The Auditor-General
Audit Report No.10 2005–06
Performance Audit

Upgrade of the Orion Maritime Patrol Aircraft Fleet

Department of Defence
Defence Materiel Organisation

Australian National Audit Office

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Australian National
Audit Office

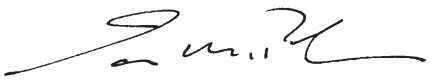
Canberra ACT
23 September 2005

Dear Mr President
Dear Mr Speaker

The Australian National Audit Office has undertaken a performance audit in the Department of Defence and the Defence Materiel Organisation in accordance with the authority contained in the *Auditor-General Act 1997*. Pursuant to Senate Standing Order 166 relating to the presentation of documents when the Senate is not sitting, I present the report of this audit and the accompanying brochure. The report is titled *Upgrade of the Orion Maritime Patrol Aircraft Fleet.*

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

Yours sincerely



Ian McPhee
Auditor-General

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

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Abbreviations

AFS	Advanced Flight Simulator
AII	Australian Industry Involvement
AP-3C	Australian P-3C *Orion* aircraft
AR	Anomaly Report
ARDU	Aircraft Research and Development Unit
DMO	Defence Materiel Organisation
DMS	Data Management System
EAS	Equipment Acquisition Strategy
FMS	(US) Foreign Military Sales
LOA	Letter of Offer and Acceptance
OMS	Operational Mission Simulator
RFT	Request for Tender
SEL	Software Engineering Laboratory
TAP-3	Training Australian P-3 *Orion* aircraft
UK	United Kingdom
US	United States

Orion AP-3C aircraft on patrol

Source: Department of Defence.

Summary, Conclusions and Lessons Learnt

Summary

Background

1. Australia's Air Force operates 19 *Orion* maritime patrol aircraft, which entered service in 1978 and 1984–1986. The refurbishment of the *Orion* fleet was approved in late 1992 with a contract signed in January 1995. Project Air 5276 is a multiphased project aimed at upgrading the aircraft's combat systems to ensure its military effectiveness, and extending the aircraft's life through to its planned withdrawal from service in 2015.

2. The major elements of Project Air 5276 nearing project completion in 2004–2005 (see Table 1) included[1]:

- an Upgrade Project for 18[2] aircraft (from the P-3C to the AP-3C configuration), including the acquisition of associated support;
- the purchase, under the United States (US) Foreign Military Sales (FMS)[3] system, of three second-hand *Orion* aircraft and their modification to a training and utility (that is, passenger and cargo transport) aircraft (designated TAP-3 – Training Australian P-3) and acquisition of a fourth aircraft to become a source of spare parts; and
- the contract for an acquisition of an Advanced Flight Simulator (AFS) was signed in July 1998.

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1 Phase 1 of the Project was a Project Definition Study.

2 One of the 19 aircraft is used for development purposes and was not included in the Upgrade Project.

3 A Letter of Offer and Acceptance for $US 30.93 million was signed in February 1994. The FMS is a major component of the activities under the US Government Security Assistance Program authorised by the US Foreign Assistance Act and the Arms Export Control Act.

Table 1

Major *Orion* upgrade and life extension projects

Projects	Initial approval $ million	Foreign exchange and price escalation $ million	Real cost (scope) increases $ million	Revised approval $ million	Expenditure to 30 June 2005 $ million
P-3C Upgrade	629.54	192.24	28.74	850.52	782.13
TAP-3 Acquisition	42.00	11.92	-	53.92	53.92
Advanced Flight Simulator Acquisition	47.80	9.27	0.85	57.92	55.65
Totals	719.34	213.43	29.59	962.36	891.70

Source: ANAO analysis of Defence and DMO documentation.

3. Subsequent elements of Project Air 5276 provide for electronic warfare self-protection measures and the upgrade or replacement of the aircraft's Infra-red Detection System; the communications suite and data links; Electronic Support Measures; and other systems[4] that may become obsolete during the remaining in-service life of the aircraft. These Project elements are estimated to cost in excess of $550 million.

4. The performance objectives of the main element of Project 5276, the P-3C Upgrade Project, were to:

- contribute to the life extension to 2015 of the aircraft fleet, largely through a significant reduction in the weight of the operational aircraft;
- shift the centre of gravity of the aircraft forward (for greater operational safety and flexibility); and
- enhance the aircraft's military capabilities.

5. The Upgrade Project replaced five major sub-systems on the aircraft, namely the radar, acoustics, navigation, communications, and data management system (DMS – the aircraft's central computer). The Upgrade Project also included the acquisition of operational support systems, comprising an Operational Mission Simulator (OMS) for the training of operational crews, a Systems Engineering Laboratory (for software maintenance and development, technical research and modification development) and a Mission Replay and Analysis Module (for pre- and post-flight mission support).

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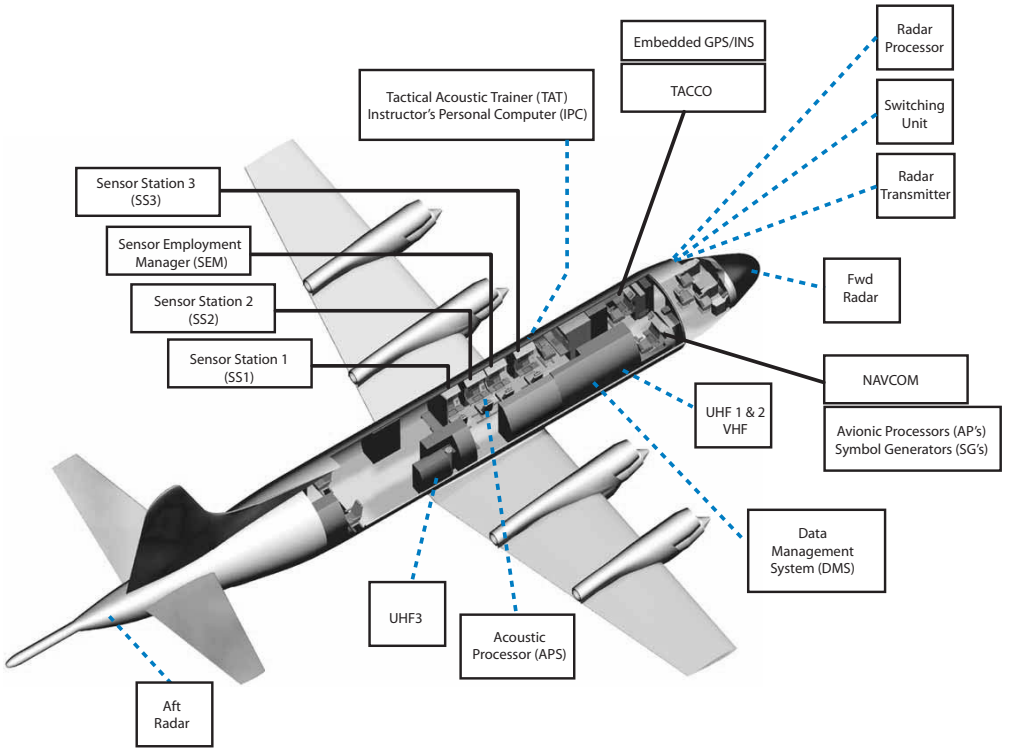
[4] These include the radar, operational mission simulator, the acoustics and data management.

6. Figure 1 shows the subsystems which have been replaced in the Upgrade Project. The major activity in the Project was to develop, modify and reuse software, involving more than three million source lines of code. This activity posed the greatest technical, schedule and cost risks to the Project.

Figure 1

Subsystems replaced in the Orion Upgrade Project



Fwd Radar	Forward (Front) Radar
GPS/INS	Global Positioning System/Inertial Navigation System
NAVCOM	Navigator/Communicator
TACCO	Tactical Coordinator
UHF 1&2	Ultra High Frequency radios 1 and 2
VHF	Very High Frequency radio

Source: Department of Defence.

7. To provide on-site technical support for the Upgrade Project, some 140 Australian industry personnel were required at 13 Contractor and subcontractor sites. This included over 60 positions in three overseas countries.

Audit approach

8. This audit was undertaken towards the conclusion of the major approved elements of Project Air 5276, when more than 90 per cent of estimated project costs were expended. The elements of the Project examined

in the audit were initiated in the early 1990s, predating the recent reforms in the Defence capability development and acquisition framework. These reforms led to the 'two pass' capital equipment definition, analysis and approval process outlined in the 2005 Defence Capability Development Manual.[5]

9. The audit objective was to examine the adequacy of Defence's and DMO's management of the nearly completed elements of Project Air 5276. The ANAO identified a number of causes for time delays and cost escalation in those elements. Those causes are outlined in the overall audit conclusions, to assist in the achievement of improvements in future planning and management of capital equipment acquisitions.

Overall audit conclusions

10. The *Orion* Upgrade Project met its performance objectives. The modified aircraft have achieved, and in a number of roles exceeded, the expected operational performance. The capability enhancements allow the aircraft to cover a given surveillance area in greater detail and in a third less time.

11. The ANAO found that the long delays in the Project (some four years in the delivery of the upgraded aircraft) meant that equipment met contractual requirements but some equipment was already obsolete at the time of installation in the aircraft. Defence, the Contractor and subcontractors underestimated the unique features of the design and production work to be undertaken, and the complications involved in integrating a range of different new systems, both with each other and with the retained aircraft systems. These complexities were made more difficult to manage in the absence of a fully developed software testing facility, which had been a pivotal part in the Project's planning. Nevertheless, the Upgrade Project has met its performance objectives and the upgraded aircraft have played a significant part in Australian border protection and coalition[6] operations.

12. In the purchase and modification of three second-hand *Orion* (TAP-3) aircraft, the ANAO found that, in Defence's decision making on the method of procurement, insufficient attention was paid to the financial and technical constraints in contractual commitments under the US Foreign Military Sales system. These constraints were insufficiently considered as an integral part of a comprehensive sourcing analysis before Defence decided on a method of

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5 The 'two pass' process aims to generate significantly more detailed and accurate data on cost, schedule and capability issues than had occurred in previous Defence capability development processes. See chapter 1, paras. 1.9-11.

6 *AP-3C* aircraft participated in international military operations in the Middle East Area of Operations.

procurement. The delays in the delivery of refurbished aircraft ranged from 9 to 25 months.

13. The acquisition of the Advanced Flight Simulator highlights the importance of having at hand appropriately skilled personnel to ensure that projects can be started and progressed in a timely manner. Against planned timelines, the delivery of an essential training capability was over two years late, and the tactical training capability was three years late. The ANAO found that the current inability to use the AFS for a number of high risk and high airframe fatigue-inducing training sequences means that the AP-3C *Orions* have to be used for that training, resulting in higher risks and costs, including the consumption of airframe fatigue life. The Air Force expects to be able to keep the *Orions* operating until their planned withdrawal from service, and Defence is undertaking further work with the Contractor to increase the AFS's capabilities.

Key findings

Upgrade of the *Orions* (Chapter 2)

14. The ANAO found that the 18 modified aircraft have met all of the Project's performance objectives. The Air Force element operating the aircraft, No. 92 Wing based at Edinburgh, South Australia, has substantially met its military preparedness requirements. The capabilities of the upgraded *Orion* aircraft have played a significant part in Australian border protection and coalition operations.

15. The main delays of several years against the planned timetable occurred in the acceptance of the prototype aircraft, the aircraft design, and the Systems Engineering Laboratory. Defence, the Contractor and subcontractors underestimated the unique features and complexity of the design and production work required, particularly the complications involved in integrating different new systems, both with each other and with the retained aircraft systems.

16. Deliveries of the upgraded *Orion* aircraft were some four years late. Acceptance of the first aircraft was 51 months behind the contracted schedule. Delivery and acceptance of upgraded aircraft accelerated after Air Force's acceptance into service of the first aircraft in July 2002. By September 2003, the 10th aircraft was accepted, and in December 2004, the final (18th) aircraft was accepted.

