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Performance Audit

Management of Air Combat Fleet In-Service Support

Department of Defence

Defence Materiel Organisation

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Australian National
Audit Office

Canberra ACT
21 February 2007

Dear Mr President
Dear Mr Speaker

The Australian National Audit Office has undertaken a performance audit in the Department of Defence and 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 *Management of Air Combat Fleet In-Service Support.*

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

AUDITING FOR AUSTRALIA

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Abbreviations

ACG	Air Combat Group
ADF	Australian Defence Force
AEO	Authorised Engineering Organisation
AIMS	Advanced Inventory Management System
AMO	Authorised Maintenance Organisation
ANAO	Australian National Audit Office
APS	Australian Public Service
ARDU	Aircraft Research and Development Unit
ASD	Aerospace Systems Division
ASIP	Aircraft Structural Integrity Program
BRIAN	Basic Repairable Item Analysis Network
CAMM2	Computer Aided Maintenance Management version 2
CSIG	Corporate Services and Infrastructure Group – now known as the Defence Support Group (DSG)
DAO	Defence Acquisition Organisation
DGTA	Directorate General Technical Airworthiness
DGTA-ADF	Director General Technical Airworthiness – ADF
DMO	Defence Materiel Organisation
DRN	Defence Restricted Network
DSG	Defence Support Group – formerly Defence Corporate Services and Infrastructure Group (CSIG)
DSTO	Defence Science and Technology Organisation
FALCON	Financial Accounting Logistics On-line Network
FLEI	Fatigue Life Expended Index

F-WELD	F-111F Wing Economic Life Determination
HIC	Hornet Industry Coalition
HUG	Hornet Upgrade
IFOST	International Follow-On Structural Test
IMT	Integrated Management Team
IPSSR	Improve Project Scheduling and Status Reporting
ISO 9001:2000	International Organization of Standardization, 9001:2000 *Quality management systems-Requirements*
LMSQNs	Logistics Management Squadrons
OEM	Original Equipment Manufacturer
QEMS	Quality and Environmental Management System
QMS	Quality Management System
RAAF	Royal Australian Air Force
ROMAN	Resource and Output Management Accounting Network
SDSS	Standard Defence Supply System
SENGO	Senior Engineering Officer
SPO	System Program Office
US Navy	United States Navy

Summary and Recommendation

Figure 1

RAAF F-111, Hornet and Hawk in formation flight.

Source: Royal Australian Air Force, Air Combat Group.

Summary

Background

1. This audit focuses on the Australian Defence Force's (ADF's) Air Combat fleet's logistics support, regular maintenance and structural refurbishment. These activities are collectively referred to as fleet in-service support. The current Defence White Paper states that Air Combat is the most important single capability for the defence of Australia.

2. The Air Combat fleet is valued at $3.12 billion, almost ten per cent of the $31.99 billion of the total value of ADF specialist military equipment in 2005–06. The Defence Materiel Organisation (DMO) spent $323.71 million on the Air Combat fleet's in-service support in 2005–06, which represents nine per cent of the $3.59 billion DMO spent on ADF capability sustainment in 2005–06.

3. The Air Combat fleet consists of:

- 26 F-111s which provide the ADF with air strike and reconnaissance capabilities;
- 55 F/A-18A (single seat) and 16 F/A-18B (dual-seat) Hornet aircraft, which provide the ADF with air defence and tactical fighter capabilities; and
- 33 Hawk 127 Lead-in Fighter dual-seat aircraft, which are used for initial jet fighter pilot training.

4. At the time of the audit the Hornet fleet was undergoing a major upgrade known as the Hornet Upgrade project, which by August 2006 had an estimated cost of some $2.92 billion. This project aims to enhance the Hornets' capabilities and to extend their service life until their planned withdrawal between 2012–15. Also, the F-111 fleet was nearing the completion of a $634.66 million capability upgrade, and Defence had scheduled its withdrawal from service from 2010.

5. The audit covers the fleet's support in terms of:

- Operational Maintenance undertaken by Air Force's Air Combat Group (ACG) squadrons. These squadrons operate the fleets and provide them with first-line maintenance on the flightlines; and
- Deeper Maintenance undertaken by contractors and to a lesser extent by the ACG squadrons. Deeper Maintenance involves structure

inspections and overhaul, repair, calibration, testing and alignment of aircraft systems and Repairable Items.

6. DMO's Strike Reconnaissance Systems Program Office (Strike Reconnaissance SPO) located at Amberley, Queensland; and Tactical Fighter Systems Program Office (Tactical Fighter SPO) located at Williamtown, NSW, manage the Deeper Maintenance contracts and the fleets' overall logistics and engineering support. ACG manages the fleets' Operational Maintenance.

7. The audit objective was to assess the effectiveness of the Air Combat fleet's in-service support arrangements to provide capability for air combat operations. Capital equipment acquisition projects covered by this report are limited to the Hornet and F-111 structural refurbishment projects, which aim to ensure these aircraft remain serviceable until their withdrawal from service.

Key findings

Fleet management framework (Chapter 2)

8. Tactical Fighter SPO and Strike Reconnaissance SPO held quality management system compliance certificates, which covered their management plans and processes. These plans and processes satisfied the ADF's technical regulations. The SPOs' logistics, engineering and financial systems enabled them to adequately manage their in-service support responsibilities and to report to senior management. However, some of these systems suffer data transfer congestion due to capacity limitations within the Defence Restricted Network.

9. Compliance with the ADF's technical airworthiness regulations is mandatory for all ADF aircraft and associated systems maintenance efforts. The ANAO noted both SPOs and ACG were complying with these regulations and, together with the ADF's Director General Technical Airworthiness (DGTA), were satisfactorily monitoring the regulatory compliance of their contractors.

10. In recent years ACG has found it increasingly difficult to sustain its engineering and technical workforce capability. ACG personnel are acquiring less depth and breadth in experience, skills and supervision due to the progressive commercialisation of the fleets' Deeper Maintenance. This is occurring at a time when the squadrons face increased on-the-job training needs due to:

- increased inspections, structural refurbishment and general maintenance associated with ageing aircraft;
- increased maintenance training associated with the introduction of upgraded systems;
- increased regulatory compliance associated with Authorised Maintenance Organisation certification; and
- increased logistics governance associated with asset and equipment accounting.

11. This represents a challenge in balancing the needs for skills retention while at the same time pursuing the benefits afforded by commercialisation of the fleets' Deeper Maintenance. Air Force and DGTA are aware of the tensions involved in positioning Air Force's engineering and technical workforce capability, and are currently reviewing the situation.

12. Many of the 7 200 lines of Hornet Repairable Items are repaired in the United States of America (US), where they attract repair costs which are paid in US dollars. The Standard Defence Supply System (SDSS) is unable to process foreign currencies. This limitation compels Tactical Fighter SPO personnel to conduct a complicated time-consuming Repairable Item management process for repairs that attract US dollar charges. This process impedes efficient supply chain management, and increases accounting accuracy risks.

Hornet and Hawk in-service support (Chapter 3)

13. For the period 1991 to 2005, Hornet fleet flying hours remained largely in line with Air Force planning and ACG's operational requirements. During 2005–06 the number of Hornet aircraft provided by Tactical Fighter SPO to Air Force increased to above that specified in the Materiel Sustainment Agreement between DMO and Air Force.

14. The commercialisation of most Hornet Deeper Maintenance routine maintenance has resulted in improved reliability in achieving routine servicing targets. However, the Air Force squadrons have not achieved the level of schedule reliability attained by the contractors. This is because many Air Force personnel responsible for Hornet Deeper Maintenance routine servicing are also responsible for higher priority Operational Maintenance on the flightlines. This dual role leads to increased routine service durations.

15. In recent years Tactical Fighter SPO has improved the Hornet fleet's supply chain efficiency and assurance of supply, as measured by demand satisfaction rates of Repairable Items and Breakdown Spares.[1] At the time of the audit demand satisfaction rates for these spares exceeded 90 per cent. This has been accompanied by increasing supply chain effectiveness as measured by a gradual reduction in Hornet cannibalisation rates. The overall outcome was achieved through Tactical Fighter SPO and its contractors' continuous improvement efforts, together with increased logistics funding of $232 million.

16. BAE SYSTEMS Australia (BAE SYSTEMS) has been contracted to provide a pool of 33 Hawk aircraft to two Air Force squadrons since 2001. During the initial two years of the Hawk in-service phase, the Hawk fleet's availability was below contracted requirements because of latent defects appearing in the aircraft's oxygen systems and hydraulic system connector corrosion. When these defects were corrected, aircraft availability improved markedly and at the time of the audit the number of Hawk aircraft available to Air Force exceeded the minimum required under the contract.

17. The Hawk acquisition contract included 25 years of logistics support, renewable at five-year intervals, with the first renewal due in June 2006. In mid 2006 DMO entered into an agreement with BAE SYSTEMS to extend the initial five-year logistics support to April 2007. This extension was to allow resolution of pricing and work scope issues raised in BAE SYSTEMS's tender for the second five-year period.

F-111 in-service support (Chapter 4)

18. The F-111 fleet flew almost all of its authorised flying hours, for a large majority of the period 1991 to 2006. However from 2000 to 2003 the fleet experienced reduced aircraft availability caused by wing and fuel tank airworthiness and safety certification issues. These issues reduced both the authorised and actual flying hours, until they were resolved in September

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1 Spares demands are deemed to be satisfied if deliveries are made within specified priority durations, which are typically 24 hours, 5 days, 10 days or 48 days, from the time they are ordered by maintenance personnel.

2002. By November 2006 the number of F-111 aircraft available to Air Force had reached the target agreed in the DMO-Air Force Materiel Sustainment Agreement.

19. Since F-111 Deeper Maintenance was commercialised in 2001, the procedures for overhauling and replacing the fleet have been improved, as indicated by reductions in the time taken to complete the most complex F-111 Deeper Maintenance routines. There has also been the development of a greater understanding of F-111 systems reliability trends and associated aircraft ageing issues. F-111C mission critical and safety critical systems reliability data respectively show these systems to have experienced improved reliability during the period 2001 to 2005. For example, the F-111C mission critical systems had a six-fold improvement in mean time between failures since 2002. This has translated into increased sortie timeliness, and increased time available to the F-111 contractors and Air Force maintenance squadrons to clear their backlogs of Repairable Item repairs. These results flow from the systems engineering and maintenance skills held by the contractors combined with managerial efficiencies within the contractor organisations and their business relationships with Strike Reconnaissance SPO.

20. ACG squadrons have at times experienced difficulty in maintaining a sound Deeper Maintenance capability, and ACG is seeking to correct this through Air Force's Maintenance Quality Management System reviews and audits. At the time of the audit, DGTA was monitoring the situation and was satisfied that the maintenance difficulties did not present unacceptable risk to F-111 airworthiness. Both ACG and DGTA implement routine surveillance of the squadrons' compliance with technical airworthiness standards.

21. Since January 2003 F-111 spares supply chain efficiency and assurance of supply for Breakdown Spares remained predominantly 10 per cent above the target rate of 85 per cent. However, for Repairable Items it was on average five per cent below the target rate of 95 per cent. Supply chain effectiveness, as indicated by spares cannibalisation rates, remained largely within agreed limits.

22. The Defence Support Group's (DSG's) Facilities Operations Program is facing an increasing back-log of facilities maintenance at RAAF Amberley.[2] Defence advised maintenance funding is prioritised to those areas of the estate that represent the highest risk. The risk management decision on prioritisation of funding is made by the Defence Infrastructure Sub-Committee.

