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Performance Audit

‘Wedgetail’ Airborne Early Warning and Control Aircraft: Project Management

Department of Defence

Australian National Audit Office

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Canberra ACT
2 March 2004

Dear Mr President
Dear Mr Speaker

The Australian National Audit Office has undertaken a performance audit in the Department of Defence in accordance with the authority contained in the *Auditor-General Act 1997*. I present the report of this audit and the accompanying brochure. The report is titled *'Wedgetail' Airborne Early Warning and Control Aircraft: Project Management*.

Following its tabling in Parliament, the report will be placed on the Australian National Audit Office's Homepage—<http://www.anao.gov.au>.

Yours sincerely



P. J. Barrett
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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Audit Manager
Dr Raymond McNally

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Abbreviations

AAR	Air to Air Refuelling
ACWP	Actual Cost of Work Performed
ADF	Australian Defence Force
ADFTA	Australian Defence Force TDL Authority
AEO	Authorised Engineering Organisation
AEW&C	Airborne Early Warning and Control
AEW&CPO	Airborne Early Warning and Control Project Office
AEW&CSPO	Airborne Early Warning and Control System Program Office
AIOS	Acceptance Into Operational Service
AIT	Analysis and Integration Team
AMO	Authorised Maintenance Organisation
AMS	Airborne Mission Segment
AMTC	Australian Military Type Certificate
ANAO	Australian National Audit Office
ANZ	Australian and New Zealand
APSA	Acquisition Process Support Aerospace
ARDU	Aircraft Research and Development Unit
ASC	AEW&C Support Centre
ASCD	Airborne Surveillance and Control Division
ASD	Aerospace Systems Division
ASF	AEW&C Support Facility
AT&E	Acceptance Test and Evaluation
BBJ	Boeing Business Jet
BCWP	Budgeted Cost of Work Performed
BCWS	Budgeted Cost of Work Scheduled
CAF	Chief of Air Force
CASA	Cost Analysis and Strategy Assessment

CATT	Commonwealth AEW&C Test Team
CCP	Contract Change Proposal
CCB	Configuration Control Board
CDF	Chief of the Defence Force
CDR	Critical Design Review
CENGR	Chief Engineer
CEPMAN 1	Capital Equipment Procurement Manual 1
CMMI	Capability Maturity Model Integration
CONOPS	Concept of Operations
CPI	Cost Performance Index
CS ²	Cost and Schedule Control System
CSIG	Corporate Services and Infrastructure Group
DAO	Defence Acquisition Organisation
DAOMAN	Defence Acquisition Organisation MANual
DAR	Design Acceptance Representative
DCMA	Defense Contract Management Agency (US)
DGTA	Directorate General Technical Airworthiness
DGTA-ADF	Director General Technical Airworthiness – ADF
DIE	Defence Information Environment
DMO	Defence Materiel Organisation
DMOKS	Defence Materiel Organisation Knowledge System
DOFA	Department Of Finance and Administration
DRP	Defence Reform Program
DSTO	Defence Science and Technology Organisation
DT&E	Development Test and Evaluation
EAS	Equipment Acquisition Strategy
EMS	Engineering Management System
EMP	Engineering Management Plan
EV	Earned Value

EVMS	Earned Value Management System
EW	Electronic Warfare
FAA	Federal Aviation Administration (US)
FCA	Functional Configuration Audit
FEG	Force Element Group
FMS	Foreign Military Sales
FOT&E	Follow-on Operational Test and Evaluation
FPS	Function and Performance Specification
FSPPC	Force Structure Planning and Programming Committee
GFD	Government Furnished Data
GFE	Government Furnished Equipment
GFI	Government Furnished Information
GFM	Government Furnished Materiel
GTTI	Government Titled Technical Information
HASC	Head Airborne Surveillance and Control
IBR	Integrated Baseline Review
IDA	Initial Design Activity
IFF	Identification Friend or Foe
ILS	Integrated Logistics Support
IP	Intellectual Property
IPT	Integrated Product Team
ITR	Independent Technical Review
JORN	Jindalee Operational Radar Network
JP	Joint Project
JTWG	Joint T&E Working Group
LAN	Local Area Network
MASF	Materiel Acquisition and Sustainment Framework
MESA	Multi-role Electronically Scanned Array
MOS	Measures of Operational Suitability

MSE	Mission System Equipment
MSS	Mission Support System
NPOC	Net Personnel and Operating Costs
OFT	Operational Flight Trainer
OMS	Operational Mission Simulator
OT&E	Operational Test and Evaluation
PAT&E	Production Acceptance Test and Evaluation
PDAS	Project Design Acceptance Strategy
PCA	Physical Configuration Audit
PDR	Preliminary Design Review
PIF	Performance Incentive Fee
PMAP	Project Management and Acquisition Plan
PMB	Performance Measurement Baseline
PMM	Project Management Method
PMMv2	Project Management Method version 2
PSM	Practical Software and Systems Measurement
QA	Quality Assurance
QC	Quality Control
RMS	Risk Management System
RPT	Resident Project Team
SAMS	Standard Acquisition Management System
SETA	Systems Engineering Technical Assistance
SIDA	Strategic Industry Development Activity
SIL	System Integration Laboratory
SISMS	Standard In Service Management System
SOH&S	System Occupational Health and Safety
SOI	Statement of Operating Intent
SOW	Statement of Work
SPI	Schedule Performance Index

SPMM	Standard Project Management Method
SPO	System Program Office
SR	Service Release
SS	System Specification
ST&E	Supportability Test and Evaluation
STC	Supplementary Type Certificate
TAT&E	Type Acceptance Test and Evaluation
T&E	Test and Evaluation
T&EC	Test and Evaluation Concept
TDL	Tactical Data Link
TEMP	Test and Evaluation Master Plan
TIE	Tactical Information Environment
TRIMS	Technical Risk Identification and Mitigation System
TULIP	Through Life Interoperability Planning
UAV	Unmanned Aerial Vehicle
USAF	United States Air Force
USD	United States Dollar
USDM	Under Secretary Defence Materiel
US FAA	United States Federal Aviation Administration
V&V	Verification & Validation
WBS	Work Breakdown Structure

Wedgetail Airborne Early Warning and Control Aircraft



Source: The Boeing Company.

Summary, Conclusions and Recommendations

Summary

Background

1. In 1998, Defence awarded Initial Design Activity (IDA) contracts, valued at \$A 8.483 million each (December 1997 prices), to the leading tenderers for Defence's 'Wedgetail' Airborne Early Warning and Control (AEW&C) project. In July 1999, the then Minister for Defence announced that The Boeing Company (Boeing) was the preferred tenderer for the project. It was envisaged that the first of seven aircraft would be delivered in 2004–05 with a total cost of the project estimated to be over \$2 billion.
2. In December 2000, the contract was awarded to Boeing. The Wedgetail project has an approved budget of \$A 3.43 billion as at December 2003.¹ It is to provide the Australian Defence Force (ADF) with an AEW&C capability based on four Boeing 737 AEW&C aircraft and associated supplies and logistic support. The Airborne Surveillance and Control Division of the Defence Materiel Organisation (DMO) manages the Wedgetail project.² By November 2003, Defence had spent \$A 1.107 billion on the project.
3. The AEW&C mission will be to conduct surveillance, air defence, fleet support and force coordination operations in defence of Australian sovereignty and other national interests. When required, the AEW&C capability will support civil or military operations through law enforcement, regional cooperation and peacekeeping.
4. At the time of the audit, the Wedgetail project was in its acquisition phase. The AEW&C systems were undergoing varying stages of design, development, integration and test. Development of the principal component of the system, the Boeing 737 AEW&C Airborne Mission Segment, involves extensive integration of advanced radar, communications and self-protection systems, and major structural and systems modifications to the 737-700 airframe, avionics and engines. The 737 AEW&C aircraft are valued at some five times the cost of the unmodified 737 aircraft.

¹ The Wedgetail capability costs include the \$2.63 billion Wedgetail acquisition contract with Boeing, which covers four aircraft, two additional mission system sets, associated support systems and facilities. The project budget also includes a further \$800 million, outside the Boeing contract, for logistics support, facilities, Government Furnished Materiel, and contingencies.

² Defence's AEW&C project is also referred to as 'AIR 5077—Airborne Early Warning and Control', 'Project Wedgetail' or 'the Wedgetail project'. This project will produce the first Boeing 737-based AEW&C aircraft.

5. The Wedgetail project has attracted wide interest in terms of its systems development and management. Defence's management of the project is seen to benefit from lessons learnt in other major Defence projects, including the Jindalee Operational Radar Network (JORN) project and the Collins submarine project. It is also seen as a 'model' for future DMO projects.

Audit Approach

6. The audit objective was to assess the adequacy of DMO's management of the AEW&C acquisition post December 2000 contract signature. The audit examined the project from the project management perspective, including the link between the requirements, acquisition and in-service support phases. The audit did not examine the processes giving rise to the terms of the contract and the Government's approval. Nor did it examine the project's management of the AEW&C Australian-US Government-to-Government contracts,³ or the project's infrastructure components managed by Defence Corporate Services and Infrastructure Group.

Key Findings

Defining and Acquiring the capability (Chapter 2)

7. Since the Wedgetail acquisition contract was signed in December 2000, the approved cost of the AEW&C capability has increased by \$319 million from \$3.11 billion to \$3.43 billion, as of December 2003.⁴ This increase was composed of \$A 164.1 million in labour and materiel cost increases, \$A 158.5 million in foreign exchange adjustments, and \$A 3.5 million in project cost decreases.

8. The AEW&C capabilities' operation and personnel costs, based on a four AEW&C aircraft with a 25 year life of type, are yet to be fully determined. However, the prime acquisition contract requires Boeing to iteratively calculate operating and maintenance costs using a life-cycle cost model. At the time of the audit, the Wedgetail project office estimated the AEW&C capabilities' operating and personnel cost to be some \$A 90 million per annum. However, the estimate will improve in accuracy

³ Foreign Military Sales contracts.

⁴ The AEW&C capability cost increases relate to the Boeing contract and to other contracts for associated supplies and logistic support.

as the AEW&C capability design matures and as in-service support contracts become more clearly defined.

9. Defence adopted a fixed price incentive fee contracting strategy that holds Boeing responsible for system performance, covering all aspects of the design, construction, testing, documenting and offering for acceptance of the Wedgetail systems. The contract contains a Performance Incentive Fee (PIF) pool, limited to \$US 40 million, available for superior effort in management and technical achievement.

10. The ANAO observed the project was progressing ahead of schedule against some 14 progress milestones and, by October 2003, Defence had approved PIF payments to Boeing totalling \$US 11.8 million.

11. The Wedgetail project's strategy of acquiring advanced technology has important organisational design implications. Boeing's 737 AEW&C program and Defence's Resident Project Team (RPT) in Seattle have implemented Integrated Product Team (IPT) and Analysis and Integration Team (AIT) structures, comprised of the range of specialists needed to design, develop and support the products and systems Boeing is to deliver. These teams provide extensive opportunities for close working relationships between developer and customer organisations. This increases the probability that the project will remain continuously effective in developing engineering and management solutions to the 737 AEW&C design and development challenges, which are at the leading edge of AEW&C aircraft technology.

12. Defence has a Project Governance Board, which comprehensively and formally reports monthly to DMO's Under Secretary Defence Materiel (USDM) on the Wedgetail project's current and projected schedule, cost, and capability risks and issues. The IPT structure and the Governance Board arrangement align with concepts put forward in Defence's capability systems life-cycle management policy. They also maximise opportunities for effective stakeholder engagement and assurance that project management remains effective.

Project Management and Systems Engineering (Chapter 3)

13. The Wedgetail project team has not implemented DMO's recent Project Management Method (PMM). Instead, it has retained a 20-volume Project Management and Acquisition Plan (PMAP) based on earlier project management policies and procedures. This has been continuously evolved to include selected PMM concepts. It has also implemented technical and operational regulatory policies and processes, innovative progress measurement processes, and innovative risk and issues management processes.

14. The Wedgetail Project Manager has sought assistance in assessing how the project may be aligned with the PMM. The intention is to implement this method in the project's in-service support phase, which commences in 2007. This strategy seems to be reasonable given the large investment the Wedgetail project team has made in developing its PMAP, and the competent way it has continually evolved it.

15. The Wedgetail project's systems engineering processes have been tailored to provide sufficient data to allow effective management of the project. Audit evidence indicates the Wedgetail project team has effectively managed its project management and systems engineering responsibilities.

16. The project must, by 2008, satisfy ADF technical, operational and logistics requirements. The ADF's Airworthiness Board will assess the project's performance against these requirements, and advise the Chief of Air Force on the AEW&C aircraft and systems type certification and release into operational service.

17. Chapters 4, 5 and 6 discuss the Wedgetail project's technical, operational and logistics requirements and management processes. Chapter 7 outlines the project's monitoring, evaluating and review processes, and the progress measurements associated with the assurance that progress toward certification and service release is being achieved satisfactorily. Chapter 8 outlines risk and issues management processes being applied to the project's requirements and acquisition phases.

Technical integrity (Chapter 4)

18. The Wedgetail project is satisfying the ADF's technical integrity management requirements in terms of ensuring that design approval and design acceptance requirements are reflected in the AEW&C acquisition contract, the project's engineering management system, and in technical review processes.

19. The AEW&C acquisition contract requires Boeing to conduct an extensive design, and development process; provide design approval certification of the AEW&C design; and to gain airworthiness certification from an independent airworthiness authority. Consequently, Boeing has achieved and maintained Authorised Engineering Organisation (AEO) status for the design, development, modification, integration and verification of the 737 AEW&C aircraft. The United States Federal Aviation Administration (US FAA) is the project's independent airworthiness authority.

20. The Wedgetail project is implementing an ADF-approved design acceptance strategy and process; and has demonstrated its compliance

with the airworthiness regulations via a formal audit carried out by the ADF's Directorate General Technical Airworthiness Project Regulation staff. That audit found that the Wedgetail project's Engineering Management System was effective and robust, and that the RPT was a very competent organisation.

21. Project records indicate Boeing and the RPT are maximising the probability that Wedgetail project's design acceptance process will be fully effective in satisfying technical integrity requirements.

Operational integrity (Chapter 5)

22. Operational integrity is largely demonstrated through test and evaluation (T&E) processes, which aim to reduce the risk that the aircraft and its systems will not satisfy user expectations in terms of cost, quality, delivery schedule, mission success, system vulnerability and personnel safety.

23. The project has an extensive T&E organisational structure backed by contractual obligations requiring Boeing to conduct development and acceptance T&E processes. These are consistent with the project's overall management strategy of Boeing having total system performance responsibility for the Wedgetail AEW&C system.

24. Representatives from Boeing and Defence have formed a Joint Test and Evaluation Working Group to resolve T&E issues and to monitor the progress of the T&E program. In addition, a Defence AEW&C Test Team was established to support the Wedgetail T&E program and to facilitate the smooth transfer of responsibility for T&E from acquisition to the in-service phase.

25. Air Force intends to embed a number of its operators and maintainers within the Boeing T&E organisation in development and acceptance T&E roles. This arrangement is expected to provide valuable Wedgetail system knowledge and T&E experience, which will assist the Air Force's Wedgetail operational T&E program.

26. The T&E program, in its initial stage of development and implementation, appears, at the time of the audit, to represent a comprehensive and sound approach to demonstrating the Wedgetail's operational integrity. However, conclusive evidence of how effectively the Wedgetail project is performing the operational integrity process will not be apparent until 2005, when acceptance T&E is scheduled to commence.

Logistics integrity (Chapter 6)

27. The Wedgetail project needs to establish logistics support arrangements that comply with the ADF's technical regulation management requirements regarding the AEW&C system's continual technical and operational integrity.

28. The contract requires Boeing to conduct logistics support analysis in order to identify and evaluate the logistic support necessary to effectively maintain the AEW&C system's airworthiness. At the time of the audit, the logistics data and analysis were evolving in line with the maturing system design and development.

29. The Wedgetail project's \$A 1.295 billion Australian Industry Involvement (AII) program is a major contributor to the project's logistics support arrangements in terms of establishing, in Australia, the ability to manage, control, support and adapt the system throughout its service life. The project's AII priorities have, to a large degree, been factored into the AEW&C system acquisition contract, or are the subject of ongoing negotiations related to the in-service support arrangements needed when the first AEW&C aircraft is delivered in 2006.

30. However, there have been some initial setbacks, such as a lack of US Government export licences for some of the project's advanced technology that precluded the award to local industry of contracts valued at some \$A 44 million. Another \$A 50 million in AII was not possible due to the decision not to fit-out two Wedgetail aircraft in Australia. That outcome resulted from the decision to purchase only four aircraft, rather than the previously planned seven, which made the Australian fit-out economically non-viable.

31. At the time of the audit the AII was ahead of schedule, with achievement to August 2003 valued at \$A 533 million, against \$A 335 million planned.

Progress measurement (Chapter 7)

32. The Wedgetail project's progress measurement systems are important components of the integrity processes, in that they measure progress in technical, operational and logistics terms, as well as cost and schedule achievement. This multiple perspective makes it difficult for deviations from planned progress to remain undetected by management at all levels. Hence there is greater probability that development problems are identified and corrected in a timely and effective way. This is particularly important for the Wedgetail project, given its advanced

technology and that three-quarters of the acquisition contract price is to be paid prior to the acceptance of the first AEW&C aircraft.

33. In aggregate cost and schedule terms, from September 2002 to August 2003, the system acquisition contract's actual costs were slightly below budgeted costs, and work performed was marginally behind work scheduled. Although not ideal in a schedule sense, this is nevertheless an effective outcome. However, attempts to maintain the schedule in an advanced technology area of the project have resulted in increased costs to contractors.

34. In milestone achievement terms, by October 2003, Boeing had completed three milestones on schedule and 14 ahead of schedule. Of these, seven were completed more than two months ahead of schedule.

35. Progress measurements include validating progress toward arriving at the 'right' AEW&C system as defined in the system specification, and verifying that system development follows agreed processes as defined in the statement of work. The Wedgetail IPTs make extensive and routine use of incremental build processes, and computing system development measurements, in order to minimise computing system development risk. This work is crucial to the project's success.

36. The audit evidence suggests that the progress measurements have assisted the IPTs to identify early project risks and issues, and are enabling corrections to be achieved in a timely and effective way, at no additional cost.

Risk and issues management (Chapter 8)

37. The Wedgetail project contains extensive areas of advanced technology development. Consequently, there are significant risks requiring concerted effort by the contractors to resolve, as well as risks needing treatment by Defence in terms of ongoing system engineering requirements management and contingency management. The Wedgetail project team has employed a comprehensive approach to risk management. It sought, through Defence-funded Initial Design Activities, to refine and reduce project risks as far as possible before the project proceeded to the system acquisition contract. This strategy involved developing and reviewing project requirements in discrete and successively detailed stages, and at each stage refining the Wedgetail system's function and performance specifications.

38. Since contract signature in December 2000, the Wedgetail project team has continuously identified and tracked its risks by monitoring the project's cost and schedule indicators and system development

measurements, and by maintaining insights into all areas of AEW&C system development through its IPT and AIT arrangements with Boeing.

39. The ANAO review of project records indicate that the RPT was following the project's risk management guidelines, and that it remained actively engaged in risk management processes. As the need arose, the RPT engaged its Systems Engineering Technical Assistance contractor, and sought US Air Force assistance with identifying and analysing risks.

40. The project uses a Defence corporate Risk Management System (RMS) which, at the time of the audit, essentially provided a risk logging arrangement and was under further development. The RMS enables a structured and comprehensive approach to risk management. However, it contains scope for improvement in terms of an extension of its functions to include financial analysis of risk exposure, and strengthened links to contingency fund management. At the time of the audit, the RPT performed that function separately.

41. Issues, on the other hand, are unplanned events that have happened and which require management intervention to reduce negative impacts on project outcomes. This intervention may take two forms—a request to the customer organisation for a specification change or a change in acceptance criteria; or additional costs falling on suppliers to correct off-specification work. Hence issues management is reactive, whilst risk management is pro-active. At the time of the audit, DMO's Business Systems Branch was working with the RPT on integrating an issues management database into the RMS.

42. Project records indicate that the RPT is managing its issues satisfactorily and that, in a similar way to its risk management, the RPT takes the important step of financially analysing their issues and linking them with its contingency fund management and reporting.

43. The draft DMO policy on management of contingency provisions in major capital equipment projects allows for the expenditure of contingency funds for the constructive and innovative development of initiatives to contain and reduce emerging risks. The ANAO's case study of the Wedgetail project's contingency fund usage revealed the project benefited from the multi-disciplinary perspective provided initially by its IPTs and finally by the project's Configuration Control Board. It also benefited from the Business Case approach to contract changes, which allowed the sponsor (usually one of the IPT Leaders) to advance views within a structured format.

Overall conclusions

44. Since the mid-1990s, Defence has effectively managed the AEW&C requirements phase and the links to the acquisition phase. Even though much of that work pre-dated Defence's post-1990s acquisition reforms, in essence it satisfies the acquisition phase requirements of the most recent defence capability development process, namely, the capability systems life-cycle management process. The ANAO found that this substantial body of work provides the project's acquisition personnel with a vital foundation of capability requirements analysis, effective contracting strategies, and project management strategies and processes.

45. Conclusive evidence as to how effectively Defence has performed its Wedgetail acquisition management responsibilities will be some years off given that, at the time of the audit, the AEW&C systems were still in their early development phase, with first system integration scheduled for late 2005.

46. However, we note that the Wedgetail project team has implemented organisational designs, strategies and management processes, which remain appropriate for this advanced technology project. The ANAO found that the progress measurement system indicates the contractors are on track to effectively meet required outcomes, within an ambitious development schedule. The ANAO plans to include a follow-up audit of the Wedgetail acquisition project in the 2005–06 audit work program.

47. At the time of the audit field work, the ANAO found the key factors contributing to successful management of this complex project include:

- a carefully developed and effectively implemented project management method, coupled with effectively tailored systems engineering processes. These enable sufficient data to be available for effective management of the project, and ensure that process tailoring continues as needed;
- extensive initial design and risk management processes that sought to define and reduce project risks as far as possible before acquisition contract signature. This included a requirements definition process that, in discrete and successively detailed stages, refined the acquisition contract's statement of work and the Wedgetail system's function and performance specifications;

- well-developed and competently implemented design approval and acceptance strategy and engineering management systems, that comply with the ADF's technical regulations;
- a comprehensive test and evaluation strategy and organisational structure, designed to demonstrate the system's operational integrity;
- appropriate logistics support strategies aimed at achieving compliance with the ADF's technical regulations in terms of providing assurance concerning the AEW&C system's continued technical and operational integrity;
- effective incremental build processes, and computing system development measurements, capable of detecting early deviations from planned progress and then informing management at all levels. The measurements form an integral part of the project's risk and issues management systems, rather than simply satisfying progress reporting requirements; and
- comprehensive risk and issues management systems that remain actively engaged with project management and systems engineering processes, as well as with contingency fund management.

48. The ANAO audit made six recommendations, indicating where there was some opportunity for improvements in DMO. Two recommendations are specific to the Wedgetail project and aim to assist the project to sustain its management achievements. The remaining four are relevant to DMO's reform program. These aim to assist other DMO projects to benefit from the management innovations used by the Wedgetail project.

Defence's response

49. Defence agreed with all six recommendations. Defence advised the ANAO of its response to this audit as follows:

Defence agrees with the structure, content and findings of the report.

The report correctly concludes that the Wedgetail project is being managed effectively and efficiently, and is employing a comprehensive risk management approach. Defence agrees with the audit finding that, while conclusive evidence of the effectiveness of the acquisition approach will only be available when the system meets its delivery milestones in late 2006, the Wedgetail team has implemented appropriate organisational

designs, strategies and management processes for this advanced technology project.

The DMO reform program aims to ensure that all projects are managed effectively, and that they learn from the experiences of others. Consequently, I welcome the recommendations in the report which aim to assist other projects to benefit from the management innovations used by the Wedgetail project; Defence agrees all the recommendations and has, indeed, commenced their implementation. Specific comments against each recommendation are at the enclosure to this letter. [These comments are provided under each recommendation, and together with the comments above form Defence's full response to the audit.]

Recommendations

Set out below are the ANAO's recommendations, with report paragraph references and an indication of the Defence response. The recommendations are discussed at the relevant parts of this report.

- Recommendation No.1**
Para. 7.45
- The ANAO recommends that Defence:
- (a) evaluate the use of the Wedgetail project's computing system development measurement concepts and processes as a practical example of a successful implementation of its Practical Software and Systems Measurement Policy; and
 - (b) incorporate any lessons learnt in the current review and update of the policy.

Defence response: Agreed.

- Recommendation No.2**
Para. 7.60
- The ANAO recommends that the Wedgetail project team implement the incremental configuration audit program, in order to further improve the reliability of its technical review process.

Defence response: Agreed.

- Recommendation No.3**
Para. 7.74
- The ANAO recommends that consideration be given to the costs and benefits of maintaining its present Resident Project Team personnel profile, including its Design Support Network and Systems Engineering Technical Assistance arrangements, until the first Wedgetail aircraft is delivered.

Defence response: Agreed.

**Recommendation
No.4
Para. 8.40**

The ANAO recommends that Defence include in its review of project risk management policy the use of the Technical Risk Identification and Mitigation System in future capital equipment acquisition projects, including those projects progressing toward contract signature.

Defence response: Agreed.

**Recommendation
No.5
Para. 8.49**

The ANAO recommends that Defence implement an enhanced risk management system consistent with the outcomes of its risk management policy review, which would include:

- (a) the integration of risk management and issues management;
- (b) adding a financial analysis function to both systems; and
- (c) piloting the design, development, testing and evaluation of the new system within the Wedgetail project.

Defence response: Agreed.

**Recommendation
No.6
Para. 8.63**

The ANAO recommends that Defence pilot the design, development, testing and evaluation of its new risk management system within the Wedgetail project.

Defence response: Agreed.

Audit Findings

1. Introduction

This chapter provides a general introduction to Defence's AEW&C capability acquisition program and describes the audit approach and report structure.

Background

1.1 Defence's AEW&C program is developing an entirely new ADF⁵ capability based on advanced AEW&C technology. Program needs and requirements analysis commenced in the 1980s and involved the concerted effort of capability development personnel within the former ADF Headquarters, the Air Force and the former Defence Acquisition Organisation (DAO—now known as DMO). In December 2000, the program progressed to the acquisition phase, and is managed by DMO's AEW&C System Program Office (SPO).

1.2 In 1986, Defence evaluated industry proposals concerning airborne surveillance and early warning systems.⁶ In 1989, the Department commenced planning the acquisition and employment of AEW&C aircraft.⁷ In 1991, Defence considered the introduction of an AEW&C capability would improve air defence effectiveness. At the time, Defence decided that, if higher levels of funding were provided, it would bring forward proposals that had been deferred or reduced. The AEW&C capability was one such proposal.⁸

1.3 During the 1990s, Defence refined its reasons for acquiring an AEW&C capability and the associated cost estimates. In May 1994, the then Force Structure Planning and Programming Committee endorsed the project's Major Capability Submission, put forward by the then Headquarters ADF, and approved the project's first phase.⁹ This phase involved a \$A 1.66 million Project Definition Study, which assessed the capability deficiencies in the ADF's Air Defence System and the most effective materiel alternative needed to address the deficiencies. Air Force

⁵ The ADF comprises the three Australian Defence Services—Navy, Army and Air Force.

⁶ Department of Defence, *Defence Report 1985–86*, September 1986, p.12.

⁷ Department of Defence, *Defence Report 1988–89*, September 1989, pp.18, 93.

⁸ Department of Defence, *Force Structure Review 1991*, May 1991, pp.2, 41. See also *Defending Australia Defence White Paper 1994*, November 1994, pp.42, 47, 155.

⁹ Major Capability Submissions were a key component of the then *Force Structure Development Process*, which has since been replaced by capability development policy and processes defined in the *Capability Systems Life Cycle Management Guide 2002*. Department of Defence, Defence Instruction (General) ADMIN 05-1, *The Force Development Process*, January 1992 [superseded internal instruction].

completed the study in December 1995. The latter assessed the AEW&C requirements in terms of system performance and platform numbers.¹⁰

1.4 In February 1996, the Force Structure Planning and Programming Committee approved additional phases, namely:

- Phase 2—Initial Design Activities, estimated at some \$A 50 million (December 1996 prices), which sought to mitigate the project's technical risks;
- Phase 3—the acquisition of an initial fleet of at least four aircraft at some \$A 1.450 billion (December 1996 prices) to be decided in 1997–98; and
- Phase 4—the acquisition of a follow-on fleet of additional aircraft at some \$A 600 million (December 1996 prices) to be decided in 2000–02.¹¹

1.5 Phase 2 commenced on 7 May 1997, when DAO requested tenders for initial design activities.

1.6 In 1998, Defence awarded Initial Design Activity (IDA) contracts, valued at \$A 8.483 million each (December 1997 prices), to the leading tenderers for the project, that is, Boeing, Lockheed Martin Corporation and Raytheon Systems Company. These contracts reduced the project's risks by funding each company to refine their appreciation of Air Force's requirements for an AEW&C system; to advance their design specifications; and to agree with Defence on a process for tailoring systems engineering processes.¹² These contracts were completed in mid-1999.¹³ Records indicate that they were an integral part of an effective contracting strategy.

1.7 Defence combined Phases 3 and 4 into a single acquisition phase in 1997. In July 1999, the then Minister for Defence announced that Boeing was the preferred tenderer for the project. It was envisaged at the time that the first of seven aircraft would be delivered in 2004–05 with a total cost of

¹⁰ Royal Australian Air Force, *Project Air 5077 Airborne Early Warning and Control Equipment Acquisition Strategy Phases 2 and 3 Issue 1*, 25 July 1996, pp.3–4. Materiel Division—Air Force, *Air Force New Major Investment Program 1996–2001*, p.2.

¹¹ Royal Australian Air Force, *Project Air 5077 Airborne Early Warning and Control Equipment Acquisition Strategy Phases 2 and 3 Issue 1*, 25 July 1996, pp.3–4.

¹² In Boeing's case the IDA contract was signed on 28 January, Project Air 5077, Contract C338364 *Conditions of Contract*, p.20.

¹³ Department of Defence, Management Audit Branch, *Initial Report on the Airborne Early Warning and Control Project, Project Definition and Initial Design Activities*, December 2000, p.5.

the project estimated to be over \$2 billion. This decision was based on an evaluation of the tendered operational capability, AII, cost and risk.¹⁴

1.8 The Government considered the future of the AEW&C project within the context of the Defence 2000 White Paper. It decided to proceed with the acquisition of a four aircraft 'one-area' of operations AEW&C capability, with options to be included in the contract for additional three aircraft for a limited to full second area of operations capability later in the decade.¹⁵ The \$A 2.477 billion (December 2000 prices) Wedgetail system acquisition contract with Boeing was signed on 20 December 2000.