17. All but one of the last twelve aircraft were completed in about 230 days compared to an average of 610 days for the first four aircraft produced at the Contractor's Australian production site. The delays in delivery were primarily due to:

- inability to fully test interactions of modified equipment and software before installation on the aircraft because of a lack of complete simulation fidelity;
- greater than expected software development effort, and integration problems related to the DMS;
- difficulties arising in contractor/subcontractor relationships;
- underestimation of the extent of integration effort required of the Contractor;
- technical difficulties related to radar performance in some conditions; and
- engineering changes for equipment such as satellite communications, on-line Harpoon missiles and a structural data recorder. They were to meet requirements external to the Project Office and added to project scope, cost and schedule.

18. The protracted delays in delivery of the modified *Orion* aircraft have meant that Air Force had to operate fewer, and less capable, operational aircraft during the period of delivery delays. Furthermore, the delays resulted in some subsystems on the aircraft becoming obsolete before their installation in the aircraft. High cost items at risk of obsolescence in the future include the DMS, radar, and the OMS.[7]

19. The Contract for the Upgrade of the *Orions* placed the performance risk on the Contractor. However, there were no specific penalties for delays. As a result, protection for Defence against delivery delays was limited. When Defence's persuasive efforts to minimise delays in deliveries failed, the provisions of the Contract largely restricted Defence's ability to exert pressure to delaying payments to the Contractor until relevant milestones were met. Nevertheless, Defence was able to conclude a Deed of Settlement with the Contractor, to receive goods and services in kind to the value of $5 million.

20. To monitor and control risks to safety, fitness for service and environmental compliance, Defence has put in place a technical regulatory framework as the basis for managing technical integrity in the acquisition and maintenance of equipment. The ANAO found that in the *Orion* Upgrade, the Project Office developed a series of plans and procedures that helped ensure that the requirements of the Defence technical regulatory framework were met.

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[7] Defence's Project Air 5276 Phase 9 addresses AP-3C obsolescence issues relating to the radar, the OMS, the acoustics and the DMS.

Acquisition and Refurbishment of Second-hand aircraft (Chapter 3)

21. Project Air 5276 included the acquisition of three *Orion* training aircraft, designated as TAP-3s. Their main purpose (primary mission) was to reduce the training burden from the main *Orion* fleet, thus extending the service life of that fleet. The three TAP-3's only achieved about 300 dedicated flying training hours a year against a target of more than 1,200 hours. Also, the full fleet of three aircraft was only used from February 1999 to November 2003.

22. Air Force mainly flew the TAP-3s as utility aircraft. In carrying out that role, the aircraft helped to ensure that No. 92 Wing's *Orion* pilots maintained flying currency on the aircraft. There are no cost comparisons available to determine whether the use of the TAP-3s for the utility aircraft role was cost-effective. Defence considers that the availability of the TAP-3 aircraft provided operational flexibility which was significant but difficult to cost.

23. During their in-service period, the TAP-3 aircraft usually flew about 1 050 hours a year (750 hours in the transport role, 300 hours on pilot and crew training). On transport (including logistic resupply and repair) flights, the TAP-3 aircraft provided a considerable amount of continuation flying training[8] to the *Orion* pilots. This was flying training that would not have been available at the time because of low numbers of available P-3C aircraft and the low fidelity of the flight simulator in service at the time. Defence considers that without the TAP-3 flights, No. 92 Wing would not have been able to maintain currency of all of its assigned pilots, and that the TAP-3 aircraft were valuable by providing options for additional operational tasking on a day to day basis, particularly when the C-130 transport fleet was very busy

24. Defence chose the FMS route for this element of the Project because FMS was considered to offer advantages on cost, schedule and risk. From contract signature (February 1994) to completion of this element (December 1998), contract costs rose from $US 31 million to $US 37.79 million, and total costs of the TAP-3 acquisition from an estimate of $A 42 million to $A 53.92 million.[9]

25. Delays in the delivery of the three refurbished TAP-3 aircraft were 9, 19 and 25 months, respectively. This schedule slippage was estimated by Air Force to cost about $US 5 200 per working day in project management and engineering overheads. Cost escalation and delivery delays were due in part to an underestimation of the cost and delivery time implications of the differences in Air Force's servicing requirements and standards compared to US Navy aircraft servicing practices at the time. There was inadequate

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[8] Continuation training refers to the number of flying hours required by pilots to maintain currency on an aircraft type, over a period of time.

[9] Net exchange rate gains amounted to $1.55 million, and price increases to $13.47 million.

consideration by Defence of the implications of signing a 'cost-plus' agreement, which provided less than full visibility and auditability on some technical and financial aspects.

26. The ANAO found that the main factors contributing to the problems experienced in the acquisition of the second-hand *Orion* aircraft included:

- worse than expected condition of the aircraft purchased;
- FMS cost recoupment policy;[10]
- limitations on Air Force's ability to ensure that the charges made in the FMS case were correct;
- US Navy servicing work not meeting Air Force's technical standards and limitations on Air Force's ability to ensure that these standards were achieved; and
- Defence and US Navy failed to recognise the unique features of the Australian requirements for modification and servicing and the associated cost implications.

Acquisition of the Advanced Flight Simulator (Chapter 4)

27. Due to difficulties in finding staff with the relevant skills for the Flight Simulator Project Office, preparation of the Request for Tender (RFT) slipped from the planned release of July 1996 to May 1997. Defence's RFT documentation requested that tenderers for the AFS meet a 22 months delivery schedule. That is just four months more than the typical timeline for a commercial (production line) simulator which does not require extensive development and flight data collection work.

28. In an attempt to shorten the delivery time for the simulator, Defence assumed responsibility for the provision of flight data to the simulator manufacturer. Air Force undertook flying to collect the flight data, in conjunction with data collection for a separate program to collect fatigue test data. The instrumentation for the fatigue test data collection corrupted the flight data collected for the simulator. Defence agreed to pay the simulator manufacturer $1.04 million for the extra work required to be done as a consequence of the faulty flight data, and extended, by 10 months, the delivery schedule for the AFS to provide an essential training capability.

29. The delivery of a more advanced, tactical training capability by the AFS was three years late. Defence applied liquidated damages for late delivery, as provided in the contract. The amount of $1.15 million was offset against

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[10] Standard financial terms and conditions for FMS are set by the US Government. They are outlined in para. 3.19.

moneys owed by Defence to the Contractor for the achievement of milestones in the Project.

Lessons learnt

30. The major lessons learnt from the *Orion* life extension and upgrade Projects include:

- In the P-3C Upgrade Project, the Contract provided limited protection for Defence against delivery delays. When Defence's persuasive efforts to minimise delays failed, Defence's ability to exert pressure was largely restricted to delaying payments to the Contractor until milestones were met. In future acquisitions, contractors should be given greater incentives to adhere to schedules, and cogent penalties for delivery delays.
- Defence and contractors underestimated the unique features of the design and production work to be undertaken, and the complications involved in integrating a range of different new systems, both with each other and with the systems retained on the aircraft. These complexities were made more difficult to manage in the absence of a fully developed software testing facility, which had been a pivotal part in the Project's planning. The recent reforms in Defence capability development and acquisition provide revised processes which are aimed to produce more detailed and accurate data on cost, schedule and capability than was provided in previous Defence processes.
- Greater awareness of the risks involved in acquiring second-hand equipment under the FMS route, and of the need to fully establish the condition of the equipment, would have highlighted the requirement for a more thorough investigation of alternative acquisition options to mitigate those risks.
- The delays in the delivery of the aircraft simulator due to skills shortages, and the risks incurred to try to make up for those delays, highlight the importance of having at hand appropriately skilled personnel to ensure that projects can be started and progressed in a timely manner.
- Taking into account its experience with the AP-3C simulator, Defence, in the 'Wedgetail' Early Warning and Control Aircraft Project, which has an approved cost of $3.46 billion, placed full responsibility on the Contractor for the flight trainer to meet simulator fidelity requirements.

Agency response

31. The Department of Defence provided a response on behalf of DMO and Defence. An extract from the response stated that:

The report acknowledges the important fact that the subject project was initiated in the early 1990s when a different acquisition process existed. Project Air 5276 2A, 2B and 3 were developed collectively, but separately, and managed under different directorates and by different project offices.

Since that time, including through the use of lessons learnt from these project phases, Defence has significantly improved its capability development, procurement, and project management processes and skills. Throughout the Air 5276 Phase 2 and 3 life-cycles, which are not yet complete, Defence believes contemporary best practice of the time was employed and capability value for money was maximised. While some capability and support outcomes are still being addressed, the overall capability outcomes from this series of complex integration project phases have showcased the ADF AP-3C weapon system as one of the most capable maritime patrol and response capabilities in the world.

32. The Defence response also agreed to the lessons learnt. It noted that the merits of penalties for contractor delays have to be weighed against the schedule risk premium which a contractor could be expected to add when bidding. The full Defence response is at Appendix 1.

Audit Findings

1. Introduction

This chapter provides a general introduction to the life extension and upgrade Project of the Air Force's Orion maritime patrol aircraft and outlines the audit approach and report structure.

Background

1.1 Air Force's *Orion* maritime patrol aircraft entered service in 1978 and 1984–86. They are part of Air Force's Output 4.3, Capability for Surveillance and Response Operations and carry out maritime surveillance, reconnaissance, and strike activities, as well as offensive air support and search and rescue. The 19 *Orions* are scheduled to deliver 8,200 flying hours in 2004–05, at an estimated cost of $557 million.

1.2 The origin of Project Air 5276 dates back to the early 1980s, to studies on a mid-life update of the *Orions* to keep them in effective service until about 2020. By the early 1990s, there were indications that a replacement for these aircraft could be required as early as 2001–05. In 1992, to address life extension and capability issues of the *Orions*, Defence had at least ten separate capital acquisition projects aimed at:

- improving the operational performance of the aircraft;
- ensuring their interoperability with other Australian Defence Force systems; and/or
- extending the life of the aircraft.

1.3 Project Air 5276 started with a Project Definition Study (Phase 1 of the Project), endorsed by Defence's Force Structure, Policy and Programming Committee in June 1991, at a cost of $2 million. The study, carried out between June 1991 and April 1992, was to determine the scope, timing and management strategy for a project combining as many as practicable of the *Orion*-related acquisition projects.

1.4 The Final Report of the Working Group which carried out the Project Definition Study concluded that, with careful management, it was feasible to operate the *Orion*s to 2015, provided that:

- a significant reduction in the weight of the aircraft was achieved (largely through the replacement of heavy, obsolescent equipment);
- the number of aircraft was augmented through the purchase of three additional *Orions* to be used as training aircraft (to reduce the average fatigue load of the operationally equipped aircraft); and

- more aircrew training was transferred from the aircraft to a flight simulator.

1.5 Project Air 5276 is a multi-phased project aimed at upgrading the *Orion* aircraft's combat systems to ensure its continuing military effectiveness, and extending the aircraft life to the planned withdrawal from service of the aircraft in 2015.[11]

1.6 In this audit, the ANAO examined Phases 1 to 3 of the Project:

- Phase 1: Project Definition Study at an approved cost of $2 million;
- Phase 2A: Upgrade of the *Orion* fleet of aircraft (from the P-3C to the AP-3C configuration), including the acquisition of associated support, at an approved cost of $850.52 million;
- Phase 2B: Purchase of three second-hand *Orion* aircraft and their modification to training/utility (i.e. passenger and cargo transport) aircraft (designated as TAP-3) and the acquisition of a fourth *Orion* aircraft to become a source of spare parts, at a cost of $53.92 million; and
- Phase 3: Acquisition of an AFS, to train aircrew and maintenance personnel, at an approved cost of $57.92 million.

1.7 Phase 2A involved the replacement of five major sub-systems on the aircraft, namely the radar, the acoustics, navigation, communications, and data management. This element of the Project also included the acquisition of operational support systems.[12]

1.8 The major activity in Phase 2A was software related, involving the development, modification and reuse of more than three million source lines of code, posing the greatest technical, schedule and cost risks to the Project. To provide on-site technical support, some 140 Australian industry personnel were required at 13 Contractor and subcontractor sites. This included over 60 positions in three overseas countries.