23. The ANAO noted that challenges remain in ensuring more effective liaison and role clarity between DSG and its clients. DSG faces increasing facilities management difficulties in instances where contractors occupying Defence facilities carry out work for several DMO SPOs, or for commercial entities in line with Defence's industry support objectives. DMO and Air Force manage such difficulties through performance measurement and reporting systems, and through increased stakeholder liaison in the form of support management boards, integrated management teams and working groups. The ANAO reviewed the Customer Supplier Agreement between the Air Force and DSG, and the Base Support Agreement between DSG's South Queensland Region and RAAF Amberley's Base Commander. The ANAO found both agreements would benefit from more viable performance measurement and reporting mechanisms of a nature already established between Air Force and DMO.

Structural integrity management (Chapter 5)

24. Aircraft structural integrity management is the responsibility of DGTA's Aircraft Structural Integrity Section, with aircraft structural inspections and refurbishment programs conducted by the SPOs in conjunction with ACG. Structural fatigue tests and evaluations, conducted by the Defence Science and Technology Organisation (DSTO) and DGTA have identified structural integrity issues in all three fleets. Tactical Fighter SPO is managing a two-phase Hornet structural refurbishment program with a total estimated cost of $977 million. Strike Reconnaissance SPO is managing an F-111 wing refurbishment and replacement program costing some $1.18 million per wing set. A range of Defence organisations and BAE SYSTEMS are managing the Hawk fleet's greater than expected tailplane structural fatigue consumption rate.

2 DSG's Facilities Operations Program delivers general maintenance and minor new works at Defence facilites on a regional basis across Australia.

25. The ANAO considers that the structural integrity of the Air Combat fleet is being well managed by each SPO with assistance from their contractors, DGTA and DSTO. This is indicated by the timeliness and cost of the F-111 wing refurbishment and replacement program; the extensive planning, prototyping and Initial Rate of Production techniques being applied to the Hornet structural refurbishment program; and the close monitoring of Hawk 127 structural integrity issues.

Overall audit conclusions

26. Air combat aircraft fleet in-service support involves highly-developed organisational relationships between the DMO, ACG, DGTA and contractor organisations. The ANAO considers that these organisations were effectively managing the Air Combat fleet's in-service support within a complex mix of operational needs, funding priorities, maintenance capacities and aircraft capability upgrades. Logistics and engineering support provided to the fleets are shown by key performance indicators to be effective in meeting ACG's needs, and on current indications and resource commitments, it is reasonable to expect that the fleets will remain available until their planned withdrawal dates.

27. The key factors that have contributed to these outcomes include:

- the availability of appropriately trained and experienced SPO logistics, engineering and acquisition project teams, located adjacent to Air Force's operational squadrons;
- the application of well-developed and applied technical regulations covering engineering and maintenance of ADF aircraft, and the organisations that support them; and
- the development of effective commercial support programs, which are coupled with DMO and Air Force management practices that focus on teamwork, performance monitoring, continuous improvement, and openness to external reviews and regulatory oversight.

28. Risks to the continued success of fleet's in-service support relate to reductions in the numbers of qualified and experienced Air Force technical workforce personnel and to ageing aircraft that require increased inspections, structural refurbishment and general maintenance. Furthermore, the Defence

Support Group's back-log of facilities maintenance at RAAF Amberley also present risks to Air Combat fleet in-service support.

Agency response

29. The Department of Defence provided a response to this report on behalf of the DMO and Defence. Defence agreed with qualification to the recommendation, and provided the following overall comment:

> Defence notes the overall positive assessment of the Management of the Air Combat Fleet In-Service Support. The areas identified for improvement are known and have either already been addressed or are being addressed.

Recommendation

Set out below is the ANAO's recommendation, which is discussed at the referenced part of this report.

Recommendation No. 1 **Para 2.21**	The ANAO recommends that Defence and Defence Materiel Organisation consider the cost and benefits of upgrading its Standard Defence Supply System to include foreign currency processing capability for Repairable Items. ***Defence response:*** *Agreed with qualification*.

Audit Findings and Conclusions

1. Introduction

This chapter provides an overview of the Australian Defence Force's air combat aircraft fleets, it outlines their in-service support organisational structure and sets out the audit's scope and objectives.

Background

1.1 The Australian Defence Force's (ADF's) Air Combat Group (ACG) provides an air combat capability based on two F-111 squadrons,[3] three F/A18 squadrons,[4] an Operational Conversion Unit, and two Hawk Lead-in fighter squadrons.[5]

1.2 The current Defence White Paper states that Air Combat is the most important single capability for the defence of Australia, because control of the air over our territory and maritime approaches is critical to all other types of operation in the defence of Australia.[6]

1.3 Defence records show that the Air Combat fleets had a depreciated value of $3.12 billion in June 2006. Table 1.1 provides the value of each fleet and the amount of depreciation since they entered into service.

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3 The F-111 squadrons are operated by Air Combat Group's 82 Wing - No 1 Squadron, which is an operational mission squadron and No 6 Squadron, which is a training squadron. 43 F-111s were acquired in 1973, 1980 and 1993. Of these fifteen are F-111Gs, which Defence purchased at a cost of $147.9 million (April 1992 prices). The aim was to extend the F-111 fleet's life beyond the original life-of-type target of 2010 to 2020, by rotating the F-111Gs through the F-111C fleet. With completion of F-111C Block Upgrade Program in late 2006, the F-111G aircraft will no longer be required, and their operations are planned to cease in June 2007. After then the F-111Gs will be used for spares.

4 The F/A-18 fleet is operated by 81 Wing – No.3, and 77 Squadrons and No.2 Operational Conversion Unit at Williamtown, New South Wales and No.75 Squadron at Tindal, Northern Territory. The F/A-18s were acquired between 1985 and 1990.

5 The Hawk fleet is operated by 78 Wing – No.76 Squadron at Williamtown, and 79 Squadron at Pearce, Western Australia. Defence acquired the Hawk fleet between 1997 and 2000.

6 *Defence 2000 – Our Future Defence Force*, p. 84.

Table 1.1

Air Combat fleet valuation and depreciation as at June 2006.

Fleet	Value $millions	Depreciation $millions	Written Down Value $millions
F-111	1 865	1 568	296
Hornet	5 916	3 725	2 191
Hawk	807	179	628
Total	8 588	5 473	3 115

Source: Department of Defence

Fleet in-service management structures and costs

1.4 Air combat aircraft fleet in-service support involves highly-developed organisational relationships between the DMO, ACG, and contractor organisations (see Figure 1.1). DMO has overarching responsibility for providing aircraft fleet engineering, logistic support and acquisition project management services. In-service support of individual aircraft is provided at two levels:

- Operational Maintenance undertaken by ACG squadrons. These squadrons provide aircraft flightline servicing and fault diagnosis and repairs at the Line Replaceable Unit level;[7] and
- Deeper Maintenance undertaken by contractors and to a lesser extent by ACG. It involves structure inspections and overhaul, repair, calibration, testing and alignment of aircraft systems and Repairable Items.[8]

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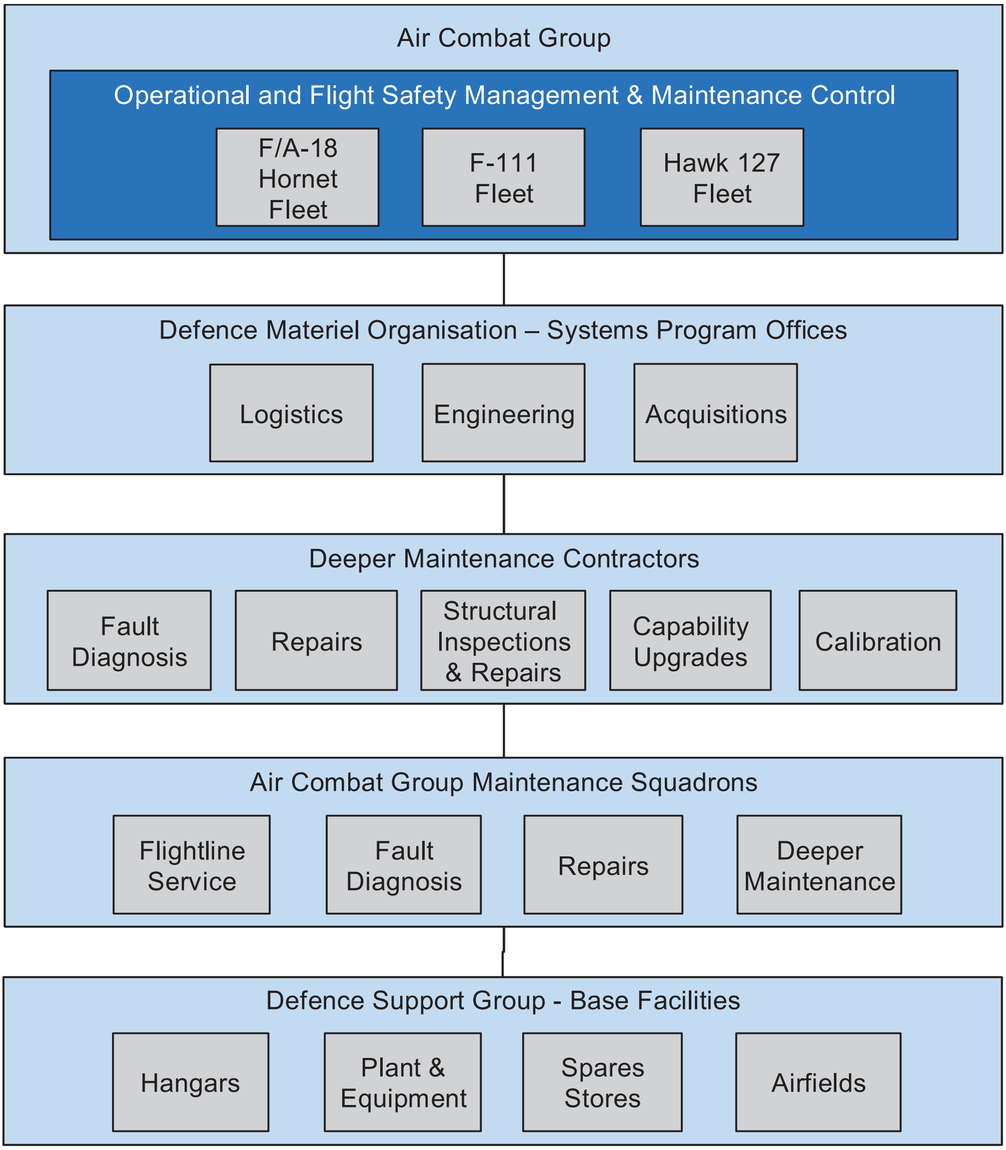
7 Line Replaceable Units (LRUs) are the lowest appropriate level of repairable item that can be readily diagnosed and replaced at the equipment site. They include electronic items such as circuit cards, modules and assemblies.

8 Deeper Maintenance includes scheduled maintenance, unscheduled maintenance and repairs, which require extensive Repairable Item dismantling in specialised jigs, and the use of specialised support equipment, technical skills or industrialised facilities.

Figure 1.1

Air Combat Fleet Support Structure



Source: Australian National Audit Office.

1.5 The Defence Science and Technology Organisation (DSTO), Original Equipment Manufacturers (OEMs), the ADF's Directorate General of Technical Airworthiness (DGTA) and Air Force's Aircraft Research and Development Unit (ARDU), provide DMO with scientific, engineering and equipment manufacturing support, aircraft design, maintenance policy and management guidelines, and aircraft and related systems test and evaluation support.