1.9 In addition to the systems acquisition contract, there is \$A 633.6 million (December 2000 prices) in the project's budget to cover integrated logistic support; personnel, training and AEW&C capability support infrastructure at RAAF Williamtown and RAAF Tindal; Government Furnished Materiel (GFM); contingencies; and various other non-prime contractor activities.

1.10 The AEW&C capability is expected to enter its in-service phase in 2007, with the commencement of operational test and evaluation. Defence expects the Wedgetail aircraft to have a 25 year life of type commencing in 2007. The project's acquisition contract is expected to continue to May 2010, when Boeing is required to complete the last of 75 progress milestones.

Audit Approach

1.11 The ANAO's 2002-03 Audit Work Program provided for a potential audit of the 'Wedgetail' AEW&C project (the Wedgetail project), which at the time of the audit was Defence's third largest capital equipment acquisition project. The ANAO audited the \$A 5.333 billion Anzac ship project in 1994-95 and the \$A 5.115 billion Collins submarine project in 1997-98.¹⁶

1.12 The ANAO scheduled the Wedgetail project audit for calendar year 2003.¹⁷ This was to allow DMO time to complete its reform agenda prior to the planned follow-up audit of Defence's management of its major

¹⁴ The Hon. John Moore MP, Media Release Min 202/99, *Australia Decides on Boeing for AEW&C*, 21 July 1999, p.1.

¹⁵ Commonwealth of Australia, *Defence 2000 Our Future Defence Force*, 2000, p.86. *Project Wedgetail*, presentation to the ANAO, March 2003.

¹⁶ December 2002 prices; Department of Defence, *Defence Annual Report 2002-03*, p.273; ANAO Audit Report No.29, 1994-95, Preliminary Study—ANZAC Ship Project Contract Amendments, June 1995; ANAO Audit Report No.34 1997-98, *New Submarine Project*, March 1998.

¹⁷ Australian National Audit Office, *Audit Work Program 2002-2003*, July 2002, pp.30-31.

equipment acquisition projects.¹⁸ The audit program also allowed the Wedgetail project office to complete the Wedgetail sub-system design reviews, and hence provide increased visibility of the project's risks and their treatment.

1.13 In February 2003, the ANAO notified the Defence Inspector General that a preliminary study of Wedgetail project was to commence. That study began in March 2003. It proceeded to an audit in April 2003. Audit fieldwork was conducted between April and August 2003 at the AEW&C Project Office in Canberra and at the project's RPT in Seattle, USA. The fieldwork involved interviewing relevant project personnel and examining relevant computer records and documents.

1.14 The audit benefited from the positive attitudes and assistance of all Wedgetail project personnel. The ANAO is grateful for that assistance and in particular thanks Air Vice-Marshal Norman Gray AM, Mr Bill Spencer, Mr John Grubb and project team members in Canberra and Seattle, for their cooperation.

1.15 The audit was conducted within the Wedgetail project's management framework. Audit criteria were based on:

- the Wedgetail project's management method;
- systems engineering management concepts and technical review and audit concepts within the engineering standards specified in the Wedgetail acquisition contract;
- Defence's *Capability Systems Life Cycle Management Manual 2002*; and
- Defence's policy and management guidelines applied to risk management, test and evaluation, contract amendments, contract price escalation, and Australian Industry Involvement.

Audit objective and scope

1.16 The audit objective was to assess the adequacy of Defence's management of the Wedgetail project's acquisition phase. The audit focused on the Wedgetail SPO's management role with respect to the acquisition of four Boeing 737-Wedgetail AEW&C aircraft fitted with state-of-the-art radar, and advanced communication and self-protection systems.

¹⁸ The first ANAO audit of Defence's management of its major equipment acquisition projects was completed in 1999. See ANAO Audit Report No.13 1999–2000 *Management of Major Equipment Acquisition Projects—Department of Defence*, October 1999.

1.17 Appendices 1 and 2 provide a more detailed outline of the Wedgetail project's overall scope and its contribution to the Defence Information Environment.

1.18 The audit examined the Wedgetail project from the project management and systems engineering perspectives, including the link between the requirements and acquisition phases. The audit did not examine the processes giving rise to the terms of the contract and Government approval. Nor did it examine the project's management of the Wedgetail Government Furnished Materiel (GFM) Government-to-Government contracts, or the project's infrastructure components managed by Defence Corporate Services and Infrastructure Group.

1.19 The audit was conducted in accordance with ANAO auditing standards at a cost of \$292 000.

Boeing and Northrop Grumman's comments

1.20 Boeing advised the ANAO of its response to the overall proposed audit report as follows:

The Boeing Company is pleased to have this opportunity to comment on the ANAO performance audit report, transmitted by the reference letter, on the Wedgetail AEW&C Project. Our assessment of the report is that it is a fair and balanced description of the project at the time of the audit in 2003. The findings and conclusions accurately reflect an appreciation for the complex and specialized nature of this developmental project and the degree of system integration the effort requires.

1.21 Northrop Grumman advised the ANAO of its response to an extract of the proposed report as follows:

The Northrop Grumman Corporation appreciates the chance to comment on the draft ANAO audit report. In addition, Northrop agrees with the ANAO findings that the program is essentially on track, with technical challenges being effectively met by the contractor teams.

Pushing the edge of technology, as in the case of the Multi-role Electronically Scanned Array (MESA) radar, involves an element of risk. Northrop Grumman, in partnership with The Boeing Company, entered into the Wedgetail Program aware of and accepting the associated technology risks. Northrop Grumman is cognizant of the Commonwealth concerns on program performance and risk management.

Understanding these concerns, Northrop Grumman has responded aggressively throughout the developmental program as challenges have been identified. As indicated in the ANAO audit report, this has resulted in maintaining an excellent adherence to schedule three years into the program. It has also resulted in an increased investment on the part of

Northrop in the program. Northrop Grumman remains committed to delivering a quality product on schedule.

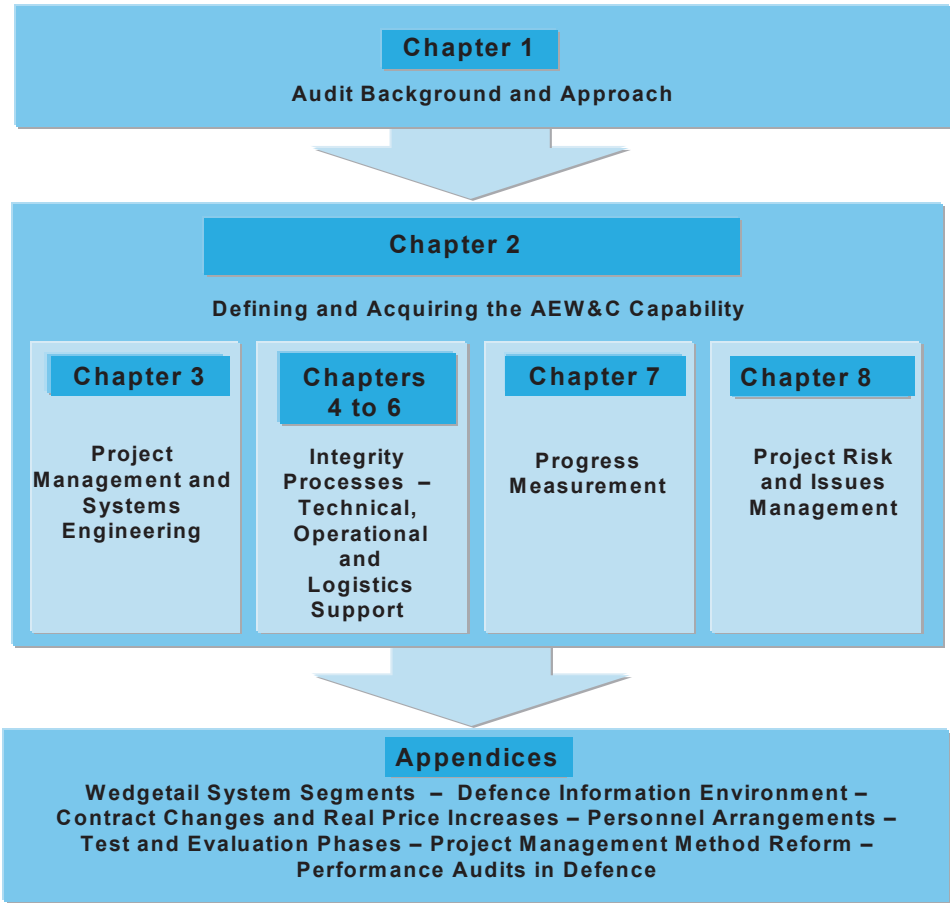
Northrop Grumman will continue to aggressively manage both the schedule and performance challenges, even if this continues to require increased investment to achieve both goals.

Report structure

1.22 The report contains eight chapters, with coverage as shown in Figure 1.1.

Figure 1.1

‘Wedgetail’ Airborne Early Warning and Control Project—Report structure



2. Defining and Acquiring the AEW&C Capability

This chapter outlines the AEW&C capability needs and requirements analysis phases, and discusses their influence on the acquisition phase. It also outlines the commercial arrangements and organisations responsible for acquiring the AEW&C capability.

Introduction

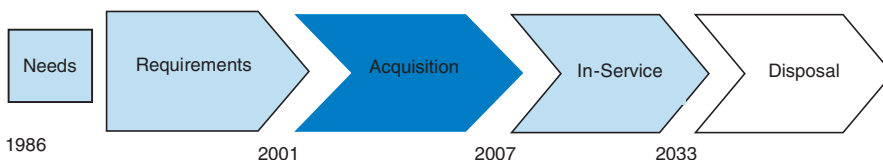
2.1 The AEW&C program commenced over 15 years ago. Not surprisingly, during that time, Defence's capability development process has changed. Nevertheless, the AEW&C capability development phases have much in common with the current process, which covers:

- capability gap analysis that defines a military need within the context of strategic policy and military strategy;
- requirements analysis that defines the capability needed in terms of functions to be performed, the standards to be achieved under defined operational conditions, estimated costs to be incurred, and the schedule to be met;
- acquisition of the required capability and transition into service;
- in-service operation, support and modification; and
- disposal through progressive withdrawal from service.¹⁹

2.2 Figure 2.1 illustrates the AEW&C capability life-cycle timeline.

Figure 2.1

AEW&C Capability Life-cycle Timeline



Source: ANAO, based on Defence information.

¹⁹ Department of Defence, *Capability Systems Life Cycle Management Manual 2002*, November 2002, paras. 1.16; 3.25–26. Defence records indicate that needs analysis and requirements analysis phases are often tailored in ways contingent upon Defence capability needs. This tailoring aims to provide increased assurance that the acquisition phase will deliver a capability that satisfies schedule, performance and life-cycle cost requirements.

2.3 This chapter reviews the AEW&C capability cost structure and the system engineering links across the Wedgetail project's needs, requirements phase and acquisition phase. The remaining chapters focus mainly on the project's acquisition phase, as it relates to research and development, integration and initial manufacture. They also include a review of the project's in-service phase preparations.

2.4 The chapter does not discuss the 'two pass' Government approval process, as that process was still under development during the Wedgetail's requirement's phase.

AEW&C capability costs

2.5 The Wedgetail system initial acquisition cost amounted to \$A2.258 million (September 1998 prices) comprising the following currencies:

- US dollar component—\$US 1,093.1 million; and
- Australian dollar component—\$A 412.2 million.²⁰

2.6 In order to maintain the contract's value relative to those amounts over the acquisition contract's nine year life, the contract allows Boeing to claim price variations based on agreed formulae. These formulae were negotiated with the intention of fairly compensating Boeing for the difference between the base date prices, and price conditions at the time the work was actually undertaken.

2.7 Defence seeks annual adjustments to the project's approved funding so that it can fund these price variations. The project's approved cost at December 2003 was \$A 3.43 billion. This amount is comprised of the \$A 2.63 billion Wedgetail acquisition contract with Boeing, and \$A 800 million covering initial support, facilities, GFM and contingencies.²¹ Price and exchange increases totalled \$219.2 million from the contract price base of September 1998, to when the acquisition contract was signed in December 2000.

2.8 There are three basic ways in which contract costs have varied since December 2000. Prices change as a result of variations in labour rates and material costs. Currency exchange rates change, in line with changes in world financial market conditions. Finally, contracted work scope change

²⁰ Project Air 5077, Contract C338364 *Conditions of Contract*, Section 3.1.1.

²¹ AEW&C Project, *Governance Board Monthly Report*, 17 October 2003, Annex B.

with resulting 'real' changes to the contract price. These are explained below.

Price variations—labour and materials

2.9 Boeing submits contractual milestone and earned value payment invoices, accompanied by price variation claims based on labour and material price variation formulae contained within the contract.²²

2.10 In order to fund price variations over the life of the project, the Commonwealth budgetary process provides Defence with annual funding adjustments. These adjustments are based on indices set by the Department of Finance and Administration (Finance) and are passed onto projects in the context of a 'Global Update' following the approval of Defence's Budget Estimates. Any difference between Boeing's invoices and the project's annual global funding update is funded temporarily from the project's contingency funds. The project then seeks contingency fund supplementation, if required, in the next round of the Commonwealth's budgetary process.

2.11 Since the Wedgetail acquisition contract was signed in December 2000, the project cost has increased by a total of \$A 164.1 million as a result of the annual labour and materials indexation process.

Exchange variations—currency exchange rates

2.12 The contract with Boeing is written in both Australian and US dollars, which gives rise to significant foreign exchange (FOREX) risk. Exchange variations, either favourable or unfavourable to either side, are incurred whenever amounts are invoiced and paid in US dollars. Consequently, the Wedgetail project receives annual variations to its funding to enable it to meet exchange rate variations which are expected to result from the payment of claims in US dollars. These annual variations are based on the 'official' exchange rate set by Finance, and are provided to projects in the form of a 'Global Update'.

2.13 Funds spent on exchange rate variations depend on the exchange rate at the time of payment. The project seeks annual supplementation or approved budget reductions where there is an appreciable difference between the 'official' exchange rates Finance used to calculate the Global Update and the prevailing rates at the time payments were made.

2.14 Defence advised the ANAO that the AEW&C project's cost has increased in total by \$A 158.5 million since contract signature in December

²² Project Air 5077, Contract C338364 *Conditions of Contract*, Section 3.3.1.

2000, as a result of foreign exchange adjustments.²³ This reflects a \$A 249.8 million reduction factored into project's estimated cost, due to the significant appreciation of the \$A in 2003.²⁴

2.15 Finance guidance on FOREX exposure requires Commonwealth agencies to manage their FOREX risk. However, as a general policy effective from 1 July 2002, this does not extend to entities managing their FOREX risks by externally hedging their FOREX exposure.²⁵ This reversed prior policy that, from May 2000 to 30 June 2002, allowed agencies to hedge their FOREX exposure.²⁶

2.16 The ANAO did not find evidence that the Wedgetail project had managed its FOREX risk, other than minimising its US dollar exposure by specifying part of the contract value in Australian dollars to cover all work expected to be carried out in Australia. The project seeks supplementation, or reductions, to its approved budget in relation to FOREX movements as outlined above.

'Real' price variations

2.17 'Real' price variations result from contract changes that affect what is to be delivered under the contract. Defence advised the ANAO that, by August 2003, aggregate 'real' price variations in the acquisition contract price totalled \$A 4.5 million, and had been funded from project contingency funds. The Wedgetail project's contract change process, and itemised 'real' price changes, are outlined in Appendix 3.

AEW&C capability personnel and operating costs

2.18 The Wedgetail system acquisition contract requires Boeing to establish, implement and control a Wedgetail system life-cycle cost program. This program provides the Wedgetail project office with updated reports and a Cost Analysis and Strategy Assessment (CASA) model, which record the results of Wedgetail system life-cycle cost analysis, and life-cycle cost strategic decisions.²⁷ CASA model updates are linked to contract milestones.

²³ AEW&C Project advice 17 September 2003.

²⁴ AEW&C Project, *Governance Board Monthly Report*, 17 October 2003, Annex B.111

²⁵ Finance Circular 2002/01: *Foreign Exchange (FOREX) Risk Management*, 26 June 2002.

²⁶ Finance Circular 2000/3: *Budget Framework for the Management of Foreign Exchange (FOREX) Exposure*, May 2000.

²⁷ See ANAO Audit Report No.43, 97–98, *Life-cycle Costing in the Department of Defence*, May 1998, pp.3–6, 50,51.

2.19 The CASA model forms the basis of Defence's AEW&C capability life-cycle cost analysis and subsequent Net Personnel and Operating Cost (NPOC) submissions. The NPOC process is designed to identify variations in Defence's personnel and operating costs caused by the introduction of new or enhanced Defence capability. The process continues as part of the in-service phase of the new or enhanced capability.

2.20 The AEW&C capabilities' NPOC, based on a four AEW&C aircraft 25 year life, are yet to be fully determined. However, at the time of the audit, the Wedgetail project office estimated the AEW&C capabilities' NPOC to be some \$A 90 million per annum.²⁸ This estimate includes the cost to Defence of the Wedgetail in-service support costs including fuel, Air Force No.2 Squadron personnel costs, and general overhead costs attributed to the AEW&C capability from other Defence groups.

2.21 The Wedgetail project office will produce more accurate AEW&C capability NPOC submissions when the Wedgetail design matures, and when in-service support contracts become more clearly defined.

Transition from capability requirements analysis to acquisition

2.22 The Senate Foreign Affairs, Defence and Trade References Committee in March 2003 reported:

One of the significant problems hindering successful project outcomes in the past has been inadequate definition of capability requirements, and poor articulation of those requirements to those responsible for acquisition. In the capability development life cycle the nexus between the Requirements and Acquisition phases is crucial.²⁹

2.23 The ANAO examined Wedgetail project's requirements analysis and how that analysis influenced the acquisition contract and project management. A critical element of the requirements process is the production of a Concept of Operations (CONOPS) document, which describes a system's goals, objectives and generally desired capabilities, without indicating any particular design solution.³⁰ The CONOPS translates the needs analysis, which identified a need to reduce a current or

²⁸ Of that amount \$24 million is for salaries.

²⁹ Senate Foreign Affairs, Defence and Trade References Committee, *Report on the inquiry into materiel acquisition and management in Defence*, March 2003, pp.xi, 23–28.

³⁰ Electronic Industries Alliance, EIA Standard EIA-632, *Process for Engineering a System*, January 1999, pp.6,105; Department of Defence, *Capability Systems Life Cycle Management Manual 2002*, November 2002, para. 3.43; Defence Materiel Organisation, *Guidance for the Preparation of an OCD, FPS and TCD*, April 2002, pp.11–13.

prospective capability gap, into system function-orientated descriptions that allow project personnel to develop conceptual-level System Specification. The System Specification describes the system's technical, performance, operational and support characteristics, including the allocation of function, performance and interface requirements.³¹

2.24 The Wedgetail project team produced a CONOPS document and supplemented it with a Statement of Operating Intent (SOI), which describes the conditions under which the mission system was to perform in terms of:

- atmospheric parameters (including those impacting on structural loading conditions);
- exposure to corrosive environments;
- ground movement and parking conditions;
- runway surface and arrest conditions;
- vibration; and
- electromagnetic environment.³²

2.25 The project team also produced a Wedgetail System Specification and placed it into the acquisition contract's Statement of Work (SOW). The SOW was included in the Request for Tender for the Wedgetail system, along with an information copy of the CONOPS. These will be used as the basis for determining the Wedgetail system's 'fitness for purpose'.³³

2.26 The Wedgetail CONOPS and SOW are accompanied by a Test and Evaluation Master Plan (TEMP), which provides the overall planning strategy and guidance necessary for defining, planning, reviewing and approving the T&E of the Wedgetail system.³⁴ The TEMP sets out the T&E procedures that aim to validate whether the system does what the users expect of it – i.e. is it the right system? The TEMP also outlines the T&E procedures aimed at verifying whether the system responds as expected –

³¹ System specifications are also known as Type 'A' specifications, Function and Performance Specifications (FPS), or Performance Specifications. B.S. Blanchard, *System Engineering Management*, Second Edition 1998, Wiley-Interscience, John Wiley & Sons Inc, New York, pp.97; Department of Defence, *Capability Systems Life Cycle Management Manual 2002*, November 2002, para. 3.43; Electronic Industries Alliance, EIA Standard EIA-632, *Process for Engineering a System*, January 1999, pp.51-52, 107.

³² Department of Defence, *AEW&C Baseline Statement of Operating Intent*, September 2001.

³³ AEW&C Project, *Type Certification Plan*, December 2002, Section 3.2.2; Project Air 5077, Contract C338364 *Conditions of Contract, Statement of Work—System Acquisition*, Section 1.1.1.

³⁴ AEW&C Project, *Test and Evaluation Master Plan*, September 2002.

i.e. is it operating as designed? The project continues to refine its TEMP and the underlying test plans and procedures, as discussed in Chapter 5.

2.27 In addition to the TEMP, the Wedgetail project has a Project Design Acceptance Strategy (PDAS) endorsed by the ADF's Director General Technical Airworthiness and other stakeholders. The PDAS records stakeholder agreement with the Wedgetail system specifications, and hence provides a key pre-requisite for Airworthiness Design Acceptance (see Chapter 4).³⁵ It also defines the Engineering Management System to be applied to the Design Acceptance of technical items procured under the Wedgetail acquisition contract with Boeing. The PDAS also assists the development and negotiation of engineering aspects of the Wedgetail project's initial in-service support contract, which is discussed further in Chapter 6.³⁶

2.28 Finally, the Wedgetail project has an extensive 20 volume Project Management and Acquisition Plan (PMAP) containing policy and guidance that seeks to ensure the project is well organised and coordinated, and that project team members have clear responsibilities and accountabilities for project outcomes. The PMAP contains the project's Equipment Acquisition Strategy (EAS) that, in broad terms, outlines the project strategic and operational management approach. The EAS has, in part, been superseded by project changes in 2000. It was due for a major rewrite at the time of the audit.

Commercial arrangements

2.29 The AEW&C capability acquisition strategy included the design development and construction of a new generation AEW&C aircraft, based on Boeing 737-700 series commercial aircraft, and fitted with advanced technology radar and extensive communications and other electronic systems. This strategy gave rise to a set of commercial arrangements and organisational structures considered suitable for delivering the desired capability within a fixed price contract environment.

2.30 Boeing, as the prime contractor, has total system performance responsibility for all aspects of the design, construction, testing, documenting, and offering for acceptance, of the Wedgetail systems.³⁷ Boeing is to deliver:

³⁵ AEW&C Project, *Type Certification Plan*, December 2002, Section 3.2.4.

³⁶ AEW&C Project, *Project Design Acceptance Strategy*, December 2002, Section 1.1.1.1.

³⁷ Project Air 5077, Contract C338364 *Conditions of Contract*, Section 2.2.2.

- four 737-based Wedgetail 'Airborne Mission Segments' (AMS) by August 2007. The contract contained an option for an order of up to three additional aircraft and other supplies to be exercised up to 21 months after the effective date (by 20 June 2003). Defence and Boeing were negotiating a 12 month extension of this option at the time of the audit;
- two sets of additional Mission System Equipment (MSE), apart from the four MSE to be fitted to the 737 airframes;
- two fixed, and two deployable, Mission Support Systems (MSS); and
- a Wedgetail Support Centre (ASC), which includes Operational Mission Simulator (OMS) and Operational Flight Trainer (OFT) facilities. The ASC also contains a Wedgetail Support Facility (ASF), which includes engineering and software support, test equipment, technical information and spare parts.

These deliverables are described in more detail in Appendix 1.

2.31 The contract requires Boeing to deliver the first two Wedgetail aircraft in November 2006, and the remaining two in March and August 2007.³⁸ The contract includes a provision for three years of initial in-service logistic support, at a price not to exceed \$A 97 million (September 1998 prices), and to be agreed at least 12 months prior to the delivery of the first AEW&C aircraft.³⁹ The project's initial logistics support costs and strategy were under review at the time of the audit. (See paragraphs 2.18-21.)

2.32 Progress payments are based on Boeing completing work scheduled in the project's earned value system, and on the attainment of 75 milestones, valued at some three-quarters of the contract price⁴⁰ (See Chapter 7).

2.33 The contract contains a financial security for contract performance totalling two per cent of the contract price, and a financial security for repayment of milestone payments, which increments to a maximum (in two currencies) of \$US 190 million for the US components and \$A 46.652 million for the Australian components.⁴¹

³⁸ *ibid.*, Annex 1 to Attachment D.

³⁹ *ibid.*, Section 10.1.

⁴⁰ Project Air 5077, Contract C338364 *Conditions of Contract*, Section 3.2. Annex 1 to Attachment D.

⁴¹ *ibid.*, Section 4.2 and Section 4.1.1. Annex 1 to Attachment D. September 1998 prices.

2.34 The contract also contains liquidated damage amounts linked to 11 of the 75 milestones, which may be invoked if Boeing fails to complete performance of a nominated milestone. The liquidated damage settlement would take the form of deductions of payments due to Boeing, and would amount to nine per cent of the nominated milestone value (following a three month grace period), and an additional three per cent each month thereafter. The total amount of liquidated damages is not to exceed \$A 45.179 million for the all Australian components and \$US 105.959 million for all US components.⁴²

2.35 The contract contains a PIF pool, limited to \$US 40 million (December 2000 prices) over the life of the project. PIF payments are available for superior effort in management and technical achievement according to an incentive fee plan.⁴³

2.36 The performance incentives focus on specific project milestones which Defence considers of crucial importance to maintaining a successful program. The incentives are seen to mitigate schedule risk by providing additional incentives to Boeing to maintain an ambitious milestone achievement schedule, in order to allow additional time for system test and evaluation, without delaying delivery.

2.37 Defence records indicate this strategy remains effective in ensuring early delivery of important progress milestones. Boeing has achieved three milestones on schedule and 14 ahead of schedule. Consequently, by September 2003, Defence had approved PIF payments totalling \$US 11.851 million.

Boeing's Team Structure

2.38 Boeing has structured its Wedgetail AEW&C program according to the products and systems that it is to deliver. It manages the program using IPTs comprised of the range of specialists needed to design, develop and support the products and systems. The teams have documented charters and responsibility, authority and accountability. Their structures and charters are controlled through a formal change process.

2.39 Boeing authorises its IPTs to make changes to process, cost, schedule and technical parameters that do not directly or indirectly affect other IPTs or the customer. Empowerment for such decision-making is authorised to the lowest management level commensurate with the task being performed.

⁴² *ibid.*, Section 11.5. September 1998 prices.

⁴³ *ibid.*, Section 14.12.

2.40 Issues affecting other IPTs, or the customer, are managed by Boeing's AIT. The AIT is responsible for allocating design and other requirements to IPTs, and for analysing and managing the interfaces between the Wedgetail segments. The AIT is also responsible for conducting and managing speciality engineering, configuration and data management, operational analysis. Boeing's AIT has overall responsibility for developing, managing and implementing the Wedgetail technical review program.⁴⁴ The AIT's risk management responsibilities include reviewing all medium or high-level risk items. The IPTs monitor and manage their respective risks.

2.41 Suppliers are also included into the product teams structure, and customers are aligned and integrated into the product teams as they prefer. As the representative of the Wedgetail project's prime customer, DMO's Wedgetail RPT in Seattle has taken up the opportunity to structure itself in line with IPT and AIT concepts adopted by Boeing.

Department of Defence responsibilities

2.42 Defence, through DMO, is primarily responsible for monitoring Boeing's performance in meeting its obligations under the Wedgetail system acquisition contract. During the design and development phase, DMO's Wedgetail project office personnel gain insights into the contractor's progress and advise on areas of system development that would not satisfy the contracted Statement of Work and System Specification. Project office personnel have no system co-development responsibilities as Defence rarely takes on that role.

2.43 The project office does not direct or approve the manner in which Boeing is to achieve conformance with contractual specifications. In fact Boeing has the contractual right, for example, to ignore Defence advice on the adequacy of design and development or to proceed to some subsequent work packages even if prior reviews are not successful. These decisions rest with Boeing, which must weigh up the risks of whether its actions will lead ultimately to the milestone requirements not being met.

2.44 In addition to its progress monitoring role, Defence is responsible for providing Boeing with some 340 items of GFM, which includes:

- Government Furnished Equipment (GFE) such as the AEW&C broadcast intelligence system;

⁴⁴ Boeing, 737 AEW&C Wedgetail Project, *Technical Review Plan*, Revision D, October 2001, section 5.1.1.

- Government Furnished Information (GFI) such as technical information and advice; and
- Government Furnished Data (GFD) such as data provided from Air Force systems.

2.45 The GFM, is in part, supplied through Foreign Military Sales (FMS) contracts with the US Defense Department. The GFM includes those classified AEW&C systems and sub-systems that require Government-to-Government sales agreements. The project's FMS contract management was not examined in this audit.

Partnering

2.46 Concurrent with the signing of the Wedgetail system acquisition contract in December 2000, the Minister for Defence and the Boeing Vice President-General Manager of Government Information and Communication Systems signed a Partnering Statement that established a set of partnering principles. In February 2001, the statement was translated into a Partnering Charter signed by DMO's Head AEW&C, Boeing's Manager for 737 AEW&C Programs, Northrop Grumman Corporation's Vice President Airborne Surveillance Systems, Boeing Australia Ltd's Managing Director, and British Aerospace Systems (Australia)'s Chief Executive.

2.47 The charter requires the Partnering Team Members⁴⁵ to:

- provide high-level commitment to ensure that this nationally significant project is outstandingly successful;
- encourage enthusiastic support in all the participating organisations.
- commit to a 'no surprises environment' for early recognition and resolution of issues and problems;
- employ open, honest and effective communications to build and maintain trusting working relationships; and
- recognise the experience and knowledge that each party possesses and use them to the overall benefit of the project.

2.48 Evidence throughout this audit report indicates that the Partnering Team Members are effectively honouring that agreement.

⁴⁵ Defence Materiel Organisation, The Boeing Company—Government Information & Communication Systems, Northrop Grumman Corporation—Electronic Sensors and Systems Sector, BAE Systems Australia, and Boeing Australia Ltd.

3. Project and Systems Engineering Management

This chapter focuses on the Wedgetail project's management structure and method, and the project's tailoring of technical review provisions contained in the Wedgetail systems engineering standards. These standards and their tailoring are of particular importance to the project's role to monitor Boeing's performance of its contractual obligations.

