Guidelines*, Canberra, 2011, p. 6.

capability risks. The Australian Government can reasonably look to the Commonwealth representative in the Alliance, the DMO, as 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 since 2005 has engaged a firm with expertise in managing major construction contracts to provide day-to-day advice to the DMO on contractual issues. These arrangements assist the DMO in its interactions with the Industry Participants, and in providing advice on risk management approaches. As discussed in paragraphs 3.42 and 3.43, the position of independent chair of the overarching Alliance Principals Council provides another potential source of insight and advice.

3.36 Further, the Australian Government, through the responsible (shareholder) Minister, has additional mechanisms available to protect the Commonwealth's interest and manage risks relating to the performance of GBEs and their subsidiaries, should it wish to expand its oversight of performance.[189,190]

AWD Alliance governance

3.37 The AWD Alliance's operations are overseen by three major governance bodies: the Principals Council, the Project Board, and the Alliance Management Team. The Alliance governance and management arrangements are shown in Figure 3.3.

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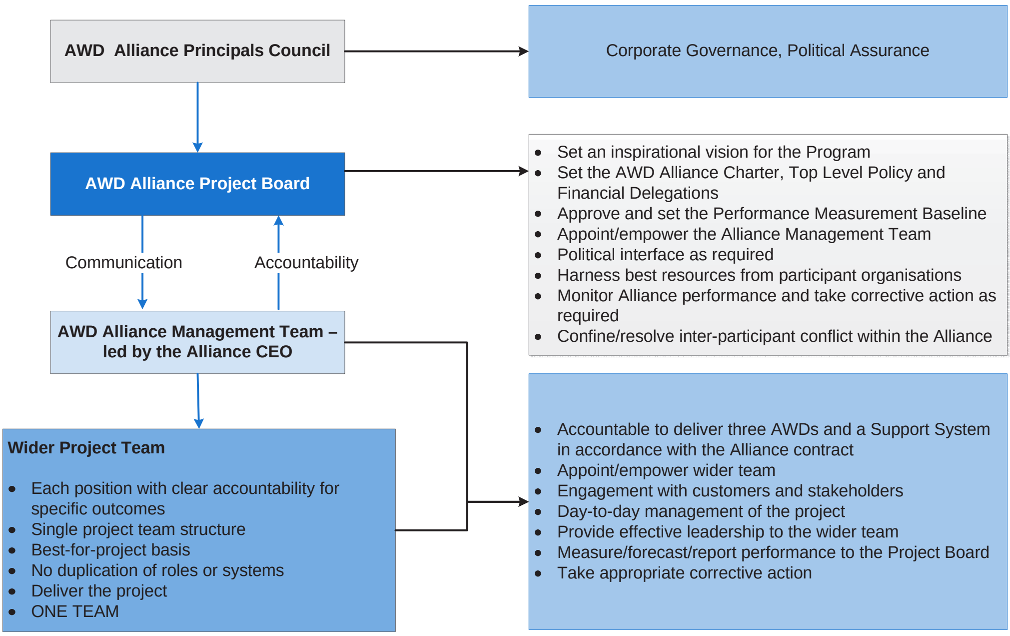
189 The *Commonwealth Government Business Enterprise—Governance and Oversight Guidelines* provide that the main features of the Commonwealth's relationship with its GBEs include a strong interest in the performance of GBEs, 'active oversight by the Commonwealth', and the exercise of strategic control consistent with shareholder Ministers' accountability to the Parliament and the public. The mechanisms available to government to manage risks include the inclusion of indicators in Corporate Plans, an annual Statement of Corporate Intent reflecting agreed outcomes, confidential quarterly progress reports provided by the Chair to the stakeholder Minister(s), annual strategic meetings involving the Minister(s), and continuous disclosure requirements relating to the operations of the GBE and its subsidiaries. Department of Finance and Deregulation, *Commonwealth Government Business Enterprise—Governance and Oversight Guidelines*, Canberra, 2011, pp. 6–7, 15–24.

190 The ASC's shareholder Minister announced on 17 December 2013 the appointment of three new board members.

3.38 An integral part of the Alliance's operations-level governance is the application of a Quality Management System for the governance, management and leadership of the AWD Alliance, which is certified by a third-party Quality Management Certification organisation. In July 2008, the Alliance's Enterprise Management System underwent a third-party certification audit that examined its compliance with the International Standards Organisation's AS/NZS ISO 9001:2008, *Quality Management System—Requirements*. That audit resulted in the achievement of certification to ISO 9001:2008 in September 2008. A triennial recertification audit conducted in August 2011 did not lead to any corrective action requests, and resulted in a continuation of ISO 9001:2008 certification. That certification is also relevant to the Alliance maintaining its Authorised Engineering Organisation status (see paragraphs 4.14 to 4.17).

Figure 3.3: AWD Alliance governance and management arrangements



Source: Commonwealth of Australia, ASC AWD Shipbuilder, Raytheon Australia, *Air Warfare Destroyer (SEA 4000) Alliance Based Target Incentive Agreement, Attachment 16 – Project Management Principles*, p. 3.

3.39 The following sections provide further detail on the Alliance's governance and management structure.

AWD Alliance Principals Council

3.40 The AWD Alliance Principals Council, first established in December 2005 for SEA 4000 Phase 2 (the design phase)[191], was reconstituted for the AWD build phase. The Principals Council consists of the Chief Executive Officer DMO; the Chief of Defence's Capability Development Group; the Chairman of ASC Pty Ltd (that is, of the parent company of ASC AWD Shipbuilder); the President Integrated Defence Systems, Raytheon Corporation, USA; and an independent chair appointed by the Minister for Defence. The Principals Council operates at the top of the AWD Program's governance hierarchy. Its functions are to:

- provide leadership, oversight and strategic direction;
- resolve disputes;
- provide Ministerial advice;
- act as an advocate for the program;
- provide a forum to inform participants of work progress and to exchange views; and
- make decisions on matters referred to it by the Project Board.

3.41 At its second meeting, on 17 December 2008, the Council agreed 'that it was important that it meet regularly, three to four times per year, with at least one meeting to be held in Adelaide each year.'[192] However, the Council has only met eight times since 2007, and at the time of the audit, the most recent meeting had been held in February 2012. This is despite significant and persistent detailed design immaturity, and construction and shipbuilding productivity issues (discussed in Chapters 5 and 6 respectively), and a claim for a schedule extension and Target Cost Estimate adjustment by the Industry Participants, which has not been resolved at the Project Board level (see paragraph 5.73).

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191 Senator the Hon. Robert Hill, Minister for Defence, *New Alliance Council for Air Warfare Destroyer Program*, media release, 8 December 2005.

192 The AWD Alliance contract, in canvassing the nature and functions of the Principals Council, specifies that this body should hold meetings at least once a year. The Phase 3 Project Management Plan states that the Principals Council meets at least twice a year, or more frequently as need dictates.

3.42 AWD Alliance records in 2010 emphasised the importance of the Principals Council, but noted the need to clarify the role of the independent chair:

> [the] respective Principals on the Council were well informed through normal organisational reporting and did not need to be informed of Alliance performance via the Council. The briefings to the Council therefore only had the objective of informing the independent chair. Noting the role of the Council in dispute resolution and strategic direction, and the detailed knowledge of the 'dependent' Principals, the role of the 'independent' person is not clear.[193]

3.43 The position of the independent chair has been left unfilled since August 2011, on the grounds that the role was under review to ensure that it was best structured to meet the needs of all parties to the Alliance. There would be merit in expediting the review, as the independent chair offers a potential source of additional insight and advice to the Alliance participants, the Defence Minister and the ASC shareholder Minister (the Minister for Finance). As indicated in paragraph 3.40, the independent chair is appointed by the Minister for Defence, after consultation with the Industry Participants.[194]

Recommendation No.1

3.44 The ANAO recommends that the DMO:

- reinvigorate the AWD Alliance Principals Council, as a source of additional leadership, insight and strategic advice on key issues facing the Alliance participants; and
- raise with the Minister for Defence the appointment of a suitably experienced and independent AWD Alliance Principals Council Chair.

Defence's response: *Agreed*

Defence will re-invigorate the Principals Council and appoint a suitably experienced independent Council Chair.

AWD Alliance Project Board

3.45 The AWD Alliance Project Board is below the AWD Alliance Principals Council in the governance structure. Its members are: the AWD Program

193 AWD Alliance, *Project Board Meeting Minutes*, 24 November 2010.

194 For further discussion of the AWD Alliance Principals Council, see paragraphs 5.70–5.72.

Manager (Chair), the Managing Director of Raytheon Australia, and the Chief Executive Officer of ASC Pty Ltd.[195] The Project Board:

- provides overall guidance and direction for the work of the Program;
- provides an educational and discussion forum for the Board members;
- appoints, and supervises the work of, the Alliance CEO;
- makes a range of project decisions;
- monitors and reviews the performance of the Alliance participants;
- establishes the procedures and processes by which the Alliance CEO provides information to the Board;
- reviews, monitors and oversees construction, and compliance with the Procurement Plan;
- selects the Alliance Management Team; and
- resolves disputes.

3.46 In practice, since 2008, the Alliance CEO has also attended Project Board meetings, although he does not have a vote. The board is concerned with governance of the project, monitoring ongoing performance and approving strategies for acquisition. Financial decisions which affect changes in the scope of the Alliance and Platform System Design contracts require Commonwealth approval, and if necessary the exercise of the Commonwealth financial delegation held by the AWD Program Manager.[196]

3.47 Decision-making by the AWD Project Board is required to be unanimous. While this means that all decisions have the collective support of the three Alliance participants, it also means that any one party can restrict or delay decisions sought by the majority of the Alliance participants. This creates a risk in the event that the AWD Project Board is unable to resolve an outcome on an issue in a timely manner, or at all. However, from the Commonwealth's perspective, the arrangement for unanimous decision-making has been established to protect the Commonwealth's interests, in the event that the

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195 Following a decision of the Alliance Principals Council in July 2009, the Alliance contract was amended in 2011 to change ASC's membership of the Project Board from the CEO of ASC Shipbuilding Pty Ltd to the CEO of the parent company, ASC Pty Ltd. Previously, the Alliance CEO had filled the role of ASC member on the Project Board.

196 The Alliance CEO is accountable for management of the project within the project budget.

DMO does not agree with a position taken by the Industry Participants. In circumstances where there may not be a unanimous view, the Alliance principles of cooperation and collaboration should inform the parties' approach to negotiations.

3.48 The Project Board has generally met at least monthly since 2007. The minutes of the Project Board show that it is concerned with preparing and reviewing management strategies covering the DDGs' design and construction, and with key issues raised during the day-to-day management of the project. These include the Alliance's commercial management and budgeting, insurance, and media and communications. The minutes also indicate that, since mid-2010, the Project Board has been concerned about the cost and schedule impact of immaturity in the detailed design, and it has pursued practical remedies for the situation, including engagement with the Platform System Designer (Navantia). However, as at November 2013, detailed design immaturity and its adverse impact on ASC's production costs and schedule had persisted for over three years, indicating that the strategies adopted by the AWD Project Board have not been fully effective in addressing the timely resolution and mitigation of detailed design immaturity.[197] This is discussed further in Chapter 5.

AWD Alliance Management and Product Teams

3.49 The Alliance Management Team is comprised of personnel from each of the three Alliance participants (Defence, ASC and Raytheon), and its functions are to manage, under the Alliance CEO, relevant aspects of work, and to give effect to the decisions of the Principals Council and the Project Board. The Alliance Management Team reports to the Alliance CEO. The Alliance CEO is appointed by the Project Board, and is responsible to it for carrying out the decisions of the Principals Council and the Project Board, and managing all AWD work as an agent of the Industry Participants.[198]

3.50 The use of Integrated Product Teams is intended to ensure that decisions are made at the lowest level commensurate with technical knowledge requirements and effective risk management. The Alliance

197 In October 2013, the Alliance CEO commented to the ANAO that 'It is debatable whether the strategies have been fully effective or whether it has been possible to fully mitigate the impact of design change. The two are not necessarily the same.'

198 The Alliance headquarters are at the AWD Systems Centre, located at the Techport Australia Maritime Precinct, in Adelaide (discussed at paragraphs 2.58 to 2.59).

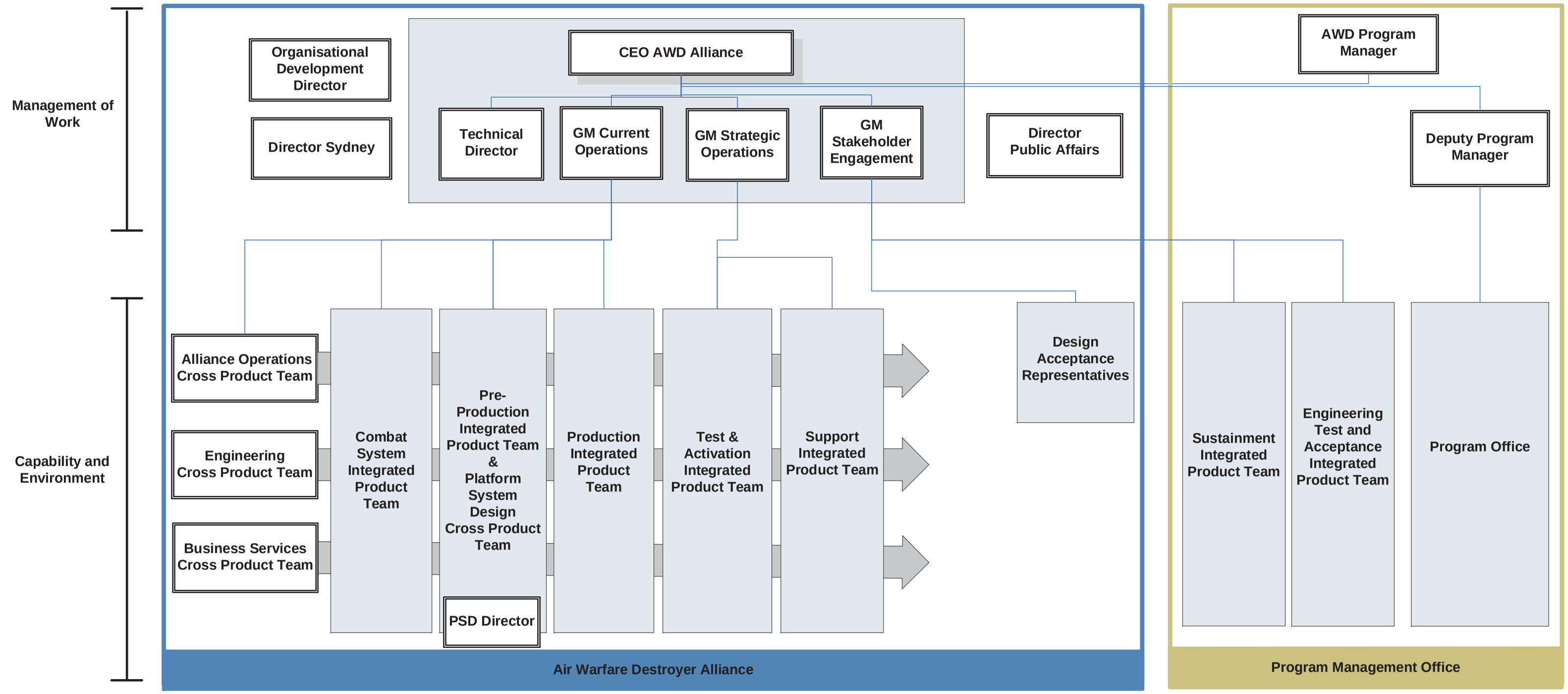
Integrated Product Teams are shown in Figure 3.4. Delegations of Engineering Authority are provided (through the Engineering Director) to individuals working within the Integrated Product Teams as required to support decision-making within each team.

3.51 The AWD Program also has Cross Product Teams, which are intended to ensure that plans and processes are integrated across the Alliance. These teams are arranged as follows:

- The Operations Cross Product Team is responsible for control and monitoring of the delivery of the three ships. This team controls the Alliance-wide Master Schedule, and has broad responsibility for project management, planning and control.
- The Engineering Cross Product Team provides engineering governance to the Alliance, establishing the engineering plans, processes and frameworks that integrate engineering activities across the Integrated Product Teams. These functions contribute to the maintenance of Authorised Engineering Organisation certification for the AWD Program Management Office. The Engineering Cross Product Team also provides management and control of the DDGs' top-level system specification and requirements management for the Alliance, in support of Designers' Certificates and Design Certification of the AWD System (examined in paragraphs 4.26 to 4.36).
- The Business Services Cross Product Team provides business services, including: workforce planning, risk and opportunity management, financial management, earned value management, contract management, facilities, information technology, human resource management, administration, reporting, insurance management and security services.

3.52 An important task in forming the Alliance involved developing an organisational culture that would result in effective working relationships between the Alliance's senior executives and management teams. This requires openness, mutual trust and honest dealing, and the sharing of data across the Alliance organisation. As mentioned in paragraphs 1.9 and 3.20, the Alliance contract binds three diverse organisations: the Commonwealth's Department of Defence, represented by the DMO, as the owner-participant; and two non-owner participants, namely ASC AWD Shipbuilder Pty Ltd, a subsidiary of a

Figure 3.4: AWD Alliance organisational structure, July 2013



Reporting Notes:
Director Business Services Cross Product Team reports to CEO
Director Public Affairs reports to CEO, activities coordinated with GM Stakeholder Engagement
Director Engineering Cross Product Team reports to GM Strategic Operations
Alliance Operations Cross Product Team responsibilities managed between GM Current Operations and GM Strategic Operations

Source: AWD Alliance.

Note: By November 2013, the Alliance also had a Shipbuilding Shared Services unit; see Table 3.1 on page 132.

GBE, and Raytheon, a public company. While there are ongoing tensions in the relationships between these organisations, relating to specific issues[199], AWD Program documents and Alliance participant cooperation observed as part of this audit indicate that overall there has been progress in developing the Alliance structure and intended culture.

AWD Alliance personnel

3.53 As at November 2013, the AWD Alliance organisation consisted of the personnel outlined in Table 3.1.

3.54 Of the 1913 personnel listed below, 1489 were employed by ASC, 371 by Raytheon Australia, 38 by Defence, and 15 by Navantia. One of the Defence personnel, a Navy member, reports to the Alliance CEO and to the DMO's AWD Program Manager. The remaining Defence personnel report to managers in the respective product teams.

Table 3.1: AWD Alliance personnel numbers, November 2013

Team	Personnel
Combat System Integrated Product Team	172
Pre-Production Integrated Product Team	304
Production Integrated Product Team	1052
Test & Activation Integrated Product Team	84
Support Integrated Product Team	105
Alliance Operations Cross Product Team	17
Engineering Cross Product Team	41
Business Services Cross Product Team	79
Shipbuilding Shared Services	59
Total	**1913**

Source: AWD Alliance.

3.55 At the time of the audit fieldwork, there were no Defence personnel located at the subcontracted shipyards at the BAE Systems shipyard in

199 For example, the Industry Participants have made a claim for a Target Cost Estimate adjustment relating to the impact of design immaturity. The AWD Alliance Project Board could not come to an agreement on the Target Cost Estimate claim, because the Commonwealth member, on advice from the DMO, could not agree to the claim. As at July 2013, the Industry Participants were considering their position on the matter. See paragraph 5.73.

Williamstown, nor at the Forgacs shipyards in Newcastle. However, the Alliance's Design Acceptance Representatives inspect the shipyards to verify compliance with the Alliance contract's engineering requirements. These Design Acceptance Representatives are members of the Alliance and are not necessarily Commonwealth employees. This underscores the importance of the Alliance contract's provisions regarding shipbuilding oversight, in terms of quality control and the regulation of the technical integrity of ADF Maritime Materiel.[200]

Cost of administration

3.56 As indicated in paragraph 3.3, the owner-participant of an alliance contract generally faces high administration costs in terms of auditing, application of specialist expertise, senior management input and day-to-day management participation in the arrangement. As at May 2013, Defence had placed 27 Defence personnel and two Lockheed Martin personnel in the Alliance. This number does not include other Defence Organisation personnel who also undertake AWD Program work, or senior DMO and Defence management.

3.57 In October 2013, Defence informed the ANAO that:

> The AWD Program Management Office (PMO) administers the AWD Program from a Commonwealth perspective, and the major PMO costs relate to personnel.[201] The PMO numbers have remained at around 50 since 2011. The Commonwealth also has an obligation to provide personnel to work in Alliance positions, and has routinely made about 30 people available. The Embedded Service Fee, which covers both Alliance and PMO personnel, is considered a reliable indicator of the PMO costs, and these are expected to remain at around $8 million until they begin to tail away after 2019. Defence believes that these [figures represent] savings [which] would not have been possible if the program had not adopted the Alliance-like structure, and that

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200 The AWD Program's technical regulation arrangements for the design and acceptance of the DDGs are discussed in paragraphs 4.26–4.43.

201 The average PMO personnel numbers are: four Average Funded Strength staff, 40 Australian Public Service staff, six Contracting Support Branch Australian Public Service, and one Professional Service Provider.

By way of comparison, Defence advised that the ANZAC Systems Program Office (SPO), which administers the ANZAC Ship Integrated Materiel Support Program Alliance (ASIPA) from a Commonwealth perspective, had an Average Funded Strength/Full Time Equivalent of 25.33 staff.

the visibility of the work in progress provided by Commonwealth personnel working in the Alliance has reduced the numbers needed in the PMO.[202]

3.58 The Alliance contract has also 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. Instead, contract amendments have been dealt with at a much broader level, as shown in Table 2.2. This has avoided the need for significant RAN and DMO involvement in assessing design changes and negotiating price adjustments, and removed the risk of potentially costly claims for the time taken to contractually agree to design changes. In the context of the challenges faced by the AWD Program, the Alliance CEO has noted that:

> it is clear that there is no way in which the traditional Defence contracting model would have coped without a substantial impact on the project and progress. More than likely it would have led to a project swamped by commercial positioning, and related distractions rather than a dedicated focus on successful project outcomes.[203]

3.59 Nonetheless, design changes have still come at a significant cost to the Commonwealth, because of the Direct Project Costs associated with block construction rework, the contribution of design change to schedule slippage, and the consequent delay in availability of the capability to the RAN.[204]

3.60 Design change has also had significant implications for the Industry Participants, through schedule impacts and a reduction in Fee. In October 2013, ASC informed the ANAO that:

> Each design change that brings about additional work affects the Industry Participants, in that if the Target Cost Estimate is not adjusted, the Industry Participants run the risk of losing their Fee through pain-share. Consequently there is no motivation for the Industry Participants to introduce change into the design unless they are compensated accordingly.

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202 DMO's obligation to provide personnel to the Alliance was offset by a reduction in the Target Cost Estimate.

203 Rod Equid, AWD Alliance CEO, speech to Pacific 2013 International Maritime Conference, Sydney, 8 October 2013.

204 Design changes still need to be assessed by the RAN's technical and operational regulators. For detailed discussion of the implementation and impact of design change, see Chapter 5.

AWD Alliance reporting

3.61 The Alliance Industry Participants report to Defence through the mechanisms contained in the Alliance contract. The principal mechanism, in terms of the Industry Participants' cost and schedule performance, is the Earned Value Management System (see paragraphs 6.73 to 6.111). There are also a range of other reports that provide more detailed explanations of the AWD Program's progress, in terms of day-to-day project risk and issues management, and system verification and validation monitoring.

3.62 The Alliance CEO informed the ANAO in October 2013 that, in his opinion, Defence enjoyed:

> unprecedented transparency with respect to Industry Participant information and program performance data generally, due to the embedded Commonwealth personnel, the day-to-day interaction with the Program Management Office, and the open-book arrangements.

Provisional Acceptance Incentives and Liquidated Damages

3.63 As indicated in paragraph 3.18, the Alliance contract contains a fundamental obligation on the Industry Participants to deliver the DDGs as specified and within schedule.

3.64 Provisional Acceptance of each DDG is to be granted by the Commonwealth if the DDG complies with the Alliance contract's requirements, subject only to Minor Defects and other Defects (identified through the conduct of verification and validation activities) that the Commonwealth does not require to be rectified.[205]

3.65 The Alliance contract contains incentive Fees of $200 000 for each week that Provisional Acceptance of a DDG is achieved earlier than the Key Target Date for Provisional Acceptance. If the Industry Participants do not achieve Provisional Acceptance of the DDGs as scheduled, after a six-month grace

205 Verification and validation is discussed in paragraphs 4.44 to 4.50.

period Liquidated Damages can be applied by the Commonwealth.[206] The agreed amounts of Liquidated Damages payable for delays are as follows:

- for Ship 1, $100 000 per week for the first seven weeks, $1 million for the eighth week and $2.4 million for the ninth and later weeks;
- for Ship 2, $1.2 million per week; and
- for Ship 3, $0.6 million per week.

3.66 Defence records show that the above amounts were negotiated with the Industry Participants on the basis of detailed calculations of the real cost to the Commonwealth of providing alternative capability during the period concerned. The calculations took into account the cost of providing: current naval assets; additional air cover to substitute for the non-availability of the Aegis Weapon System; and additional crews. They also took into account savings to the Commonwealth that would have accrued with on-time delivery.

3.67 The AWD Program Management Office was also advised that the risk-sharing principles underlying the Alliance operate in relation to Liquidated Damages. Rather than having the Commonwealth collect the Liquidated Damages from the Industry Participants, Liquidated Damages, if imposed, are to be treated as Non-Reimbursable Direct Project Costs. This means that 50 per cent of the amount of Liquidated Damages imposed counts towards the Industry Participants' pain-share gain-share arrangements. By this measure, schedule risks, in terms of the additional costs that the Commonwealth will bear due to late acceptance of a DDG, are shared between the Commonwealth and the Industry Participants.

DMO management position

3.68 The DMO has actively participated in the Alliance's governance structure, in its operations through the placement of Defence personnel into the Alliance organisation, and has also closely monitored the build phase through its AWD Program Management Office. At the same time, the DMO

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206 This liquidated damages regime was adopted when it became too difficult to implement the original principle—recommended by Defence's advisers in 2004—that the Industry Participants would be liable for the first $100 million of cost associated with the work to rectify major errors made during construction. Insurance for this plan did not represent good value, and instead, it was decided that all rework would be allowed as reimbursable Direct Project Costs and hence subject to the pain-share/gain-share regime, and that liquidated damages would also be introduced into the contractual arrangements.

has placed significant emphasis on the fundamental obligation established in the Alliance contract that the Industry Participants deliver the DDGs and other supplies, and on the contractual warranties provided by the Industry Participants (see paragraph 3.28), which were based on the Industry Participants' own assessments during Phase 2 of the AWD Program.

3.69 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[207], major construction problems had re-emerged at subcontractor level, and shipbuilding productivity remained well below expected levels.[208]

3.70 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 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.

Platform System Design contract

3.71 A key element of the AWD Program is the work being performed by Navantia under its Platform System Design (PSD) contract with Defence. This contract obligates Navantia to supply design documentation to support the construction of the DDGs. Navantia is also supplying consultancy and other services, which are intended to ensure that the lessons from the initial build by Navantia are transferred to ASC as the follow-on shipyard.

3.72 As discussed in paragraph 3.14, the intention of including the Platform System Designer in the Alliance arrangement did not eventuate. The DMO's *Phase 2 Overall Program Report* states that neither Navantia nor Gibbs & Cox were prepared to agree to the liability regime that the Alliance contract was to impose, and in the absence of an alliance arrangement, the Commonwealth's relationship with the US and Spanish governments was expected to improve

207 See paragraphs 5.36 to 5.61 and 6.55 to 6.65.

208 See paragraph 6.51 and 6.112 to 6.131.

access to government-owned Intellectual Property.[209] 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 $4.2 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. For its part, Navantia informed the ANAO in October 2013 that there was a lack of clarity with respect to the proposed liability regime. Navantia 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.

3.73 Defence decided to form a separate Platform System Design contract with Navantia. Defence sought to minimise the impact of Navantia's absence from the Alliance by incorporating provisions into the Alliance and PSD contracts that provide for cooperation and collaboration between Navantia and the Alliance.

3.74 Over several years, a substantial amount of design change and updated documentation has been introduced into the AWD construction program (see paragraphs 5.43 to 5.74 and Figure 5.10). While the Alliance has applied a range of strategies to address detailed design immaturity, the problem and its consequences were ongoing in 2013. The most recent initiatives to improve the design-to-production process have included measures to better incorporate Navantia's knowledge and experience into the Alliance.[210] Nevertheless, Navantia is not represented on any of the key Alliance governance bodies, including the Project Board.

3.75 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, which is one of the main reasons for establishing such an arrangement. In practical terms, Navantia's relative 'distance' from the project, compared to the Alliance Industry Participants, has contributed to difficulties

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209 Access to Intellectual Property is very important in enabling the maintenance of a complex system over its long service life.

210 These arrangements are discussed in paragraphs 5.63–5.66.

in addressing detailed design immaturity issues in the most timely way possible, resulting in more out-of-sequence rework than was budgeted for. Navantia's absence from the Alliance arrangements has 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.[211]

3.76 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.

How the PSD contract operates

3.77 While the Industry Participants are not parties to the PSD contract, they were involved in negotiating and agreeing the contracted scope of work.[212] For their part, the Industry Participants have acknowledged that the design of the Platform System for the DDGs will be carried out by Navantia under the PSD contract, and that they (the Industry Participants) will manage the work of the Platform System Designer under the PSD contract.[213] Moreover, the PSD contract price is included in the Alliance contract's Direct Project Costs, and

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211 In his January 2014 response to an extract from this audit report, the Alliance CEO stated that 'in the case of the AWD [Platform System Designer], Navantia is motivated to strive for program success more because of protection of their international reputation than direct financial outcomes which are limited in any case by the relativity between the PSD work-share and the overall program costs'. See page 9 of the Alliance CEO's comments to the ANAO, reproduced in Appendix 2. Separately, the Alliance CEO informed the ANAO that Navantia has been treated in and has acted in an alliance manner.

In its January 2014 response to an extract from this audit report, Navantia stated that it considered 'that it is rather unfair to associate the amount of engineering issues in AWD with the fact that Navantia is not exposed to the reduced incentive payments of the Alliance. Navantia has demonstrated its commitment to the program at all times, providing services beyond its contractual obligation and increasing its level of effort to adapt the information to a less skilled workforce.' See pages 3–4 of Navantia's comments to the ANAO, reproduced in Appendix 5.

212 Four ASC staff and two Raytheon staff were on the Alliance team that negotiated the Platform System Design contract with Navantia, in Spain and Australia, in May and June 2007. The April 2007 DMO Negotiation Instruction noted that 'The objective of attendance by the Industry Participant representatives is to ensure a common Alliance approach towards the engagement of the PSD.'

213 Commonwealth of Australia, ASC AWD Shipbuilder, Raytheon Australia, *Air Warfare Destroyer (SEA 4000) Alliance Based Target Incentive Agreement, General Conditions of Contract,* clause 25.1.

the PSD costs thus form part of the Alliance contract's pain-share gain-share arrangement.

3.78 The PSD Supplies provided by Navantia include the Technical Data Package (see paragraphs 5.27 to 5.32), consultancy services to the Alliance, and technology transfers, including the Manufacturing Resource Planning System, NECORA. Navantia is responsible for ensuring the performance of the platform, *provided* that the ships are built and tested in accordance with Category 1 of the Technical Data Package.

3.79 Defence provides the Technical Data Package and platform design consultancy services supplied by Navantia to the Industry Participants under the Alliance contract. Because of the limited technical involvement of Defence in the work under the Alliance contract, and to enable the Industry Participants to manage the risks associated with the design and consulting services, the Commonwealth has granted limited delegations to a PSD Director, appointed by the Industry Participants following the approval of the Project Board, for the day-to-day management of the PSD contract. These delegations include accepting Navantia's PSD Supplies under the PSD contract on the DMO's behalf.[214] This underscores the importance of the Alliance contract's provisions regarding the Industry Participants' role of managing the PSD work, in the context of the DMO's role as owner-participant with ultimate responsibility for the outcome of the delegated activity.

PSD Director

3.80 The PSD Director manages the PSD contract with Navantia on a day-to-day basis, and:

(a) is subject to the control and direction of the Alliance CEO;

(b) is the agent of the Industry Participants or an Industry Participant (as applicable) in relation to all matters concerning the work under the PSD contract; and

(c) is, to the extent of his or her delegation, the agent of the Commonwealth, and has delegated authority to bind the

214 In October 2013, the Alliance CEO informed the ANAO that the basis for acceptance of PSD supplies does not require the Industry Participants to validate the design, nor could they do this even if they so wished, because they do not have access to the underlying design intent or the supporting design models.

Commonwealth as expressly authorised in writing by the Commonwealth.

3.81 The PSD Director was a Raytheon employee, until he was succeeded by an ASC employee in late 2012.

3.82 Some design documents offered by the Platform System Designer for Acceptance or Approval have been rejected under the delegations to the PSD Director. The design documents rejected by the PSD Director were considered unusable due to the extent of errors and omissions. These documents were subsequently reworked and redelivered by Navantia. The delivery of design documents is discussed further in Chapter 5 (see paragraphs 5.33 to 5.61).

PSD contract amendments

3.83 Since the signing of the Platform System Design contract, 36 Contract Amendment Proposals have been approved, including 21 that have affected the design, as shown in Table 3.2. Navantia informed the ANAO in October 2013 that Contract Amendment Proposals 6, 12, 18, 34 and 40[215] involved up to five rebaselines of the combat system. Five other Contract Amendment Proposals (not listed in Table 3.2) have increased the value of consultancy services from Navantia by $34.253 million[216], and there have been ten Contract Amendment Proposals that were administrative in nature. In December 2006 prices, the value of the PSD contract has increased from $373.551 million at signing in October 2007, to $411.900 million as at July 2013.

Table 3.2: Design changes affecting the Platform System Design contract, as at July 2013

Contract Amendment Proposal	Date Approved	Purpose	Cost ($m, Dec 2006)
1	22 January 2008	Technical changes to align the PSD contract to the negotiated basis of the Alliance contract	0.031

215 Contract Amendment Proposal 40, Combat System Design Chill, has not yet been formally approved, but has incurred costs under the Alliance's internal arrangement to expedite some construction activity before formal approval has been completed. This 'proceed as if approved' arrangement includes a not-to-exceed cost, and limits on any schedule or other implications are formally advised by Defence. Two other proposed Contract Amendment Proposals are covered by similar arrangements.

216 This includes a $10 million increase to the Alliance's Target Cost Estimate by Contract Amendment Proposal 42 in July 2013.

Contract Amendment Proposal	Date Approved	Purpose	Cost ($m, Dec 2006)
4	15 August 2008	Replacement of RAST Helicopter Recovery System with ASIST	1.603
6	14 November 2008	Combat Information Centre rearrangement	2.227
7	6 September 2010	TDP Update	
9	14 November 2008	F-105 Changes	
10	4 September 2008	Deletion of support for Sea Sprite	
12	17 November 2008	Rebaseline for Hobart Class Combat System	4.936
14	12 April 2010	F-105 Changes	
15	30 April 2010	Gun Magazine	0.021
16	29 May 2009	Tank Boundary	0.168
18	22 March 2011	Alignment with Combat System Vendor Furnished Information Delivery 3.1 and Current Limiting Devices	2.599
19	9 April 2010	Sewage ventilation	0.210
21	18 August 2011	Modification of available space, Gymnasium and Active Towed Array Sonar room	0.710
24	5 August 2011	Magazine Fire-Fighting Measures	0.358
25	23 December 2011	Sewage Treatment Plant obsolescence	0.286
27	17 November 2011	Modification to Galley, Bakery and Pantry/Self Service	0.230
28	23 December 2011	Electronic Warfare Configuration	1.311
29	22 December 2011	Improvements to Combat System Government Furnished Material	0.589
30	22 December 2011	Direct Support Element Compartment	0.913
34	23 January 2013	Improvements to Combat System Government Furnished Material	1.850
45	1 July 2013	Naval Fire Control System	0.283
Total cost			**18.325**

Source: ANAO analysis of AWD Alliance data.

Notes: The stated cost includes in 17 cases the cost of preparing the Contract Amendment Proposal. Actual change to the contract value from the listed Contract Amendment Proposals is an increase of $17.230 million (base date December 2006). Two other Contract Amendment Proposals reduced the value of the PSD contract by $14.777 million.

For Navantia's diagram of the impact of these Contract Amendment Proposals on individual ship blocks, see Figure 5.2.

3.84 While the cost of changes to the Platform System Design contract, set out in Table 3.2, amounts to $18.325 million, the real significance of these contract amendments is in their impact on the development of the detailed design and the build program (see Chapters 5 and 6).

Intellectual Property

3.85 An important aspect of commercial contracting is the issue of Intellectual Property rights. As long ago as 1994, the Industry Commission commented on Intellectual Property in its report *Defence Procurement*:

> The efficiency of acquisition of goods and services by Defence depends importantly on the ownership of and access to intellectual property (IP). This issue is becoming progressively more important as computer software accounts for a growing proportion of the procurement costs of many major projects. The ability to provide through-life support, and to extend the life of many weapons 'platforms', depends critically on access to intellectual property.[217]

3.86 The Intellectual Property ownership and licensing arrangements provided for under the Alliance contract and related agreements (including the Platform System Design contract between the DMO and Navantia) are complex, and require relatively detailed management arrangements. In the *2011–12 Major Projects Report*, the DMO reported the risk that the AWD Program's Intellectual Property requirements might not be delivered, leading to negative impacts on through-life support. The DMO reported that remedial action taken to address that risk was to work with the Alliance to improve the Intellectual Property data that needed to be captured.[218]

3.87 By 2013, the Alliance had developed an Intellectual Property database listing 30 710 Intellectual Property items, with each item supported by descriptions and links to reference documents. A desktop review by the AWD Program Management Office in September 2012 identified significant issues with the data presented. This was primarily related to the quality of data being entered into the source databases. Subsequent reviews in May and June 2013 showed signs of improvement, but issues remain, particularly with older data. The Alliance Industry Participants have advised that they will continue their efforts to remediate the data sets, and this work will be regularly monitored by the AWD Program Management Office.

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217 Industry Commission, *Defence Procurement*, Report No.41, August 1994, p. 122.

218 ANAO Report No.15, 2012–13, *2011–12 Major Projects Report*, p. 197.

Conclusion

3.88 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.

3.89 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.[219] 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.[220] 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.

3.90 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

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219 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.

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

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.

3.91 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, should government wish to receive such information.

3.92 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.

3.93 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, and 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 use 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. The direction and actions of the DMO should seek to best mitigate the key risks faced by the AWD Program at this point in time, so as to achieve the timely delivery of capability to the RAN and limit the overall cost to the Commonwealth.

3.94 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.

3.95 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.

4. Engineering, Regulation and Test and Evaluation

This chapter examines the AWD build phase from the perspectives of definition of systems engineering requirements, technical regulation, and test and evaluation.

Introduction

4.1 The AWD Program is a complex and lengthy systems engineering program subject to a series of interrelated engineering processes. Systems engineering involves the orderly process of bringing complicated systems into being through an integrated set of phased processes that covers user requirements definition, system design, development and production, and operational system support.[221] It is Defence policy that the acquisition of ADF capability should proceed on a firm foundation of systems engineering processes that:

- define capability requirements in terms of the functions each system is to perform and how well each function is to be performed;
- progressively review system designs; and
- progressively conduct tests and evaluations that seek to verify and validate compliance with contracted requirements.

4.2 With respect to the major systems delivered to the RAN, the effectiveness of these processes is dependent upon:

- the Defence Capability Development Group's (CDG's) definition of the RAN's capability requirements;
- the DMO's verification and validation that systems accepted from contractors comply with government-approved requirements, and the DMO's compliance with the RAN's technical and safety regulations; and

221 Blanchard, B.S., *System Engineering Management*, Second Edition, John Wiley & Sons, New York, 1998, pp. 1, 10–12, 35–48.

- the RAN's certification that the systems offered for release into operational service are fit for service, and any risks posed to personnel, public safety, and the environment fall within acceptable levels.