1.6 Given the importance placed on the ADF's airborne capabilities, and the subsequent need to develop a highly-reliable organisational capacity to properly maintain those capabilities, Air Force spent over a decade refining its aircraft fleet support structures, relationships and management processes. This effort may be summarised as follows:

- The formation in the early 1990s of a Logistics Management Squadron (LMSQN) for each Air Force weapon system. These squadrons provided each RAAF aircraft fleet with improved engineering and logistics support, through the integration of each fleet's engineering and logistics support organisation and their location adjacent to Air Force's operational squadrons;

- The formation of the Directorate of Technical Airworthiness – Air Force in 1993, which evolved into the Australian Defence Force's Directorate General Technical Airworthiness in 1998. DGTA develops and audits the implementation of technical regulations covering engineering and maintenance support of all ADF aircraft and associated systems. This is done on behalf of the Chief of Air Force who is the ADF's Airworthiness Authority. DGTA concentrates on the approval of organisations and the processes they follow, rather than approving the work itself;

- The formation of the ADF's Airworthiness Coordination and Policy Agency in 1998 which, on behalf of the Chief of Air Force, provides high-level oversight and audit of ADF aircraft fleet technical and operational airworthiness. This is primarily achieved through annual airworthiness reviews of the fleets, which are conducted by Airworthiness Boards comprised of aviation experts independent of the specific fleet under review. These boards advise and make recommendations to the Chief of Air Force on ADF aircraft type certification, Service Release and in-service management;

- The formation of DMO's Systems Program Offices (SPOs) in 2000. This removed the organisational and geographic divide between acquisition and in-service support, by holding SPO Directors responsible for managing the acquisition, through-life logistics support and disposal phases of Defence's capital equipment life-cycle. In the case of Air Force fleets, this was achieved by merging the acquisition project teams from the former Defence Acquisition Organisation (DAO) into the much larger Logistics Management Squadrons;

- The expansion of Defence's commercial support program from the mid 1990s. This further improved fleet in-service support by enabling the LMSQNs/SPOs to more closely engage with industry. Closer engagement allows for improved aircraft engineering and maintenance through increased in-service support knowledge development, sharing and retention.

- The adoption of business-like management practices enabled by the above organisational changes. These practices focus on achieving continuous improvements through adherence to approved processes, measurement of performance, and openness to external reviews and regulatory oversight. Together these practices have led to effective teamwork between the SPOs, their supporting contractors, and their Air Force operational units.

F-111 maintenance and upgrade management

1.7 The F-111 fleet maintenance and capability upgrades are managed by the DMO's Strike Reconnaissance System Program Office (Strike Reconnaissance SPO), located at Amberley, Queensland.[9] Strike Reconnaissance SPO had 100 employees in July 2006. Of these, 28 were ADF personnel and the remaining 72 were full-time Australian Public Service (APS) personnel. The APS turnover rate for the previous year was seven per cent, and the ADF personnel turnover rate was 30 per cent.

1.8 Strike Reconnaissance SPO is responsible for delivering maintenance products and services that meet the agreed F-111 availability target defined in

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[9] Since 2005–06, DMO SPOs work to performance agreements known as Materiel Acquisition Agreements with Capability Development Group and Materiel Sustainment Agreements with ADF Groups.

the Materiel Sustainment Agreement with Air Force. This is achieved predominantly through setting maintenance requirements and monitoring and verifying the contractors' performance of their contractual obligations. Interactions between Strike Reconnaissance SPO and its contractors have matured beyond arm's length contractual relationships to include the formation of an F-111 Support Management Board comprising senior representatives from Strike Reconnaissance SPO, Headquarters ACG, ACG's 82 Wing and the F-111 support contractors. This board is supported by Integrated Management Teams.[10] Strike Reconnaissance SPO also has a close working relationship with F-111 maintenance squadrons within 82 Wing, which is underpinned by the Materiel Sustainment Agreement between DMO and Air Force.

1.9 Strike Reconnaissance SPO's F-111 in-service support expenditure excluding salaries, salary related allowances and military workforce charges, totalled $131.13 million in 2005–06. This was within one per cent of its $129.91 million budget. Strike Reconnaissance SPO spent a further $17.60 million on capital projects, against a total capital project budget of $23.73 million. F-111 in-service support is primarily delivered by four Contractors and two ACG squadrons.

Hornet and Hawk maintenance and upgrade management

1.10 The Hornet and Hawk fleet maintenance and capability upgrades are managed by DMO's Tactical Fighter Systems Program Office (Tactical Fighter SPO), located at Williamtown. Tactical Fighter SPO had 267 employees in July 2006. Of these, 144 were full-time APS personnel and the remaining 123 were ADF personnel. The APS turnover rate over the previous year was 13 per cent and the ADF personnel turnover rate was 36 per cent. These turnover rates are based on the standard formula of dividing the total number of personnel that left the organisation during the last 12 month period by the total number of personnel at the beginning of that period.

1.11 When personnel transfers or promotions within an organisation are included in an organisation's turnover calculation, this produces a higher

10 The Integrated Management Teams comprise the range of specialists needed to coordinate specific business areas and to propose business solutions for Management Board approval. Their areas of interest span Operational Maintenance support, supply chain management, performance measurement, the impact on industry of the F-111 withdrawal from service announcement, and general fleet management issues.

turnover rate. In Tactical Fighter SPO's case, its APS total turnover rate was 26 per cent based on 19 internal transfers and promotions and 17 departures. This brings Tactical Fighter SPO's APS turnover rate closer to the 33 per cent turnover rate, which occurs with the ADF's standard three-year posting cycle.

1.12 Tactical Fighter SPO is responsible for delivering maintenance products and services that meet agreed Hornet and Hawk fleet availability targets defined in the Materiel Sustainment Agreement with Air Force. This is achieved through setting maintenance requirements and monitoring and verifying the performance of its 30 Hornet maintenance contractors and its Hawk maintenance contractor. These are underpinned by maintenance and service contracts.

1.13 The Hornet Upgrade program required Tactical Fighter SPO to establish a local industry capability to conduct large-scale on-aircraft modifications and Deeper Maintenance. This resulted in Boeing Australia Limited, L-3 Communications MAS Canada Inc. and BAE SYSTEMS Australia Ltd forming the Hornet Industry Coalition in February 2003. Tactical Fighter SPO and the coalition work together through steering groups, management boards, integrated management teams and working groups.[11] In 2006 Tactical Fighter SPO and the coalition signed a Hornet Aircraft Support Head Agreement, which seeks to increase contracting efficiency by establishing a generic set of agreed terms and conditions for the work performed by the coalition. A key aspect of this agreement is the sharing of knowledge and information under protection of confidentiality agreements between all parties.

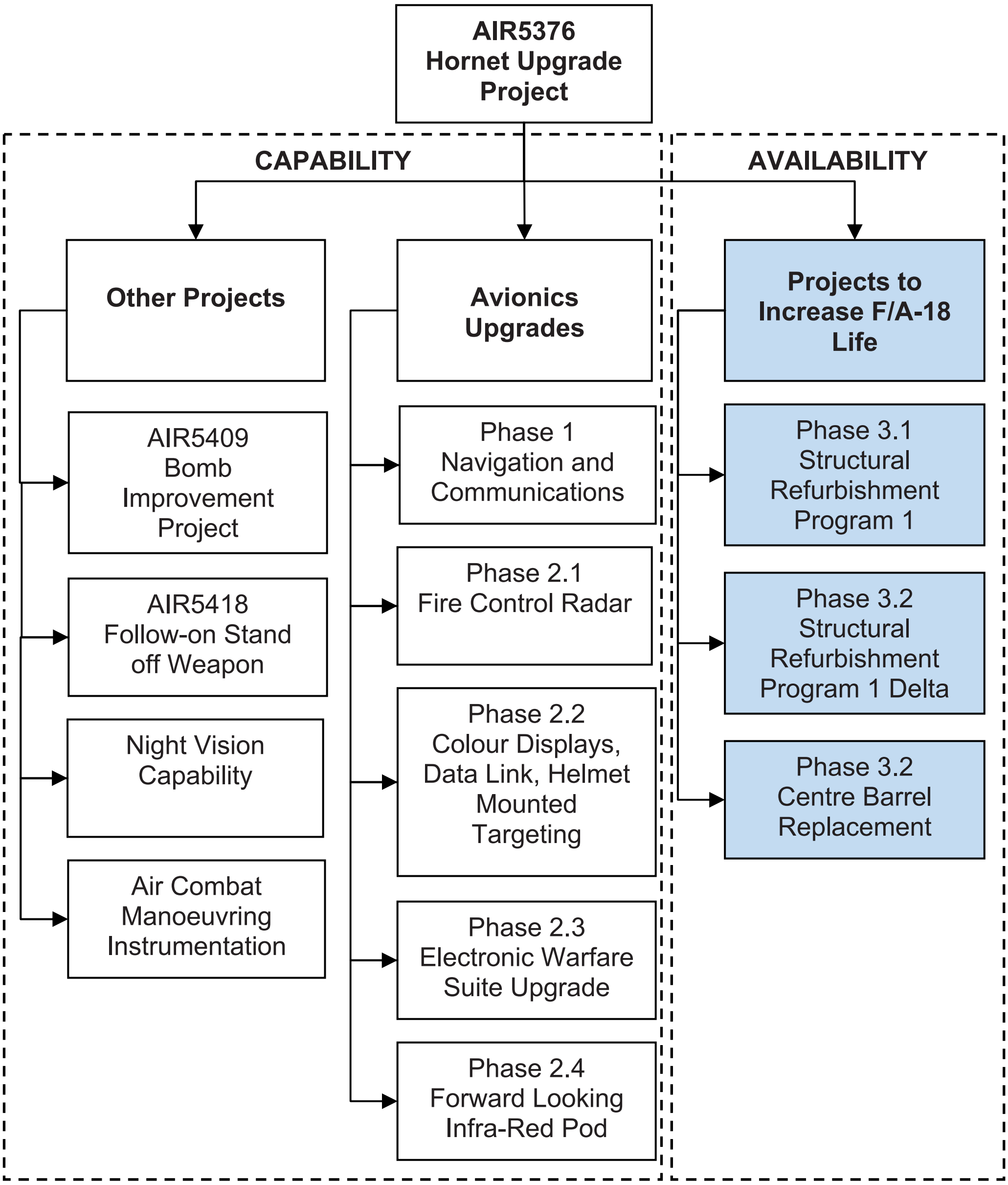
1.14 In 2005–06 Tactical Fighter SPO's in-service support expenditure excluding salaries, salary related allowances and military workforce charges totalled $152.96 million and $39.62 million for the Hornet and Hawk fleets respectively. The overall total expenditure of $192.58 million was within 0.4 per cent of the $193.47 million budget. Tactical Fighter SPO spent

[11] Tactical Fighter SPO is seeking to maintain the integrity of its formal contracts by gaining agreement that none of the arrangements or the records taken at meetings are to be construed as establishing formal contractual arrangement between the parties, or amending any contractual or other authority established by contract or law. The participants in each of the forums are required to act only in accordance with the authority and capacity inherent in their positions within their parent organisations. In that regard, the decisions and agreements reached within the forums only represent advice to those who have the authority to carry out what has been recommended. However, by participating jointly within the management framework, the parties plan to gain synergy, and to improve effectiveness and efficiency by mutual cooperation towards common goals.

$142.85 million on capital projects mainly related to the Hornet Upgrade (HUG) project outlined in Figure 1.2.

Figure 1.2

HUG project outline: August 2006



Source: Defence Materiel Organisation, Tactical Fighter Systems Program Office.

1.15 The HUG project aims to enhance the Hornets' capabilities and to extend their service life until their planned withdrawal date of 2012–15. Tactical Fighter SPO advised the ANAO that as at November 2006, the HUG project had an estimated cost of some $2.92 billion and was comprised of three phases:

- Phase 1 was completed in 2002, at a cost of some $284.5 million;
- Phase 2 is underway and as at November 2006, $1.03 billion of its $1.65 billion budget had been spent; and

1.16 Phase 3 is underway and as at November 2006, $135.2 million of its $977 million budget had been spent. The project's structural refurbishment phases are shaded in blue, and these are included in the audit as they form part of the work required to ensure the Hornet fleet is available for operations until it is withdrawn from service.

Audit approach

1.17 The audit scope covers key issues related to ADF's F-111, Hornet and Hawk Lead-in fighter fleet in-service support. The audit objective was to assess the effectiveness of the fleets' in-service support arrangements. Capital equipment acquisition projects covered by this report are limited to the Hornet and F-111 structural refurbishment projects. The audit examined the in-service support of the fleets from an outcomes perspective, by drawing on the performance information used by each SPO to manage their programs.