AEW&C program structure

3.1 The Vice Chief of the Defence Force's Director-General Aerospace Development sponsors the Wedgetail project. The Under Secretary Defence Materiel's (USDM's) Airborne Surveillance and Control Division (ASCD) manages the Wedgetail project through the AEW&C System Program Office (AEWCSPO). The AEWCSPO encompasses the AEW&C Project Office (AEW&CPO) in Canberra, and the AEW&C RPT in Seattle USA (with elements in Baltimore USA and Adelaide). For simplicity, this report refers to the AEWCSPO and the AEW&CPO, as the Wedgetail SPO and the Wedgetail project office.

3.2 In November 2001, ASCD gained responsibility for a group of aerospace surveillance projects, namely:

- Space Based Infra-Red System;
- Global Hawk; and
- Tactical Unmanned Aerial Vehicle.

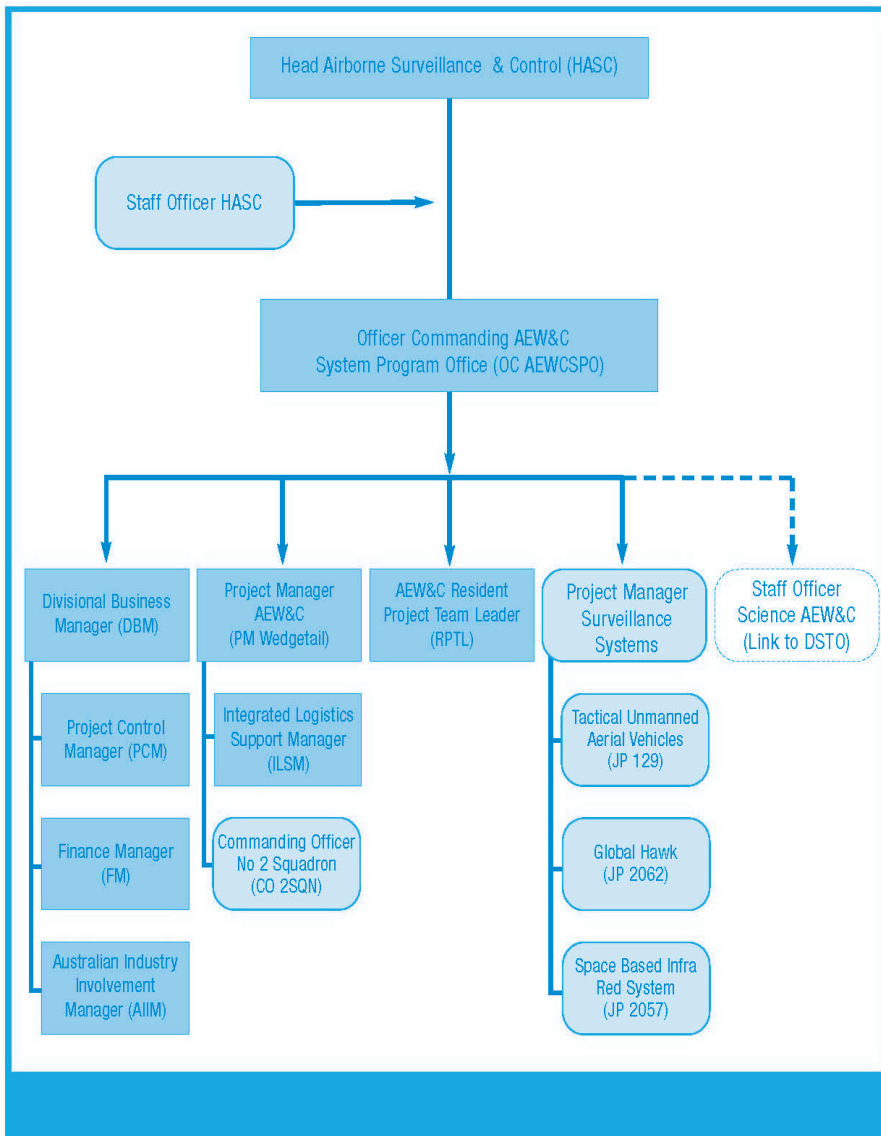
3.3 These projects share a common mission: to establish aerospace surveillance systems that meet endorsed requirements. The ANAO was advised that ASCD has sought to optimise cross-project cooperation with the view of maximising the benefit of skills, experience and lessons learned from each project. In the event of competing priorities, the Wedgetail project has primacy so as to protect AEW&C capability acquisition.⁴⁶

⁴⁶ Department of Defence, *Officer Commanding AEW&C SPO Directive 02/01 Revised AEW&C SPO Organisation and Responsibilities*, 23 November 2001, p.4.

3.4 Figure 3.1 shows the Wedgetail SPO's structure and Appendix 4 discusses the project's personnel arrangements. The darker coloured boxes indicate the areas included in this audit.

Figure 3.1

Wedgetail System Program Office Structure

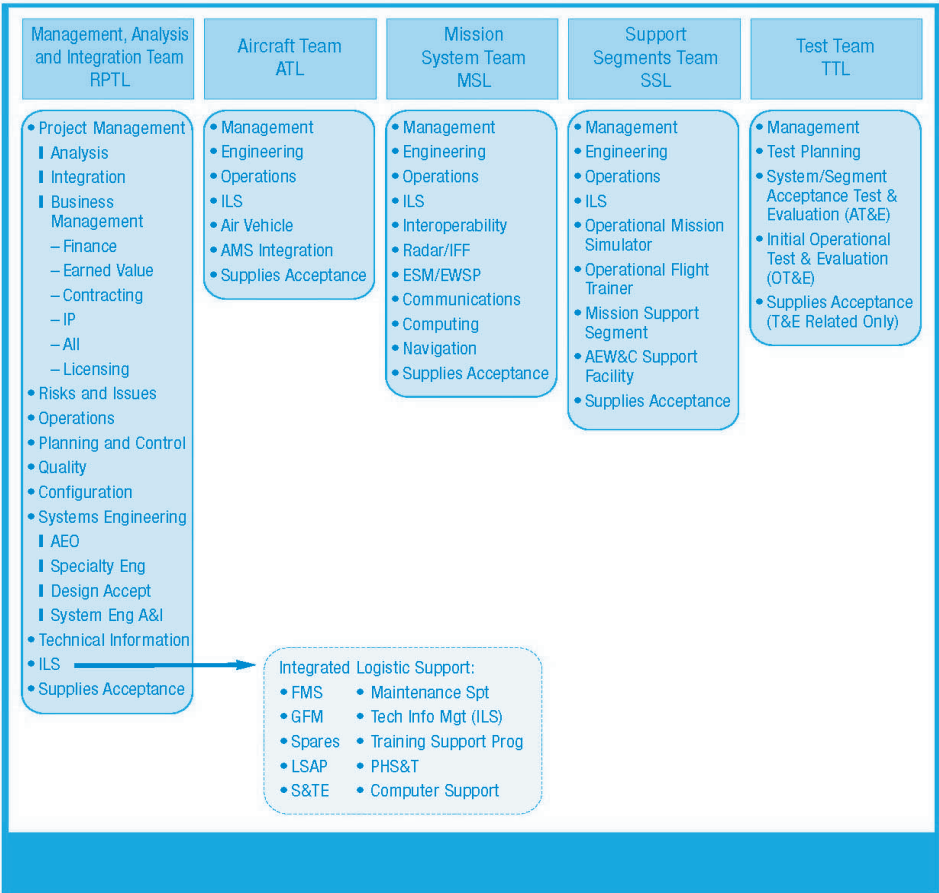


Source: Department of Defence.

Wedgetail project’s Integrated Product Teams and Management Analysis and Integration Team

3.5 The DMO’s Wedgetail RPT in Seattle is structured in accordance with Boeing’s IPT and AIT concepts. The RPT structure, shown in Figure 3.2, has three multi-discipline IPTs—aircraft (airframe, engines and flight systems); Wedgetail Mission Systems; and Support Segments. It also includes a Management Analysis and Integration Team and a Test Team. The RPT also retains a functional organisational structure, which provides the teams with resources and management processes.

Figure 3.2
Resident Project Team (Seattle) Integrated Product Team Structure



Source: Wedgetail project, Department of Defence.

3.6 The basic principle behind the IPT concept is that decisions should be made at the lowest level commensurate with technical knowledge requirements and effective risk management. Collectively, the IPT members should represent the know-how needed, and have the ability to control the resources necessary, for the delivery of quality products. Individually, the team members should be empowered and authorised to agreed limits to make commitments for the organisation or functional area they represent.⁴⁷

3.7 The Wedgetail IPTs are headed by 'Leads' who work with the Engineering Manager on issues concerning the aircraft system technical integrity (airworthiness), and with the Test Team Lead on issues concerning the Wedgetail system's operational integrity (fitness for purpose). IPT performance is monitored and reviewed and any disputes resolved by AITs and Project Directors, which are in turn have their performance monitored and reviewed by SPO Directors and Project Governance Boards.

3.8 Supplementing the IPTs and the Test Team are Systems Engineering Technical Assistance contractors engaged in design verification and validation and computing system development measurements, and a Design Support Network.

3.9 The project also engaged the US Air Force Electronic Systems Center under a FMS case to conduct Independent Technical Review Risk Assessments of the project during the IDA and at key phases of the system development and design review process.

3.10 An examination of RPT's records indicate the IPT arrangements are effective in ensuring the RPT remains fully informed of Wedgetail development activities, risks and issues. This aligns well with the IPT concepts put forward in Defence's capability systems life-cycle management policy.⁴⁸

3.11 However, the teams retain a hierarchical structure in terms of leadership focused responsibility, office accommodation and management style. This may, to large degree, be unavoidable in part given the RPT's size, and the project's Air Force personnel rank structure. The project continues to maintain a non-hierarchical 'team' culture, which assists to preserve the essential and valuable elements of the IPT concept. This is

⁴⁷ Department of Defence, *Capability Systems Life Cycle Management Manual 2002*, November, 2002, paras, 3.94-3.99.

⁴⁸ Department of Defence, *Capability Systems Life Cycle Management Manual 2002*, November 2002, paras, 3.94-3.99.

particularly important in the many technologically advanced areas of the project, where specialists at various levels hold key knowledge and experience.

Project Governance

3.12 Oversighting the Wedgetail SPO is a five member DMO Project Governance Board, which is advisory in nature and is intended to meet for three hours, ten times a year.⁴⁹ At the time of the 1999-2000 ANAO audit of Defence's management of major equipment acquisition projects,⁵⁰ the DAO commenced forming Project Boards and IPTs as part of DAO's PRINCE2-based Project Management Method (PMM).⁵¹

3.13 The rationale for the Project Boards and IPTs was to improve the quality of decision information by ensuring that stakeholders provided input to the development and management process, and that proper account was taken of those inputs. Project Boards were to guide the IPT and ensure that the IPT's products fairly and accurately reflected the inputs of the stakeholders.

3.14 Since the 1999-2000 audit, DMO has replaced the Project Boards with 10 Project Governance Boards responsible for maintaining major capital equipment project managerial transparency and accountability, and for providing guidance and advice throughout the life of each project. The Project Governance Boards independently review projects; make objective assessments about their status and procedural health; provide advice to Project Managers; and provide ongoing advice and assurance to the USDM.

3.15 Defence advised the ANAO that, while the Project Boards are not accountable nor responsible for project outcomes, they are responsible for providing sound advice to the USDM, Project Managers and Division Heads.

3.16 The ANAO examined the Wedgetail project's monthly reports to its Project Governance Board. We found the reports provided comprehensive accounts of current and projected schedule, cost, and capability risks and issues. The advice was in narrative form supported by graphical summaries showing progress data, often drawn electronically from data

⁴⁹ Department of Defence, *Airborne Early Warning and Control (AEW&C) Project Governance Board: Board Charter & Standard Operating Procedures*, November 2002.

⁵⁰ ANAO Audit Report No.13 1999–2000 *Management of Major Equipment Acquisition Projects—Department of Defence*, October 1999.

⁵¹ UK Office of Government Commerce, *Managing Successful Projects with PRINCE2*, 2002.

used by the contractors to manage the project. Chapter 7 provides examples of progress measurements that the Wedgetail project provides monthly to its Governance Board.

Project Management

3.17 Project Managers are directly accountable and responsible for project outcomes. Project management involves managing the day to day planning, execution, monitoring and controlling of project activities. IPTs are also responsible for project outcomes through the provision of guidance and/or direction to their teams in accordance with project management policy and directions.

3.18 Defence advised the ANAO that Project Managers are to comply with Project Governance Board advice or explain to USDM why the Board's advice was not followed.

Defence project management policies and methods

3.19 An effective PMM establishes a set of concepts and processes that form the minimum requirements of a properly managed project. The aim is to ensure project management is well organised and coordinated, and that those managing and sponsoring projects have clear responsibilities and accountabilities for project outcomes.

3.20 Since the late 1980s, Defence has established comprehensive project management policies and procedures, which it first published in the Capital Equipment Procurement Manual 1 (CEPMAN 1). Project managers were required to compile, from CEPMAN 1, a PMAP tailored to meet their project's management requirements.

3.21 In 1998, Defence commenced developing a PMM to cover all project phases from needs and requirements analysis, acquisition and in-service support to disposal. The Defence sought to have the PMM applied to all 200 or so major acquisition projects by July 2000.⁵² Defence policy, since then, requires the latest PMM version (PMMv2) to be adopted for projects, unless there is a compelling reason to follow a different methodology. By this stage, the project was already utilising CEPMAN 1, and the risks of changing to a new PMM was considered to outweigh the benefits.

⁵² ANAO Audit Report No.13 1999–2000 *Management of Major Equipment Acquisition Projects—Department of Defence*, October 1999, pp.56–69. ADHQ, *Defence Whole of Capability, Whole of Life Implementation Plan*, May 2000.

Wedgetail project's management method

3.22 The Wedgetail project has implemented selected PMM concepts, the most notable being Project Governance Boards and IPTs; and developed innovative progress measurement processes and innovative risk and issues management processes (see Chapters 7 and 8).

3.23 In February 2000, Defence conducted a PMM pre-implementation interview with the Wedgetail Project Director. This disclosed that, even though the Wedgetail project appeared to be managed well and had a well-defined organisational structure, it was less clear that the project's management method drew together tasks into plans for the medium and long-term. The Reviewer found the Wedgetail project could benefit from PMM.

3.24 Despite some concerns regarding the interview findings, the SPO's Director saw benefit in continuing to develop an option for the possible conversion of the Wedgetail project to the PMM; and requested discussions on how the project could transition to, and be effectively managed under, the PMM.

3.25 The Wedgetail project has not formally converted to the PMM. However, Defence's PMM reforms have continued to gain momentum. In May 2003, Defence introduced a revised version of its PMM, entitled PMMv2, as part of a Materiel Acquisition and Sustainment Framework (MASF). MASF comprises a Standard Acquisition Management System (SAMS) and a Standard In Service Management System (SISMS), with PMMv2 as the underpinning project management method.

3.26 In May 2003, the ANAO requested Defence advice on its project management reform program in order to assess whether the Wedgetail project could benefit from specifically defined PMM improvements. Defence's advice, provided in Appendix 5, states that it did not have a reliable method of benchmarking improved performance.

3.27 Based on that advice, it is difficult for the ANAO to assess the extent to which the advantages would outweigh the risks in having the Wedgetail project implement PMMv2 at this phase of the project. A re-write of the Wedgetail management method would risk project management stability. That risk needs to be offset by at least reliably benchmarked and improved performance attributable to PMMv2.

3.28 The Wedgetail Project Director advised the ANAO, in August 2003, that the project had approached the relevant policy branch seeking their assistance in jointly assessing how the project might best align itself with SAMS/PMMv2 for the management of the Wedgetail system acquisition

contract. The Project Director further advised that the Wedgetail in-service support contract will be developed and managed in accordance with SISMS/PMMv2 from its outset.

Wedgetail systems engineering management

3.29 The Wedgetail project's systems engineering standards and processes defined within the acquisition contract's SOW and System Specification, are important contributors to technical, operational and logistics integrity processes.

3.30 Engineering management within the Wedgetail project follows a systems engineering approach described in Electronic Industries Alliance Interim Standard EIA-632 *Process for Engineering a System*,⁵³ which is based on the US Defense Standard, MIL-STD-499B *Engineering Management*. The Wedgetail Project Manager advised the ANAO that EIA-632:

- is well understood by industry, particularly US Defense industry, which had been working to MIL-STD-499A since the inception of the Systems Engineering concept in the early 1980s;
- integrates well with a number of supporting standards, called for in the Wedgetail acquisition contract's SOW such as MIL-STD-490A Specifications, MIL-STD-1521B *Technical Review and Audits for Systems, Equipments & Computer Software*, MIL-STD-498 *Software Development*, and MIL-STD-973 *Configuration Management*, as well as a range of specialty engineering standards; and
- retains key systems engineering principles normally found in military standards.

3.31 The technical review provisions contained in the Wedgetail system's engineering management standards and processes are of particular importance to the Wedgetail project's role of monitoring, evaluating and reviewing the contractors' progress. These must be tailored to ensure they are both effective and efficient.

3.32 Standards and process tailoring is an important task that requires effective cooperation and agreement between the parties, as it has significant contractual and engineering risk implications. Tailoring is needed to ensure that systems engineering and technical reviews progress in a logical, efficient and effective manner. Without appropriate tailoring, the task of maintaining the engineering documentation and reviewing process may become as onerous, costly and risky as the overall system

⁵³ AIR 5077, *Project Management and Acquisition Plan (PMAP)*, Volume 1 Issue 2 p.19.

design and production effort itself. A failure to adequately tailor the systems development standards and processes on the JORN project was one of the JORN project's early management problems.⁵⁴

3.33 The ANAO was advised that the Wedgetail project avoided many systems engineering problems by ensuring that, prior to acquisition contract signature, the Wedgetail system standards and management processes were tailored for specific Wedgetail segments according to the contemporary best practice contained in tailoring reports and guidelines. This occurred as a part of the IDA.

3.34 Defence agreed to a tailoring process based on technical review and audit output criteria, review objectives and documentation. In all instances, tailoring must be coordinated with the RPT, and agreed to both by Boeing's Senior Design Engineer and the RPT.⁵⁵

3.35 The audit examined the project's records relating to technical integrity (Chapter 4), operational integrity (Chapter 5), and progress measurement (Chapter 7), to assess their effectiveness in providing the information needed to monitor contractor performance in meeting contractual obligations. Project records indicate that these engineering processes had been tailored to meet the project's Technical Review Program requirements, and that tailoring continued as needed particularly in regard to test and evaluation, software development measurements and configuration audits.

⁵⁴ ANAO Audit Report No.28 1995-96, *Jindalee Operational Radar Network Project*, June 1996, p.35.

⁵⁵ Boeing, *Technical Review Plan (TRP)*, CDR(S)-EM-016, October 2001, p.14.

4. Technical Integrity

This chapter focuses on the way the Wedgetail project provides adequate assurance that a satisfactory level of safety, fitness for service, and environmental compliance (collectively known as technical integrity) is achieved in terms of aircraft design and construction.

Introduction

4.1 The following three chapters bring together the three key ADF regulatory frameworks the project needs to accord with to effectively have the Wedgetail aircraft accepted into operational service. The acceptance process requires the ADF's Airworthiness Board to receive adequate assurance of an aviation system's:

- technical integrity;
- operational integrity (see Chapter 5); and
- logistics support necessary to ensure the continued integrity of the system (see Chapter 6).

4.2 Following adequate assurance of these matters, the Airworthiness Board grants:

- Special Flight Permits—which allow the conduct of specific, normally limited, flying operations;
- Australian Military Type Certificates—which certify that aircraft designs are airworthy; and
- Service Release—which signifies that the project's technical, operational and logistics requirements are satisfied and the Airworthiness Board deems that the aircraft can be safely operated in the roles detailed in the Wedgetail Statement of Operating Intent.

4.3 The Wedgetail project's technical integrity, operational integrity and Service Release processes, are necessarily complicated and extensive, in keeping with the project's size, advanced technology and risk profile. This chapter provides an overview of the Wedgetail technical integrity processes, which were under way at the time of the audit.

Defence's technical integrity framework

4.4 Defence has introduced a technical regulation framework to monitor and control risks to safety, fitness for service and environmental compliance (collectively known as 'technical integrity') of ADF materiel.

The framework sets the criteria against which people, processes, products and organisations can be judged; and monitors and audits compliance with technical regulation policy and management guidelines. The framework's core principles are centred on the need for ADF materiel to be designed, constructed, maintained and operated to approved standards by competent and approved individuals, who are acting as members of an approved organisation, and whose work is certified as correct.⁵⁶ Approved organisations must have:

- **Systems:** technical management systems appropriate to the type of work being performed. These include quality management systems such as ISO 9001, technical management systems, 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** having appropriate authority, training, qualifications, experience, demonstrated competence and integrity to undertake the activities required;
- **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.⁵⁷

4.5 The Chief of Air Force (CAF), as the appointed ADF Airworthiness Authority, is accountable to the Chief of the Defence Force (CDF) for the airworthiness of ADF aircraft. CAF relies on the ADF's airworthiness management system frameworks and processes to establish confidence that a satisfactory level of airworthiness (both technical and operational) is established and maintained for each ADF aircraft. This confidence is sought through Australian Military Type Certificates for the aircraft

⁵⁶ Defence Instruction (General), OPS 02-2—*Australian Defence Force Airworthiness Management*, October 2002.

⁵⁷ ADF, Australian Air Publication 7001.053, *Technical Airworthiness Management Manual*, Section 3 Chapter 1.

design, Certificates of Airworthiness for each individual ADF aircraft,⁵⁸ and through the Service Release process.⁵⁹

Technical airworthiness regulatory framework—DMO aspects

4.6 Many SPOs and project offices within DMO are acquiring, modifying and maintaining aircraft and aircraft-related equipment.⁶⁰ Consequently, they are required to comply with the ADF's technical airworthiness regulations that, amongst other things, guide the development of industry solicitation documents such as Statements of Work and System Specification. The regulations also guide the development of elements of DMO project management policy and guidelines such as Project Design Acceptance Strategies (PDAS), Engineering Management Plans, and the tailoring of ISO 9001 quality standard requirements.⁶¹

4.7 The Director General Technical Airworthiness (DGTA-ADF), as the ADF's Technical Airworthiness Regulator, oversees DMO's compliance with technical airworthiness regulations.⁶² DMO's Aerospace Systems Division's (ASD's) Acquisition Process Support Aerospace (APSA) is responsible for administering ASD's Engineering Management System.

4.8 At the time of the audit, ASD underwent a DGTA regulatory compliance audit to assist it to become an Authorised Engineering Organisation (AEO).⁶³ AEO status provides assurance that appropriate management systems, personnel, processes and data are being applied to aircraft and related system designs.

⁵⁸ AIR 5077, *Project Management and Acquisition Plan (PMAP)*, Volume 1 Issue 2 p.18.

⁵⁹ Defence Instruction (General) OPS 02-2 – *Australian Defence Force Airworthiness Management*, October 2002.

⁶⁰ The relevant DMO divisions are Aerospace Systems Division (ASD), Electronic Systems Division (ESD), Land Systems Division (LSD), Maritime Systems Division (MSD) and Airborne Surveillance & Control Division (AS&C).

⁶¹ Defence Instruction (General) OPS 02-2 – *Australian Defence Force Airworthiness Management*, October 2002; establishes the need for technical airworthiness management of all ADF aircraft. Commercial organisations are contractually required to comply. ADF, Australian Air Publication 7001.053, *Technical Airworthiness Management Manual*, Section 3 Chapter 12.

⁶² The Technical Airworthiness Regulator's role is to establish the regulatory framework for technical airworthiness management, define the standards to be applied to the design of aircraft, and to assign authority to organisations to conduct engineering activities in accordance with the defined regulations.

⁶³ Directorate General Technical Airworthiness – Australian Defence Force, SCI/4520/39/02 PT 4 (28), *ANAO Wedgetail Performance Audit Comments*, October 2003, p.1.

4.9 APSA's role is to support all aerospace-related projects, except for those accountable to a program office Chief Engineer.⁶⁴ APSA has team experts in integrated logistic support, reliability engineering and technical publications support. APSA also had a team expert in new project establishment. However, due to resource pressures in 2003, this team was dissolved and absorbed into DMO acquisition projects.

4.10 The ANAO was advised that DGTA has delegated the ASD Chief Engineer as Design Acceptance Representative (DAR), responsible for Design Acceptance certification of ADF aircraft and related equipment acquired by ASD projects. While ordinarily a DAR delegation may not be further delegated, DGTA allows the ASD Chief Engineer (by exception) to further delegate authority for Design Acceptance certification to Project Engineering Managers via approval of the PDAS. Such approval is only given after the ASD Chief Engineer is satisfied that the project personnel are sufficiently competent.⁶⁵

The RPT's regulatory compliance

4.11 The Wedgetail RPT in Seattle has received delegated Engineering Authority for Wedgetail Design Acceptance Certification, and is required to adhere to technical airworthiness regulations pertaining to design certification activities.⁶⁶ In order to receive Engineering Authority Delegation, the RPT demonstrated compliance with the airworthiness regulations via a formal evaluation of its systems, personnel, processes and data. It is subject to continued evaluation through ASD surveillance audits.

4.12 The Wedgetail project's PDAS, and its referenced subordinate plans and instructions, define the key project engineering management systems and processes. The PDAS also identifies the key project personnel including the RPT Project Engineering Manager (the Senior Design Engineer), IPT Leaders (as the nominated Deputy Senior Design Engineers), and a network of engineers performing design acceptance activities.

⁶⁴ ADF, Australian Air Publication 7001.068, *Design and Technical Support Processes*, Section 4 Chapter 3. DMO Aerospace projects are generally accountable to the Chief Engineer (CENGR) of the applicable SPO for the operation of their engineering management system unless they are too complex or have no clear relationship with any existing SPO.

⁶⁵ Directorate General Technical Airworthiness – Australian Defence Force, SCI/4520/39/02 PT 4 (28), *ANAO Wedgetail Performance Audit Comments*, October 2003, p.1. See also ADF, Australian Air Publication 7001.068, *Design and Technical Support Processes*, Section 4 Chapter 3.

⁶⁶ AIR 5077, *Project Management and Acquisition Plan (PMAP)*, Volume 1 Issue 2 p.18.

4.13 The ADF's Directorate General Technical Airworthiness has audited the Wedgetail project and established that the project's personnel have appropriate qualifications, training and experience for the scope and level of authority they exercise.⁶⁷

Wedgetail Design Approval

4.14 To assure airworthiness of the Wedgetail aircraft and systems prior to Defence acceptance, the Wedgetail acquisition contract requires Boeing to provide Design Approval Certification and to conduct a Type Certification Program resulting in the issue of a Supplementary Type Certificate from an Independent Airworthiness Authority.⁶⁸

4.15 The Wedgetail project's independent airworthiness authority is the US FAA. FAA Regulations require Boeing to maintain Engineering Authority Certification status for aircraft and other commercial off the shelf products, which are subject to compliance with FAA regulations. In terms of the Wedgetail project, this mainly relates to Boeing satisfying design and construction standards set by the FAA, with regard to the Boeing 737 designs and the design changes that affect airworthiness.⁶⁹

4.16 The design and development of the 737-based Wedgetail aircraft is subject to an extensive design approval process conducted by Boeing and certified by the FAA. The Wedgetail aircraft are based on the Boeing Business Jet (BBJ) variant of Boeing's 737-700 product line. The BBJs combine 737-700 fuselage with the strengthened wings and undercarriage of the 737-800. The BBJ variant received FAA certification in 1998.⁷⁰

4.17 The Wedgetail aircraft will require FAA Supplementary Type Certification for the BBJ major structural and system modifications needed to install and integrate the Wedgetail mission systems, such as the radar and communication systems, and for the changes to the aircraft's operating intent.⁷¹ However, the FAA will not certify the military operational performance of the Wedgetail mission systems. Hence, the system's

⁶⁷ DGTa audits of the AEW&C Resident Project Team were undertaken in February 2002 and June 2003.

⁶⁸ Project Air 5077, Contract C338364 *Conditions of Contract, Statement of Work—System Acquisition*, Section 5.3.1.5

⁶⁹ AEW&C Project, *Type Certification Plan*, December 2002, Section 2.3.4.

⁷⁰ AEW&C Project, *Project Design Acceptance Strategy*, December 2002, Section 3.1.7.1

⁷¹ *ibid.*, Section 3.1.7.

operational performance is to be verified through Acceptance Test and Evaluations (AT&E) – as detailed in the next chapter.⁷²

4.18 In addition to the need for the Wedgetail aircraft to gain a Supplementary Type Certificate from the FAA, the aircraft also need to gain an Australian Military Type Certificate from the ADF's Airworthiness Board.

4.19 This requirement is factored into the Wedgetail project's acquisition contract and engineering management systems, which requires Boeing to achieve and maintain an ADF AEO status for the design, development, modification, integration and verification of the Wedgetail aircraft. AEO status provides assurance that the appropriate management systems, personnel, processes and data are being applied to design approval certification.⁷³

4.20 The ANAO was advised that the Director General Technical Airworthiness, in his role as the ADF Technical Airworthiness Regulator, awarded Boeing AEO status following an evaluation of its engineering system in November 2001,⁷⁴ and that Boeing has continually maintained that status.

4.21 The contract also requires Boeing to make available to Defence all data and documentation it prepares as part of these certification activities, for use by Defence to obtain an Australian Military Type Certificate, or for any other certifications that may be required.⁷⁵ That includes Certificates of Conformance that attest that each delivered Wedgetail aircraft conforms to the approved design, as certified by the FAA. Boeing is also required to document, for Defence approval, any known variations or non-conformances.⁷⁶

⁷² AEW&C Project, *Type Certification Plan*, December 2002, Section 2.3.14.

⁷³ Design approval certification is the formal statement by the Boeing Senior Design Engineer that the design meets, and has been shown to meet, all the requirements of the relevant specifications; Boeing, 737 AEW&C Wedgetail Project, *Technical Review Plan*, Revision D, October 2001, section 5.1.4.

⁷⁴ AEW&C Project, *Project Design Acceptance Strategy*, December 2002, Section 3.1.3.1

⁷⁵ Project Air 5077, Contract C338364 *Conditions of Contract, Statement of Work—System Acquisition*, Section 5.7.2.5.2.

⁷⁶ AEW&C Project, *Type Certification Plan*, December 2002, Section 2.6.2.

Wedgetail Design Acceptance

4.22 Design Acceptance Certification is a prerequisite to the issue of an Australian Military Type Certificate and a Service Release. It is therefore the key component of the Wedgetail acceptance into service process.