1.9 Phases 2 and 3 were initiated in the early 1990s, predating the recent reforms in the Defence capability development and acquisition framework, which led to the 'two pass' capital equipment definition, analysis and approval process outlined in the 2005 Defence Capability Development Manual. Defence's Capability Development Group is now responsible for assessing and

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[11] Defence Capability Plan 2004-2014, Public Version, February 2004, p. 21.

[12] These comprised the OMS for the training of operational crews, a Systems Engineering Laboratory (for software maintenance and development, technical research and modification development), and a Mission Replay and Analysis Module for pre- and post-flight mission support.

defining present and future military capability needs, and for managing Defence's overall major capital investment program.

1.10 The 'two pass' Government approval process involves formal Government consideration on three occasions. The process brings together Capability Development Group and DMO Integrated Project Teams with the aim of generating significantly more detailed and accurate qualitative data on cost, schedule and capability issues than had occurred in previous Defence capability development processes. Implementation of the new processes is expected to result in better project outcomes.

1.11 The process aims to generate significantly more detailed and accurate data on cost, schedule and capability issues than had occurred in previous Defence capability development processes.

1.12 Projects currently planned to further upgrade the AP-3C aircraft under Project Air 5276 include:

- Phase 4, which is being progressed under Defence's Rapid Prototyping, Development and Evaluation Program, to provide electronic warfare self-protection measures;
- Phase 5, to replace the existing infra-red detection system;
- Phase 6, to upgrade the aircraft's communications suite and data links;
- Phase 7 (renamed as Project Air 7000 Phase 2), to examine options for, and to acquire, the manned aircraft component of the Air Force's maritime patrol and response capability to replace the AP-3C aircraft;
- Phase 8, to upgrade the ALR 2001 Electronic Support Measures, and to provide sufficient replacement components for the system to remain operational to 2015; and
- Phase 9, to address obsolescence issues relating to the radar, operational mission simulator, the acoustics and DMS.

Australian Industry Involvement (AII)

1.13 As quantitative targets, the Contractor had to achieve 29 per cent of the *Orion* Upgrade Contract price in local content, and 27 per cent of the duty free price of the imported content of supplies as offsets.[13] The ANAO found that, in July 2004, the Contractor's total AII achievement was $287.24 million against a contracted amount of $280.76 million. Defence advised the Contractor in October 2004 that no further reporting on AII was required.

[13] Offsets are work activities directed to Australian industry by an overseas supplier.

1.14 The general industry objectives applicable to AII in the Contract included the establishment, to the optimum extent practical and economical, of full life-of-type support for both the imported and locally developed and/or produced equipment. Although the quantitative targets of the AII requirements in the contract had been met, the ANAO could not locate any comprehensive review by Defence on the success of the Project's contracted AII activities in fostering Australian industry's through-life support capabilities.[14]

1.15 The Contract for the construction of the AFS placed a commitment on the Contractor to achieve 40 per cent AII (Local content and Strategic Industry Development Activities). The Contractor had achieved 75 per cent by the end of February 2004.

Audit approach

1.16 The Defence Materiel Organisation (DMO) manages some 240 major capital equipment projects which have a total estimated cost in excess of $50 billion. The approved funding for the upgrade of the *Orion* maritime patrol aircraft fleet amounts to less than two per cent of the estimated cost of DMO's major capital projects. This audit represents the second ANAO performance audit in 2005–06 on Defence's and DMO's management of major capital acquisition projects. The first such audit, *Management of the M113 Armoured Personnel Carrier Upgrade Project*,[15] examined the effectiveness of the management of the upgrade of M113 fleet for the Australian Defence Force. That upgrade was estimated to cost $566 million.

1.17 The audit was undertaken towards the end stage of Phases 2 and 3 of Project Air 5276, when more than 90 per cent of the Project costs were expended. The audit objective was to examine the adequacy of Defence's and DMO's management of these two Phases of the Project.

1.18 Audit fieldwork was carried out from September 2004 to May 2005. The audit team held discussions and examined documentation at the Maritime Patrol Systems Program Office, the Aerospace Systems Division, the Air Force Bases Edinburgh and Pearce, and the production facilities at Avalon Airport, Victoria. Issues Papers were released in May 2005, a Discussion Paper was

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[14] In Recommendation No. 1 of Audit Report No.46 2002-03, *Australian Industry Involvement Program, Department of Defence*, the ANAO recommended that Defence report its performance in achieving the Government's Australian Industry Involvement objectives against key performance indicators derived from agreed outputs and outcomes for the Program. Defence, in April 2005, advised the ANAO that it had undertaken a number of measures to implement this recommendation, including the development of new requirements, which are expected to result in a more outcomes focused approach to the delivery, measurement and reporting of Australian industry engagement activities in Defence projects.

[15] ANAO Audit Report No.3 2005-06, *Management of the M113 Armoured Personnel Carrier Upgrade Project*, July 2005.

released in June 2005 and a draft report was provided to Defence and DMO in August 2005.

1.19 The audit was conducted in accordance with ANAO auditing standards at a cost of $345 000.

Report structure

1.20 The remainder of the report is structured into three chapters. Chapter 2 discusses the upgrade of the *Orion* fleet of aircraft to the AP-3C configuration. Chapter 3 reviews the purchase and modification of second-hand *Orion* aircraft. The final chapter examines the acquisition of a flight simulator to train *Orion* aircrew and maintenance personnel.

2. Upgrade of the *Orion* Fleet of Aircraft

This chapter outlines the processes and systems used by Defence in managing the life extension and upgrade Project for the Orion aircraft.

Table 2.1

Timeline for Project Air 5276 Phase 2A: Upgrade of *Orion* fleet

Time	Activity
Capability Requirement	
May 1992	Major Capability endorsed by the Force Structure Policy and Programming Committee.
September 1992	Equipment Acquisition Strategy (EAS) endorsed by the Defence Source Definition Committee.
November 1992	Government approval.
Request for Tenders and Contract Signature	
July 1993	Request for Tender (RFT) issued.
September 1993	Tenders closed.
July 1994	Successful tenderer announced.
Jan 1995	Contract signed to modify 18 *Orion* aircraft and provide support facilities.
Project Progress	
August–September 1995	Preliminary Design Reviews.
May 1997	Critical Design Review for aircraft and support facilities.
October 1997	1st (prototype) aircraft handed over to Contractor at Greenville, Texas.
January 1999	First production aircraft handed over to Contractor at Avalon Airport, Victoria.
May 1999	First flight of prototype aircraft.
December 1999	Fourth production aircraft handed over to Contractor.
December 2000	Aircraft hand over to Contractor on hold for 18 months, as the Contractor was unable to continue the modification program due to industrial unrest, and to allow time to make demonstrable progress towards acceptance of the prototype aircraft.
August 2001	Deed of Settlement with the Contractor for $5 million as compensation to Defence for delivery delays. Commencement of Acceptance Flight Tests of prototype aircraft, after software update at Avalon Airport.
July 2002	Acceptance of prototype aircraft and Mission Replay and Analysis Module.

Time	Activity
August 2002	First four production aircraft accepted into service.
December 2002	Operational Mission Simulator accepted.
September 2003	10th aircraft accepted.
December 2003	Software Engineering Laboratory accepted.
December 2004	Acceptance of the final (18th) aircraft.

Source: ANAO analysis of Defence documentation.

Background

2.1 The Upgrade Project of the *Orion* aircraft was aimed to prolong the life of the aircraft to 2015 (largely through an expected decrease in aircraft weight of some 1,600 kilograms), and to enhance their surveillance capability. The Project, approved by the then Government in November 1992 in the context of the 1992–93 Budget, was estimated to cost $629.54 million.[16] The Project included the acquisition of:

- aircraft mission systems;[17]
- an Operational Mission Simulator (OMS);
- a SEL; and
- a Mission Replay and Analysis Module.

2.2 The Statement of Requirement attached to the RFT was functionally based. Tenderers were asked to tender against the overall capability, with solutions of predominantly non-developmental (commercial or military off-the-shelf) equipment. They were encouraged to propose modifications or replacements on the basis of best value for money to Defence, in terms of acquisition and life-cycle costs.

2.3 Tenders were evaluated against seven criteria.[18] E-Systems Incorporated, Greenville Division, a US based aircraft systems integration company, won the tender on the basis of best value, taking into consideration all seven evaluation criteria.[19] A contract was signed with the successful

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16 Phase 2 was approved as one project. Figures for Phase 2A have been calculated by the ANAO by deducting Phase 2B from totals for Phase 2.

17 The systems included communications, navigation, radar, acoustic and data management subsystems.

18 The criteria were operational capability; technical aspects; logistics; management (including project, risk, schedule and quality control management); financial; contractual (compliance with preferred terms and conditions on matters such as intellectual property rights, warranties, insurance and guarantees); and Australian Industry Involvement.

19 Out of the seven criteria, E-Systems Incorporated was preferred in six. Against the remaining criterion (AII), E-Systems Incorporated rated a strong second, meeting all AII requirements in the RFT.

tenderer in January 1995.[20] The contract was for a fixed price of $A 273.70 million and $US 239.50 million (a total of $A 590 million at the January 1995 exchange rate of $A/$US 0.758). The Contract set minimum performance criteria to be met by new equipment to be installed in the aircraft, and stipulated that the modifications were not to degrade the performance of the equipment retained on the aircraft.

2.4 By the end of 2004–05, the notional[21] approved project cost for Phase 2A was $850.52 million. Real (scope) increases included $4.98 million in August 1996 for a Harpoon missile capability and $33 million in November 1998 to remedy inadequate provision for logistic support in the Project.

2.5 The ANAO examined the documentation for contractual acceptance and authority to pay for the aircraft and support equipment in the P-3C Upgrade Project. The ANAO found that the relevant requirements had been met.

Project management

2.6 In January 1992, an *Orion* Upgrade Project Office was formed in Canberra. A Project presence was established at the US Contractor's location at Greenville, Texas, in December 1994, and at the Australian production site at Avalon Airport in July 1998. The Canberra Project Office was relocated to be part of the Maritime Patrol Systems Program Office at Edinburgh, South Australia, in 2001.

2.7 The Systems Program Office was appointed by the Defence Force's Technical Airworthiness Regulator as an Authorised Engineering Organisation[22] and attained ISO 9000 accreditation in October 2002.[23]

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[20] Greenville Division was taken over by Raytheon Company to become Raytheon E-Systems Inc., which later changed its name to Raytheon Systems Company and then Raytheon Company Aircraft Integration Systems (RCAIS). In May 2002 contract novation occurred as RCAIS was taken over by L-3 Communications Integrated Systems, Greenville (Texas), referred to as L-3 Com.

[21] See footnote 16.

[22] Authorised Engineering Organisation certification provides a high level of confidence that an organisation has:

- 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 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

2.8 In early 1997, the Project Office issued a comprehensive Project Management Directive. It incorporated the 1994 Integrated Logistics Support Plan, the 1995 Engineering Management Plan, the 1995 Quality Assurance Management Plan, and the 1996 Test and Evaluation Master Plan. The Project Directive was to be reviewed and revised by the Project Office every six months throughout the life of the Project. The ANAO could not locate any revisions of the Directive after mid-1997.

2.9 The Engineering Management Plan acknowledged that the Project had an aggressive schedule. The Plan also stated that the systems to be provided under the contract were, in the main, non-developmental and readily available. The major activity in the Project was software related, involving the development, modification and reuse of more than three million source lines of code. This posed the greatest technical, schedule and cost risks to the Project.

2.10 The SEL was a critical element in the Project's planning. It was to be accepted by early November 1997, before delivery of the first aircraft (referred to as the prototype). The Project Directive stipulated that no modifications to the *Orion* aircraft were to be installed until the Mission Systems have been successfully tested in the ground based facility (the SEL). This applied both to the prototype and the follow-on (production) aircraft.

Software and hardware testing

2.11 The first aircraft was handed over for modification and testing at the Contractor's facility at Greenville in October 1997. Testing of the *Orion* modification equipment and associated software occurred as Factory Acceptance Testing at subcontractors' premises in the US.