1.18 The audit fieldwork was conducted between February and November 2006, at the Williamtown, Amberley and Tindal Air Force Bases, and at DSTO's Air Vehicles Division, Fishermans Bend, Melbourne. The fieldwork involved interviewing relevant Air Combat fleet in-service support personnel and examining relevant computer records and documents.

1.19 The audit was conducted in accordance with ANAO auditing standards at a cost to the ANAO of $335 000.

Report structure

1.20 The remainder of the report is organised into five chapters. Chapter 2 discusses the management systems used by Strike Reconnaissance SPO and Tactical Fighter SPO, their compliance with the ADF's technical regulations, and engineering and technical workforce training. Chapters 3 and 4 discuss each fleet's in-service support arrangements. Chapter 5 discusses the Hornet, Hawk and F-111 fleet structural integrity issues, and the steps taken to ensure each fleet's service life meets or exceeds their planned withdrawal dates.

2. Fleet Management Framework

This chapter discusses Air Combat fleet management systems, airworthiness management, and ADF aircraft engineering and maintenance personnel training.

Background

2.1 Tactical Fighter SPO and Strike Reconnaissance SPO's primary responsibility is to make available to Air Force the number of aircraft specified within Materiel Sustainability Agreements between DMO and Air Force. This requires each SPO to manage its program within a complex mix of factors, some often beyond their control. These factors include:

- Defence funding priorities, this determines the size of each aircraft fleet, and the extent of its in-service support;
- Deeper Maintenance capacity, which is determined by the size of the skilled workforce in industry. This dictates the completion rates of aircraft Deeper Maintenance and capability upgrades;
- Operational Maintenance capacity, which is determined by the size of the skilled workforce in Air Force. This dictates the completion rates of aircraft Operational Maintenance, and Deeper Maintenance routines;
- Capability upgrade requirements, which are determined by the need to maintain a regionally relevant capability. These dictate the frequency and extent of aircraft capability upgrades; and
- Extensive maintenance demands of advanced combat aircraft. These aircraft are designed to strict weight limitations and demanding performance requirements, which reduce the scope for extensive structural integrity margins through heavy construction, and extensive system safety margins through backup systems.

2.2 The SPOs' day-to-day activities range from program management tasks, to highly specialised management responsibilities, such as maintaining logistics management systems and processes that comply with airworthiness regulations. SPO management tasks include maintaining an approved range of plans and management processes and providing program status and financial reports to DMO's senior executives. Most of the Air Combat fleet's Deeper Maintenance is contracted out, hence both SPOs are responsible for monitoring the performance of their contractors, as well as maintaining close working relationships with the Air Force squadrons that conduct the fleet's Operational Maintenance and selected Deeper Maintenance.

Program management plans, processes and systems

2.3 Tactical Fighter SPO and Strike Reconnaissance SPO each have well-established management policies and processes set out in a hierarchy of business plans, technical plans and standing instructions, to ensure their personnel and the organisations supporting the SPOs are effectively coordinated, and remain compliant with the ADF's technical airworthiness management regulations. These management policies and processes are required by airworthiness regulations to be managed within a Quality Management System (QMS).[12]

2.4 Tactical Fighter SPO and Strike Reconnaissance SPO hold current ISO 9001:2000 *Quality Management Systems Requirements* compliance certificates, covering their management plans and processes, and these plans and processes conformed to the ADF's technical regulations.

2.5 DMO commenced to standardise its management policies, processes and practices in 2002, with the intention of making the standardised set available to its personnel through its internal IT system by 2005. In April 2003 DMO made the evolving documents accessible to all DMO personnel through a centrally controlled intranet-based online software application called the Quality and Environmental Management System (QEMS). As at August 2006 DMO had not established QEMS at the level of standardisation envisaged in 2002. Rather, QEMS was being used as a publishing tool that provided DMO personnel with visibility of management documents linked to it.

Project schedule and status reporting

2.6 DMO commenced developing the Improve Project Scheduling and Status Reporting (IPSSR) system in 2002, with the aim of reducing time spent

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[12] The management plans and processes are reviewed through periodic internal QMS audits, two yearly technical regulation compliance audits by the Airworthiness Regulation personnel within the Directorate General Technical Airworthiness-ADF, and two yearly QMS certification audits by a third party ISO quality system certification firm.

on managing and reporting project performance, and providing greater control over projects and contractors.

2.7 Tactical Fighter SPO and Strike Reconnaissance SPO each have dedicated project control and schedule specialists, and use IPSSR for reporting acquisition project performance. Strike Reconnaissance SPO's IPSSR system automatically imports project work break-down structure and schedule data from its Contractors' cost and schedule control systems. This reduces the risk of data transfer errors, but increases the need for the SPO to validate the data by frequent cost and schedule control system surveillance audits.

2.8 Tactical Fighter SPO has not configured its IPSSR system to automatically import contractors' data. Tactical Fighter SPO prefers to analyse and validate contractors' schedule and progress data prior to manually loading that data into IPSSR. As at August 2006 each of Tactical Fighter SPO's four HUG sub-Phases had a designated IPSSR project control and schedule specialist, and these projects remained fully compliant with DMO's IPSSR requirements.

Fleet management systems

2.9 Strike Reconnaissance SPO has used a highly-dynamic set of integrated software packages, known as Fleet Doctor, since 1995. Strike Reconnaissance SPO has tailored and populated Fleet Doctor for F-111 maintenance and modification planning, fleet performance analysis and evaluations, and fleet availability management. This includes using Fleet Doctor to model F-111 maintenance program options in order to meet operational requirements through to the F-111 fleet's planned withdrawal date.

2.10 Tactical Fighter SPO uses another management program known as FOXY to account for the complexity of the Hornet Upgrade program. FOXY provides Tactical Fighter SPO with an ability to develop and test a range of aircraft availability scenarios based on a complex mix of flying operations requirements, structural fatigue consumption, Hornet routine servicing and upgrade requirements, and industry capability constraints. This program is capable of determining the production schedule options that best suit operational requirements and the Hornet upgrade program.

Maintenance and logistics management systems

2.11 ADF and contractor organisations are required to implement maintenance management systems that satisfy the ADF's technical airworthiness regulations. Tactical Fighter SPO and Strike Reconnaissance SPO's primary maintenance management system is the Computer Aided Maintenance Management version 2 (CAMM2).[13] CAMM2 contains records of the physical state of each aircraft and associated systems, in terms of scheduled maintenance and maintenance resulting in aircraft item removal or installation.

2.12 In 2004 DGTA reviewed CAMM2's implementation by Strike Reconnaissance SPO Contractor units responsible for F-111 maintenance, and also its implementation by Air Force's 82 Wing. DGTA then conducted a CAMM2 surveillance compliance audit of Strike Reconnaissance SPO Contractor units in 2005, which raised eight observations that have now been actioned.

2.13 In 2004 Tactical Fighter SPO found CAMM2 to be incapable of processing maintenance forecasting and scheduling of Hornet engine components, and determined that it may not be cost effective to provide CAMM2 with that capability. Consequently, Tactical Fighter SPO continued to use the Engine Service Life Monitoring Program (ESLMP) to manage the service life of Hornet engine components.

2.14 Tactical Fighter SPO and Strike Reconnaissance SPO personnel also use a combination of other highly-specialised logistics management systems that include:

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[13] CAMM2 has been used with restrictions in Hornet and Hawk fleet support since 1999 and 2000 respectively, and with restrictions in F-111 fleet support since 2004. Prior to 2004, the F-111 fleet maintenance management was conducted using an earlier version of CAMM, which was in use by Air Force since the early 1980s. Used in conjunction with CAAM2, is the Australian Defence Aviation Authorised Spares System (ADAASS), which lists spare parts authorised for installation in ADF aircraft and associated systems. In special circumstances, items listed in approved Modification Orders, or in AEO authorised engineering documentation may also be installed in aircraft.

- SDSS (Standard Defence Supply System), which is used to monitor spares inventory stock levels, generate automated stock re-ordering against actual usage, and to record stock transaction histories;[14]
- BRIAN (Basic Repairable Item Analysis Network), which is used by Tactical Fighter SPO to track Repairable Item work orders and their history, by manual entries of data from the other logistics management systems;[15]
- AIMS (Advanced Inventory Management System), which is used to determine provisioning requirements for Breakdown Spares and Repairable Items, and
- NetMAARS (Networked Maintenance Activity Analysis and Reporting System), which uses data mining software to collect, collate, analyse and report aircraft fleet maintenance data.

2.15 As most of these systems use the Defence Restricted Network (DRN), they suffer operation delays caused by DRN congestion. This congestion is likely to increase in line with the ADF and DMO's increasing reliance on Logistics Information Systems. There may be cost-effective efficiency improvements to be gained by reducing DRN congestion.

2.16 Defence's upgrade of its Standard Operating Environment, from Windows NT to Windows XP, cannot be fully implemented in Strike Reconnaissance SPO and Tactical Fighter SPO as there are several ADF aircraft engineering and in-service support databases that require testing before operating under Windows XP. These include the Structural Information System database and BRIAN.

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14 Tactical Fighter SPO uses SDSS to manage the 52 000 lines of spares needed to support the Hornet and associated systems. These consist of 7 200 lines of Hornet Repairable Items valued at $43 million and 44 800 lines of Breakdown Spares valued at $69.5 million. In 2005–06, Tactical Fighter SPO arranged the repair of 2 834 Repairable Items. Of these, 1 730 were purchased from local firms using SDSS; 594 were purchased via the US Foreign Military Sales using SDSS order forms, and 510 were purchased from firms overseas using ROMAN. Similarly, Strike Reconnaissance SPO and its contractors use SDSS to manage the 61 112 lines of spares needed to support the F-111 and associated systems. These consist of 3 565 lines of F-111 Repairable Items valued at $1.046 billion and 57 547 lines of Breakdown Spares valued at $0.345 billion. For the Hawk fleet, its in-service support is the responsibility of the Australian subsidiary of the Hawk original equipment manufacturer BAE. Consequently, the vast majority of Hawk fleet spares are managed by BAE SYSTEMS using its Ultramain Maintenance Management System.

15 SDSS, ROMAN, CAMM2, AIMS and FALCON are the primary work order tracking systems.

2.17 As at October 2006 Tactical Fighter SPO had quarantined some 170 of its 352 computer terminals from the Windows XP upgrade, so that they could continue to be used in their fleet engineering and in-service support roles. At the same time, Strike Reconnaissance SPO had quarantined 5 of its 173 terminals in specialist workstation arrangements for the same reason. This has prevented the SPOs from fully benefiting from the upgrade, and has complicated the Information System management in terms of user account management, software package licensing, and the use and configuration of computer peripherals.

Financial management systems

2.18 There remains scope for improved management system integration in DMO. SPO personnel are required to manually enter data into four separate finance systems;

- SDSS to track Repairable Item and Breakdown Spares quantities and locations and to raise purchase orders in Australian dollars;
- ROMAN (Resource and Output Management Accounting Network) to process purchase orders and invoice payments;
- FALCON (Financial Accounting Logistics On-line Network) to track financial commitments and expenditure against budgets; and
- BRIAN to track Repairable Item work orders.

2.19 This results in inefficient resource usage and increases the risk of financial data errors through transcription errors. Defence's Joint Project 2077, *Military Integrated Logistics Information System*, aims to resolve those issues by integrating several Defence logistics management systems.[16]

2.20 Many of the 7 200 lines of Hornet Repairable Items are repaired in the United States of America (US), where they attract repair costs which are paid in US dollars. SDSS is unable to process these foreign currency transactions. This has supply chain management and accounting accuracy implications.