4.3 Within this context, this chapter outlines the AWD Program's requirements definitions, and the Alliance contract's provisions for the verification and validation of these requirements through a Defence-approved test and evaluation program. The chapter also outlines the progress achieved by the Alliance in terms of its technical regulatory compliance.

AWD requirements definition

4.4 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. The Capability Definition Documents comprise the Operational Concept Document, the Function and Performance Specification and the Test Concept Document.[222] 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

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222 The Operational Concept Document (OCD) is intended to inform system acquirers and developers of the ADF's operational requirements. Without specifying particular solutions, the OCD: describes the characteristics of the required capability from an operational perspective; facilitates an understanding of the overall system goals from both the Mission System and Support System perspectives; details missions and scenarios associated with operations and support from both the Mission System and Support System perspectives; provides a reference for determining 'fitness for service'; and provides a justifiable basis for the formal requirements for both the Mission System and Support System.

The Function and Performance Specification (FPS) defines what the ADF requires. It specifies the system's functional requirements from the perspective of the needs of final users; specifies, in quantifiable terms, the system's critical performance requirements that are the basis for design acceptance and qualification testing of the system; and provides the basis for the contracted Mission System and Support Systems' design specifications.

The Test Concept Document (TCD) outlines the approach and strategy to be used to verify and validate that the design and operational requirements of the new or upgraded capability have been met. It defines the ADF's intended test and evaluation approach and strategy for accepting the system, agreed between the DMO and Defence; it forms the basis for the project's Test and Evaluation Master Plan, and identifies the funding and resources required for the project's test and evaluation program, which culminates with System Acceptance and Operational Release; it defines the Critical Operational Issues (identified in the Operational Concept Document) that are to be tested and evaluated to assess the system's ability to perform its mission; it defines the Critical Technical Parameters derived from the critical requirements identified in the Function and Performance Specification; and finally it defines the agreed operational scenarios that need to be successfully trialled in order for the delivered capability to receive Operational Release.

Systems Specification (HCSS).[223] Further, under the PSD contract, the AWD Alliance is required to conduct test procedures provided by Navantia to prove the performance of the Hobart-class DDGs' Platform System.

4.5 Defence records indicate that CDG, the DMO and the RAN made long-term efforts to ensure that the Operational Concept Document reflected user needs, taking into account funding priorities. Systems engineering principles were then used to translate these needs into the Function and Performance Specification, and into a Test Concept Document that specifies how the achievement of each function and performance specification was to be verified. Overall, there were eight iterations of the Operational Concept Document, six iterations of the Function and Performance Specification and four initial iterations of the Test Concept Document. Initial development of the Capability Definition Documents was largely complete by Second Pass approval on 19 June 2007.

4.6 During 2010, Defence developed a fifth Test Concept Document to achieve alignment with its new Capability Management processes and with the Materiel Acquisition Agreements process.[224]

4.7 Since the Critical Design Review in January 2010, there have been some changes to the contracted Hobart-class specifications to reflect the function and performance of the numerous off-the-shelf subsystems. Defence informed the ANAO that these changes to the specifications are closely monitored and agreed by the Capability Manager's AWD Capability Implementation Team and the CDG representatives. As at April 2013, the Capability Definition Documents had been fundamentally stable since Second Pass approval in June 2007.

4.8 A significant future change to the Hobart-class DDGs' design will be the modifications to the helicopter hangar and Support Systems required in support of the Sikorsky MH-60R helicopter, which was selected in June 2011 to operate from the Hobart-class DDGs. At the time of the audit, a Platform Integration Study by the DMO's AIR 9000 Multi-Role Helicopter Program's

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223 The HCPSS forms part of both the Alliance contract and the Platform System Design contract. It describes the systems, arrangements, dimensions, structures, materials, components, equipment and other elements; and the standards, capacities and performance characteristics of the Hobart-class DDG. The HCSS details the requirements for the Combat System and Support System.

224 SEA 4000 Phase 3's Materiel Acquisition Agreement is outlined in paragraph 1.31.

Phase 8 Program Office was under way to fully define the necessary modifications to be incorporated into the ships.

4.9 In the *2012–13 Major Projects Report*, the DMO stated that:

> all significant government specified capability is currently planned to be achieved and in some warfare areas, the capability will be exceeded.[225]

Technical Regulation

4.10 In June 2002, the then Secretary of Defence and the then Chief of the Defence Force jointly issued an instruction establishing the ADF's Technical Regulatory Framework. The instruction aimed to standardise and integrate, at an overarching policy level, each Service's responsibility to ensure that ADF materiel is fit for service, and only poses acceptable risk to personnel, public safety, and the environment.[226] Management structures, policy and processes for the Technical Regulatory Framework are set out in three sets of manuals, developed by each Service's Technical Regulatory Authority on behalf of its Service Chief.

4.11 The ADF Technical Regulatory Framework sets out materiel certification processes intended to provide Capability Managers with assurance that a product, service or organisation complies with stated specifications, standards or other requirements.[227] The certification of ADF materiel is a continuous process, operating for each phase of a project:

- **Pre-contract:** During pre-contract negotiations, certification requirements (in the form of a Certification Basis[228], Certification Plans and System Safety Program Plans) are to be agreed for inclusion into acquisition contracts. Also during this period, the Defence organisations responsible for the engineering aspects of RAN materiel design and construction are to obtain authorisation to perform their

225 ANAO Report No.12, 2013–14, *2012–13 Major Projects Report*, p. 148.

226 Defence Instructions (General) LOG 4-5-012, *Regulation of technical integrity of Australian Defence Force materiel*, September 2010, p. 2.

227 Defence Instructions (General) LOG 4-5-012, *Regulation of technical integrity of Australian Defence Force materiel*, September 2010.

228 Defence Instructions (General) LOG 4-5-012, *Regulation of technical integrity of Australian Defence Force materiel*, September 2010. The Certification Basis is comprised of the compilation of requirements relating to a Mission System's technical integrity. Technical integrity is defined as its fitness for service, safety and compliance with regulations for environmental protection.

engineering tasks through Authorised Engineering Organisation (AEO) certification.

  - The Alliance contract contains a Project Certification Plan and Safety Program Requirements, and the AWD Alliance first received AEO certification in July 2008 (see paragraphs 4.15 to 4.17).

- **Production:** During this phase, Prime Contractors and the DMO are to certify that designs and products comply with contracted and regulatory requirements. Both parties to the contract are to confirm, through verification and validation activities, that end-products fulfil the requirements of their intended use, and should identify any potential risks to technical integrity.[229] Validation activities may involve harbour and sea acceptance trials, and mission trials in the case of First of Class Trials.[230]

  - The AWD Program's verification and validation program is outlined in paragraphs 4.44 to 4.50.

- **Post System Acceptance:** This phase extends beyond the DMO's contractual acceptance of Mission and Support Systems to include the other Fundamental Inputs to Capability, including trained naval personnel and the incremental transition of remaining materiel (see Table 1.3). During this phase, RAN regulators complete their review of the project's Reports of the Materiel State (TI 338[231]) of new or upgraded RAN capability and Safety Case Reports and their supporting evidence, in order to assess the level of risk to seaworthiness disclosed by the

229 Royal Australian Navy, ABR 6492, *Navy Technical Regulations Manual* (NTRM), July 2003, Vol. 2, Section 2, Chapter 4.

230 First of Class Trials are those trials, including First of Class flight trials, designed to:

- measure and record the actual performance envelope of new equipment, systems and units independent of operator performance;
- establish a baseline against which future performance of equipment can be tested; and
- be part of test and evaluation conducted during the naval test, evaluation and acceptance period.

Royal Australian Navy, ABR 6205, *Naval Operational Test and Evaluation Manual*, Revision 4, July 2010, Glossary.

231 TI 338 reports are developed by DMO Systems Program Offices, and provide key risk information to the RAN's Commanding Officers and Force Commanders. These provide an account of the materiel state of the Mission and Support Systems, in terms of operational limitations within the parameters approved by government at Second Pass approval, and hazard risk assessments of the remaining risks at the time of materiel release by the DMO to the RAN. Royal Australian Navy, ABR 6205, *Naval Operational Test and Evaluation Manual (NOTEMAN),* Edition 4, 2011, Annex A to Chapter 5.

TI 338s and Safety Case Reports. The Regulators' endorsements are a necessary component of the submissions to the Chief of Navy seeking Initial Operational Release or Operational Release of new or upgraded RAN capability. The AWD Program's **Post System Acceptance** phase is to commence with Operational Test and Evaluation of HMAS *Hobart* in 2016.

- **In Service:** Periodic re-validation of a ship's certification occurs in accordance with certification renewal programs. The RAN also has Materiel Condition Assessment processes focused on functional performance assessments to confirm fitness-for-service, and physical condition assessments to determine whether the risks to mission, the environment and personnel are within acceptable limits. This phase is not expected to commence for the first ship until 2017.

4.12 The following text box outlines the key roles and responsibilities of the RAN Regulatory System.

RAN Regulatory System structure

The RAN's Regulatory System has three regulatory domains:

- **Operations Regulation**, headed by Commander Australian Fleet, and the Delegate: Chief Staff Officer Operational Seaworthiness Directorate;
- **Technical Regulation and Logistic Support Regulation**, headed by the Director General Technical Seaworthiness (DGTS); and
- **Safety Management System Regulation**, comprising Head Navy People and Reputation, and the Delegate: Director General Navy Certification and Safety.

DGTS is the RAN's current Technical Regulatory Authority and is responsible for the certification of the technical integrity of ADF maritime materiel. DGTS is also accountable for ensuring that requirements are defined, and that responsible authorities are competent to discharge their responsibilities, are authorised to do so, and have appropriate management systems in place. Under current reforms, this role will be taken over by the Head Navy Engineering.

4.13 As the Hobart-class DDGs are to have a helicopter capability, they will require Airworthiness Certification of their shipborne aviation facilities. Director General Technical Airworthiness (DGTA) is the certification authority and subject-matter expert for ADF aviation systems, and so will assist the RAN's Technical and Operational regulators with recommendations concerning the acceptance of these facilities and their risks.

Hobart-class DDG certification

4.14 Certification is the act of issuing a certificate that provides assurance that a product, service or organisation complies with a stated specification standard or other requirements. The certification of compliance with the RAN Regulators' requirements provides the basis for the Chief of Navy's consideration of Initial Operational Release and Operational Release of new or upgraded naval materiel.[232,233]

4.15 The AWD Program commenced developing its Project Certification Plan in 2007. Since then, the Alliance has revised the Project Certification Plan to include feedback from the RAN, and to provide the basis for four subordinate Certification Plans covering armament, security accreditation, shipbuilder certification, and aviation certification. In May 2011, the AWD Program received a letter of endorsement from Head Navy Engineering covering the program's updated Technical Integrity Certification Basis.

4.16 Defence's Technical Regulatory Framework requires Defence organisations that undertake the design and construction of ADF materiel, or that accept designs and construction, to be authorised to perform their tasks through Authorised Engineering Organisation (AEO) certification. AEOs are to ensure that all ADF materiel is designed, constructed and maintained to approved standards, by competent and authorised individuals who are acting as members of an approved organisation, and whose work is certified as correct.[234]

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232 The RAN recognises the costs of over-regulation, and so the degree of regulation to be applied to naval capability is to be based on formal risk management principles, and should, wherever possible, be developed with an awareness and recognition of civil regulatory standards and regimes. The acceptable levels of residual risk will vary according to the context associated with that capability, including its physical and operational environments, and accordingly to changes in standards and expectations over time. Regulators are to identify their regulatory requirements, and tailor these to the risk inherent in each capability. Department of Defence, Defence Instructions (Navy) ADMIN 37-16, *Navy Regulatory System,* July 2008, pp. 1–3.

233 RAN regulations applicable to CDG and DMO's roles include:

- ensuring that, prior to Second Pass approval by government, each project's Capability Definition Documents have been certified as complying with the RAN Regulators' requirements;
- ensuring that each project's Certification Plan is approved by the DMO Project Director, endorsed by the RAN's Regulatory Authorities and authorised by the Director General Navy Certification and Safety, at the 'earliest stages of an acquisition/procurement'; and
- managing ongoing compliance with approved Certification Plans.

234 AEO certification provides high confidence that the organisation has:

- technical management systems appropriate to the type of work being performed. These include quality management systems such as ISO 9001, engineering management systems, design support networks, and configuration management systems. The organisation must also have a Senior Design Engineer, responsible to the Senior Executive for ensuring compliance of the organisation with the regulations, and for assigning Engineering Authority to individuals within the organisation;
- personnel with appropriate authority, training, qualifications, experience, demonstrated competence and integrity to undertake the activities required;

Footnote continued on the next page…

4.17 The AWD Alliance first achieved AEO status in July 2008. The AEO authorisation was reviewed in 2011 and remains valid until July 2014. As an AEO, the AWD Alliance undertakes regular interaction with regulators. Regulator transparency of the AWD Program's technical integrity is achieved through regulator endorsement of the Engineering Management Plan and Project Certification Plan.

AWD Classification arrangements

4.18 A ship is known as being *in class* if it meets all the minimum requirements laid down by a Classification Society. Defence informed the ANAO that, where appropriate, it utilises shipping industry Classification Societies to provide independent verification that the majority of the RAN's fleet complies with design, construction and operation requirements that govern each vessel's particular class. This aligns with commercial shipbuilding practice whereby, for finance and insurance purposes, shipbuilders contract Classification Societies to independently verify and certify that ship designs and construction comply with international conventions, rules and regulations.[235] This is primarily done for commercial reasons, as it puts the onus on the shipbuilder to achieve certification, whilst simultaneously isolating the shipowner from any disagreement over certification and any delay that may arise from that dispute.

4.19 The certification (classing) of the Hobart-class DDGs under Class Society rules was not within the agreed scope of the Alliance contract that was signed in October 2007. The DMO informed the ANAO that most of the design work for the F-100 Class was performed during the period 1995 to 2000, and that the design is based on military standards derived from the US Navy or

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- processes that are documented, controlled and approved for all the organisation's engineering activities. These include procedures and plans to specify and define technical activities, which must be controlled and approved by an appropriately qualified individual, nominated within the quality system; and
- data applied to, and derived from, technical activities that are accessible, authoritative, accurate, appropriate and complete.

Adapted by the ANAO from Australian Defence Force, Australian Air Publication 7001.053, *Technical Airworthiness Management Manual*, Section 3, Chapter 1; and Department of Defence, Defence Instructions (Navy) ADMIN 37-16, *Navy Regulatory System*, July 2008, p. 3.

235 The main rules and regulations pertaining to commercial shipping are the International Maritime Organisation's safety and environment protection regulations.

North Atlantic Treaty Organisation (NATO) countries. A range of shipbuilding standards are referenced in the F-100 contract specification.[236]

4.20 Rules are now available for the classification of warships, and these include the NATO ANEP 77 *Naval Ship Code*, promulgated in 2009.[237] These rules are designed for naval ships as an alternative to the Safety of Life at Sea Convention (known as SOLAS), and include links to relevant commercial ship rule sets. They are intended to provide a common set of minimum specifications and parameters for the construction and operation of naval vessels, so as to assist design and construction and to improve inter-operability and through-life logistics support. Class Societies normally perform a plan approval or a construction survey function when engaged to class a vessel against these rules.

4.21 However, as Classification Society Naval Rules did not exist when the F-100 Class was designed, it is unrealistic to expect the F-100 design to be fully compliant with those rules. The DMO advised that the Hobart-class DDGs are not being built to a prescribed set of Class rules, and the intention is not to class the ships once in service. However, the DDG System Program Office, or the RAN, may engage a Classification Society to provide specific assurance services if and when required.

4.22 At the time of the audit, the RAN informed the ANAO that current reforms of Navy's regulatory system include a review of the application of international conventions, including 'classing' of vessels, and the implementation of a Defence Seaworthiness Management System.

Australian Maritime Safety Authority and Classification Society certificates

4.23 Warships are not obliged to conform to Australian Maritime Safety Authority (AMSA) requirements for safety and environmental protection. However, the Head Navy Engineering is to take cognisance of these requirements, unless operational priorities make them inappropriate or impracticable. A Classification Society may be engaged to undertake an assessment to detail any variances from the AMSA requirements.

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236 These standards-setting organisations and standards are: Data Distribution Service (DDS), the US Navy's Naval Sea Systems Command (NAVSEA), and NATO's Standardization Agreement (STANAG).

237 ANEP 77 provides a generic set of function and performance requirements related to safety and environmental protection requirements applicable for naval ships.

4.24 The AWD Alliance has engaged a Class Society to assess the DDGs' compliance with AMSA Marine Orders, based on the DDGs' Critical Design Review documents and ship inspections. The Class Society will not perform a plan approval or a construction survey function that is normally associated with classing a vessel, but will be required to provide a level of assurance that the contemporary practices defined by the Marine Orders have been addressed. Four assessments are to be performed: the first is a preliminary assessment based on the design information available at the time of the AWD System's Critical Design Review, and this is to be followed by three assessments—one for each of the DDGs as they near completion.

4.25 Defence informed the ANAO that in August 2013, the Critical Design Review assessment by a Class Society was underway, and the RAN Regulators were of the opinion that:

- the AWD Alliance will continue attempts to obtain the outstanding information to allow the compliance assessment to continue;
- outcomes of the compliance assessment will feed into the safety case argument for AWD. Non-compliances (including instances where information is missing) which result in a potential hazard will be subject to the AWD safety management process; and
- the AWD Alliance will provide further updates of progress towards completing the compliance assessment.

Designer's Certificates and Design Certification

4.26 The ADF philosophy of technical regulation is that organisations responsible for delivering supplies or services are required to provide Designer's Certificates certifying that the materiel for which they are responsible is approved, that it complies with specified standards, and that it is technically fit for service in its intended role.

4.27 Defence's technical regulations also require Design Acceptance Representatives to provide Design Certificates that certify they have validated the design by proving, through evaluation of a designer's claims outlined in Designer's Certificates and supporting Objective Quality Evidence, that the specified intended end-use of a product or system has been accomplished in its intended environment. Design Certification of the Hobart-class DDGs is the responsibility of the Alliance.

4.28 The AWD Program's engineering authority delegations for Designer's Certificates and Design Certification are outlined in Figure 4.1.

The Alliance Technical Director and DDG Designer's Certificates

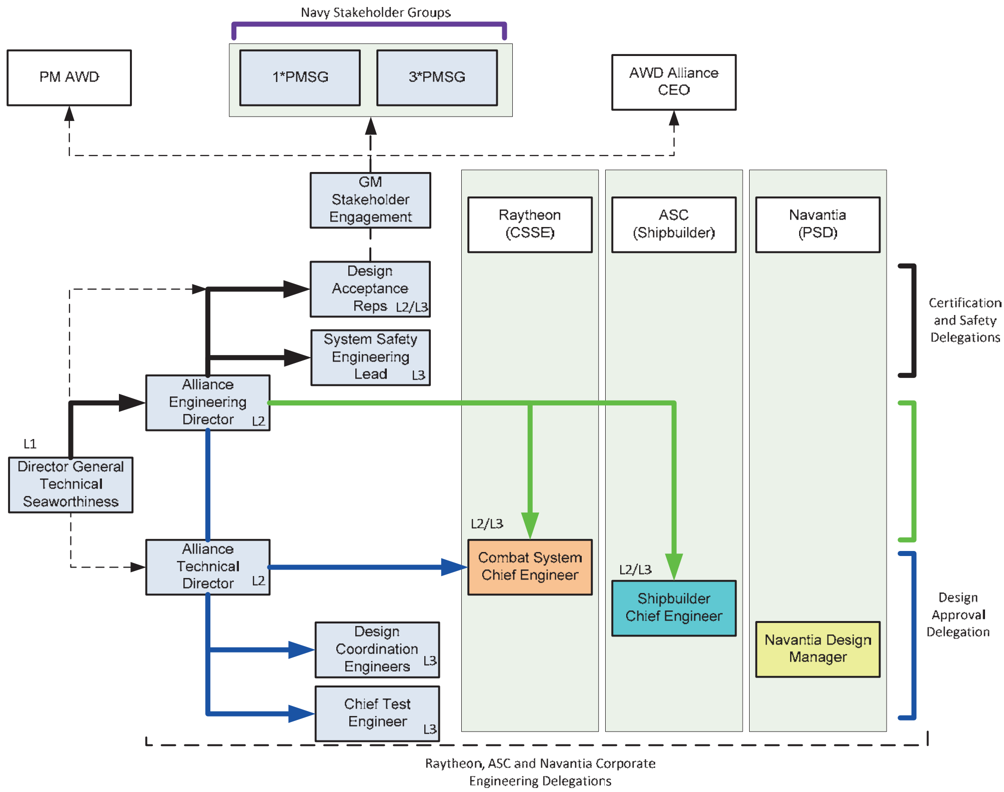
4.29 The Alliance Technical Director is responsible for the certification of the Hobart-class DDGs' design. The Technical Director is the delegate responsible for issuing the Designer's Certificate for the DDGs' 'Whole of Ship Capability'. He is also responsible for providing Objective Quality Evidence to Design Acceptance Representatives in support of Design Certification decisions, and for delegating engineering authority for Design Approval to the AWD Combat System Chief Engineer, to Design Coordination Engineers and to the Alliance's Chief Test Engineer.

4.30 As shown in Figure 4.1, Design Approval delegations cover Combat System engineering, Shipbuilder engineering and Platform System design; these delegations are outlined below.

Combat System Designer's Certificate

4.31 Raytheon Australia is the designer of the Combat System, and its Combat System Chief Engineer is to provide the Designer's Certificate for that system. Raytheon's 'Design Authority' delegates are allocated responsibility for Designer's Certificates against specific elements of the Combat System. An interim Designer's Certificate is required for the Combat System prior to sea trials. The integration of the Combat System into the Platform System requires a final Designer's Certificate to be issued by the AWD Technical Director.

Figure 4.1: AWD Program's engineering authority delegations, and Design Acceptance reporting



Source: Air Warfare Destroyer Program Management Office.

Note: The blue arrows show the Design Approval authority delegations for Designer's Certificates, the black arrows show the Design Acceptance authorisations for Design Certificates, and the green arrows show the engineering management delegations. The figure also shows the hierarchical flow-down of delegations from the Director General Technical Seaworthiness at Level 1, to the systems, coordination and test engineers at Level 3.
L1, L2, and L3 indicate the level of delegation under the RAN's Technical Regulatory Framework.
1*PMSG and 3*PMSG refers to the one and three-star Program Management Stakeholder Groups.
PM AWD refers to the DMO's AWD Program Manager.

Shipbuilder engineering Designer's Certificate

4.32 The AWD Program has a Shipbuilder Chief Engineer, responsible for production engineering management, including design approval of production engineering. This includes production-enabling products such as mocks, jigs, fixtures, lifting and handling arrangements and general engineering within the shipyard.

Platform System Designer's Certificate

4.33 Navantia is the designer for the Hobart-class DDG Platform System, the major elements of which are shown in Figure 1.1. Navantia's Design Manager is to provide the Designer's Certificate for the Platform System Design.[238]

4.34 Before the first DDG commences sea trials, an interim Designer's Certificate for the Platform System will need to be issued by Navantia, although this has not yet been contracted. This interim certificate is to be followed by Navantia providing a final Designer's Certificate 45 days prior to Provisional Acceptance. Navantia's contract makes it responsible for warranting that the function and performance of the Hobart-class Platform System satisfies the contracted specification, *provided* that the ships are built in accordance with Category 1 of the Technical Data Package (see paragraph 5.30).[239]

4.35 Any risks to fitness for service, safety or the environment are to be identified, documented and submitted by the designers to the Design Acceptance Representatives. Design Acceptance Representatives may call upon the AWD Program's Technical Support Network to assist with design acceptance, where that is appropriate, to cover the competency and risk profiles of particular designs that are being accepted.[240]

Certificates of Conformance

4.36 Underpinning the Designers' Certificates are system and subsystem Certificates of Conformance issued by their respective Original Equipment Manufacturer, including ASC AWD Shipbuilder. These certificates provide an assurance that the DDGs and their installed equipment have been manufactured in a way that fully complies with their approved specifications.

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238 To assist with the timely resolution of issues during ship construction, Navantia has, at the Alliance's request, provided a document that details criteria and thresholds under which the ASC, Raytheon and their block subcontractors are authorised to make minor design adjustments during production. For details, see paragraph 6.22.

239 The Platform System Designer (Navantia) represents and warrants to the Commonwealth that the DDGs, if constructed in accordance with the Technical Data Package (Category 1), will achieve the Platform System's specified function and performance requirements.

240 RAN technical regulations recognise that AEOs do not normally have sufficient internal technical resources or the capability to carry out all their engineering responsibilities using only their own personnel. Achieving AEO status is therefore dependent upon the establishment of adequate external technical support arrangements that complement and supplement internal technical capacity and capability.

The Alliance Engineering Director and DDG Design Acceptance

4.37 The Alliance Engineering Director is responsible for engineering management within the Alliance, including management of the Alliance's technical risks and system safety, and for maintaining the Alliance's AEO status under the Navy's Technical Regulatory System. This responsibility includes ensuring that only competent and authorised persons manage the technical risks that fall within their engineering delegations.

4.38 The Alliance Engineering Director is responsible for providing an independent assessment of the technical integrity risk associated with the Hobart-class DDGs' design. He has a Level 2 engineering authority delegation from the Director General Technical Seaworthiness (DGTS), for design acceptance covering the DDGs' Platform System and Combat System elements, and for the DDGs' Support System. He issues Level 3 Design Acceptance Representative delegations within the AWD Program for design acceptance, based on each individual's role and competence to conduct design acceptance.

4.39 The Design Acceptance Representatives are engineers who, in accordance with the requirements of the Naval Technical Regulatory System, are required to be independent of the designers. They provide validation of the designers' certification, prior to acceptance of the supplies. They may be members of, or independent contractors to, the Australian Defence Organisation, provided they are not involved in the design.

4.40 Unlike the ADF's Technical Airworthiness Regulations, the RAN's Technical Integrity Regulations do not involve Design Acceptance Representatives accepting designs offered by Design Authorities. Instead, the RAN's Design Acceptance Representatives provide independent assessments of the technical integrity risk associated with design, construction and maintenance, and provide advice to the person with executive authority, who may then accept or reject that risk.[241] Furthermore, the RAN's regulations do not restrict the position of Design Acceptance Representatives to Commonwealth employees. At the time of the audit, the AWD Alliance's Engineering Director, and his subordinate engineers who hold Design Acceptance Representative delegations, were not necessarily Commonwealth employees, and they operated under Alliance Industry Participant and Navantia engineering delegations.

4.41 Normative regulatory structures 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, as outlined above, 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 the DMO's AWD Program Manager on design acceptance issues (see Figure 4.1). GMSE also chairs the RAN's one-star Program Management Stakeholder Group, and reports to the three-star Program Management Stakeholder Group.

4.42 In August 2013, Defence informed the ANAO that the Naval Technical Regulatory System (see paragraph 4.12) 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. Defence advised that these mechanisms include:

(a) Design Acceptance Representative assessments of non-compliances and changes to the DDGs' certification basis being forwarded to, and

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241 AWD Alliance, *Engineering Management Plan*, Issue 6, May 2012, p. 22. The RAN's Technical Integrity Regulations state that the responsibility of this individual is to conduct a validation of the design, design process, the Designer's Certificate and Objective Quality Evidence presented, and identify the risk to technical integrity associated with the design when incorporated into ADF Maritime Materiel. The individual responsible for design certification must be delegated that role, and this delegation must be recorded in the Engineering Authority Register. The Design Acceptance Representatives (DARs), if required, may be assisted in validating the design by other competent individuals not involved in the design, but the DAR remains solely responsible for design certification. ABR 6492, *Naval Technical Regulations Manual*, July 2003, Volume 2, Section 2, Chapter 3, paragraph 3.5a.

assessed by, authorised representatives of the Navy Technical Regulators;

(b) Design Acceptance Representative assessments of hazards identified within the AWD system safety program being forwarded to, and assessed by, authorised representatives of the Navy Technical Regulators;

(c) the AWD Program Management Office routinely seeking advice from authorised representatives of the Navy Technical Regulators on the program's system safety program; and

(d) the involvement of authorised representatives of the Navy Technical Regulators on AWD Critical Design Reviews.

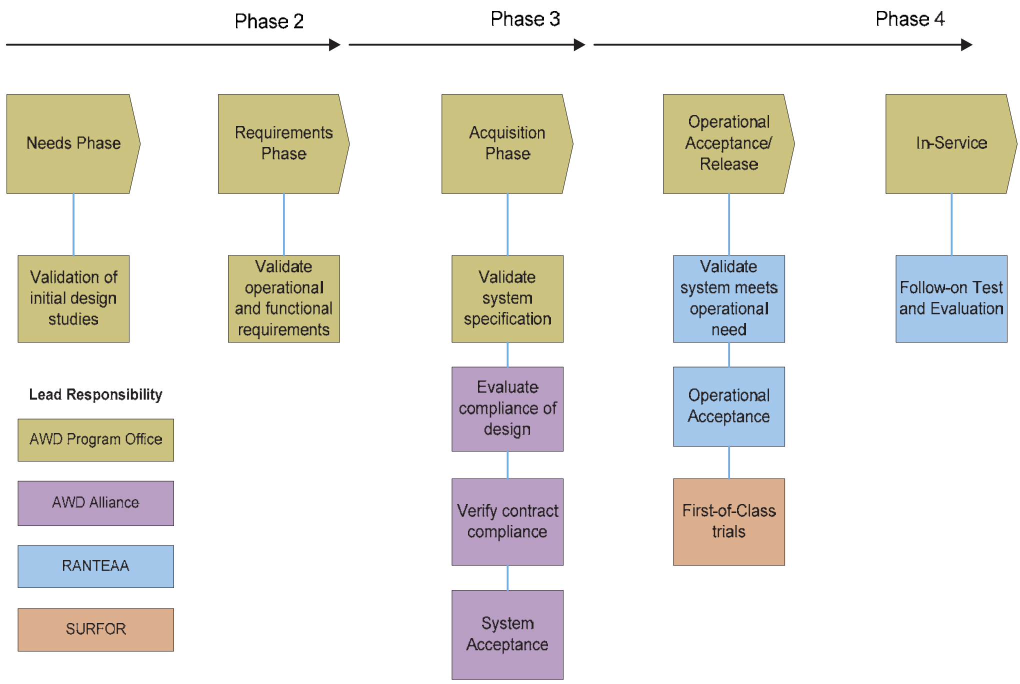
AWD Program certification reviews

4.43 The AWD Program has a Regulatory Review Group (RRG) formed to conduct regular reviews of the certification program activities. This group is co-chaired by the RAN's Director General Navy Certification and Safety and the AWD Alliance Engineering Director, and it includes representatives from amongst the Navy Regulatory System personnel. The Regulatory Review Group is responsible for reviewing the development of the AWD Program's Project Certification Plan, examining working-level regulatory issues and, if necessary, referring such issues to the one-star Program Management Stakeholder Group (PMSG) for consideration and resolution.

System verification and validation

4.44 The Alliance contract requires the Industry Participants to develop, deliver and maintain a schedule of test and evaluation activities leading to acceptance of each DDG by the DMO. At the time of the audit, the AWD Program had not completed building the first ship, and very few of the DDGs' systems had been installed and set to work. Consequently, the verification and validation activities for system acquisition, shown in Figure 4.2, had not progressed to any significant extent in terms of testing installed systems, because installed systems-level tests had not commenced.[242] This section of the report therefore outlines the AWD Program's preparations for its system-level test and evaluation and verification and validation phases.

Figure 4.2: Verification and validation phases and their major activities



Source: AWD Alliance, *Air Warfare Destroyer Test and Evaluation Master Plan*, September 2007.

Notes: RANTEAA—RAN Test, Evaluation and Acceptance Authority.
SURFOR—RAN Surface Force.

Test and Evaluation

4.45 Defence regulations require that data applied to, and derived from, technical activities must be authoritative, accurate, appropriate and complete.[243] The DMO is required to maintain records of the testing and evaluation, contractual acceptance, and configuration management of ADF materiel, in a systematic and complete fashion. This is essential for ADF materiel acceptance, in terms of providing assurance that the materiel remains

242 The Alliance CEO informed the ANAO in January 2014 that 864 of 1986 combat-system-level requirements had by then passed verification and validation categories 0–3. (These categories of testing precede the Harbour Release Tests and Sea Acceptance Trials that occur after the systems are installed into the ship.)

243 Such data must always be accessible, but need not be retained in-house.

fit for service and poses only acceptable risk to personnel, public safety, and the environment.

4.46 DMO Project Office personnel are required to confirm the contractual compliance of design requirements through the documented traceability of requirements during the design process, and the documented verification of those requirements during the construction process. This may involve project personnel witnessing Acceptance Tests, specified within the Alliance contract, and attending any other testing conducted by the AWD Alliance or its suppliers. The intention is to confirm that contractual design requirements, as set out in an acquisition contract's statements of work, have been factored into the design and construction process.

4.47 Once designs are complete, the test and evaluation of final products commences, with the objective of verifying and validating that all design requirements have been met. It is DMO policy that progressive verification and validation be used to ensure that contractors maintain an appropriate degree of oversight and control over the evolving system's production. In this way, risks and issues affecting contractual compliance may be resolved before the system is presented by the contractors for System Acceptance by the DMO. The overall aim is to prevent a need for costly and time-consuming redesigns, production reworks and the subsequent need for regressive test and evaluation later in the process.

4.48 The DMO's systems engineering standard requires the recording of verification results in accordance with acquirer–supplier agreements, verification plan instructions or product directives or procedures. Verification Cross Reference Matrices, complete with verification results based on an approved test and evaluation program, are relied upon during the materiel certification process to provide objective evidence that contractors have complied with contractual specifications, standards and requirements.[244]

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244 Defence Materiel Organisation, *ASDEFCON (Strategic Materiel) Handbook*, March 2002, Part 3, Draft. Since 2002, DMO has produced other versions of ASDEFCON (SM), with the latest being published in 2004.

Verification is defined as: confirmation by examination and provision of objective evidence [through test and evaluation procedures] that specified requirements to which a product or service, or aggregation of products and services, is built, coded, assembled and provided have been fulfilled. [ISO 9000:2006, *Quality management systems—Fundamentals and vocabulary*]. Put simply, verification is a process for proving that product designs and development comply with specified function and performance requirements.[245]

Validation is defined as: proof through evaluation of objective evidence that the specified intended end-use of a product or system is accomplished in an intended environment.[246] Put simply, validation is used to determine whether or not a system, product, or service is operationally effective and suitable.

4.49 The AWD Alliance contract requires the AWD Program Management Office's approval of the AWD Test and Evaluation Plan and its verification and validation plans, and approval of Acceptance Test Plans and Acceptance Test Procedures. The contract also requires the Program Management Office's acceptance of test reports. The AWD Program uses a Test Management System (TMS) database, a Requirements Management System (RMS) database, a Hazard Tracking System (HTS) and a Verification Cross Reference Matrix to compile a complete account of the results of tests and evaluations used to verify and validate compliance with contracted requirements. The Verification Cross Reference Matrix is to be offered by the Alliance to the Commonwealth for acceptance at the time of System Acceptance.

4.50 However, as mentioned earlier, 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 Ship 1's combat system 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.

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245 Defence Materiel Organisation, *DMO Acquisition and Sustainment Manual*, 2007, pp. 74–5.
The DMO's verification and validation manual categorises verification and validation procedures into inspections, demonstrations, analysis, modeling and simulation, tests, system reviews, audits, defence trials, walkthroughs, experiments, red teaming, operational analysis and research, and explosive ordnance proof. Defence Materiel Organisation, *Defence Materiel Verification and Validation Manual*, November 2008, pp. 18–19, 56–66.

246 International Standards Organisation, ISO 9000:2006, *Quality Management Systems—Fundamentals and vocabulary*.

Conclusion

4.51 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.

4.52 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.

4.53 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.

4.54 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.

4.55 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.[247]

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247 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.

5. Design Progress

This chapter examines the Hobart-class DDG design, design and construction risk reduction, and the incorporation of design changes into the Hobart-class.

Introduction

5.1 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.[248] 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. That decision reduced the need to develop a new platform design from first principles, and was intended to help manage program risk.

5.2 Navantia has now delivered five Álvaro de Bazán-class (F-100) frigates to the Spanish Navy (Armada Española), and five Fridtjof Nansen-class (F310) frigates to the Royal Norwegian Navy. Platform System modifications derived from lessons learned in the construction and operation of the F-100s were applied to the fifth Spanish frigate, the F-105, and many of these changes have been included in the Hobart-class DDG platform design.[249]

5.3 On receipt of the Second Pass government approval in June 2007, Defence, with the agreement of the Industry Participants, engaged Navantia as the Hobart-class Platform System Designer, responsible for:

(a) modifying the design of the Platform System for the F-104 to take account of an Australianised Combat System (based on the Aegis Weapon System), obsolescence, Australian legislative requirements[250] and specified platform changes; and

(b) providing to Defence the design of the Platform System for the Hobart-class DDGs, and other goods and services, including production information and technology transfer, training and other assistance (all

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248 Bentley, C., *Prince2: a practical handbook*, 2nd edn, Elsevier Butterworth-Heinemann, Oxford, 2002, p. 217.

249 The fifth Álvaro de Bazán-class FFG, F-105 *Cristóbal Colón*, was commissioned into the Spanish Navy in October 2012.

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

forming part of the Platform System Design Supplies) to allow the DDGs to be constructed, and thereafter used and maintained, by Defence.

5.4 Other inputs to the Platform System Design come directly from the day-to-day Navantia and AWD Alliance collaboration, which seeks to improve the design from the end-user standpoint. Any changes to the design after the Platform System Design contract was awarded in October 2007 were to be managed by Engineering Change Proposal and Contract Amendment Proposal processes.

5.5 Platform System design changes may be considered as evolutionary and relatively low-risk when the designers, shipbuilders and technical regulators have a long 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. The latter environment places a heightened importance on the timely and effective communication of design changes, and the ability of shipyards to identify and resolve design problems and issues, prior to their incorporation into the build program. Accurate and clear design documentation, and rapid feedback to resolve design problems and issues are necessary for minimising rework[251] and associated cost and schedule overruns during construction.[252]

5.6 Figure 5.1 shows the complex network of domestic and international relationships and the communications necessary to provide the DDG design, produce blocks, report problems and issues, and receive feedback from the designer on technical queries.

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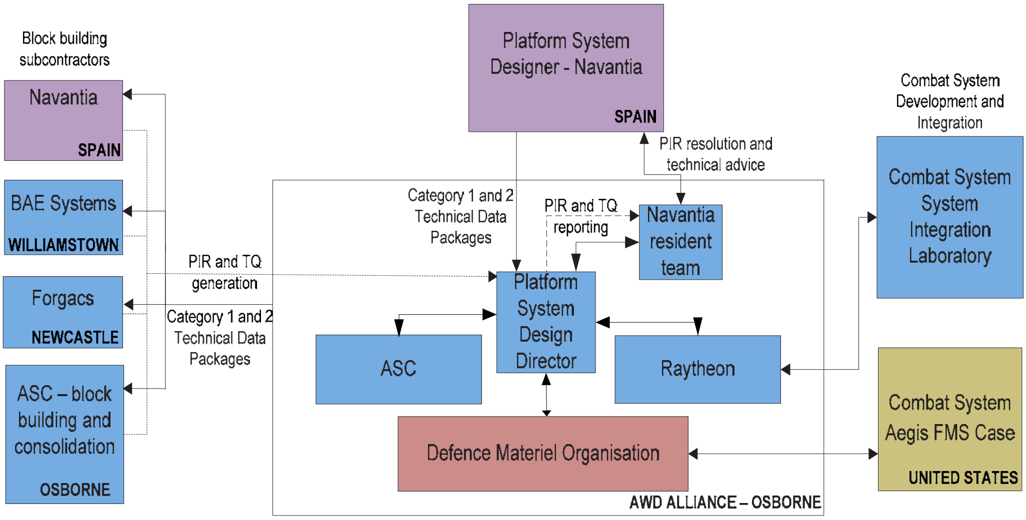
251 As discussed in Chapter 6, rework may not be limited to one ship, as the AWD Program involves parallel work that can affect all three ships.