2.12 After Factory Acceptance Testing, equipment and software were tested by the Contractor in a laboratory at Greenville. The laboratory had a hardware integrator (Systems Integration Laboratory) and an embryonic SEL[24] for software integration.

2.13 Flight testing of the prototype aircraft took place at Greenville from May 1999 to December 2000. Both Factory Acceptance Testing and Laboratory Testing involved simulators to test the interfacing of new equipment and software with other aircraft systems. These did not always completely replicate

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- data applied to, and derived from, technical activities that are accessible, authoritative, accurate, appropriate and complete.

[23] ISO 9000 is the International Organization for Standardization's quality management system. It refers to an organisation's structure for managing its activities to ensure that it meets customer requirements and applicable regulatory requirements while aiming to enhance customer satisfaction and achieving continual performance improvement.

[24] The SEL was not accepted until December 2003. See Tables 2.1 and 2.2.

the performance of the systems on the aircraft.[25] Consequently, when equipment was installed on the aircraft and trialled, in on-ground and flight tests, the equipment quite often did not perform as required, even if it had passed Factory and Laboratory Testing.[26]

2.14 This was reflected in the high number (1743) of Anomaly Reports (ARs) raised in the period of test flying. ARs were issued when performance of the AP-3C did not match specifications. ARs provide a record of inadequate performance needing to be remedied. An AR is closed when the anomaly has been resolved.

2.15 In December 2000, after more than three years at Greenville, the prototype aircraft was flown from the US to the Contractor's production facilities at Avalon Airport, for further acceptance testing and rectification of faults. In October 2001 the aircraft was ready to be delivered to the Air Force, which began Initial Operational Test and Evaluation of the aircraft in January 2002. Air Force's report on that testing concluded that the AP-3C aircraft performed in all required roles at least as effectively as the P-3C. In July 2002, Air Force contractually accepted the AP-3C design and the prototype aircraft, conditional on the remediation of some deficiencies recorded on nine Applications for Deviation or Waivers.

2.16 The modified aircraft have achieved, and in a number of roles exceeded, the expected operational performance. Figure 2.1 shows the number of open ARs and the number closed, from January 1998 to November 2003, when the last one was closed. Figure 2.1 reflects the increase in ARs raised during ground testing of the prototype aircraft in mid 1998 and flight testing in early 1999, and the reduction of 490 ARs in June and July 2002, leading to acceptance of the prototype aircraft and the AP-3C aircraft design in July 2002. The resolution of performance defects resulted from the cooperative work of Contractor, subcontractor and Defence personnel.

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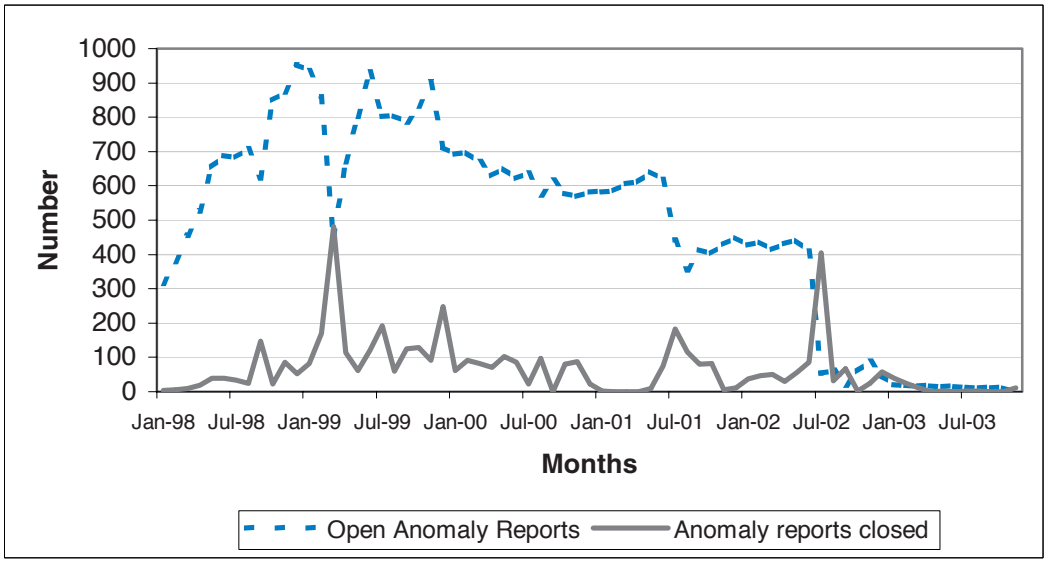
[25] Defence noted that this should not be viewed as a failing. Factory Acceptance Testing was part of the continuum of testing.

[26] It may be too expensive to design and build Factory Acceptance Test equipment to ensure that all testing can be done at that stage, which may lead to the acceptance that some testing is done first on the aircraft. Furthermore, Defence noted that there was no laboratory testing system which checks every software path, nor did the Project Office have the time to do so. However, while the Contractor and subcontractors had invested in Factory Test Equipment from the outset, that equipment was not always updated to keep pace with changes to system interfaces.

Figure 2.1

Number of Anomaly Reports Open and Closed, January 1998 to November 2003.



Source: ANAO analysis of Defence documentation.

Technical Regulatory Framework

2.17 The modifications to the *Orions* in the Upgrade Project required amendment of the certification (under Supplementary Type Certification) of the aircraft as AP-3Cs.[27] Supplementary Type Certification and full service release of the AP-3C weapon system (except SEL) was obtained on 21 November 2002.

2.18 Acceptance of the aircraft was tested by the ANAO against the formal requirements of Defence's Technical Airworthiness Management Manual, using documentation supplied by Defence. The ANAO found that those requirements had been met.

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[27] Certification of the AP-3Cs was based on a strategy linking a number of elements, namely: State registration of the P-3C under an Australian Military Type Certificate (AMTC 0005 Issue 2); design and production of the AP-3C Upgrade by L-3 COM as a Design Approved Contractor; L-3 COM verification of all contractual requirements leading to Design Approval; Federal Aviation Administration oversight, of L-3 COM processes; formulation of airworthiness criteria by a Federal Aviation Administration team to form the basis of the Certification Basis Description (agreed in the Technical Airworthiness Regulator Endorsement of AP-3C Certification Basis); and validation of airworthiness and contractual requirements by the Systems Program Office performing the role of Compliance Finding Agency against the criteria in the Certification Basis Description.

Schedule delays

2.19 The Contract, which was performance based, placed the performance risk on the Contractor. However, protection for Defence against delay was limited. Over most of the life of the Project, Defence and the Contractor worked closely together to reduce delays, but the technical complexity of the integration task far exceeded their expectations.

2.20 After three years at the Contractor's development facility in the US, the prototype still had about 600 anomalies which needed to be rectified at the Australian production facility. The combined effort of the local Contractors and Defence staff (who had a presence at Avalon Airport) achieved a significant reduction of faults in mid 2002, resulting in the acceptance of the prototype aircraft and its design.

2.21 Acceptance of the first aircraft was 51 months behind the contracted schedule (see Table 2.2). The delay was primarily due to:

- inability to fully test interactions of modified equipment and software before installation on the aircraft because of a lack of complete simulation fidelity;
- greater than expected software development effort[28] and integration problems related to the DMS;
- difficulties arising in contractor/subcontractor relationships;
- underestimation of the extent of the integration effort required of the Contractor;
- technical difficulties related to radar performance in some conditions; and
- engineering changes for equipment such as satellite communications, on-line Harpoon missiles and a structural data recorder.

[28] In the DMS, it was expected that of the 800 000 source lines required, 68 per cent could be used from software code developed for the US Navy *Orions*. That expection was not met by a significant percentage.

Table 2.2

Expected and actual timetable for the Upgrade Project of the *Orion* aircraft

PLANNED or CONTRACTED TIMETABLE	MILESTONES	ACTUAL TIMETABLE	SLIPPAGE (MONTHS)
Not applicable	Project Definition Study completed	April 1992	not applicable
July 1993	Request for Tender Closed	September 1993	2
February 1994	Defence Source Definition Committee Consideration of Source Evaluation Report	July 1994	5
June 1994	*Orion* Upgrade Contract signed	January 1995	8
November 1997	Acceptance of Systems Engineering Laboratory	December 2003	73
April 1998	Acceptance of 1st (prototype) aircraft	July 2002	51
March 1999	Acceptance of 5th aircraft	August 2002	41
November 1999	Acceptance of 10th aircraft	September 2003	46
July 2000	Acceptance of 14th aircraft	May 2004	46
February 2001	Acceptance of last (18th) aircraft	December 2004	46

Source: ANAO analysis of Defence documentation.

2.22 Delivery and acceptance of converted aircraft accelerated after acceptance of the first aircraft. By September 2003, the 10th aircraft was accepted, and in December 2004, the final (18th) aircraft was accepted, involving a slippage of nearly four years. All but one of the last twelve aircraft were completed in about 230 days compared to an average of 610 days for the first four aircraft produced at Avalon Airport.

2.23 There were regular meetings between the Contractor and Defence, seeking to resolve issues in a cooperative manner. The ANAO noted that, in the absence of a contractual remedy[29] to compensate Defence for delivery

[29] This would generally be covered by a clause relating to liquidated damages whereby the Australian Government would be able to recover amounts due to delays in a project, under an agreed formula.

delays, Defence was able to negotiate a Deed of Settlement with the Contractor. Under that deed, Defence received goods and services in kind to the value of $5 million, delivered through arrangements involving 14 Contract Change Proposals.

2.24 Although Air Force set up a dedicated Project Office early in the life of the Project, it took over two years from the endorsement of the EAS[30] to contract signature (seven months behind the planned time). However, the main delays of several years against the planned timetable occurred in the acceptance of the prototype aircraft, the aircraft design, and the SEL. Defence, the Contractor and subcontractors underestimated the unique features and complexity of the design and production work required, particularly the complications involved in integrating different new systems, both with each other and with the retained aircraft systems.

Figure 2.2

Orion releasing a torpedo

Source: Department of Defence

[30] See Table 2.1.

Delivery of military capability

2.25 The objectives of Phase 2A of Project Air 5276 were to:

- contribute to the life extension to 2015 of the *Orion* aircraft fleet, largely through a significant reduction in the weight of the aircraft;
- shift the centre of gravity of the aircraft forward (for operational flexibility and safety reasons); and
- enhance the *Orions*' surveillance capabilities.

2.26 The upgrade has achieved a weight reduction of 1 450 kilograms, and shifted the aircraft's centre of gravity forward, thereby providing increased operational flexibility and safety.

2.27 The modified aircraft has met, and, in a number of operational roles, exceeded, the expected operational performance. The capability enhancements allow the aircraft to cover a given surveillance area in greater detail and in a third less time than in the P-3C configuration. Defence advised the ANAO in September 2005 that, because of operational requirements, 92 Wing was unable to utilise the requisite number of aircraft to complete the full range of operational testing and evaluation at the time, but that this testing has since been conducted.

2.28 Although some four years late in delivery, the AP-3C *Orions* have met expected operational performance. The Air Force element operating the *Orions*, No. 92 Wing, has substantially met the required levels of preparedness for military response options with a warning time of less than 12 months, as well as the required levels of training to meet preparedness requirements with a warning time exceeding 12 months. The capabilities of the upgraded *Orions* have played a significant part in Australian border protection and coalition operations.

2.29 Some high-end war-fighting preparedness and training targets were not achieved as a result of a high operational tempo. In 2003–04, the *Orion* aircraft achieved 86 per cent of their planned flying hours (7 702 hours against a target of 9 000 hours).[31]

Obsolescence

2.30 The AP-3C equipment subsystems are based on mid 1990's technologies, and their hardware configurations were essentially set in 1997.

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[31] Defence ascribed the shortfall to *high levels of preparedness being maintained, the inability to make sufficient aircraft available because of the high operational tempo, the transition to the upgraded aircraft, and limitations in available logistics funding. (*Department of Defence, Annual Report 2003-04, November 2004, pp. 149 and 150).