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[16] The Defence Capability Plan 2006–2016 lists JP2077 having an overall cost estimate of $150 million for initial in-service delivery, and $350 to $450 million for its final in-service delivery. These deliveries are scheduled for 2012 to 2014. JP2077's main focus is on inventory management and not systems engineering and maintenance. Also, it may not be funded to increase the DRN's capacity, even though it will most probably place greater demands on the DRN.

SDSS's foreign currency limitation compels Tactical Fighter SPO personnel to conduct a complicated time-consuming Repairable Item management process for repairs that attract foreign currency charges. This process impedes efficient supply chain management, and increases accounting accuracy risks.

Recommendation No.1

2.21 The ANAO recommends that Defence and Defence Materiel Organisation consider the cost and benefits of upgrading its Standard Defence Supply System to include foreign currency processing capability for Repairable Items.

Defence Response

2.22 Agreed with qualification. Defence and DMO note that the ANAO report outlines (Para 2.20) issues that arise from the use of both ROMAN and SDSS to manage the procurement of repair services from an overseas Defence agency. Current protocols mandate the use of ROMAN as the procurement tool. SDSS is not required to support overseas procurement and therefore it has not been fitted with FOREX capabilities. DMO will conduct a cost benefit study of the viability of conducting overseas procurement of repairable items through the Military Integrated Logistics Information System, the system replacing SDSS under JP2077.

Fleet technical airworthiness management

2.23 The ADF's technical airworthiness management system is designed to ensure aircraft:

- safety is maximised through competent design, construction and maintenance;
- service life is maximised through reduced structural fatigue and corrosion; and
- operational capability is maximised by operating to approved standards.

2.24 The ADF seeks to achieve an adequate level of safety, service life and capability assurance through approved systems, processes and management controls. Defence organisations and contractors involved with ADF aircraft engineering are required to attain Authorised Engineering Organisation (AEO) certification based on approved Engineering Management Systems. These systems are implemented by defined organisations headed by Senior Design Engineers and have been audited by DGTA. Similarly, Defence organisations and contractors involved in ADF aircraft maintenance are required to attain Authorised Maintenance Organisation (AMO) certifications based on Maintenance Management Systems. These are implemented by defined organisations headed by Senior Maintenance Managers and have been audited by DGTA.

2.25 The ADF's AEO and AMO authorisations aim to provide high-confidence that the organisation has:[17]

- Technical management systems, documented in Engineering or Maintenance Plans, which are appropriate for the type of work being performed. These include quality management systems such as ISO 9001, technical management systems, engineering or maintenance management systems, design or maintenance support networks, and configuration management systems;
- 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 and maintenance activities. These include procedures and plans to specify and define technical activities, that must be controlled and approved by an appropriately qualified individual nominated within the quality system; and
- Data applied to, and derived from, technical activities that are accessible, authoritative, accurate, appropriate and complete.

2.26 AMOs are also required to have authorised maintenance and storage facilities.

2.27 Given the number of organisations involved in air combat fleet engineering and maintenance support, and the complicated nature of AEO and AMO surveillance compliance audits, the ANAO did not conduct its own AEO and AMO surveillance compliance audits. Instead the ANAO relied on Defence's records and management assertions on these audits.

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[17] Australian Defence Force, Australian Air Publication 7001.053, *Technical Airworthiness Management Manual*, Section 3 Chapter 1, and Section 4 Chapter 1.

Hornet and Hawk fleet engineering management

2.28 Tactical Fighter SPO retains overall responsibility for ensuring the effective provision of Hornet and Hawk fleet engineering support, and is accountable for the technical airworthiness of the Hornet and Hawk fleets. In November 1995 Tactical Fighter SPO's predecessor received AEO certification from DGTA, on the basis of its Engineering Management System as documented in its Engineering Management Plan.[18] In February 2002 Tactical Fighter SPO underwent an expansion in scope of engineering authority to include Design Acceptance of Hawk aircraft. Since attaining AEO certification Tactical Fighter SPO has undergone recurrent surveillance compliance audits by DGTA, with the most recent occurring in June 2006. That audit resulted in no corrective action requests.

2.29 Tactical Fighter SPO is responsible for maintaining effective Hornet fleet engineering management functions including Design Acceptance, configuration management, drawing and document management, and type certification management. However, regarding the Hawk fleet, whilst Tactical Fighter SPO's Senior Design Engineer is responsible to DGTA for the technical integrity of the Hawk fleet, BAE SYSTEMS is responsible for the day-to-day engineering and logistics management of the fleet under its Total Logistics Support Contract with Defence.[19]

2.30 Tactical Fighter SPO is supported by seven contractors that provide engineering services and hold AEO certifications, of these, one is sponsored by DGTA. The AEOs undergo a technical regulations surveillance compliance audit every two years, which is conducted by Tactical Fighter SPO. The remaining contractor sponsored by DGTA is audited by DGTA every two years.

2.31 Tactical Fighter SPO is also supported by some 20 other contractors, such as the Hornet Original Equipment Manufacturers, and by the US Navy.

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[18] Tactical Fighter SPO was formed in August 2000 through the amalgamation of the Tactical Fighter Logistics Management Squadron (TFLMSQN), the Lead-In Fighter Project Office, the Tactical Fighter Project Office, and the Tactical Fighter Weapon System Support Facility, which transferred from ACG to Tactical Fighter SPO.

[19] Tactical Fighter SPO's Senior Design Engineer is delegated by DGTA as the Design Acceptance Representative (DAR) for the Hornet and Hawk fleets. In that capacity, the Senior Design Engineer may accept aircraft and related system design changes, which may emanate from contractor or ADF AEOs, on behalf of the Commonwealth.

These contractors provide engineering services but do not hold AEO certification, as Defence's Technical Airworthiness Regulations recognise the certification systems of the United States National Airworthiness Authorities.

F-111 fleet engineering management

2.32 Strike Reconnaissance SPO retains overall responsibility for ensuring the effective provision of F-111 fleet design and maintenance support delivered by four contractors. Strike Reconnaissance SPO is accountable for the technical airworthiness of the F-111s, and has undergone recurrent AEO surveillance compliance audits by DGTA, with the most recent occurring in April 2005. This audit resulted in one corrective action request, which DGTA closed in July 2005 following a review of Strike Reconnaissance SPO's corrective actions. The next audit was due in late 2006.

2.33 The four contractors that provide Strike Reconnaissance SPO with F-111 design support hold AEO certifications, and have undergone AEO surveillance compliance audits by Strike Reconnaissance SPO since 2004. As at July 2006 only one contractor had outstanding corrective action requests and it was in the process of addressing them.

Hornet and Hawk fleet maintenance management

2.34 Tactical Fighter SPO is responsible for monitoring the technical regulation compliance status of its contractors. As at August 2006, 15 of the 31 contractors that provide Hornet and Hawk fleet maintenance support had AMO certifications and 10 had received exemptions from AMO certification from DGTA. Of the remaining four contractors, three are working under Tactical Fighter SPO assigned Temporary Maintenance Authority while awaiting transfer to the Maintenance Support Network of prime contractors, and the remaining one is awaiting AMO requirements to be confirmed.

2.35 The Air Force squadrons that provide maintenance support to the Hornet and Hawk fleets have AMO certifications, and surveillance compliance audits in 2005 and 2006 resulted in minor corrective action requests only.

F-111 fleet maintenance management

2.36 The four contractors that provide maintenance support to the F-111 fleet hold AMO certifications by DGTA. The AMO surveillance compliance audits conducted by DGTA and Strike Reconnaissance SPO personnel in 2005 confirmed that the Contractors' maintenance personnel remained appropriately trained. They also confirmed that the contractors' maintenance personnel were being assessed and authorised on an annual basis in accordance with ADF regulatory requirements. DGTA has assessed the contractors as presenting low risk to F-111 airworthiness.[20] However, Strike Reconnaissance SPO's monitoring of contractor staffing levels has identified a gradual decline in F-111 maintenance experience, and Strike Reconnaissance SPO recognise that this emerging issue requires careful management as the F-111 fleet approaches its planned withdrawal date.

2.37 The two Air Force squadrons that provide maintenance support to the F-111 fleet have AMO certifications, and regulation surveillance compliance audits conducted by DGTA in 2005 resulted in two major corrective action requests. These requests were subsequently satisfied and the matters closed. In October 2006 the squadrons had seven minor corrective action requests, four of which had been actioned and their closure sought from DGTA. The remaining three were still being addressed in October 2006.

ADF aircraft engineering and maintenance personnel training

2.38 The F-111 technical workforce has satisfied technical regulation requirements, as indicated by the continuation of their AMO certifications. ACG's July 2006 F-111 Annual Airworthiness Board Submission, reports there were 53 maintenance-related Aircraft Safety Occurrence Reports, down some 30 per cent from the previous year, and 51 Maintenance Deficiency Reports. The cited causes of the Aircraft Safety Occurrence Reports were knowledge based errors, and violations and failures to follow procedures and supervision. This indicates need for improved technical workforce training and career development opportunities within the squadrons.

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[20] DGTA Submission for ACS/ACG Airworthiness Review for the A08 F 111, 24 July 2006.

2.39 The Hornet and Hawk technical workforce has satisfied technical regulation requirements, as indicated by the continuation of their AMO certifications. ACG's 2006 Annual Review of Serviceable Release for the Hornet fleet, reports there were 63 maintenance related Aircraft Safety Occurrence Reports, down from 79 in the previous year. The cited causes of the Aircraft Safety Occurrence Reports related to documentation and publication errors; policy, procedures or directive issues; flightline or aircraft handling; and foreign object damage. 81 Wing considers that its achievement of satisfactory DGTA and ACG audit results indicates that Hornet AMOs were functioning effectively, and that the issues identified in the Aircraft Safety Occurrence Reports can be managed by ACG's Senior Maintenance Managers. The 2006 review reported that improved Maintenance Manager training has been developed to address oversight and documentation errors within the Maintenance Control System. ACG's 2006 Hawk 127 Air Worthiness Board Submission – Operational Maintenance, notes there were 48 maintenance related Aircraft Safety Occurrence Reports. The cited causes of these reports related mainly to maintenance knowledge, skills, supervision and substandard equipment.

2.40 The open and transparent reporting environment of the kind that generated these Aircraft Safety Occurrence Reports provides vital feedback on the effectiveness and safety of ACG's Operational Maintenance function.

Engineering and technical workforce turnover rates

2.41 In 2005–06 Strike Reconnaissance SPO, and Tactical Fighter SPO had ADF personnel turnover rates of 30 and 36 per cent respectively, which accords with Air Force policy of a three-year posting cycle. These rates may contribute to the loss of staff continuity and corporate knowledge. However, loss of corporate knowledge is largely mitigated by the SPOs' management systems, which feature extensive record keeping procedures and systems. Also from a personnel recruitment and training perspective, the ADF postings are largely managed by Air Force and often involve Air Force personnel already experienced in the F-111 and Hornet fleet support. Accordingly, the degree of recruitment and training overheads incurred by the SPOs is less than that which typically occurs with civilian appointees.

2.42 ADF personnel turnover rates mainly result from ADF engineers and technical personnel career development, which require completion of a mix of technical education and training; military training and leadership experience; specialist engineering and technical support experience; and contracting, finance and project management experience. All these elements contribute to the creation of aircraft in-service support knowledge, spanning operational outcomes required by ADF units through to the skills needed by the next generation of engineers, technicians and managers.[21]

Engineer training and development

2.43 Defence personnel who perform Design Acceptance activities on behalf of the Commonwealth, require wide-ranging engineering expertise and experience, so that they may apply engineering rigour and process to Design Acceptance tasks, rather than simply apply a quality check of the design process. Design Acceptance is a key product acquisition function involving the determination of whether or not a product is, or would be, of technical acceptability by the ADF. Its purpose is to provide confidence to ADF agencies and staff that the product is safe and fit for purpose.[22] Following Design Acceptance is Service Release, which is a determination that the necessary operational and logistics support systems are in place to adequately support the product when it is operated as intended.