252 In the latest ANAO *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, *2012–13 Major Projects Report*, p. 157.

Figure 5.1: Design distribution and feedback loops in the AWD Program



Source: ANAO analysis.
Note: PIR—Problem and Issue Report.
TQ—Technical Queries.

Design and construction risk reduction

5.7 The effective creation of a design requires a workforce with the appropriate skills, the capacity to complete the task on time, and the tools, data and processes to develop and proficiently verify the design. The last and, to most commentators, most important ingredient is experience.[253]

5.8 The overall aim of any major construction program is to maintain build quality, and to mitigate the risks of schedule delay and cost overruns. In 2011, a report on the shared modular build of warships, prepared by the RAND Corporation for the US Navy, identified several key areas of focus for risk reduction.[254] These areas, and the ANAO's summary assessment of their management as part of the AWD Program, are set out in Table 5.1 below.

253 Department of Defence, Defence Materiel Organisation, *Future Submarine Industry Skills Plan. A Plan for the Naval Shipbuilding Industry*, May 2013, p. 51.

254 National Defense Research Institute, *Shared Modular Build of Warships: How a Shared Build Can Support Future Shipbuilding*, RAND Corporation, Santa Monica, 2011, pp. 39–40. The term 'modular build' is equivalent to the 'block construction' terminology generally used in this ANAO report.

Table 5.1: AWD Program risk reduction areas, and ANAO's summary assessment of the AWD Program

Key risk area	Description	ANAO assessment
Design completion	Detailed design[255] is a key step in mitigating rework requirements during module integration, because it allows better quality control and ensures accurate and timely stock delivery to the production process. This becomes even more important when those modules are to be built at two or more locations. In particular, the design at the module interfaces needs to be fully understood and, therefore, practically complete for modules to integrate easily and at least cost.	The detailed design, in terms of construction drawings, continues to be changed. Design completion has therefore not been achieved (see paragraphs 5.36 to 5.61).

255 In commercial shipbuilding, the three design phases typically involve:

- basic design: fix ship steel structure and set hydrodynamics; design safety systems and get approvals from applicable authorities; route all major distributive systems, including electricity, water, and other utilities; ensure that the ship will meet the performance specification; complete (shipbuilder) and review (buyer);
- functional design: provide further iteration of the basic design (generally equates to 3-D modelling); provide information on exact position of piping and other outfitting in each block; complete (shipbuilder) and review (buyer); and
- detail (production) design: generate work instructions that show detailed system information, and include guidance for subcontractors and suppliers, installation drawings, schedules, materials lists, and lists of prefabricated materials and parts; often outsourced by shipbuilder and generally not reviewed by buyer.

US Government Accountability Office, *High levels of knowledge at key points differentiate commercial shipbuilding from Navy shipbuilding*, Washington DC, May 2009, GAO-09-322, pp. 23–4. This GAO report found that in US Navy shipbuilding programs, new designs often make little use of prior ship designs. As a result, a full understanding of the effort needed to execute a program is rarely achieved at the time a design and construction contract is negotiated. Further, complete information on the systems that will be installed on the ship may not be available, leading to changes that ripple through the design as knowledge grows. Starting construction without a stable design is a common practice, and the resulting volatility leads to costly out-of-sequence work and rework.

Key risk area	Description	ANAO assessment
Motivating cooperation	Contractual requirements are only the first stage of cooperation between shared-build shipyards. For the more complex warships, a higher level of trust and openness is needed between the parties involved. This can be difficult when there is an underlying and continuing shipbuilding competition. Strong collaboration can lead to shared best practices and reduced costs. The government (or Navy) has a role to play in bringing shared-build yards together, and can encourage cooperation by, for example, contracting structures and profit share arrangements.	There is evidence of cooperative arrangements between the three Australian shipyards involved in the AWD Program. This is reinforced by alliance management processes and the emphasis on the importance of achieving shared responsibility for outcomes expressed in the cost-plus-incentive-fee Alliance contract (see paragraphs 3.29 to 3.32). The delegation by the Commonwealth to the Industry Participants of responsibility for the day-to-day management of the Platform System Design contract provides for collaboration between the parties. In practice, in response to immaturity in the detailed design, the AWD Alliance has had to take measures to better leverage Navantia's knowledge and experience into the Alliance (see paragraphs 5.62 to 5.69).
Design and design-to-production organisation	Shipyards involved in a shared-build strategy need to reach a detailed and common understanding of what affects the module interfaces and their integration. Such commonality requires either common design software or compatible software linked to a common design data bank.	All three shipyards are required to build the Hobart-class DDGs using mandatory specifications and supportive guidance contained within the Technical Data Package provided by Navantia (see paragraphs 5.27 to 5.32, and 6.5 to 6.11). Since 2011, these shipyards have used a software-based dimensional accuracy control system to ensure the required dimensional accuracy is achieved (see paragraphs 6.13 to 6.21). While the shipyards do not share a 3-D Computer Aided Design (CAD) model of the platform design, since July 2010, Navantia's team at ASC has had access to a 3-D CAD model of the Hobart-class DDG design to assist in resolving design issues (see paragraph 5.64(c)).

Key risk area	Description	ANAO assessment
Aligning production practices and schedules	Aligning production practices requires each yard, and in particular the integration yard, to understand differences in production processes. This is of vital importance at the interfaces of complex, outfitted modules. Aligning the production schedules also requires pacing module construction to the same completion drumbeat.	Each shipyard involved in the AWD Program has developed production processes in line with its particular facilities and workforce. There have been significant changes in block allocations between the shipyards in response to construction issues (see paragraphs 6.48 to 6.51). At the time of the audit, the AWD Program was dealing with a large number of Corrective Action Requests from an Integrated Baseline Review, which noted that the schedule was at risk of failure despite recent review work (see paragraphs 6.81 to 6.92).

Source: ANAO analysis of Defence records.

Note: Risk areas and descriptions are based on: National Defense Research Institute, *Shared Modular Build of Warships: How a Shared Build Can Support Future Shipbuilding*, RAND Corporation, Santa Monica, 2011, p. xiv.

5.9 In 2006, when the AWD Program was preparing for Second Pass approval of the build phase (Phase 3), the design and engineering assumptions for SEA 4000 were that:

- The Shipbuilder (ASC) was reliant on the Platform System Designer (Navantia) to provide the ship design capability to deliver full detailed design data packs.
- It was expected that the Shipbuilder would have a design and engineering department with sufficient capability to complete specific AWD production engineering activities. The primary role of the design and engineering department would be to verify that the design work conducted by the Platform System Designer correctly interpreted the design changes necessary for the DDGs (at the functional design level, rather than to verify the accuracy of the detailed design in its 'build to print' form).
- The Shipbuilder would not make any changes to the Platform System Designer's build sequence and block sizes, hence did not require a large Computer Aided Design (CAD)/Modelling capability.[256]

256 Existing Design Project Manager, ASC AWD Shipbuilder Pty Ltd, *Existing Design Estimating Assumptions*, prepared for DMO, 15 December 2006, p. 15.

5.10 As discussed in paragraph 2.20, Defence undertook a detailed process, as part of SEA 4000 Phase 2, to assess the way forward; and by the end of Phase 2, was confident that design issues would not impact unduly on the construction program. While Defence could reasonably derive confidence, as part of that process, from Navantia's long history and experience in designing and building warships, a less tangible but nonetheless important consideration in the Australian context would have been Navantia's lack of previous experience in exporting a design to a third-party shipyard. This factor, combined with the non-inclusion of Navantia in the Alliance contract (discussed in Chapter 3), has added risks to the AWD Program that were not fully assessed as part of SEA 4000 Phase 2. The ANAO has observed (see paragraph 3.76) that, ideally, an alliance should include the key contributors to the task being undertaken, and 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. Similarly, there would be merit in assessing the past experience and performance of key capability partners in respect to working in a distributed shipbuilding context.

5.11 In a similar vein, prior to the AWD build program, ASC lacked shipbuilding experience. As noted in paragraph 2.18, during Phase 2, in recognition of its lack of shipbuilding experience, ASC engaged Bath Iron Works to provide expertise in shipbuilding technology and interim design and construction risk reduction. The Alliance informed the ANAO that Bath Iron Works personnel were also appointed to key Alliance positions, including Shipbuilding Director and Technical Director, and Platform System Design representatives were stationed at all three yards (ASC, Forgacs and BAE).

Lead Yard Services

5.12 When a lead shipbuilder transfers its design, it is common for the shipbuilder to also provide Shipbuilding Lead Yard Services of the kind needed to address the key risk areas outlined in Table 5.1. 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.[257] They include planning and production support that is intended to ensure, as far as is reasonably practicable, that the lessons from the initial build are transferred to the follow-on build yard. The transfer of the lessons from the initial build is expected to be captured in 'as built' drawings.[258]

5.13 However, the Alliance formed the view that the design-to-production process could operate effectively without Navantia providing extensive Lead Yard Services. In October 2013, ASC noted that the DDGs should have effectively been 'build to print', and informed the ANAO that:

> Navantia is contractually obliged to provide a complete and accurate design based on the F-104, a ship which was in service, thus implying that the design being delivered included the 'as built' elements of that ship. The view taken at the relevant time was reasonable, as the F-100 design had been built four times, and the fifth [ship of that class] was in production well ahead of the AWD production schedule. The expectation was that production issues, commonly captured in 'as built' or 'red lines', would have been fed back into the design after the first-of-class had been built and tested in Spain by Navantia. This is standard shipyard practice to avoid rework by repeating design errors on subsequent ship builds.[259]

5.14 While the AWD Program expenditure for Phases 1 and 2 amounted to some $262 million, and this expenditure was directed towards establishing a sound design, there remained significant untested expectations about the quality of the detailed design documentation to be provided by Navantia.

5.15 Navantia raised issues with the ANAO in relation to the design-to-production process adopted for the Hobart-class DDGs. Specifically:

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257 UK National Audit Office, HC98-III Session 2007–2008, *The Landing Ship Dock (Auxiliary) Project*, 30 November 2007, pp. 7, 13.

258 These drawings are usually the original design drawings revised to reflect any changes made in the shipyard, such as changes to pipe or duct routing or to electrical-cable tray routing or terminal-unit locations. 'As built' drawings may be derived from 'red line' drawings, which are essentially intermediate drawings that show corrections or changes made to previous drawings. The term 'red line' refers to the usual practice of using red pens to amend drawings by hand to reflect changes made during block production.

259 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.

- the build sequence was driven by the installation of the Combat System, and the sequence was not the same as that followed for the F-100;
- the Intermediate Products (used to plan and budget the construction) were not defined in line with Navantia's drawings structure, leading to a mismatch with Navantia supplies[260]; and
- some procedures and building strategies developed by Bath Iron Works were not directly applicable to the Hobart-class DDGs.[261]

5.16 While the Alliance has taken steps to better integrate Navantia's knowledge and experience over time (as discussed at paragraphs 5.62 to 5.69 below), a key lesson to be drawn for future shipbuilding programs is that a higher level of integration should be sought between the designer and shipbuilder throughout the program. Further, the advice provided by ASC and Navantia at paragraphs 5.13 and 5.15 above indicates that the Phase 2 (design) process, and subsequent design reviews (discussed below), were not fully effective in working through a range of fundamental issues relating to the design, which continue to impact on the program's build phase.

Design progress

5.17 The Hobart-class DDG design process commenced within Defence's Capability Development Group when, with the assistance of the DMO, the DDGs' requirements were defined. This process (outlined in paragraphs 4.4 to 4.8) produced the AWD Alliance contract's Hobart Class Platform System Specification (HCPSS) and Hobart Class Systems Specification (HCSS). These documents specified the DDGs' functional requirements from the RAN's operational-use perspective, and the DDGs' critical performance requirements, which form the basis for design acceptance tests and evaluations, and operational tests and evaluations.

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260 In its January 2014 response to an extract from this audit report, ASC stated that 'the requirement to adjust the content, structure and schedule of design product deliveries in the PSD Contract in order to align with the AWD Build Strategy remains vague, and a major source of frustration for the Alliance parties. For example, as the Technical Data Package (TDP) content, structure and delivery schedule specified in the PSD Contract is based on Navantia's own build strategies for its shipyards, the resulting design products have not aligned with the AWD Build Strategy (i.e. a distributed vs centralised build strategy).' See page 2 of ASC's letter to the ANAO, reproduced in Appendix 3.

261 The Alliance CEO informed the ANAO that the build sequence was driven by the Osborne shipyard design, which included level facilities, as against the inclined-way facilities used by Navantia.

Production of functional drawings and construction drawings, and the Preliminary Design Review

5.18 The production of Hobart-class DDG functional drawings commenced in October 2007, after the signing of the Platform System Design contract. This involved refining the changes and selected options to be incorporated into the F-104 baseline design to produce the Hobart-class design, and completing the functional drawings.[262] At that time, most of the changes to the F-104 baseline involved replacing the Combat System with the Australianised Combat System, complying with Australian legislative requirements, and ensuring that suitable replacements were specified for obsolescent equipment.

5.19 Functional drawings produced during this period included the Hobart-class:

- general arrangements;
- spaces arrangements;
- general scantlings structural drawings;
- piping system diagrams;
- electric and electronic systems diagrams; and
- mechanical systems arrangements and accommodation arrangements.

5.20 The development of construction drawings commenced in August 2008, and was scheduled for completion in August 2011. As the Hobart-class platform design is based on Navantia's F-104 design, some construction drawings not affected by the agreed changes to the F-104 configuration were provided to the AWD Alliance prior to the completion of the Critical Design Review in December 2009 (see paragraph 5.22). Construction drawings produced during the 2008 to 2010 period focused on product definitions and construction optimisation processes.

5.21 The Hobart-class DDGs' Preliminary Design Review (PDR) commenced in December 2008 and concluded in February 2009, with the completion of follow-up actions. The PDR was conducted by Navantia over a three-day period, and was attended by Alliance and Commonwealth representatives.

262 The term 'drawing' has to be understood in the traditional sense; the drawings may be composed of a number of sheets (hundreds, in many cases) containing sketches, arrangements, general notes and information, instructions, material lists, numerical tables, weights and centre of gravity, etc.

The objectives of this review were to confirm that: the DDGs' subsystems had all been defined appropriately and satisfied their parent requirements; approaches to the next level of design development had been appropriately planned; and risks were identified and appropriate risk mitigation plans were in place. Once the PDR was complete, more detailed design activities commenced, and these continued throughout 2009.

Critical Design Review

5.22 The Critical Design Review (CDR) was conducted in November–December 2009. The CDR Panel was co-chaired by the DMO and the AWD Alliance, and included RAN, DMO, DSTO and Alliance representatives. The scope of the CDR included reviews of the combat system, the support system and the platform system. This multi-disciplined engineering review examined whether the project could proceed into production and test, and whether the systems to be constructed would meet stated performance requirements within cost, schedule, risk, and other system constraints.

5.23 With regard to the Platform System, the objectives of the CDR were for Navantia to demonstrate that:

- specifications and drawings had been appropriately defined;
- building block designs satisfied their parent requirements;
- enabling product requirements had been adequately defined; and
- the building blocks were either ready for further development, adequately defined for procurement, or adequately defined for fabrication.

5.24 The November 2009 final report of the Platform System CDR complimented Navantia on the quality of the functional design, and concluded that 'the team is well positioned to proceed through Detail Design and Construction'. However, one of the key challenges facing the program was identified as 'churn in the design and construction due to changes, holds and revisions'. The actions arising from the CDR were completed in February 2010.

5.25 In October 2013, the Alliance CEO informed the ANAO that:

> [The Critical Design Review] was contractually set for the functional design, not the detailed design. This is a critical distinction, noting that the majority of the Technical Data Package maturity issues [arising during the build phase] relate to the detailed design of the platform and not the functional design.

5.26 The construction of the DDGs began in December 2009, a month after the CDR report had noted that the program was well positioned to proceed through detailed design and construction. In 2013, the AWD Program Manager identified one of the challenges at the outset of the AWD Program as 'concurrent platform system design and build'.[263] Nevertheless, neither of the program's design reviews covered the detailed design of the DDGs.

Delivery of platform construction Technical Data

5.27 The effectiveness of a shared or distributed-build strategy, such as that employed by the AWD Program, is reliant on the shipbuilders receiving accurate and stable technical data packages. These are necessary to enable efficient production and effective quality assurance processes. They are also necessary contractually, because, in the case of distributed-build programs, accurate and stable technical data enables lead shipyards and subcontractor shipyards to agree and work to criteria for completion and acceptance of the various ship blocks which make up the vessel.

5.28 Navantia is required to provide Technical Data Package Category 1 deliverables that conform to the HCPSS. The designer is also required to provide Technical Data Package Category 2 deliverables, which contain reference information to assist with the construction, testing, trialling and delivery of the DDGs in Australia. The block design data packs were scheduled for delivery progressively between the completion of functional drawings in February 2009 and the completion of the last block design data in April 2011.

5.29 Under the Platform System Design contract, the Technical Data Package is subject to review at six-monthly intervals, with either accuracy confirmed or the drawing(s) updated and reissued by the Platform System Designer through a process known as Maintenance Drops.

5.30 The Category 1 Technical Data Package, as delivered for Approval or Acceptance, should comprise all the Platform System Design information needed for a professional, skilled shipbuilder to construct, test, trial and deliver the Platform System for the DDGs, and for a skilled Combat System–Systems Engineer to install and physically integrate the Australianised Combat

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263 AWD Program Manager, speech to Pacific 2013 International Maritime Conference, Sydney, 8 October 2013.

System into the Platform System. The Category 1 Technical Data Package contains:

(a) Platform Functional Design Drawings and Documents;

(b) Platform Detailed Drawings;

(c) Platform Construction Drawings and Reports, including Standard Drawings and Material Lists;

(d) Platform Purchase Technical Specifications; and

(e) Platform Test and Trials Protocols.

5.31 The Category 2 Technical Data Package provides supporting documentation for the construction of the vessels in Australia, which the Shipbuilder is recommended to follow. This package contains:

(a) Production Procedures;

(b) the Build Strategy;

(c) the latest version of Work Orders;

(d) preliminary Material List Estimates;

(e) Planning Documentation; and

(f) Integrated Logistics Support documentation.

5.32 The Category 1 Technical Data Package supplies from Navantia are warranted to be fit for the purpose for which they are provided.

Acceptance of Platform System Design supplies

5.33 After Navantia has delivered its design documentation to the DMO through Navantia's NECORA system, the Alliance's Platform System Design group then manages these Platform System Design supplies. On advice from the Industry Participants, the PSD Director may accept or reject these supplies.[264] If they conform to the contract requirements, they are formally accepted and made available for use by the Alliance.

5.34 If a delivery of Platform System Design supplies contains a Key Platform System Design Supply, and has been accepted prior to the related

264 The PSD Director, nominated by the Industry Participants, is the Commonwealth Representative's delegate.

milestone date, then the liquidated damages provisions in the Platform System Design contract cannot be applied. However, under those circumstances, contractual remedies still exist, by way of requiring Navantia to make good any omissions, defects or non-conforming materials or work in the Platform System Design supplies, at no cost to the Commonwealth.[265]

5.35 From these Platform System Design supplies, ASC compiles work packs containing fabrication and installation data, for use by the shipyard production teams. ASC's work packs are then used by each shipyard to produce work instructions and procedures that take into account each yard's internal practices, skills and resources.

Immaturity in the detailed design

5.36 AWD Alliance records indicate that drawing revisions and updates have occurred for a variety of reasons, as categorised in Table 5.2.

Table 5.2: Categories of Hobart-class DDG design change

Change category	Description
Certification	Changes required to achieve certification by regulatory bodies (e.g. security, explosive ordnance, aviation).
Platform System Design Omission	Changes required to correct errors or omissions in the Platform System Design identified by Navantia.
F-105 Lessons Learned	Changes to the Platform System Design identified by the Spanish F-105 Build and Test Programs.
Ship 1 Lessons Learned	Changes identified by the Alliance during the AWD Build and Test Programs to correct Technical Data Package errors and omissions.
Design Issues	Changes necessary to resolve Problem and Issues Reports and Technical Queries
Commonwealth-requested Change	Changes requested by the AWD Program Management Office.
System Safety	Changes required to address hazards identified by the Alliance System Safety Program.
Obsolescence	Changes required to address equipment obsolescence issues.

265 The Platform System Design contract does not contain provisions relating to compensation payable to the Commonwealth for the cost of rework that can be directly attributed to omissions or defects in the Platform System Design supplies. As discussed below (see paragraphs 5.36 to 5.38), it is difficult to explicitly attribute the sources of design change to a particular cause. The main recourse for defective supplies is rectification of the supplies under warranty.

Change category	Description
Combat System Design Vendor Furnished Information	Combat System design changes promulgated through Vendor Furnished Information.
Non-compliance	Changes to the platform required to address design non-compliances with the specified requirements.
Legislative Compliance	Changes required to comply with legislative requirements.
Platform System Vendor Furnished Information	Changes required to comply with changes to Platform System Vendor Furnished Information (for example, changes in equipment installation requirements).
Integrated Logistics System	Changes required to address issues identified by Integrated Logistics System analyses, for example, the need to carry additional support equipment.
On-board Allowance List	Changes required to accommodate items on the ship's On-board Allowance List.

Source: AWD Alliance.

5.37 The total number of construction drawings for the Hobart-class DDG is 2132, and the total number of revisions issued as at October 2013 was 6071.[266] Overall, the high number of revisions and the range of design change categories indicate significant immaturity in the detailed design of the Hobart-class DDGs.

5.38 During the audit, the ANAO was advised by the parties that it is difficult to calculate the contribution of different causes to the level of design change. Further, there has been disagreement over the relative contribution of 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.[267] The ASC informed the ANAO that it had no reason to suspect that these drawings failed to incorporate 'as built' design corrections and lessons learned from the construction of the F-105. On the other hand, Navantia has emphasised that over 1700 drawings were affected by Contract Amendment Proposals, and that Vendor Furnished

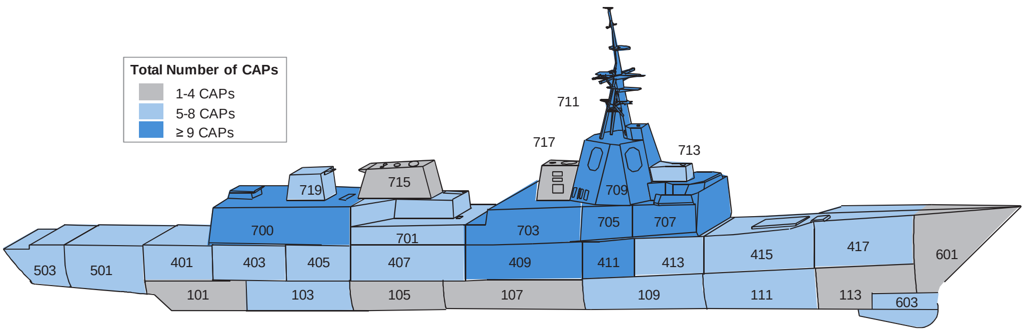
266 Navantia informed the ANAO in November 2013 that it estimated some 2400 of the revised drawings involved significant changes, while the rest mainly addressed minor errors, editorial matters, technical queries, and so forth.

267 The Alliance CEO informed the ANAO in October 2013 that design defects and deficiencies were estimated to account for 63 per cent of the total volume of change experienced on the project. F-105 lessons learned were estimated to account for 15 per cent; and late, defective or deficient Vendor Furnished Information for 13 per cent.

Information (VFI) caused 700 hold-ups (notices to stop work) that had to be implemented in later drawings.[268]

5.39 Navantia provided the ANAO with a diagram (Figure 5.2) showing the number of approved Platform System Design Contract Amendment Proposals that have affected individual blocks.[269]

Figure 5.2: DDG blocks affected by Platform System Design Contract Amendment Proposals (CAPs)



Source: Navantia, November 2013.

5.40 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.[270]

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268 While acknowledging that a larger proportion of all drawing changes was attributable to Navantia, Navantia considered that no more than 10 per cent of the significant drawing changes have occurred as a result of errors or lessons learned from the F-105, and that external sources such as contract amendments and Vendor Furnished Information have been the main causes of significant changes to drawings.

269 See Table 3.2 for a list of the approved Platform System Design Contract Amendment Proposals that have affected the design.

270 The Alliance CEO informed the ANAO in January 2014 that the Alliance is building in accordance with the Category 1 Technical Data Package. Any deviations from this design documentation require Commonwealth and/or Platform System Designer endorsement, which limits 'on the spot' changes being made by the Alliance production workforce.

See also discussion of the Threshold Document at paragraphs 6.22 to 6.24.

Timing of design issues

5.41 Issues relating to design change first arose in 2009, and have continued to the present. In May 2013, the AWD Program Management Office informed the ANAO that:

- The early Technical Data Package deliveries covering functional descriptions and Purchase Technical Specifications were, in general, acceptable for use.[271] However, when deliveries of construction drawings commenced in 2009, it became apparent that there were drawing quality issues.
- It was not until 2010, when Alliance block production work had advanced to a stage where design interface defects[272] were arising on the blocks, that the potential extent and implications of these defects became apparent. The defects and deficiencies associated with the Technical Data Package construction drawings had, to that point in time, included missing dimensions, missing detail, translation errors, and CAD errors. This resulted in the rework and redelivery of a large number of drawings. The redeliveries invariably occurred later than expected for Ship 1, with consequent block rework and resource implications.
- Navantia was incrementally supplying revised design drawings with errors corrected, in compliance with the Platform System Design contract's warranty provisions.
- The drawing defects and deficiencies are not related to the issue of late Vendor Furnished Information for the Combat System (see paragraph 5.42), for which workarounds and stopgaps had been agreed between the Platform System Designer and the Alliance.

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271 However, in October 2013, ASC informed the ANAO that the Purchase Technical Specification documents:

> generally have required numerous updates, noting that, on average to the end of April 2013, each Purchase Technical Specification has been revised 3.8 times (see Figure 5.5). Many of these revisions subsequently require formal changes to subcontracts where they are delivered after a subcontract is executed (this is in addition to known changes, that is, revisions to incorporate changes required from negotiations with subcontractors). This invariably generates additional cost.

272 A design interface defect can result in pipes not connecting, for example.

Vendor Furnished Information

5.42 In order to meet its contracted obligations, Navantia relies upon the Alliance for the timely supply of Vendor Furnished Information for the purpose of completing design drawings needed for equipment installations. The supply of this Vendor Furnished Information should have been completed by March 2011 (some 41 months after contract signature). For a variety of reasons, the delivery milestones for Vendor Furnished Information were not achieved. As a consequence, Technical Data Package deliveries for the blocks containing Combat System equipment and related systems were either late or incomplete. However, in cases where Vendor Furnished Information was incomplete, provision in the Technical Data Package had been made for the space, weight and platform system requirements of the Combat System equipment and related systems. Platform design statistics show that subsequent Technical Data Package updates occurred as additional Vendor Furnished Information was made available.

Extent of design change

5.43 In relation to the amount of change to be expected in a shipbuilding program, a RAND Corporation report published in 2005 identified that the scale and cost of change differed between commercial and military shipbuilding programs:

> Military ships of a given class may have a unique design, while commercial vessels tend to be more evolutionary or produced from established designs. When changes are made, they are accomplished within just one to four weeks for commercial vessels but require from four to 22 weeks for military ships. Contractors we interviewed also indicated that commercial ship changes, even for complex projects, also tend to be smaller than those for military ships, as indicated by the value of change orders, approximately 4 percent of total vessel cost for new production for commercial ships and approximately 8 percent for military ships.[273]

273 RAND Europe, *Monitoring the Progress of Shipbuilding Programmes*, MG-235, RAND Corporation, Santa Monica, 2005, pp. 24–5.

5.44 Other studies indicate that real cost changes, as a result of design changes, amounting to 15 per cent for lead warships and 10 per cent for follow-on warships are not unreasonable.[274]

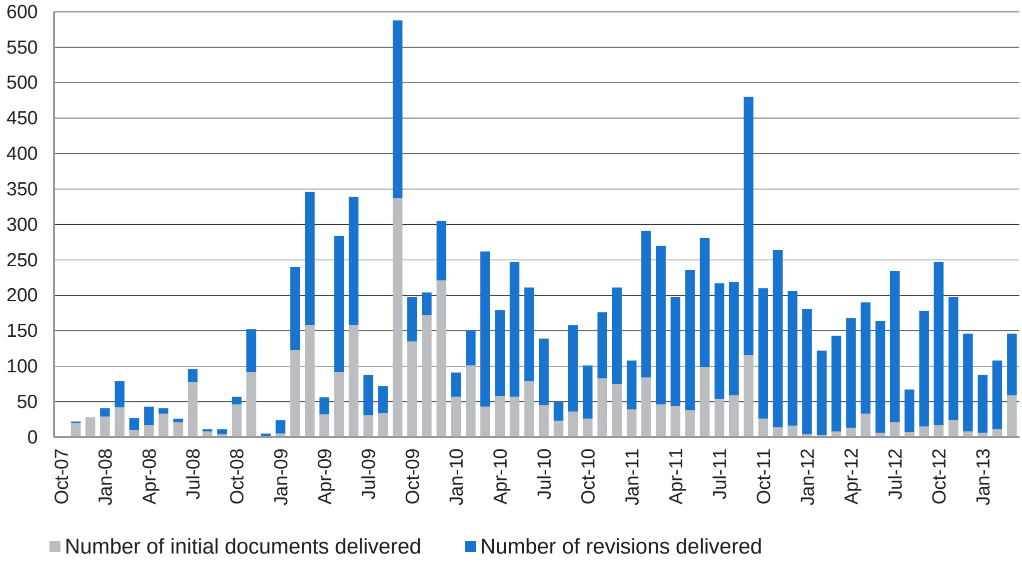
5.45 Defence informed the ANAO that, in terms of hours worked, the amount of design change experienced by the AWD Program to the end of Maintenance Drop 1 (October 2011) amounted to around seven per cent of the budgeted cost of the build program. Since then the amount of design change has increased, predominantly with the commencement of Maintenance Drop 2 in August 2011 and Maintenance Drop 3 in March 2013. In October 2013, the Alliance CEO informed the ANAO that:

> the volume of design change seen by production [is] above 20 per cent. The Alliance management systems are able to readily isolate costs associated with the top-down change. However, isolating costs associated with maturity issues is more complex.

5.46 Figure 5.3 is an extract from an AWD Alliance report showing the extent of design document changes received from Navantia via Technical Data Package updates, from the commencement of the Platform System Design contract in October 2007 to March 2013. The grey column for each month shows the number of initial documents delivered, while the blue column shows the number of revisions delivered.

274 See, for example, DL Clark, DM Howell, and CE Wilson, *Improving naval shipbuilding project efficiency through rework reduction*, Naval Postgraduate School, Monterey, 2007, pp. 62–8.

Figure 5.3: Platform System Design document revisions, October 2007–March 2013



Source: AWD Alliance, April 2013.

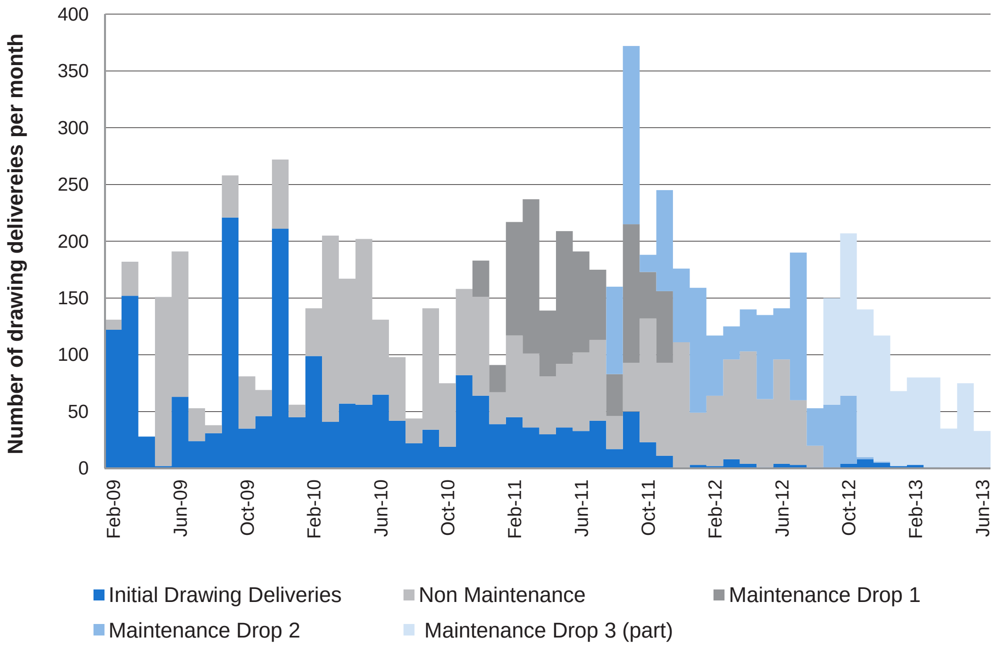
Note: This figure includes data for both construction drawings and other documents; the totals of initial documents (3480) and revisions (7240) in this figure are therefore different from the number of construction drawings (2132) and revisions (6071) stated in paragraph 5.37. The proportion of revised documents in this figure is 208 per cent, while in paragraph 5.37 the proportion is 285 per cent.

5.47 Overall, Figure 5.3 shows that the large number of revisions continued into 2012 and 2013, which demonstrates that there has been ongoing detailed design immaturity during the DDGs' block construction phase. As indicated in Table 5.2, some drawing revisions were necessary to incorporate the Australianised Combat System and other engineering changes required by Defence (such as the replacement of the RAST helicopter landing system with ASIST). Defence advised that these engineering changes, which followed an Engineering Change Proposal process and led to the implementation of contract amendments that affected the design baseline, had resulted in 3785 design document amendments (as of April 2013).

5.48 Figure 5.4 shows the extent of construction drawing changes received from Navantia via Technical Data Package updates, from the commencement of deliveries in February 2009 to June 2013. The figure shows five categories of construction drawing deliveries: the initial delivery, first revision, Maintenance

Drops 1 and 2, and an ongoing Maintenance Drop 3.[275] Overall, Figure 5.4 shows that the large number of revisions continued into 2012 and 2013, also demonstrating that there has been ongoing detailed design immaturity during the DDGs' block construction phase.

Figure 5.4: Platform System Design construction drawing revisions, February 2009–June 2013



Source: AWD Alliance, October 2013.

5.49 Figure 5.5 shows that, by March 2013, there had been an average of 2.75 revisions for every drawing delivered for the 31 blocks in each Hobart-class DDG.[276] In October 2013, ASC informed the ANAO that:

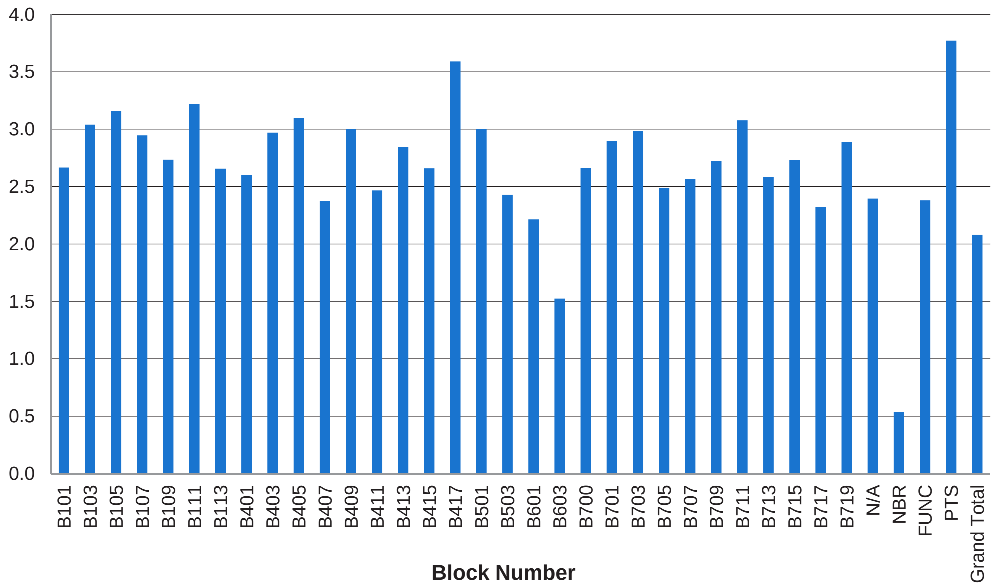
> While the data in Figure 5.5 indicates a high level of design change, it only partly reflects the issue. The amount of change in each drawing revision is also important, as that is what generates the rework and impacts. For example,

275 Maintenance Drop 1, involving 881 revised drawings, was delivered from November 2010 to October 2011. Maintenance Drop 2, involving 1046 revised drawings, was delivered from August 2011 to October 2012. Maintenance Drop 3, involving 493 revised drawings, was delivered from March to November 2013. As noted in footnote 262, a drawing may include hundreds of sheets.

276 The average cited includes only the data for blocks, which is a subset of the data shown in Figure 5.5; it does not include the data entitled N/A, non-block related, functional, or Procurement Technical Specification, nor the block containing the sonar dome on the bow of the ship.

Block 407 pipe work drawings have been updated three times. This could have only resulted in three minor pipe segment changes, however 100 per cent of the pipe work on that block has been changed.

Figure 5.5: Average number of revisions per drawing delivered, as at March 2013



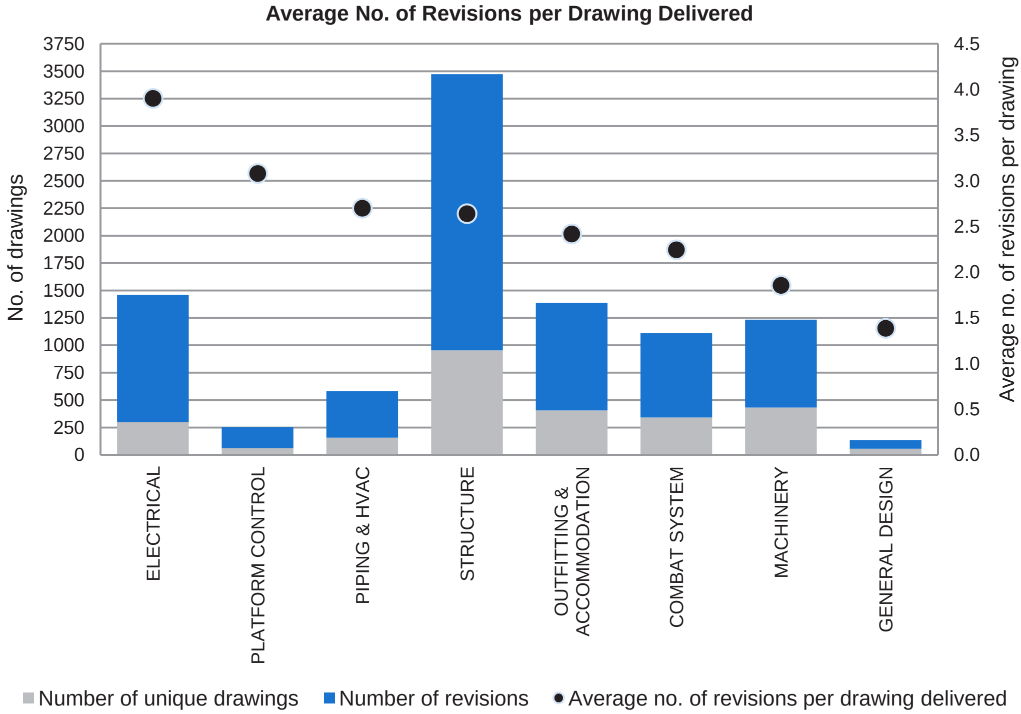
Source: AWD Alliance, March 2013.

Notes: NBR Non-block related.
FUNC Functional.
PTS Purchase Technical Specification.