4.23 The Wedgetail RPT's Senior Design Engineer is responsible for managing the Wedgetail Design Acceptance process, including the progressive review of design activities and associated milestones, culminating in the Design Acceptance certification of the Wedgetail system. The Senior Design Engineer is required by the technical airworthiness regulations to manage the Design Acceptance process in accordance with an approved Project Design Acceptance Strategy, using approved ASD procedures implemented by competent personnel using an approved Engineering Management System.⁷⁷

4.24 Overall Design Acceptance certification is based on a review of all design and development milestone results.⁷⁸ However, the RPT's Senior Design Engineer is not required to review the technical integrity of all Wedgetail design decisions, calculations and design outputs. The design agency (Boeing) by virtue of achieving and maintaining AEO status, certifies its own designs.⁷⁹ In accordance with ADF Technical Airworthiness Regulations, the RPT Senior Design Engineer may certify Design Acceptance once he/she is satisfied that the Boeing-approved design has been produced against an approved specification, and the design has been verified as meeting the specification.

4.25 Once all design and development milestones are successfully completed and reviewed for technical integrity, the Senior Design Engineer is responsible for applying to the Director General Technical Airworthiness, who is the ADF Technical Airworthiness Regulator, for a recommendation to the ADF Airworthiness Authority concerning the granting of an Australian Military Type Certification.⁸⁰

⁷⁷ Australian Defence Force, Australian Air Publication 7001.053, *Technical Airworthiness Management Manual*, Section 3 Chapter 12.

⁷⁸ The RPT performs a design-for-use acceptance certification role in terms of the technical acceptability to the Wedgetail equipment design for its use in service; Boeing, 737 AEW&C Wedgetail Project, *Technical Review Plan*, Revision D, October 2001, section 5.1.4.

⁷⁹ Australian Defence Force, Australian Air Publication 7001.053, *Technical Airworthiness Management Manual*, Section 3 Chapter 12.

⁸⁰ ADF, Australian Air Publication 7001.053, *Technical Airworthiness Management Manual*, Section 3 Chapter 12.

Wedgetail project Australian Military Type Certification and Service Release Program

4.26 On completion of the first aircraft, the Wedgetail project office is to provide DGTA staff with the Wedgetail Statement of Operating Intent, Design Certificate, Design Acceptance Certification, Type Record, Safety Case, and Instructions for Continuing Airworthiness. DGTA staff will then seek a recommendation from the Director General Technical Airworthiness to the Airworthiness Board, concerning the issue of Australian Military Type Certificate.⁸¹

4.27 The project's acceptance strategy and engineering management system record the engineering decisions made in the exercise of engineering authority. Consequently, the strategy and engineering records should satisfy the key pre-requisites for Design Acceptance, and assist the Wedgetail RPT's Senior Design Engineer to establish whether the Wedgetail is technically acceptable for ADF use.⁸²

4.28 Military type certification and Service Release will need to occur by 2008, when the AEW&C capability is scheduled for acceptance into service. This process is assisted by the Wedgetail project having its Statement of Work and System Specification approved by the project's Defence stakeholders, as well as having an approved design acceptance strategy and other key plans (including Test and Evaluation, Type Certification, and System Safety plans) endorsed by the ASD Senior Engineer, the Director General Technical Airworthiness and other stakeholders.

Aircraft Certificate of Airworthiness

4.29 In addition to the aircraft type certification process, each aircraft must receive a Certificate of Airworthiness. The RPT's Senior Design Engineer is responsible for issuing Certificates of Airworthiness for each Wedgetail aircraft based upon the Design Certificate, individual Certificates of Conformance and individual Records of Production Build Quality submitted by Boeing.⁸³ The RPT's Quality Assurance Manager manages the development of suitable insight processes to ensure that

⁸¹ AEW&C Project, *Type Certification Plan*, December 2002, Section 2.4.7.

⁸² AEW&C Resident Project Team, RPT Standing Work Instruction, *ENG-03 Engineering Decision Recording*, December 2002, p.1.

⁸³ Airborne Early Warning and Control for the ADF, *Project Management and Acquisition Plan, Volume 20, Quality Assurance Management Plan*, December 2002.

manufacturing build quality is appropriately addressed as described in the project's Quality Assurance Plan.⁸⁴

Quality Assurance

4.30 Quality management systems focus specifically on satisfying consumer expectations for products and services of predictable uniformity, reliability and acceptable price. High-risk high-value products, such as the Wedgetail systems, require quality assurance (QA) activities to embrace design, materials and work procedures to provide adequate confidence that quality is built into products at each stage of the design and production process. Formal QA systems:

- address the production process as well as individual product samples;
- place the onus on manufacturers to demonstrate, with objective quality evidence, that their products and processes comply with recognised quality standards and specifications; and
- assist in managing safety and performance risks, including risks which initially may not be apparent, or for which there may be no safe or practical tests or trials.

4.31 Contractors' quality control (QC) systems contain the operational techniques and activities used to ensure that required quality is maintained during manufacture. QA and QC are the contractor's responsibility. However, since DMO Project Offices have quality outcome responsibilities, they also have QA responsibilities.

4.32 Defence QA policy supports the ADF technical integrity policy through ensuring that the method of assuring that quality is appropriate to the supplies. The aim of Defence undertaking QA is to ensure that material is fit for the stated purpose and poses no hazard to personnel, public safety or the environment.⁸⁵ Within Project Offices, QA representatives review contractor compliance with contracted management systems and processes, and undertake product inspections to gain assurance that quality requirements leading to the acceptance of supplies has been achieved.

4.33 The RPT's Quality Assurance Manager is the delegated Wedgetail QA representative and manages the development of suitable oversight processes to ensure compliance with quality standards and that

⁸⁴ *ibid.*

⁸⁵ Defence Instruction (General) LOG 02-1—*Defence Policy on Quality Assurance*, May 2003.

manufacturing build quality conforms with the project's Quality Assurance Plan.⁸⁶

QA and Design Acceptance

4.34 QA is a critical element of the design acceptance strategy and, as such, QA management is seen to be a key component of the Wedgetail project Engineering Management System. QA management by the Wedgetail RPT is primarily focused on assuring compliance with Boeing's QA processes and, in turn, the flow down of Boeing's quality requirements to its subcontractors.⁸⁷

4.35 The application of QA to design, manufacture and maintenance (prior to Defence acceptance) is seen by the project as a fundamental principle on which the award of AEO status to Boeing was provided and against which continued compliance is assessed. Likewise, Design Acceptance of the Wedgetail systems, including the Wedgetail support segments, is undertaken on the basis that quality assurance objectives have been met.⁸⁸

4.36 The RPT gains assurance through its QA personnel participating in Boeing's product and process audits and continually maintaining an insight to Boeing's quality control and quality inspection functions.

Compliance Assurance

4.37 Compliance assurance is the system by which the ADF's Director General Technical Airworthiness is assured that:

- an organisation seeking engineering or maintenance authority is capable of complying with the regulatory requirements; and
- organisations with existing authority are continuing to satisfy the regulatory requirements.⁸⁹

4.38 Compliance assurance activities range from desktop reviews of documentation through to formal on-site auditing. The type and frequency of compliance assurance activities are tailored to reduce the impact on the

⁸⁶ Airborne Early Warning and Control for the ADF, *Project Management and Acquisition Plan, Volume 20, Quality Assurance Management Plan*, December 2002.

⁸⁷ *ibid.*, Section 9.1.

⁸⁸ Airborne Early Warning and Control for the ADF, *Project Management and Acquisition Plan, Volume 20, Quality Assurance Management Plan*, December 2002, Section 9.1.

⁸⁹ Australian Defence Force, Australian Air Publication 7001.053, *Technical Airworthiness Management Manual*, Section 1 Chapter 6.

organisation being evaluated while at the same time providing appropriate confidence that regulatory requirements will be met. The intent is to balance the risk to the ADF with the resources required to ensure compliance.⁹⁰

4.39 DGTa Project Regulation staff audited the RPT in February 2002, and again in June 2003, to assess the Wedgetail project's Engineering Management System in terms of its compliance with airworthiness regulations. These audits were conducted on behalf of ASD Chief Engineer in support of ASD's project office surveillance audit program. As mentioned above, the Wedgetail RPT's Senior Design Engineer is required by the technical airworthiness regulations to manage the Design Acceptance process in accordance with an approved PDAS, using approved ASD procedures implemented by competent personnel using an approved Engineering Management System. Surveillance audits aim to provide assurance that ASD projects remain continually effective in satisfying these requirements.

4.40 The June 2003 DMO surveillance audit found that, despite a need to document some minor systems engineering processes, the Wedgetail Engineering Management System represented an excellent example of an effective and robust Acquisition Engineering Management System and that the RPT was a very competent organisation.⁹¹

Wedgetail safety program

4.41 The contract also requires Boeing to perform a system safety program, leading to the production of a Safety Case. The Safety Case is to draw on the safety analysis conducted under the FAA certification for the basic aircraft, and be re-validated and extended as required for the Wedgetail modification. The contract also requires Boeing to implement MIL-STD-882C *System Safety Program Requirements*, to address areas of design or operation not included in the 737 safety analysis.⁹²

4.42 The Wedgetail project's System Occupational Health & Safety Plan, produced by Boeing, includes safety analyses aimed at hazard control and the prevention of personal injury and equipment damage. A software safety program is integrated with the system safety program.

⁹⁰ *ibid.*, Section 1 Chapter 6.

⁹¹ DMO, 2000/6943/2(26), *AIR 5077 AEW&C Resident Project Team Engineering Management System Audit Report June 2003*, 30 September 2003, p.4.

⁹² Airborne Early Warning and Control, *Software Acquisition Management Plan*, June 2002.

4.43 RPT personnel are responsible for monitoring the conduct and outputs of the safety program, and the development of the Safety Case. While RPT staff review the hazard identification and analysis activities, Boeing remains responsible for the technical accuracy of the Safety Case and its role in defining the Wedgetail system's airworthiness.

5. Operational Integrity

This chapter focuses on operational integrity and the way the Wedgetail project establishes adequate assurance that user expectations will be satisfied.

Operational integrity

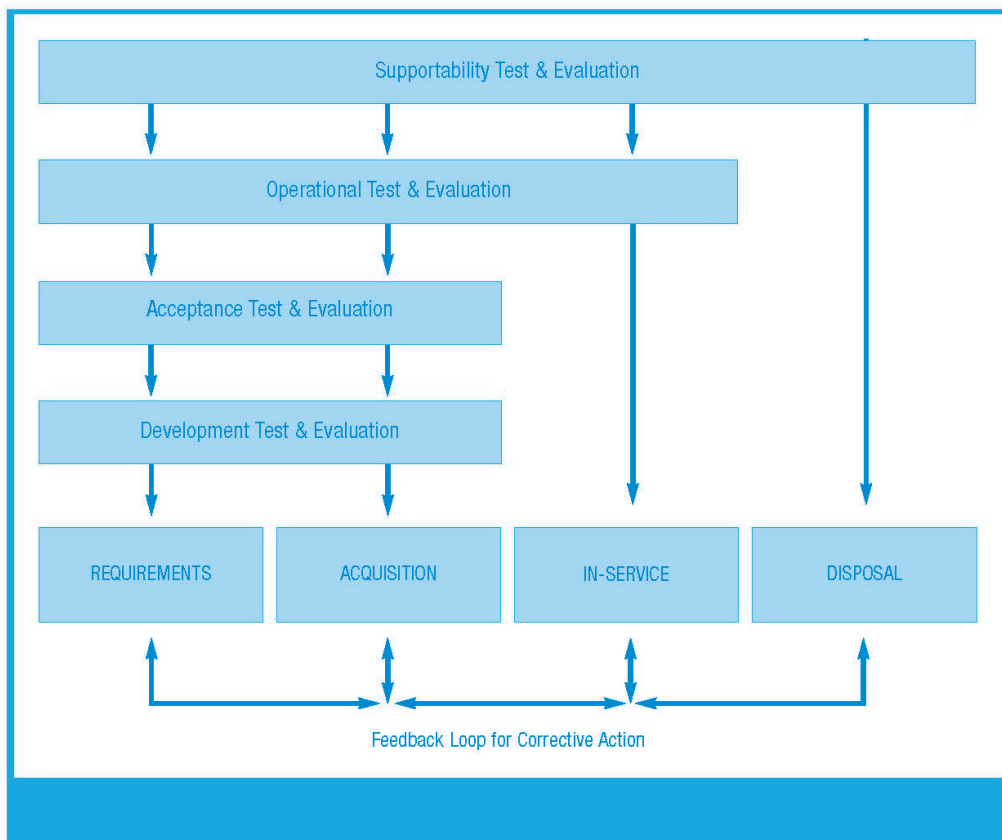
5.1 In addition to providing adequate assurance regarding the technical integrity of the Wedgetail design, the Wedgetail project needs to provide assurances regarding the system's operational integrity in terms of operational effectiveness and operational suitability. Operational integrity is largely demonstrated through the T&E processes, which aim to reduce the risk that the aircraft and its systems will not satisfy user expectations in terms of cost, quality, delivery schedule, mission success, system vulnerability and personnel safety.⁹³

5.2 The Wedgetail project operational integrity process is contained within the development, acceptance and operational T&E phases shown in Figure 5.1.

⁹³ See ANAO Audit Report No.30 2001–2002, *Test and Evaluation of Major Defence Equipment Acquisitions*, January 2002.

Figure 5.1

Defence Materiel Life Cycle—Test and Evaluation Aspects



Source: Department of Defence.

5.3 The Wedgetail project is required to follow Defence's T&E policy which states:

The three categories of T&E [Development, Acceptance and Operational T&E] are to be used either separately or in combination in Defence. Programs may decide the combination of the categories and timing to suit their specific needs. ... The underlying objective is to conduct T&E throughout a Defence materiel project, from conception to disposal (ie a 'T&E continuum'), to confirm the successful completion of a stage and gain information useful to the conduct of the next stage. T&E is to be used to produce objective evidence in terms of operational capability or materiel performance, confirming that some specific milestone has been

achieved and assessing the technical risk of proceeding to the next milestone in the project plan.⁹⁴

5.4 T&E is conducted to provide assurance of the technical, operational and logistics integrity of the Wedgetail system. However, assurances concerning a system's technical integrity are based on the project's systems, personnel, process and data that need to comply with ADF technical regulatory framework requirements. Consequently, even though some decisions concerning design approval and acceptance may be derived through T&E, overall technical integrity assurances are established by processes more wide-ranging than T&E.

5.5 Appendix 6 provides a detailed description of the various Wedgetail T&E phases. The Wedgetail's T&E program seeks to:

- support technical risk assessments during the Wedgetail systems development program – this aligns with development T&E (DT&E) conducted by Boeing;
- demonstrate to Defence that the Wedgetail system, segment or sub-systems comply with the contract specification – this aligns with acceptance T&E (AT&E) conducted by Boeing;
- assess the operational effectiveness and operational suitability of the Wedgetail system; and to then develop, trial and validate tactics for the Wedgetail system operating as part of an integrated air defence system. This aligns with initial and follow-on Operational T&E (OT&E) conducted by Defence;⁹⁵ and
- evaluate the logistics support required to ensure the Wedgetail system's continued technical and operational integrity. This aligns with supportability T&E (ST&E), which according to Defence's T&E policy, is conducted during all phases of the Defence materiel life-cycle. Wedgetail logistics support is discussed in Chapter 6.

5.6 A system's operational integrity is largely assured through T&E focused on operational capability and materiel performance issues.⁹⁶ These include:

- critical operational issues, which include the effectiveness and suitability issues that must be examined to determine whether the Wedgetail system can perform its missions;

⁹⁴ Defence Instruction DI(G) LOG 08-10 *Defence Test and Evaluation Policy*, 1996, para 13.

⁹⁵ AEW&C Project, *Test and Evaluation Master Plan*, September 2002, Section 1.7.1.

⁹⁶ AEW&C Project, *Type Certification Plan*, December 2002, Section 2.3.14.

- measures of operational effectiveness, which are used to determine the capacity of a system to perform its intended function to the required standard, over the expected range of operational circumstances, in the expected environment, and in the face of the expected threat, including countermeasures; and
- measures of operational suitability (MOS), which are used to determine a system's reliability, logistics supportability, compatibility and interoperability with other capability elements. MOSs are also used to determine system safety and ergonomic acceptability, when operated and maintained by typical military personnel in the expected numbers, at the expected training and experience level.

5.7 At the time of the audit, the Wedgetail project was developing operational effectiveness and suitability tests for inclusion in its OT&E program, which is scheduled to commence in 2007.

Wedgetail T&E organisation and responsibilities

5.8 The strategy of holding Boeing responsible for DT&E and AT&E is consistent with the project's overall management strategy of Boeing having total system performance responsibility for the Wedgetail system.⁹⁷ Nevertheless, Defence exercises a measure of control over the project's T&E by formally approving AT&E plans, procedures and reports.⁹⁸

5.9 The strategy requires the Wedgetail RPT to have sufficient visibility of, and participation in, Boeing's T&E program to enable the management of project risks, without compromising Boeing's responsibilities. Consequently, the Wedgetail acquisition contract enables RPT personnel to:

- observe Boeing DT&E activities, including Test Readiness Reviews;
- participate in DT&E activities, such as mission console operations during selected DT&E tests and operational demonstrations, ranging from quite informal testing to relatively formal testing such as 'AT&E dry runs';⁹⁹ and

⁹⁷ AIR 5077, *Project Management and Acquisition Plan (PMAP)*, Volume 1 Issue 2, Section 11.

⁹⁸ Project Air 5077, Contract C338364 *Conditions of Contract*, Statement of Work, Section 5.6.3.

⁹⁹ AEW&C Project RPT Standing Work Instructions, *Commonwealth Conduct During Boeing Test and Evaluation*, Section 6.

- witness all AT&E activities, and participate in those activities where a greater level of involvement is agreed to be necessary for Defence to verify compliance with the requirements.¹⁰⁰

5.10 This strategy enables the RPT to gain insights into the Wedgetail system’s design and performance and compliance with the System Specification, as well as early insights into the degree to which the system is likely to be ‘fit for its intended purpose’.

5.11 Fitness for purpose will be formally assessed during the AT&E phase with reference to the Wedgetail’s CONOPS and SOI, which were developed during the precontract period and progressively refined since.¹⁰¹

5.12 The Wedgetail T&E responsibility matrix is shown in Table 5.1.

Table 5.1
Wedgetail Test and Evaluation responsibility matrix.

	Development T&E	Acceptance T&E	Initial Operational T&E	Follow-on Operational T&E
Department of Defence	- observe - review	- witness - review - approve	- plan - manage - conduct - report - resource	- plan - manage - conduct - report - resource
Boeing	- plan - manage - conduct - report - resource	- plan - manage - conduct - report - resource	- support	
Joint Test and Evaluation Working Group	- monitor - advise - resolve	- monitor - advise - resolve	- monitor - advise - resolve	

Source: Wedgetail project, Department of Defence.

¹⁰⁰ Project Air 5077, Contract C338364 *Conditions of Contract*, Statement of Work, Section 5.6.

¹⁰¹ AEW&C CONOPS Issue 3 and Supplements 1-5 Issue 1.

5.13 Boeing and Defence representatives have formed a Joint Test and Evaluation Working Group to resolve T&E issues and to monitor the T&E program's progress. In addition, a Defence AEW&C Test Team was established to support the Wedgetail T&E program and to facilitate the smooth transfer of responsibility for T&E from the acquisition to the in-service phase.¹⁰²

5.14 Project records indicate that the composition and structure of Defence's test team will change as the Wedgetail project progresses through its development, acceptance and operational T&E phases.

5.15 At the time of the audit, the test team comprised engineering, logistics, scientific and operational staff from the RPT and SPO. The team also included Defence Science and Technology Organisation (DSTO) personnel, Systems Engineering Technical Assistance (SETA) contractor personnel, and a cadre of Air Force T&E specialists such as test pilots, flight test engineers and flight test air combat controllers.

5.16 Eventually, the test team will also include AEW&C mission, flight and maintenance crew from Air Force's Surveillance and Control Force Element Group, and Air Force's No.2 Squadron, as well as staff from other specialist organisations as required.¹⁰³

Air Force T&E personnel embedded within Boeing

5.17 Air Force intends to embed a number of operators and maintenance personnel within the Boeing T&E organisation to support the conduct of development and acceptance T&E. These Air Force personnel will operate and maintain the Wedgetail system under test, and on completion of the T&E program they will transfer back to Air Force. This arrangement is expected to provide Air Force with Wedgetail systems knowledge and T&E experience needed for the project's in-service phase, and for the Air Force's OT&E program.

5.18 To preserve Boeing's total system performance responsibility and Defence's approval rights for AT&E plans, procedures and reports, the embedded personnel will, for the purposes of T&E, be treated as Boeing employees and not as part of Defence's AEW&C test team.

¹⁰² AIR 5077, *Project Management and Acquisition Plan (PMAP)*, Volume 1 Issue 2, Section 11.

¹⁰³ AEW&C Project, *Test and Evaluation Master Plan*, September 2002, Section 7.2.1.

T&E plans and procedures

5.19 The Wedgetail project T&E Master Plan (TEMP) covers DT&E, AT&E and OT&E. Boeing has produced a master test plan covering DT&E and AT&E. At the time of the audit, Boeing was developing the hierarchy of test plans, shown in Appendix 6, which contain the T&E procedures Boeing will use during the system development and acceptance phase. They represent a very substantial body of work, for example, one test plan incorporates some 140 test procedures. The test plans were scheduled for delivery to Defence in September 2003.

5.20 At the time of the audit, the RPT's SETA contractor was developing the project's OT&E plan.

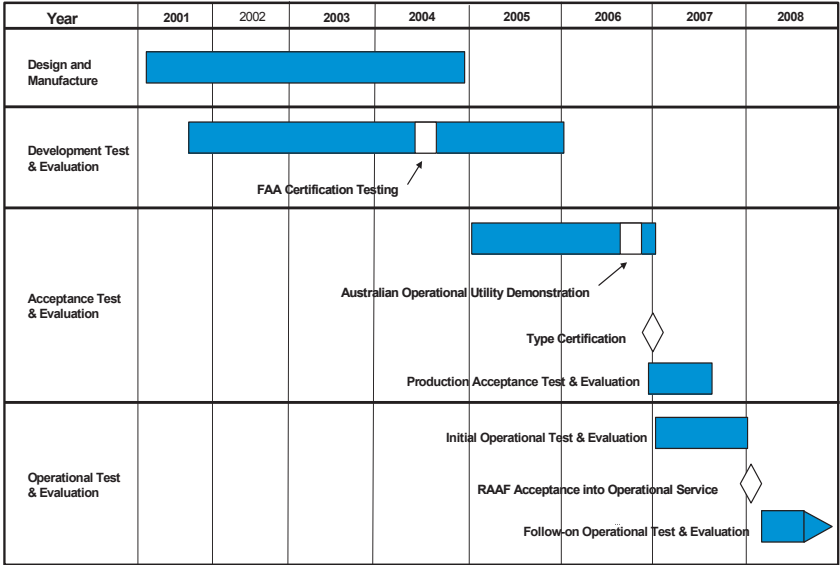
Wedgetail T&E schedule

5.21 At the time of the audit, the RPT was observing Boeing's DT&E processes, and was preparing for AT&E scheduled for 2005, and for OT&E scheduled for 2007.

5.22 The Wedgetail project intends to conduct a number of Operational Utility Demonstrations during 2005 and 2006, under realistic operational conditions, prior to delivery of the Wedgetail system. For contractual reasons, these demonstrations are considered as part of DT&E and OT&E, rather than just as an OT&E activity.

5.23 Figure 5.2 shows the scheduled program of T&E activity over the life of the project. The bulk of the project's T&E tasks are scheduled to significantly increase in 2005, with the start of sub-system and system-level AT&E.

Figure 5.2
Wedgetail Test and Evaluation Schedule



Source: Wedgetail project, Department of Defence.

T&E advice and reports

5.24 Boeing is responsible for reporting DT&E and AT&E results, in terms of specification compliance and fitness for purpose issues. In addition, the RPT intends to produce supplementary T&E test reports to highlight any test failures or significant test events and issues, and to assess the operational integrity of the Wedgetail system.

5.25 Boeing and RPT test reports will be used to assess the Wedgetail system’s operational ‘fitness for its intended purpose’ prior to its delivery, and later during the assessment of operational airworthiness requirements prior to Service Release.¹⁰⁴

5.26 The Wedgetail project will also provide an operational test report using data gathered during the DT&E, AT&E and OT&E test phases to support recommendations for Acceptance into Operational Service of the Wedgetail system.

¹⁰⁴ DMO anticipates that Service Release of the Wedgetail system will enable a Limited Initial Operational Capability (IOC), whereby Wedgetail can conduct certain approved roles.

Progress on the Test Verification Matrix

5.27 The Wedgetail project has a Test Verification Matrix, which details how Boeing and the RPT will verify the achievement of the contracted System Specification. In 2002, the ANAO reported that the Wedgetail project was completing its Test Verification Matrix and that the project's TEMP would be amended to reflect a revised testing concept, strategy and sequence.

5.28 Since then, the Wedgetail project has obtained agreement with Boeing on the way contractual compliance is verified with regard to each of the contracted system specification.¹⁰⁵ On that basis, the project's TEMP was being updated and System Specification compliance verification had commenced.

5.29 Work was also continuing on developing the CONOPS verification process needed for OT&E.

¹⁰⁵ Boeing, 737 AEW&C Wedgetail Project, *Technical Review Plan*, Revision D, October 2001, section 4.5.8.

6. Logistics Integrity

This chapter examines the in-service logistic support systems the project is developing to assure the continued integrity of the Wedgetail aircraft and systems once they have been released into service.

Introduction

6.1 The Wedgetail project needs to establish in-service logistics support arrangements that comply with Defence's regulatory framework, in order to provide assurance of the continued technical and operational integrity of the Wedgetail aircraft and their associated supplies and support systems. These arrangements typically consist of six integrated elements:

- logistics engineering, which evaluates a system's safety, reliability and maintainability, and determines the most effective through life support plan;
- maintenance engineering, which determines maintenance procedures and schedules;
- technical documentation development, covering equipment operation and maintenance manuals;
- supply support analysis, which determines the range and depth of spare parts and test equipment, and provides the initial spares support;
- operator and maintainer training; and
- information technology development to support each of the above logistics elements.

6.2 The Wedgetail project is seeking to develop a layered in-service logistics support program covering:

- the operational-level—provided by aircraft crew;
- flightline-level—provided by the Air Force's AEW&C operations and maintenance squadron (No.2 SQN); and
- depot-level—provided by the project's in-service support contractors.

6.3 Each in-service support layer must comply with Defence's regulatory framework. This framework requires ADF aircraft to be designed, constructed, maintained and operated to approved standards, by competent and approved individuals, who are acting as members of an

approved organisation, and whose work is certified as correct.¹⁰⁶ Technical airworthiness regulations require aircraft in-service support organisations to have relevant Authorised Maintenance Organisation (AMO) status.¹⁰⁷

6.4 The Wedgetail project AII program is a major contributor to the project's logistics support arrangements. The AII management strategy involves Australian industry during the development, production and in-service support phases of the Wedgetail project. It aims to establish, in Australia, the ability to manage, control, support and adapt the Wedgetail system throughout its service life.

6.5 This chapter provides an overview of the logistic support and AII arrangements, which at the time of the audit were in their early stages of development.

Logistics support arrangements

6.6 The acquisition contract requires Boeing to establish, implement and control an integrated support program for the Wedgetail system and its related support elements.¹⁰⁸ This accords with the project's total system performance responsibility philosophy, whereby the prime contractor (Boeing) takes full responsibility for the performance of all aspects of the Wedgetail system on delivery to Defence. This also includes the logistics program. As a result of this strategy, logistics elements are acquired along with the prime equipment as part of the system acquisition contract.¹⁰⁹

6.7 The contract requires Boeing to conduct logistic support analysis in order to identify and evaluate the logistic support necessary to maintain the Wedgetail's technical and operational integrity. The output of the analysis is a Logistic Support and Analysis Record, which specifies, amongst other things, the required levels of spare and repair parts, test and support equipment, and skilled personnel. Logistics support identification and evaluation is a key component of ST&E mentioned in Chapter 5.

¹⁰⁶ Defence Instruction (General), OPS 02-2—*Australian Defence Force airworthiness management*, July 2000, p.2.

¹⁰⁷ ADF, Australian Air Publication 7001.053, *Technical Airworthiness Management Manual*, Section 2, 4.1.1.

¹⁰⁸ Project Air 5077, Contract C338364 *Conditions of Contract, Statement of Work—System Acquisition*, Section 6.1.

¹⁰⁹ Project Air 5077, Airborne Early Warning and Control, *Integrated Logistic Support Plan*, 1996, Section 2.3.3.

6.8 Boeing is also contracted to develop and deliver the logistics and life-cycle cost data using software already in use by the ADF.¹¹⁰ This software, when fully populated with Wedgetail logistics data, will be used to manage the life-cycle cost aspects of the Wedgetail systems when they are in service.

6.9 At the time of the audit fieldwork, the logistics data and analysis was evolving in line with the maturing Wedgetail system design and development.

Wedgetail in-service support

6.10 The contract with Boeing includes provision for the parties to negotiate in good faith to reach agreement on a four aircraft three year initial support contract at least 12 months prior to delivery of the first Wedgetail aircraft, at a price not to exceed some \$A 97 million (September 1998 prices).¹¹¹

6.11 At the time of the audit the Wedgetail SPO and Boeing commenced developing the Wedgetail in-service support arrangements. Early advice from the Wedgetail SPO indicates that the support contract will be outcomes focussed, and will include comprehensive performance indicators and financial incentives and penalties.

6.12 The Wedgetail SPO is planning to develop the support contract's conditions and SOW by the end of 2004, with the intent of obtaining contract signatures in 2005. This timetable is in line with the expected delivery of the first aircraft in 2006.

6.13 In order to maintain formal assurance of the continued airworthiness of ADF aircraft and systems after they have achieved Service Release, the ADF's Director General Technical Airworthiness assigns Airworthiness Maintenance Organisation (AMO) status to competent Defence and commercial organisations following formal evaluations of their airworthiness maintenance capabilities.

6.14 The Wedgetail in-service support subcontractor will be required to attain AMO status for the Wedgetail work they do. Air Force or DMO organisations that undertake operational or flightline-level maintenance will also need AMO status. These arrangements will need to be in place before the in-service phase commences in 2007, and be well established to allow acceptance into service in 2008.

¹¹⁰ OMEGA2B, and Cost Analysis and Strategy Assessment (CASA) Version 3.01

¹¹¹ Project Air 5077, Contract C338364 *Conditions of Contract*, Section 10.