2.44 The engineering expertise necessary for Design Acceptance and Service Release may take a decade to develop, and require the engineer to ideally gain experience in:

- aircraft maintenance engineering carried out by Air Force squadrons;
- aircraft design standards, airworthiness certification standards and technical airworthiness regulation carried out by DGTA;
- project engineering management, and sustainment engineering management carried out within DMO SPOs; and

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21 Strike Reconnaissance SPO and Tactical Fighter SPO, since their initial formation as Air Force Logistics Management squadrons in the early 1990s, have been managed by a succession of ADF personnel having skills and experience developed through the Air Force training system.

22 ADF Design Acceptance is intrinsically a Defence function and cannot be contracted out. It applies to all equipment and commences at equipment specification stage and ends with Design Acceptance Certification. Aircraft Design Acceptance is to be carried out by Design Acceptance Representatives personally appointed by the ADF's Director General Technical Airworthiness. However, Design Acceptance may be 'assumed' by commercial AEOs acting within specified situations and in accordance with approved procedures. *Technical Airworthiness Maintenance Manual*, Section 3 Chapter 7.

- aircraft Deeper Maintenance and complex modifications carried out by commercial organisations.

2.45 ACG's July 2006 F-111 Annual Airworthiness Board Submission indicates that such exposure is not always achieved by Air Force personnel because limitations associated with the opportunities available to gain aircraft design, logistics management and Deeper Maintenance management experience.

2.46 Similarly, Strike Reconnaissance SPO and Tactical Fighter SPO personnel have limited opportunities to gain design experience. The substantial AEO and AMO support Strike Reconnaissance SPO receives from its contractors has resulted in the SPO's design development, review and approval tasks being reduced to design specification approvals and Design Acceptance for project engineering activities.[23] This has reduced Strike Reconnaissance SPO's ability to provide its junior engineers with the design experience required to satisfy the Design Engineer eligibility criteria set by DGTA. To address that situation, Strike Reconnaissance SPO placed one of its engineers into DMO's F-111 engine maintenance facility and two engineers into Boeing's F-111 structure design office. Tactical Fighter SPO has a similar issue with Hawk design engineering as a result of BAE SYSTEMS being responsible for virtually all engineering activity associated with the Hawk fleet.

2.47 The net result of the commercialisation of engineering functions has decreased the number of Air Force Senior Maintenance Manager positions, while the number of Design Acceptance Representatives has remained the same. This has resulted in constrained opportunities for Air Force Engineering Officers to gain Deeper Maintenance and complex modification experience, and in turn this has lead to fewer Air Force personnel progressing through engineering officer development to Design Acceptance Representative and Senior Maintenance Manager roles. This results in Air Force being more susceptible to the experience loss through departures from the service.

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[23] Unlike Design Acceptance, design reviews and approval may be contracted out. The ADF's technical airworthiness regulations require all significant (high risk) designs to be personally approved by an AEO's Senior Design Engineer or by appropriately delegated Deputy Senior Design Engineers. Non-significant designs may be approved by persons authorised by Senior Design Engineers. All designs must be independently reviewed by competent persons.

Senior Maintenance Manager levels of experience

2.48 Air Force Squadron Senior Maintenance Managers are responsible for ensuring that effective management and control systems are established and maintained within the AMO to monitor and maintain compliance with approved procedures, standards and practices. These engineers require aircraft maintenance and design expertise, so that they may accept overall responsibility for maintaining the airworthiness of aircraft or aeronautical products in their charge.

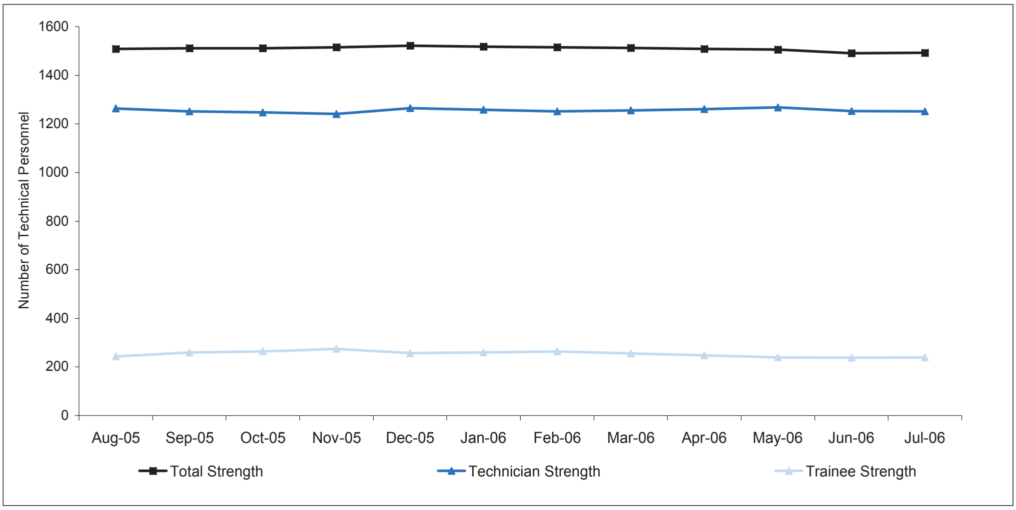
2.49 Senior Maintenance Managers also need to liaise closely with DMO SPOs, DGTA, and the commercial organisations that provide Deeper Maintenance. Experience in those organisations would benefit Senior Maintenance Manager competence and effectiveness. This experience begins with the junior ranks but the ability to gain that experience has diminished under the Defence's Commercial Support Program. As at October 2006 some 70 per cent of ACG's Senior Maintenance Managers had SPO experience, 20 per cent had DGTA experience and 10 per cent had commercial experience.

Air Force technical personnel training

2.50 ACG is experiencing shortfalls in its number of fully qualified technical personnel, and shortfalls in the experience held by F-111 and Hornet technicians, tradesmen and trade supervisors. Figure 2.1 shows ACG's technical workforce in terms of its total strength, the number of fully qualified technicians and the number of trainees undertaking on-the-job training to become fully qualified technicians. It indicates that some 17 per cent of ACG's workforce are yet to become fully qualified. This results from a shift in technical workforce training policy from the tradition of extensive technical training being provided prior to flightline maintenance assignments, to more extensive on-the-job training at the flightlines.

Figure 2.1

Air Combat Group technical workforce, August 2005 to July 2006.



Source: Royal Australian Air Force, Air Combat Group.

2.51 The on-the-job training load placed on the squadrons is increasing due to:

- increased maintenance requirements associated with ageing aircraft;
- increased maintenance training associated with the introduction of upgraded systems;[24]
- increased regulatory compliance associated with AMO certification; and
- increased logistics governance associated with asset and equipment accounting.

2.52 These technical workforce issues have resulted in a need to arrange personnel loans between squadrons or to direct personnel transfers at critical periods. Maintenance workforces with the most acute shortfalls are Explosive Ordnance and the Avionics Technician streams, with 75 Squadron at Tindal experiencing the greatest impact in terms of having sufficient numbers of qualified and experienced personnel. ACG is resolving this issue by affording 75 Squadron priority for allocation of personnel in 2007. The qualified technical

[24] This increased maintenance effort will decline with increases in technical workforce experience with the new systems.

staff shortfalls have also been raised by ACG in submissions to the Hornet Airworthiness Board in March 2006.[25]

2.53 Hornet qualified technical workforce shortfalls reduce ACG's ability to provide on-the-job training and close supervision of its technical personnel undergoing training. This places a burden on fully qualified personnel who are responsible for closely supervising and signing for the work done by personnel who have not become fully qualified; and for ensuring maximum numbers of available aircraft achieve a serviceable mission worthy state.

2.54 The F-111 technical workforce situation is similar to that currently experienced by the Hornet workforce, with particular concern regarding a decline in the breadth and depth of experience held by some technical streams, particularly Explosive Ordnance specialists.

ADF Aviation Technician and Trade Workforce reviews

2.55 Air Force's Directorate of Personnel Capability Management commenced a review of the ADF aviation technician and allied trades workforce in early 2005. This review repeats a number of previous reviews that had resulted in recommendations not being implemented because they lacked the resources needed to address all workforce planning issues, or had overlapping responsibilities and conflicting priorities.[26] The result was a general lack of progress and disputes over training needs, experience shortfalls, and resource usage.

2.56 In August 2005 Air Force formed a four-person full-time project team, known as 'Project Vulcan', to further review the ADF aviation technician and allied trades workforce. This review is intended to holistically address issues identified with the technical workforce structure and training. By September

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25 Airworthiness Boards are held to ensure the continued safe operation of a weapon system. Board meetings are held annually. Air Combat Group and DMO's Director General Aerospace Combat Systems undertake to exchange information as necessary to support Airworthiness Board submissions, and consult to resolve any differences of opinion prior to Airworthiness Board meetings.

26 Directorate of Personnel Capability Management Air Force, *Project Vulcan Terms of Reference*, December 2005. The earlier reviews extend back to the early 1990s, and include RAAF Technical Trade Restructure, Aviation Maintenance Capability Review, the 'Douglas Review' of CETECHs, the Schubert Review and reviews by the Technical Trade Working Group.

2006 Project Vulcan had led to changes to the Air Force technician promotion system that redressed leadership and technical experience deficiencies.

2.57 DGTA established the ADF Aircraft Maintenance Improvement Project (AMIP) in mid 2005, to address wide-ranging contributors to adverse trends in ADF aircraft maintenance, and to assign an action agency to each contributor. This project provides an opportunity for ADF aircraft engineers, technicians, supervisors and managers to collectively identify maintenance improvements. The overall aim is to achieve a more consistent, effective and efficient compliance with the maintenance practices and standards contained within aircraft maintenance regulations.

2.58 ACG is also seeking opportunities to improve its squadrons' maintenance outcomes within its current resource priorities, through:

- improved maintenance management structures and processes;
- improved technical training needs analysis, training assessments and training delivery;
- improved supply chain management; and
- improved alignment between available aircraft and the squadrons' flying programs.

This is being pursued through a Hawk Maintenance Management Review completed in December 2005, a Hornet Maintenance Capability Review of September 2006, and the F-111 Maintenance Capability Review of late 2006.

Figure 2.2

F/A-18 Hornet head-on view.

Source: Royal Australian Air Force, Air Combat Group.

3. Hornet and Hawk In-Service Support

This chapter discusses the effectiveness of the Hornet and Hawk Lead-in Fighter in-service support management processes.

Background

3.1 The Hornet fleet was acquired between 1984 and 1990, prior to the introduction of the current ADF Airworthiness Management System. The Hornet aircraft received an Australian Military Type Certificate in June 1998, based on prior certification of the Hornet by the US Navy, and on the outcome of a Chief of Air Force mandated review and endorsement of the satisfactory airworthiness of the Hornet fleet.