The four year delay in the delivery of the aircraft has meant that some of the subsystems in the aircraft were obsolete before installation in the aircraft.

2.31 The Project Office has been aware of the risks of obsolescence and initiated an Obsolescence Management Framework and an associated Obsolescence Management Tool to provide a structure for management and funding of AP-3C obsolescence. High cost items at risk of obsolescence include the DMS, the radar, and the mission simulator. Defence initiated Project Air 5276 Phase 9 to address those risks. Phase 9 has an expected in-service delivery schedule of 2007 to 2009.

2.32 Project Air 7000 addresses the replacement or refurbishment of the *Orion* platform. Phase 1 involves a study into, and the purchase of, multi-mission unmanned aerial vehicles for maritime patrol and surveillance. The planned in-service delivery for those vehicles is between 2009 to 2011. Phase 2 includes a study into the acquisition of a manned aircraft component for the maritime patrol capability, and the purchase of new aircraft or the refurbishment/remanufacture of AP-3C *Orion* aircraft. The expected in-service delivery is between 2013 to 2015.

Sustainment

2.33 Air Force undertook a Net Personnel and Operating Cost Study in 1999. It indicated that the cost of operating the *Orion* fleet would increase by $6.5 million over the first three years of transitioning to the AP-3C, and afterwards by $4.5 million for the life of the aircraft. The Study has not been updated. In early 2004, Air Force identified a logistic shortfall for the Maritime Patrol aircraft in the forward estimates period (2004–05 to 2007–08). Additional funding, approved by the Government in April 2004, eliminated that shortfall. In June 2005, DMO estimated that the sustainment costs for the *Orions* were about $113 million a year. In September 2005, Defence advised the ANAO that a stable post-production operational base-line for AP-3C fleet had now been established, and the Net Personnel and Operating Cost of the AP-3C fleet was being updated.

2.34 Between September 2000 and March 2003, Defence signed seven contracts, with Original Equipment Manufacturers or their Australian partners, for the in-service support of the AP-3C. The contracts had up-front establishment of capability fees (amounting to $3.05 million) and periodic maintenance of capability fees (amounting to $2.19 million per annum). Defence has been invoiced for repair and maintenance work as it occurred (by May 2005, that expenditure amounted to $18.14 million).

2.35 Defence considers that, at the time of negotiating the seven contracts, it had little leverage to insert performance incentives and sanctions, and that the pay-as-you-go arrangements were highly transactional. In mid 2004, the

Systems Program Office had planned to issue contract changes in the first quarter of 2004–05, to reduce the financial transactional overhead; improve the management of Government Furnished Material and obsolescence issues; and to seek performance incentive arrangements. At the time of the audit, arrangements for cost-effective long-term logistic support of the *Orions* had not been finalised.

Lessons learnt

2.36 The protracted delays in delivery of the modified *Orion* aircraft have meant that Air Force had to operate fewer, and less capable, operational aircraft during the period of delay. Furthermore, the delays resulted in some subsystems on the aircraft becoming obsolete before their installation in the aircraft.

2.37 The Contract for the Upgrade of the *Orions* placed the performance risk on the Contractor. However, protection for Defence against delivery delays was limited. When Defence's persuasive efforts to minimise delays in deliveries failed, Defence's ability to exert pressure was largely restricted by the contract provisions to delaying payments to the Contractor until relevant milestones were met.

2.38 More thorough analysis of the development and integration risks in the Project would have provided opportunities to earlier identify causes of delay and take remedial action, thereby reducing the extent of the delays. Nevertheless, the Upgrade Project met its objectives and the upgraded aircraft have played a significant part in Australian border protection and coalition operations.

2.39 To monitor and control risks to safety, fitness for service and environmental compliance, Defence has put in place a technical regulatory framework as the basis for managing technical integrity in the acquisition and maintenance of equipment. The ANAO found that in the *Orion* Upgrade, the Project Office developed a series of plans and procedures that helped ensure that the requirements of the Defence technical regulatory framework were met.

3. Acquisition and Refurbishment of Second-hand *Orion* Aircraft

This chapter examines Defence's project management of the acquisition of four second-hand Orion aircraft from the US Navy.

Table 3.1

Timeline for Project Air 5276 Phase 2B: Purchase of four, and modification of three, *Orion* aircraft to TAP-3 configuration

Time	Activity
Capability Requirement	
May 1992	Air Force issued the Concept of Operations.
Approval Phase	
August 1992	Government approval
November 1992	The Defence Source Definition Committee endorsed the EAS for the purchase and refurbishment of the *Orion* aircraft, under the US FMS system.
October 1993	The US Department of the Navy provided an informal quote of $US 31million for the aircraft, and modification and servicing work. Air Force requested that the US provide a Letter of Offer and Acceptance.
December 1993	The Force Structure Policy and Planning Committee agreed to support the acquisition, at a cost of up to $A 42 million at April 1993 prices.
February 1994	Letter of Offer and Acceptance (LOA) for $US 30.93 million under FMS signed.
Project Progress	
July 1995	Spares aircraft delivered.
September 1996	Cost for taking the aircraft out of mothballing (aircraft activation) and depot level servicing increased by $US 1.6 million.
April 1997	Cost for the activation and servicing work increased by a further $US 3.35 million.
July 1997	1st modified aircraft delivered.
February 1998	Depot Level Servicing costs rose by $US 0.52 million.
August 1998	2nd modified aircraft delivered.
October 1998	US reduced the purchase price for the 4 aircraft by 50 per cent ($US 3.48 million) as they were in worse condition than assessed by the US in the LOA. The reduction was fully absorbed by cost increases for servicing work carried out by the US Navy.
February 1999	3rd modified aircraft delivered. Total Project costs amounted to $53.92 million ($US 37.79 million for the FMS case).
November 2003 to February 2004	Withdrawal from service of the TAP-3s.

Source: ANAO interpretation of Defence documentation.

Requirements development and approval

3.1 As part of Phase 2 of Project 5276, three second-hand *Orion* aircraft were to be purchased to assist in extending the life of the Air Force's fleet of maritime patrol aircraft. A concept of operations for the three TAP-3 aircraft was developed in May 1992. The training aircraft were to be optimised to perform their primary mission of pilot training. The TAP-3 fleet was to operate up to 1 500 hours a year, of which more than 1 200 were to be in the training role and less than 300 hours in the cargo or passenger carrying role.

3.2 The EAS of November 1992 emphasised the importance of having the TAP-3 aircraft in Air Force service by mid 1996 (to maximise their contribution in extending the life of the P-3C aircraft), and by the end of 1996 (to support operational availability of *Orion* aircraft during Phase 2A of the Project).

3.3 The EAS acknowledged that the refurbishment and modification of the aircraft to Air Force configuration could be completed by either a commercial contractor after competitive tendering, or by US Navy maintenance organisations under FMS. The FMS route was selected because it was considered that it offered advantages on cost, schedule and risk.[32]

3.4 Under FMS, no AII opportunities would be available in Phase 2B. Some opportunities for Australian industry could be offered if the refurbishment and modification work was to be put to commercial tender. However, Defence considered that this work would not involve new technologies or the establishment of new capabilities, and that it would not contribute to the Project's industry objectives of establishing Australian supportability of upgraded P-3C aircraft. Consequently the AII focus in the EAS was placed on Phase 2A.

3.5 In December 1993, Defence's Force Structure, Policy and Programming Committee agreed to support the acquisition of three training aircraft and one

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[32] FMS procurement would be cheaper because it would involve simpler project management requirements and avoid start-up and learning curve costs, due to earlier US Navy experience in P3-A/B refurbishment. These costs 'could be significant for small production runs of three aircraft.' If commercial procurement were adopted, tendering and source selection processes and rescheduling of refurbishment and modification planning and design activities (which were expected to be fast tracked under FMS) 'would add at least 18 months to the schedule, delaying entry of the aircraft into service until early 1997.' Furthermore, commercial procurement, because of higher technical risk and learning curve requirements, was seen to have the potential to significantly delay aircraft delivery much beyond early 1997. Although the refurbishing tasks of Phase 2B were considered to have a low technical risk, some elements of the modification work (e.g. the modification of the cabin door, which involved penetration of the aircraft pressure hull) was assessed as involving significant risk. The experience of the US Naval Depot Jacksonville in 'this type of work' was considered to lessen the technical risks considerably. See *Project Air 5276 – P-3 Refurbishment Project, Equipment Acquisition Strategy (Issue 2)*, November 1992.

aircraft for spares,[33] at a cost of up to $42 million at April 1993 prices ($2 million for non-FMS costs, $40 million for FMS costs).

Contract and contract changes

3.6 In February 1994, Defence signed an LOA (a contract under the FMS system) for $US 30.93 million[34] (equivalent to $A 43.56 million) for the purchase of four aircraft, their activation, the modification and depot level servicing[35] of three of them, and related services such as engineering support and technical publications.

3.7 From contract signature to completion in December 1998, the FMS costs rose to $US 37.79 million, and total cost for this Project element ended up as $A 53.92 million. Net exchange rate gains amounted to $1.55 million, and price increases to $13.47 million. There was no increase in scope.

3.8 The US Navy reduced the purchase price of the four aircraft after approaches by the Air Force to obtain a reduction in the charges for depot level servicing. Under FMS, the US Navy was obliged to charge the full cost of the servicing undertaken. The US Navy agreed to halve the acquisition price of the aircraft, downgrading the condition assessment for the three TAP-3 aircraft from serviceable to 'unserviceable, repairs required.' The full extent of the price reduction was added to the allocation for depot level servicing, as was a $US 200 000 reduction in the allocation for aircraft modifications.

3.9 Schedule slippage (see Table 3.2) for the TAP-3 aircraft ranged from nine to 25 months. This was estimated by Air Force to cost about $US 5 200 per working day in project management and engineering overheads.

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[33] Support for the acquisition of the fourth aircraft was given on the basis of providing a saving to the Project of $A 4.4 million.

[34] The price was in 'then-year dollars,' that is it was escalated to the expected prices at the time of carrying out the delivery of items and services.

[35] Depot level servicing or maintenance involves the repair, overhaul, modification, and upgrade of weapon systems, vehicles, and other Defence items.

Table 3.2

Comparison of estimated and actual aircraft delivery times

Aircraft	Estimated delivery in LOA February 1994	Actual delivery	Variance in months
Spares aircraft	March 1995	July 1995	4 [(a)]
1st TAP-3	October 1996	July 1997	9
2nd TAP-3	January 1997	August 1998	19
3rd TAP-*3*	January 1997	February 1999	25

Note [(a)] This was largely due to the additional effort required to prepare the aircraft for an intercontinental flight to Australia, when it turned out that the aircraft could not be disassembled at the US Aerospace Maintenance and Regeneration Center (AMARC), because no outside organisation was allowed to work there.

Source: ANAO interpretation of Defence documentation.

3.10 The ANAO's analysis of the factors contributing to the problems experienced by the Project identified the following main elements:

- worse than expected condition of the aircraft purchased;
- FMS cost recoupment policy;
- limitations on Air Force's ability to ensure that the charges made in the FMS case were correct;
- US Navy servicing work not meeting Air Force's technical standards and limitations on Air Force's ability to ensure that these standards were met; and
- Defence and US Navy failed to recognise the unique features of the Australian requirements for modification and servicing and the associated cost implications.

Aircraft condition

3.11 To assist the Air Force in the selection of aircraft, an FMS case was raised in August 1992. AMARC was to provide engineering technical assistance (at a cost of $US 421 002), preliminary aircraft inspection services ($US 8 536) and site surveys ($US 121 623).

3.12 The Air Force conducted a desk-top analysis of about 100 aircraft held in storage at AMARC. Inspection by AMARC personnel resulted in the rejection of all of those aircraft due to material defects or unacceptable airframe fatigue lives.

3.13 Following a further desk-top analysis, Air Force staff visited a number of US Naval Air Stations to identify suitable P-3B aircraft which were about to be retired. In April 1993, shortly after those aircraft had been placed into storage, a combined Air Force and US Navy team inspected them at AMARC.