5.50 Figure 5.6 shows the number of drawing changes per shipbuilding discipline, as at March 2013. In the structure area, for example, for a total of 954 unique drawings, 3473 drawings had been issued. The right axis of the figure and the black dots show the average number of revisions per drawing for each major discipline, ranging in number from 3.9 revisions of electrical drawings, to 2.2 revisions of structural drawings, to 1.4 revisions of general design drawings.[277]

277 It should be noted that the volume of change per revision is an important factor not shown in the figure.

Figure 5.6: Drawing revisions by shipbuilding discipline, as at March 2013



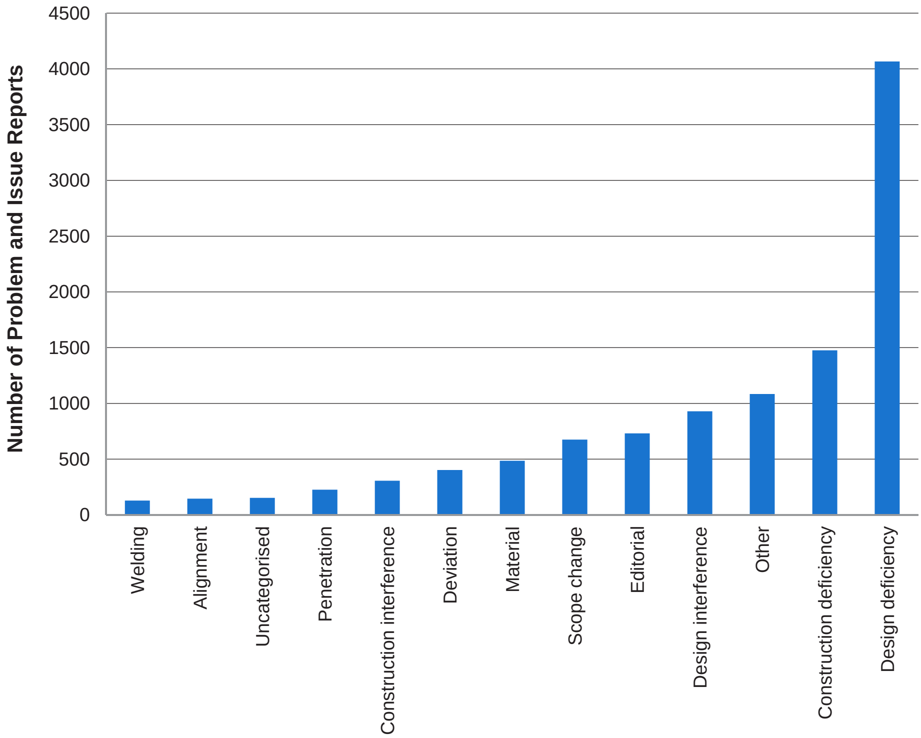
Source: AWD Alliance, April 2013.

5.51 Figure 5.7 shows the categories assigned by Alliance staff to Problem and Issue Reports in the AWD Alliance's engineering database. These reports are raised by block building teams, and they identify areas of the Platform System Technical Data Packages that require clarification or additional designer input. These reports therefore represent the shop-floor view of design issues, rather than a definitive analysis. As noted previously, without a detailed analysis, it is very difficult to attribute specific causes to a particular design problem.

5.52 By discipline, AWD Alliance data indicates that 30 per cent of the Problem and Issue Reports relate to Primary Structure, 30 per cent relate to piping, 13 per cent relate to Hull Outfit, and 12 per cent to electric cabling and equipment. The remaining 16 per cent are attributed to a variety of disciplines, such as heating, ventilation, and air conditioning (HVAC), foundations, machinery, protective coatings and insulation.[278]

5.53 Of the 10 813 records in the Problem and Issue Reports database, design interference and design deficiency together accounted for 4996 records, or 46.2 per cent of all records—by far the largest percentage of all records.[279] The next major grouping of categories, construction interferences and construction deficiencies, together accounted for 1783 records, or 16.5 per cent of all records.

Figure 5.7: Categories of Problem and Issue Reports, July 2009–April 2013



Source: ANAO analysis of AWD Alliance data.

278 Because of rounding, figures in this paragraph do not add to 100.

279 Design interferences include incorrect spacing of structures, equipment, piping systems, cable systems and air-conditioning systems. Interferences result in clashes occurring, or correct operation being hindered, during or after equipment and system installation.

Design defects include missing dimensions, missing detail, translation errors, and CAD errors.

5.54 Each drawing revision's impact on the construction program is dependent on when the revision is received. For example, revisions occurring before the commencement of block construction may require changes in the supply of material to the shipbuilder. However, revisions received during a block's construction have a greater impact, as these may result in a need for costly and time-consuming rework. In the case of similar blocks which are being built in parallel, rather than sequentially, rework may be required for each of the blocks, effectively multiplying the impact of design changes.[280]

5.55 In October 2013, the Alliance CEO informed the ANAO that:

> Whilst the volume of change in the Technical Data Package supplies 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.

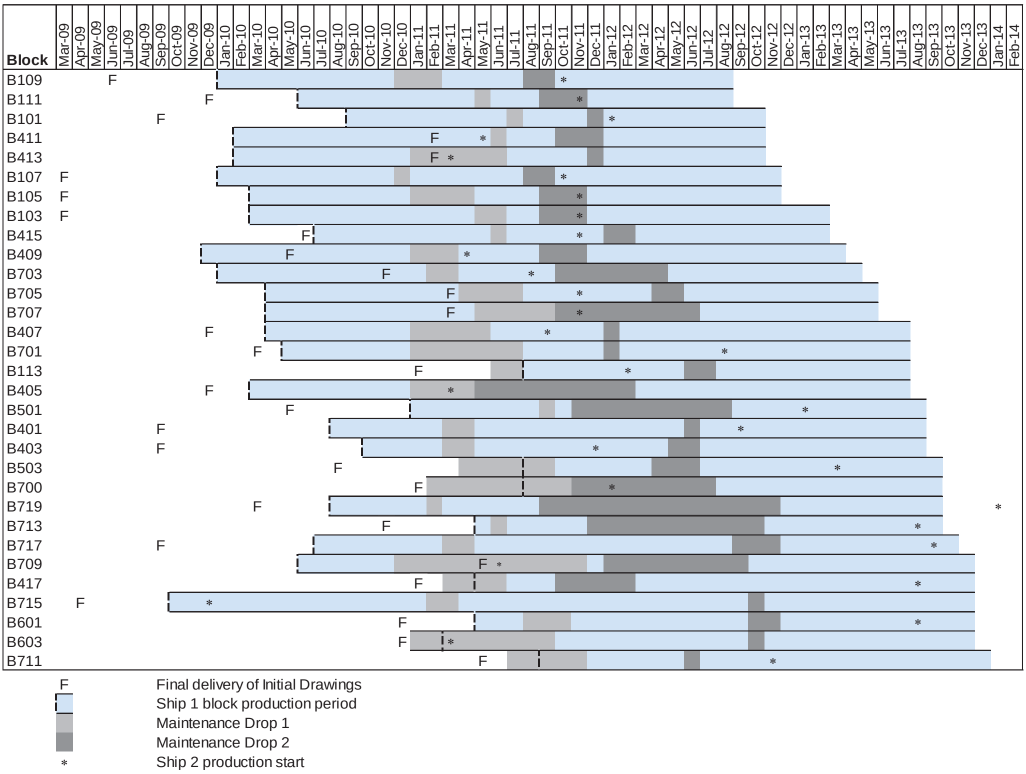
5.56 Figure 5.8 shows that Maintenance Drop 1 was typically received between a third and half way through the block construction period for Ship 1. Similarly, Maintenance Drop 2 was typically received more than half way through the block construction period for Ship 1 for many blocks.

5.57 The Alliance CEO further informed the ANAO that:

> Despite the timing of the receipt of the Maintenance Drops, not all the change has affected production, as shown in [Figure 5.9]. This figure represents Alliance experience to a point of time and the impact on production. New emerging issues may have a much greater rework and schedule impact. Of all the change received and processed to date, it is estimated that 45 per cent has been accommodated in sequence, either by naturally aligning with the production schedule or as a result of the Alliance re-sequencing work to accommodate the change. Of the remaining change, less than 20 per cent is estimated to have resulted in rework, and 17 per cent is estimated to have had no impact at all.

280 See paragraphs 6.55 to 6.65 for examples of the kind of rework experienced during the construction of the first DDG.

Figure 5.8: Timing of block construction and of drawing revision deliveries, March 2009–November 2012



Source: AWD Alliance, October 2013.

5.58 Figure 5.9 shows the Alliance CEO's estimate of the impact of design change on the construction program.

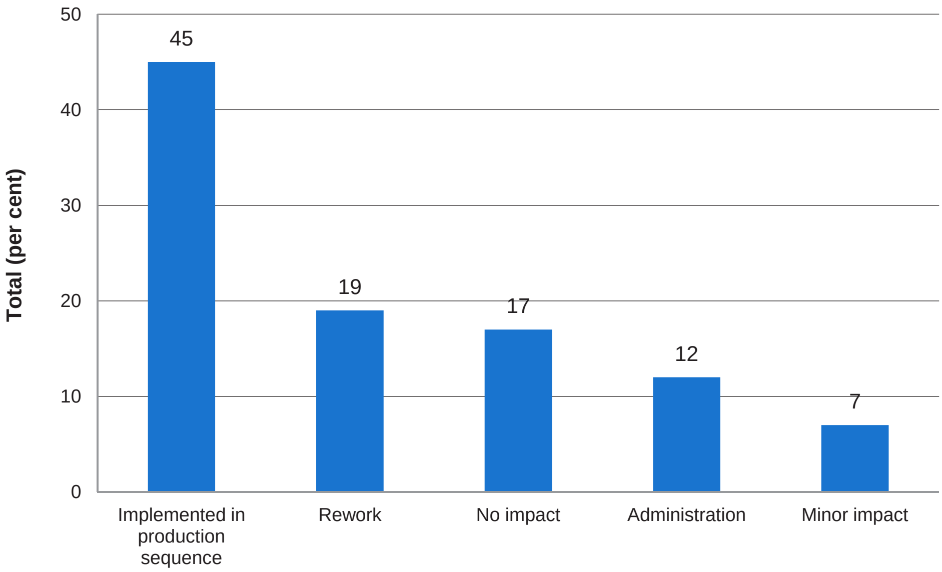
5.59 Navantia informed the ANAO that once a design drawing is delivered to the Alliance, it enters a process in which there are many approvals and reviews, such as configuration, engineering, and planning. This process is considered by Navantia to be lengthy. Navantia advised that this has created a backlog that has at times peaked at more than one thousand sheets.[281] Against

281 In its January 2014 response to an extract from this audit report, Navantia stated that it is 'fully convinced that the major driver for cost overruns and delays has not been the number of modification/revisions/errors/omissions […], but rather the deficiencies in the process and management of such issues, which in an experienced shipyard would have had a relatively small impact.' See page 3 of Navantia's comments to the ANAO, reproduced in Appendix 5.

The Alliance CEO informed the ANAO in January 2014 that the design drawing review process was new, instigated by the Alliance to manage the ongoing volume of design change being introduced, to mitigate its impact on production and to understand its impact so that the DMO could approve the change before implementation.

this background, there would be merit in Defence working with its Alliance partners and Navantia to review the design change management process, with a view to addressing the potential for any further backlogs.

Figure 5.9: Impact of design change (AWD Alliance estimates)



Source: AWD Alliance, October 2013.

Notes: These estimates are based on drawing counts and management judgement. They do not consider impacts on non-production activities, for example, planning.
In its January 2014 response to an extract from this audit report, ASC noted that 'The significant period between the initial drawing deliveries and the updated revisions being provided (12–24 months) has greatly exacerbated' the impact of design change in Ship 1. See page 3 of ASC's letter to the ANAO, reproduced in Appendix 3.

5.60 More fundamentally, under the Platform System Design contract Navantia does not have to pay compensation as a result of the timing or volume of Technical Data Package revisions. This is principally because the Technical Data Package was expected to be revised as the design matured and as Australian requirements were incorporated into it. However, this has also meant that there are reduced contractual incentives for Navantia to eliminate errors and omissions quickly.

5.61 As mentioned in paragraph 5.43, the RAND Corporation found in 2005 that the value of the change orders for military shipbuilding programs equated to eight per cent of the total vessel cost. While not providing a directly comparable figure, in October 2013 the Alliance CEO informed the ANAO that the volume of design change seen by production is above 20 per cent. The level of detailed design immaturity has also significantly exceeded what was expected at the time of Second Pass approval in 2007.[282] When considering these measures together with the various causes of design change, it is reasonable to expect shipbuilding programs to implement a range of timely management responses to address the associated risks, which are examined below.

The Alliance's response to Technical Data immaturity

5.62 If the Industry Participants consider that the Technical Data Package is inconsistent with the contractual specifications or otherwise deficient or defective, the Alliance contract requires them to report promptly to the DMO and to assist the DMO in resolving the matter, including by dealing with the Platform System Designer, if necessary.[283]

5.63 The Alliance has taken a range of actions to mitigate the impact of Technical Data Package issues and immaturity in the detailed design. Figure 5.10 provides a timeline that highlights key actions. It shows the Alliance and Navantia responding to immaturity in the detailed design and its implications for the production process over a four-year period.

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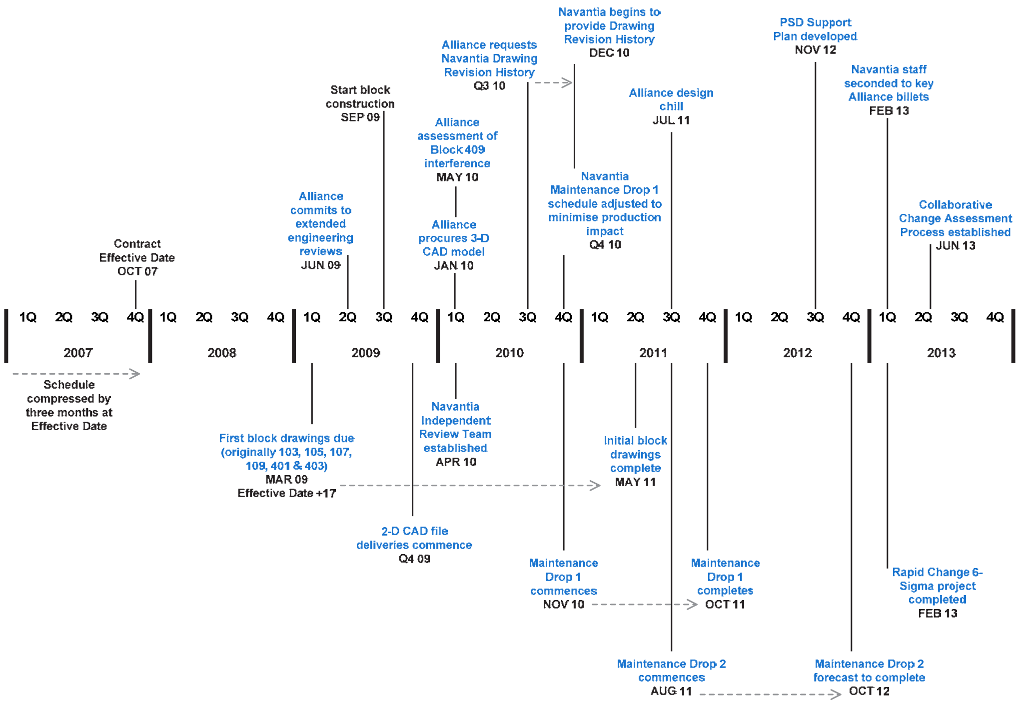
282 In his January 2014 response to an extract from this audit report, the Alliance CEO outlined his view of the headline considerations in relation to the detailed design; see page 5 of the Alliance CEO's letter to the ANAO, reproduced in Appendix 2.

283 Commonwealth of Australia, ASC AWD Shipbuilder, Raytheon Australia, *Air Warfare Destroyer (SEA 4000) Alliance Based Target Incentive Agreement, General Conditions of Contract,* clause 23.

Figure 5.10: Timeline of AWD Alliance actions to address detailed design immaturity



Source: AWD Alliance, June 2013.

Note: The Effective Date of the Alliance contract was 5 October 2007.

5.64 The key actions taken by the Alliance to address immaturity in the detailed design have included:

(a) In 2010 the Alliance Industry Participants decided to continue to build blocks without simply rejecting Technical Data Package supplies until they had reached the required level of maturity.[284] The Project Board approved this approach, considering that some block rework was normally expected in shipbuilding, and although the imperative to continue working might appear to not be an effective strategy, it was considered to have benefits. In October 2013, the Alliance CEO informed the ANAO that:

284 AWD Alliance Industry Participants, *Air Warfare Destroyer—SEA 4000-1180: Extension Claim and TCE Adjustment Claim, Annex D: Steps taken to minimise schedule delay*, 30 March 2012, pp. 2–3.

> Whilst some level of defects and deficiencies was detected by inspection, the majority were more insidious and either discovered in production or identified later by the Platform System Designer in the form of change.
>
> Original defects were tolerable and accepted with comments. The reason for continuing forward was made as a best-for-project decision to hold schedule and cost. The later introduction of change via Maintenance Drop 1 and the introduction of change by the Platform System Designer was a bigger problem. By then, block production was underway and the delivery schedule was fixed and 'insured' [for the Commonwealth] with Liquidated Damages.

In addition, in the Industry Participants' view, by working collaboratively with the Platform System Designer as contemplated by the Alliance contract and Platform System Design contract, and not triggering a contractual dispute that might have debilitating consequences for the program, the Industry Participants sought to ensure that the drawings were revised, at no additional cost to the Commonwealth, under the Platform System Design contract.[285]

At the time this strategy was adopted, the significance of the defects and deficiencies for production was not known. For example, the Industry Participants have stated that they were not aware, and had no reason to suspect, that completed interference checks[286] had not been conducted on the drawings by Navantia, nor were they aware that some production lessons learnt on the F-100 class had not been fed back into the drawings.

(b) Applying additional engineering review effort to the Technical Data Package deliveries, in order to isolate and assess the impact of construction drawing changes on production. This effort required an average of 20 full-time personnel for the duration of the initial block construction drawing deliveries from March 2009 to April 2011. Whilst

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285 Even though drawings may be revised under warranty, the cost of consequential block production rework is being borne by the Commonwealth as Direct Project Costs.

286 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.

these actions were successful in reducing the level of defects and deficiencies that were progressing into production, some defects were extremely complex, to the extent of being impossible to detect by drawing reviews alone. For example, drawing defects leading to clashes between structure and piping remained in drawings that had been passed to the AWD Alliance production team. It is also important to note that by early 2010 the Technical Data Package reviews could not be completed in the time available, as they had saturated the AWD Alliance shipbuilding engineering and planning departments' resources. This resulted in late releases of design drawings to ship production.[287]

For its part, Navantia established a review team which was intended to ensure that the quality issues from the Initial Block Platform Construction Drawing deliveries were not repeated. However, the review process also led to schedule delays (and additional unanticipated cost) by introducing another step into the delivery process, which delayed the release of drawings to the Industry Participants typically by 4–8 weeks. The Industry Participants also succeeded in having Navantia increase its design team in Australia by 14.

As at June 2013, the Estimate At Completion budget for engineering support was 125 000 hours, some 20 000 hours above the original estimate.

(c) Introducing Computer Aided Design (CAD) tools. In 2010 and 2013 the AWD Alliance purchased a basic version of Navantia's 3-D CAD model of the ship as an aid to visualising identified clashes and defects in the Platform System Design. The CAD model is used by the AWD Alliance's planning and production teams to clarify production queries and issues (often within a four to six-hour period), and if possible to reduce the number of queries raised with Navantia.[288]

Since July 2010, Navantia has also provided its team in Australia with remote access to its full 3-D CAD model of the Hobart-class DDG design. This enables Navantia to investigate design issues and queries

287 By mid-2010, the Alliance was not meeting the Platform System Design contract's Platform System Design data review time of 20 working days or less, as the Block Drawing reviews were typically taking two months, and four months for Non Block Related reviews.

288 For further discussion of 3-D CAD, see paragraphs 6.7 to 6.11.

within its office at ASC, using the 3-D CAD model. As a part of that effort, in February 2013, Navantia established a Design Approval Delegate within ASC to approve design changes (within his delegation), and to update the CAD model. Overall, the Industry Participants consider that the introduction of CAD tools and the Platform System Design Approval Delegate have delivered significant program benefits.

(d) Conducting schedule prioritisation. The Alliance established a Block Maintenance Drop release schedule that aligned, as far as practicable, with the production sequence for Ship 1, and released updated construction drawings to the Ship 2 program in its earlier stages of construction. The Alliance considers that, had this prioritisation action not been taken, the impact of Maintenance Drop 1 on Ship 1 would have been far greater. These schedule prioritisation efforts continued for Maintenance Drop 2.

(e) Processing change more efficiently, by working with Navantia to identify drawing changes early and to manage the change effectively at the block construction sites. This action included the deployment of three full-time planners from Bath Iron Works (Maine, USA) to Forgacs for three months to assist in mitigating the impact of the large number of piping-related design changes. These planners also worked with Navantia to enable the changes made in drawing updates to be quickly identified and their impact on production assessed.

(f) Introducing 'form, fit and function' assessments, to support technical, risk-based decisions on whether or not drawing updates are material to the design intent and therefore whether they necessarily need to be flowed to production or can be waived. This required close and timely collaboration and agreement between the AWD Alliance and the AWD Program Management Office to ensure that no unacceptable risk was introduced into the program.

(g) Better leveraging of Navantia's F-100 knowledge and experience. In November 2012, stronger links were created between Navantia's design team in Spain and the Alliance's production team in Australia. The role of Navantia's on-site resident team was expanded from providing a transactional support capacity to being fully integrated into the Alliance team. This included the appointment and secondment of Navantia personnel to Australia to the key Alliance positions of

Platform Design Manager, Build Strategy Manager, Ship Manager and Chief Test Engineer. The overall objectives of these initiatives include improving operational efficiency and providing greater assurance regarding the production schedule by:

– facilitating the interpretation of the platform design intent as expressed in the Technical Data Package;

– providing local platform design authority delegations in Australia;

– facilitating platform design baseline control in Australia;

– improving waterfront change agility;

– improving non-conformance management and build change lead times; and

– supporting whole-of-ship certification.[289]

(h) Establishing a Collaborative Change Assessment Process in June 2013. This process involved an assessment of the criticality of design changes (that is, whether individual changes are to be implemented or not, and how best to treat change that is to be released to production). The Alliance informed the ANAO that, although not yet fully adopted as at June 2013, this new step was 'already demonstrating close collaboration between the parties to manage both the volume and the impact of design change'.

5.65 As already noted, there has been more immaturity in the detailed design of the DDGs than expected. The AWD Program's ability to respond quickly to such issues was affected by a number of features of its original set-up, which have had to be addressed subsequently. These included: Navantia being outside the Alliance; not exploiting CAD/CAM from the outset; and not having a Navantia Platform Design approval delegate at ASC Osborne.

289 In the *2012–13 Major Projects Report*, the DMO acknowledged an emergent risk that 'The PSD contract may not provide the level of support that is required to complete ship construction in a timely and cost effective manner', and stated its remedial action as 'Establishment of ongoing design support services including construction design support and local design authority availability in support of Ship construction through to delivery of Ship 03'. ANAO Report No.12, 2013–14, *2012–13 Major Projects Report*, p. 157.

5.66 While the Alliance has taken a range of actions to address immaturity in the detailed design, this has occurred over a four-year period, during which time issues have continued to emerge, giving rise to significant redesign and rework during construction. Some of the key steps taken to better manage immaturity were not implemented until late 2012, and the Collaborative Change Assessment Process was being developed in June 2013.

5.67 It was not until November 2013, in the course of the audit, that the ANAO observed action in accordance with the Alliance contract provision outlined in paragraph 5.62 above as to how to deal with potentially deficient or defective design data. The Alliance advised the DMO that changes to keel block drawings received in 2013 as part of Maintenance Drop 3—after the completion of the keel blocks in 2012—indicated 'that the drawings received in 2009 were deficient and defective "resulting in an inability for the ship to function as specified"', and the DMO approached Navantia for its advice on the matter.[290]

5.68 In its November 2013 response to the DMO, Navantia advised the DMO that the only potential impacts of the revised drawings, in terms of ship functionality, were caused by engineering changes and contract amendments. Navantia also stated that only a very small proportion of piping in the blocks would be affected. Navantia did not agree with the Industry Participants' claim 'that the drawings received in 2009 were deficient and defective "resulting in an inability for the ship to function as specified"', noting its experience in successfully delivering the Spanish F-100 class of ships.

5.69 During the design phase of the AWD Program, the Alliance placed reliance on the expectation that Navantia's detailed design would not be subject to a large amount of revision. Further, the design reviews conducted during the build phase of the AWD Program (see paragraphs 5.18 to 5.26) did not examine Navantia's detailed design documentation. While the design change management process was one of the matters considered as part of the Production Readiness Review (see paragraphs 6.25 to 6.31), the Alliance has applied a long series of new strategies in order to address significant volumes of change in design documentation more efficiently and effectively. These factors highlight the need for Defence to ensure that the design change

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290 Air Warfare Destroyer Program Management Office, *Air Warfare Destroyer—Keel Block Pipework Changes*, AWD/OUT/2013/868, 6 November 2013.

management process is sufficiently robust in light of the anticipated and actual volume and timing of design change. Further, the anticipated level of design change should be based on project analysis and prior experience for similar projects.[291]

AWD Principals Council and Project Board consideration of Technical Data immaturity

5.70 The impact of design changes was discussed at the AWD Principals Council's February 2012 meeting, particularly with regard to Technical Data Package changes received through Maintenance Drops 1 and 2, which were received from November 2010 and August 2011 respectively (see paragraph 5.71). The minutes of this meeting recorded the CEO DMO's view that the issue of technical data immaturity was one for the AWD Alliance to resolve. He commented that the Commonwealth had made a significant investment in prior phases[292], and the Industry Participants had been given the opportunity to define and agree to the products provided by Navantia, and had been paid to do so. In addition, all parties had signed off as being able to execute the program, and the Alliance was paid to manage the Platform System Design contract, but not its terms and conditions.[293]

5.71 The AWD Principals Council's February 2012 minutes also noted advice from the CEO of the AWD Alliance that, amongst other things:

- the issue of the Technical Data Package and design change was the single largest program issue, and one of the root causes of the cost and schedule issues then being experienced;
- the AWD Program was seriously impacted by the quantity of late change to the Technical Data Package, particularly in Maintenance Drops 1 and 2;

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291 In the *2013–13 Major Projects Report*, the DMO acknowledged that the major challenges faced by the AWD Program include: 'achieving maximum productivity levels through efficient shipyard operation and change management'. ANAO Report No.12, 2013–14, *2012–13 Major Projects Report*, p. 150.

292 As noted in paragraph 2.6, the total expenditure on SEA 4000's prior phases was $262.501 million, which constitutes 3.1 per cent of the current $8.455 billion budget for all project phases identified in Table 2.1.

293 AWD Alliance Principals Council, meeting minutes, 20 February 2012, paragraph 17.

- the Alliance believed that the Maintenance Drops were intended for maintenance of the Technical Data Package to correct minor issues, and were not the mechanism to introduce large volumes of change; and
- the delay being experienced by the program to have corrections and lessons learned put into the drawings was stated to be 12 to 24 months.[294]

5.72 As at November 2013, the AWD Alliance Principals Council had not met for 21 months—since February 2012—and had not conducted further deliberations on the Technical Data Package issue. A further Council meeting that had been scheduled for October 2013 had to be postponed.

5.73 As a consequence of the design documentation issues outlined above, 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. This claim was subsequently considered by the Project Board, but the Board could not come to agreement on the claim, in that the Commonwealth member did not agree with the validity of the claim due to advice provided by the DMO. As at July 2013, the Industry Participants were considering their position on the matter.

5.74 In October 2013, the Alliance CEO informed the ANAO that:

> Whilst the Platform System Designer has worked diligently to correct the defects and deficiencies with the Technical Data Package, there is no clear [Alliance contract] provision to deal with consequential impact of the resulting changes. The resulting volume of rework and disruption to the sequence of work in production has been significant in terms of cost and schedule impact, particularly for ASC and its block subcontractors.[295]

Emergent design and construction issues

5.75 In October 2013, the Alliance CEO further informed the ANAO that:

> The program is entering the more complex outfitting and activation phase of the build. Key areas already underway include the engine rooms and

294 ibid., paragraph 16.

295 In its January 2014 response to an extract from this audit report, ASC contended that 'there are relevant contractual provisions dealing with this issue, which were the subject of considerable negotiation prior to execution of the [Alliance contract]. Noting that the claim with respect to the design remains unresolved, it is not appropriate for any party to comment further on this issue.' See page 4 of ASC's letter to the ANAO, reproduced in Appendix 3.

accommodation spaces. This phase of the build is typically where the more complex system-level design issues begin to manifest.

The program is managing a number of emergent technical issues some of which relate to the ongoing design change or will require future change to resolve. The issues include:

- Electrical system: cabling design, earthing and bonding, switchboards, hangers;
- Torpedo handling system;
- Water Mist system; and
- Keel block piping—Ship 1.

5.76 Further, in September 2013, the Chief Executive Officer of ASC publicly warned that ongoing design revisions might disrupt the delivery schedule, and that the 2017 schedule for delivery of Ship 2 was 'tight'.[296] Equally, he also publicly suggested lessons learned for Future Submarines, particularly related to the quality of design prior to production.[297]

5.77 As discussed in paragraph 5.70, the DMO has appropriately reminded the Industry Participants of their obligations. 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.

Conclusion

5.78 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

296 Sarah Martin, 'AWD program "plagued" by design changes', *The Australian*, 18 September 2013, p. 2.

297 Sarah Martin, 'Coalition facing troubled waters as it prepares to sink $250bn into naval shipbuilding', *The Weekend Australian*, 28 September 2013, p. 15.

requirements 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.

5.79 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.

5.80 The Alliance formed the view that the design-to-production process could operate effectively without Navantia providing extensive Lead Yard Services[298], 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.

5.81 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. This has involved Navantia providing a large number of revised design documents between 2009

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298 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.

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.

5.82 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.

5.83 The Alliance CEO informed the ANAO in October 2013 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.

5.84 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.

5.85 Irrespective of the extent and 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.[299] 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. 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.

299 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.

6. Build Progress

This chapter examines the progress achieved in building the DDGs, and the impact of design change. It also considers the build program's overall cost and schedule performance.

Introduction

6.1 Block construction forms the major part of the shipbuilding process, and so has significant implications for the success of the shipbuilding program, including its cost and schedule performance. Within the Alliance contract, Hobart-class DDG block construction and consolidation costs amount to $1.030 billion of the $2.198 billion (December 2006 prices) cost of constructing the three DDGs complete with their Combat Systems.

6.2 Both the AWD Alliance and the Platform System Design contracts require the Industry Participants to develop build strategies and production processes that will result in each DDG block complying with its build quality specifications. They are to undertake their work to the standards of a professional, skilled naval shipbuilder.

6.3 The DDGs are being built using a distributed-build method, with block construction taking place at four shipyards: ASC at Osborne; BAE Systems at Williamstown; Forgacs at Newcastle; and Navantia at Ferrol, Spain. The assembling, outfitting, equipment and systems installation, and test and acceptance activities are being undertaken at the Techport Australia Common User Facility at Osborne, South Australia.

6.4 Each DDG is comprised of 31 blocks weighing between 20 tonnes and 205 tonnes, which are fabricated and outfitted with systems and equipment, and then consolidated to complete the ship. In addition to providing work to a number of shipyards in different locations, this approach is intended to allow block building and outfitting to proceed independently and simultaneously in safer and more productive workshop environments, rather than on hardstands or on board the vessel when on slipways or afloat.

Design and design-to-production organisation

6.5 Shipyards involved in a shared-build strategy need to reach a detailed and common understanding of what affects the block interfaces and their integration. All aspects of modern shipbuilding are Information Technologyintensive, from detailed design drawings, parts databases, quality control and configuration management to build execution systems and business management systems. When multiple shipyards collaborate on distributed warship-building programs, timely data exchange is a crucial requirement as is effective coordination.[300]

6.6 In the AWD Program, ASC provides data and technical information to BAE Systems and Forgacs, and has management teams in those shipyards to manage each block construction subcontract. All subcontract block work is to be undertaken in accordance with work packs supplied by ASC, and these work packs include Navantia's Technical Data Package Category 1 and 2 information. The subcontracting shipyards may submit applications for deviations and waivers regarding compliance with the requirements of the Hobart Class Platform System Specification for the AWD Program Manager's approval.[301]

Computer Aided Design (CAD) and production

6.7 According to Navantia's System Engineering Management Plan for the Hobart-class DDGs, the construction drawings were to be created using the 'most modern 3-D CAD' tools, taking the Existing Design for the Spanish Navy's F-100 program as the basic reference. This process involves developing a 3-D model of the structure of each block or section, and then populating this model with 3-D models of the equipment and the distributed systems (piping, ducting, cabling and so forth) that are to be installed on the block.

6.8 In its April 2007 *Phase 2 Overall Program Report*, the DMO noted that Navantia used different 3-D CAD applications for general design and arrangements; hull structure design; and piping and Heating, Ventilation and Air Conditioning (HVAC). The DMO did not identify this as a matter of

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300 National Defense Research Institute, *Shared Modular Build of Warships: How a Shared Build Can Support Future Shipbuilding*, RAND Corporation, Santa Monica, 2011, p. 15.

301 In January 2014, Forgacs informed the ANAO that: 'A misinterpretation of the standards applicable to the AWD Program between the ASC onsite team and Forgacs created a paradigm of rigid adherence to the specification to such an extent that thousands of hours of extra work on rectification of these issues caused significant delays in the delivery of the blocks, cost overruns and quality issues as a result of damage caused by the actual repair effort. Recent acknowledgement of this misinterpretation has resulted in a collaborative 'gold standard' agreement between Forgacs and ASC of the application of the specification—especially with respect to the welding standard and block dimensional tolerances at the block mating edges—improving schedule and quality of the product at Forgacs, and significantly reducing cost'.

concern. However, in October 2013, the Alliance and ASC respectively informed the ANAO that:

> Various CAD tools were used by Navantia, but these were not integrated. As a consequence it is intrinsically more difficult to identify and resolve detailed design issues.
>
> The 3-D CAD models were in separate tools for each discipline, preventing basic interference and clash detection, which has now manifested itself as large amounts of rework in production, particularly in the piping discipline.

6.9 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. As discussed in paragraph 5.9, 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.

6.10 The immaturity in the detailed design experienced during ship construction led to the Alliance purchasing a basic CAD model from Navantia in February 2010.[302] This 3-D model does not provide full CAD capability, but it assisted production engineering and visualisation of production requirements. Until January 2013, the use of this 3-D model was limited by the Alliance having only 31 licences for the software. In January 2013, in response to ongoing production issues, an additional 3-D PDF model was purchased, and was made available throughout the shipyards as an aid in resolving production issues. Further, in February 2013, Navantia placed a design approval engineer at ASC Osborne to facilitate more timely resolution of design issues that are within his delegation (see paragraph 5.64(g)).

6.11 The DMO informed the ANAO that Alliance Production and Engineering teams are now able to more effectively isolate technical problems and issues, with the assistance of Navantia's on-site resident team. The purchase and use of the 3-D CAD model, and increased integration with Navantia, have been positive developments for the AWD Program, supporting more timely and effective resolution of design and construction issues. However, it would have been preferable to have applied suitable technology

302 As noted in Table 5.1 and paragraph 5.64(c), Navantia has also provided its team in Australia with remote access to its full 3-D CAD model of the Hobart-class DDG design since July 2010.

and expertise from the outset of the build program, particularly given the risks associated with exporting a design for the first time to a new shipbuilder.[303]

Recommendation No.2

6.12 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.

Defence's response: *Agreed*.

Dimensional accuracy requirements and control

6.13 In a distributed-build program such as the AWD Program, dimensional accuracy tolerance budgets are assigned to each block builder to ensure that blocks built at different shipyards and at different times will join together within tolerance.

6.14 The dimensional accuracy requirements for the construction of the structural elements of ship blocks are typically specified to be about half the thickness of the ship hull and deck plates. This allows tolerable pressures to be applied to the hull and deck plates to achieve an exact fit before the blocks are welded together. In the case of a ship with hull or deck plates that are eight millimetres thick, dimensional tolerance at the joins is four millimetres. In the case of major structural components, such as the ships' centre-line girders, and in particular the alignment of engine, gearbox and propeller-shaft mountings, the required dimensional tolerance is in the order of two millimetres or less.[304]

6.15 Achieving this degree of dimensional accuracy is extremely challenging in the DDG blocks, as they contain a mix of heavy and lightweight steel assemblies of varying thickness. These blocks require welding sequences that prevent metal distortion, which normally occurs as a result of metal contracting as it cools after the welding process. These welding sequences are determined via a mix of recommendations from welding engineers, and the knowledge and experience of workshop personnel. These requirements were

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303 In its January 2014 response to an extract from this audit report, Navantia stated that the Alliance's acquisition of 3-D models in 2010 was premature, and that it believed its support to the AWD Program through onsite and online access meant that the absence of 3-D models should not have constituted an inconvenience. See pages 4–5 of Navantia's comments to the ANAO, reproduced in Appendix 5.

304 Excessive misalignments may result in unacceptable stresses, leading to structural failure.

factored into the shipbuilding cost and schedule estimates agreed to by each shipyard.[305]

6.16 The shipbuilding accuracy requirements mandated in the Category 1 Technical Data Package are reflected in AWD block building contracts. If there is a deviation from the dimensional accuracy requirements, corrective actions can involve rework, or acceptance of the deviation, subject to approval by Navantia, the platform designer. This ensures that Navantia can fulfil its responsibility of providing a warranty that the Hobart-class DDG Platform System will, if constructed in accordance with the Category 1 Technical Data Package, achieve the function and performance requirements specified in the Hobart Class Platform System Specification.

Dimensional and Accuracy Control systems

6.17 In advanced manufacturing, the required accuracies are achieved through the use of Dimensional and Accuracy Control systems. Aligning distributed-build production practices requires each shipyard—in particular the block consolidation shipyard—to understand the differences in each shipyard's production processes, and how those processes will affect the achievement of specified dimensional accuracy. This is of particular importance at the interfaces of complex, outfitted blocks, where dimensional accuracy at key points in the block fabrication process is necessary to ensure that blocks can be accurately consolidated with the rest of the ship.

6.18 From the outset of the AWD Program, ASC, BAE Systems and Forgacs have conducted dimensional control activities based upon the use of:

- specified three-dimensional ship's coordinates that define discrete points on each ship's superstructure;
- use of Total Station theodolites to record three-dimensional ship's points; and
- use of a suite of Check Sheets, developed by ASC, to define and record ship's points.

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305 The Alliance CEO informed the ANAO that the dimensional control plan is that welding is done once. He also noted that, as soon as design change involving hot work is implemented, dimensional control becomes more difficult, as additional heat, applied by out-of-sequence welding, may introduce distortion that is difficult to correct.

6.19 In addition, since approximately late 2011, all three sites have used a standardised coordinate measurement system (CMS), to measure and record the position of the discretely specified measurement points on each block being built.

6.20 The suite of Accuracy Control Check Sheets is tailored for each of the 31 blocks, and is used to record compliance with design requirements at key stages of block construction and consolidation. These Check Sheets are submitted to ASC's Accuracy Control Team to confirm compliance with the requirements, and to detect any variations early in the production process.

6.21 The Alliance does not track statistical trends in dimensional accuracy because of the sample sizes involved and the variability in block complexity. The Alliance provided Check Sheet data for Blocks 409, 411 and 413 on Ships 1 and 2, and this data shows improvement in dimensional accuracy from Ship 1 to Ship 2.

Flexibility to manage minor design issues

6.22 In October 2013, Navantia informed the ANAO that it has sought to assist ASC to solve minor production issues, which can appear all through the construction of the ship, by developing a 'Threshold Document'. This document, requested by the Alliance, provides ASC Production with some flexibility to make decisions when ship functionality, performance and safety are not compromised. For example, the Threshold Document allows for changing the design to resolve minor clashes, in cases when those changes have no impact on the Technical Data Package Category 1 specification.[306] Navantia also informed the ANAO that this flexibility has not reached the production sites, which is where production issues are identified and where it would be most efficient to 'solve issues on the spot'.