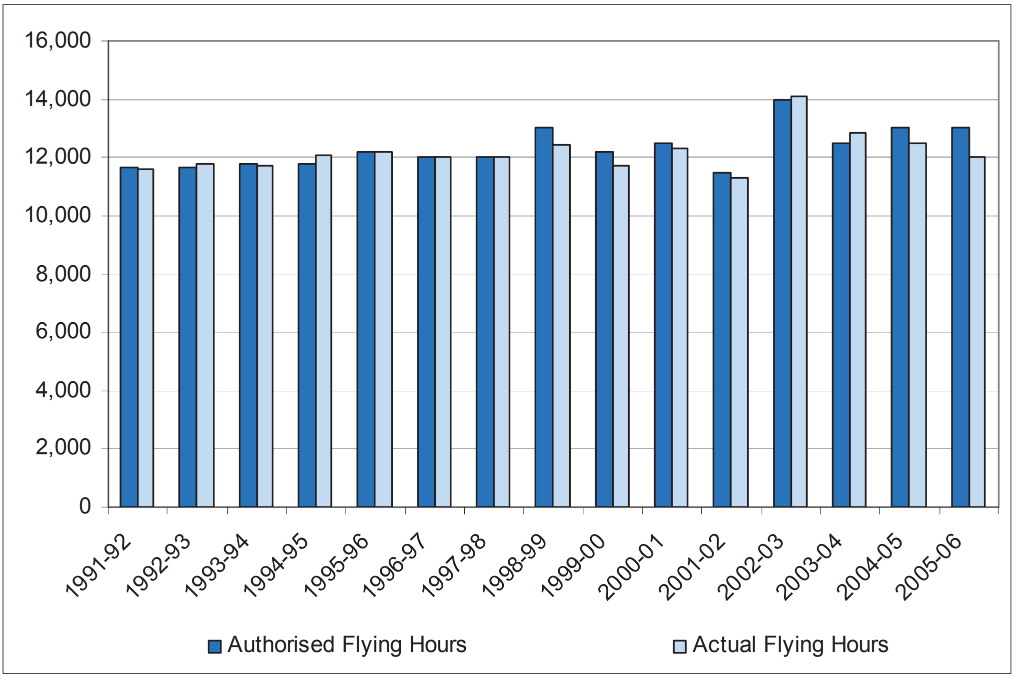
3.2 The Hornet fleet has undergone annual type certification and Service Release reviews by ADF Airworthiness Boards since 1998. These boards assess the airworthiness management of each ADF aircraft type, and are responsible for recommending to the Chief of Air Force (as the ADF Airworthiness Authority) whether or not a particular aircraft type's Service Release may be reconfirmed. The most recent Airworthiness Board review of the Hornet occurred in April 2006. This review resulted in the Chief of Air Force extending Hornet type certification and Service Release for another year.

3.3 Major design changes to the Hornet are also reviewed by Airworthiness Boards, as a precursor to the issue of a Supplemental Type Certificate (STC) by the Chief of Air Force in his capacity as the ADF Airworthiness Authority. The most recent Hornet STC relates to the Hornet Upgrade Phase 2.2, and this was issued in February 2006.

3.4 Figure 3.1 shows that for the period 1991 to 2006, the Hornet fleet flying hours were largely in line with Air Force planning and ACG's operational requirements.

Figure 3.1

Hornet fleet flying hours, 1991 to 2006.



Source: Royal Australian Air Force, Air Combat Group.

In-service support organisational structure

3.5 Tactical Fighter SPO conducts Hornet spares assessments, Repairable Item repair contract management, engineering assessments, technical airworthiness assurance, airworthiness compliance auditing and engineering data management. Tactical Fighter SPO also manages the Hornet fleet's outsourced Deeper Maintenance, which entails workshop maintenance activities involving the repair, maintenance, testing and calibration of Hornet systems. These systems include hydraulic and propulsion systems, weapon systems and aircraft structures.

3.6 Most Hornet in-service support is provided by Tactical Fighter SPO through some 30 contracts which the SPO directly manages, 21 other contracts managed by Defence's Common Services System Support Office (CSSSO), and 24 active Foreign Military Sales (FMS) cases.

3.7 These FMS cases are with the US Government and cover engineering and logistics support of Hornet systems. The US Navy and Marines operate Hornets, and the FMS cases allow Tactical Fighter SPO to purchase Hornet spares as part of the US Government purchases. This yields cost efficiencies and lower lead-times associated with the higher-volume orders, as well as enabling the sharing of costs and effort associated with Hornet maintenance engineering research and development. The FMS arrangements also provide for access to specialist equipment and Hornet engineering and maintenance publications.

Operational Maintenance

3.8 Hornet Operational Maintenance is carried out by ACG's 3 Squadron, 75 Squadron, 77 Squadron and 2 Operational Conversion Unit. These organisations perform both flightline maintenance activities as well as Deeper Maintenance activities.

3.9 There were large numbers of Hornet aircraft undergoing unscheduled maintenance during 2005–06. ACG data indicate that this was predominantly due to consistent shortfalls in the number of qualified maintenance personnel; a technical workforce training burden; and an increase in unscheduled servicing requirements due to aircraft ageing (see paragraphs 2.42 - 2.52).

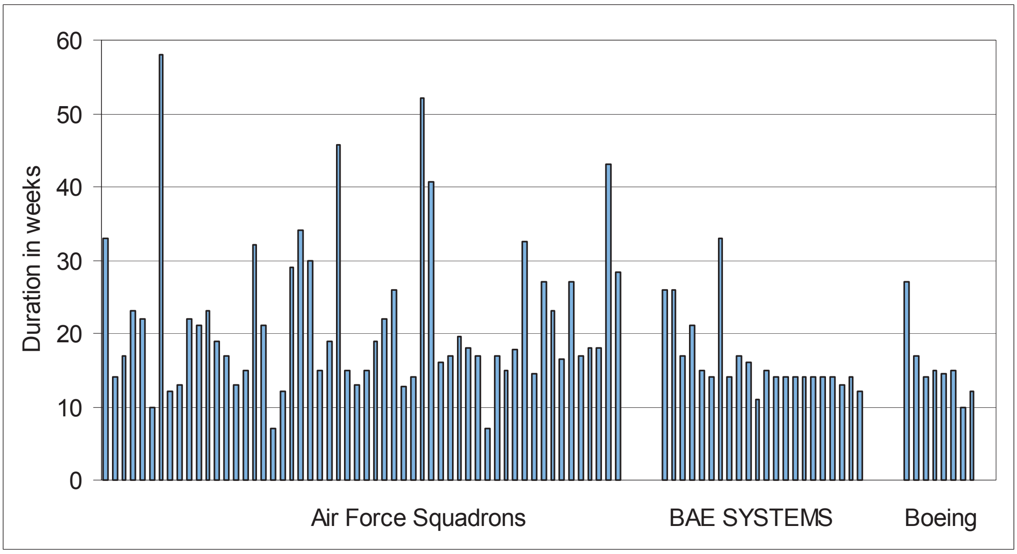
Deeper Maintenance

3.10 Hornet on-aircraft Deeper Maintenance is carried out by Air Force's 3 Squadron, 75 Squadron, 77 Squadron and 2 OCU, and more extensive Deeper Maintenance and modification incorporation is carried out by the Hornet Industry Coalition, which is contracted through Boeing.

3.11 Figure 3.2 shows the completion rates of Hornet Deeper Maintenance level 3 routine servicing, known as R3 servicing. R3 servicing involve the completion of a defined set of Deeper Maintenance planned maintenance and inspection packages involving aircraft structures, flight controls, jet engines, avionics and hydraulic systems. The target completion rate for each Hornet R3 servicing is 14 weeks. Each column in Figure 3.2 represents the time taken in weeks for a specific aircraft to undergo an R3 servicing.

Figure 3.2

Hornet routine Deeper Maintenance durations, September 2002 – February 2006.



Source: Defence Materiel Organisation, Tactical Fighter Systems Program Office.

3.12 BAE SYSTEMS, Boeing and the squadrons have demonstrated an ability to achieve the 14 week target. However, the squadrons have not achieved the same schedule reliability as the contractors, because Air Force personnel that conduct R3 services are often called upon to also conduct Hornet Operational Maintenance on the flightlines. This lengthens the time taken to complete R3 services, which in turn reduces the number of aircraft available for flying operations.

3.13 At the time of the audit the Hornet fleet maintenance requirements did not include the deeper and more thorough Level 4 and 5 Routine Servicing (known as R4 and R5 servicing), which has been conducted on the F-111 fleet since the mid 1980s. This is due to the different design philosophy for the Hornet aircraft, which aimed to remove the need for extensive Deeper Maintenance.

In-service support statistics

3.14 Tactical Fighter SPO has a performance measurement system which systematically assesses the performance of each of its 19 cost centres. The result is performance data that focus on key management process results, rather than on the processes themselves. The performance data demonstrates Tactical Fighter SPO's commitment to DMO's Materiel Sustainment Agreement with Air Force, and to DMO's corporate governance requirements.

3.15 The system is capable of identifying performance trends and predicting future performance outcomes. This has enabled the SPO to intervene early to ensure desired outcomes are achieved. It is also linked to the SPO's annual budget process.

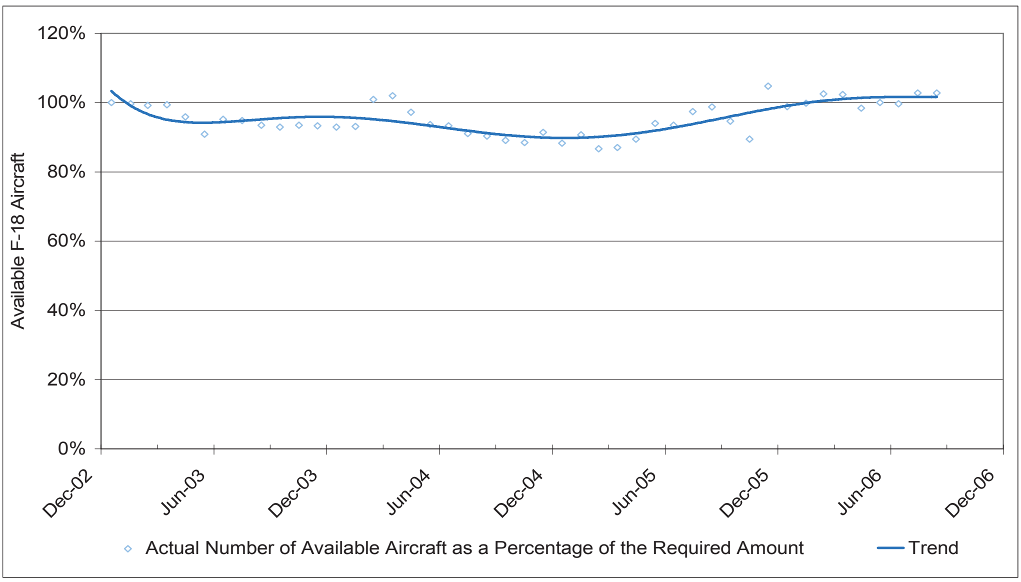
3.16 This chapter draws upon a sample of data sets used by Tactical Fighter SPO to manage its in-service support of the Hornet fleet.

Hornet availability

3.17 As shown in Figure 3.3, during 2005–06 the number of Hornet aircraft provided by Tactical Fighter SPO to Air Force increased to above that specified in the Materiel Sustainment Agreement between DMO and Air Force.

Figure 3.3

Hornet aircraft availability, September 2002 – September 2006.



Source: Defence Materiel Organisation, Tactical Fighter Systems Program Office.

3.18 This result occurred during a period of extensive Hornet upgrades and shows that Tactical Fighter SPO, together with the Hornet Industry Coalition are effectively managing the Hornet availably program. The number of aircraft awaiting Tactical Fighter SPO action has improved from an average of two per month during 2004–05 to one per month in 2005–06.

Hornet serviceability

3.19 From the available fleet, ACG's Operational Maintenance squadrons are required to maintain on the flightline a classified number of serviceable mission worthy aircraft. During 2005–06 ACG's performance against Hornet fleet serviceability targets was below expectations. This resulted from increasing unscheduled maintenance issues combined with difficulties that squadrons, at times, have experienced in maintaining a sound Deeper Maintenance capability. This capability development issue results from a combination of:

- increased commercialisation of fleet maintenance support, which leads to ADF personnel acquiring less depth and breadth in experience, skills and supervision;
- changes in technical workforce training arrangements, which increased the scope of technical workforce trainee supervision and mentoring at the squadrons; and
- Air Force qualified technical workforce shortages, relative to increases in flying hours, the technical workforce training policy, and increased maintenance needs of ageing aircraft.