3.14 The inspection team recommended three aircraft be considered for acquisition as TAP-3 aircraft. The team had found corrosion outbreaks on each of these three aircraft. The more significant outbreaks of corrosion were on the horizontal stabilisers. Repair work was expected to involve the removal of the horizontal stabiliser plank or spar cap. The inspection report states that US Navy personnel at AMARC had indicated that this was a common practice in US Depot Level Servicing and would not extend the scope of servicing.[36] Taking this into account, the inspection team considered that the material condition of these three aircraft did not involve prohibitive present and future costs of ownership.

Contract provisions on aircraft condition

3.15 The LOA of February 1994 describes the condition of two of the three TAP-3 aircraft as 'serviceable/fair' and one as 'serviceable/good.' The spares aircraft was described as 'unserviceable/repairs required.' The LOA also stated that all four aircraft would be supplied operationally equipped, in 'as is, where is' condition. Irrespective of the condition of the aircraft at the time of inspection by the Air Force, the 'as is, where is' condition was to be established by joint Air Force/US teams at the time of de-preservation.

3.16 Acceptance by Defence of the above provisions meant that it bore the full risk of deterioration in the state of the aircraft and/or removal of equipment from the time of inspection to the time of de-preservation.[37]

3.17 The ANAO could not locate any records concerning the effects of deterioration of the TAP-3 aircraft at AMARC, where they remained for protracted periods.[38] Defence advised the ANAO in June 2005 that deterioration in the desert storage with low humidity over the relatively short period would have been minimal. However, the Air Force's experiences in selecting the *TAP–3* aircraft should have given rise to some caution.

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[36] The corrosion on the left and right horizontal spar caps on all three TAP aircraft was later found to be beyond economical repair and the spar caps had to be replaced. Estimated repair cost per aircraft was $US 185 000 against replacement cost of $US 375 000.

[37] Defence advised the ANAO in June 2005 that the situation highlighted represented standard FMS terms of contract.

[38] The first aircraft is recorded as arriving in Jacksonville for modification and servicing on 22 September 1995, the second on 19 December 1995, the third on 9 April 1996.

3.18 There were indications that equipment from the aircraft was removed after the Air Force inspections. One aircraft was later found to be without engines and the Air Force was charged 98 work hours for the removal of engines from a donor aircraft, and their installation in the TAP-3 aircraft. Defence documentation states that *during the course of the TAP-3 Program, several engines have been rep*laced at AMARC and Jacksonville.[39] The effect was to increase project work and cost.[40] Defence advised the ANAO in June 2005 that the situation described in this paragraph was covered by standard FMS 'as is, where is' contracting policy. Inspecting an aircraft gave no right to a customer, nor place any obligation on the US Government. Furthermore, the Air Force had a requirement for 'Dash 14' engines. Some engines on the aircraft were 'Dash 12s', which had to be changed before the start of modification work on the aircraft.

FMS recoupment

3.19 FMS standard financial terms and conditions have the following provisions:

- The prices of items to be procured are billed at their total cost to the US Government.
- Unless otherwise specified, the cost of items to be procured, availability determination, payment schedule, and delivery projections are estimates based on the best available data.[41]
- The purchaser agrees to pay to the US Government the total cost of the items even if costs exceed the amounts estimated in the LOA.
- The purchaser may cancel the LOA or delete items from it, but is responsible for all costs resulting from that cancellation or deletion.

3.20 The LOA terms are such that Defence was liable for any cost incurred by the US Government in providing the goods and services contracted.

Charging to the FMS case

3.21 From the early stages of the Project, the Air Force persistently sought details to verify the costs charged to the FMS case. When requests at working level did not yield satisfactory responses, the Air Force, at senior level, raised

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[39] TAP-3 Variation Proposal 85/TAP-3 dated 5 June 1998. The variation was raised to correctly reflect actual engine work required per aircraft.

[40] Aircraft No. 153,434 was charged 434 hours for 'engine changes,' additional to the original bid, aircraft No. 153,439 had 86 hours for 'additional engine work.'

[41] The LOA of 24 February 1994 did not 'otherwise specify.'

concerns over cost overruns and schedule delays, and sought assurances that sound management practices were effectively exercised by US authorities.

3.22 The Air Force continued its efforts to obtain greater access to costing data. This was spurred by indications, in October 1997, that a large number of hours charged to the case could not be accounted for; personnel not working on it were being charged; that tasks were being charged at ten times the normal number of hours for particular work; and that material costs were excessive. Although additional information on the charges made was provided by the US Navy, the Australian Defence authorities could not obtain data of sufficient detail and comprehensiveness to verify that the full extent of the charges made was justified.

Meeting Air Force's technical standards

3.23 The TAP-3 aircraft was sufficiently different from the main Air Force *Orion* fleet to require separate Air Force aircraft certification. A Design Certificate[42] for the TAP-3s was requested by Air Force from the US Navy. However, under FMS, the standard Air Force procedure of a commercial contractor having to achieve Design Authorised Contractor status and then certifying the design, was not applicable. Instead, the US Navy provided a Letter of Recommendation for Air Force Airworthiness Certification. This did not extend to certifying the design. Instead, the letter provided assurances that the design had been accomplished by technically qualified personnel; under standard engineering practices; and with every reasonable precaution to ensure the accuracy of the final documentation.

3.24 To ensure that the design and modification activities were undertaken to a standard acceptable to Air Force's Technical Airworthiness Authority, Air Force undertook a Design Organisation Review, which Air Force considered to be less rigorous than the requirements to be met for a contractor to achieve Design Authorised Contractor status.

3.25 The US Navy's Statement of Compliance for each aircraft, in conjunction with the US Navy's letter of recommendation for Air Force airworthiness certification, formed the basis of Air Force's airworthiness certification for each TAP-3 aircraft.

3.26 In its *TAP-3 Accomplishment Summary*, the Air Force concluded that, by purchasing the aircraft through FMS, it had been prevented from having a direct influence on a traceable and accountable design chain.

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[42] Defence Instruction (Air Force) AAP 7001.048, *Air Force Airworthiness Manual*, AL 0, 11 November 1994, states that a Design Certificate is a prerequisite for Air Force aircraft certification.

Unique features of the Australian requirements and rework

3.27 When the TAP-3 acquisition commenced, it was regarded by Defence as a low risk project, consisting of purchasing, under FMS, four off-the-shelf (mothballed) aircraft from the US, and having them converted by the US Navy, which had recently performed similar conversions on Norwegian P-3 aircraft. The TAP-3 Accomplishment Summary indicates that, out of the total of 33 modifications for the TAP-3s, only two modifications (electric windscreen wipers and the underwater sound signal door disable) were similar to the work on the Norwegian aircraft.

3.28 The amount of corrosion treatment work on the TAP-3s exceeded expectations largely because, as the aircraft were opened up, corrosion damage turned out to be greater than expected. Defence advised the ANAO in June 2005 that it had been the practice by US Navy depots to superficially treat such corrosion. This did not meet Air Force's technical airworthiness standards.

3.29 Until the *TAP*-3 experience, the Air Force considered that US Navy and Air Force engineering standards were the same or very similar. The average actual cost per aircraft for the Depot Level Servicing[43] of the Australian aircraft (all manufactured in 1976) ended up at $US 5.22 million. A portion of the increase can be ascribed to the cost of meeting the Air Force's higher standards. In addition, a sizable portion of the servicing cost increases for the TAP-3s has been ascribed by Defence to a high level of extra work required. Initial work by the US Navy Depot had to be undone and repairs reworked. Under FMS conditions, the customer had to bear those costs, even if US Navy standards had not been met by the initial work.

Capability delivered

3.30 In respect of the TAP-3s primary role, the Operational Test and Evaluation Report of May 1998 stated that the TAP-3 aircraft was capable of taking over the majority of the pilot and flight engineer training conducted by the P-3C aircraft. The main exception was for training requiring exposure to the full crew internal communications system. The aircraft carried out P-3C pilot training until there was no more need for that because of the gradual replacement of the P-3C by the AP-3C. Conversion of the TAP-3s to the AP-3C configuration was not considered by the Air Force to be cost-effective.

3.31 In respect of the TAP-3s' secondary role as transport aircraft, the TAP-3 was assessed by the Air Force as performing very well.

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[43] Described in the LOA as similar to, but more extensive, than those for US Navy aircraft. Depot Level Servicing costs for US Navy P-3 aircraft were estimated to be about $ US 2 million.

3.32 Although the TAP-3 aircraft were delivered late, because of even greater delays in the AP-3C upgrade program, the third TAP-3 was delivered one month after the first *Orion* aircraft entered the P-3C Upgrade production facility. Consequently, the TAP-3*s* contributed in some part to the achievement of two objectives in the EAS, namely of increasing the number of *Orion* aircraft available during the major part of the P-3C Upgrade; and extending the life of the *Orion* fleet by taking over some of the training flying tasks from the main operational aircraft.

3.33 However, the objective in the Concept of Operations of flying more than 1 200 hours a year in the training role was never achieved. Air Force records indicate that during their in-service period, the TAP-3 aircraft usually flew about 1 050 hours a year (750 hours in the transport role, 300 hours on pilot and crew training). Defence advised the ANAO in June 2005 that, on transport (including logistic resupply and repair) flights, the TAP-3 aircraft provided a considerable amount of continuation flying training[44] to the *Orion* pilots. This was flying training that would not have been available at the time because of low numbers of available P-3C aircraft and the low fidelity of the flight simulator in service at the time. Defence considers that without the TAP-3 flights, No. 92 Wing would not have been able to maintain currency of all of its assigned pilots, and that the TAP-3 aircraft were valuable by providing options for additional operational tasking on a day to day basis, particularly when the C-130 transport fleet was very busy.[45]

3.34 In 2000, the TAP-3 aircraft flew 1 500 hours, which included transport support to deployed maritime patrol and fighter aircraft. That support allowed Air Force's Air Lift Group to concentrate on assisting the military deployments to East Timor.

Disposal

3.35 With completion of the *Orion* aircraft conversion program to the AP-3C configuration, and Air Force's decision that it was not cost-effective to modify the TAP-3s for AP-3C training, the main role for the TAP-3s ceased to exist.[46] Air Force developed a disposal plan which was approved by the Minister for Defence in March 2005. The plan proposes that the aircraft be stripped of

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[44] Continuation training refers to the number of flying hours required by pilots to maintain currency on an aircraft type, over a period of time.

[45] The TAP-3 were able to carry parts and repair crew to support AP-3C aircraft which had a problem away from the Edinburgh airbase.

[46] Given Air Force's current and expected usage of the aircraft; the results of fatigue testing of the *Orions* since the early 1990s; and the training undertaken on the AFS, Air Force now expects to be able to maintain the AP-3C fleet in service until 2015, without the TAP-3s. The Project objective of augmenting the *Orion* fleet whilst aircraft had to be withdrawn from the operational fleet to be upgraded, had been met.

airframe and avionics parts which can be used by Air Force. Air Force estimated that, over the next 10 years, those parts would save about $39 million in expenditure, mainly on avionics, against an estimated cost of $0.650 million in harvesting them. The expected savings resulting from the stripping of the TAP-3 aircraft were taken into account in Defence's planning of the future logistics expenditure requirements for the *Orion* aircraft.

Lessons learnt

3.36 Until the TAP-3 Project, Air Force considered that it had airworthiness engineering standards which were the same or very similar to the US Navy's. Therefore the work in the Project was expected to be similar to other work which had been carried out by the US Navy on *Orion* aircraft, yielding efficiencies as a result of the US Navy's previous experience. A more thorough examination of the degree of similarities of the work previously undertaken by US Navy, and that proposed for the TAP-3s, may have resulted in a more comprehensive examination of alternative service providers, eg commercial providers.