6.23 Navantia stated that the Alliance's production process does not provide convenient delegations to approve any deviation from the Technical Data Package, even when it is within the thresholds established in the Threshold Document. Navantia considers the production process to be overly complex and time-consuming, in that it involves: calling the Alliance Liaison Team;

306 The Threshold Document authorises variations from the design in the order of 50–150 mm, depending on the location. Such design changes are expected to be documented by the shipyard in 'red line' and 'as built' drawings.

raising a Problem and Issue Report (PIR); sending it to the Navantia Resident Team; receiving an answer to the PIR; the Alliance Liaison Team documenting the answer; and gaining approval to implement the PIR solution. Navantia noted that, by the time the PIR answer is received by ASC Production, complete with work orders, some weeks have passed.[307]

6.24 As discussed at paragraph 5.59, subject to the effectiveness of recent Alliance strategies to deal with design changes more efficiently, there could be merit in Defence working with its alliance partners and Navantia to review the design change management process, with a view to addressing the potential for any further backlogs.

Production Readiness Review and commencement of construction

6.25 The organisational requirements for shipbuilding design-to-production, outlined in the previous section, highlight the importance of a Production Readiness Review (PRR) to demonstrate, before production begins, that:

- manufacturing processes or materials, or the requirements for manufacturing development effort, satisfy design requirements; and
- the following systems/processes are ready to commence production: planning, facilities allocation, incorporation of producibility-orientated changes, identification and fabrication of tools, test equipment, long-lead-time acquisitions, and so forth.

6.26 The Alliance PRR Plan (first issued in June 2009) noted that the platform design and most major Combat System equipment items were based upon existing designs, and this had allowed production planning to be advanced in parallel with the development of the designs. The plan involved the assessment of the maturity of the Production Baseline documents and data,

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307 In his January 2014 response to an extract from this audit report, the Alliance CEO stated that 'Limited local authority is delegated to the Shipbuilder through the 'Thresholds Document' provided by Navantia (noting that this document was sought by the Alliance and negotiated in the period September 2009 to January 2012). The document provides limited delegation and the most effective treatment of TDP issues has been through the resident Navantia Liaison team and the focus on priority resolution of Technical Queries (TQs) through the Navantia design support network. With effect January 2014, a total of 5,409 TQs had been directed to Navantia with 71% of the 1,295 requested 24 hour responses being satisfied.' See page 5 of the Alliance CEO's letter to the ANAO, reproduced in Appendix 2.

as well as the risk of design change impacting the Production Baseline. It also noted that processes for controlling risk exposure due to design change needed to be in place.

6.27 The AWD Program's PRR was scheduled for July 2009, in time for the commencement of block construction in September 2009. This system-level PRR was held on 27 August 2009. The review panel was informed that there was no clear date by which the design would be stabilised (referred to as a production baseline freeze), because changes needed to be considered case-by-case. Nevertheless, the view of the Alliance was that there was a well established process to manage design change. The PRR Report noted:

> general agreement that despite some threats of future rework and potential delays to some later block deliveries, there is no reason not to proceed to production of the early keel blocks as planned. It was noted that there are other 'gates' prior to committing blocks to production at which decisions could be made to delay if the impact of potential change was viewed as high enough to warrant it.[308]

6.28 ASC informed the ANAO in January 2014 that the PRR assessed Navantia technical data, and discovered that additional effort was required to convert it into a usable format for each shipyard. ASC also stated that critical operational processes were evaluated during the PRR, including ASC's ability to use technical data in production, and to manage technical problems discovered when construction was underway.

6.29 ASC, BAE Systems and Forgacs then tested their readiness to commence block construction by building pilot blocks. The pilot blocks enabled the testing of data packages, work orders, material supply, manufacturing processes and the production workforce. At the end of the pilot program, a PRR was conducted by the Alliance in each shipyard to confirm that the shipyards were ready to proceed into full production. The results of the PRR process were as follows:

- BAE Systems passed its PRR on schedule in November 2009 and commenced block production in December 2009;

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308 AWD Alliance, *AWD System PRR Meeting Minutes*, 27 August 2009.

- ASC delayed its formal PRR to accommodate preparations for the BAE Systems PRR. ASC subsequently successfully passed its PRR and commenced block production in December 2009; and
- Forgacs passed its PRR and commenced full production on schedule in March 2010.

6.30 ASC informed the ANAO in January 2014 that Forgacs did not initially pass its PRR primarily because its pipe manufacturing facility was not ready, and approval for Forgacs to commence production was delayed until March 2010 as a direct result of the PRR.[309]

6.31 The PRRs 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 the technical data (discussed in the previous chapter), facilities and personnel were in place and ready to begin production.

6.32 The following sections examine the block construction and rework issues in more detail.

Build sequence management

6.33 To achieve shipbuilding efficiency within cost and schedule budgets, the shipbuilding process needs to follow an optimal construction sequence. This approach calls for designing and building ships using block construction concepts that allow block construction, outfitting and acceptance testing to be completed in each shipyard. This minimises the work to be performed once the ship is in the water, which tends to be costlier than completing tasks on land.

6.34 Shipbuilders plan to install the ship's systems into each block prior to block consolidation (integration) in order to improve construction efficiencies. If equipment is not ready in time for installation into each block, the shipbuilder will have to work around the missing equipment. Once units are installed, access to internal ship compartments becomes more difficult.

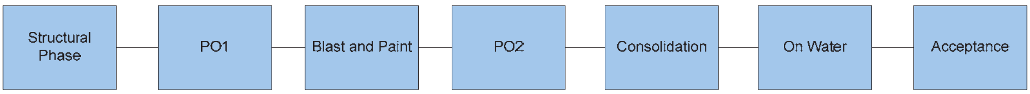
309 Forgacs similarly informed the ANAO that the Forgacs shipyard had been engaged in building 'haul pack' truck bodies for mining operations after the cessation of naval ship construction work in the nine years prior to AWD project signature, and as such had lost much of its shipbuilding capacity, equipment serviceability and knowledge. Forgacs also stated that the logistics capacity of its shipyard to store and protect ship material was insufficient to meet the requirements of the AWD Program.

Additional labour hours will be needed, because spaces will be less accessible and equipment will require more time for installation.[310]

6.35 Build sequences are detailed in shipbuilders' Integrated Master Schedules, which link all of the detailed construction tasks based on Key Event Dates, on a block-by-block basis. At the time of the audit, the AWD Alliance's Integrated Master Schedule was being adjusted as part of the Integrated Baseline Review process in order to take account of schedule changes and any rework necessary for each block (see paragraphs 6.81 and 6.84–6.92).

6.36 Figure 6.1 shows the block construction sequence adopted by the AWD Program, for each individual block.

Figure 6.1: Block construction sequence



Source: AWD Alliance.

6.37 Details of the sequence are as follows:

- Structural Phase: building the structural shell segments of the ship that form the hull;
- Production Outfitting Stage 1 (PO1): this is the phase of outfitting a block prior to abrasive blasting and the application of protective coatings. It includes all 'hot work' (such as cutting and welding) and all installations that can be done before abrasive blasting, such as piping, pipe penetrations, cableways, ducts, foundations and supports. PO1 is conducted with the block upside-down to enable easier and safer metal work, especially welding;
- Blast and Paint: the block is grit blasted to bare metal, and protective coatings are applied;
- Production Outfitting Stage 2 (PO2): this is the phase of outfitting a block after abrasive blasting and painting. It includes all 'cold work' that can be done on a block before the block is moved to the

310 US Government Accountability Office, *Defense Acquisitions: Cost to Deliver Zumwalt-Class Destroyers Likely to Exceed Budget*, Report to the Subcommittee on Seapower, Committee on Armed Services, U.S. Senate, GAO-08-804, July 2008, p. 9.

Shipbuilding Hardstand for joining with the rest of the vessel. PO2 includes some equipment installation, cabling, insulation and lighting;

- Consolidation: joining the blocks together to form the completed hull and connecting systems (where appropriate, blocks are joined to form a grand block before being consolidated onto the ship);
- On water: the final stage of outfitting, preparing the ship for habitation; and
- Acceptance: handover to the DMO.

6.38 Figure 6.2 shows the interior of one block during its PO2 phase.

Figure 6.2: Hobart-class DDG Block 407 during its PO2 phase, May 2013

Source: AWD Alliance, May 2013.

6.39 By January 2014, block production was well advanced at all four shipyards. 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 undergoing PO1 and PO2 fit-out. BAE Systems was continuing the structural consolidation, PO1 and blast-and-paint of Ship 3 blocks, while the acceptance process for Ship 3 keel blocks built by Navantia was under way. Figure 6.3 shows the future HMAS

Hobart under construction in October 2013, and Figure 6.4 shows the status of block construction as at January 2014.

Block construction issues

6.40 As discussed earlier, the production strategies and processes used to build steel blocks need to take into consideration distortion of the steel structures, which is inevitably introduced during the welding of steel plate and beam elements. The development of those strategies and processes requires skilled production engineers, dimensional control and monitoring specialists, and welding specialists to consider wide-ranging variables related to the material properties, dimensions and configuration of the steel assemblies to be welded.

6.41 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.

Initial block construction issues at BAE Systems

6.42 Block 107 of Ship 1 was the first Hobart-class DDG block to be constructed by BAE Systems. This keel block was complex, required precise dimensional control, and was a challenge for a shipyard that had not constructed such a complex block since the 1993–2006 Anzac-class and 2005–07 Project Protector ship construction programs.[311] This block was also subject to accelerated production to recover time lost due to the later-than-expected signing of the block construction subcontracts.[312]

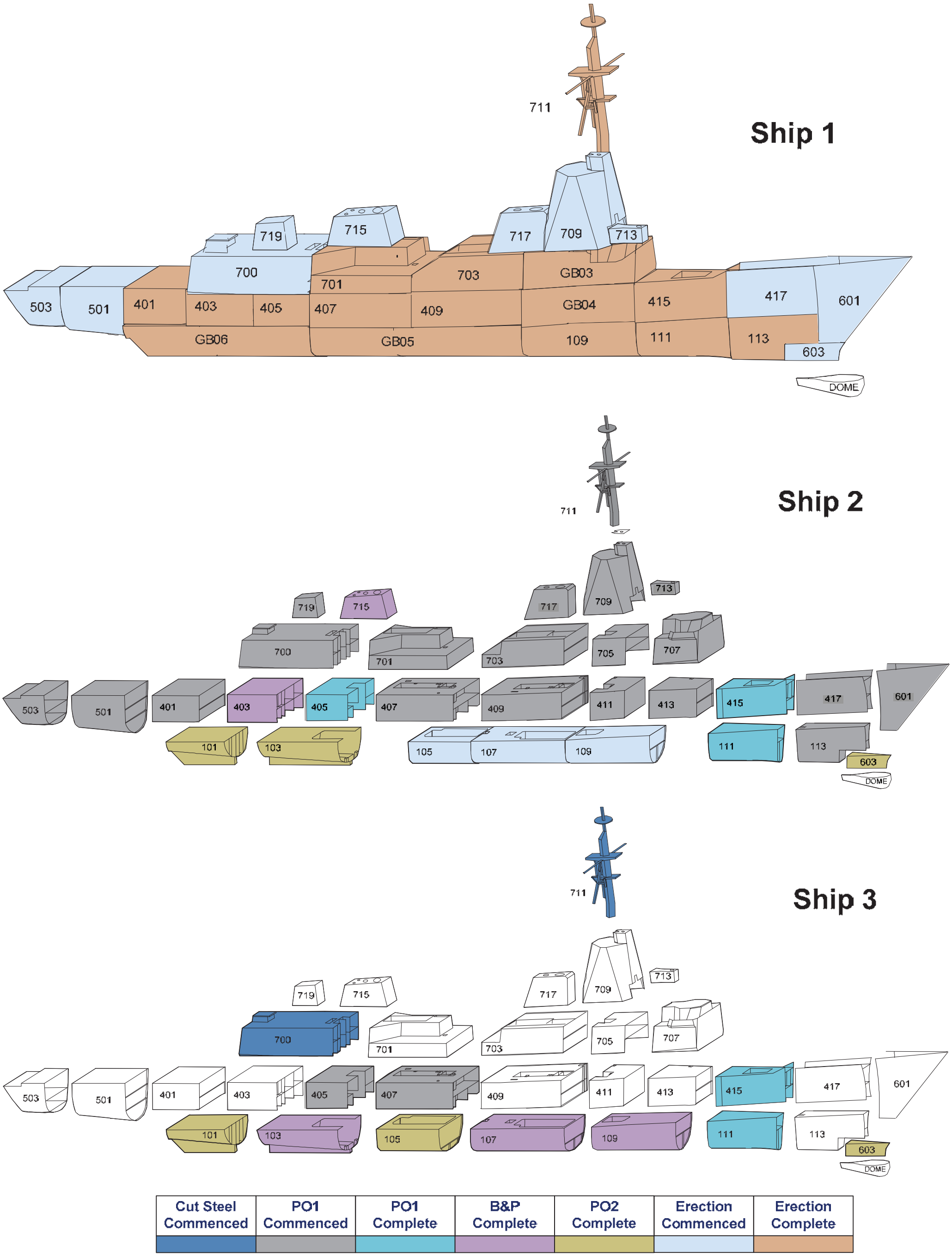
311 New Zealand's Project Protector program produced two offshore patrol vessels (OPVs), which have been operated by the Royal New Zealand Navy since 2010, as well as other ships. The OPVs are named HMNZS *Otago* and HMNZS *Wellington*.

312 In October 2013, ASC informed the ANAO that the BAE Systems subcontract was late to signature because of the financial issues at NQEA Australia Pty Ltd in the closing moments of the block tender process.

Figure 6.3: The future HMAS *Hobart* under construction, October 2013

Source: ASC.

Figure 6.4: Ship construction status for Ships 1–3, as at January 2014



Source: AWD Alliance, January 2014.

Note: PO1 and PO2 are discussed in paragraph 6.37.

B&P: Blast and Paint.

6.43 On 7 May 2010, a routine inspection by ASC quality inspectors revealed defects in Block 107. BAE Systems was notified that Block 107 was out of dimensional tolerance and that the overall block was distorted. BAE Systems formally advised ASC in August 2010 that distortion encountered during the fabrication of Ship 1, Block 107, Sub-block 66 was likely to delay the production schedule for a number of blocks.[313] The AWD Alliance then advised the AWD Program Management Office, in September 2010, of a Delay Event as defined by the Alliance contract.

6.44 Defence advised the then Minister for Defence on 25 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

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313 BAE Systems stated that the potential for significant distortion of the sub-block was inherent in its design. The sub-block was extremely densely populated with stiffeners, girders and pipes, leading to a high density of welded joints. The welding design made the sub-block more susceptible to distortion by using single-sided, full-penetration welds on thick panels (up to 16 mm), requiring approximately twice as much heat to be put into the plate compared with a double-sided weld. The hardness of the DH36 steel used in the design made the sub-block more prone to heat-induced distortion, compared with AH36 steel.

Distortion of Block 107, Sub-Block 66 (107SB66), which exceeded design tolerances, was attributable to the build methodology employed, which did not compensate adequately for the distortion potential inherent in the design. Compensating or mitigating factors not present in the build strategy included, in order of significance:

- employing a build sequence that included shell plates being welded together 'off-block' and then installed to the frame as a blanket and, more generally, employing a build sequence that saw large sections of 107SB66 being welded off-block so as to minimise heat input to the plate, as advised by the Platform System Designer, Navantia;
- the use of a cambered construction jig (in lieu of the flat jig actually used) to offset the expected distortion, as advised by the Platform System Designer in discussions in early May 2010; and
- the use of weld sequences tailored to suit the 107SB66 design.

In the absence of weld sequences tailored to the AWD Program, generic weld sequences were employed by BAE Systems based, initially, on its experience with the Anzac Ship Project methodology. Subsequently, and in response to ASC's Problem and Issue Report No. 2117, BAE Systems developed and implemented a procedure for Control of Distortion and Welding Sequences, for use specifically with the AWD platform. BAE Systems stated however that—in the absence of the other compensating or mitigating factors listed above—no weld sequence would rectify the high level of distortion observed in 107SB66 in any appreciable way.

BAE Systems Australia, *SB0002C—Offsite Block Subcontract—Notice of Delay Event—Ship 1 Blocks 107 non-conforming Customer Furnished Material (CFM) resulting in out-of-tolerance distortion of B107SB66*, letter to ASC AWD Shipbuilder, 30 August 2010.

organisations'.[314] The consequent delay became a matter of public record on 26 October 2010.[315]

6.45 In May 2011, Defence advised the then Minister that concurrent work on the Landing Helicopter Dock ships (LHDs)[316] and DDGs at the BAE Systems Williamstown shipyard had stretched the shipyard's capacity, so that, if no action was taken to relieve the pressure on the BAE Systems shipyard, the first DDG would be two years late.

6.46 During this period, the then Ministers for Defence and for Defence Materiel were involved in discussions with BAE Systems management in both Australia and the United Kingdom.[317] BAE Systems subsequently added more experienced personnel to its Williamstown management team, including some brought from the United Kingdom.

6.47 The first three blocks constructed by BAE Systems, which had been affected by the production difficulties leading to dimensional inaccuracies, were ultimately delivered to ASC in August and September 2011.[318] Defence informed the ANAO that, following their delivery, ASC undertook corrective action on these blocks to ensure that they (and all other blocks) were consolidated in accordance with recognised standards and requirements[319], and the Hobart Class Platform System Specification.

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314 In its January 2014 response to an extract from this audit report, BAE Systems stated that 'Whilst we agree with the statement in the report that a lack of sufficiently experienced shipbuilders was a significant cause (certainly BAE Systems as a responsible contractor needed to and did take action on its shortcomings including using reach back and additional hiring to bring in additional experienced resources), it was not the only cause. There were design issues, issues with data provided to BAE Systems and issues with inexperience on the part of our customer for the blocks [ASC] as well.' See page 1 of the BAE Systems letter to the ANAO, reproduced in Appendix 6.

315 *The Australian* newspaper published a report about the AWD production difficulties on 26 October 2010. Cameron Stewart, '$8bn navy flagship founders after construction bungle', *The Australian*, 26 October 2010, p. 1. Defence advised the Minister of the problems the day before this article was published.

316 HMAS *Canberra* and *Adelaide*.

317 The Hon. Stephen Smith MP, Minister for Defence, *Changes to Air Warfare Destroyer construction program,* media release, Canberra, 26 May 2011.

318 The Hon. Jason Clare MP, Minister for Defence Materiel, *First keel block delivered for new Australian warship*, media release, 18 August 2011; the Hon. Jason Clare MP, Minister for Defence Materiel, *AWD—Another two blocks delivered*, media release, 27 September 2011.

319 International Association of Classification Societies, IACS No.47 – *Shipbuilding and Repair Quality Standard*, and International Standards Organisation, ISO 13920 – *General Tolerance for Welded Construction*.

AWD Alliance reallocates BAE Systems blocks to other shipbuilders

6.48 From late 2010 to early 2012, the AWD Alliance reallocated blocks from BAE Systems to the other shipyards, with a view to reducing the anticipated two-year delay on each of the three ships by up to 12 months.[320] Defence advised the then Minister in November 2010 that the reallocation of blocks from BAE Systems to Forgacs was not a punitive move by the Alliance, but was based on a need to reduce the risk of further cost and schedule overruns:

> Construction work in the BAE Systems shipyard for the amphibious ships (LHD superstructure) and AWDs will require 19 blocks or sub-blocks being fabricated in parallel (according to Alliance–BAE Systems discussions). There are five AWD blocks being fabricated at present. The block reallocation plan developed by the Alliance and BAE Systems technical teams aims to reduce the risk of project management workload, shipyard facility constraints and skilled workforce demand, as well as allow the BAE Systems workforce to concentrate on completing higher levels of outfitting in the remaining nine blocks.

6.49 On 28 February 2011, as part of its response to the production difficulties outlined above, BAE Systems proposed a new operational schedule, following a review and replanning of its Williamstown shipyard operations. However, the Alliance Project Board rejected the reschedule proposal. Instead, the Alliance negotiated a reduced scope of block work with BAE Systems, and the scope of the block contracts with Forgacs and Navantia was expanded.

6.50 The progression of the block allocations arising from the AWD Program's difficulties is shown in Figure 6.5. The figure includes the May 2013 reallocation of four blocks from Forgacs to BAE Systems, which recognised 'that BAE Systems has the capacity and skill to successfully take on an increased share of the workload'.[321]

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320 The Hon. Stephen Smith MP, Minister for Defence, *Changes to Air Warfare Destroyer construction program*, media release, Canberra, 26 May 2011.

321 The Hon. Stephen Smith MP, Minister for Defence, *2013 Defence White Paper. Naval Shipbuilding. Release of the Future Submarine Industry Skills Plan*, media release, 3 May 2013.

6.51 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.[322] In December 2013, three more blocks were reallocated from Forgacs to BAE Systems.[323]

6.52 The current block construction allocation for the three Hobart-class DDGs is shown in Figure 6.6.

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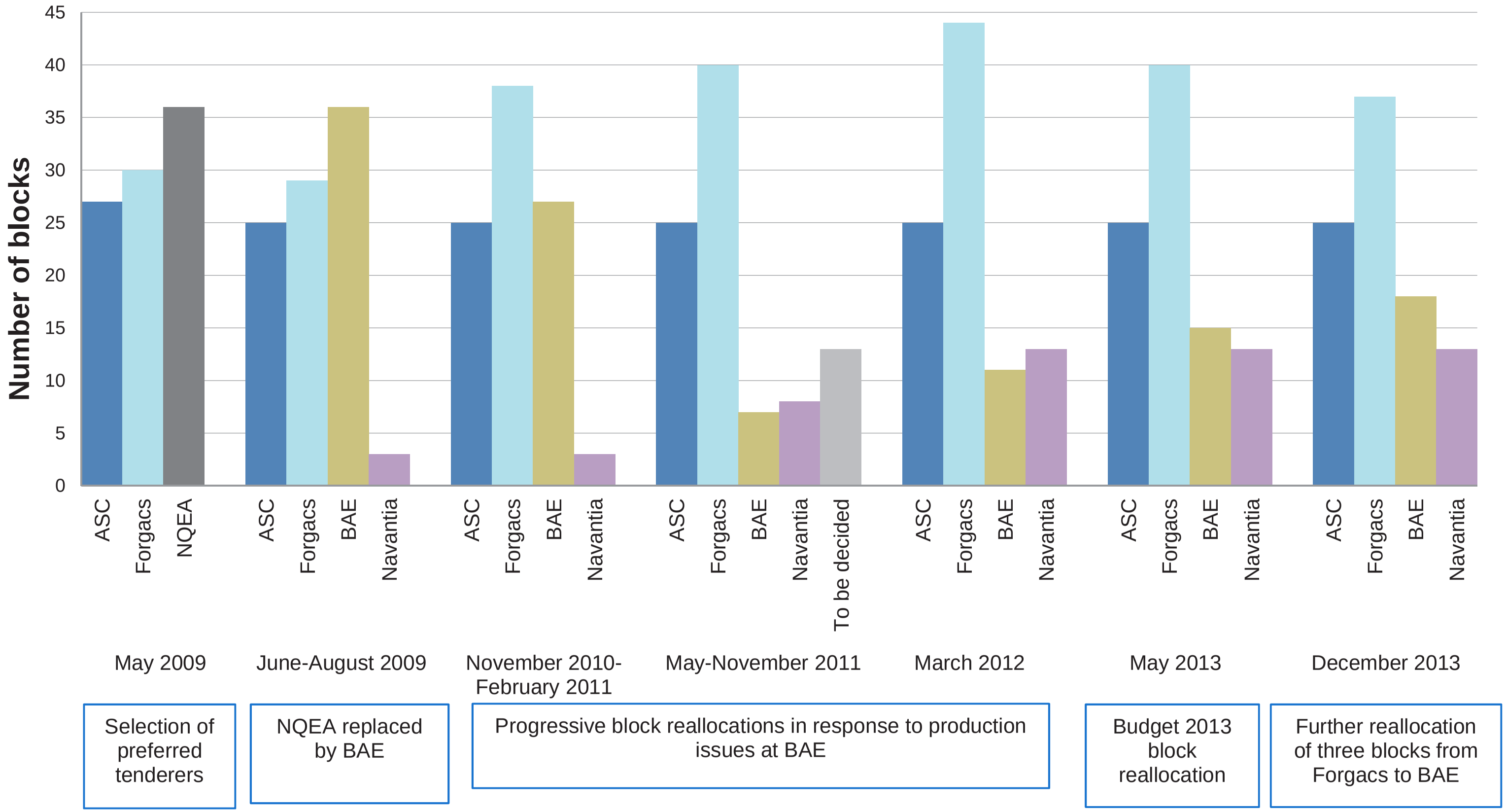
322 Media reports in November 2013 stated that 'Forgacs is having major problems with its blocks'. See for example Ian McPhedran, 'Minister's concern at $8 billion destroyer project', *The Advertiser*, 18 November 2013, p. 4. The CEO DMO also advised a Senate Estimates hearing in November 2013 that reallocation of some blocks might take place. Senate Foreign Affairs, Defence and Trade Legislation Committee, *Estimates Hansard*, 20 November 2013, p. 86.

In its January 2014 response to an extract from this audit report, Forgacs stated that 'many of the facilities, cranage 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.' See page 1 of the Forgacs letter to the ANAO, reproduced in Appendix 7.

Separately, Forgacs informed the ANAO that immaturity in detailed design has caused significant rework as well as schedule and administrative cost in the production of the Forgacs assigned blocks. Specifically, the technical effort required to interpret the ASC-supplied drawings has taken many extra hours of effort to provide work packs to the construction workforce that could be built to print. Additionally, as errors were discovered in the source documents as a result of this production activity, the resultant new drawings and consequent rework of blocks has caused further delays and cost.

323 In its January 2014 response to an extract from this audit report, BAE Systems stated that 'the Blocks reallocated during 2013 were offered and contracted on a fixed price, fixed schedule subcontract that results in lower cost and lower risk to ASC than if they had been reallocated under the original subcontract. This is the result of improvements in productivity and quality that come from having a continuity of work that allows a shipyard to increase and then maintain its experience and capabilities and therefore, should be given considerable weight in the overall audit conclusions and recommendations.' See page 2 of the BAE Systems letter to the ANAO, reproduced in Appendix 6.

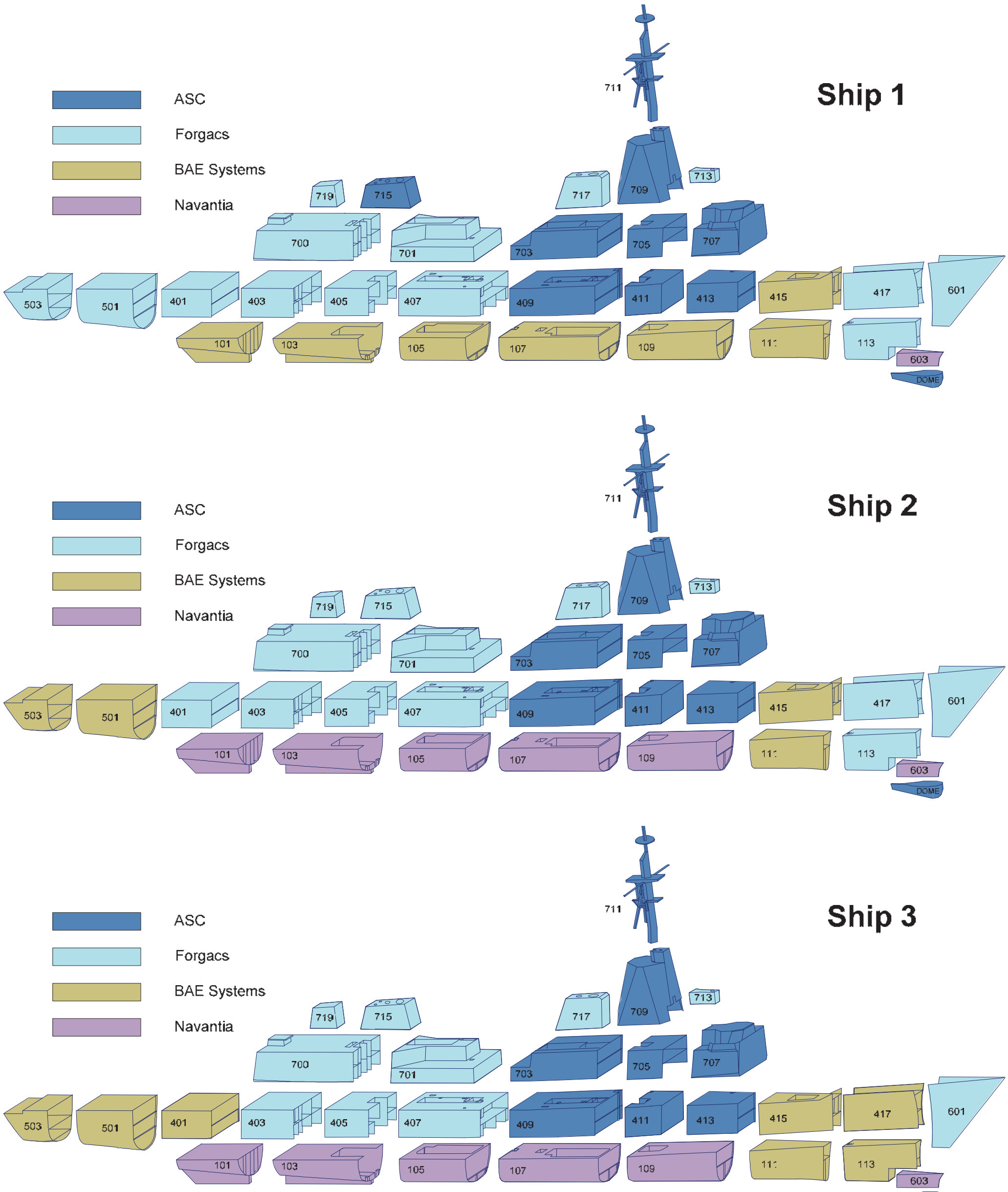
Figure 6.5: Numbers of DDG blocks allocated to shipyards, 2009–13



Source: AWD Program Management Office.

Note: These figures do not include the three sonar domes, supplied by Tods (UK), which will be incorporated into the sonar blocks (Block 603) being constructed by Navantia.

Figure 6.6: Specific DDG blocks allocated to shipyards, as at January 2014



Source: AWD Alliance.

Note: The ASC allocation includes the three mast blocks (Block 711), which ASC has subcontracted to MG Engineering, Adelaide.

Production capacity and capability issues

6.53 In June 2011, some of the underlying capacity and capability issues facing Australian shipyards were described by an Alliance Project Board paper as follows:

> During Phase 2 of the Program, industry and government operated on the shared assumption that the Australian shipbuilding industry in general had the core management, programmatic and technical skills required to execute major warship construction programs, and that potential subcontractors to AWD had sufficient financial capacity, facilities and commercial appetite to develop capabilities necessary to win and execute contracts for significant portions of the AWD hull block production.
>
> This perception was based on the registrations of interest received from interested companies, which included detailed capability statements and previous contract histories. This view was reinforced by the endorsement of various state governments to the work being placed with nominating companies, and the commitment to provide successful bidders with practical support.
>
> During the 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.
>
> In practice, the number of companies able to fulfil all of the technical and contractual requirements to take on the work was limited, the source selection was consequently protracted, and a late decision was made to place work with BAE Systems when Queensland-based company NQEA Pty Ltd was unable to provide the necessary financial securities.[324]

6.54 One implication of this frank assessment of the state of Australia's shipbuilding capability at the beginning of the AWD Program is that the premium for an Australian build of the ships, estimated at around $1 billion in 2007, may have been underestimated.

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324 AWD Alliance, *Schedule Replan*, Project Board paper, 16 June 2011, p. 2.

In a similar vein, the then Deputy CEO DMO had advised a Senate Estimates hearing in May 2011 that his 2007 advice to government on the likely complexity and time issues of the AWD project, and the capacity of BAE Systems, was wrong. Senate Foreign Affairs, Defence and Trade Legislation Committee, *Estimates Hansard*, 30 May 2011, p. 119.

Block production rework

6.55 In 2010, the Alliance Project Board decided that, rather than rejecting Technical Data Package supplies until they had reached the anticipated level of maturity, a better strategy would be to continue working and consequently allow some defects and deficiencies in the Technical Data Package supplies to progress into production. As noted in paragraph 5.64(a), 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.

6.56 Immaturity in the Technical Data Package ultimately required production rework of the kind shown in the following figures, which illustrate the impact of design immaturity in the areas of piping and doorways. Many other areas of the ship have been similarly affected by piping changes, as well as by other design changes, such as equipment mounting and electrical cable rearrangements.

6.57 It is important to note that not all design changes that resulted in block production rework have been initiated by Navantia.[325] Changes to the F-104 design necessary to incorporate the Australianised Combat System involved the installation of approximately 70 combat-system and sub-system elements in almost all compartments throughout each ship. These design changes required some block rework after the PO2 and consolidation stages, as a result of the delivery of late or incomplete Vendor Furnished Information (after PO1 completion) that affected the design (Vendor Furnished Information is discussed in paragraph 5.42).

6.58 As at June 2013, rework on blocks in Ship 1 had involved extensive amounts of time and materiel. For example:

- after Ship 1 Block 703 had completed the PO2 phase, the impact of Maintenance Drop 2 was that the block required an additional 2028 hours of rework, involving hot work (that is, welding) of piping, heating, ventilation and air conditioning assemblies. Also, a contract amendment (Contract Amendment Proposal 41) resulted in an

325 As discussed in paragraph 2.29, these related to the incorporation of Australian capability requirements and F-105 design elements into the Hobart-class DDGs.

additional 8554 hours of hot work, involving the installation of alternate 440-volt power outlets; and

- similarly, Ship 1 Block 409, having completed the PO2 phase, required an additional 8666 hours of hot work after Maintenance Drop 2. This involved equipment foundations, structure, piping, heating, ventilation, air conditioning and electrical work. Further, a contract amendment (Contract Amendment Proposal 40) imposed an additional 1931 hours of hot work, involving foundations for combat system equipment. Two further contract amendments affected electrical, piping, heating, ventilation and air conditioning.

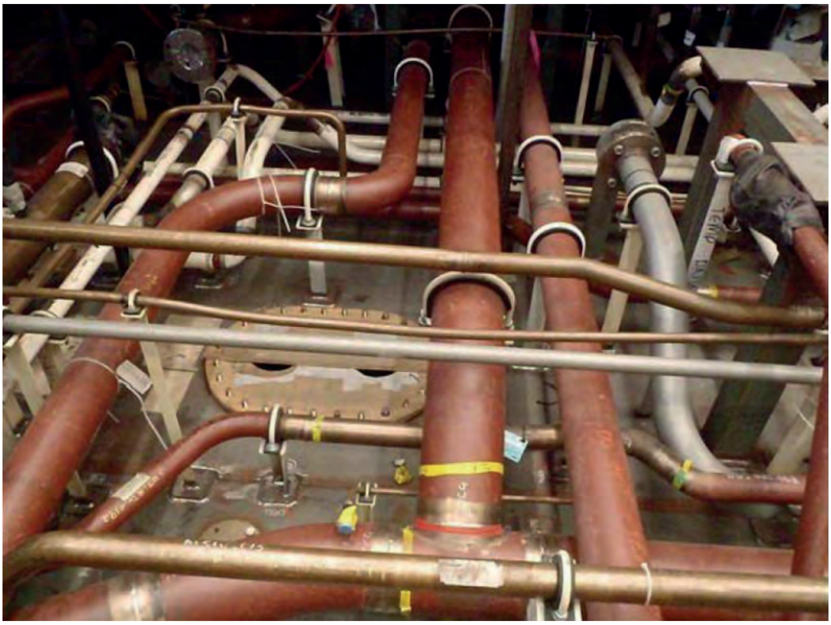
6.59 In summary, reworking two of the 31 blocks in Ship 1, as described above, required ASC to conduct an additional 21 179 hours of hot work. Additional activity required to complete the rework will include painting and restoration of any affected outfitting, such as electrical cabling, and re-testing of welds.

6.60 Figure 6.7 shows an example of the extensive amount of rework in Ship 1 pipe production and installation that was caused by changes in the detailed design late in the PO1 production phase.

6.61 Figure 6.8 shows Ship 1 rework caused by changes in the detailed design during the PO2 production phase. Rework occurring during this phase is particularly costly because it increases personnel injury risks due to the need to install and weld pipes in the overhead position. It also increases the risk of damage to surrounding installations, and requires the compartment to be reinspected for specification compliance, and repainted.[326]

326 The Alliance CEO and the ASC informed the ANAO that Figure 6.8 also shows the view plate (structure), which needed to be replaced twice, introducing hot work that impacted half the breadth of the block.

Figure 6.7: Piping system rework—Block 107 during PO1 phase



Source: AWD Alliance, March 2012.

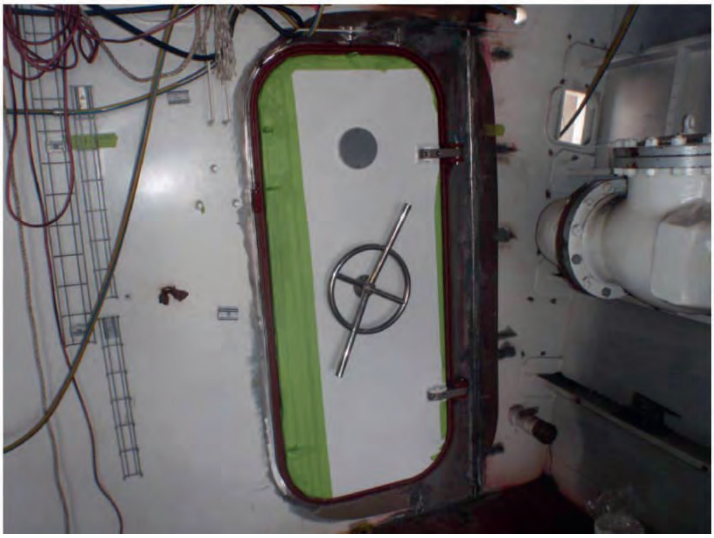
Note: Unpainted pipe has been subjected to rework.

Figure 6.8: Piping system rework—Block 407 after block consolidation

Source: AWD Alliance, March 2012.

6.62 Figure 6.9 shows an example of the extensive amount of relocations of watertight doorways caused by changes in the detailed design during the PO2 phase in Ship 1. Many doorways throughout the ship were moved by approximately 150 mm from their original position, to enable the doors to open to a minimum of 90 degrees, in line with Australian safety regulations.[327]

Figure 6.9: Rework on doorways to provide a minimum 90-degree opening



Source: AWD Alliance, March 2012.

Note: The doorway has been moved 150 mm to the left of its original position.

6.63 Figure 6.10 shows some of the large number of pipe spools that have required replacement, either because of the procurement of pipe that did not meet specifications, or because of changes in the detailed design during the PO1 and PO2 phases. In the first case, a supply-chain failure led to the installation of defective pipes into the ship.[328] Navantia informed the ANAO that it assisted the Alliance by endorsing a design change, so that only 570 pipes were replaced after 2000 had been inspected. The replacement pipes include higher-specification copper nickel pipes that comply with military specifications that relate to dimensional requirements, materiel properties, traceability and quality control requirements. The exception to this design

327 The Alliance CEO informed the ANAO that 'This change should have been treated before the TDP was issued to the Alliance.'

328 ASC lodged an insurance claim to cover the costs associated with defective copper pipe.

change was the retention of copper pipes within the ships' potable water systems. More broadly, changes in the detailed design have led to large-scale replacement of pipes during construction of Ship 1.

Figure 6.10: Pipe waste in temporary storage at ASC

Source: AWD Alliance, March 2012.

6.64 As a result of the production rework discussed above, the Alliance has experienced production cost overruns across multiple blocks, predominantly during the PO2 stage and Ship 1 block consolidation. Cost overruns have continued for Ship 2, during the Structural and PO1 phases, due to the inclusion of design change, associated rework and labour instability as additional labour has been applied to Ship 1. Cost overruns have also resulted from the need to erect blocks with reduced levels of outfitting in order to meet the consolidation schedule.