Intellectual property

6.15 Intellectual property (IP) related to equipment acquisition projects often takes the form of technical information related to Defence system operation and maintenance.¹¹² The Wedgetail system acquisition contract provides that all contractor-owned IP may be used by Defence, royalty-free and non-exclusively to enable Defence or another person on behalf of Defence to:

- (a) operate the Wedgetail system;
- (b) perform operating maintenance on the Wedgetail system;
- (c) perform deeper maintenance on the Wedgetail system, except where the contractor can demonstrate, to Defence's satisfaction, that a competitive Australian and New Zealand (ANZ) Industry maintenance capability exists;
- (d) modify the supplies;
- (e) dispose of the supplies;
- (f) certify the AMS for the purpose of ADF airworthiness requirements; and
- (g) train persons to do any of the activities referred to points (a) through (f).

6.16 Boeing is to warrant that the technical information is sufficient to enable suitably qualified persons to perform deeper maintenance and to modify the Wedgetail aircraft and its support segments. The technical information is also to be sufficient to train personnel in respect to the Wedgetail system's deeper maintenance and modifications to the full extent of the AII plan.

6.17 The technical information must also be sufficient to define and maintain the airworthiness certification basis of the Wedgetail aircraft to verify compliance of the aircraft with that certification basis.

6.18 The RPT's Engineering Manager and Integrated Logistics Support Manager have managerial responsibility for receiving and checking technical information deliveries at project, Air Force, and Australian industry premises prior to approving progress payments.

6.19 Wedgetail intellectual property is discussed further in Appendix 7.

¹¹² Project Air 5077, Contract C338364 *Conditions of Contract*, Contract Deliverable Requirements CDR (S)-EM-124.

Australian industry involvement in Wedgetail logistics support

6.20 Created in 1986 and evolved since then, the AII program is the major program through which Defence gives effect to Government policy on Australian industry. It has been the primary mechanism through which Defence has sought to develop and enhance Defence support capabilities in industry. AII policy objectives are to:

- develop and sustain strategically important capabilities in Australian industry to support ADF operations and Defence capability development; and
- maximise Australian industry involvement in Defence's procurement of goods and services, consistent with the Government procurement policy objective of achieving best value for money for Defence.¹¹³

6.21 In accordance with that policy, the Wedgetail project includes important AII program requirements that seek to develop a local industry capability for the integration, modification and support of the Wedgetail system.

Local content and Strategic Industry Development Activity

6.22 The Wedgetail system acquisition contract recognises local content as work carried out by 'Australian and New Zealand Industry' in Australia or New Zealand (ANZ) by:

- any body corporate registered under the Corporations Law, the *Companies Act 1955 (New Zealand)*, or incorporated under any other law of the Commonwealth, or a State or Territory of Australia, or a law of New Zealand; or
- a natural person; or
- any other person acceptable to the Project Authority.¹¹⁴

6.23 Local content is measured in terms of the value added by ANZ industry in satisfying the contract's SOW, including any related profit.

6.24 In addition to local content there is Strategic Industry Development Activity (SIDA). A SIDA is defined as an AII Plan activity, which does not

¹¹³ ANAO Audit Report No.46, 2002–03, *Australian Industry Involvement Program*, June 2003.

¹¹⁴ Project Air 5077, Contract C338364 *Conditions of Contract*, Section 1.21.

form part of the supplies, but which complements specified local content in achieving the industry objectives.

6.25 In November 1997, an Augmented Defence Source Selection Board agreed target levels in the order of 45 to 60 per cent of the acquisition contract price be set for local content and overall AII respectively, subject to the results of a Departmental study¹¹⁵ and negotiations with the successful tenderer.

6.26 At that time AII priorities included:

- design and development of the Wedgetail system, particularly strategically important surveillance sensors, mission systems, communications systems, electronic warfare systems, electronic support systems and tactical intelligence sub-systems;
- system integration tasks sufficient to provide industry with ability to control, manage, enhance, upgrade, adapt, repair and maintain the Wedgetail systems and associated test and support equipment through life;
- full through-life support of the AEW&C capability, particularly in relation to software and systems engineering;
- development and conduct of test evaluation during the acquisition phase that is sufficient for the development of a through life T&E capability; and
- establishment, through involvement in the acquisition phase, of a principal Australian entity to participate in a facility providing through-life operational and logistic support of the AEW&C capability.¹¹⁶

Wedgetail AII contracts

6.27 The project's AII priorities have, to a large degree, been factored into the Wedgetail system acquisition contract, or are the subject of ongoing negotiations related to in-service support arrangements discussed earlier in this chapter. However, there have been some initial setbacks, such as a lack of US Government export licences for some of the project's advanced technology that precluded the award to local industry of contracts valued at some \$A 44 million. Another \$A 50 million in AII was not possible due to the decision not to fit-out two Wedgetail aircraft in

¹¹⁵ AIR 5077, *Project Management and Acquisition Plan (PMAP)*, Volume 1 Issue 2, Section 9.

¹¹⁶ Materiel Division – Air Force, *Air Force New Major Investment Program 1996-2001*, p.12.

Australia.¹¹⁷ That outcome resulted from the decision to purchase only four aircraft, rather than the previously planned seven, which made the Australian fit-out economically non-viable.

6.28 In February 2002, the Wedgetail project received a contract change proposal from Boeing for a change in the local content plan. The proposed change increased the value of local content from \$A 398 million to \$A 413 million (September 1998 prices). This increase reflected the transfer of elements of systems engineering previously precluded from inclusion in the plan (\$A 14 million) and other changes associated with updates to individual ANZ subcontractor AII plans.¹¹⁸

6.29 At the time of the audit scheduled AII, in aggregate cost terms, totalled \$A 1.295 billion (September 1998 prices), which consisted of local content valued at \$A 413 million, and SIDA valued at \$A 882 million.

All achievement verification and validation

6.30 The Wedgetail SPO is responsible for verifying, reporting, auditing and validating local content and SIDA in terms of the overall scope of the project's industry objectives. The acquisition contract contains a highly integrated and complex AII plan, which addresses a series of tasks that Australian industry needs to complete in order for Defence to obtain a Wedgetail through-life support capability. The tasks relate to:

- design and development of the AEW&C system;
- systems integration;
- transfer of targeted technologies, technical data, knowledge and intellectual property;
- development and conduct of testing and evaluation; and
- establishment and operation of the Wedgetail support facility.¹¹⁹

¹¹⁷ Department of Defence, *AEW&C Project Presentation – Australian Industry Involvement*, 6 March 2003.

¹¹⁸ Boeing, *Change Proposal Business Case, Amendment 1 to Australian Industry Involvement Plan*, 26 February 2002.

¹¹⁹ Boeing, *Australian Industry Involvement Progress Report No.3*, July 26, 2002 – January 17, 2003, pp.8,9.

6.31 SIDA tasks include:

- development of export opportunities through export sales, technology transfers, research and development collaborative venture activities which can sustain and develop the ANZ support base;
- development of knowledge and skills through training/skills transfer; and
- local manufacture of systems and components and/or local aircraft production, including co-production of aircraft components.

6.32 Boeing provides Defence with six-monthly AII progress reports and the Wedgetail project uses the reports as the basis for AII progress reviews. At the time of the audit, the Wedgetail SPO had appointed an AII Manager in Canberra, who is responsible for verifying and validating AII progress via a combination of desktop reviews and visits to Boeing and its subcontractors.

6.33 The ANAO was advised that verification methods include tracing data samples to check the accuracy of local content claims, and detailed examination of Boeing and subcontractors' records. Verification of SIDA achievement includes milestone reviews and thorough examination of Boeing and subcontractor records.

6.34 In September 2003, the AEW&C Project Office advised the ANAO that AII progress was running well ahead of the plan. In aggregated cost data terms total reported AII achievement to August 2003 was \$A 533 million at September 1998 prices (comprised \$A 133 million local content and \$A 400 million SIDA), against the \$A 335 million planned.

7. Progress Measurement

This chapter examines Wedgetail project's progress measurement system, and progress achieved in key areas of the project.

Introduction

7.1 An equipment acquisition project's progress measurement system should provide information for general project management purposes, risk management, and financial performance management. The progress measurement system also forms an integral part of the system's engineering control process, as contractors need to measure technical progress in terms of cost and schedule linked to systems engineering requirements achievement. This is particularly important for the Wedgetail project, as \$A 1.8 billion (December 2003 prices—three-quarters of the acquisition contract price) is to be paid prior to the acceptance of the first Wedgetail aircraft.¹²⁰ This figure reflects the project's lengthy design development and test and evaluation phases.

7.2 The Wedgetail project uses five principal processes to assess progress, which are outlined below:

- milestone achievement;
- Earned Value Management System (EVMS);¹²¹
- computing system development measurements;
- technical reviews that follow systems engineering standards; and
- Verification & Validation (V&V) of hardware and software progress.

7.3 These progress measurement systems provide the Wedgetail contractors and project personnel with information for general project management purposes, risk management, and financial performance management. They also form important components of the system's engineering control process, as the contractors need to measure technical progress in terms of cost and schedule estimates as well as in terms of system engineering requirements achievement. These processes are discussed below.

¹²⁰ Department of Defence, Management Audit Branch, *Initial Report on the Airborne Early Warning Project, Project Definition and Initial Design Activities*, December 2000, p.9.

¹²¹ The EVMS is also referred to as a Cost and Schedule Control System (CS²).

Milestones

7.4 The contract contains a schedule of 75 milestone payments, which total some three quarters of the contract price. The milestone payment amounts specified in the schedule are not necessarily linked with the actual or budgeted cost of work performed at the time of the nominated milestone. Rather, they are based on projected prices over the period of the contract, which were agreed to during contract negotiations.

7.5 Twenty milestones are designated as 'critical milestones'. These include critical design reviews, completion of aircraft modifications and software builds, completion of airworthiness flight-testing, acceptance of each Wedgetail aircraft, and the acceptance of major segments that constitute the AEW&C support facilities and systems.

7.6 Milestone achievement is determined by a combination of technical reviews and the successful completion of products defined in the acquisition contract. At the time of the audit fieldwork Boeing had completed three milestones on schedule and 14 ahead of schedule. Of these, seven were completed more than two months ahead of schedule.

7.7 Figure 7.1 shows Boeing fitting the combined Multi-role Electronically Scanned Array (MESA) radar and Indicator Friend or Foe (IFF) antenna to the second Wedgetail aircraft, one month ahead of schedule.¹²²

¹²² Milestone 19—Radar/IFF Dorsal Antenna #1 (for AMS #2) received—Project Air 5077, Contract C338364 *Conditions of Contract*, Annex 1 to Attachment D.

Figure 7.1

Wedgetail Aircraft Undergoing Development



Source: The Boeing Company.

Earned Value Management System

7.8 A fundamental project management responsibility is to ensure that the contractor's cost and schedule progress data are sufficient and reliable to accurately track and review results being obtained. To be meaningful, this data must:

- portray budgets allocated over time to specific contract tasks;
- indicate work progress;
- relate properly to costs, schedule and technical accomplishment;
- remain valid, timely and auditable; and
- provide summary information at a practical level.

7.9 In carrying out this responsibility, the Wedgetail project relies on Boeing's 737-Wedgetail EVMS as the predominant mechanism for measuring and reporting cost and schedule progress over the life of the project.

7.10 The contract with Boeing is a fixed price contract paid in part by accomplishment of pre-determined milestones (75 per cent of the contract

value) and, in part, on the basis of earned value (25 per cent of the contract value).

7.11 The EVMS's role in the progress payment mechanism, and its role in measuring and reporting cost and schedule progress, results in the need for it to be accepted and validated as being consistent with EVMS standards adopted by both Defence and the US Department of Defense's Defense Contract Management Agency (DCMA).¹²³

7.12 The Wedgetail SPO advised the ANAO that Boeing's EVMS is recognised by Defence under the auspices of the November 1995 trilateral 'mutual recognition' Memorandum of Understanding between the United States, Canada and Australia. It further advised that the EVMS's effectiveness is kept under surveillance by Defence and DCMA in order to provide confidence that it contains valid data consistent with the intent of the Wedgetail contract. This surveillance includes monthly reviews of sample Cost Performance Report data and supporting documentation, and periodic (approximately annual) comprehensive reviews of the EVMS baseline planning and reporting system. The comprehensive reviews, known as Integrated Baseline Reviews (IBRs) are discussed further in Appendix 8.

7.13 The RPT advised the ANAO that Boeing's EVMS was well maintained, and that the IBR revealed only four minor findings that needed follow-up action. These were not material to the execution of the program. Two related only to system improvement suggestions. Based on that advice, the ANAO considers that Boeing and the RPT have made reasonable efforts to ensure the project's cost and schedule management information reporting system can be relied upon.

Key features of the EVMS

7.14 The EVMS provides the project with a Performance Measurement Baseline (PMB), used to assess and manage organisational and task performance in terms of project costs and schedule. The PMB is comprised of a cumulative graph of the planned value of work to be performed over a project's duration.

7.15 At the time of the audit, the Wedgetail project's EVMS had some 9 330 individual work and planning packages scheduled for completion by 2010. Overall, work performed on the packages had been largely within cost and schedule estimates.

¹²³ Project Air 5077, Contract C338364 *Conditions of Contract*, Section 14.6.

7.16 Progress on each work and planning package is typically measured using an earned value measurement technique selected from the following eight alternative techniques:

Measured earned value:

1. Work package milestones;
2. Quantifiable per cent complete;
3. Assessed per cent complete;
4. Usage-driven assessment;
5. Rolling-wave assessment; and/or
6. Labour standards.

Apportioned earned value:

7. Scope for which planning and earned value measurement is directly related, and in proportion to, other measured effort control accounts/work packages.

Level of effort:

8. Scope of a general or supportive nature that is impractical to measure; therefore, earned value is set to budget value with the passage of time.¹²⁴

7.17 Project personnel often encounter difficulties in determining earned value regarding work packages incomplete at the time of an EVMS reporting period, or regarding work done out of sequence or ahead of schedule. Also, in complex design, development and production projects like Wedgetail, any engineering setback means that previous earned value may not correctly portray actual technical accomplishment. Consequently, in order to reduce earned value measurements risks, projects adopt a multi-disciplinary approach to assessing work package progress. The disciplines include computing system development measurements, technical reviews and audits, and verification and validation.

Cost Performance Reports

7.18 Boeing provides the Wedgetail RPT with monthly Cost Performance Reports based on its EVMS, which reports contractor performance against the contract's schedule, progressive costs, and cost to complete the contract. If contractor performance varies from project plans

¹²⁴ Adapted by the ANAO from, Boeing, *Integrated Performance Measurement Manual*, October 2000, p.11.

by more than five or 10 per cent, depending on particular items, the performance report must provide reasons for the variation.¹²⁵

Schedule progress

7.19 Project teams need schedule progress data to inform them of whether work was performed under, on or over the planned duration. Schedule progress is measured by comparing the earned value of work performed with the planned value of work performed, at a particular point in time. Or, in other words, it is measured by comparing budgeted cost of work performed (BCWP) with the budgeted cost of work scheduled (BCWS) at a particular point in time.¹²⁶

Cost progress

7.20 Projects require cost data to inform them of whether work was performed at a cost that was under, on or over budgeted cost. Cost progress on work performed is measured by comparing actual costs with the earned value of the work performed, at a particular point in time. Or, in other words, it is done by comparing actual cost of work performed (ACWP) with BCWP at a particular point in time.

7.21 The contract with Boeing is a fixed price contract so Boeing's actual costs do not feature in the progress payments. However, Defence needs to remain aware of the project's cost progress given that cost overruns may result from a combination of inadequate original task estimates, technical difficulties requiring the application of additional resources, or differences in planned labour costs, materials or personnel efficiency.

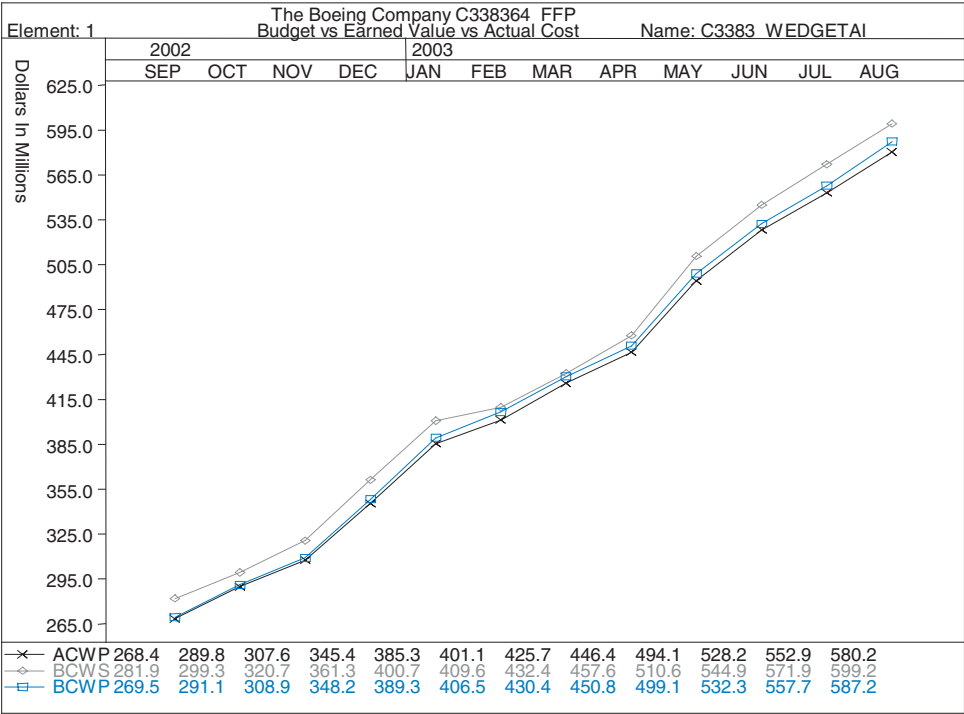
7.22 Boeing's Cost Performance Reports provide a reasonable basis to monitor progress in cost and schedule terms, as shown by the cumulative cost and schedule trend data in Figure 7.2.

¹²⁵ Project Air 5077, Contract C338364 *Conditions of Contract*, Section 14.8.

¹²⁶ At the time of the audit the term BCWP was being replaced with 'Earned Value', BCWS was being replaced with 'Planned Value', and actual cost of work performed (ACWP) was being replaced with 'Actual Costs'.

Figure 7.2

Wedgetail Project Cost and Schedule Performance



Source: Wedgetail project, Department of Defence.

7.23 Figure 7.2 shows that from September 2002 to August 2003, the system acquisition contract's actual costs, in \$US terms, were running slightly below earned value (ACWP was less than BCWP), and that earned value was running slightly behind planned value (BCWP was less than BCWS). Although not ideal in schedule terms, this is a satisfactory outcome given the project involves extensive advanced technology. This is an indication that Boeing is effectively managing the project from a cost and schedule perspective, as of August 2003.

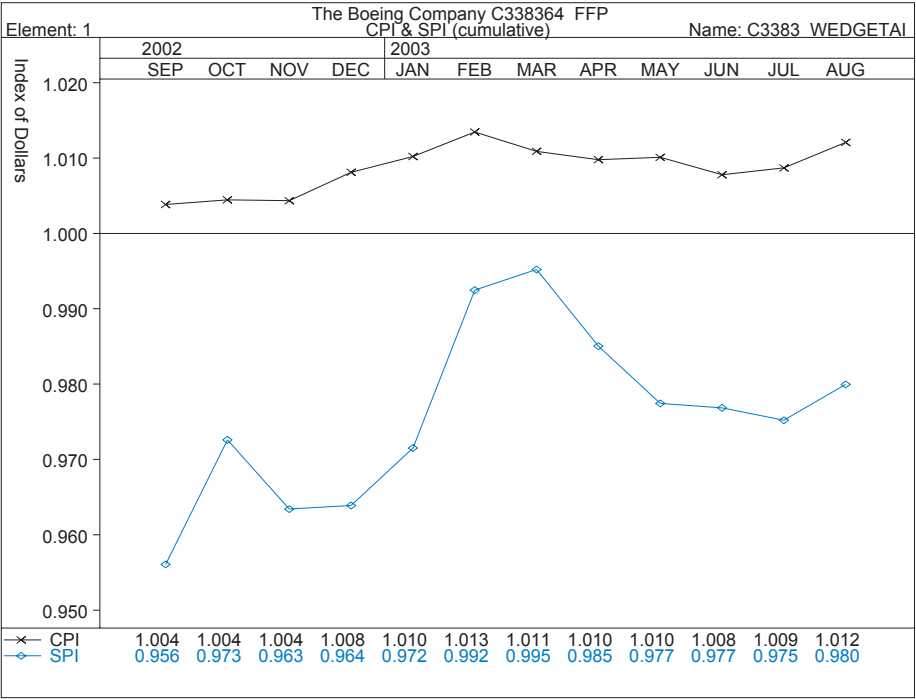
Cost and Schedule Performance Indices

7.24 Figure 7.3 presents cost and schedule performance using performance indices derived from the EVMS data. Cost Performance Index (CPI) is derived from the ratio of earned value and actual costs (BCWP divided by ACWP), and Schedule Performance Index (SPI) is derived from the ratio of earned value and planned value (BCWP divided by BCWS). The indexes may be left in their absolute form or converted to

percentages. For example, a result of 0.98 is equivalent to 98 per cent achievement.

Figure 7.3

Wedgetail Project Cost and Schedule Performance Indices

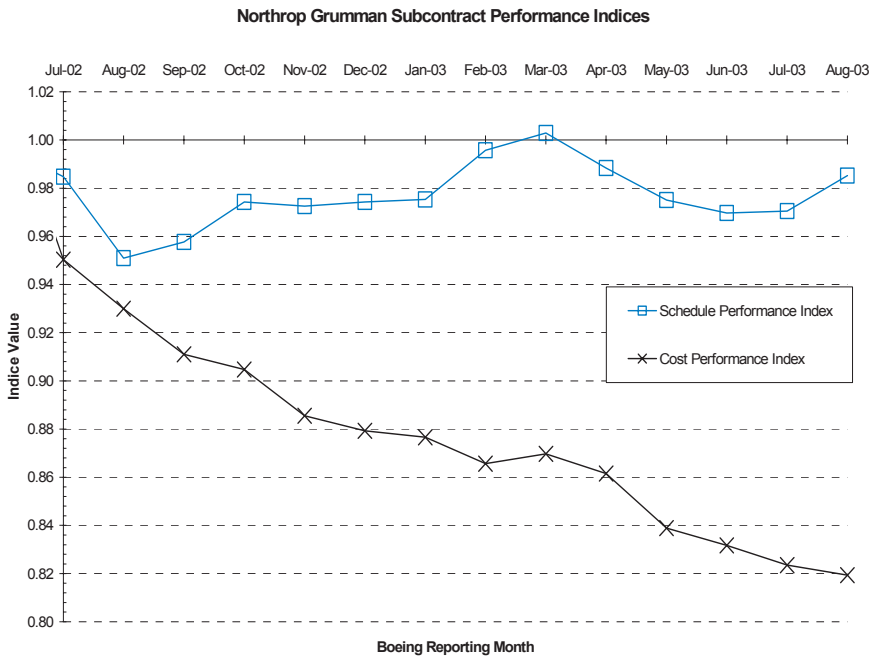


Source: Wedgetail project, Department of Defence.

7.25 Figure 7.3 shows, for the 12 months to August 2003, that the Wedgetail acquisition contract’s Cost and Schedule Performance Indices finished slightly over 100 per cent cost efficiency and 98 per cent schedule efficiency. Hence, from that perspective, the project was performing well within acceptable tolerances. However, the indices were derived from Boeing's costs to achieve outcomes and so subcontractors’ actual cost efficiencies are not reflected in these figures. This results from the ‘fixed price’ nature of the subcontracts whereby subcontractors’ Cost Performance Indices are set to 100 per cent.

7.26 Figure 7.4 shows Northrop Grumman's subcontract effort on the MESA radar and IFF elements of the Wedgetail projects work breakdown structure.

Figure 7.4
Northrop Grumman Performance Indices



Source: Wedgetail project, Department of Defence.

7.27 The above figure shows that, in August 2003, schedule performance was well within tolerance at approximately 99 per cent schedule efficiency. However, this was being achieved at the expense of cost performance, which was at approximately 82 per cent cost efficiency and trending down. This area of the Wedgetail project involves the most extensive advanced technology. Hence, the contractors’ ability to maintain schedule performance within a five per cent tolerance band should be recognised as being an effective outcome. Although, clearly this result was achieved with actual costs growing over the period to exceed the sub-contractor’s budgeted cost by some 18 per cent.

7.28 At the time of the audit fieldwork, Boeing and Northrop Grumman were working together to resolve technical difficulties within the project’s MESA radar and IFF elements.

7.29 Defence advised the ANAO that given the Wedgetail project is based on fixed price contracts, any additional costs associated with Northrop Grumman's efforts to maintain its scheduled performance is not transferable to its prime contractor (Boeing) or to Defence.

Computing system development measurements

7.30 The total amount of software required for the Wedgetail system may exceed 3.75 million source lines of code. Of that amount, about a third is new code and the remainder re-used or modified from other projects. That amount of code is in itself a significant risk to the project, and this risk is compounded by the geographic distribution of the code writing and testing effort. It is further compounded by the large amount of electronic systems development taking place in conjunction with software development.

7.31 A key project management initiative adopted by the contractors and the RPT to minimise computing system development risk is an extensive and routine use of computing system development measurements, extending beyond cost and schedule progress. The measurements were selected through the joint efforts of the RPT, Boeing, Northrop Grumman and BAE Systems, during a facilitated workshop.¹²⁷ They include:

- Per cent Activity Complete—measures the progress of software development activities;
- Requirement Volatility—measures requirements growth and maturity by tracking the number of requirements changes over time;
- Work Products—measures the progress of discrete software products during development;
- Build Content—measures planned and actual progress of the incorporation of functionality for each software build release;
- Test Coverage—measures the planned and actual progress of the results of testing for each software build release;
- Problem Reports—measures the status, priority, effectiveness, and time taken to resolve software change requests;
- Software Product Size—measures the planned and actual size of software products;
- Data Deliverable Items—measures the planned and actual delivery and approval of contractually-required software data items;
- Staffing Profile—measures the headcount, experience and training of the software organisations; and

¹²⁷ Airborne Early Warning and Control, *Software Acquisition Management Plan*, June 2002.

- Computer Resource Utilisation—measures the planned and actual use of computing resources (Central Processing Unit, memory and input/output).¹²⁸

7.32 These measures are underpinned by over 25 sub-measures, and are summarised by the RPT in its monthly report to the Project Governance Board. The measures are applied to the Wedgetail aircraft's systems and support segments (see Appendix 1).

Software development progress

7.33 The Wedgetail contractors have programmed the project's computing system software development into a series of year long builds that overlap by six months, based on successively more extensive functional requirements. Each build progresses through a requirements update, detailed design, code and test, configuration item integration and test, and finally to subsystem integration and test.

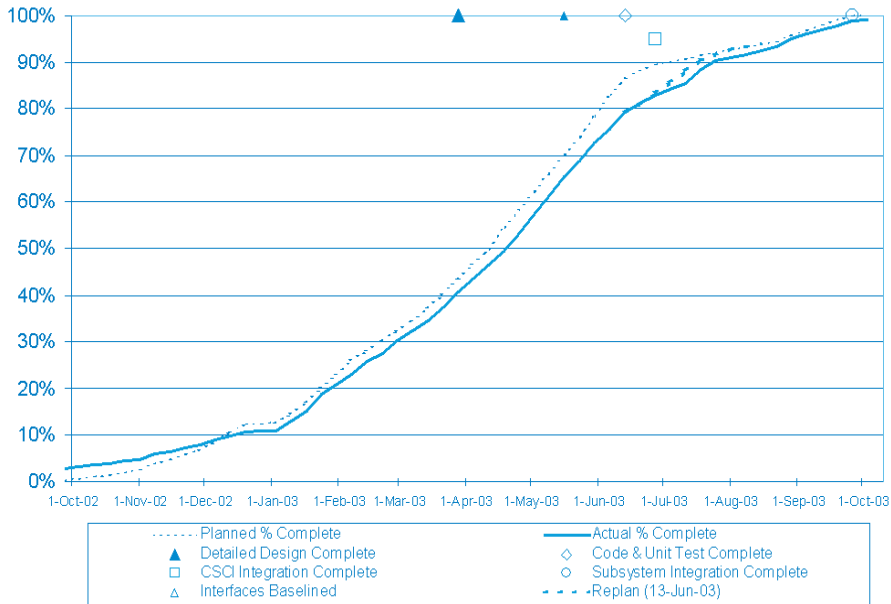
7.34 The measures indicate that the software developers have achieved effective outcomes in terms of the software development schedule for software Builds 1 to 5.

7.35 Builds 1 and 2 were developed prior to the contract's effective date (20 June 2001).¹²⁹ These builds were not deliverable products, instead they allowed Boeing to reduce risk through computing product proof of concept testing, and timing and sizing evaluations. Build 3 was the first of the post effective date 'in-contract' builds, and was completed on schedule in March 2003.

7.36 The following figures indicate that the Wedgetail Mission Computing System software development teams made steady progress to complete software Build 4 (see Figure 7.5) on schedule, and were 12 per cent behind the software Build 5 schedule (see Figure 7.6).

¹²⁸ Boeing, *Software Development Management Plan for the Australian Defence Force Airborne Early Warning and Control System*, Issue H, Annex A.

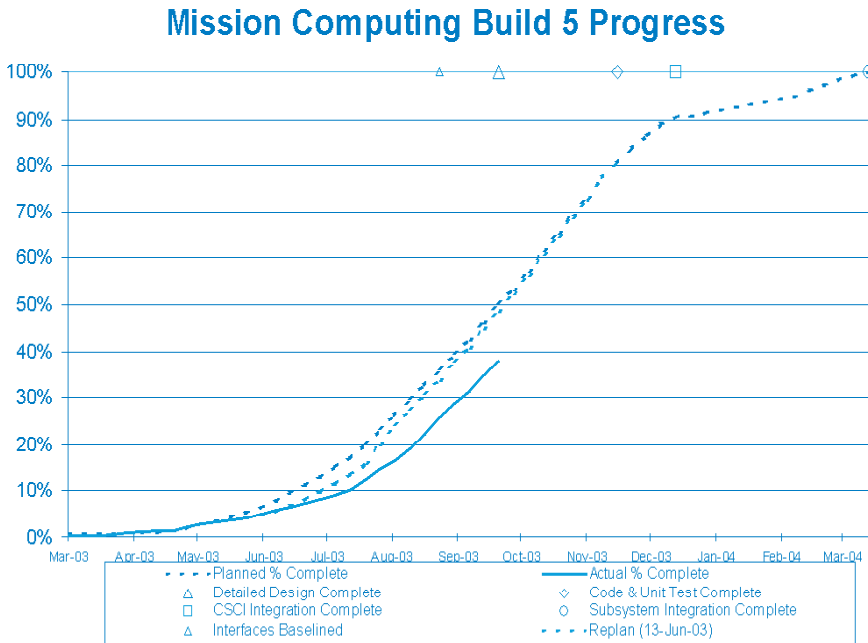
¹²⁹ Effective date is the date on which the U.S. export requirements were met by Boeing, thus allowing the contract to proceed in terms of deliveries to Defence.