3.37 In taking the FMS route, Defence agreed to acquire equipment in an 'as is, where is' condition, with a limited ability to carry out a thorough inspection and assess the state and extent of less transparent defects. A further contract stipulation under FMS was that the 'as is, where is' condition was to be established at a later time than the inspections which formed the basis of accepting specific individual aircraft listed in the LOA. This involved the risk of deterioration over time and the loss or replacement of items between the initial inspection prior to contract signature, and the establishment of the 'as is, where is' condition. There was insufficient awareness of the risks that these two contract conditions involved. Greater awareness of the risks involved in acquiring second-hand equipment under the FMS route, and of the need to fully establish the condition of the equipment, would have highlighted the requirement for a more thorough investigation of alternative acquisition options to mitigate those risks.

4. Acquisition of an Advanced Flight Simulator

This chapter examines Defence's project management of the acquisition of an Advanced Flight Simulator for the training of Orion air and ground crew.

Table 4.1

Timeline for Project Air 5276 Phase 3: Acquisition of the Advanced Flight Simulator (AFS)

Year	Activity
June 1995	Project Definition Study.
November 1995	Major Capability Submission endorsed by Force Structure Policy and Programming Committee.
April 1996	EAS endorsed by Defence Source Definition Committee.
August 1996	Government approval.
January /May 1997	Training Task Analysis.
May 1997	Request for Tender issued.
August 1997	Tenders close.
January 1998	Source Evaluation Report considered by Defence Source Selection Board.
March 1998	Preferred tenderer withdraws from contract negotiations.
May 1998	Negotiations with Tyco Australia Pty. Ltd. commence.
June 1998	Flight Data collection begins.
July 1998	Contract signed with Tyco Australia Pty. Ltd for $37.75 million.
October 1998	Contract novated to Thomson-CSF Pacific Pty Ltd.
May 1999	Flight Data collection ceases.
January 2003	Stage 1 training capability accepted.
December 2003	Liquidated damages regarding Stage 2 capability commence.
May 2004	Liquidated damages cease.
June 2004	Stage 2 (excluding some training sequences) capability accepted.
December 2004	Commercial Agreement with Contractor signed to facilitate closure of the Project.

Source: ANAO interpretation of Defence documentation.

Background

4.1 The upgrade of the *Orion* maritime patrol aircraft was to be complemented by the acquisition of a high fidelity (Civil Aviation Safety Authority Level 5 flight simulator qualification standard) flight trainer (titled AFS). The AFS was to contribute to the life extension of the *Orion* fleet of aircraft by transferring from the aircraft, training for high-risk aircraft operations (such as stalls and shut-down engine manoeuvres), and other

training sequences (such as take-off and landing practice) which result in high aircraft fatigue.

4.2 Adhering to the project schedule was considered important for flight maintenance and safety reasons as well as aircraft fleet fatigue life concerns.

4.3 Government funding for the AFS was approved in August 1996 in the 1996–97 Budget process. At that time, the AFS was expected to be in service by July 1999, while the first of the updated AP-3C *Orions* was expected to be accepted into service in July 1998.

4.4 The original budget for the AFS was $47.80 million in December 1996 prices. Cumulative price variations to the end of June 2005 amounted to $3.61 million; exchange rate variations to $5.66 million; and real (scope) increases to $0.85 million.

Exterior of AP-3C Flight Simulator

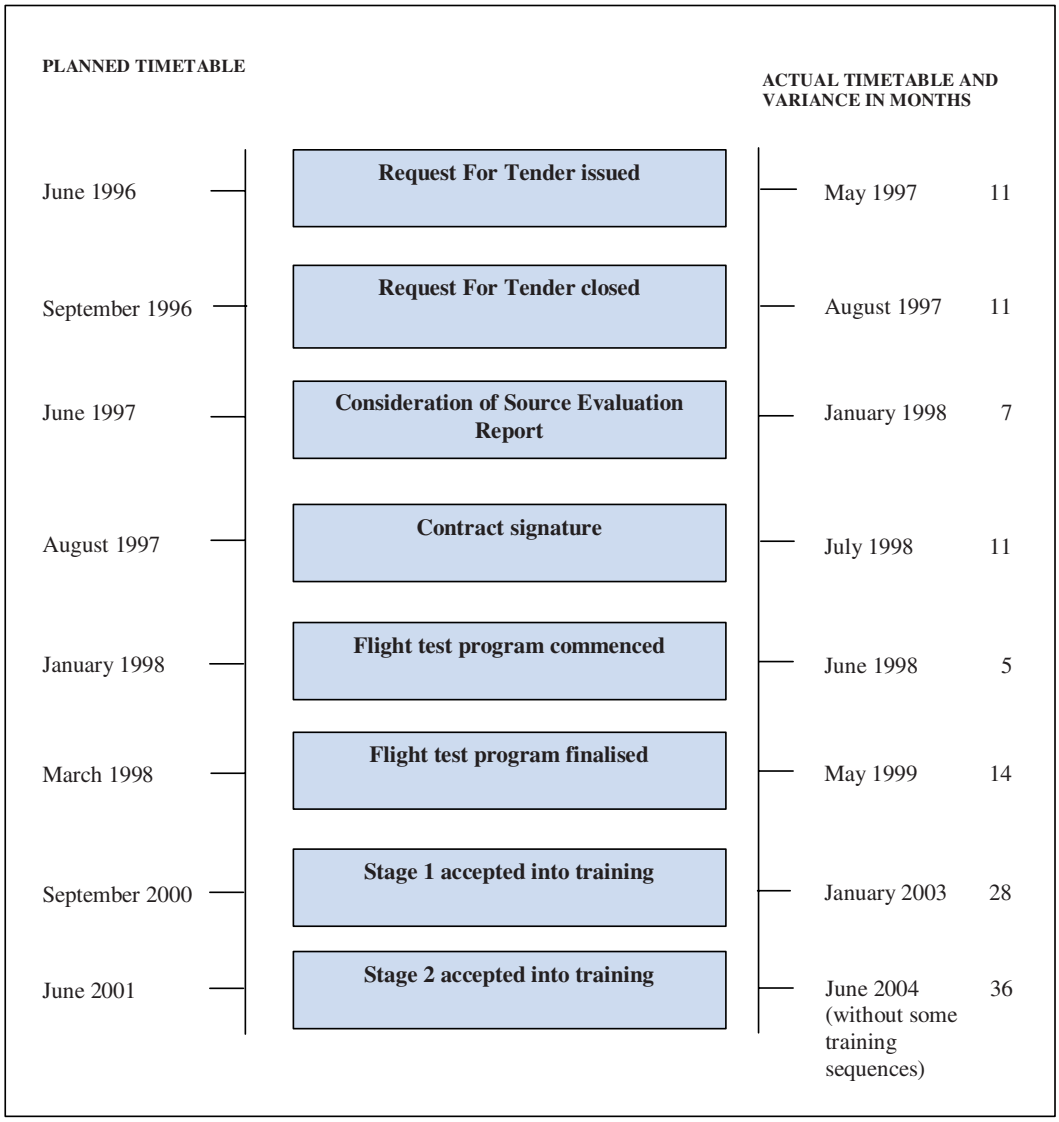
Source: Department of Defence.

Schedule slippage

4.5 Figure 4.1 shows timelines planned, at the time of the Major Capability Submission and Contract signature, against the achieved timetable.

Figure 4.1

Planned and actual timetable for the acquisition of the Advanced Flight Simulator



Source: ANAO analysis of Defence documentation.

4.6 Due to difficulties in finding staff with the relevant skills for the Project Office, preparation of the RFT slipped from the planned release of June 1996 to May 1997. Defence's RFT documentation requested that tenderers provided the AFS in a 22 months delivery schedule. That is just four months more than the typical timeline for a commercial (production line) simulator which does not require extensive development and flight data collection work. To mitigate against schedule slippage, a phased introduction of the AFS into training was adopted. Stage 1 would provide an essential training capability, while Stage 2 would deliver a tactical training capability. The phased introduction was expected to save 12 months on the Project schedule.

4.7 The preferred tenderer withdrew from contract negotiations in March 1998. Negotiations then commenced with Tyco Australia Pty Ltd (whose subsidiary Wormald Technology had originally responded to the RFT). The original Wormald Technology bid had been for a 23 months delivery schedule. Defence agreed to extend the schedule to 25 ½ months, with an additional four weeks period of grace before liquidated damages could be claimed.

4.8 Contract signature occurred 11 months behind schedule on 23 July 1998 with Tyco Australia Pty Ltd. The Contract had a fixed price of $37.75 million and a $4 million cap on liquidated damages. The work was to be undertaken by Wormald Technology. Defence sought, and obtained, a parent company performance guarantee from Tyco International.

4.9 Shortly after contract signature, Thomson-CSF Pacific Pty Ltd. purchased Tyco Australia Pty Ltd's simulator interests (Wormald Technology), including the rights to the Contract. Defence agreed to a deed of novation transferring the Contract to Thomson-CSF Pacific Pty Ltd in October 1998. Defence sought and obtained a parent company performance guarantee from the new Contractor's parent, Thomson Training and Simulation Limited, located in the UK.[47]

4.10 On novation of the Contract, at the Contractor's insistence, the Contractor's previously unlimited liability was capped at $75 million. As a quid pro quo, the Contractor agreed to provide 1 000 hours of extra database modelling effort at no change in price.

Flight data collection

4.11 Defence contracted Aerospace Technical Services Pty Limited in May 1997 (in conjunction with the Air Force's Aircraft Research and Development Unit (ARDU)) to gather flight data of a quality sufficient to develop a simulator to Civil Aviation Safety Authority Level 5.

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[47] In 2000, as part of the renaming of Thomson-CSF Pacific Pty. Ltd. business units as Thales business units, the Contractor was renamed Thales Training and Simulation Pty. Ltd.

That Contract, for $363 635, was entered into by Defence before the AFS contract was signed, in an attempt to shorten the AFS's delivery schedule following the delays in the issue of the RFT.

4.12 Data collection flights were conducted from June 1998 to May 1999. In conjunction with the data collection for the AFS, a Flight Loads Test Program was carried out by ARDU. That program was carried out as the Air Force's contribution to a US Full Scale Fatigue Test of the *Orion* aircraft and involved expanding the instrumentation carried by the test plane.

4.13 In July 1999, the AFS Contractor notified the Simulator Project Office that some of the Flight Test Data had been corrupted, and also forwarded a report, detailing the problem; its effect on subsequent flight modelling activity; and providing options for dealing with the problem. The report noted that internal, and other analyses, carried out after each test flight, had identified some anomalies in the data. However, as these were within acceptable tolerance limits, the flying program was continued.

4.14 In May 2001, after consideration of the options available, Defence decided that the AFS Contractor should proceed to develop the AFS to a level which would allow training transfer (from the aircraft to the simulator) equivalent to Civil Aviation Safety Authority Level 5. This was to be achieved by using subjective fine-tuning, without further flight test data collection. It was recognised at the time that it might be necessary to gather further flight test data at a later stage.

4.15 The AFS Contractor began initial development of the flight model for the AFS on the assumption that Defence had provided a functional set of flight data. The discovery that there were errors in the flight test data caused timetable delays and flow-on costs as extra work was required to progress the flight model.

4.16 Defence agreed to pay the AFS Contractor $1.04 million for the extra work required to be done as a consequence of the faulty flight data, and extended the delivery schedule for Stage 1 functionality to 1 October 2002. Stage 1 was accepted on 28 January 2003, after an extensive testing program involving significant levels of subjective tuning and testing.[48] In light of the contribution of the faulty flight test data to the delay, Defence did not seek Liquidated Damages for the late delivery of Stage 1.[49]

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[48] Contract Change Proposal 011, provided the schedule and cost relief as compensation for extra work incurred by the contractor as a result of deficient flight test data. The contract included a grace period of three months before the contractor became liable for Liquidated Damages on Stage 1 delivery.

[49] The AFS project was not tightly linked to the upgrade of the Orion P-3C fleet. Because of the delays in the delivery of upgraded AP-3C aircraft, there would have been limited training value in delivering the AFS at the earlier times stipulated in the AFS Contract. However, the extra time would have provided an opportunity to improve the AFS's performance.

Visual system

4.17 The image generating system used in the AFS was changed from the tendered system to what was considered to be a more advanced and mature system. This change occurred during the Critical Design Review, the point at which Defence agreed to the baseline configuration for the AFS.