6.65 Under the Alliance contract, the Industry Participants are not directly liable for the cost of the rework they carry out. 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 (see paragraph 3.30) in that they impact on the Industry Participants' Fee. Also, the time taken to conduct rework reduces the Industry Participants' ability to qualify for additional incentive Fees that are linked to Provisional Acceptance of a DDG being achieved earlier than the Key Target Date for Provisional Acceptance[329]; furthermore, the time needed to conduct rework increases the Industry Participants' exposure to the Alliance contract's liquidated damages regime (see paragraph 3.65).[330]

Combat system development

6.66 In Australian defence projects, large, complex and software-dependent equipment such as a ship or submarine combat system is normally the source of the greatest risk and the majority of problems. To mitigate the Hobart-class DDGs' combat system development risks, the government decided that the ships would be equipped with an Aegis Weapon System very similar to those fitted to the US Navy's DDG-51 destroyers. That system consists of the AN/SPY-1D(V) 3-D radar, a Mk 41 Vertical Launching System for missiles, and combat system computers, consoles and displays.

6.67 The Aegis system, and associated systems engineering support, is being acquired from the US Government through a $1.22 billion Foreign Military Sales (FMS) agreement, from numerous suppliers. Lockheed Martin, as the US Navy's Combat System Engineering Agent (CSEA), has been responsible for the integration and testing of the core components of Aegis, which is conducted at the US Navy Sea System Command's Combat System development facility at Moorestown, New Jersey, USA. The cost breakdown for the Aegis Weapon System FMS case is shown in Table 6.1.

6.68 Raytheon Australia is responsible for the planning, specification, design and final integration of the Australianised Combat System, which comprises an upgraded Aegis Weapon System and additional Australian elements to meet specific capability requirements.

329 Provisional Acceptance of each DDG is to be granted by the Commonwealth if the DDG complies with the Alliance contract's requirements, subject only to Minor Defects and other Defects (identified through the conduct of verification and validation activities) that the Commonwealth does not require to be rectified.

330 In the *2012–13 Major Projects Report*, the DMO acknowledged that the major challenges faced by the AWD Program include: 'managing the level and timing of changes to the production baseline to minimise production rework'. ANAO Report No.12, 2013–14, *2012–13 Major Projects Report*, p. 150.

Table 6.1: Aegis Weapon System cost breakdown

Budget item	Price (US$ million)
Administrative Charges	36.6
AEGIS System, Support Equipment and Spares	693.3
Program Management	10.0
Technical Assistance	426.4
Technical Documentation	21.2
Training	22.9
Transport	9.5
Total	1219.9

Source: AWD Program Management Office.

6.69 The Aegis Weapon System sits at the core of the combat system architecture. The other subsystems are dispositioned by functional groups, for example, navigation, communications and information systems, very-short-range air defence, and so forth. These other functional groups interface with Aegis to a greater or lesser extent, but they are not Aegis subsystems. These systems are being acquired from Original Equipment Manufacturers, and they communicate with the Aegis core through the newly designed Australian Tactical Interface.

6.70 The Australian Tactical Interface has been adopted and designed to mitigate combat-system development risks by:

- preserving the integrity and certification basis of the existing Aegis Weapon System;
- eliminating the need to change existing equipment interfaces;
- eliminating the need to create a divergent RAN Aegis baseline; and
- reducing total ownership cost risks by enabling the implementation of Australian upgrades and enhancements.

6.71 The combat system integration commenced in 2010 at product vendor sites in Europe, as well as at the US Navy's Sea Systems Command facility mentioned above. Integration testing is also now occurring in the Australian Combat System Through Life Support Facility at Macquarie Park, Sydney; and at Raytheon's Communications Integration Facility at Osborne, South Australia.

6.72 The Hobart-class DDG Combat System installation and set-to-work program is at a relatively early stage, and has not been examined in this audit.

Construction cost-and-schedule performance

6.73 In all major production projects, there are a number of tasks such as planning, estimating, monitoring and controlling tasks—related to finance, personnel and material resources—that are needed to maximise project outputs at minimal cost. In the context of warship building, these tasks become more complex as the size and distribution of shipyard organisations and their work scope increase.

6.74 Any loss of visibility of the progress of work affects management's ability to intelligently control engineering, personnel, materials, facilities and schedule achievement. This will often result in construction cost increases and schedule slippage. Responsible managers can rectify production problems quickly before they become critical, if they are aware of the status of personnel resources and work progress in a timely manner. Under such circumstances, management can assign logical priorities to solving various production problems, and ideally new techniques can be developed, applied and evaluated to improve shipyard production methods.

6.75 Phase 3 of the AWD Program uses five principal processes to assess progress:

- milestone achievement;
- Earned Value Management System metrics[331];
- development metrics;
- technical reviews that follow systems engineering standards; and
- verification and validation of hardware and software progress, based on an approved test and evaluation program.

Earned Value Management

6.76 In the AWD Program, Earned Value Management (EVM) is used as the predominant system for integrating all progress measurement processes, to

331 The Earned Value Management System is also referred to as a Cost and Schedule Control System (CS2).

arrive at a holistic measure of the acquisition project's performance in terms of cost, schedule and technical achievement. The implementation of an Earned Value Management System (EVMS) is a recognised function of cost estimating, planning and scheduling, and the follow-through of program management. It ensures that the cost, schedule and technical aspects of the contract are truly integrated. The US Department of Defense guidelines on the use of an EVMS represent a framework for an integrated management system that:

- plans the timely performance of work;
- budgets resources;
- accounts for costs, and measures actual performance against plans; and
- replans resources needed to complete the contract when significant deviations from plans are identified.[332]

6.77 The AWD Alliance uses an integrated EVMS based on the systems used by Raytheon and ASC.[333] The AWD Alliance's Business Services Cross Product Team (see paragraph 3.51) compiles the Earned Value data to produce monthly EVM reports. These reports are aligned to the Industry Participants' accounting periods, and are delivered 15 working days after the month-end cut-off date. The EVM reports provide the basis for reporting the program's progress, in terms of cost and schedule performance, to the AWD Project Board, and to the one-star Program Management Stakeholder Group.[334]

6.78 The EVMS data also provides the basis for authorising progress payments, including Fee payments.[335] The accuracy of that system, particularly regarding its function of providing full disclosure of actual costs (Actual Cost of Work Performed), is critical to safeguarding the Commonwealth's interests and managing the pain-share gain-share arrangements over the life of the Alliance contract. Consequently, the AWD Program's EVMS needs to be accepted and validated as being consistent with guidelines adopted by the

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332 US Department of Defense, Defense Contract Audit Agency, *DCAA Contract Audit Manual*, July 2011, Vol. 2, Section 11-201.

333 Data from BAE Systems, Forgacs and Navantia is incorporated into the Earned Value Management System used by ASC and Raytheon.

334 The Alliance's Business Services Cross Product Team also provides the program's cost and schedule performance data to the Alliance's Integrated Product Teams and Cross Product Teams.

335 See discussion of the Fee arrangements, beginning at paragraph 3.29.

DMO, in the interest of the program maintaining accurate progress reporting and financial management.

6.79 At the time of the audit, the work under contract that was needed in order to complete the AWD acquisition project was factored into the AWD Program's EVMS in the form of 14 571 individual work and planning packages scheduled for completion by 2019. Of these, 7855 work packages with a value of $3.016 billion had been completed by November 2013, 1693 work packages were open and 5023 packages were yet to be opened. The open work packages were comprised of 400 at Raytheon, 1113 at ASC, 47 at BAE Systems, 75 at Forgacs and 58 at Navantia.

6.80 Payments for progress achieved on work packages are made on the basis of a reimbursement of defined Direct Project Costs and the payment of a Fee determined by performance against the Target Cost Estimate. ASC and Raytheon provide a Tax Invoice to the AWD Program Management Office each month, which identifies the amount of Direct Project Costs incurred during the previous month.

EVMS certification and Integrated Baseline Review

6.81 The Alliance contract has a number of Key Target and Event Dates. The first of the Key Event Dates required the Industry Participants, within nine months after the contract was signed, to submit to a formal on-site Integrated Baseline Review, as described in Table 6.2, and this was completed in June 2008.[336] By October 2008 (12 months after contract signature), the Industry Participants were required to have established, and be maintaining, an EVMS that complied with requirements defined in Australian Standard AS 4817-2006, *Project performance measurement using Earned Value*, and the *Defence Supplement to AS 4817-2006*.

336 Commonwealth of Australia, ASC AWD Shipbuilder, Raytheon Australia, *Air Warfare Destroyer (SEA 4000) Alliance Based Target Incentive Agreement*, Attachment 6 – *Statement of Work*, Clause 3.2.5.

Table 6.2: Integrated Baseline Review

An Integrated Baseline Review (IBR) is a technical and schedule review, focusing on the assignment, definition, scheduling and resourcing of work (including budgets), thus establishing early visibility into the acceptability of the Contractor's contract planning. Where the contract provides for payment by earned value, the IBR also reviews the methods and metrics used to measure contract performance. Where a Contractor is using an already validated EVM system, the IBR is used as a streamlined approach to assessing the acceptability of the Performance Measurement Baseline on new contracts. The objectives of the IBR are to: (a) ensure that the complete scope of work is covered in the Contract Work Breakdown Structure; (b) assess whether the technical scope can be accomplished within cost-and-schedule baseline constraints, and whether resources have been appropriately distributed to the contract tasks; (c) assess whether there is a logical sequence of effort that supports the contract schedule; (d) identify areas of risk in resource allocations and in the technical performance of the contract, and understand the cost and schedule implications of that risk; (e) assess the validity and accuracy of the Contractor's baseline by examination of at least one Cost Performance Report or Cost Schedule Status Report; and (f) develop Project Office understanding of the Performance Measurement Baseline, resulting in a better appreciation of the Contractor's performance management process and the methodologies used to measure performance.

Source: Defence Materiel Organisation, *Integrated Baseline Review Handbook, DMH(Proj) 11-0-002*, January 2010.

6.82 With respect to the work of subcontractors, unless otherwise agreed by the Project Board, the EVMS requirements in the Alliance contract apply to any subcontract or group of subcontracts requiring work in excess of twelve months where the subcontract prices exceed:

(a) $50 million—for military off-the-shelf products with development content; or

(b) $20 million—with significant development effort; or

(c) $10 million—for software development work, or systems integration work.

6.83 However, Government Furnished Material—such as the Aegis Weapon System acquired by the Australian Government through the US Government's Foreign Military Sales program—is not included in the AWD Program's EVMS.

AWD Program rebaseline

6.84 In September 2012, Defence and the Industry Participants commenced the task of rebaselining the AWD Program's construction schedule to incorporate a 15-month delay to Ship 1 and an 18-month interval between the Provisional Acceptance of each of the three ships (see paragraphs 1.20 and 1.21). A Schedule Change Request made by the Alliance in September 2012 was incorporated into the Alliance contract by a Contract Amendment Proposal (CAP) approved by Defence in December 2012.[337]

6.85 In order to complete the AWD Program's rebaseline, the program's EVMS and associated Contract Master Schedule have to be aligned to the agreed changes in the delivery schedule. Consequently, during the first half of 2013, the AWD Alliance was recalculating the build program's cost Estimate At Completion[338], and was examining the remaining plans, work scope and resources necessary to complete the build. The Estimate At Completion recalculation was due to be completed in August 2013.

6.86 As at August 2013, the AWD Program rebaseline had progressed as follows:

- Revised Alliance Key Event Dates were agreed and provided to the Alliance teams in September 2012, with instructions that the Performance Measurement Baseline's projected cost-and-schedule estimates were to reflect the program working to these new dates.
- The schedule baseline was updated during 2012, and the Cost Estimate to complete this schedule extension was presented to the Alliance CEO and the Project Board at the fourth-quarter 2012 Estimate At Completion review.
- The cost to move the program to the new schedule dates would have resulted in an unfavourable increase to the Estimate At Completion, and consequently, on advice from the Project Board, was not approved by the Alliance CEO.

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337 For example, for Ship 1, the new Key Event Dates inserted into the Alliance contract were:

9 December 2013	Complete Hull Integration;
1 December 2014	Start Combat System Light Off; and
10 August 2015	Commencement of Category 5 Trials.

338 Estimate At Completion is the estimated cost of the build program—that is, the out-turn cost.

- Teams were required to investigate how to reduce costs against their fourth-quarter 2012 Estimate At Completion estimates, and put forward these proposed cost reductions to the CEO at the first-quarter 2013 Estimate At Completion review.
- Following on from this, the Alliance's Control Account Managers were requested to incorporate the cost reductions into their second-quarter 2013 Estimate At Completion, which was the next comprehensive Estimate At Completion undertaken and presented to the Alliance CEO and Project Board for approval.
- Once approved, the second-quarter 2013 Estimate At Completion was intended to form the final Cost position for the budgeted work remaining against the revised schedule dates.
- The Integrated Baseline Review was to be conducted on the Performance Measurement Baseline for the remaining work by August 2013.

6.87 The Integrated Baseline Review, arising from the September 2012 program reschedule, was intended to result in a restoration of confidence in the AWD Program's cost and schedule estimates, and was initially to be completed by May 2013. Despite Project Board concern that the Integrated Baseline Review was critical as a means of baselining work and budgets, and that progress was not able to be accurately measured in the interim, the May 2013 target was not met.

6.88 On 2 October 2013, Defence informed the ANAO that the Integrated Baseline Review had not been completed, and that a final report was expected in 'September/October 2013'.

6.89 However, on 9 September 2013 the AWD Alliance had completed an Integrated Baseline Review report that contained 18 Major and 30 Minor Corrective Action Requests that were to be ready for closure by 1 November 2013. The report found that there were 'significant problems with the baseline' for the Alliance's Integrated Product Teams for Pre-Production, Production and Support, and that 'the current Program Estimates To Complete and schedule [were] at risk of failure despite the work done at Q2 2013 Estimate At Completion reviews'.[339] The report concluded that:

- It was […] particularly evident in Production that disconnect existed between the amount of work the Control Account Managers had planned to complete (particularly in the near term) versus the amount of resources available […];
- many issues need to be addressed prior to acceptance of the Performance Measurement Baseline […];
- the AWD Program faces challenges but is in the process of implementing what should prove a reliable management and reporting system suitable for the scope of work being undertaken for the Program.

6.90 The Integrated Baseline Review Team was of the view that the Production baseline as presented was 'challenged from a cost and schedule perspective'. A second Integrated Baseline Review of the Production stream was recommended after completion of corrective action activities. The team also found that the Performance Measurement Baseline was 'very success-oriented and does not allow for the probability of rework due to "first of class" problems', and that the issues of rework and unbudgeted scope had 'the potential to impact [on] budget and [on] ability to effectively manage work scope'. The Forgacs subcontract (see also paragraph 6.51) was not reviewed during this process.

6.91 Among the Major Corrective Action Requests raised by the Integrated Baseline Review were:

- ensure all scope is budgeted prior to work commencing (Business and Services, Pre-Production and Production Integrated Product Teams);
- in light of significant problems[340], amend the cost and schedule baseline in order to accurately reflect an achievable forward plan for the production program (Production Integrated Product Team);

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339 Air Warfare Destroyer Alliance, *2013 Integrated Baseline Review Report*, 9 September 2013, pp. 3–6.

340 Including design change, left-off work from block subcontractors, rework, defect rectification or lack of material availability, as well as inaccurate forecasts of labour requirements, and a medium to high level of uncertainty in Estimate At Completion projections in the order of 20–50 per cent in some instances.

- consider replanning more complex activity with interim milestones (Production Integrated Product Team)[341];
- conduct more training in use of the Earned Value system (Business and Services, Pre-Production, Production and Support Integrated Product Teams).

6.92 Overall, 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.[342] 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.

Performance Measurement Baseline

6.93 The AWD Program's EVMS provides a Performance Measurement Baseline, which 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).

6.94 The remainder of this chapter contains statistics and graphs drawn from the AWD Alliance's EVMS as at September–November 2013. However, in light of the finding of the September 2013 Integrated Baseline Review, as outlined in the preceding section, that 'many issues need to be addressed prior to acceptance of the Performance Measurement Baseline', there are some doubts as to the quality of the data presented, and therefore there is reduced confidence in the AWD Program's cost and schedule estimates.

6.95 Figure 6.11 shows the Alliance's cumulative cost and schedule performance. From June 2008 to November 2013, the AWD Program's EVMS

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341 Currently, a number of Production work packages are shown as 40 per cent complete upon commencement, with the remaining 60 per cent accredited once the work package is completed; the Integrated Baseline Review suggested that this is an appropriate methodology only when a work package takes less than two months to complete.

342 Defence informed the ANAO that five Major Corrective Action Requests were outstanding as at January 2014.

showed the Alliance's Actual Cost of Work Performed (ACWP or Actual Costs) trending above the Budgeted Cost of Work Performed (BCWP or Earned Value).[343] During the same period, the Alliance's Budgeted Cost of Work Performed trended below the Budgeted Cost of Work Scheduled.[344] As at September 2013, the expenditure on the Alliance contract had reached $3.129 billion, and on the basis of the EVMS data for work budgeted and performed to that point in time, the Alliance was some:

- $196 million or 6.3 per cent over budget (as against $80 million or 3.2 per cent in September 2012); and
- $60 million or 2 per cent behind schedule (as against $52 million or 2.1 per cent in September 2012).

6.96 Detailed analysis of the Alliance's cost and schedule performance data shows that the Alliance's over-budget costs have steadily increased since September 2010, and its behind-schedule performance has been largely steady at around 2 to 3 per cent.

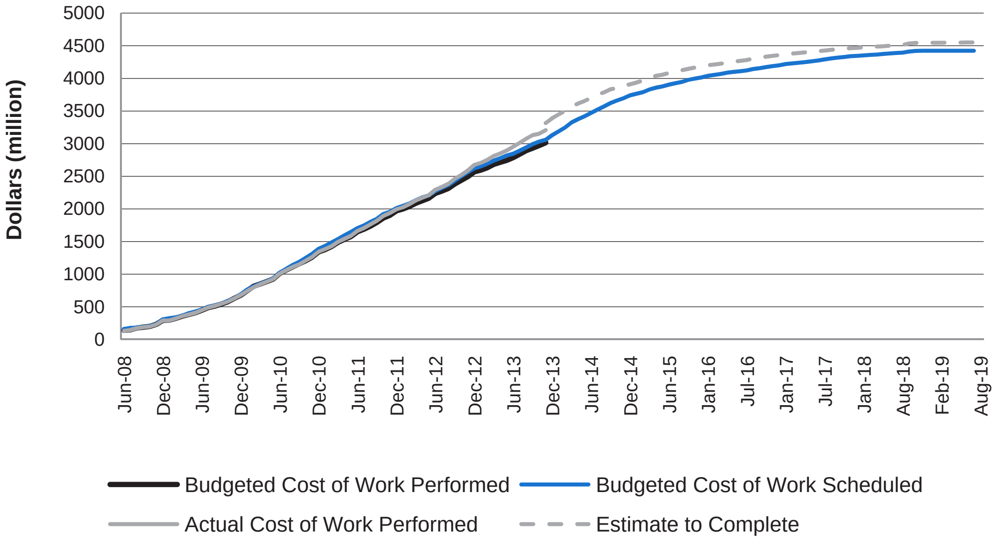
6.97 The causes of these performance trends include:

- In terms of work scope, the AWD Program's ship construction work scope has increased over time, due to unanticipated immaturity in the Platform System technical data. This work scope instability has not been contained within the allocated budgets for schedule and cost.
- In terms of the cost of block production, productivity is yet to reach expected levels, partly because industrial capability and skills development have not increased as quickly as anticipated, and partly because of the increases in work scope outlined above.

343 In other words, the amount of the budget actually spent on the work scheduled at that time exceeded the budget allocated to that work. Therefore progress occurred at a greater cost than was estimated.

344 In other words, the value of work completed at that time was less than the budgeted cost of work scheduled. Therefore schedule progress occurred more slowly than was estimated.

Figure 6.11: AWD Alliance's cumulative cost and schedule performance, June 2008–November 2013



Source: AWD Alliance, November 2013.

Note In the light of 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. The Alliance CEO informed the ANAO in January 2014 that future unplanned detailed design change cannot be accurately scoped, costed and scheduled, and is therefore not included in the Estimate At Completion.

Earned Value Variance at Completion

6.98 The AWD Program's EVMS is used to forecast the difference between the DDG build program's Budget at Completion (BAC or budget allocated to the build program) and its Estimate at Completion (EAC or the estimated cost of the build program—that is, the out-turn cost). Based on the EAC conducted in December 2013 by the Alliance's Control Account Managers (see Figure 6.11), the AWD Program's EVMS indicated that the Alliance contract would be completed for $4.611 billion. Following assessment of risks, opportunities, estimating uncertainty and schedule delay, the total cost to complete the program was judged to be $4.776 billion, which is $302 million or 6.8 per cent over the program's Target Cost Estimate. This variance includes $27 million costed for work that has not yet been formally approved by contract amendments.[345] Following the completion of the Integrated Baseline Review report in September 2013, the Alliance was to recalculate this estimate, taking into account progress in closing out the corrective actions arising from the Integrated Baseline Review.

6.99 In December 2013, in the *2012–13 Major Projects 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.[346]

6.100 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.

Industry Participant cost and schedule performance

6.101 Since June 2008, the AWD Alliance has provided the AWD Program Management Office with monthly EVM reports that document the individual contractors' progress in terms of the value of work accomplished with respect to Alliance budgets authorised by the Alliance CEO, and Alliance schedules approved by the Alliance CEO. When considered together, the value of work accomplished and the time taken to achieve that value provide a direct indication of each contractor's productivity.

Combat System–Systems Engineering

6.102 As outlined in paragraph 3.20, Raytheon, as the Combat System–Systems Engineer, is responsible for the design, equipment, component acquisition and integration of the Combat System. This includes coordinating the activities performed by the US Navy and Lockheed Martin in supply of the Aegis Weapon System, within the broader scope of the engineering activities required to deliver the Hobart-class DDGs' Combat System. The budget allocated to combat system development is $1.159 billion (December 2006

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345 On a different measure, during 2012–13, as previously reported by the ANAO, the AWD Program exceeded its financial-year budget allocation by $106.4 million as a result of increased Direct Project Costs from the Industry Participants for labour, materials and sub-contract costs. ANAO Report No.12, 2013–14, *2012–13 Major Projects Report*, pp. 147, 151.

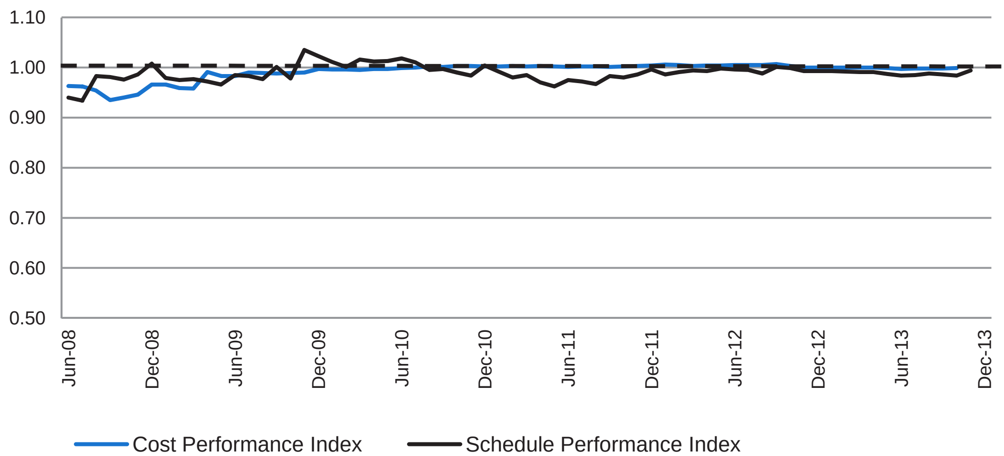
346 ANAO Report No.12, 2013–14, *2012–13 Major Projects Report*, p. 143.

prices). However, Government Furnished Material—such as the Aegis Weapon System acquired by the Australian Government through the US Government's Foreign Military Sales program—is not included in the AWD Program's EVMS.

6.103 Figure 6.12 shows Raytheon's overall Cost Performance Index (CPI), which is derived from the ratio of the Budgeted Cost of Work Performed (Earned Value) and the Actual Cost of Work Performed (Actual Cost).[347] A CPI of greater than one means that the accomplished work is under budget, while a CPI of less than one means that the cost of completed work is over budget.

6.104 Figure 6.12 also shows Raytheon's overall Schedule Performance Index (SPI), which is derived from the ratio of the Budgeted Cost of Work Performed (Earned Value) and the Budgeted Cost of Work Scheduled (Planned Value).[348] An SPI of greater than one means that the work accomplished is ahead of schedule, and if it is less than one, the work was performed behind schedule.

Figure 6.12: Raytheon Australia AWD Program cumulative cost and schedule performance indices, June 2008–November 2013



Source: AWD Alliance, November 2013.

6.105 As at September 2013, when some 69 per cent of the budget for the DDGs' Combat System–Systems Engineering work had been expended, Raytheon's cost efficiency was 1.0 or 100 per cent, and its schedule

347 Cost Performance Index = BCWP/ACWP or Earned Value/Actual Cost.

348 Schedule Performance Index = BCWP/BCWS or Earned Value/Planned Value.

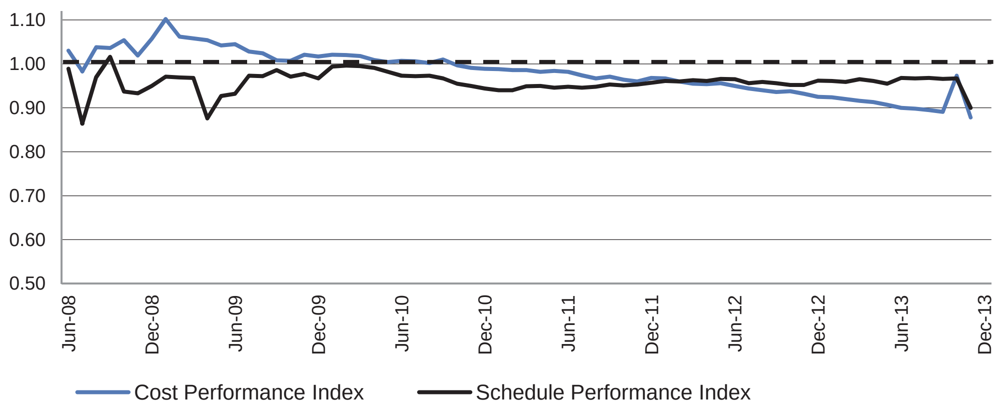
performance was 0.99 or 99 per cent, and this performance continued into November. Raytheon's CPI and SPI indicate that Raytheon has placed equal priority on schedule achievement and cost control.

DDG shipbuilding

6.106 As outlined in paragraph 3.20, ASC AWD Shipbuilder is responsible for block construction, consolidation and outfit of the DDGs, including installation of the Combat System equipment and components. ASC also manages Pre-Production and the outsourcing of block production to BAE Systems, Forgacs and Navantia. The budget allocated to DDG block construction and consolidation is $1.030 billion (December 2006 prices).

6.107 Figure 6.13 shows that ASC's overall CPI has steadily declined, from 1.0 in September 2010 to 0.88 by November 2013 (from 100 per cent to 88 per cent). In other words, ASC's control over its costs declined from progressing on-budget in September 2010 to being 12 per cent over budget in November 2013. This has resulted in a Variance at Completion (VAC—estimated actual costs compared with budgeted cost) of $320 million (as at September 2013).

Figure 6.13: ASC AWD Shipbuilder overall cumulative cost and schedule performance indices, June 2008–November 2013



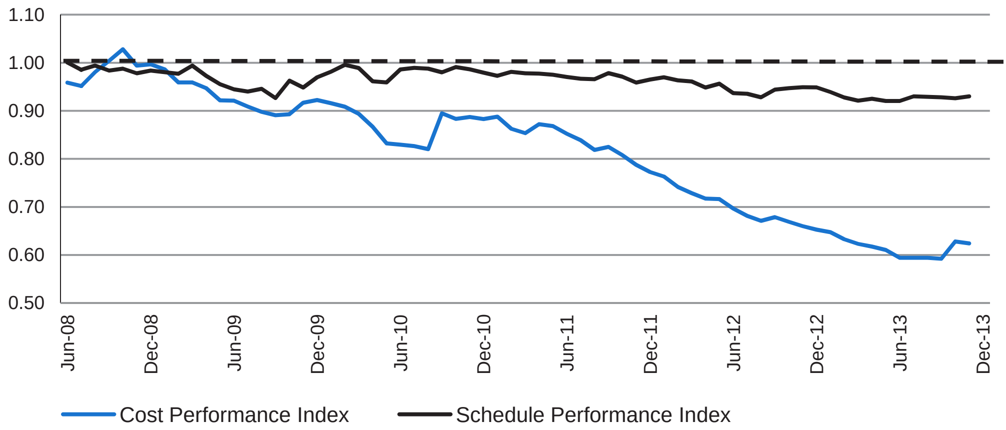
Source: AWD Alliance, November 2013.

Note: Includes ASC's total scope of work: DDG pre-production, production and block construction by ASC and its block subcontractors, consolidation and outfitting including installation of Platform System and Combat System equipment and components, and overall supervision, operations, production management, apprentice and production training.

6.108 The degrading trend in cost performance is most apparent in ASC's production data. AWD production activities predominantly involve block construction, which commenced in December 2009 at ASC and BAE Systems, and in March 2010 and May 2011 at Forgacs and Navantia respectively. Production also includes block transportation, and block consolidation at ASC.[349]

6.109 Figure 6.14 shows ASC's CPI and SPI for DDG production. The CPI data show a continuing trend of significant cost overruns since the beginning of the program.

Figure 6.14: ASC AWD Shipbuilder production cumulative cost and schedule performance indices, June 2008–November 2013



Source: AWD Alliance, November 2013.

Note: This figure includes only DDG block construction by ASC and its block subcontractors, block consolidation, production supervision, operations, production management, apprentice and production training.

6.110 By November 2013, it was costing ASC $1.60 to produce work that was originally estimated to cost $1.00, or in EVMS terms, cost efficiency had declined from 1.0 in September 2010 to 0.62 (62 per cent). 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.[350]

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349 Production data does not include DDG pre-production, which includes engineering reviews and planning, configuration management, Combat System production support, work orders and materials support.

350 In the *2012–13 Major Projects Report*, the DMO acknowledged that the major challenges faced by the AWD Program include: 'achieving maximum productivity levels through efficient shipyard operation and change management'. ANAO Report No.12, 2013–14, *2012–13 Major Projects Report*, p. 150.

6.111 The SPI data shown in Figure 6.14 indicate that, by November 2013, ASC's shipbuilding was running seven per cent behind schedule. Further, ASC's CPI and SPI indicate that ASC has placed its production priorities mainly on achieving high-standard build to specifications, together with schedule achievement. The aim of this strategy is to achieve high-quality outcomes and at the same time avoid large time-related cost increases that occur with schedule overruns.

Underlying causes of low shipbuilding productivity

6.112 Cost increases can result from both design changes and inefficient production-engineering strategies and processes. Up until 2013, the Alliance did not report detailed analysis of shipbuilding cost and schedule data, drawn from the program's EVMS, on the extent to which design change and other factors impacted productivity. In October 2013, ASC and the Alliance CEO noted difficulties associated with identifying the cost of design changes. The Alliance CEO stated that:

> The Alliance management systems are able to readily isolate costs associated with the top down change. However, isolating costs associated with maturity issues, is more complex, although not because the systems are incapable of doing so, but more because the [Platform System Designer] does not differentiate change cause on drawings at sufficient fidelity to allow accurate cost apportionment and because of the complexities of dislocation and disruption not allowing accurate cost capture. That said, there are actions being taken to improve change cost capture.

6.113 During the DDG construction program, immaturity in detailed design documentation has tended to overshadow other factors contributing to low shipbuilding productivity. For example, at its February 2012 meeting, the 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 [Technical Data Package] and agreed that an increase in productivity would require the design to stabilise and change to cease.[351]

6.114 In October 2013, ASC informed the ANAO that the productivity impacts of design changes and defective documentation include:

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

- disruption of work sequencing, which in turn generates high labour rotation and an inability to realise 'learning curve' (that is, efficiency through experience) benefits;
- rework caused by design change; and
- work interruptions arising from unavailability of material and technical information.

6.115 ASC also informed the ANAO that:

> ASC has actively applied its resources to address the external factors that influence the ASC shipyard productivity and adapt with urgency and pace to gain improvements in direct labour productivity and overall production process efficiency. This has been achieved by the use of LEAN 6 Sigma[352] and other processes and leveraging off Bath Iron Works' extensive experience in production management.

6.116 The link between stable or mature design and shipbuilding productivity continues to be emphasised in the media. For example, in September 2013 the ASC CEO was quoted as highlighting that ongoing design revisions might disrupt the delivery schedule.[353]

6.117 In 2013 the Alliance CEO began presenting more detailed monthly cost-variance data to the Alliance Project Board, drawing on EVMS data and ASC Control Account Manager estimates. The cost-variance data presents estimates of the extent to which the following factors impacted shipbuilding productivity:

- design change;
- out-of-sequence work;
- defects and left-off work;
- rework;
- productivity and estimating error;

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352 Lean Six Sigma is a combination of the LEAN manufacturing practice—pioneered by Toyota, and focusing on the elimination of waste—with the Six Sigma strategies and techniques developed by Motorola, focused on improving quality by removing defects and errors.

353 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.

- block subcontractors' performance; and
- other factors.[354]

6.118 The DMO's AWD Program Office analysed the monthly cost-variance data for the period August to December 2013. The DMO's analysis showed that all of the factors mentioned in paragraph 6.117 directly contributed to cost increases. The DMO's analysis also showed that the most significant direct contribution driving cost increases was block subcontractor performance. The direct contribution of design change to overall monthly cost increases was relatively small during the five-month period.[355] The DMO informed the ANAO that:

> One factor identified has been design change from the Platform System Designer and much emphasised by ASC. Other clear impacts have been subcontractor management and productivity performance in each of the three Australian yards, all the latter are the responsibility of the shipbuilder to manage. A modest level of design change is normal and the shipbuilder is required to manage the plan to implement change with the minimum of impact to the overall program. That is the basis of the contract. There are multiple other factors that impact cost including schedule, Class 1 change, detailed design change, subcontractor management and omissions from the initial estimates.

6.119 In a similar vein, in January 2014 the Alliance CEO informed the ANAO 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. Naturally 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. The majority of these issues are well described in the ANAO report. The ANAO has provided a significant volume of commentary on the 'detailed-design' including noting that related issues have 'tended to overshadow other factors contributing to

354 The AWD Program Office informed the ANAO that this data had not been collated in this manner by ASC or the AWD Alliance prior to August 2013.

355 Design change also has an indirect impact on other factors listed in paragraph 6.117.

low shipbuilding productivity'. The ANAO has provided a level of disclosure of the other performance causal factors that include especially 'subcontract outcomes' and 'productivity', which have had and are having a significant impact on the AWD Program.[356]

External reviews and assessments of productivity

6.120 Since 2010, the DMO has engaged the internationally recognised shipbuilding advisory firm First Marine International (FMI) to carry out an independent assessment of the objective and actual productivity of the Australian DDG block builders.

6.121 FMI has identified a number of inherent factors relating to the nature and architecture of the AWD Program that affect productivity. These factors include the Alliance, new/revitalised yards and workforce, limited availability of experienced personnel, the short-term nature of the project and hence a low level of ship construction technology, the dispersed construction methodology, and the third-party design, technical information and build strategy. FMI noted that these inherent factors need to be taken into account when assessing the performance that could be achieved or considering performance improvement actions.

6.122 In 2010, FMI found that:

> Although it is unlikely that core productivity[357] will be achieved on this project, in order to maximise the potential it is suggested that:
>
> 1. The maximum possible attention is given to resolving the issues surrounding the technical information and the transfer of technology from Navantia.
> 2. A concerted effort is made to move away from project development and to settle into a stable production process as quickly as possible.
> 3. Effective processes are needed to ensure the maximum productivity improvement is gained from lessons learnt.

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

357 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. First Marine International, *Assessment of objective shipbuilding productivity for the AWD project, SEA 4000 Air Warfare Destroyer Program*, 28 July 2010, p. 6.

4. A culture of continuous improvement and cooperation is fostered which is supported by some good shipbuilding process metrics, rather than just the EVM data.[358]

6.123 The 2010 FMI report proposed that the Alliance and the Australian shipyards introduce a set of performance measures to be included in monthly management reports. FMI also proposed a specific set of measures, which were a mix of output and process measures. The measures addressed matters such as the number of hours of work on structural steel, pipe and painting; the proportion of support workers; and the proportion of supply items that arrive on time to production.

6.124 In 2011, FMI found that good progress had been made in resolving Navantia technical information issues and the transfer of technology, and in settling into a stable production process. FMI also found that some work had been done in capturing lessons learned and driving down the learning curve. However, its report noted that no work had been done to 'introduce a culture of continuous process improvement supported by process metrics to drive performance improvement'.

6.125 FMI's 2012 update report, released in February 2013, noted that its 2010 and 2011 reports included general observations and suggestions for productivity improvement that are relevant to the project as a whole. FMI reported that:

> The changes made have lead to improvements in some areas. However, opportunities for improvements still exist on Ship 1. The focus on Ship 1 also appears to be diverting attention away from fully realising the performance improvement potential on Ships 2 and 3.[359]

6.126 FMI also 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.[360] FMI's 72 observations and suggestions were grouped into the following five

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358 First Marine International, *Assessment of objective shipbuilding productivity for the AWD project, SEA 4000 Air Warfare Destroyer Program*, 28 July 2010, p. 17.

359 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. 31.

360 These unreported issues were Australian Standards creep and project focus ahead of productivity.

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.[361]

6.127 With respect to detailed design maturity, FMI reported in its 2012 update that:

> The processes for configuration management and the development of the as-fitted drawings remain undefined. However robust the change management process is believed to be, to date the quality of the Navantia technical information has been poor.[362]

6.128 While reporting good progress in some areas in relation to technical information and change, FMI's 2012 update also reported little effective action in relation to the absence of 'as built' technical information, mismatches between technical information and build strategies, and the level of rework due to technical information.

6.129 In January 2014, the DMO informed the ANAO that many of the performance improvement opportunities reported by FMI since 2010 were yet to be implemented, and that the DMO believed these improvements were critical to the achievement of improved shipbuilding productivity. The AWD Program Manager informed the ANAO that:

> ... the shipbuilder and the Alliance must accept that there is a productivity and cost issue in ship production (and identify the causal factors), measure the issues and analyse the trends, then remediate. The Commonwealth, through

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361 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.

In his January 2014 response to an extract from this audit report, the Alliance CEO stated that 'Since 2010, the DMO has contracted for international benchmarking of the AWD shipbuilding production productivity. This benchmarking suggests that whilst the assumed productivity levels underpinning the initial AWD budgets were credible, the achieved productivity outcomes have been further away from best practice and suggested performance targets than anticipated. Of course there are a variety of reasons for this including the need to re-establish the quiescent industrial base particularly in the case of the lead shipbuilder ASC, where the Shipbuilding team is largely a start-up organisation with the vast majority of staff newly hired and from outside the sector. A similar situation arose with the block subcontractors. Other contributory factors (such as the disruption due to churn in the detailed-design) are discussed subsequently in this response. Whilst the outstanding quality of the product being built is an absolute credit to the production work-force and leadership, program issues remain with respect to cost, productivity and schedule certainty.' See page 3 of the Alliance CEO's letter to the ANAO, reproduced in Appendix 5.