Figure 7.5**Wedgetail mission computing system development progress—Build 4****Mission Computing Build 4 Progress**

Source: Wedgetail project, Department of Defence.

Figure 7.6

Wedgetail mission computing system development progress—Build 5



Source: Wedgetail project, Department of Defence.

7.37 Build 5 is the most ambitious of the builds. The RPT advised the ANAO that Boeing has recruited additional personnel for the Mission Computing Team; and that the reduced Build 5 activity scheduled for December 2003 to March 2004, provides an opportunity to recover the schedule slippage.

7.38 The RPT advised that Builds 6 through 8 contain progressively less functionality and less new code than their predecessors, and that this strategy is part of the software development program’s risk management.

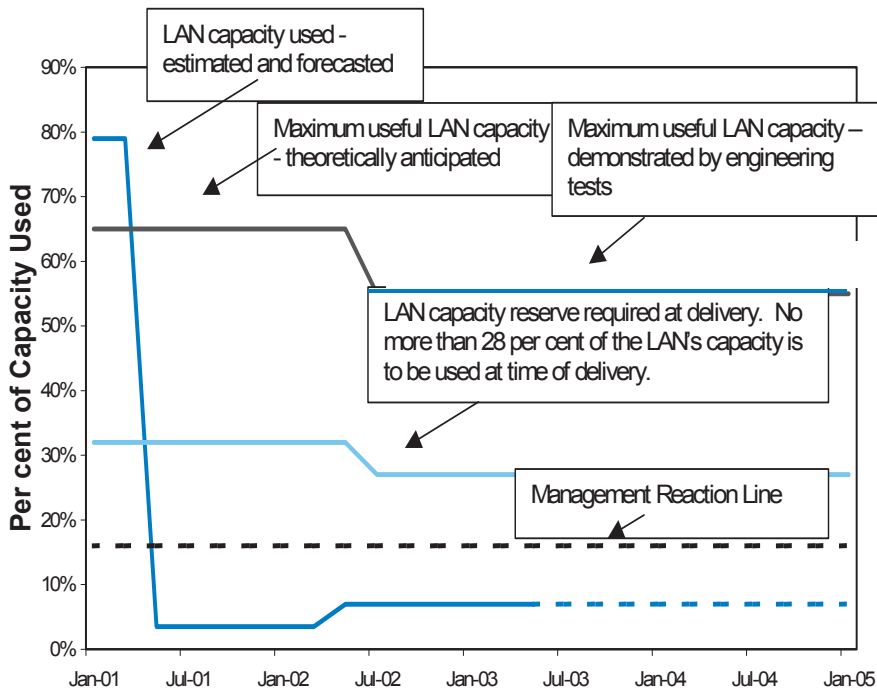
Computing system development risk and issues management

7.39 Importantly, the contractors do not treat the measurements simply as progress reporting deliverables required by the acquisition contract. Instead, the measurements have been selected and applied as an integral part of the project’s risk and issues management systems. Likewise, Defence’s RPT, assisted by its SETA contractor, monitors and analyses the measurements for system development trends, and to gauge the effectiveness of risk and issues management initiatives.

7.40 For example, the Wedgetail mission computing system's local area network (LAN) utilisation rates shown in Figure 7.7, are used here to demonstrate how Boeing uses computing system development measurements to manage Wedgetail's development risks.

Figure 7.7

Mission System Computing resource utilisation—local area network



Source: Wedgetail project, Department of Defence.

7.41 This figure shows that in January 2001, Boeing estimated that the Wedgetail mission computing system's LAN utilisation would exceed the LAN's theoretical useful capacity by some 15 per cent, and its required reserve capacity by almost 50 per cent. Consequently, the estimated level of LAN use exceeded the Management Reaction Line and alerted management to the risk that the LAN, as designed at the time, would not cope with demands placed upon it when it entered operational use.

7.42 In response to those measurements Boeing implemented a risk management strategy, involving architectural and engineering changes that increased the LAN capacity until its estimated percentage of capacity use fell below the Management Reaction Line.

7.43 This is one example of over 30 similar examples of the Wedgetail project's use of computing system development measures to assess progress, and manage and report risk and issues trends.

7.44 Defence advised that the Wedgetail computing system development measurement program demonstrates the implementation of the full intent of its Practical Software and Systems Measurement (PSM) policy first introduced in 1998.

Recommendation No.1

7.45 The ANAO recommends that Defence:

- (a) evaluate the use of the Wedgetail project's computing system development measurement concepts and processes as a practical example of a successful implementation of its Practical Software and Systems Measurement Policy; and
- (b) incorporate any lessons learnt in the current review and update of the policy.

Defence response

7.46 Defence agrees with the recommendation. The Wedgetail computing system development measurement program demonstrates the implementation of the full intent of the DMO Practical Software and Systems Measurement (PSM) policy first introduced in 1998. The Wedgetail project has successfully implemented the DMO PSM Policy through application of the appropriate resource and process requirements. The Directorate of Software Engineering has recently completed an independent review of the implementation of the PSM methodology in the DMO. DMO intends to reflect the outcomes of this review in an update of the DMO PSM policy and guidance.

Technical reviews and configuration audits

7.47 The RPT staff independently witness and review the emerging design in accordance with an approved Technical Review and Audit Program. Technical reviews and audits are a key component of the Wedgetail system's engineering program, and afford Defence the opportunity to gain insight to the evolving design and implementation of specified requirements, assess risks and issues. While the objective of each technical review and audit varies, the overall objective is to ensure that the

proposed design is ready to proceed to the next phase of development and verification.¹³⁰

7.48 The Wedgetail contract contains two principal sets of requirements. The first set contains the full range of AEW&C operational performance requirements, such as the detection and tracking of targets, through to equipment reliability and maintainability. The Wedgetail RPT verifies contractor compliance with the performance requirements by observing approved inspections of equipment and documentation by appropriately qualified personnel, and through T&E.

7.49 The second set of requirements contain the Wedgetail system engineering requirements that specify the management processes and system development standards with which the contractor needs to comply when performing work under the contract.

7.50 The Wedgetail project verifies development progress through a series of technical reviews based on Boeing's Technical Review Plan, and on engineering standards and processes tailored to meet the contractual requirements.¹³¹ The technical reviews follow a process that progressively evaluates the Wedgetail system development using a hierarchy of hardware and software item reviews based on segment reviews, sub-system reviews and component reviews. The technical reviews are linked to computing systems development measurements, and to risk and issues management systems.

7.51 These reviews provide important insights into progress made on Wedgetail design and development, and reduce the risk of unacceptable supplies being offered for acceptance. It also permits the contractors the maximum flexibility possible to produce the supplies.

7.52 The RPT has issued instructions requiring its reviewers to document their work, follow standardised review techniques, and ensure they adhere to role, responsibility and review coordination instructions.¹³² Reviewers are also required to update the project's risk and issues databases if reviews and audits reveal that need.

¹³⁰ AEW&C Resident Project Team, RPT Standing Work Instruction, *ENG-02 Commonwealth Participation in Technical Reviews*, June 2002, p.1.

¹³¹ The standards, which are listed in Appendix 4, include EIA/IS-632, MIL-STD-1521B and MIL-STD-973. Boeing 737 AEW&C Programs Wedgetail Analysis and Integration Team, *Technical Review Plan (TRP)*, CDR(S)-EM-016, Revision D, October 2001.

¹³² Resident Project Team, Standard Work Instruction, PORJ-09, *SAC Contract Deliverables Review*, June 2002.

Configuration audits

7.53 Wedgetail records shown in Table 7.1 indicate the project is progressing from system design to system development. That signifies a need for the Wedgetail system's functional and physical requirements to become more fully defined in the product configuration baseline documentation. That baseline documentation forms a single point of reference for all individuals concerned with Wedgetail's design and development process.

7.54 The Wedgetail contractors need to carefully manage product baseline documentation through a configuration management and audit process that seeks to ensure consistency between all Wedgetail hardware and software items and their supporting technical documentation.

7.55 Table 7.1 also shows that, in July 2003, the number of below sub-system functional and physical configuration audits was to be advised. These audits are important because they are crucial contributors to the reliability of the technical review process. Successful completion of all audits is a prerequisite to the 2006 acceptance testing of the Wedgetail aircraft and its support segments.¹³³

¹³³ The Wedgetail system acquisition contract specifies a configuration management process and a configuration audit program. Project Air 5077, Contract C338364 *Conditions of Contract, Statement of Work – System Acquisition*, Section 4.4.

Table 7.1**Technical Reviews and Configuration Audits**

Technical Reviews and Configuration Audits	Number Scheduled	Number Completed	Per cent Completed
System Requirements Review	1	1	100%
Initial Design Review	1	1	100%
Final System Design Review	1	1	100%
Segment Preliminary Design Reviews	5	4	80%
Segment Critical Design Reviews	5	1	20%
Sub-system Requirements Reviews	7	7	100%
Preliminary Design Reviews – Sub-systems	6	6	100%
Critical Design Reviews – Sub-systems	6	6	100%
Developmental Progress Review (DPR) – Mission Computing	6	1	16%
Aircraft 90 per cent Reviews	149	129	87%
Below Sub-system Reviews	23	17	74%
Test Readiness Reviews (Hardware/Software)	TBA	-	0%
Below Sub-system Functional Configuration Audit	TBA	-	0%
Below Sub-system Physical Configuration Audit	TBA	-	0%
Sub-system Functional Configuration Audit	7	0	0%
Sub-system Physical Configuration Audit	7	0	0%
Segment Functional Configuration audit	6	0	0%
Segment Physical Configuration Audit	6	0	0%
System Functional Configuration Audit	1	0	0%
System Physical Configuration Audit	1	0	0%
System/Sub-system Formal Tests	TBA	0	0%
Segment Formal Tests	TBA	0	0%
Total Technical Reviews and Configuration Audits	TBA	0	0%

Source: Wedgetail project, Department of Defence, July 2003.

7.56 The Wedgetail Engineering Manager advised the ANAO, in July 2003, that the RPT was working with Boeing on developing an incremental approach to the conduct of such audits, in order to avoid the risks of 'big

bang' auditing at the end of the production phase. The aim was to supplement the audits planned for the end of the Wedgetail production phase (and immediately prior to aircraft acceptance tests and evaluation), with incremental audits conducted in conjunction with technical reviews. The ANAO notes that incremental technical reviews and audits are important components of the Boeing 737 AEW&C program's technical review philosophy.¹³⁴

7.57 The ANAO was advised, in September 2003, that the incremental auditing process will be defined in the Wedgetail Configuration Audit Plan, which is a Project Authority 'Approved' document not due for delivery by Boeing until 2006.

7.58 The ANAO was advised further, in October 2003, that Boeing and its subcontractors have committed to the incremental audit approach, and that this approach will commence in November 2003, with the arrival of the first qualified equipment. The incremental audit process was expected to be formalised through Defence's approval of the Boeing Configuration Audit Plan.

7.59 This example of Configuration Audit Plan tailoring is in line with best systems engineering practice of agreeing to systems development process changes, when scope for proactively improving the effectiveness of the process becomes apparent.

Recommendation No.2

7.60 The ANAO recommends that the Wedgetail project team implements the incremental configuration audit program, in order to further improve the reliability of its technical review process.

Defence response

7.61 Defence agrees with the recommendation. As noted in the body of the report, tailoring of the Systems engineering process needs to be undertaken during system development; the Wedgetail Project's initiative to pursue an Incremental Configuration Audit Program follows this approach. The Incremental Configuration Audit Program commenced in November 2003 with the arrival of the first qualified equipment.

¹³⁴ Boeing 737 AEW&C Programs Wedgetail Analysis and Integration Team, *Technical Review Plan (TRP) CDR(S)-EM-016*, Revision D, October 2001, ss.4.1, 4.3.5, 4.5.2, 4.5.8-9.

Verification & Validation

7.62 Project engineering personnel within capital equipment development and production projects are often responsible for verifying, from the system design and development perspective, that the system, sub-system and components meet design and development requirements; and for validating that the total system meets the customer's performance specifications.

7.63 In terms of software engineering:

A 'verification' of software design is accomplished to ensure that each of the various individual software products fulfills its specific purpose. The verification process often constitutes a step-by-step approach to testing one program, followed by the testing of the second program given the results of the first, and so on. The verification is iterative by nature and is generally oriented to specific software items. On the other hand, validation is directed towards the systems level. The goal is to ensure that the overall software element(s) of the system complies with the requirements of the system specification. This is accomplished through system test and evaluation where software is integrated into hardware, operating personnel, facilities, elements of support, and so on.¹³⁵

7.64 Consequently, V&V is a key component of T&E and an integral part of a comprehensive engineering management strategy.

7.65 At the time of the audit fieldwork, the Wedgetail project was in its research and development phase, and hence system validation involved checking that Boeing was developing the 'right' Wedgetail system by assessing how well the system, or proposed system, addressed user needs as defined in the CONOPS and Wedgetail System Specification contained within the Wedgetail acquisition contract's SOW.

7.66 The project was also verifying whether Boeing was building the Wedgetail system correctly through specification analysis, design analysis, inspection, testing, and document review.

7.67 V&V is highly complex and specialised work, especially within software-intensive projects such as Wedgetail. It involves progress reviews, specification clarification and design reviews. This needs to be done with a high degree of precision, as it is often crucial to the success of capability acquisition projects. The Wedgetail project office conducts V&V of the Wedgetail system, with assistance from a Design Support Network of various Defence organisations, such as DSTO and the Directorate

¹³⁵ B.S. Blanchard, *System Engineering Management*, Second Edition 1998, Wiley-Interscience, John Wiley & Sons Inc, New York, pp.146–147.

General Technical Airworthiness. The project office also uses Systems Engineering and Technical Assistance (SETA) contractor assistance when necessary.

7.68 SETA contractor assistance is particularly important to the Wedgetail project, as the project contains a number of technical challenges, including the integration of Boeing 737 systems with a range of existing and developmental military systems. Additionally, Wedgetail provides a new AEW&C capability for the ADF and the ADF's 'corporate knowledge' of AEW&C operations and technology is not yet extensive.

7.69 In February 1999, the Wedgetail project engaged SETA contractor Ball Aerospace (Australia) Pty Ltd (now known as Ball Solutions Group) as the project's V&V consultant. Ball Solutions Group is tasked with addressing V&V issues where neither the SPO nor the project's Design Support Network have the expertise and resources commensurate with the level of risk.¹³⁶

7.70 Given the degree of uncertainty regarding the complexity and duration of V&V activities, the project prefers to engage its V&V specialists on Time and Materials contracts with Not to Exceed prices. Further, given the difficulty in fully defining V&V activities and knowing what specialists are available at any given time, the Wedgetail project has engaged Ball Solutions Group to manage the process of bringing together the best available specialist for specified V&V activities.

7.71 The Wedgetail acquisition contract with Boeing allows Defence to use contractors to undertake V&V of any work undertaken under the contract.¹³⁷ However, the Wedgetail system, sub-system and components are protected in accordance with limitations and provisos identified by the US Office of Defense Trade Controls with respect to technology transfer of hardware, software, technical documentation/data, and know-how to Foreign Persons or a Foreign Country.¹³⁸ These provisos place certain limits on Defence's V&V activities in the Wedgetail project.¹³⁹

¹³⁶ AIR 5077, *Project Management and Acquisition Plan (PMAP)*, Volume 1 Issue 2 p.18. The contract provides for the appointment of Verification and Validation contractors, Project Air 5077, Contract C338364 *Conditions of Contract*, Section 2.4.

¹³⁷ Project Air 5077, Contract C338364 *Conditions of Contract*, Section 2.4.

¹³⁸ *Technology Transfer Control Plan for 737 Airborne Early Warning and Control (AEW&C) Wedgetail Program*, December 2001.

¹³⁹ Wedgetail Issues Management System, Issue No.0448, *Radar/IFF Export Licence Restrictions*, accessed 11 June 2003.

7.72 Project records indicate the need for projects involved with advanced technology to carefully negotiate the technical data access they need to review contractors' progress. That access needs to be sufficient to allow projects to provide timely V&V advice on areas of system development that would not satisfy the contracted SOW. It does not need to be sufficient to allow co-development of the systems under development, as Defence rarely takes on that role.

7.73 V&V and related activities undertaken by the RPT with assistance from its Design Support Network and SETA contractors are crucial to the success of the AEW&C capability acquisition project, in terms of the integrity assurances needed and the continuing effectiveness of the RPT's contribution to the project's IPT arrangements.

Recommendation No.3

7.74 The ANAO recommends that consideration be given to the costs and benefits of maintaining its present Resident Project Team personnel profile, including its Design Support Network and Systems Engineering Technical Assistance arrangements, until the first Wedgetail aircraft is delivered.

Defence response

7.75 Defence agrees with the recommendation. The personnel profile for the Resident Project Team, and its support arrangements, was carefully constructed to provide the most cost-effective management arrangements for this complex project. Other than minor variations in skill-sets required through the various test phases, the personnel profile of the Resident Team will remain unchanged until delivery of the first aircraft.

8. Risk and Issues Management

This chapter discusses risk and issues management within the Wedgetail project's RPT in Seattle.

Introduction

8.1 All projects, especially advanced technology projects such as the Wedgetail project, contain risks, issues and problems associated with the inherent uncertainty regarding technology choices and the process needed to achieve desired outcomes. A risk is the possibility or potential that an expected outcome is not achieved, or is replaced by another.¹⁴⁰ Issues and problems, on the other hand, are unplanned events that have happened and which require management intervention to reduce negative impacts on project outcomes.

8.2 Defence's risk management policy states 'formal risk management is no longer discretionary and is now considered an essential component of public sector management and sound corporate governance'. The policy document communicates the joint commitment of the Secretary and the Chief of the Defence Force to formal and systematic management of risk throughout Defence.¹⁴¹

8.3 At the time of the audit, Defence had not published similar policy on issues and problem management. However, DMO's Project Management Method Version 2 (PMMv2) retains a number of PRINCE2 features that call for an issues management mechanism for controlling unplanned project events that require an informed project response.¹⁴²

The Wedgetail project's risk and issues profile

8.4 Large and technologically advanced projects, such as the Wedgetail project, present significant management challenges to Defence and contractor organisations. The Wedgetail specification is particularly challenging given the research and development effort needed to design, develop and integrate, into the Boeing 737 airframes, an advanced

¹⁴⁰ *Capital Works Investment Risk Management Guidelines*—New South Wales Government, November 1993.

¹⁴¹ Department of Defence, *Defence Risk Management Implementation Plan 2002–2003*, April 2002, Foreword and Introduction.

¹⁴² DMO, *PMMv2 Manual: Improving Project Management in the DMO*, 16 May 2003, Section 8.3.4. UK Office of Government Commerce, *Managing Successful Projects with PRINCE2*, 2002, pp.166, 271–275.

Multi-role Electronically Scanned Array radar, and an extensive array of radio communication systems and other electronic sensor and self protection systems.

8.5 The technological challenges of particular note include electronic system compatibility, computing system hardware and software capability, communication system interoperability and system engineering design integration.

Risk share arrangements

8.6 The Boeing 737-AEW&C program, and the affordability of the Wedgetail system, is based on Boeing and some of its major subcontractors investing in the system in anticipation of a larger market for 737-AEW&C aircraft. As a consequence, the contractors, through their own research and development funds, fund a proportion of the 737-AEW&C development costs.¹⁴³

8.7 The emphasis placed on risk management by both parties is particularly intense in the light of the large amounts invested in the project, the importance it has for ADF capability, the anticipated sales of additional 737-AEW&C aircraft, and the significant management performance indicators reflected in the contract's PIF strategy.

Pre-contract risk reduction activities

8.8 The Wedgetail acquisition strategy sought to define and reduce project risks as far as possible before the project proceeded to the system acquisition contract. This strategy involved developing and reviewing project requirements in discrete and successively detailed stages, and at each stage refining the Wedgetail system's function and performance specifications.

8.9 This strategy involved three \$A 8.483 million (December 1997 prices) Initial Design Activity (IDA) contracts granted to the leading tenderers for the project—Boeing, Lockheed Martin Corporation and Raytheon Systems Company. The IDA contracts had two risk reduction outcomes: they enabled the contractors and Defence to work together to reduce the project's technical, cost and schedule risks; and they enabled the contractors to retain their project teams between the submission of tenders and source selection.

¹⁴³ Project Air 5077, Contract C338364 *Conditions of Contract*, Section 2.2.1.5.

8.10 The IDA involved:

- defining the physical architecture of multiple possible Wedgetail solutions;
- demonstrating the critical engineering and management processes necessary to produce a Wedgetail aircraft which meets Defence requirements; and
- ensuring that Defence and the tenderers fully understood the risks and costs of proceeding with any particular design solution, before awarding a single contract for full development and production.

8.11 The IDAs also enabled the tenderers to tailor their design specifications, and to agree with Defence on a process for tailoring their engineering processes. The strategy produced:

- refined system specifications;
- refined cost and schedule estimates; and
- comprehensive understanding of the requirements and of the risks associated with the design solution selected to meet those requirements.

8.12 Another important risk reduction aspect of this process was that it gained the technical and operational airworthiness authorities' endorsement of the Wedgetail System Specification that describes what operations the system must perform to accomplish its mission, and hence form key pre-requisites for Design Acceptance. As part of the System Specification endorsement, the airworthiness authorities also endorsed the tailoring of design specifications, and the process for tailoring the engineering process specifications.

8.13 Pre-contract engineering management activities also concentrated on design requirements definition and requirements traceability. The Wedgetail project established a systems engineering requirements database which records how the design requirements were derived and the reason for any change in requirements.¹⁴⁴

8.14 Nevertheless, at the time of source selection in July 1999, the project contained high technical risks given the preferred solution was then at, and arguably beyond, the leading edge of AEW&C technology. Consequently, in the case of the preferred tenderer Boeing, the IDA was

¹⁴⁴ AIR 5077, *Project Management and Acquisition Plan (PMAP)*, Volume 1 Issue 2, Section 10.

extended from July 1999 to the acquisition contract signature on 20 December 2000 to enable Boeing to continue reducing project risks.¹⁴⁵

8.15 The IDA was further extended from December 2000 to August 2001 (IDA Phase 3) following the acquisition contract signature. This enabled Boeing to continue its design activities and to maintain its team arrangements until the contract was put into effect in June 2001, following the granting of US Government export licences for Wedgetail AEW&C technology.

8.16 At the end of the IDA, Defence and Boeing had completed the Wedgetail Systems Requirements Review, Initial Design Review, and Final System Design Review.¹⁴⁶ Boeing had also completed the mission computing software Builds 1 and 2. These builds were not deliverable products; instead they allowed Boeing to reduce risk through computing product proof of concept testing, and timing and sizing evaluations. Build 3 is the first of the 'in-contract' builds.

8.17 The IDA contracts granted to Boeing total \$A 70.819 million and comprise:

- Initial IDA contract approval with Boeing \$A 8.483 million;
- IDA Phase 2 approval (preferred tenderer stage) \$A 32.184 million; and
- IDA Phase 3 approval (post-contract signature stage) \$A 30.152 million.

The Wedgetail SPO advised the ANAO that the IDA Phase 3 cost was deducted from the Wedgetail system acquisition contract price, and project records indicate that the approved project cost of \$A 2.629 billion (December 2003 prices) includes the IDA cost.¹⁴⁷

Post-contract signature risk reduction activities

8.18 The Wedgetail project uses prototyping and incremental build and testing strategies within critical and higher-risk sub-systems, such as the mission computing system, to effectively manage project risks.

¹⁴⁵ Defence, Management Audit Branch, *Initial Report on the Airborne Early Warning and Control Project, Project Definition and Initial Design Activities*, December 2000, p.5.

¹⁴⁶ Boeing 737 AEW&C Programs Wedgetail Analysis and Integration Team, Technical Review Plan (TRP) CDR(S)-EM-016, Revision D, October 2001, s.4.2.

¹⁴⁷ AEW&C Project, *Governance Board Monthly Report*, 17 October 2003, Annex B.

8.19 The performance incentives built into the Wedgetail acquisition contract are also seen to mitigate risk by placing incentives on Boeing to maintain an ambitious milestone achievement schedule, which will allow additional time for system test and evaluation, without delaying delivery.¹⁴⁸

8.20 The acquisition contract requires Boeing to identify, assess and rank risks and to report risk treatment responses using a risk management method consistent with AS/NZS 4360:1999, *Risk Management*.¹⁴⁹ Boeing is required to maintain a risk register and risk abatement plan for each risk that, if left unchecked, would substantially impact the project's critical success factors. Boeing is also required to give Defence unrestricted on-line access to its risk register and individual risk abatement plans.¹⁵⁰

8.21 Boeing provides RPT personnel access to its risk management activities via weekly AIT council meetings, and via its AIT meeting presentation database, which deals with medium- to high-level risks and their mitigation. The RPT maintains deep insights into the project's risks, on a day-to-day basis, through its IPT arrangement with Boeing, and through the range of progress measurement processes discussed in Chapter 7.

Risk management by the Wedgetail RPT

8.22 The risk management standards and policy used by the project include:

- AS/NZS 4360:1999, *Risk Management*: provides a generic guide for the establishment and implementation of the risk management process; and
- CEPMAN 1: provides the project with its initial risk management policy and guidance.

8.23 The guiding principles underpinning the RPT's approach to managing the risks it faces, include accepting that risk management is a disciplined process that:

- assists the project to direct management effort appropriately;

¹⁴⁸ Project Wedgetail (AIR 5077) Airborne Early Warning and Control, *Change Proposal/Business Case, No. 944*, June 2003.

¹⁴⁹ Project Air 5077, Contract C338364 *Conditions of Contract, Data Item Description—PM-04, Risk Management Plan*.

¹⁵⁰ Project Air 5077, Contract C338364 *Conditions of Contract, Statement of Work—System Acquisition*, Section 4.2.

- deals with 'threats' to the project in a timely, iterative and methodical manner;
- avoids punishing managers and individuals who identify high risk items within their functional area;
- avoids a 'tick and flick' exercise, done once at the start of the project or at the beginning of a new project phase and then forgotten;
- avoids becoming a highly complex mathematical exercise; and
- ensures risks are identified, monitored and treated in a manner appropriate to their potential impact on the project's Key Result Areas.¹⁵¹

The RPT's overall aim is to integrate risk management into its broader management practices.

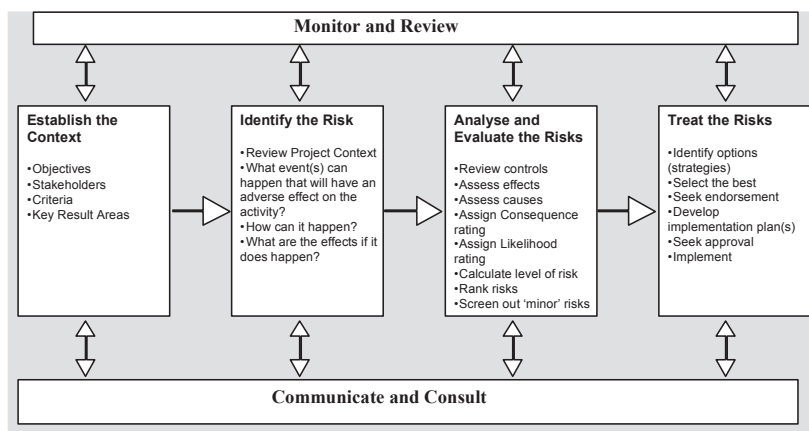
8.24 The project uses a Defence corporate Risk Management System (RMS), which at the time of the audit was still under development.¹⁵² The RMS enables a structured and comprehensive approach to risk management by requiring risk owners to follow the structured risk management standard depicted in Figure 8.1. At the time of the audit fieldwork, the RMS database identified 145 Wedgetail project risks under active management. Of these, 18 were assessed as high-risk.

¹⁵¹ AIR 5077, *Project Management and Acquisition Plan (PMAP)*, Volume 17, Risk and Issues Management Plan, August 2002.

¹⁵² DMO advised that it was reviewing its risk management policy, guidance and training, and that updated policy is expected to be available in release 3 of the Materiel Acquisition and Sustainment Framework (MASF) scheduled for release in late 2003.

Figure 8.1

Defence's Risk Management Process



Source: Wedgetail Resident Project Team, Department of Defence.

Risk identification

8.25 The Wedgetail project has sought to maximise its ability to identify project risks by establishing its RPT at the primary work sites where the Wedgetail systems are developed. As mentioned in Chapter 3, the RPT has also formed three multi-discipline IPTs, a Management Analysis and Integration Team, and a Test Team. These teams receive risk management assistance from SETA contractors engaged in design V&V and computing system development measurements, and from a Design Support Network.

8.26 Risk items are recorded and tracked by IPTs and the AIT in accordance with the Risk Management Plan. Measurements related to medium or high-risk items are reported at risk reviews within the RPT and within Boeing's AIT. Low risks are monitored by the individual IPTs who own them.

8.27 In order to further improve visibility and appreciation of the risks it faces, the project engaged the USAF Electronic Systems Center under a FMS case to conduct Independent Technical Review (ITR) of the project during the IDA and at key phases of the system development and design review process.

8.28 The Wedgetail project's November 2002 ITR provides detailed descriptions of 74 risks in 13 different technical areas. Of those 74, 25 risks were rated as high or extreme. The ITR found, since its baseline review in August 2002, that no new risks had developed and, in many technical areas, some 21 risks had been effectively addressed to an extent that they

were downgraded from the high or extreme risk category. Nevertheless, the ITR reported a range of significant system development risks requiring concerted effort by the contractors to resolve, as well as risks needing treatment by the RPT in terms of ongoing system engineering requirements management and contingency management.¹⁵³

Risk analysis and evaluation

8.29 The RPT, through its IPT structure, analyses and evaluates Wedgetail design and development risks through direct liaison with the contractor IPTs. This close liaison enables the RPT to clarify its risk exposure in both technical and financial terms.

8.30 The project uses a corporate RMS that, at the time of the audit, essentially provided a risk logging system and was under further development. There would be advantages in extending the RMS's functions to include financial analysis of risk exposure so as to strengthen the links between risk and contingency fund management.

Risk treatment

8.31 The Australian and New Zealand Risk Management Standard states that, ideally, responsibility for treatment of risk should be borne by those best able to control the risk. It also states that successful implementation of the risk treatment plan requires an effective management system, which specifies the methods chosen, assigns responsibilities and individual accountabilities for actions, and monitors them against specified criteria.