4.18 The field of vision required for use in the AFS required an increase of approximately 50 per cent in the horizontal range normally supported by the new system, requiring it to generate an image over a much larger angle.

4.19 An independent assessment of the visual system was carried out in November 2002. It concluded that the visual system failed to meet the required standard because it failed to exhibit satisfactory terrain detail. On a re-assessment conducted in January 2003, the Assessor accepted that the visual system now met the contracted standard, although the quality of visual display was noticeably below that of other existing systems.

Liquidated damages

4.20 The contracted due date for delivery of Stage 2 was 3 September 2003. The contract allowed a period of grace before the imposition of Liquidated Damages. Liquidated Damages were applied from the contractually agreed date of 5 December 2003. They were put on hold from mid May 2004, after testing of the AFS indicated that it had been developed to a stage where it could be used for Stage 2 training. Introduction of the AFS into Stage 2 training was subject to approval by the Air Force's AFS Manager. This was given in early June 2004 and confirmed by the Project Office. When liquidated damages ceased, Defence was owed $1.15 million. The amount was offset against moneys owed by Defence to the Contractor for the achievement of milestones.

4.21 In December 2004, a Commercial Agreement between the Project Office and the Contractor was made to facilitate an expedient closure of the AFS Project. The Agreement included clarification of software roll-out and testing requirements into the future, and contained provisions which were in the style of a time and materials contract.

Operational Mission Simulator (OMS) linkage

4.22 During the AFS contract negotiations in mid-1998, it was agreed that the Contractor would establish the OMS[50]/AFS training linkage at a price of $1.06 million. In February 2001, the Contractor for the AFS advised Defence

[50] The OMS was to be acquired as a part of Phase 2 of Air 5276 to train AP-C3 aircrew in a realistic mission simulations using the full weapons systems.

that the OMS had been designed without the requirement for that AFS/OMS link being considered.

4.23 In September 2001, the Project Office stated that a fully functional OMS/AFS linkage, to enable the two simulators to act as a single training entity, would cost between $3 million to $5 million. The work would have required the AFS to be shut down for two to three weeks and the OMS for 14 weeks and would have required the OMS maintenance contract to be re-negotiated. This extended timetable was to allow sufficient time to make significant changes to the OMS software and hardware.

4.24 In February 2002, Defence decided not to proceed with the linkage. In June 2005, a Contract Change was finalised to reduce the value of the contract for the work contracted for but not undertaken on the proposed OMS/AFS linkage. Although the two simulators cannot be linked to provide training as a single entity, the OMS and AFS meet their approved requirement to provide data to other simulators using the Distributed Interactive Simulation Standard.

Project closure

4.25 Preparation of a Closure Plan for the Contract commenced in mid 2004. The Plan was intended to assist in the transition from the AFS's construction to its long-term maintenance.[51]

4.26 Defence and the Contractor undertook joint development efforts on the AFS in November and December 2004. In early February 2005, Defence understood that, because of flight data deficiencies, the AFS would not receive accreditation at Civil Aviation Safety Authority Level 5. Nevertheless, Defence undertook testing in order to establish the level of training which could be transferred from the aircraft to the simulator; and to set a baseline for on-going fidelity testing.

4.27 During February 2005, a commercial organisation, endorsed to advise Defence on simulator accreditation, conducted a series of tests of the performance of the AFS. The organisation found that there had been an overall improvement in the performance of the AFS. It had passed 85 per cent of the objective tests and 82 per cent of the subjective tests that had been conducted. However, this was not considered sufficient to pass the AFS for accreditation at Civil Aviation Safety Authority Level 5.

4.28 A number of flight performance problems were noted in the February 2005 tests. The AFS flight model was not correct, and, in a number of areas, the

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[51] The Plan outlined how the remaining milestones under the AFS contract were to be completed; outstanding engineering issues to be resolved (and allocating responsibility for finalisation); outstanding flight issues to be resolved; the testing procedures to be undertaken to finalise acceptance of the AFS; and procedures to resolve any outstanding contractual issues.

AFS was not performing like the aircraft. The AFS was not at a level to carry out all training for high-risk, high aircraft-fatigue inducing training sequences.

4.29 In March 2005, Defence had 17 unsatisfactory items outstanding on the AFS. The Project Office initiated reviews to take stock of the current position and help develop options on the future of the Project. The Project Management Steering Group met in May 2005 to consider the way ahead for the Project. The Steering Group agreed that additional work was to be undertaken in the Project. That work was limited to rectifying deficiencies which prevented the required level of training transfer (rather than pursuing accreditation). A Working Group was formed in May 2005. At the time of completion of the audit fieldwork, the Working Group was to identify the training limitations of the AFS, and to develop detailed resource and schedule estimates on how to rectify those limitations.

Outcomes

4.30 Table 4.2 compares the annual number of training hours to be provided by the AFS[52] with the hours achieved in the period March 2004 to February 2005:

Table 4.2

Comparison of planned annual AFS training hours and achievement

Type of training	Planned hours	Achieved hours	Variance in hours	Percentage variance
Initial pilot and flight engineers	600	902	302	50
Pilot and flight engineers continuation (up-keep of skills)	800	716	(84)	11
Ground (maintenance personnel)	500	431	(69)	(14)
Operational, linked with the Operational Mission Simulator	400	0	(400)	no link[53]
Total	2,300	2,049	(251)	(11)

Source: ANAO interpretation of Defence documentation.

4.31 In addition to the hours shown above, the AFS was used for training by New Zealand personnel (187 hours, provided on a repayment basis when the AFS was available for use) and for further development work on the AFS (125 hours), undertaken on a joint basis between Defence and the Contractor.

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[52] Part 2 of the Major Capability Submission for Air 5726 Phase 3, Issue 4, September 1995.

[53] See paras. 4.22-24.

4.32 By early 2005, in light of experience with ab initio pilot trainees (trainees who had no previous flying experience with any *Orions*) on the AFS, Defence considered the AFS acceptable for providing maintenance crew and flight engineer training, as well as pilot procedural training to the same level provided by the previous flight simulator. However, all pilot training sequences required consolidation on the aircraft.

4.33 Flight performance testing in February 2005 and anecdotal evidence revealed significant flight performance problems. As a consequence, some training was transferred back to the aircraft, including some high risk and high airframe fatigue-inducing training sequences.

4.34 In June 2005, the main user of the AFS, Air Force's No. 92 Wing, assessed that the AFS was not meeting its training requirements, and arguably was not any more capable of meeting its training requirements than the simulator it had replaced. Detailed planning on how to rectify this situation was not completed at the time of the audit. The current inability of the AFS to be used for some high risk and/or high airframe fatigue-inducing training sequences means that the AP-3C *Orions* have to be used for that training, resulting in higher risks and costs, including the consumption of airframe fatigue life.

Lessons learnt

4.35 The ANAO considers that, had there been sufficient qualified staff resources available to the Project Office at the commencement of the Project, the delays in issuing the RFT may have been avoided. The additional time pressure on Contract delivery resulting from this delay contributed to the problems experienced by the Project, in particular the decision of Air Force to take responsibility for the collection of flight data to be provided to the AFS Contractor, and therefore for the soundness of that data. After corruption of flight data occurred, performance deficiencies relating to fidelity between aircraft and AFS performance were difficult to attribute to latent defects[54] in the items and services provided by the Contractor, as opposed to faulty flight data.

4.36 The question of who should carry responsibility for the collection and accuracy of flight data for simulators is a vexed one. In the Operational Flight Trainer for the P-3C *Orions*, purchased by Defence in 1982, poor flight performance and handling characteristics of the simulator were attributed by users to inaccurate flight data supplied by the aircraft manufacturer. In the AFS Project, Air Force contracted out the gathering of flight data as a separate contract from the construction of the simulator. However, Air Force carried out

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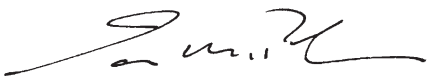
[54] A latent defect means a failure which arises from a deficiency in design, material or workmanship, and was not reasonably discoverable by inspection prior to acceptance of the supplies.

the data collection flying. Changes in the instrumentation on the aircraft to accommodate data collection for a separate program introduced data corruption, which blurred the responsibility for some deficiencies in the performance of the AFS.

4.37 Taking into account its experience with the AP-3C simulator, Defence, in the 'Wedgetail' Early Warning and Control Aircraft Project, placed full responsibility on the Contractor for the flight trainer being able to meet simulator fidelity requirements.[55]

4.38 The construction of a simulator, before the aircraft and the systems to be simulated have attained an agreed design, poses unique problems. To ensure fidelity with the final aircraft design involves significant additional work, including re-integration and regression testing,[56] time delays and costs. These must be weighed against the long time gap between acceptance of aircraft in service, and the availability of a flight simulator for training, which may occur if development of the simulator awaits acceptance of the aircraft design.



Ian McPhee
Auditor-General

Canberra ACT
23 September 2005

[55] In that project, 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, including the flight simulator. See the ANAO's Audit Report No.32 2003-04, '*Wedgetail' Airborne Early Warning and Control Aircraft: Project Management. Department of Defence*, March 2004, para. 2.30 and p. 129, para. 6.

[56] Regression testing is a repetition of tests when changes to the system configuration have been made after commencement of Acceptance Testing and Evaluation.

Appendix

Appendix 1: Agency response

Australian Government
Department of Defence
Inspector-General Group

2004/1062960/1
IG 421/05

6 September 05

Mr Colin Cronin
Executive Director
Performance Audit Services Group
Australian National Audit Office
GPO Box 707
Canberra ACT 2601

Dear Mr Cronin,

ANAO PERFORMANCE AUDIT ON THE UPGRADE OF THE ORION MARITIME PATROL AIRCRAFT FLEET

1. On 4 August 2005 you sought a Defence response to the section 19 draft report on the Upgrade of the Orion Maritime Patrol Aircraft Fleet. I now provide you with the whole of Defence response to the draft report (see Annex A).

2. Also attached at Annex B is a list of textual amendments.

3. My point of contact in this matter is Miss Elizabeth Giles (Tel: (02) 6266 4595, Fax: (02) 6266 4592 or email: elizabeth.giles@defence.gov.au).

Yours sincerely,

C Neumann

Claude Neumann
Inspector General

Annexes:
A. Defence comments and response to the Report
B. Amendments to the Draft Section 19 Report on the Upgrade of the Orion Maritime Patrol Aircraft Fleet

***Defending Australia** and its National Interest*

DEFENCE COMMENTS AND RESPONSE TO THE REPORT

The report acknowledges the important fact that the subject project was initiated in the early 1990s when a different acquisition process existed. Project Air 5276 Phases 2A, 2B and 3 were developed collectively, but separately, and managed under different directorates and by different project offices.

Since that time, including through the use of lessons learned from these project phases, Defence has significantly improved its capability development, procurement, and project management processes and skills. Throughout the Air 5276 Phase 2 and 3 life-cycles, which are not yet complete, Defence believes contemporary best practice of the time was employed and capability value for money was maximised. While some capability and support outcomes are still being addressed, the overall capability outcomes from this series of complex integration project phases have showcased the ADF AP-3C weapon system as one of the most capable maritime patrol and response capabilities in the world.

Defence notes that while the projects have been adjusted for foreign exchange and price adjustment, in line with Government policy, real cost increases account for less than 4.5% ($37.98m) of Orion Upgrade Project, and 1.5% ($0.86m) of the Advance Flight Simulator Project.

Significant work has been undertaken to improve the acquisition of major capital equipment as a result of the Defence Procurement Review (DPR) 2003. This has resulted in improved contracting strategies, project management skills and project approvals processes. For instance, Defence is now adopting commercial options in lieu of Foreign Military Sales (FMS) acquisitions where they are more cost-effective and there is the flexibility to do so. An example is AIR 5077 – Airborne Early Warning and Control aircraft where Defence adopted a direct contractual arrangement with Boeing, supported by bilateral Memoranda of Understanding with the relevant Governments rather than utilising the FMS system.

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