362 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. 37.

scorecard input to industry and regular meetings including Defence–Department of Finance meetings, has identified the urgent need for productivity and cost improvements. That call for improvement has not been consistently accepted by the shipbuilder.[363]

6.130 Progress has been made by the Alliance in developing key performance measures of productivity. During 2012 the Commonwealth and the Alliance agreed to focus on productivity as one of two key areas for performance indicator reporting.[364] In August 2012, the Alliance wrote to the DMO, noting that it would, amongst other actions, establish a Productivity Improvement Team, implement FMI's suggested basket of measures and conduct a review against these. Extensive productivity metrics were reported on for the first time in the Project Status Report released in February 2013.

6.131 Against the backdrop of the range of factors contributing to the low shipbuilding productivity in the construction phase of the DDGs, it is clear that a rigorous focus is needed on addressing the underlying causes so that construction cost and schedule overruns are contained over the remainder of the DDG build program. The independent review of the AWD Program presents an opportunity to identify strategies aimed at addressing construction challenges, increasing productivity and mitigating further cost overruns, in a timely manner.

Recommendation No.3

6.132 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.

Defence's response: *Agreed*.

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363 In its January 2014 response to an extract from this audit report, ASC stated that 'ASC's own productivity and performance in our shipyard and our supplier shipyards is improving as we apply the lessons we have learned, both good and bad, to the program.' See page 1 of ASC's letter to the ANAO, reproduced in Appendix 3.

364 The Alliance contract permits the AWD Program Manager to set key performance indicators for the Industry Participants and—if the Industry Participants achieve superior performance against these indicators—to pay them a performance bonus of up to $1 million (November 2006 prices) in a six-month period. Commonwealth of Australia, ASC AWD Shipbuilder, Raytheon Australia, *Air Warfare Destroyer (SEA 4000) Alliance Based Target Incentive Agreement, General Conditions of Contract*, clause 49.

Conclusion

6.133 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.

6.134 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.[365] 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.

6.135 The Production Readiness Reviews conducted by the Alliance in late 2009 and early 2010 to determine the readiness of block construction

365 AWD Alliance, *Schedule Replan*, Project Board paper, 16 June 2011, p. 2.

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.

6.136 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.[366] 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.

6.137 The detailed design data immaturity issues discussed in Chapter 5 have also 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.

6.138 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

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366 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.

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 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.

6.139 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.

6.140 Between 2010 and 2013, the Alliance and ASC did not routinely quantify the various elements that contributed to reduced productivity.[367] 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.[368] 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

367 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.

368 See paragraphs 5.45 and 6.112.

Manager estimates of the extent to which different factors impacted on shipbuilding productivity.[369] 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.[370]

6.141 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.[371]

6.142 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

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369 The DMO's AWD Program Management 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.

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

371 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.

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.

7. Support System and Transition from Guided Missile Frigates

This chapter examines Defence's development of the Support System arrangements required to ensure that the Hobart-class DDGs remain operational once they have been placed into service. The paper also examines Defence's management of the transition from the Guided Missile Frigates (FFGs) to the DDGs, and the associated risks.

Introduction

7.1 Being the 'parent navy' of a class of ship or submarine requires the RAN, and its acquisition and sustainment organisations and their supporting industries, to place appropriate priority on managing and investing in a cost-effective Support System, which includes engineering services, configuration control, supply support, training and intellectual property. It should also include developing an industry capacity to understand the class's design philosophy to the extent necessary to design and implement modifications and to undertake major repairs safely and effectively.[372]

7.2 Investments in Support Systems—which are also referred to as in-service support arrangements, sustainment arrangements, or Integrated Logistics Support arrangements—often prove costly and risky. For example, since the 1990s, the in-service support capability for the Collins-class submarines has been more costly and less effective than was envisaged. The Collins in-service support arrangements were not fully defined during the Collins build phase.[373] In the case of the AWD Program, Defence has been more proactive, by commencing the development of the Hobart-class DDG Support System early in the AWD Program's build phase.

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372 ANAO Audit Report No.23, 2008–09, *Management of the Collins-class Operations Sustainment*, p. 12.

373 ANAO Audit Report No.34, 1997–98, *New Submarine Project*, pp. xxiii, 125–9.

The 2012 Coles report on the Collins program made a range of criticisms and observations on the cost-effectiveness of in-service support arrangements and submarine availability. The report noted that the cost-effectiveness of the Collins in-service support arrangements in achieving each Materiel Ready Day—on available but not absolute indicators—is about half that of international comparators. Further, the availability performance of the Collins-class has been slightly over half that achieved by the comparable international programs; the time in planned maintenance was about one third greater than for other nations; and the maintenance overruns and the percentage of days lost due to defects were approximately double that of the comparators.

Department of Defence, *Study into the Business of Sustaining Australia's Strategic Collins Class Submarine Capability* (The Coles Report), Canberra, November 2012, pp. ii, vi.

7.3 This chapter examines Defence's development of the Support System arrangements required to ensure that the Hobart-class DDGs remain operational once they have been placed into service. The paper also examines Defence's management of the transition from the FFGs to the DDGs, and provides a brief overall assessment of the risks to the RAN's major surface ship capability from the perspective of the DDGs' delivery schedule and the retention of skills developed through the AWD Program.

Support System development

7.4 The DDG Support System is influenced by the design of the evolved F-104-class FFG Platform System (provided by Navantia and in service with the Spanish Navy), and the design of the Aegis Weapon System (provided by the US Navy).[374] However, the DDG Support System and concept differs from the Spanish Navy and US Navy Support Systems, given the need to align with the RAN's Surface Combatant in-service support environment. The overall scope of the Hobart-class DDG Support System arrangements—as specified in the Materiel Acquisition Agreement between the DMO and Defence, and in various Alliance documents—includes the following principal subsystems, equipment and services:

- an Integrated Platform Management System Pierside Monitor, consisting of a set of computer and display equipment for each DDG, located pierside and capable of remotely monitoring each DDG's platform systems, including their fire and emergency systems;
- a Logistics Information Management System, utilising the current RAN Ship Logistic Information Management System (SLIMS);

374 The DDGs' Platform System is based upon the F-104 and F-105 designs in service with the Spanish Navy, consisting of:

- hull structure, including shell and supporting structure, hull decks and hull platforms;
- propulsion plant, including propulsion unit, transmission and propulsion support systems;
- electric plant, including electric power distribution, lighting and power generation support systems;
- integrated platform management, general equipment arrangements, safety, security and personnel related systems;
- auxiliary systems, including climate control, sea-water systems and fresh-water systems; and
- outfit and furnishings, including ship fitting, hull compartments, living spaces and working spaces.

- a Combat System Through Life Support Facility capable of land-based engineering development, integration, testing and maintenance for the non-Aegis elements of the Combat System;
- a Command Team Trainer capable of training at the level of a command team;
- a Training Simulator capable of training crew members in the operational procedures and maintenance of the onboard Hobart Class Integrated Platform Management System;
- Bridge Simulator Data, comprising visual and ship characteristics data of the Hobart-class Ship System, to be integrated into the existing HMAS *Watson* bridge simulator system, to allow crew training in the handling of the ship in harbours, inshore and in offshore waters;
- equipment and data required to support the delivery of training, maintenance, engineering, and supply support services;
- special-purpose Support and Test Equipment required to support Organic and External (Light Repair and Maintenance) for the Mission System and Support System components of the Hobart-class DDGs;
- crew training for three ship companies plus an additional 20 per cent, and provision of DDG-specific documentation and courseware for subsequent training;
- three years of depot stocks for replenishment of onboard spares (two years for mandated Foreign Military Sales (FMS) equipment), 90 days of onboard spares (first outfit for three ships), and selected long-lead-time and insurance spares (as determined by the Capability Manager and the DMO); and
- additional Program Management Office Support System products and services, including facilities to house the Systems Program Office, an Integrated Logistics Support Facility, an AWD Training Centre, an Operational Support Facility, and modifications to wharves to support berthing of the Hobart-class DDGs at Garden Island in Sydney.

Support System contracts

7.5 The DDG Support System is a deliverable under the Alliance contract. However, the Alliance is not currently contracted to provide in-service support. In essence, the AWD Alliance is contracted in large part to 'seed' the sustainment capability through the Integrated Logistics Support Program specified in the Alliance contract. This includes recommending to the DMO a comprehensive model for the ongoing management and update of the Integrated Logistics Support elements necessary for the in-service phase.

7.6 The intention is that the Alliance should use its contractual framework and organisation to deliver the Engineering Support, Maintenance Support, Supply Support and specific Training Support for the DDGs for a transition period (approximately 2016–20) prior to the implementation of the future steady-state in-service support contract. This period will be known as the Transition Support Period.[375]

7.7 The largely off-the-shelf nature of the Platform System and Combat System designs results in a need for the DMO and the RAN to form close engineering, design and logistics-support arrangements with the relevant F-104 FFG logistics program in Spain for the DDG Platform System, and with the US Navy for the Aegis Weapon System.[376] The overall aim is for the logistics data and products supporting the DDGs to be based predominantly on material already in Australian Defence inventory, acquired via FMS with the US Navy or through Technical Agreements with the Spanish authorities. This existing data, including Logistics Support Analysis data and records, is intended to be used without alteration except where deemed unsuitable in the Australian context.

7.8 The DDGs have some commercial off-the-shelf (COTS) systems, and so there is a need for the DMO and the RAN to also form close engineering, design and logistics support arrangements with the Original Equipment Manufacturers or their agents in Australia and overseas.[377]

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375 At the time of the audit, the Transition Support Period was not included in the Alliance contract's scope. The Support System elements that have been included in the Alliance contract's scope are outlined in paragraph 7.4.

376 Military off-the-shelf (MOTS) equipment is defined as items, including software, which are of a kind offered for sale (whether from a standard catalogue, product list or otherwise) in a military market on standard commercial terms and at standard prices. MOTS equipment may be deployed without modification in a variety of configurations. AWD Alliance, *Integrated Support Plan*, May 2010, p. 7.

377 Commercial off-the-shelf (COTS) equipment is defined as equipment of a kind widely used and offered for sale (whether from a standard catalogue, product list or otherwise) by many vendors in a market (whether a general market or a military market) on standard commercial terms and at standard prices. COTS equipment may be deployed without modification in a variety of configurations. AWD Alliance, *Integrated Support Plan*, May 2010, p. 6.

7.9 The Alliance was contracted to supply limited Logistics Support Analysis data on the off-the-shelf systems, including the Aegis Weapon System. Logistics Support Analysis is necessary to identify and evaluate the logistics support necessary to maintain the DDGs' equipment in a fully operational and safe state. The output of this analysis would be Logistics Support Analysis Records for each DDG system, which would specify, amongst other things, the required levels of spare and repair parts, test and support equipment, and skilled personnel.

7.10 The AWD Program's Logistics Support Analysis recognises that the RAN may operate the systems in different operating and maintenance environments to that of each system's parent navy, and this may reduce the valid use by the RAN of the parent navy's Logistics Support Analysis. In August 2013, the RAN informed the ANAO that the data received from Navantia is based on core Logistics Support Analysis conducted by Navantia as the designer and repair agent for the Spanish Navy, and Navantia continues to modify the data based on the Spanish Navy's in-service experience of failures and repairs. The RAN further advised that the data is being modified to better align with the RAN's operational environment and expected ship utilisation, and it will be updated based on operational and maintenance experience once the DDGs are in service. The US Navy data is to be used in a similar way for the FMS elements.

7.11 The Integrated Logistics Support Program is managed by the Alliance's Support Integrated Product Team. The DDG Support System is to be developed by the Alliance Industry Participants by:

- conducting analysis necessary for the development of support for the Mission System and Support System deliverables;
- developing plans for the in-service phase of the DDG capability. These plans are to be produced in time to allow the conduct of detailed planning, training and associated activities;
- supplying some items necessary to support the Mission and Support Systems pending the commencement of the Through Life Support contract;
- planning for the initial establishment of Through Life Support arrangements; and
- incorporating into the Support System the support for Government Furnished Material as provided by Defence.

7.12 Initial sustainment planning for the DDGs has been described in this report for the purpose of establishing whether the necessary work to develop the DDGs' Support System is under way. Progress is being monitored by the RAN, including by the one-star and three-star Program Management Stakeholder Groups. However, the sustainment phase of the DDGs' lifecycle is not expected to begin until 2016. For this reason, it is too early to assess the adequacy of the Support System arrangements.[378]

Facilities

7.13 All 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, unless an exemption is granted.[379] Once referred to the committee, the work cannot be carried out until the House of Representatives so resolves.

7.14 Defence records show that there was a significant delay in referring the DDG Support System facilities to the Public Works Committee in order to obtain parliamentary approval to commence work.[380] Defence sought ministerial approval for referral of the facilities to the Public Works Committee in September 2011 and again in October 2011. However, the facilities were deemed by the Department of Finance and Deregulation (Finance) as being unapproved, because they were not explicitly mentioned in the June 2007 SEA 4000 Second Pass Cabinet decision.[381]

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378 Nonetheless, in the *2012–13 Major Projects Report*, the DMO acknowledged that the major challenges faced by the AWD Program include: 'Delivering an effective, efficient and sustainable through-life support system for the Hobart Class DDGs.' ANAO Report No.12, 2013–14, *2012–13 Major Projects Report*, p. 150.

379 The House of Representatives may resolve that the work is urgent, or the Governor-General may declare that the work is for defence purposes and committee scrutiny would be contrary to the public interest, or the work may be deemed to be repetitive.

380 The DDG facilities eventually referred to the Public Works Committee were the:

- Training Centre at Randwick Barracks;
- Command Team Trainer at HMAS *Watson*;
- Through Life Support Facility at Garden Island;
- Systems Program Office at Garden Island;
- Lay Apart Store at Garden Island;
- Integrated Platform Monitoring System Remote Monitoring Station at Garden Island; and
- Berthing Infrastructure at Garden Island.

381 The facilities were mentioned as a budget line item within an Attachment to the Second Pass Submission seeking selection of the Existing Design.

7.15 In early March 2012, Defence sought central agency advice on how to expedite financial approval of the DDG Support System facilities. On 16 March 2012, the Department of the Prime Minister and Cabinet advised Defence that the Minister for Defence should write to the Prime Minister seeking clarification that Defence was authorised to spend funds on AWD Program sustainment facilities. The department also offered a quick turnaround from the Prime Minister to such an urgent letter. Notwithstanding this advice to Defence, it was not until January 2013 that Defence provided specific advice to the then Minister about the failure to have the facilities expenditure explicitly approved in 2007. On 7 February 2013, the Minister for Defence wrote to the then Prime Minister, as Chair of the National Security Committee of Cabinet, seeking approval of the expenditure. In the letter, the Minister stated that:

> This was only drawn to my attention for the first time on 14 January 2013. That Defence, Finance and [the Department of the Prime Minister and Cabinet] have not been able to resolve this has seen a 12 month delay in progressing these matters for [Public Works Committee] approval.

7.16 When questioned about the cause of the delay between receiving advice from the Department of the Prime Minister and Cabinet and the letter from the Minister to the Prime Minister, Defence advised that it provided Early Indicators and Warnings reports to the Minister in September and October 2012, which included information on the funding approval issues and the subsequent delays in referring the proposed sustainment facilities to the Public Works Committee. However, Defence noted that these reports included a significant amount of detail from many Defence projects, and acknowledged that it should have provided separate ministerial correspondence to clearly highlight the funding issues.[382]

7.17 In response to the Minister's letter, the Prime Minister gave her approval, and the facilities were referred to the Public Works Committee on 21 March 2013. The Public Works Committee held a public hearing on the project on 23 April 2013, and the House of Representatives approved the facilities expenditure on 16 May 2013.

382 In a similar vein, the ANAO has recently reported a theme of Defence not advising government in a timely way of difficulties arising in major projects, sometimes allowing years to pass before providing that advice. ANAO Audit Report No.6 2013–14, *Capability Development Reform*, p. 245.

7.18 In August 2013, the RAN informed the ANAO that the overall extent of the delay to the delivery of the DDG crew training facilities at Randwick Barracks and the Command Team Trainer facility at HMAS *Watson* in Sydney was in the order of 25 months. This delay will result in the RAN and the AWD Program not having permanent, dedicated training facilities for crew and support personnel for the first DDG, and so alternate temporary arrangements will need to be established. The RAN further advised that:

- the temporary Combat System equipment training facilities are intended to be sited within the Sydney basin, so as to minimise disruption to trainers and trainees where possible; and
- Platform System-related training facilities have not been affected, as this training was always planned to be conducted in Adelaide, in close proximity to the construction of the DDGs.[383]

Maintenance spares support

7.19 The AWD Program now intends that the contract for the Transition Support Period will be agreed by the end of 2014, and that an FMS Follow-on Support Case will be put in place during 2015. Other contracts for the support of individual equipment and equipment groups—including a Through Life Support contract with their designers, Original Equipment Manufacturers or their agents—are expected to be put in place prior to or during 2015.

Support System certification

7.20 The RAN Technical Regulatory System requires certification that Integrated Logistics Support products and other deliverables have achieved the required standards, as documented within RAN technical regulations. The aim of the standards is to ensure that the logistics solutions developed for all capabilities meet the RAN's expectations, as encapsulated in current logistics policies and practices and in lessons learnt from past project decisions. The DMO agreed on the Integrated Logistics Support Certification Basis with the RAN in November 2007, and agreed that the level of conformity with the

383 In the *2012–13 Major Projects Report*, the DMO stated that an interim Facilities solution has been identified to address the potential capability gap as a result of the delay in obtaining Public Works Committee approval. ANAO Report No.12, 2013–14, *2012–13 Major Projects Report*, p. 156.

standard is to be encapsulated in the AWD Integrated Logistics Support Certification Matrix.

7.21 At the time of offering each Hobart-class DDG to the RAN for Initial Materiel Release in 2016, 2017 and 2019, the AWD Program Management Office (or AWD Systems Program Office, as applicable at the time) will be required to provide the RAN with an Initial Integrated Logistics Support Certification, based on sufficient Objective Quality Evidence provided by the Alliance and others to adequately support the ship during the Naval Operational Test and Evaluation period. Failures to achieve the required standards are to be recorded in relevant TI 338 reports (*Reports of the Materiel State of the Capability*) for the Hobart-class DDGs, together with risk assessments and mitigation strategies.

Sustainment costs

7.22 In order to budget for the lifecycle cost of a new capability, Defence's practice is to estimate the new system's Net Personnel and Operating Cost (NPOC), which is defined as:

> the difference between future and current mature operating costs associated with a capability, facility, system or specific item of equipment. It reflects the net difference between the cost estimates to operate a new, upgraded or replacement capability offset by the guidance ([Defence Management and Financial Plan] funding) available to operate the current capability, across all affected groups and the DMO.[384]

7.23 The NPOC estimation process is designed to identify variations in Defence's personnel and operating costs caused by the introduction of new or enhanced Defence capability.[385]

7.24 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 the light of their postponed delivery dates and the consequent delay in withdrawing the FFGs from service. The DDGs' NPOC was estimated

384 Department of Defence, *Defence Capability Development Handbook 2012*, Canberra, 2012, p. 133.

385 For discussion of Net Personnel and Operating Cost, see ANAO Audit Report No.6, 2013–14, *Capability Development Reform*, Chapter 7.

as $619 million in the years up to and including 2019–20, and a further $2.07 billion to 2029–30.[386]

7.25 The RAN also estimated that it would cost $684 million to sustain the remaining four FFGs between 2012–13 and June 2019, when it is expected that the last FFG will be withdrawn from service.[387]

7.26 Defence informed the ANAO that NPOC estimates require gradual refinement until the full capability has been introduced. In the case of the DDGs, the third and final trigger for the release of NPOC funding does not occur until after 2020, when the Transition Support Period ends. The AWD Program intends that the NPOC estimates will continue to be refined until that time.

Capability transition

7.27 The RAN's plan for the capability transition from the FFG fleet to the DDG fleet aligns, on a one-to-one basis, the withdrawal from service of the FFGs with the achievement of specified operational capability by the DDGs. During this period, one FFG will be assigned the role of optimising the training throughput of key elements of the RAN's workforce, in particular its technicians. The overall aim is to maintain an acceptable level of maritime air warfare capability, with an FFG available to 'surge' from the training role to full operational capability if needed.

7.28 The RAN informed the ANAO that programming one FFG, for much of the transition period, to provide an enhanced training throughput as part of the 'Raise, Train, Sustain' function would deliver benefits to the RAN's workforce training schedule, particularly for Marine Technicians. The 'Raise, Train, Sustain' concept would also allow the release of personnel—particularly Electronic Technicians—from the FFG workforce, to undertake long-lead-time training courses needed for their DDG postings.

7.29 Provisional Acceptance of DDG Ship 1 is scheduled to occur in March 2016. The three DDGs will progress through sea trials and increasing levels of

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386 These estimates include the cost to Defence of in-service support of three Hobart-class DDGs, including costs of fuel, RAN personnel, and general overhead attributed to the AWD Program from other Defence Groups—over and above the costs currently incurred for the Adelaide-class FFGs.

387 In July 2013, the RAN informed the ANAO that the cost of sustaining its remaining four FFGs in 2012–13 was $131.664 million.

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.[388]

7.30 The FFG fleet is undergoing an upgrade program, which commenced in June 1999 and, after several delays, is currently scheduled to achieve Final Operational Capability in December 2014.[389] The FFG fleet is scheduled to be progressively withdrawn from service between 2014 and 2019.

RAN capability and Support System risks

7.31 Since 1999, the RAN has withdrawn from service without replacement its previous fleet of three DDGs, as well as two FFGs from its original fleet of six FFGs commissioned between 1980 and 1993. As noted above, the remainder of the FFG fleet is scheduled to be progressively withdrawn from service by 2019. Consequently, the RAN would face increasing risks to its major surface ship capability from any further delays in the delivery of the specified Hobart-class DDG capability or the timely establishment of support and sustainment arrangements for the Hobart-class.

7.32 The development of the DDG Support System, necessary to sustain and upgrade this complex capability over its expected service life, will draw heavily on the knowledge and experience acquired in the earlier phases of the program. However, work on the Support System is likely to be undertaken against changes in the Australian shipbuilding sector. A range of Defence stakeholders have observed a risk, which is under consideration by the Australian Government[390], that the experience and knowledge gained by the

388 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.

389 ANAO Report No.12, 2013–14, *2012–13 Major Projects Report*, pp. 285, 291.

390 See for example: Mark Thomson, ‘In the market for a naval shipbuilding plan’, *ASPI Strategist* blog, 26 September 2013; ASC, *A Sustainable Australian Naval Industry*, Adelaide, October 2013; and Rod Equid, AWD Alliance CEO, speech to Pacific 2013 International Maritime Conference, Sydney, 8 October 2013.

shipbuilding sector during the build phase may not be available to meet the RAN's future whole-of-life support and capability requirements.[391,392]

391 The Alliance CEO told the Pacific 2013 International Maritime Conference that 'The AWD Alliance has already let some experienced and skilled people go and they will continue to leave the program at a rate of around 200 people each year through to 2018.' Rod Equid, AWD Alliance CEO, speech to Pacific 2013 International Maritime Conference, Sydney, 8 October 2013.

In November 2013, the CEO DMO advised a Senate Estimates hearing that 'the dip in maritime work commences in 2015. Maritime work planned and contracted at the moment continues through until 2019 but there is a drop-off in the workforce from 2015.' He also stated that the incoming government had requested a review of the maritime sector. Senate Foreign Affairs, Defence and Trade Legislation Committee, *Estimates Hansard*, 20 November 2013, pp. 85–6.

In their January 2014 responses to extracts from this audit report, BAE Systems commented on the need to avoid the 'impending gap in naval shipbuilding', and Forgacs stated that 'the ship building capability will once again dilute and disappear if not utilised in an ongoing ship building program out across the defence portfolio.' See their letters to the ANAO, reproduced in Appendices 6 and 7.

392 The 2013 *Future Submarine Industry Skills Plan* indicates that some other naval construction plans are scheduled for Second Pass approval between 2014 and 2021. These are the Heavy Landing Craft, Offshore Patrol, Supply Ship and Future Frigate, as well as the Future Submarine. However, the complexity and difficulty of the design process, as shown in this audit report, indicates that these future projects are not likely to reach the production stage in time to support the retention of skills gained as part of the AWD build phase. Department of Defence, Department Materiel Organisation, *Future Submarine Industry Skills Plan: A Plan for the Naval Shipbuilding Industry*, Canberra, 2013, p. 162.

There is likely to be at least a five-year period between the end of the DDGs' production in 2016 and the earliest possible commencement of construction of the Future Frigate Project under SEA 5000, in around 2021. Consequently, under current plans, skills gained at considerable cost may not be available in Australia for the next design and construction program for major surface ships. These issues have given rise to a range of proposals to cover the period from 2016 to 2021, including the construction of a fourth DDG and the bringing forward of other naval shipbuilding projects.

Conclusion

7.33 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.

7.34 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.

7.35 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 up to and including 2029–30.

7.36 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 which has been under consideration by Australian Governments for some years[393], 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.

Ian McPhee | Canberra ACT

Auditor-General | 6 March 2014

393 See for example: Department of Defence, Defence Materiel Organisation, *Future Submarine Industry Skills Plan. A Plan for the Naval Shipbuilding Industry*, May 2013.

Appendices

Appendix 1: Defence response to the audit

Australian Government

Department of Defence

Mr Dennis Richardson
Secretary

General David Hurley, AC, DSC
Chief of the Defence Force

SEC/OUT/2014/49
CDF/OUT/2014/157

Mr Ian McPhee
Auditor-General for Australia
Australian National Audit Office
GPO Box 707
CANBERRA ACT 2600

Dear Ian ~~Mr McPhee~~

REVISED SECTION 19 AUDIT REPORT – AIR WARFARE DESTROYER

Thank you for the opportunity to review and provide comment on this audit.

We acknowledge the considerable efforts expended by your staff in the conduct of this audit since its commencement in 2012 and we agree the audit recommendations.

Detailed comments to facilitate the finalisation of drafting are attached.

Yours sincerely

Dennis Richardson
Secretary

21 FEB 2014

D.J. HURLEY, AC, DSC
General
Chief of the Defence Force

21 Feb 14

Attachments:

1. Agency Response
2. Defence Comments, Editorials

REC'D A-G
28-2-14-2

AGENCY RESPONSE

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.

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. 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

SENSITIVE
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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.

SENSITIVE

Appendix 2: AWD Alliance CEO response to audit extract

GED
21 FEB 2014
9.05

AIR WARFARE DESTROYER
ALLIANCE

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AWD-Outbound-20563-2014

19 February 2014

Dr Tom Ioannou TO 21/2
Australian National Audit Office
GPO Box 707
Canberra ACT 2601

Dear Dr Ioannou,

CEO AWD ALLIANCE RESPONSE TO ANAO AWD AUDIT REPORT 14 FEBRUARY 2014

References:

A. ANAO 2011/2088 dated 19 December 2013
B. ANAO #3065243 dated 14 February 2014

References A and B requested CEO AWD Alliance (Alliance CEO) review of redacted versions of the ANAO draft report on their audit of the AWD program conducted in the period up to December 2013. A response to the report was requested in addition to seeking editorial comment. The Alliance CEO understands similar requests were made of all key AWD program stakeholders. This letter is the requested response, and editorial comment has been provided separately.

Standing of the Alliance CEO response to the ANAO

The ANAO has stated the purpose of the subject audit as being "focused primarily on Defence's administration of the AWD Program". Notwithstanding, the 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. By necessity therefore, both DMO and industry performance has been examined by the ANAO to satisfy the audit objectives.

A key tenet of the Alliance construct is a high level of transparency between industry and the DMO facilitated by the "open book" arrangements, the manner in which the participants work together, the AWD governance arrangements and through the Defence personnel embedded within the Alliance's IPTs and CPTs performing project work. As an extension of this transparency, Industry Participant information regarding the AWD Project was openly shared with the ANAO to support this audit.

Building Australia's future air warfare capability

Within the AWD Alliance, the Industry Participants provide the necessary professional capability and capacity to perform relevant work to satisfy their contracted obligations. The Alliance CEO role is to centrally manage the AWD work on behalf of, and in conjunction with the Industry Participants whilst at the same time collaborating with the Commonwealth. In this regard, with the assistance of members of the Alliance Management Team (AMT), program data and comments have been provided to the ANAO as evidence for their audit and in response to various earlier drafts of the audit report.

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. ANAO's audit report assembles relevant SEA 4000 historical and performance issues and has delivered related commentary and interpretation. AWD is a large and complex project and unsurprisingly, the related considerations and issues are similarly complex. AWD comprises 150,505 scheduled tasks (December 2013), is 67% complete in Earned Value terms with the scheduled tasks contained in 7,855 completed work packages, 1,693 open work packages and 5,023 planning packages remaining to completion.

The ANAO has requested individual responses to the penultimate draft audit report from each of the key AWD Alliance stakeholders with this response provided by the Alliance CEO. A level of "balance" in the views expressed by the Alliance CEO is incumbent in the nature of the AWD CEO role – both acting as an agent for the Industry Participant's and at the same time collaborating with the Commonwealth. This response has the standing of the Alliance CEO's view of the draft audit report and associated issues and is not necessarily a shared view of all of the Participants or stakeholders.

The AWD Schedule

With respect to the AWD schedule and the "delays" affecting the AWD project and summarised by the ANAO - experience would now suggest that the original contract schedule was optimistic in the circumstances of the AWD Program as it has unfolded. Impacts to the plan of record include: a small delay to contract signature, construction start-up issues within a quiescent industrial base, a lead shipbuilder with limited relevant surface combatant experience and new staff to recruit, the planned level of ship change ("Class 1" design change), and the export of a design from a third-party designer and the related level of maturity in the reference detailed-design where the reference design had been developed for use by the designer's own production organisation. That said, it is noteworthy that PDR and CDR were successfully completed on schedule by December 2008 and December 2009 respectively given that the period allowed to achieve these reviews had been constrained on the basis of the "existing platform design" and yet the effort required for the Australian Combat System was not reduced by the nature of the second pass platform decision where the Combat System approach was largely common to both the platform options considered by government at second pass. Similarly, facilities were established and in place in a timely manner.

Schedule, cost and productivity are clearly inter-related and the ANAO report discloses a number of key issues in each of these domains.

Cost

With respect to cost, the ANAO has published historical AWD Earned Value performance data against the program's internal Performance Measurement Baseline, the historical Cost Variance (CV), and the predicted Variance at Completion (VAC) based on the program Q2 2013 Estimate at Completion analysis.

AWD Project Management (performance measurement) is based on a monthly cycle of cascading reviews. A key element of these reviews is the "variance analysis" against the assigned Performance Measurement Baseline. The reporting Performance Measurement Baseline is "internal" to the Alliance on the basis that a decision was taken at start-up, not to authorise distribution of the entire Target Cost Estimate (TCE) and approximately 7% was held as Tier 2 Management Reserve (MR) as an initiative of the Alliance Management

Team (AMT) and endorsed by the AWD Board. The Tier 2 MR supplemented the contract (Tier 1) Alliance MR with management of both pools of MR as described by the ANAO. As a consequence of the Tier 2 MR, the internal Performance Measurement Baseline was initially more aggressive than the contract position represented by the TCE noting that the performance variances reported by ANAO and current projections indicate that the TCE will ultimately be exceeded.

AWD Financial Management is also undertaken through the quarterly Estimate At Completion process. Head-line reporting is the historical Cost Variance (CV) (the Actual Cost of Work Performed (ACWP) compared with the Budgeted Cost of Work Performed) and the Estimate to Complete (ETC). The expected out-turn cost for the program is the net of the ACWP, the ETC, retained MR and management's view of analysis of Risk and Opportunity costs. This may then be compared with the TCE (comprising the assigned Performance Measurement Baseline and the remaining Tier 1 and Tier 2 Management Reserve) as available funding to cover any over-run.

Since June 2011 management has predicted that the TCE will be exceeded, as reported by the ANAO, and as at December 2013 a TCE over-run of $302m was predicted with this over-run nominally being shared 50:50 between the CoA and the Industry Participants. The consequences are a reduction of the Industry Participants fee and a call on DMO's contingency set aside for the AWD program (separate to the MR allocated to the TCE).

Alliance records also disclose that the 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. Naturally 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 (and/or invalid assumptions) and production productivity not achieving the levels assumed in development of the TCE. The majority of these issues are well described in the ANAO report. The ANAO has provided a significant volume of commentary on the "detailed-design" including noting that related issues have "tended to overshadow other factors contributing to low shipbuilding productivity". The ANAO has provided a level of disclosure of the other performance causal factors that include especially "subcontract outcomes" and "productivity", which have had and are having a significant impact on the AWD Program. ANAO's conclusion *"against the backdrop of the range of factors contributing to the low shipbuilding productivity in the construction phase of the DDGs, it is clear that a rigorous focus is needed in addressing the underlying causes so that construction cost and schedule overruns are contained over the remainder of the DDG build program. The proposed* <independent> *review of the AWD Program presents an opportunity to identify strategies aimed at addressing construction challenges, increasing productivity and mitigating further cost overruns, in a timely manner"* is appropriate and the proposed independent review should be welcomed by all of the AWD participants as a positive step towards achievement of acceptable outcomes from the AWD program.

Since 2010, the DMO has contracted for international benchmarking of the AWD shipbuilding production productivity. This benchmarking suggests that whilst the assumed productivity levels underpinning the initial AWD budgets were credible, the achieved productivity outcomes have been further away from best practice and suggested performance targets than anticipated. Of course there are a variety of reasons for this including the need to re-establish the quiescent industrial base particularly in the case of the lead shipbuilder ASC, where the Shipbuilding team is largely a start-up organisation with the vast majority of staff newly hired and from outside the sector. A similar situation arose with the block subcontractors. Other contributory factors (such as the disruption due to churn in the detailed-design) are discussed subsequently in this response. Whilst the outstanding quality of the product being built is an absolute credit to the production work-force and leadership, program issues remain with respect to cost, productivity and schedule certainty. That said, FMI have also identified that opportunities for improvement remain, particularly through learning from Ship 01 to Ship 03 as reported by the ANAO.

AIR WARFARE DESTROYER ALLIANCE

2013 AWD Integrated Baseline Review

The 2013 AWD Integrated Baseline Review (IBR) was not a contracted AWD program review but was undertaken as an initiative of the Alliance CEO and endorsed by the AWD Project Board in response to ongoing growth in the Estimate At Completion for shipbuilding elements of the program and concerns over the effectiveness of financial controls that were in place.

The ANAO has detailed the definition of a conventional DMO IBR at Table 6.2. Notwithstanding, the 2013 AWD IBR focussed on both the "validity and accuracy of the AWD baseline" and the effectiveness of the Earned Value (EV) techniques and performance management processes (including process compliance) within the project. The latter aspects were emphasised because of the quarter over quarter growth in Estimate At Completion that had been experienced since commencement of production. Similarly, as reported by the ANAO, production budgets have been exceeded on a month over month performance basis, irrespective of increases being made to those budgets over time.

The ANAO has accurately reported many of the IBR findings. These include a number of process Corrective Action Requests (CARs) and a general observation that the production base-line was "very success oriented" with no allowance for rework due to "first of class" problems.

One of the key outcomes sought from the IBR was a determination of actions required to redress any EV process and compliance issues and to thus ensure effective financial reporting and control mechanisms are in place. For example, the Alliance ability to *"report more detailed cost variance analysis on factors contributing to productivity shortfalls"* (ANAO summary paragraph 35) depends on availability of source data within the Participant's financial and EV systems.

A second important IBR outcome was completion of an assessment of the achievability of the Performance Measurement Baseline (resources, cost and schedule). An effective Estimate At Completion process must maintain a healthy tension between constraining budgets (aiming to minimise expenditure) and setting achievable performance targets. An IBR, of itself, will not re-estimate a program's Estimate At Completion but may indicate that a program re-plan is necessary where budgets are inadequate or the required underlying performance targets are assessed as no longer realistic. Subsequent to the 2013 AWD IBR, the AWD Project Board tasked the Alliance CEO to perform further independent assessment of the Estimate At Completion and the proposed independent review of the AWD program is also expected to contribute in this regard.

Detailed-Design

Notwithstanding the fact that the ship design process is described in some detail by the ANAO with commentary; and has been a key AWD issue since 2010; the design considerations and issues are complex and remain at risk of being misunderstood or misinterpreted.

Firstly, the functional design for the F-100 series of ships including the AWD is sound as evidenced by the ships constructed by Navantia and delivered to the Armada. They are simply an excellent product and a similar outcome is expected for AWD.

The majority of the AWD discussion around "design" and the associated issues relate to the manner in which the design intent is translated into construction documentation. Shipbuilders refer to this step as "detailed design" but the effort may otherwise be referred to as "draughting" or "design draughting". Largely this is the process of developing further construction detail and producing construction documentation – generally two dimensional drawings that can be used to manufacture, construct and install components of the ship. Within the AWD project, production and delivery of the detailed-design is Navantia's responsibility as the Platform System Designer (PSD). The task is accomplished by developing the design and draughting in three dimensional CAD models and extracting the two dimensional construction drawings that, amongst other things, are the supplies delivered from the PSD to the AWD Alliance.

Building Australia's future air warfare capability

Page 4 of 10

In AWD, delivery of the detailed-design is accomplished as a commercial transaction with the delivered supplies comprising the much discussed Category 1 Technical Data Package (TDP). Two head-line considerations are relevant to examination of this activity: when Navantia builds their own ships, they are both the designer and the production organisation; and in the case of AWD, the design is transacted via the TDP documents and the AWD Alliance has a contracted obligation to build in accordance with the requirements of the TDP (Category 1).

Capital warship designs are complex involving tens of thousands of individual drawing sheets. No two ships are ever identical and production runs are most usually limited. Economical and time-line considerations usually constrain the effort that can be applied to the detailed-design. As a consequence, ship detailed-designs are never perfect due to their nature: that being the inherent complexity, the limited numbers of ships produced and the funding allowed for design. Modest rates of Technical Queries (TQs) to the engineering department or the third-party designer are the norm (except perhaps in very long production runs) as a result of the inherent "design maturity" issues. Also, relatively limited "Class 1" ship change often has a pervasive impact on construction products. That is, the implementation of Class 1 change increases the probability of problems or errors at the detailed-design level. Furthermore, a level of design-build concurrency is usually accepted for schedule considerations on a "managed-risk" basis. For all of these reasons, a certain rate of technical problem resolution should be expected, and as a consequence it is necessary to resolve problems as they are discovered in production. The resolution of problems in this manner may be more protracted for an exported design compared, for example, with the case of Navantia designing and building their own ships where they are able to "fix minor issues as they arise". Programs such as Success, ANZAC, DDG-51 and LCS have reported issues of a similar nature and noted various levels of success, in mitigating the attendant issues.

In the case of AWD, the Commonwealth has contracted that "the Industry Participants must construct each AWD in accordance with the requirements of TDP (Category 1) and must install and physically integrate each AWD in a way that is consistent with TDP (Category 1)". This is most likely motivated by a desire to preserve designer's warranties from Navantia and therefore, Navantia has been included in the decision making loop for TDP issues arising in AWD construction. Limited local authority is delegated to the Shipbuilder through the "Thresholds Document" provided by Navantia (noting that this document was sought by the Alliance and negotiated in the period September 2009 to January 2012). The document provides limited delegation and the most effective treatment of TDP issues has been through the resident Navantia Liaison team and the focus on priority resolution of Technical Queries (TQs) through the Navantia design support network. With effect January 2014, a total of 5,409 TQs had been directed to Navantia with 71% of the 1,295 requested 24 hour responses being satisfied.

In summary, the head-line considerations within the AWD project related to the ship's detailed-design include:

a. The AWD is a "modified MOTS" design and there is sufficient (planned) "Class 1" change to have had a pervasive impact on the construction products;

b. The reference design was created for use in an environment where the designer and production-house were within one organisation and, as described by Navantia, "many minor problems were fixed on the spot". AWD is generally constrained to building in accordance with the TDP (Category 1) and therefore problems are by necessity resolved in conjunction with the PSD. The current "Thresholds Document" has been of limited benefit with recent consideration of a revision to it discussed with Navantia;

c. The quiescent nature; and consequential limited corporate experience and currency of the contributing Australian shipyards (including ASC as the lead shipbuilder) has compelled a conservative approach including the manner in which shipbuilding decisions are processed and has thus magnified the impact of design issues; and

d. To assist the AWD Alliance, Navantia has been diligently updating the detailed design to incorporate earlier problem resolutions that had not earlier been rolled back into the reference design and also resolving other issues, but the timing of the cycling of the TDP has had an impact on the program as described by the ANAO.