8.32 In following that standard, RPT assigns risks to risk 'owners' within the IPT structure who are chosen on their ability to competently analyse and treat risks. They are responsible for ensuring that each risk assigned to them is handled in accordance with the project's risk and issue management processes. These processes require a structured analysis of treatment options including cost benefit analysis concerning the likely use of project resources, such as contingency funds, Wedgetail staff, the Design Support Network, SETA contractors and FMS support.

8.33 Risk owners are required to develop treatment strategies by working through a hierarchy of proposed resource usages, providing justification as to why one level has been discarded for another. The approved resource hierarchy is:

¹⁵³ USAF Electronic Systems Center, *Independent Technical Assessment and Risk Assessment Update for the Australian Wedgetail Program*, prepared by The MITRE Corporation, 1 November 2002, pp.3–4.

- accept the risk (as determined during the Risk Evaluation phase);
- seek to convince the agency that has the most influence on the risk event to accept responsibility for its management;
- treat with existing internal project resources (excluding contingency);
- allocate the risk treatment task to an organisation within the internal Defence elements of the Design Support Network;
- task the wider Project Support Network, i.e. the SETA contractor or FMS (noting the budgetary constraints imposed on this resource);
- seek to use contingency funding; and
- if contingency funding is not available or has been committed, seek a real increase to the Wedgetail project cost.

8.34 The ANAO examined a sample of the RPT's risk analysis and evaluation records in order to determine if there was a clear and concise record of actions taken to ensure effective project management. The records indicate that the RPT was following the project's risk management standard and management guidelines, and that the IPTs remained actively engaged in risk management processes. As the need arose, the RPT engaged its SETA contractor and sought USAF assistance with identifying and analysing risks.

8.35 The ANAO examined a package of risks, which potentially had an impact on Wedgetail operational capability. The responsible IPT developed a business case containing alternative strategies and approaches to treat the risk. The project's Configuration Control Board (CCB) considered the risk treatment options put forward by the responsible IPT leader and endorsed what it considered to be the most cost-effective risk mitigation option. The project subsequently used contingency funds to mitigate risks to operational capability by funding a package of engineering changes early in the Wedgetail design phase.¹⁵⁴

8.36 Defence advised that it was comprehensively reviewing its project risk management policy, processes, guidance and support tools, and that it is addressing the linkages to cost and schedule contingency.

¹⁵⁴ CCB minutes Business Case 885, 20 July 2002. [Classified Document].

Technical Risk Identification and Mitigation System

8.37 In addition to using a risk management process focused on system development risks, the Wedgetail project has also implemented a risk management system that focuses on its systems engineering management processes. Known as the Technical Risk Identification and Mitigation System (TRIMS),¹⁵⁵ this system enables the RPT to manage the risks inherent in the systems engineering processes used to acquire the AEW&C capability.

8.38 TRIMS solicits and compiles responses to a set of questions based on lessons learnt on US projects over many years. The questions focus on the processes used to manage risks associated with a project's systems engineering management processes, in order to provide early warning of likely cost and schedule overruns. The rationale for this is that cost and schedule overruns are preceded by technical problems which, in turn, are preceded by management process problems.

8.39 At the time of the audit, the RPT had tailored TRIMS to the project's engineering management processes, and had commenced mitigating a number of process risks which it identified using TRIMS. This is despite the Wedgetail project having very comprehensive project management processes that operate within a regulatory framework, as discussed earlier in this report.

Recommendation No.4

8.40 The ANAO recommends that Defence include in its review of project risk management policy the use of the Technical Risk Identification and Mitigation System in future capital equipment acquisition projects, including those projects progressing toward contract signature.

Defence response

8.41 Defence agrees with the recommendation. The DMO review of project risk management policy is complete. The TRIMS tool has been identified as the preferred tool to aid the identification and management of technical risks, noting that the tool will require customisation to align with DMO business processes.

¹⁵⁵ TRIMS was developed by the US Navy's Best Manufacturing Practice Center of Excellence (BMPCOE).

Wedgetail issues management

8.42 As mentioned earlier, a risk is the possibility or potential that an expected outcome is not achieved, or is replaced by another.¹⁵⁶ Issues, on the other hand, are unplanned events that have happened and which require management intervention to reduce negative impacts on project outcomes. This intervention may take two forms—a request to the customer organisation for a specification change or a change in acceptance criteria; or additional costs falling on suppliers to correct off-specification work.¹⁵⁷ Hence issues management is reactive, whilst risk management is pro-active.

8.43 The Wedgetail project has developed an issues management system that applies an issues ownership concept similar to the risk ownership concept found in its RMS. The RPT assigns issues to issues ‘owners’ chosen on their ability to competently analyse and treat the issues. The owners are responsible for ensuring that each issue assigned to them is handled in accordance with the project’s issue management processes. This system includes an issues database, which is essentially an issues log containing detailed background descriptions of unplanned events, their resolution strategies and progress.

8.44 At the time of the audit, DMO’s Business Systems Branch was working with the Wedgetail RTP on integrating an issues database into Defence’s RMS. This will result in the availability, from one corporate-wide system, of pro-active and reactive management records on each capital equipment project in Defence.

8.45 The ANAO examined whether the issues database:

- lowers the likelihood of past issues reoccurring;
- fosters improved communication and problem resolution;
- provides for regular review of issues and action items at program-level meetings;
- identifies root causes and provides for permanent corrective action;
- reduces the possibility of forgetting important issues; and
- remains accessible to project management.

¹⁵⁶ *Capital Works Investment Risk Management Guidelines*—New South Wales Government November 1993.

¹⁵⁷ UK Office of Government Commerce, *Managing Successful Projects with PRINCE2*, 2002, p.166.

8.46 The ANAO examined 10 high-importance issues recorded within the project's issues management system and found that even though many of the records were brief, they basically satisfied the above criteria.

8.47 Project records indicate that the RPT is managing its issues satisfactorily, and that it takes the important step of financially analysing its issues and linking them with its contingency fund management and reporting. At the time of the audit the link was done manually, in a similar way to the link between the project's risks and contingency fund management.

8.48 There is, therefore, scope for improving the links between issues management, risk management and contingency fund management.

Recommendation No.5

8.49 The ANAO recommends that Defence implement an improved risk management system consistent with the outcomes of its risk management policy review, which would include:

- (a) the integration of risk management and issues management;
- (b) adding a financial analysis function to both systems; and
- (c) piloting the design, development, testing and evaluation of the new system within the Wedgetail project.

Defence response

8.50 Defence agrees with the recommendation. The risk management policy review is complete and the functional requirements for the system described above have been determined. A source of supply is currently being evaluated, with the pilot system expected to be developed over the next six months.

Use of contingency funds in risk and issues management

8.51 Contingency is a component of project costs intended to provide an allowance for unforeseen cost increases arising from low initial estimates, technical problems, accidents or other occurrences. The use of contingency funds should not be seen as an indication of project management failure. This is especially the case in advanced technology projects, where the timely use of contingency funds may lead to savings, or to cost effective increases in capability. For example, it may be more cost effective to spend contingency funds early in a project's design phase, to clarify or amend

design requirements, than to do nothing and increase the risk of undesired cost, schedule or quality outcomes later.

8.52 The draft DMO policy on the management of contingency provisions in major capital equipment projects allows for the expenditure of contingency funds for the constructive and innovative development of initiatives to contain and reduce emerging risks.¹⁵⁸

8.53 The DMO expects projects to include a contingency fund provision:

- commensurate with the level of residual project risk and uncertainty, determined through appropriate risk analysis and treatment measures;
- calculated on the basis of risk assessments at the lowest levels of the project's work or cost breakdown structure;
- estimated at the same price basis as the cost element to which it applies; and
- subjected to sensitivity analysis when possible, and when warranted.

AEW&C capability contingency funds

8.54 The AEW&C capability contingency fund was originally set in 1996 at an amount reflecting Defence's estimate that the project's risks were in the medium range.¹⁵⁹ The contingency fund was adjusted later following the Wedgetail contract negotiations with Boeing and within the context of the Defence 2000 White Paper.

8.55 Defence's Management Audit Branch reported in 2000, that the project's contingency allocation was at the lower end of the range determined by project office contingency and risk assessments, and that it may not be sufficient to manage the technical and management risks still associated with the project. Management Audit Branch considered that the project's contingency fund amount would limit management flexibility in dealing with delays in technical progress. If significant delays or difficulties occur, thus may result in a need to seek real cost increases later

¹⁵⁸ DMO, *Management of Contingency Provisions in Major Capital Equipment Projects*, draft June 2003.

¹⁵⁹ Royal Australian Air Force, *Project Air 5077 Airborne Early Warning and Control Equipment Acquisition Strategy Phases 2 and 3 Issue 1*, 25 July 1996, p.41.

in the project or to reduce capability to remain within the project approval.¹⁶⁰

8.56 At the time of the ANAO audit fieldwork, some critical Wedgetail mission system designs and development remained incomplete and so contained various ongoing risks and issues.¹⁶¹ However, the ANAO did not find evidence that suggested the Wedgetail project's contingency funds availability would limit its flexibility in managing the risks and issues it faces.

Contingency fund management and reporting

8.57 The Wedgetail project allocates contingency funds according to specific and defined technical risk and issues. This is consistent with DMO's draft Financial Instructions, which would require contingency funds to be maintained at the lowest elements of the project's work/cost breakdown structure.¹⁶²

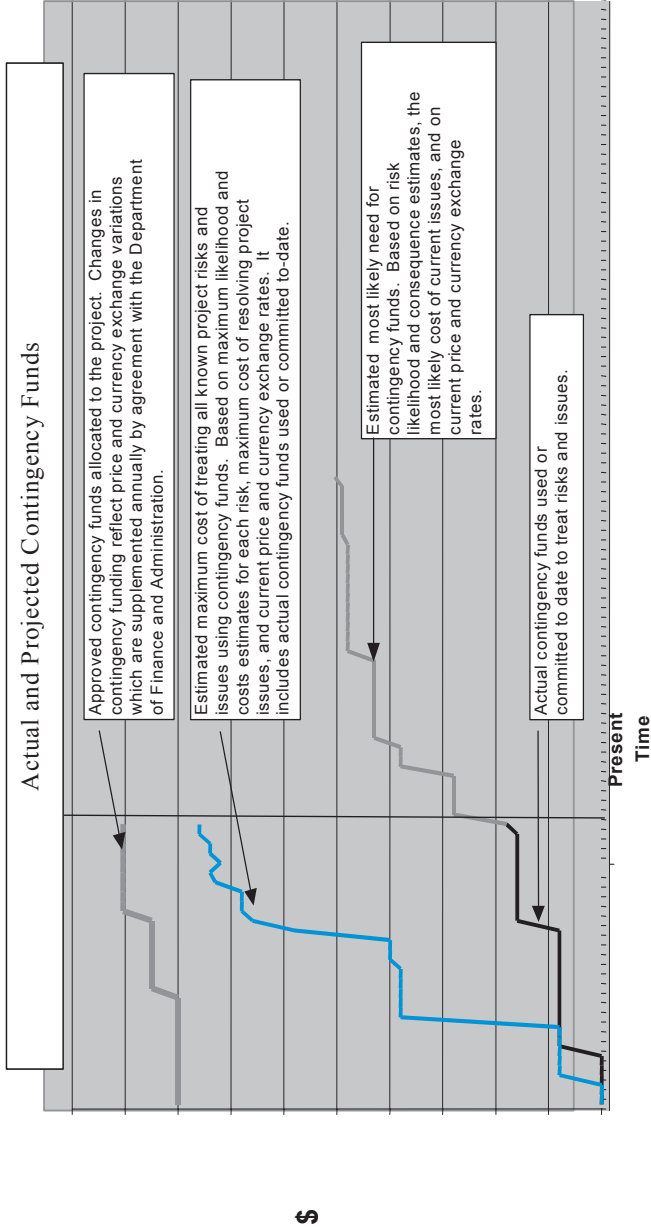
8.58 The Wedgetail project uses an innovative contingency management and reporting process that graphically represents the project's contingencies in financial terms to assist risk and issues management. The process also enables it to accurately report its risks, issues and contingency fund usage to its Project Governance Board. An illustrative example of the graphical representation is provided in Figure 8.2.

¹⁶⁰ Defence, Management Audit Branch, *Initial Report on the Airborne Early Warning and Control Project, Project Definition and Initial Design Activities*, December 2000, p.3.

¹⁶¹ Boeing, *Cost Performance Report*, 1 November 2002 through 28 November 2002.

¹⁶² Defence, Defence Materiel Organisation, *Financial Instructions*, Draft 2003.

Figure 8.2
Contingency fund management and reporting chart—illustrative version



Source: ANAO based on Defence Records

8.59 However, the links between the Wedgetail project's risk and issues financial analysis and contingency fund management were largely based on manual processes. At the time of the audit, the Wedgetail project was considering ways to reduce the effort needed to ensure all risks and management issues were adequately linked to contingency fund management.

Wedgetail project contingency case study

8.60 The ANAO examined the Wedgetail project's use of its contingency fund in a case where a mix of risks and issues justified engineering changes. This revealed that the project benefited from the multi-disciplinary perspective provided initially by the IPT and finally by the project's Configuration Control Board. It also benefited from the Business Case approach to contract changes, which allowed the sponsor (usually one of the IPTs) to put forward a well-explained business case containing:

- outlines of the risks and issues, which were referenced to the project's Risk Management System and Issues database;
- available strategies and approaches to resolve the risks and issues;
- value for money considerations; and
- related conclusions and recommendations.

8.61 The case study revealed that the Configuration Control Board agreed to the contract change Business Case recommendations and to a financial limit to be imposed on the contract change. The Wedgetail RPT Finance Manager confirmed the availability of funds and sought approval from the delegate of the Defence Chief Executive for the change proposal. After successfully negotiating the contract changes within the proposal approval amount, the RPT obtained approval to change the contract and make Defence liable for subsequent costs. These subsequent costs were to be met through the Wedgetail project's contingency fund. They were reported to the Project Governance Board through the contingency fund management and reporting process discussed above.

8.62 At the time of the audit the fieldwork, Wedgetail project team was considering ways to reduce the effort needed to ensure all risks and issues were adequately linked to contingency fund management.

Recommendation No.6

8.63 The ANAO recommends that Defence pilot the design, development, testing and evaluation of its new risk management system within the Wedgetail project.

Defence response

8.64 Defence agrees with the recommendation. The Wedgetail project has been given the lead in developing the system described above. Once the pilot is developed and evaluated, the system will be progressively rolled out across other DMO projects.



Canberra ACT
2 March 2004

P. J. Barrett
Auditor-General

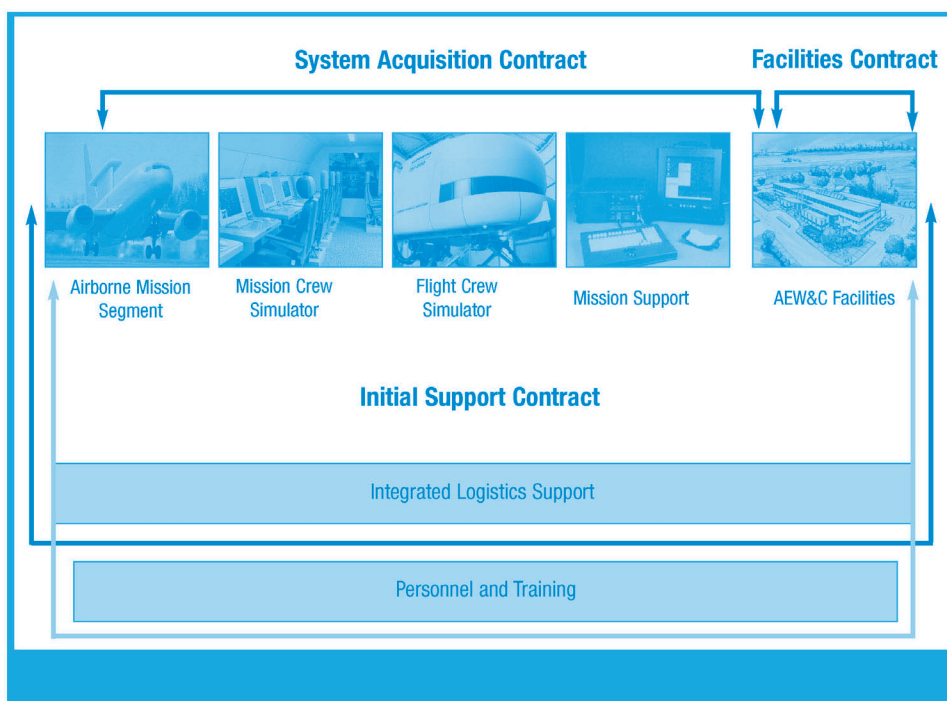
Appendices

Appendix 1: Wedgetail System Segments

1. The Wedgetail system is defined in terms of five segments, with a common logistic support infrastructure (including facilities, training and support) as depicted in Figure 1.

Figure 1

Wedgetail System Structure



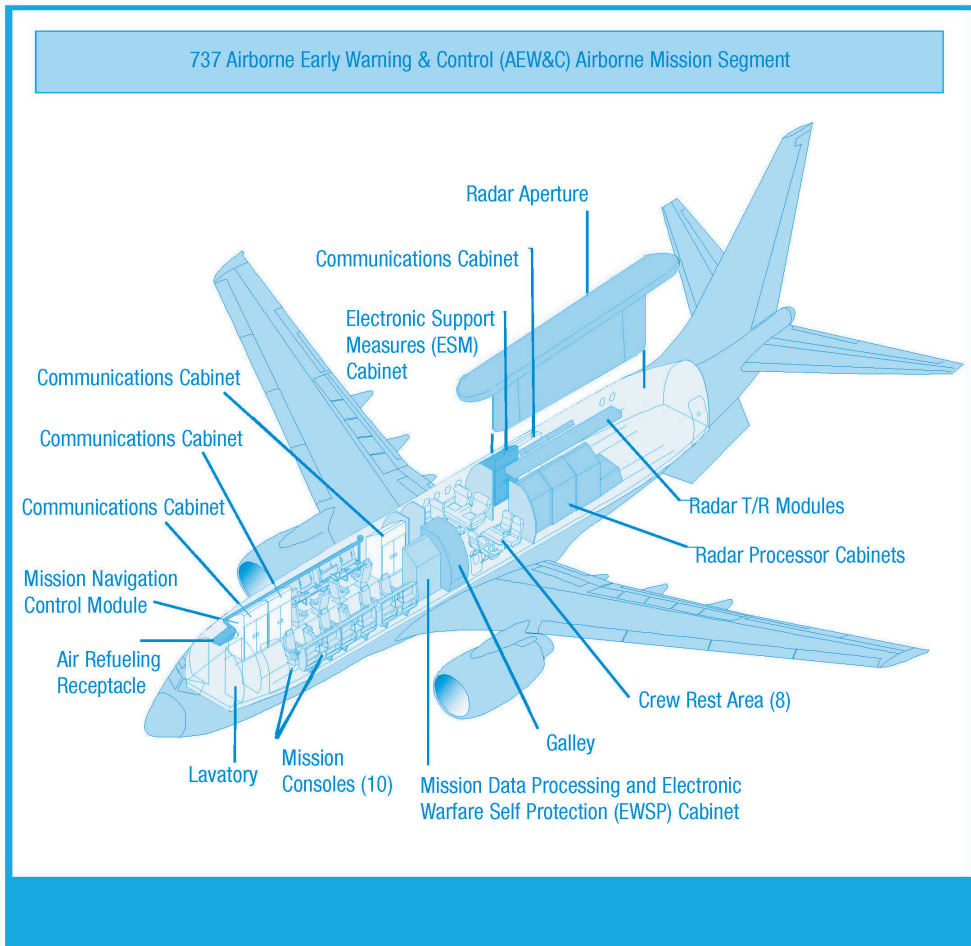
Source: Wedgetail project, Department of Defence.

2. **Airborne Mission Segment.** The Airborne Mission Segment (AMS) is divided into the aircraft and its mission system, which comprise the primary sensor and control functions of the Wedgetail System. The AMS includes active and passive detection capabilities, communications, navigation, data processing, air-to-air refueling (AAR) and Electronic Warfare (EW) self-protection functions. The Wedgetail aircraft is being developed from the Boeing Business Jet (BBJ). The BBJ is a Boeing 737-700 next generation increased gross weight variant of its 737 product line.

3. The AMS is the most complex and developmental portion of the Wedgetail system, with the MESA Radar/IFF, Mission Computing and AAR being developmental while the EW self-protection suite integrates non-developmental items. Figure 2 provides an internal view of the AMS.

Figure 2

Wedgetail Airborne Mission Segment internal view



Source: The Boeing Company.

4. Mission Support Segment. The Mission Support Segment (MSS) will facilitate preparation of mission system parameters and communication system configuration data for loading prior to a mission, and provides the capability for off-line, post mission analysis of sensor data, and post flight reports. The MSS will include Fixed Mission Support Systems located at the Home Maintenance Base RAAF Williamtown and at the Forward Operating Base RAAF Tindal, and two Deployable Mission Support Systems for use at deployment airfields. The MSS uses mainly commercial off the shelf equipment with some developmental software.

5. Operational Mission Simulator. The Operational Mission Simulator (OMS) will provide a simulation capability to train AMS Mission Crew in the full range of AEW&C operations, thereby maximising the availability of the AMS for operational purposes. The OMS will also provide an alternative test bed capability for AMS configuration changes, including verification of modified AMS software prior to dissemination to the AMS fleet. The OMS will also provide the capability to develop mission tactics and procedures. The OMS will be largely developmental. However, it is expected to re-use a significant portion of the AMS mission system and provide simulation and/or emulation of other functions.

6. Operational Flight Trainer. The Operational Flight Trainer (OFT) will provide a Full Flight Simulation capability, providing realistic simulation of the Wedgetail aircraft for the conduct of AMS flight crew training in all phases of flight and some mission related aspects. The OFT will mirror the functionality, internal physical dimensions and layout of the cockpit and avionics portions of the AMS. The OFT will be a minimal development based on a commercially available 737-700 simulator.

7. Wedgetail Support Facility. The Wedgetail Support Facility (ASF) will comprise the systems and personnel to provide the ADF with an indigenous through-life support capability to develop and implement enhancements and modifications to the Wedgetail system. The ASF will provide engineering environments, system mock-ups and environment simulators to design and test modifications to the Wedgetail system. The ASF will provide capability-modelling facilities to evaluate the benefits of proposed system enhancements, and to support the development of operational concepts and tactics. The ASF will also provide engineering environments, system mock-ups and environment simulators to enable on-going system software and hardware maintenance and minor development, including software changes and modifications, mission optimisation, and minor capability enhancements. The ASF is a combination of commercial off the shelf tools with a significant developmental software effort in the mission system/radar stimulation functions.

8. Logistics Support. The Wedgetail project is to establish the logistics support infrastructure to operate and support the AEW&C capability through life as follows:

- **Facilities.** Facilities will be provided at the Home Maintenance Base and Forward Operating Base. Boeing is required to provide a Wedgetail Support Centre to house the OFT, OMS and ASF, while facilities for Squadron buildings and hangars will be contracted directly.

- **Training.** Training packages, including syllabus, part task trainers, Computer Based Training software and hardware, and introductory training courses will be developed and provided by Boeing.
- **Repairable Items.** Sufficient Repairable Items are to be provided to sustain the system through-life. These will be determined through Boeings logistic support analysis and validated by Defence.
- **Spares.** Three years of initial spares for operations-level maintenance are to be provided with the initial acquisition.
- **Technical Information.** Boeing is required to provide sufficient technical information to allow Defence to train its personnel, and to operate, maintain, modify and certify the Wedgetail system.
- **Support and Test Equipment.** Boeing is required to identify, develop and provide the support and test equipment necessary to implement the through-life logistics plans.

Appendix 2: Defence Information Environment

1. The Government's national defence policy identifies 'the knowledge edge' as the foundation of our military capability over the coming decades.¹⁶³ This builds on earlier defence policy which identified the highest capability development priority as 'the knowledge edge' to allow Australia to use its relatively small force to maximum effectiveness.¹⁶⁴ The knowledge edge depends on a combination of military and administrative information systems that collectively form the Defence Information Environment (DIE).

2. At the time of the ANAO's 2000 audit of Defence's knowledge system projects, Knowledge Staff were establishing the processes needed for effective program management of the projects that they sponsor.¹⁶⁵ There were 50 such projects at the time of the audit. Subject to some caveats, processes to achieve good coherence between these projects were being put in place. However, the situation was much less clear for the many other projects, estimated to cost some \$A 4 billion, that would contribute to, or depend on, the DIE. These included the Wedgetail project that, at the time was being managed as an air defence system acquisition,¹⁶⁶ and was sponsored by Director-General Aerospace Development.

3. Figure 1 illustrates the way that the DIE, shown as interconnected ovals, relates to the maritime, land and air capabilities of the ADF. The AEW&C capability will become part of Defence's military information systems that, with other military systems, combine with Defence administrative systems to form the DIE.

¹⁶³ Commonwealth of Australia, *Defence 2000 Our Future Defence Force*, 2000, p.94.

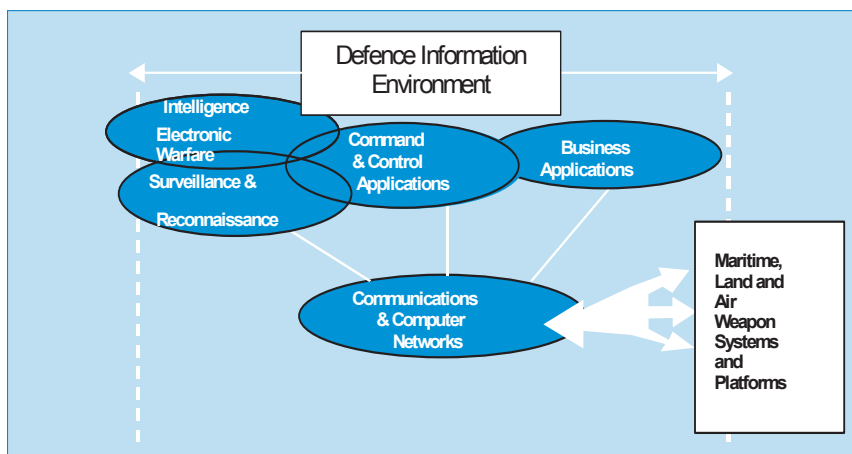
¹⁶⁴ Department of Defence, *Australia's Strategic Policy*, 1997, p.56.

¹⁶⁵ ANAO Audit Report No.11 2000–01, *Knowledge System Equipment Acquisition Projects*, September 2000.

¹⁶⁶ Department of Defence, *The Commonwealth's AEW&C Requirement*, 21 July 1999, available: <<http://www.dao.defence.gov.au/aad/ASS/air5077/AEW&CRequirement/require.htm>>, March 2003.

Figure 1

The Defence Information Environment



Source: Prepared by the ANAO from Defence records.

4. Defence expects the AEW&C capability to contribute extensively to the DIE. But it is an area of high risk in terms of the AEW&C system performance and integration needs within the Wedgetail aircraft, and the need to adhere to extensive data communication standards used by increasingly complex ADF and coalition command and control systems.

5. Since the knowledge system audit in 2000, Defence has established, within its Capability Systems Life Cycle Management process, provision for managing the requirements, system architecture and system integration phases of knowledge system projects.¹⁶⁷

6. The Wedgetail CONOPS details the system's interoperability and connectivity requirements in terms of the DIE and the ADF's evolving Tactical Information Environment (TIE). The TIE is described in the Defence Architecture Framework, which includes the Wedgetail AEW&C system and its interfaces.¹⁶⁸ Essentially, all Wedgetail aircraft are required to be fitted with a communication system sufficient to ensure a high probability of being interoperable with the range of ADF and allied forces

¹⁶⁷ Department of Defence, *Capability Systems Life Cycle Management Manual 2002*, November 2002, paras, 3.55 – 3.59.

¹⁶⁸ AEW&C Project, *AEW&C Project Integration into the Defence Information Environment*, 20 May 2003.

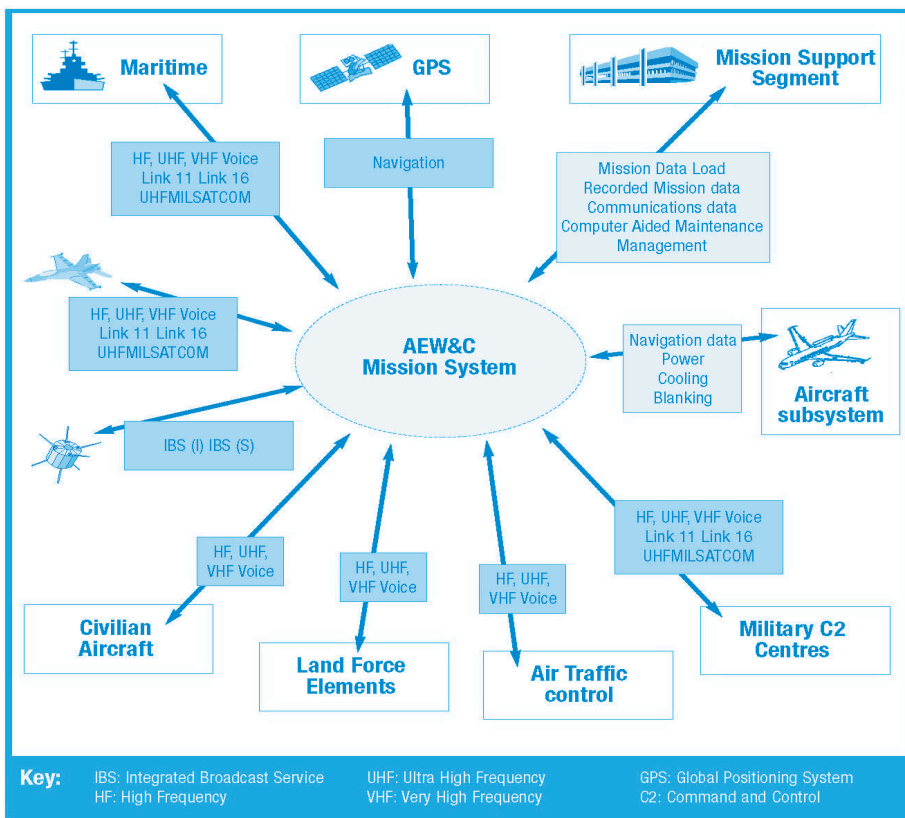
with which it is likely to operate in coalition.¹⁶⁹ AEW&C interoperability requirements cover:

- Single Service interoperability;
- Joint Service interoperability; and
- Coalition interoperability.

This interoperability will be implemented through communication systems shown in Figure 2.

Figure 2

AEW&C Mission Communication Systems



Source: Wedgetail project, Department of Defence.

¹⁶⁹ Commonwealth of Australia, *Defence 2000 Our Future Defence Force*, 2000, pp.54, 55.

7. The Wedgetail project is managing its interoperability requirements using Defence's Through-Life Interoperability Planning (TULIP) process, which is now mandated for configuration management of the ADF's Tactical Data Links (TDL). Wedgetail project staff are members of the ADF's TDL stakeholder working group, which identifies and resolves interoperability and compatibility issues between ADF platforms.¹⁷⁰

8. At the time of the audit, the Wedgetail project personnel were working to resolve important interoperability issues. These required extensive Government-to-Government agreements, given that the majority of Wedgetail communications systems are subject to FMS agreements and classified information exports. The project's FMS contract management was not examined in this audit.

¹⁷⁰ AEW&C Project, *AEW&C Project Integration into the Defence Information Environment*, 20 May 2003.

Appendix 3: Contract changes and 'real' price increases

1. The Wedgetail acquisition contract may be amended according to a protocol that allows Boeing to propose contract changes and Defence to both request and propose contract changes.¹⁷¹

2. At the time of the audit fieldwork, 51 contract changes had been agreed between the parties. Of these, 34 were engineering changes that affected the contract's specifications and eight affected the contract price, and the remaining nine were administrative changes. These amounted to a contract price increase consisting of two currencies—\$US 2.1 million and \$A 0.9 million or \$A 4.5 million in single currency terms.¹⁷²

3. The Wedgetail project has a Contract Change Proposal (CCP) process for evaluating the financial, schedule and technical implications of proposed contract changes. These processes are defined in the project's Contract Management Plan and Configuration Management Plans, and in Standing Work Instructions. The objective of the change process is to maintain:

- control over cost variations and production schedule changes;
- visibility of the full impact of a proposed contract change to support sound decision making;
- consistent contract change assessments based on a controlled record of the approved configuration of the Wedgetail systems and their change history; and
- risk reduction by way of a disciplined approach to change management.

4. These objectives require all contract amendments to satisfy at least one of the following generic criteria:

- required by Defence;
- required to correct errors or ambiguities in the contract;
- necessary for improved operational effectiveness, safety or logistic support;
- necessary for savings in life-cycle cost;

¹⁷¹ Project Air 5077, Contract C338364 *Conditions of Contract*, pp.93–94.

¹⁷² September 1998 prices.

- necessary to prevent slippage in the approved production schedule; and
- necessary for increased AII.

5. Project personnel review change proposals prior to the proposals being presented to the Wedgetail Configuration Control Board (CCB) for its consideration and approval. The CCB consists of the managers of each functional group within the Wedgetail project, and is chaired by the Wedgetail Project Manager.

6. In cases when the CCB decides that a change proposal significantly affects capability, contract price, schedule, AII content, or risk, a Business Case, accompanied by a financial assessment and proposal, is raised and presented to DMO's Head Airborne Surveillance and Control (HASC) for endorsement. HASC endorsed Business Cases are accompanied by negotiating directives, which enable the RPT to proceed, within defined negotiating limits, to finalise the agreement on proposed contract changes. If agreement cannot be reached within the negotiating limits, then the Business Case is referred back to the CCB.

7. Proposed changes to the acquisition contract's terms and conditions or SOW, which may affect the project's technical elements may be requested through Requests for Deviations, or Requests for Waivers.¹⁷³ These requests are processed using the above contract change process. However, as they often involve significant technical integrity issues, then they must also be processed through the ADF's airworthiness technical integrity process and receive Design Acceptance Certification by the RPT's Senior Design Engineer.¹⁷⁴

8. As mentioned above, at the time of the audit the contract price had increased by \$A 4.5 million. The most significant price changes resulted from a fuel jettison system being added to the Wedgetail aircraft, valued at \$A 21.559 million, and two credits from Boeing to the value of \$A 23.467 million. These credits resulted from the Commonwealth's purchase of Special Purpose Aircraft¹⁷⁵ and compensation for Defence's purchase of Government Furnished Equipment via Government-to-Government contracts, rather than from Boeing as originally agreed in the contract.

9. Table 1 lists the contract changes that had financial implications.

¹⁷³ Project Air 5077, Contract C338364, *Conditions of Contract Statement of Work – System Acquisition*, Section 4.4.

¹⁷⁴ RPT Standing Work Instruction (SWI) ENG-06 Review and Processing of Engineering Changes.

¹⁷⁵ Project Air 5077, Contract C338364, *Conditions of Contract*, Section 3.1.9, September 1998 prices.

Table 1**Price Variations Attributed to Contract Changes: September 1998
Prices (in millions)**

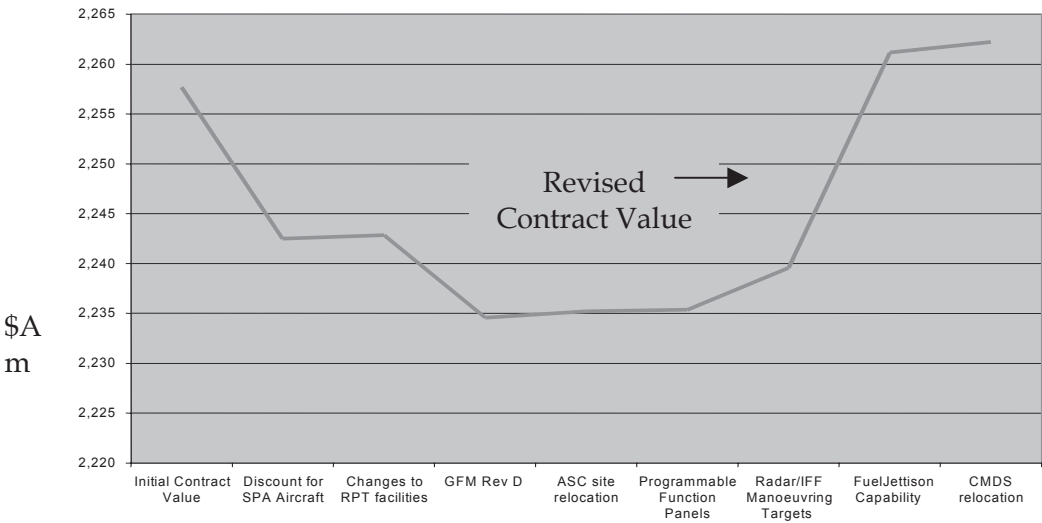
	\$A Element	\$US Element	\$A Total
Initial Contract Value	412.237	1093.063	2257.692
Discount for Australian Government purchase of Boeing Business Jet aircraft and other aircraft		(9.000)	(15.195)
Changes to Resident Project Team facilities		0.210	0.354
Government Furnished Materiel revisions		(4.900)	(8.273)
Wedgetail Support Centre site relocation	0.561	0.040	0.629
Change to programmable function panels		0.090	0.151
Radar/IFF manoeuvring targets specification change		2.500	4.221
Fuel jettison capability	0.256	12.618	21.559
CMD5 relocation	0.108	0.570	1.071
Revised Contract Value	413.162	1095.191	2262.209

Source: Wedgetail project, Department of Defence.

10. Figure 1 shows the variations in contract price with each contract change listed in Table 1.

Figure 1

Revised Contract Value by Contract Change



Source: Wedgetail project, Department of Defence.

Appendix 4: Wedgetail Personnel Arrangements

1. Defence has located its Wedgetail SPO in Canberra, and the SPO structured its acquisition project management personnel along Integrated Product Team arrangements aligned, where practical, with contractor teams. Consequently, SPO personnel are geographically spread within Australia and the US, as follows:

- 45 SPO personnel comprising ADF, Australian Public Service, Systems Engineering Technical Assistance contracted personnel and locally engaged support staff, are located in DMO's offices within Boeing's facility at Kent near Seattle, USA. This group is responsible for ensuring the contract is followed, by gaining insights into the project's progress through technical reviews, and day-to-day interface with contractor personnel. The majority of the Wedgetail system airframe, radar, communication and avionics systems development/integration is managed from Kent. These systems include some 3.75 million lines of computer software, which is a high-risk area of Defence equipment projects. The Wedgetail aircraft are manufactured locally at Boeing's 737 facility at Renton, and are modified at nearby Boeing Field;
- three SPO personnel are located at Northrop Grumman's facility near Baltimore Maryland, USA, where the MESA radar system is designed, developed and tested. This is also a high-risk area of the project given MESA radar is the first of its type to provide seamless 360 degree area coverage combined with advanced target detection and tracking features.
- 35 SPO personnel are located in Canberra where the SPO's strategic management is located and where the AEW&C logistics and operations personnel are based prior to moving to Williamstown Air Force Base in 2006; and
- three personnel are located at British Aerospace Systems in Adelaide, where the aircraft self-protection systems, mission support and simulator are under development.

2. These numbers are expected to change during the life of the project as areas of technical and other risks change, necessitating adjustment to the integrated project teaming arrangements.

3. In addition to these personnel are some 25 Air Force No.2 Squadron personnel, who are to be integrated with Boeing in roles associated with test and evaluation and with the US Air Force in roles associated with AEW&C operations and doctrine development.¹⁷⁶ These personnel will form the core operating staff for the new AEW&C capability when it is accepted into service.

¹⁷⁶ Doctrine is the body of established fundamental principles by which military forces guide their actions in support of national objectives. It is authoritative but requires judgement in application.

Appendix 5: DMO Advice on its PMM Reform Program

Background

1. As a consequence of the Government's Defence Reform Program (DRP) in 1997, the then Acquisition Program Executive directed that the then Defence Acquisition Organisation's (DAO) processes be reviewed and, where appropriate, re-engineered to improve quality, cost, time and performance outcomes. This resulted in DAO establishing a Business Process Re-engineering Project in August 1997, which strongly supported the concept of a disciplined approach to project management, and recognised the merits of a common project management methodology throughout the DAO.
2. Since then, Defence policy required its capital equipment project teams to implement a standardised project management method (SPMM), unless there was compelling reason for following a different methodology (on a case by case basis).¹⁷⁷ The PRINCE2 methodology was adapted, to some extent, to the Defence environment and as such was identified as the DAO SPMM. SPMM lately became known as PMM.
3. PMM policy, procedures, guidance and templates were developed and made available to all staff via the Defence Acquisition Organisation Manual (DAOMAN), which later became the Defence Materiel Organisation Knowledge System (DMOKS) PMM.
4. During the audit fieldwork, the ANAO requested DMO's advice on the following questions.

ANAO question:

What percentage of all 240 or so DMO projects has DMO assessed to be successfully implementing project management models based on:

CEPMAN 1;
DAOMAN-SPMM;
DMOKS-PMM?

¹⁷⁷ This policy aligns with Defence's agreement to a 1999 ANAO recommendation that, to minimise any adverse effect of Group boundaries on the capability acquisition process across Groups, Defence apply the Defence Acquisition Organisation's proposed standard project management method to all Groups involved with capital equipment acquisitions. ANAO Audit Report No.13 1999–2000, *Management of Major Acquisition Projects Department of Defence*, October 1999, pp.25, 127–128.

DMO's Advice:

5. The DMO project management methodology has been evolving over a number of years. The CEPMAN 1 was not a methodology as such, but did include guidance on project planning, risk management, financial management, tender evaluation and source selection, and contract negotiation. Many of the requirements included in the manual supported centralised control of projects and centralised decision making through the Defence Source Selection Board.

6. DAOMAN-SPMM and DMOKS-PMM are essentially the same and were an attempt to overlay a generic project management process over existing DAO/DMO processes. The implementation resulted in duplication as the generic processes based on PRINCE 2 were not adequately integrated with required defence and Government processes. In particular, requirements for accountability were confused by the role of the Project Boards (which could change requirements and budgets) required under PMM and Government decision requirements especially on issues such as scope and budgets.

7. The most recent iteration of the DMO project management methodology is PMM V2. This methodology builds on lessons learned from PMM but also integrates the project management processes with other processes including systems engineering logistics and financial management. The methodology also incorporates recognition of Government decision processes and processes performed by functional areas outside the DMO such as the Capability Staff.

8. As the latest update to the methodology has just been released an assessment of those projects fully implementing the requirement has not been made.

ANAO question:

What core project management processes and concepts are common to each of these models, and what are unique to each?

DMO's advice:

9. Under the PMM v2 the principles of the PRINCE 2 methodology (PMM) remain extant but have been tailored to reflect the environment in which Defence works. Aspects previously covered by CEPMAN but not by PMM have also been included.

ANAO question:

Has DMO measured improvements in project outcomes, which may be attributed to specifically defined improvements sought by each management model change?

DMO's advice:

10. Evolution of the model has been based on lessons learned and weaknesses identified through internal reviews, audits and independent process appraisals. As improved project outcomes are difficult to measure for some time, and equally difficult to attribute to a single improvement initiative, our approach has been to move to an integrated approach that takes best practice from the public and private sectors.

11. PMMV2 has been compared with PMBOK, PRINCE 2 and the CMMI.

12. While planned, we do not have a reliable methodology for benchmarking improved performance.

ANAO question:

What instructions, guidance and resources has DMO provided to Project Directors and Senior Executives that mandate and assist the implementation of each of these project management models?

DMO's advice:

13. The latest updated methodology, PMMv2, was launched by USDM on 9 May 2003. The following products are supporting the PMMv2 release:

- PMMv2 Overview Booklet;
- PMMv2 Manual (both electronic and hard copies);
- PMMv2 Fact Sheet; and
- Executive Pack on Materiel Acquisition and Sustainment Framework (MASF) which also covers PMMv2.

14. The PMMv2 release is also supported by the Materiel Policy and Services (MPS) helpline. MPS Branch is also working on an application oriented training program for PMMv2 as a replacement to PRINCE2 generic training. Such a training program will include the following:

- PMMv2 for Executives;
- Executive monitoring and control of PMMv2 projects;
- Introduction to PMMv2;

- Practitioner Modules;
- PMMv2 Coaching Program; and
- Advanced Technique Modules.

The PMMv2 methodology has also been totally integrated with the DMO Quality and Environmental Management System.

Appendix 6: Wedgetail T&E phases

Development Test and Evaluation

1. Boeing conducts DT&E during the development of the Wedgetail system. The overall objectives of the DT&E program are to:
 - enable Boeing to identify and reduce technical risk in support of the design effort, and to ensure that the Wedgetail system complies with the development specifications; and
 - provide Defence with familiarity with operation of the Wedgetail system under realistic operational conditions, providing confidence that the Wedgetail system is likely to satisfy contract specification requirements.
2. Defence observes and participates in DT&E activities in order to gain knowledge of both the system design and the T&E program itself. This insight enables the RPT to assess Boeing's progress in terms of design, manufacturing and test activities against the agreed plans and schedules, and to evaluate the suitability of DT&E test procedures for AT&E purposes.
3. Any risks or issues observed during DT&E are logged into the projects Risk Management System and Issues Database.

Acceptance Test and Evaluation

4. AT&E is to be conducted by Boeing to demonstrate to Defence that the system complies with all the requirements of the contract.
5. AT&E is sometimes referred to as 'formal testing' or 'for score' testing, as it is conducted to meet Defence objectives in accordance with Defence approved AT&E plans and procedures. Defence test personnel witness AT&E, which, as the term implies, is a more formal undertaking than merely observing T&E.¹⁷⁸
6. Defence's AT&E objectives include:
 - verifying that the Wedgetail system, segments and sub-systems comply with contracted specifications;
 - evaluating the Wedgetail system's fitness for purpose; and
 - assessing the Wedgetail system's operational effectiveness and operational suitability.

¹⁷⁸ AEW&C Project RPT Standing Work Instructions, *Commonwealth Conduct During Boeing Test and Evaluation*, Section 6.

7. On completion of the AT&E Program, the RPT will complete an operational assessment of the Wedgetail system, using the ADF Air Research and Development Unit (ARDU) formal report format. This report will be used to support operational recommendations concerning the Wedgetail system's Service Release and acceptance into operational service (AIOS).¹⁷⁹

Operational Test and Evaluation

8. Operational T&E (OT&E) is conducted by Defence. Wedgetail OT&E is divided into Initial OT&E (IOT&E) and Follow-on OT&E (FOT&E). These are to be conducted prior to, and following, the Wedgetail system's AIOS. IOT&E personnel will be drawn from the Surveillance and Control Force Element Group (FEG), and No. 2 Squadron.¹⁸⁰

9. Air Force needs to conduct IOT&E of the Wedgetail system as part of the operational effectiveness and suitability assessment process. Also, as it is a new ADF capability, operating procedures and tactics will have to be developed, exercised and validated using OT&E.¹⁸¹

10. Wedgetail IOT&E will be assisted by data collected during DT&E and AT&E, and so those responsible for OT&E are also involved with DT&E and AT&E processes.¹⁸² The 'fitness for intended purpose' focus taken by IOT&E personnel will assist to influence the design in terms of arriving at satisfactory operational parameters, and to help qualify the first Wedgetail systems prior to production acceptance or delivery.

Test and Evaluation Plans

11. Figure 1 lists the hierarchy of test plans Boeing will use during the Wedgetail system development and acceptance phase.

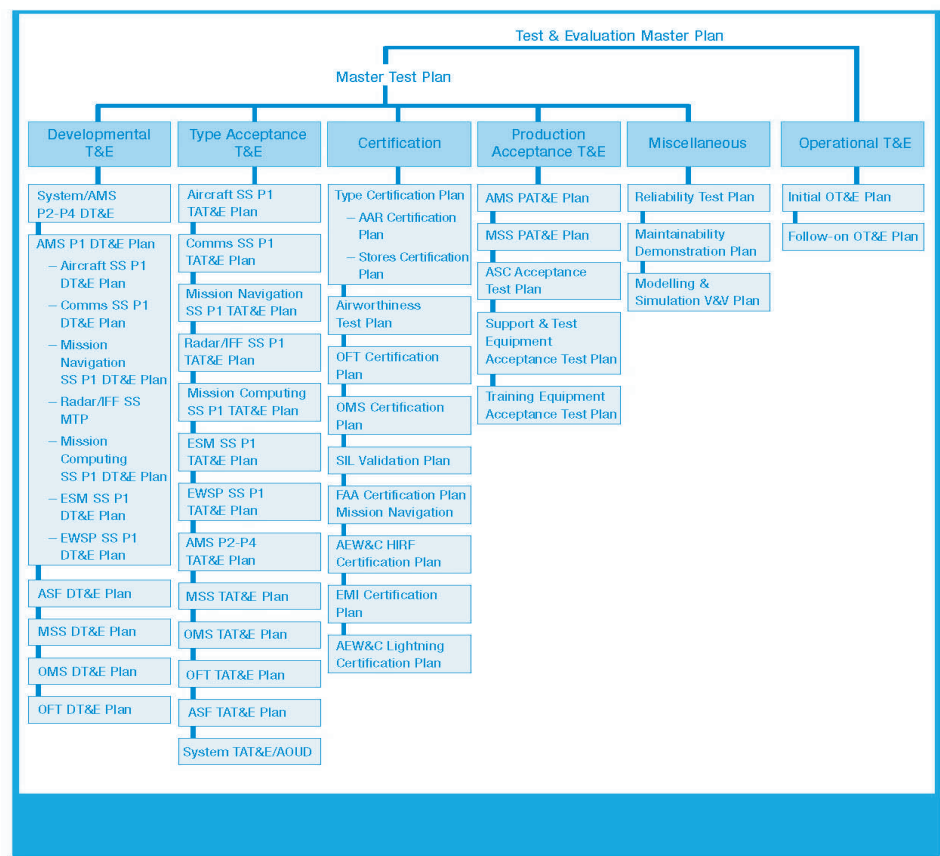
¹⁷⁹ AEW&C Project RPT Standing Work Instructions, *Commonwealth Conduct During Boeing Test and Evaluation*, Section 6.

¹⁸⁰ AEW&C Project, *Test and Evaluation Master Plan*, September 2002, Section 7.2.1.

¹⁸¹ AIR 5077, *Project Management and Acquisition Plan (PMAP)*, Volume 1 Issue 2, Section 11.

¹⁸² DI(AF) LOG 2-7 – *Test and Evaluation of Technical Equipment*.

Figure 1
Wedgetail System Test Plan Hierarchy

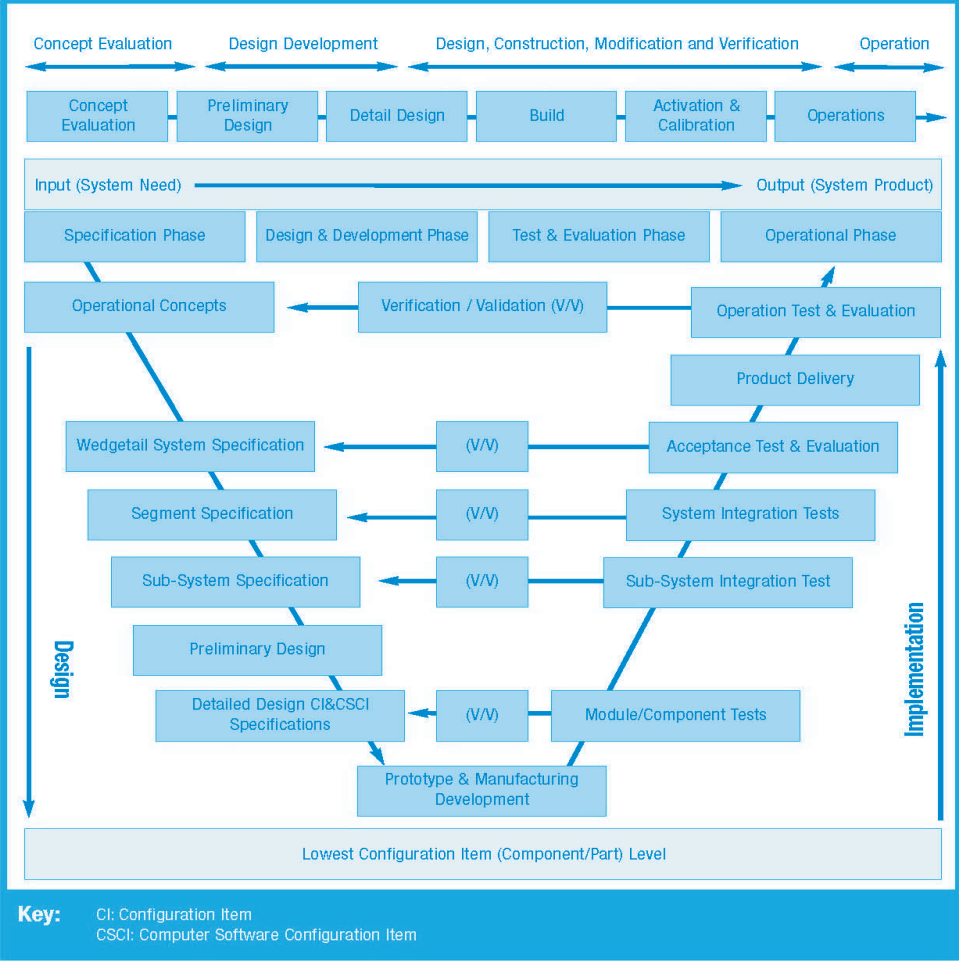


Source: Wedgetail project, Department of Defence.

T&E and systems engineering

12. T&E is a component of the systems engineering process, and this is shown in Figure 1.

Figure 2
Four-Phase Systems Engineering Process



Source: Wedgetail project, Department of Defence.

13. Figure 2 shows the engineering design process progressing down from system specification, segment specifications, preliminary and detailed designs. It also shows the design implementation T&E process progressing up from module and component DT&E to sub-system and system AT&E and finally to total system OT&E.

14. Figure 2 also shows the hierarchy of V&V processes which seek to provide important indicators of progress toward the delivery of a system that:

- is comprised of configuration items that fulfil their specific purpose—i.e. are verified as functioning as they are designed to function; and
- at the overall system level, does what the users expect of it—i.e. is validated as complying with the requirements of the system specification.

Appendix 7: Wedgetail Intellectual Property

1. Most of Defence's Intellectual Property (IP) is developed in DMO acquisition projects. IP existing within Defence or industry before any phase of a project commences is categorised as background IP, and IP developed under a contract is termed foreground IP.
2. However, under the terms of the Wedgetail systems acquisition contract, Defence owns only the IP related to the following Wedgetail system RAAF unique components, detailed in the table below.

Table 1

Wedgetail Project RAAF Unique Components

Components	Cost \$ US millions (September 1998 prices)
Electronic Support Measure (ESM)	\$52.3
Electronic Self Protection (EWSP)	\$29.5
Link 16	\$27.1
Structural Loads Monitoring System	\$5.1
AEW&C Support Facility (ASF)	\$8.4
Mission Support Segment (MSS)	\$8.3
Operational Mission Simulator (OMS)	\$6.8
Center Galley	\$0.3
DIRCM	\$10.3
Fuel Jettison	\$5.5
Total	\$148.1 million

Source: Wedgetail project, Department of Defence.

3. The Wedgetail system acquisition contract has Boeing responsible for delivering to Defence a schedule of IP generated under the contract.¹⁸³ This schedule is expected to mature as IP is progressively identified in line with the Wedgetail's maturing designs.

¹⁸³ Project Air 5077, Contract C338364 *Conditions of Contract*, Contract Deliverable Requirements (CDR(S))–GCM-04, (Intellectual Property Schedule).

4. The ANAO was advised that the IP schedule will effectively become the Wedgetail project's IP register, and that the project intends to progressively enhance the IP register by evolving it from a spreadsheet-based system to a database containing:

- type of IP;
- description of IP;
- IP owner and, where relevant, related subcontractor IP deed;
- related technical information;
- tracking of royalties;
- comments section; and
- release of IP to third parties, with references to executed Non Disclosure Agreements.

5. The ANAO was advised that the Wedgetail project has issued instructions on the control and protection of all Boeing and subcontractor information, with respect to the release of information to third parties where Defence is exercising its IP rights under the contract.

Appendix 8: Wedgetail Project Integrated Baseline Reviews

1. Budgets and work schedule estimates on advanced technology projects such as Wedgetail often need to be re-estimated yearly, given the inherent uncertainty in the design and development of advanced technology items. This raises the need for contractors to conduct Integrated Baseline Reviews (IBRs) to re-validate their project's Performance Measurement Baseline (PMB). The Wedgetail project's IBRs are discussed below.

2. Boeing's PMB has undergone two major reviews since February 2002, as outlined in the following advice provided to the ANAO, namely:

- Boeing's PMB was reviewed in February 2002 in the context of the Integrated Baseline Review by a joint team comprising the RPT, Wedgetail SPO, Australian Earned Value Policy centre, and on-site US Defense Contract Management Agency personnel. The last of the corrective actions arising from that review were completed in July 2002, with a letter of confirmation sent to Boeing on 26 August 2002.
- In December 2002, Boeing conducted a major re-plan of its cost and schedule 'balance to go'. Subsequently, in June 2003, the RPT conducted a further IBR-like exercise to revalidate Boeing's proposed revised PMB. This was referred to as the Baseline Surveillance Review, combining elements of both a Surveillance Review and an IBR. The scope and structure of the review was the same as the IBR, but on a reduced scale. However, it focused on particular areas of interest.

3. The Wedgetail RPT advised the ANAO that Boeing's EVMS was well maintained, and that the IBR revealed only four minor findings that needed follow-up action. These were not material to the execution of the program, and two amounted to only system improvement suggestions.

4. Based on that outcome, and providing no major changes to the baseline occur in the interim, the RPT is likely to conduct the next formal surveillance exercise in late 2004.

5. In addition to these two major reviews, the RPT's Earned Value Manager, supported by RPT technical personnel, undertakes monthly surveillance reviews of Boeing's Earned Value System, via earned value report validation and progress performance verification.

Appendix 9: Previous performance audits in Defence

1. Set out below are the titles of ANAO performance audit reports on Defence tabled in the Parliament in the last five financial years.

Audit Report No.2 1998–99 *Commercial Support Program*

Audit Report No.17 1998–99 *Acquisition of Aerospace Simulators*

Audit Report No.41 1998–99 *General Service Vehicle Fleet*

Audit Report No.44 1998–99 *Naval Aviation Force*

Audit Report No.46 1998–99 *Redress of Grievances in the Australian Defence Force*

Audit Report No.13 1999–2000 *Management of Major Equipment Acquisition Projects*

Audit Report No.26 1999–2000 *Army Individual Readiness Notice*

Audit Report No.35 1999–2000 *Retention of Military Personnel*

Audit Report No.37 1999–2000 *Defence Estate Project Delivery*

Audit Report No.40 1999–2000 *Tactical Fighter Operations*

Audit Report No.41 1999–2000 *Commonwealth Emergency Management Arrangements*

Audit Report No.45 1999–2000 *Commonwealth Foreign Exchange Risk Management Practices*

Audit Report No.50 1999–2000 *Management Audit Branch—follow-up*

Audit Report No.3 2000–2001 *Environmental Management of Commonwealth Land—follow-up*

Audit Report No.8 2000–2001 *Amphibious Transport Ship Project*

Audit Report No.11 2000–2001 *Knowledge System Equipment Acquisition Projects in Defence*

Audit Report No.22 2000–2001 *Fraud Control in Defence*

Audit Report No.26 2000–2001 *Defence Estate Facilities Operations*

Audit Report No.32 2000–2001 *Defence Cooperation Program*

Audit Report No.33 2000–2001 *Australian Defence Force Reserves*

Audit Report No.41 2000–2001 *Causes and Consequences of Personnel Postings in the Australian Defence Force*

Audit Report No.51 2000–2001 *Australian Defence Force Health Services—follow-up*

Audit Report No.16 2001–2002 *Defence Reform Program—Management and Outcomes*

Audit Report No.24 2001–2002 *Status Reporting of Major Defence Equipment Projects*

Audit Report No.30 2001–2002 *Test and Evaluation of Major Defence Equipment Acquisitions*

Audit Report No.38 2001–2002 *Management of ADF Deployments to East Timor*
Audit Report No.44 2001–2002 *Australian Defence Force Fuel Management*
Audit Report No.58 2001–2002 *Defence Property Management*

Audit Report No.3 2002–2003 *Facilities Management at HMAS Cerberus*
Audit Report No.30 2002–2003 *Defence Ordnance Safety and Suitability for Service*
Audit Report No.31 2002–2003 *Retention of Military Personnel—follow-up*
Audit Report No.39 2002–2003 *Navy Operational Readiness*
Audit Report No.46 2002–2003 *Australian Industry Involvement Program*
Audit Report No.51 2002–2003 *Defence Housing and Relocation Services*
Audit Report No.56 2002–2003 *Management of Specialist Information System Skills—Defence*

Audit Report No.10 2003–2004 *Australian Defence Force Recruiting Contract*

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