AIR WARFARE DESTROYER ALLIANCE

Change Management and Alliance Management of the PSD

Associated with commentary around design is change and change management. Within AWD and the ANAO report, "change" is an over-used expression that collectively describes a range of impacts from "Class 1" change (controlled by CAP and or ECP) to any update to the TDP post-delivery for use by production. Clearly there are different management requirements and consequences depending on the source and timing of the change.

The AWD program of record required finalisation of the Combat System equipment during Phase 3 of the project and concurrent with completion of the platform functional design through the PDR and CDR period. Thus updates to the PSD contract Combat System baseline was always contemplated and planned. The relevant information was transferred from the Alliance to the PSD through an agreed and contracted schedule of CS data deliverables, which was largely completed on schedule, and enacted in the PSD contract through PSD CAPs 12 and 18. Similarly, the PSD Contract Attachment 7 platform changes were also implemented in the Hobart Class design as planned in the program of record. Notwithstanding the reported detailed-design maturity issues, the fundamental AWD design has remained very stable throughout the program with limited updates made, the majority of which were planned at contract signature.

The concurrency between commencement of production and completion of the detailed-design post CDR was risk-managed as production commenced with a number of the keel blocks that had no or low impact from AWD Class 1 change and were therefore expected to be producible at low risk from the initial TDP deliverables. However, as described in some detail in the ANAO report, TDP supplies, including for the keel blocks, were revised and re-issued after formal delivery, notwithstanding the contracted and agreed delivery schedules and inadvertently compromising the production plan of record with consequences through engineering, planning and production rework and/or out-of sequence work.

These revisions resulted from a range of causes including in-process design work, resolution of hold-ups due to late provision of data from the Alliance to Navantia, outcomes from Technical Queries and a category of detailed-design "maturity issues". The "maturity issues" experienced to date most probably relate to issues that had been discovered during earlier Navantia Ship production work and that were "fixed on the spot" and not necessarily rolled back into the parent CAD models until a later time – this action intended to benefit AWD and pre-empt TQ's. Collectively, the pervasiveness of the updates to the TDP supplies, and specifically the timing, exacerbated the risk that had been accepted in the program of record concerning concurrent design and production. As identified by the ANAO, this taxed shipbuilding engineering and resulted in additional rework and/or out of sequence work. As always, this is part of a trade-off between maturity and completion of design and a longer schedule in the project planning phase.

With respect to management of the PSD, and change in the TDP supplies, it may be implied from ANAO commentary that earlier reaction may have achieved earlier and more comprehensive resolution of the issues, but this view understates certain matters of practicality:

a. The program of record was set at the contract stage based on what the parties knew at that time and against certain expectations. Acceptance of the aforementioned design-production concurrency risk was one key to constraining the schedule to acceptable bounds;

b. The early TDP supplies were accepted with defects but only where these defects were not material to production. Furthermore, for its part, Navantia introduced an independent quality review that subsequently largely eliminated this type of defect in the follow-on deliveries;

c. In applying due diligence from an Alliance perspective, some defects that would materially affect production, namely interferences, were discovered during an extraordinary detailed review of delivered data (for example Block 409 review) and some data was rejected where the consequential impact on the AWD schedule could be accommodated. For its part, Navantia subsequently implemented detailed interference checks before release of the block data to the AWD project;

d. Other problems experienced have been more insidious such that they could only be detected during use of the TDP (Category 1) data for manufacture or production, and such matters have been resolved via the Alliance Problem Identification Report (PIR) and Technical Query (TQ) processes. A rate of such arising is normal in shipbuilding although within AWD the rate of arising's has exceeded the Shipbuilder's expectations with consequences in planning, engineering and production rework as discussed by the ANAO; and

e. For Navantia's part, Navantia have also been diligently updating the TDP to include, amongst other things, their lessons learnt from the F-105 and earlier F-100 production as "TDP Maintenance". The timing of the maintenance updates have resulted in unexpected additional engineering effort together with rework and/or out-of-sequence work within production as described by the ANAO within the body of their report.

Notwithstanding the reported difficulties, the relationship between the Alliance and Navantia has remained strong and the parties have worked together to minimise the impact of detailed-design issues on AWD production. This has included Navantia's investment in additional personnel allocated to their resident team in Australia for an extended period of time to assist the program, this type of technical services or "lead-yard services" not being included in the original PSD scope as discussed by the ANAO. A number of additional actions taken by both the Alliance and Navantia to minimise the impact of TDP churn on AWD production are also described in the ANAO report. The issues developed progressively for AWD and were addressed as they arose. As a consequence of the AWD production schedule being "locked in", there was and is no practical or cost-effective opportunity to completely eliminate the impacts which are to some extent inherent in the business of shipbuilding and especially where a detailed-design is transacted from a third party that retains design authority (designer authority).

ANAO Recommendation for Design Review

The ANAO **Recommendation 2** for robust design review in future naval shipbuilding programs is partially agreed noting the complexity of the subject of ship design as identified earlier in this response. The merits of ensuring an effective review and audit process are not disputed but this should be more about guaranteeing process effectiveness and obtaining assurance of compliance by the Designer rather than independently completing or duplicating elements of the Designer's scope, the latter being unlikely to achieve the desired outcomes without formally transferring the relevant scope to the production organisation (e.g. correction of detailed design errors by the production organisation). The following considerations are germane:

a. The efficiency and effectiveness of the Designer's processes to implement Class 1 change including managing concurrency with production effort (i.e. the impact on production) should be understood, reviewed and monitored.

b. With respect to straightforward quality issues (clarity, presentation, language etc.), the Designer's internal processes should be reviewed and monitored. Whilst this type of issue is readily detected by inspection of design supplies, late correction causes unnecessary churn, and remediation at the source is more effective. Within the AWD program, this was accomplished by an update of Navantia's processes and the Navantia Independent Review Team action prior to release of data to the AWD program as described in the ANAO report.

c. The fundamental "goodness" (integrity) of the design supplies is also most effectively addressed within the Designer's own processes. This includes, for example, the "implementation of a fully-integrated design review process supported by contemporary Computer-Aided-Design technology". In the case of AWD, the process for formal interference checks of design supplies was undertaken by Navantia albeit commencing during the early block data delivery period - again as described by the ANAO.

d. The level of refinement and accuracy of the detailed design is a matter of investment in the design and the concomitant cost-benefit. A final category of residual "errors" manifest at the very detailed level of

AIR WARFARE DESTROYER ALLIANCE

detailed design and are often almost impossible to detect merely by inspection of design supplies or indeed by use of CAD. These are discovered in production and include issues that Navantia have noted are corrected "on the spot" by their own production organisation.

In summary, the recommendation for Defence assurance of the "implementation of a fully-integrated design review process supported by contemporary Computer-Aided-Design technology" is supported but this should be achieved within the Designer's organisation and may include closer engagement and integration with the responsible Designer team than was implemented on the AWD program. The thought that use of CAD for improvement of, and/or checking of, the design outside the Designer's processes and organisation would have benefit should be discouraged except in the case that responsibility for completion of the detailed design and/or correction of errors is transferred to the production organisation (bringing its own range of issues with data transactions and accountability). Notwithstanding, use of CAD to support production has merits in helping understand the design, to support planning and to explore and document problems.

Combat System Design

The ANAO report provides limited commentary on the AWD Combat System describing the Combat System as "the United States Aegis Weapon System and additional Australian elements to meet specific capability requirements". The Aegis Weapon System (AWS) provides the core air-warfare functionality, and the Australian elements satisfy the additional functionality requirements such as Electronic Warfare, Underwater Systems, Short-Range Defence and Communications needs.

The AWD program Combat System planning was conducted with a low risk appetite in satisfying these additional capability requirements with the following guiding principles:

a. Low integration risk (including necessary Aegis interfaces);

b. MOTS or non-developmental high Technology Readiness Level (TRL) status subsystems;

c. Low or no Aegis modifications; and

d. Low ship impact.

The Raytheon Combat System System Engineer role described by the ANAO was to architect, procure and integrate those additional Australian elements of the Combat System. The Australian elements accounted for 52 percent of the total CS procurement. To date there has been good progress with the Combat System successfully applying the intended principles and burning down the overall integration risk by tests and verification in various shore facilities including the United States Navy CSEDS facility that has verified the integration approach including the newly developed Australian Tactical Interface (ATI). With effect December 2013, 161 of 497 (or 32%) of the Hobart Class Performance Specification requirements had been formally sold-off to the DMO. More than 90 percent of Combat System interfaces will have been tested and verified in shore facilities prior to testing on the ship. In simple terms, the AWD Combat System approach will satisfy the Australian unique functional requirements, with an Aegis Weapon System core taking a low risk approach and assuring minimal program impact through Combat System related issues.

The Alliance Contract

The AWD Alliance and Project Team capability has been achieved and is enhanced by:

a. The personnel allocated to the AWD project team from the Participant organisations;

b. The Participant parent organisation corporate capability;

Building Australia's future air warfare capability

Page 8 of 10

c. ASC's relationship with its technology partner BIW;

d. Raytheon "reach-back" to its parent organisation;

e. The "Alliance-like" relationship maintained with Navantia;

f. The Alliance's relationship with RAN stakeholders and regulatory representatives;

g. The Alliance's relationship with the USN and its subcontractors (a relationship normally limited to government-to-government interaction); and

h. The open and effective relationship with the broader Defence stakeholder community.

Comments by the ANAO regarding the overall merits of including all key program participants in an Alliance arrangement are broadly agreed (see for example ANAO audit report paragraph 3.76). The AWD project experience emphasises that the rationale for doing so is as much about the importance of eliminating commercial/transactional boundaries as aligning the motivation of individual Participants. That is, it is about program management efficiency. For example, in the case of the AWD PSD, Navantia is motivated to strive for program success more because of protection of their international reputation than direct financial outcomes which are limited in any case by the relativity between the PSD work-share and the overall program costs.

The decision to conduct Phase 3 of SEA 4000 in an "Alliance" arrangement was taken early in the program and "willingness to participate in the contemplated Phase 3 Alliance" was a condition of tendering for AWD work. There was also a strong focus on "practicing to be an Alliance" during SEA 4000 Phase 2. The AWD Alliance contract has established a collaborative and cooperative environment between the Participants and endeavours to eliminate unnecessary transactional (commercial) boundaries for the reasons of decision making efficiency and, particularly for the owner, cost reduction. In simple terms, the Alliance contract motivated the establishment of "one AWD project team". AWD experience suggests that a successful Alliance outcome is dependent on the following:

a. Will amongst the Participants;

b. Training and educating staff and stakeholders; and

c. Practicing the agreed corner-stone principles.

The AWD Alliance is governed in the first instance by the AWD Project Board with representation from the three Participants. Decisions are taken with concurrence from all three participants. For example, the early decision not to reject PSD data in favour of developing an "Alliance like" relationship with Navantia was taken with the concurrence of the then Project Board members after weighing the identified benefits and risks. The participants and the broader stakeholder community have also been very effective at working together to minimise the impact of issues on the project (such as difficulties with the TDP) and deliver "best for project" outcomes as opposed to focusing on commercial issues.

The ANAO has summarised an understanding of the Alliance contract arrangements including referring in part to commentary from ASPI on the Alliance arrangement. In addition to the ASPI comments referenced in the ANAO report, ASPI also made a fundamental observation concerning the AWD Alliance within their report "The Cost of Defence ASPI Defence Budget Brief 2013-2014" in stating:

> *"Assuming that the TCE represents a credible estimate of the cost of work to be done, the arrangement <Alliance> has clear merits. Not only are there strong incentives to meet cost and schedule targets, but the participants are encouraged to work together to resolve problems and are inhibited from shifting costs between one another. Of course, if the TCE is uncertain or inadvertently erroneous, the whole*

AIR WARFARE DESTROYER ALLIANCE

arrangement becomes a lottery; with the potential for the tax payer to be ripped off, or for the commercial participants to be taken to the cleaners."

Given the predicted AWD cost over-run, issues surrounding cost are the root cause of the current tensions between the participants that include accountability for the impact of TDP change and shipbuilding performance/productivity. With respect to the former, on the one hand the Commonwealth views the matter as within the Alliance shared-risk cornerstone principle and on the other hand the Industry Participants have sought additional consideration referring to the provisions of the Alliance contract.

Despite these current tensions, the Alliance arrangement has achieved many of the original intentions (such as the positives identified in the above ASPI quotation); namely:

a. There are good examples of technical problem resolutions without schedule impact or protracted commercial debates;

b. The Commonwealth is not at the centre of every issue with costs to Defence escalating through variations;

c. The contract schedule has been extended whilst minimising related cost increases and in particular avoiding prolongation claims from one party when the delay is caused by another; and

d. There is a collaborative engagement with the relevant stakeholders, including the regulator community, and the program of progressive sell-off of requirements is agreed and well advanced.

In addition, the open book and collaborative approaches have been successful and maintained.

Summary

This ANAO report accurately summarises the background and status of the AWD project and the issues and challenges that have been experienced to date. These relate primarily to two inter-dependent factors: the quiescent shipbuilding sector capability and capacity; and the approach to exporting a ship design with the attendant organisational issues aptly described by ANAO. Ultimately at a head-line level, the outcome has been difficulty in maintaining the production schedule and cost performance, be it caused by disruption or participant performance.

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 work-force, development of the facilities, the 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.

Yours sincerely,

ROD EQUID
Chief Executive Officer
Air Warfare Destroyer Alliance

Building Australia's future air warfare capability

Page 10 of 10

Appendix 3: ASC response to audit extract

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IN REPLY PLEASE QUOTE: OUT 000064/2014

21 February 2014

Dr Tom Ioannou TJ 24/2
Group Executive Director
Performance Audit Services Group
Australian National Audit Office
GPO Box 707
Canberra ACT 2601

Dear Dr Ioannou,

Formal Response to ANAO Air Warfare Destroyer Performance Audit

ASC is Australia's leading naval prime contractor and our values are service, safety, leadership, integrity, results and innovation. We are 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's involvement in the AWD program began a decade ago when we were selected through open competition as the AWD Alliance Shipbuilder. We have risen to and overcome countless challenges in the period since, and the program today looks markedly different from the one first envisaged. Our workforce's experience and confidence has grown in line with our capability. We have also worked diligently and successfully with our chosen shipbuilding capability partner, Bath Iron Works, to grow our knowledge and practices quickly and efficiently.

This audit report offers a detailed and considered examination of the wide breadth of matters material to the program. 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.

There are opportunities to improve performance. The governance arrangements of the AWD Alliance have not allowed common views of program performance, including most importantly the root cause of problem issues. In some instances this has prevented the resolution of these problems in a timely fashion commensurate with the inherent schedule and cost constraints of a shipbuilding program. The most demonstrable being the treatment of design change and the related matter of the claim arising from immature technical data. ASC's own productivity and performance in our shipyard and our supplier shipyards is improving as we apply the lessons we have learned, both good and bad, to the program.

Implementation of the ANAO's recommendations will improve performance of the AWD program and the naval industry. ASC's experience in the Collins and the AWD programs continues to highlight the challenge of transferring a design to production in a new country with differing cultures, technical processes, facilities, supply chains and customers. Further, the challenge of sustaining a complex warship in service relies on these industrial capabilities being resident in country. Australia must be able to do this if we are to develop a sustainable naval industry that can grow its productivity and perform to world class standards.

Now, in consideration of this audit, the task before all stakeholders is to apply the lessons we have learned and complete the program as efficiently as possible.

Impact of design change

ASC's experience on the Collins Class build program led ASC to propose a comprehensive integrated design build approach in its SEA 4000 Shipbuilder tender response. Our chosen capability partner, Bath Iron Works, confirmed this was an appropriate structure as a result of their experience on the DDG51 program. ASC's proposal contemplated an integrated Platform System Designer (PSD) and Shipbuilder design team within the Alliance, and had the PSD leading the early functional stages of design, with lead responsibility transitioning to the Shipbuilder in the later detailed and production design stages. This approach aimed to ensure that the end production design products matched the build strategy, facility capabilities and skill levels of the shipyard and its workforce. It also supported a more efficient build, as design products are closely aligned to production work packages.

In 2007, the Government selected a ship design based on the Navantia F-100 frigate in service with the Spanish Armada, the AWD Alliance was formed and the Alliance based target incentive agreement (ABTIA) was executed. Based on a proven design that was largely build to print, the program formed around an assumption that the AWD Alliance Shipbuilder's role was limited to performing production engineering supported by the core resources necessary to receive PSD data and process it through to planning and production. The verification of the PSD functional design changes would have been performed through a standard systems engineering review process completed by the Alliance in accordance with this expectation. As the audit report points out, the reality of the engineering effort required throughout the program has differed greatly from ASC's expectations and the risks associated with the design and build strategy were underestimated at the time of the June 2007 Second Pass submission to Government.

While there has been some debate regarding the 'design to production' process in the PSD Contract, it is clear that Navantia is required to work with the Shipbuilder to develop the AWD Build Strategy. The parties have endeavoured to achieve this outcome, however, the requirement to adjust the content, structure and schedule of design product deliveries in the PSD Contract in order to align with the AWD Build Strategy remains vague, and a major source of frustration for the Alliance parties. For example, as the Technical Data Package (TDP) content, structure and delivery schedule specified in the PSD Contract is based on Navantia's own build strategies for its shipyards, the resulting design products have not aligned with the AWD Build Strategy (i.e. a distributed vs centralised build strategy). This issue has been compounded by the design maturity issues noted below.

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On numerous occasions throughout the report there is a reference to the Alliance CEO estimating that 45 per cent of design change has been accommodated in sequence and of the remaining change, less than 20 per cent, has resulted in rework with 17 per cent estimated to have had no impact at all.

ASC notes these comments are not consistent with other statements in the audit attributed to the Alliance CEO that note the receipt of revised designs (frequently after block production was already completed) has resulted in large amounts of costly out-of-sequence rework.

All design change generates rework in some form and has a cost impact. This can range from re-review and release of revised drawings, replanning of work packages, scrapping of material already procured, to re-work of production work already completed. In addition it generates consequential delays as work is replanned, new material procured and production work performed out of sequence. The significant period between the initial drawing deliveries and the updated revisions being provided (12-24 months) has greatly exacerbated this problem on Ship 01. ASC has and continues to work with the Alliance participants and Navantia to minimise the impact of the design issues on all three ships, however, the magnitude of this issue cannot be ignored.

Design maturity

The Report identifies the warranties provided by the Industry Participants to the DMO in the ABTIA, however does not clarify that these warranties were given on the basis of the understanding that the Hobart Class was based on an existing and proven design from the Navantia F-100 (and more particularly the F-104 ship). This was reflected in the selection of the F-100 class as the "existing design" under the SEA 4000 Phase 2 arrangements, which drove ASC's expectations moving forward into negotiations and execution of SEA 4000 Phase 3 (the ABTIA).

While the ABTIA and PSD contract define the design baseline as the F-104, it is ASC's view that the Alliance is being delivered a production design derived from the F-105. The F-105 has evolved from the much earlier F-104 design and as a result, significant additional design risk has been driven into the AWD program due the extensive nature of the design evolution from the F-104 to the F-105. This has manifested itself as substantial rework driven by design immaturity issues, which run across many aspects of the AWD program and have caused considerable cost and delay to date.

The Report also states that Navantia has indicated that in its shipyard many minor design changes are resolved 'on the spot' by its experienced production workforce rather than through the revision of design documentation. This highlights a key issue faced by the Industry Participants, as it was, and remains, impossible to anticipate these design changes (or in some cases defects) as they are not incorporated or corrected in the provided design. This practice by Navantia is considered to be another significant contributor to the design immaturity issues that have been experienced by the Industry Participants, and has in effect resulted in Navantia correcting its known design issues at the Alliance's expense.

Schedule and Cost Claim

The Alliance CEO is quoted in the report as stating that there is no clear contractual provision to deal with the impact of design changes. ASC does not agree with this statement and contends that there are relevant contractual provisions dealing with this issue, which were the subject of considerable negotiation prior to execution of the ABTIA. Noting that the claim with respect to the design remains unresolved, it is not appropriate for any party to comment further on this issue.

Summation

ASC is presently working towards achieving key milestones for Ship 01 (the future HMAS Hobart) with a view to her launch later this year. Ships 02 and 03 are in production. As a program, we are moving to systems integration and test, which will be followed by acceptance. Notwithstanding past challenges, and those that remain ahead, ASC reaffirms its commitment as the AWD Alliance Shipbuilder to safely deliver three ships as efficiently as possible together with our Alliance partners.

Yours sincerely

Steve Ludlam
Chief Executive Officer and Managing Director

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Appendix 4: Raytheon Australia response to audit extract

Raytheon

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4 February 2014

Dr Tom Ioannou TJ 5/2
Australian National Audit Office
GPO Box 707
Canberra ACT 2601

AIR WARFARE DESTROYER PERFORMANCE AUDIT

Reference:

A. ANAO 2011/2088 dated 19th December 2013

Dear Dr Ioannou,

Reference A provided extracts of a draft report on the ANAO audit of the AWD program conducted during 2013 and sought a formal response on the draft report.

The formal response from Raytheon Australia to the extracts of the draft ANAO report provided under Reference A is at Attachment A.

I am available to discuss the Raytheon Australia response or the draft ANAO report.

Yours sincerely,

Michael Ward
Managing Director

Attachment:

A. Raytheon Australia Response – Draft Report on the ANAO Audit of the AWD Program

Raytheon

Attachment A

Raytheon Australia Response – Draft Report on the ANAO Audit of the AWD Program

1. AWD is a large and complex project which will deliver three world-class Hobart class ships and appropriate support system to the Royal Australian Navy. The Hobart class DDGs are highly complex platforms that combine a proven ship design with a highly complex Combat System tailored specifically to meet Australian requirements.

2. The draft ANAO report provides limited commentary on the AWD Combat System which, in and of itself, represents a significant component, in both cost and capability, of the AWD program. Whilst the Aegis Weapon System (AWS) provides the core air-warfare functionality, the Combat System elements tailored specifically to meet Australian requirements, such as Electronic Warfare, Underwater Systems, Short-Range Defence and Communications, account for some 52% of the total Combat System procurement.

3. Defence's decision early in the development of the AWD program to select the AWS for the core air-warfare functionality was the cornerstone for a low risk approach to the AWD Combat System. This was complemented by an approach to Combat System planning for the additional capability elements under guiding principles that included: low or no AWS modifications, Military off the Shelf (MOTS) or high Technical Readiness Level (TRL) for sub-systems, low integration risk, and low ship impact. This approach has and will ensure minimal program impact from Combat System related issues.

4. Progress on Combat System architecture, procurement and integration has been good. The report correctly identifies Raytheon's Earned Value performance on Combat System in September 2013 as being 69% complete with a cost and schedule performance of 100% and 99% respectively. That cost and schedule performance continues into 2014. In addition, some 32% of Combat System Performance Specifications have already been sold-off to the DMO and over 90% of Combat System interfaces will have been tested and verified in shore facilities prior to testing on the ship, verifying the integration approach and reducing the overall integration risk.

5. The report provides a good description of the AWD Alliance and recognises the complexity of the unique contract structures that underpin the AWD program. The report also provides a good synopsis of the benefits and limitations of the Alliance approach taken for the AWD program and correctly identifies that the Alliance approach would have benefited from having the Platform System Designer (PSD) as an additional Alliance participant.

6. It is very important to note that AWD Alliance is not an entity in its own right but rather represents the vehicle through which the combined capabilities of the three participants are applied to the program. The Alliance depends on the full capabilities of all parties being brought to bear to deliver the agreed outcome. This includes broader corporate capabilities rather than just those capabilities permanently committed under the Alliance structure. The Alliance also depends on each party working together to resolve issues as they arise and holding themselves accountable to the other parties for their individual performance within the Alliance in accordance with the ABTIA contract. Importantly, each party in the Alliance is reliant on the other parties; the ABTIA does not provide for contractual remedies between Industry Participants for individual performance and limited remedies between the DMO and the Alliance.

Raytheon

7. The report correctly identifies that the Alliance Estimate at Completion (EAC) predicts that the Total Cost Estimate (TCE) for the program will be exceeded. This cost over-run is predominantly in Ship Building and stems from a number of root causes that warrant further investigation. Costs over the TCE will be nominally be shared 50:50 between the Commonwealth and the Industry Participants resulting in a call on the DMO's program contingency and reduction of the Industry Participants' fee respectively. The report correctly highlights ongoing challenges in regard to Ship Building. The existing and potential future cost over-runs are of significant concern and the root causes of such must be addressed if program costs are to be adequately controlled.

Appendix 5: Navantia response to audit extract

Navantia

ANAO

Navantia comments to Extract Report

1. INTRODUCTION

Navantia's response to the AWD report is based on the "Extract for Navantia S.A", which provides partial visibility to the complete report. It is a well-structured report and one that aims to analyse the overall performance of the program by addressing the engineering issues and initial contractual Alliance arrangements as being two drivers of the delays in schedule and cost overruns of the program.

It is Navantia's intention to provide its best views on where the main issues of the AWD program remain with the intention only to be constructive rather than to justify Navantia's performance on some of the issues addressed in the report.

a) PROGRAM COMPLEXITY

AWD, as with any frigate program, is a very complex program, especially given the need to integrate a sophisticated and immature Combat System (at the time on signature, October 2007).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, CAPs…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.

This complexity is within the nature of the frigate design and construction business, and AWD is not an exception. Any shipbuilding organisation for complex naval vessels must be prepared to undertake, on a day to day basis, a significant number of revisions within

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Navantia

design, procurement, planning, production and test & trials activities, and in many occasions, late from a schedule perspective. This is confirmed by Navantia's experience in several programs with different scenarios, including the Spanish FFG program, where Navantia bought the design from Bath Iron Works (BIW).

Impacts due to modifications are unavoidable, but the key is to minimise those by means of an efficient process to manage problems on a daily basis. This requires an experienced workforce, an adequate management toolset, and processes with the necessary flexibility to react to unexpected problems in order to minimise the impact. We believe this idea is captured in point 5.5 (page 152) of the "extract".

The above illustrates what any contractor must expect in any naval program as complex as the AWD. Moreover, Phase 2 provided an opportunity to analyse and understand the complexity of the AWD program. In addition to the natural complexity described above, we should include additional factors such as:

- Distributed production across Australia and Spain
- Production management process (developed by BIW) not aligned with the drawings structure
- Drawings prepared for a more experienced workforce

In addition to the technical/industrial difficulties, significant subcontracting involves commercial issues which are typically rather complicated to solve, adding complexity to the program.

It is relevant to note that the report acknowledges that one of the objectives of the AWD program was to *establish and sustain a design capability in Australia that can support the evolution of the ships in service in responsive and cost effective manner*. This, a sensible objective, highlights the lack of experience in place at the time of the contract signature (2007) for achieving complex naval contracts such as AWD.

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Without aiming to argue about Navantia's performance, which we honestly believe has been and is very satisfactory, Navantia is fully convinced that the major driver for cost overruns and delays has not been the number of modification/revisions/errors/omissions as indicated in the Extract, but rather the deficiencies in the process and management of such issues, which in an experienced shipyard would have had a relatively small impact. In the case of the AWD program, the impact is very significant. In this respect, we strongly recommend that the procedures be analysed comprehensively with the aim of finding ways to improve efficiency and flexibility. It is also worth mentioning that the AWD cost issues are compounding the problem management process, focusing attention more in documenting the associated responsibilities rather than solving the problem.

Navantia recognises that credit is due to ASC and the Alliance for achieving in a very short period of time a level of skills to manage reasonably the program and its challenges, although more time and support is required to achieve a more effective performance of the program, which still has rather a long way to go.

b) REPORT CLARIFICATIONS

In this point Navantia would like to address some specific statements within the report that we consider relevant to provision of our perspective and to provide as much clarification as possible:

b.1) **Contractual arrangements. Alliance**

It is indicated that if Navantia was part of the Alliance, the engineering modifications would have been minimised. It is reasonable to believe that a more integrated organisation works better than a less integrated organisation, but regardless of the

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Navantia

contractual arrangements, design modifications are unavoidable and in most cases are outside the designer's control as explained above. Therefore, the modifications would have been required anyway. It is also questionable that, in the scenario of Navantia being a member of the Alliance, Navantia would have had the capacity to influence the overall management process of the workflow, planning, procurement, progress control, etc. as these are key areas where companies like to implement their own policies and methods.

We consider that it is rather unfair to associate the amount of engineering issues in AWD with the fact that Navantia is not exposed to the reduced incentive payments of the Alliance. Navantia has demonstrated its commitment to the program at all times, providing services beyond its contractual obligation and increasing its level of effort to adapt the information to a less skilled workforce.

b.2) Maintenance Drops

Supported by plenty of data, the report highlights the "maintenance drops" issue and arrival of updated information late in respect to the production schedule. It is important to understand that the Maintenance Drops is a contractual provision that aims to keep the drawings up to date periodically, where most of the information has been delivered well in advance, whenever known, via Definitive or other means, to minimise impacts as much as possible on the production floor. This is common practice in shipbuilding.

b.3) 3D Model

The inconvenience of not having available the 3D model of the design until 2010 is widely mentioned in the report. Irrespective of any commercial or IP issues, which are sensitive matters, the necessity of the 3D model as a tool for the fabrication of the AWD would not be significant until the outfitting jobs are well in advance. This means that having them in mid-2010 (construction was started last quarter of 2009)

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is quite before the real necessity appeared. In addition, Navantia is supporting the construction with people on site with access to the 3D models, or on line contact with the engineering department in Spain, to solve any query that required the 3D model since 2009. Based on this, Navantia understand that the lack of 3D models until 2010 could not have provoked any inconvenient.

b.4) ASC CEO. Media Statements

Navantia is surprised that the quotation in the report of the public statement by ASC CEO about *" ongoing design revisions might disrupt the delivery schedule, and that the delivery schedule for delivery of Ship 2 was tight"* is presented as a confirmation of the design issues impact. Navantia regrets this focus, as at that time, we considered that it was totally inappropriate to use a national public media to report on the difficulties, and decided not to argue publically on the issue, although from our perspective the statement was/has mislead the public opinion on the issue.

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Appendix 6: BAE Systems response to audit extract

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28 JAN 2014
10.00

BAE Systems Australia Defence Pty Ltd
ABN 51 006 870 846

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BAE SYSTEMS

Your Ref: 2011/2088 (dated 19 Dec 2013)

23 January 2014

Dr Tom Ioannou
Group Executive Director
Performance Audit Services Group
Australian National Audit Office
GPO Box 707
CANBERRA ACT 2601

Copy Via Email: Patrick.ONeill@anao.gov.au

Dear Dr Ioannou,

BAE SYSTEMS COMMENTS ON EXTRACT OF ANAO AUDIT REPORT - AIR WARFARE DESTROYER PERFORMANCE AUDIT

1. BAE Systems thanks the ANAO for the extract provided to us and the invitation to comment on the 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.

2. Notwithstanding the above, from the information that was included in the extract provided, BAE Systems fully agrees with the statements in the report 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. Clearly therefore, a key Recommendation in this report should be for the CoA to act quickly to ensure that the impending gap in naval shipbuilding currently being faced again by the industry is avoided.

3. In a couple of places, the report mentions defects that were found on the initial blocks produced by BAE Systems. Whilst we agree with the statement in the report that a lack of sufficiently experienced shipbuilders was a significant cause (certainly BAE Systems as a responsible contractor needed to and did take action on its shortcomings including using reach back and additional hiring to bring in additional experienced resources), it was not the only cause. There were design issues, issues with data provided to BAE Systems and issues with inexperience on the part of our customer for the blocks as well. Based on the Table of Contents showing the topics and tables included in the report, these may be mentioned in the report in pages that were not in the extract provided to us, but we obviously don't know if that is the case (if not, we believe they should be mentioned as other significant causes).

Cont. …/2

BAE SYSTEMS

4. The report does mention that during 2013, Blocks have been reallocated to our company because BAE Systems "has the capacity and skill to successfully take on an increased share of the workload". We agree and would further highlight that the Blocks reallocated during 2013 were offered and contracted on a fixed price, fixed schedule subcontract that results in lower cost and lower risk to ASC than if they had been reallocated under the original subcontract. This is the result of improvements in productivity and quality that come from having a continuity of work that allows a shipyard to increase and then maintain its experience and capabilities and therefore, should be given considerable weight in the overall audit conclusions and recommendations.

Please do not hesitate to contact the undersigned should you wish to discuss or clarify anything herein.

Yours Sincerely,

WILLIAM (BILL) SALTZER
Director Maritime

Direct - (03) 9334 8099

Encls.(2)
1. Summary of High Level Response – BAE Systems
2. Editorial Comments

Appendix 7: Forgacs response to audit extract

Forgacs

Forgacs Engineering Pty Ltd
ABN: 17 000 019 616
50 Fitzroy Street (PO Box 90)
Carrington NSW 2294
Tel: 02 4978 9100 Fax: 02 4962 2848

5 FEB 2014
9.45

29th January 2014.

Our Ref: 11270

Addressee:

Dr Tom Iaonnou 6/2

Group Executive Director Performance Audit Services Group

Reference: ANAO Letter Ref No: 2011/2088

Subject: **Forgacs Comments on ANAO Air Warfare Destroyer Performance Audit**

Many thanks for the opportunity to comment on the reference document. As directed in the reference, the comments are incorporated in the format required.

We have at all times made every effort to ensure comments are relevant to the report audit findings and the recommendations articulated as succinctly and emphatically as possible as follows:

Summary of Forgacs Response

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, cranage 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 naval combat system fitted ships in Australia is well articulated by the government the concern of Forgacs is twofold:

a. That the costs of ramping back up to a competitive ship yard to maintain the indigenous shipbuilding capability has 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
b. Once established, the ship building capability will once again dilute and disappear if not utilised in an ongoing ship building 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.

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www.forgacs.com.au

AWD and ASC program rescheduling of ship delivery dates has not manifested itself in any reduction or relief in Forgacs schedule delivery dates. On the contrary, as the costs of delivering the capability increased Forgacs has been required to direct its efforts to truncate the schedule and thus reduce project overhead. This had exactly the opposite effect intended by the rescheduling initiative of the AWD Alliance. Additionally, as schedule pressures increased the resource histogram also increased; to meet the demand, marginally skilled labour was recruited and quality reduced accordingly resulting in a demand for yet more labour. Once completed the consequent rapid reduction of the workforce as a result of the compressed schedule will also contradict the aim of the AWD reschedule to provide resource levelling.

A misinterpretation of the standards applicable to the AWD Program between the ASC on site team and Forgacs created a paradigm of rigid adherence to the specification to such an extent that thousands of hours of extra work on rectification of these issues caused significant delays in the delivery of the blocks, cost overruns and quality issues as a result of damage caused by the actual repair effort. Recent acknowledgement of this misinterpretation has resulted in a collaborative 'gold standard' agreement between Forgacs and ASC of the application of the specification especially with respect to the welding standard and block dimensional tolerances at the block mating edges; improving schedule and quality of the product at Forgacs, significantly reducing cost.

Yours Sincerely,

Lindsay Stratton
CHIEF EXECUTIVE OFFICER
Forgacs

Newcastle | Tomago | Hexham | Sydney | Brisbane | Gladstone

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Appendix 8: Organisational arrangements for capability development oversight

This appendix provides further detail on the arrangements discussed in paragraphs 2.60 to 2.64.

AWD Capability Management Steering Group

1. The AWD Capability Management Steering Group (CMSG) consists of a core group of five one-star RAN Officers assisted by invited members and permanent observers predominantly from the Navy, the Defence Science and Technology Organisation (DSTO) and the DMO. The Chief of Navy formed the CMSG to assist in the provision of oversight and coordination of the DDG build phase. Specifically, the Chair of the CMSG is responsible for:

- ensuring the correct specification of program outcomes;
- ensuring the Air Warfare Destroyer Capability Implementation Team identifies and involves appropriate stakeholders;
- encouraging discussion of issues;
- recording and monitoring issues and risks;
- resolving conflicts between stakeholders;
- seeking expert advice; and
- critically reviewing information presented to the CMSG.

Three-star Program Management Stakeholder Group

2. The three-star Program Management Stakeholder Group consists of DMO's General Manager Land & Maritime (Chair), the Chief of Navy, the Chief of the Capability Development Group, and the Chief Defence Scientist. It meets approximately every one to four months, and its role is to provide executive-level support, practical advice and specialist guidance to the DMO's AWD Program Manager. It is also intended to facilitate coordination between supporting agencies, and the delivery of supporting infrastructure. The three-star PMSG oversees the one-star PMSG, and arbitrates any decisions not able to be resolved by the one-star PMSG.

One-star Program Management Stakeholder Group

3. The one-star PMSG was formed in order to support the AWD Program Manager by: providing specialist advice and guidance, facilitating the resolution of stakeholder issues, endorsing project documentation and, where necessary, recommending changes to the capability baseline. The membership of the one-star PMSG is drawn from the AWD Program and the RAN.

AWD Program Management Office

4. The DMO's AWD Program Management Office (PMO) is the Defence organisation that has overall responsibility for ensuring that the DDGs are delivered to the RAN on time, on budget and to the required capability. In the AWD Alliance contract, it is the PMO that represents the interests of the Commonwealth on a day-to-day basis. The PMO is located within the AWD Systems Centre at the Techport Australia Maritime Precinct in Adelaide. As at July 2013, the PMO consisted of 55 personnel, and an additional 27 Defence personnel and two Lockheed Martin personnel funded by Defence were working in the AWD Alliance.

AWD Capability Implementation Team

5. In 2008, the RAN identified that it would need additional personnel to undertake its newly assigned Capability Management responsibilities, and that these personnel would be required to hold specific skill sets in project management.[394] Since then it has established an AWD Capability Implementation Team (AWD CIT) to coordinate all of the activities required to deliver the AWD capability. As at January 2013, the AWD CIT consisted of a relatively small team of eight personnel.[395]

AWD Transition and Coordination Management Group

6. The AWD Transition and Coordination Management Group (TCMG) was established in April 2012 to facilitate interaction between the AWD Program, the RAN and other Defence stakeholders to ensure a smooth

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394 Mortimer Review Implementation Governance Committee, *The Role of the Capability Manager under Mortimer Framework–Capability Manager Input (Navy)*, October 2009.

395 In contrast, the New Air Combat Capability Implementation Team, which is acquiring the unmodified Military-Off-The-Shelf F-35 Joint Strike Fighter for the Royal Australian Air Force and planning its transition into service, had 90 filled positions in 2012. ANAO Audit Report No.6, 2012–13, *Management of Australia's Air Combat Capability—F-35A Joint Strike Fighter Acquisition*, p. 59.

transition of all the Fundamental Inputs to Capability, including support systems, involved in establishing the new DDG capability.

7. The TCMG includes representatives from the RAN, Defence's Capability Development Group, the AWD Program Management Office, and the Alliance, and may also have representatives from other defence groups such as Defence Support Group and Joint Logistics Command. The TCMG reports to the one-star CMSG.

AWD–LHD Sustainment Steering Group

8. The AWD–LHD Sustainment Steering Group was established in 2009, and has been commissioned to provide oversight, direction, guidance and support to two Sustainment Groups: one formed by the AWD Program Management Office (for the Hobart-class DDGs), and the other formed by the Amphibious Deployment and Sustainment Program that is acquiring the LHD Amphibious Assault Ships. These two groups have the task of defining a sustainment organisation for their respective capability platforms. The resulting organisations will encompass the full range of DMO Systems Program Office functions and enablers, as well as wider support functions such as training and facilities functions.

9. The membership of the AWD–LHD Sustainment Steering Group includes the DMO's Director General Major Surface Ships (Chair), the AWD Deputy Program Manager (Sustainment), the DMO's Director General Maritime Support, the RAN's Director General Logistics–Navy, Director General Navy Capability, Transition and Sustainment, and the LHD Systems Program Office Director.

Index

D

E

F

G

H

S

T

V

W

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Design and Implementation of the Liveable Cities Program
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