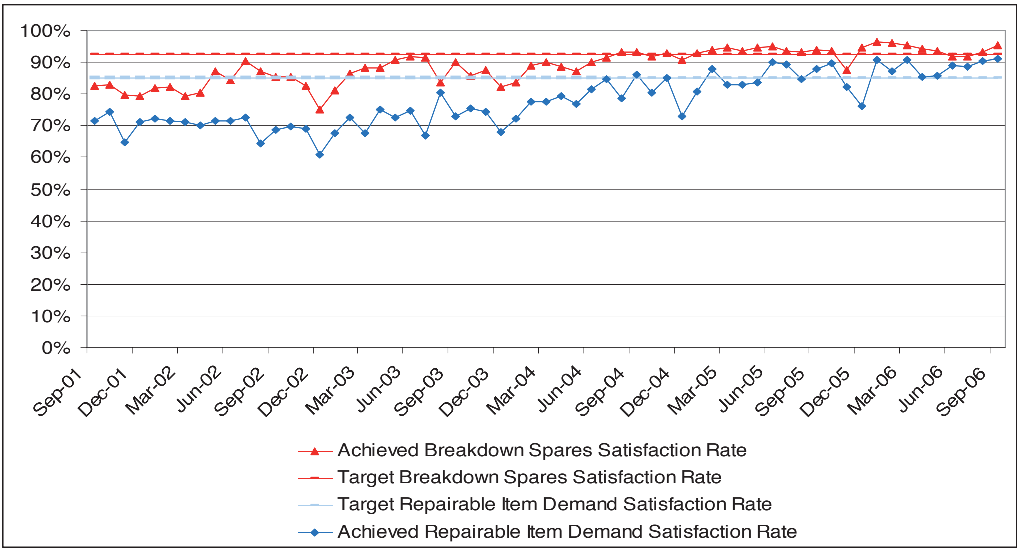
Logistics support

3.20 Tactical Fighter SPO's primary day-to-day in-service logistics responsibility is to ensure demands placed by Hornet Operational Maintenance personnel for Hornet Line Replaceable Units and Breakdown Spares are satisfied within priority timeframes.[27] Figure 3.4 shows the demand satisfaction rates of Hornet Repairable Items and Breakdown Spares.

[27] Spares demands are deemed to be satisfied if deliveries are made within specified priority durations, which are typically 24 hours, 5 days, 10 days or 48 days.

Figure 3.4

Hornet spares demand satisfaction rates, September 2001 to September 2006.



Source: Defence Materiel Organisation, Tactical Fighter Systems Program Office.

3.21 The figure shows consistent improvements, and Tactical Fighter SPO is now achieving its target demand satisfaction rate for Repairable Items (85 per cent) and Breakdown Spares (92.5 per cent). This is a marked improvement since 2001, which is attributed to:

- a $232 million increase in logistics funding in 2002–05;[28]
- a $2.5 million supply chain improvement project completed in 2005; and
- general management process improvements within Tactical Fighter SPO.

3.22 The targets for demand satisfaction are based on the need to strike a balance between investment in Repairable Item and Breakdown Spares stock holdings, versus the number of unserviceable aircraft awaiting replacement parts. This investment decision needs also to be made within the context of Air Force operational needs. Tactical Fighter SPO in 2005 estimated the cost of improving its Breakdown Spares demand satisfaction rate by one per cent would be about $1 million, and improvements above one per cent becoming exponentially more costly. This cost increase compels Tactical Fighter SPO and

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[28] Of the $232 million increase in logistics funding, $12 million was to cover the logistics required for Operation Falconer.

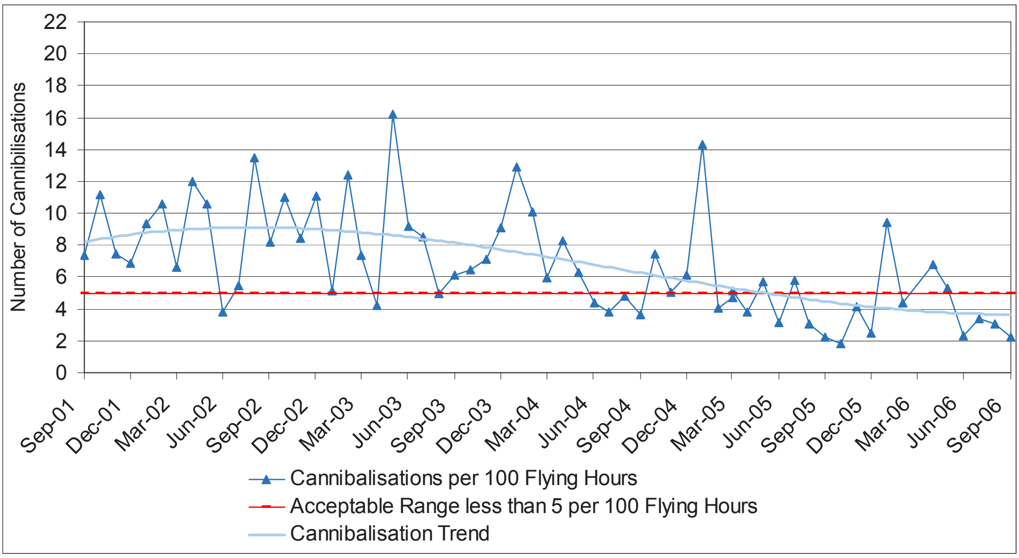
ACG to work together on assessing the cost and benefits of making additional Hornet spares investments.

Hornet cannibalisation rates

3.23 Figure 3.5 shows the post September 2001 number of serviceable components, per 100 hours of flight time, that have been removed from one aircraft (usually an aircraft undergoing Deeper Maintenance) for the purpose of replacing a faulty component in an aircraft on the flightline. This is referred to as cannibalisation, and it is an inefficient use of maintenance effort as it involves maintenance of two aircraft, rather than maintenance of one only.

Figure 3.5

Hornet cannibalisations per 100 flying hours, September 2001 to September 2006.



Source: Defence Materiel Organisation, Tactical Fighter Systems Program Office.

3.24 The graph shows a consistent downward trend in the cannibalisation rates since 2002, which coincides with Tactical Fighter SPO's increased logistics support funding and Hornet supply chain improvements.[29] In December 2004 Tactical Fighter SPO acquired an additional Repairable Item and Breakdown

[29] The increased cannibalisation rate in January each year corresponds with the low flying hours that are typical for that month. The increases are considered to arise from an upturn in system failures that occur after extended periods of aircraft inactivity.

Spares package to support Hornet deployments. This additional package, known as a flyaway kit, has addressed the cannibalisation increases that often occurred during deployments of Hornet aircraft from Williamtown and Tindal.

3.25 Cannibalisation rate improvements are considered by Tactical Fighter SPO and ACG, in terms of assessing the cost and benefit of purchasing additional Repairable Items against the cost of cannibalising Repairable Items from other aircraft, or from fully serviceable major assemblies. In some instances, such as the Hornets' radar receiver modules, the cost of purchasing additional modules may be in the order of $2 million, whereas the cost of removing serviceable modules from aircraft undergoing long-term servicing or modification, or from fully serviceable major assemblies, may be in the order of $1 500. In that example, it is cost-effective to cannibalise receiver modules from an aircraft that has entered long-term Deeper Maintenance, rather than purchasing additional spare modules. However, logistics cost-benefit cases are highly variable, and decisions involving large expenditures are made by Tactical Fighter SPO in consultation with ACG.

Hawk Lead-in Fighter in-service support

Figure 3.6

Hawk 127 in formation flight.

Source: Royal Australian Air Force, Air Combat Group.

3.26 Following an Airworthiness Board recommendation in January 2001, the then Chief of Air Force awarded the Hawk 127 aircraft an Australian Military Type Certificate and Service Release. Since then the Hawk aircraft have been granted annual continued Service Release by Chief of Air Force following the successful Airworthiness Board reviews of the Hawk Program. The Hawk fleet is used by Air Force to prepare its fighter pilots to manage high performance aircraft and advanced weapons technology.

3.27 The Hawk acquisition contract, which was signed in 1997, differs from typical Defence acquisition contracts where Defence would specify the number of aircraft to be provided and Defence would maintain the aircraft. The Hawk contract requires BAE SYSTEMS to provide the number of aircraft that BAE SYSTEMS considers necessary to meet the Air Force's approved flying hours over a 25 year period, and to provide the aircraft with Deeper Maintenance for

25 years. However, Defence has the right to seek alternative bids for maintenance work at 5-yearly intervals.

3.28 The Hawk fleets' approved flying hours was set at 9 000 hours per year. The number of aircraft BAE SYSTEMS assessed as necessary to maintain that flying rate was 33 aircraft, comprising 28 available on the flightlines and five undergoing Deeper Maintenance.

Hawk logistics contract

3.29 The Hawk acquisition contract with BAE SYSTEMS included 25 years of logistics support, renewable at five-year intervals, with the first renewal due in June 2006. Tactical Fighter SPO's expenditure on this contract, including Hawk Deeper Maintenance, for financial year 2005–06 totalled $39.62 million. In December 2005 BAE SYSTEMS tendered a price for the period July 2006 to June 2011 that exceeded the costs experienced during the initial five-years in-service support period. The tender included the additional in-service support work that BAE SYSTEMS assesses as being required to achieve:

- increased annual fleet flying hours to 9 500 hours;
- increased level of Deeper Maintenance required to cover the more extensive routine services and system overhauls due during the second five-year maintenance period; and
- increased spares support such as an additional flyaway spares kit.

3.30 In June 2006 Defence entered into an agreement with BAE SYSTEMS to extend the initial five-year logistics support contract to April 2007, to allow time to resolve the pricing and work scope issues raised in BAE SYSTEMS' tender.

3.31 The Hawk contract contains liquidated damages provisions to address Defence losses caused by BAE SYSTEMS shortfalls in meeting aircraft availability targets. DMO has applied the contract terms that relate to liquidated damages to recover Defence's predetermined losses arising from aircraft availability shortfalls shown in Figure 3.8.[30] These shortfalls attracted

[30] Section 47 of the *Financial Management and Accountability Act 1997*, specifies the recovery of Commonwealth debts.

significant liquidated damages provided for under the contract, and these were being taken in kind.[31]

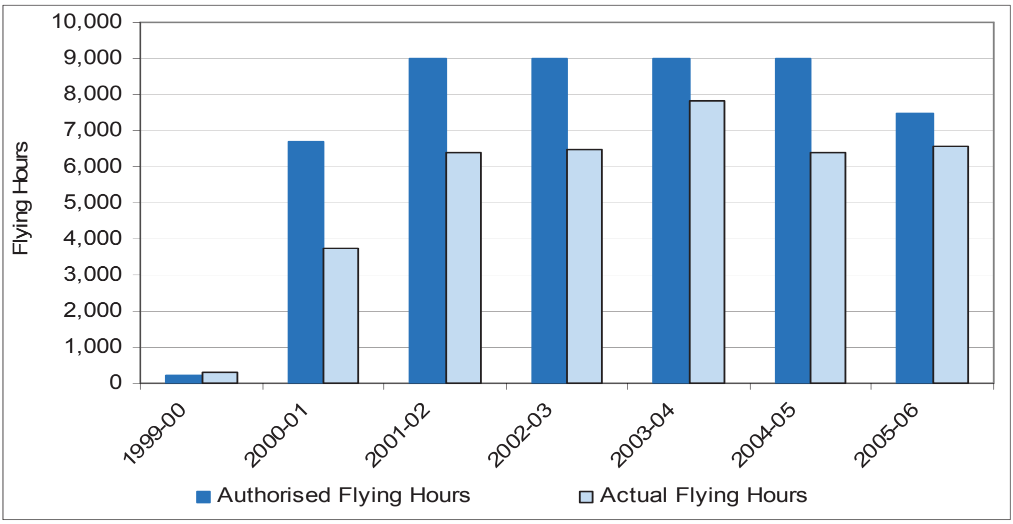
In-service support

3.32 The Hawk in-service support strategy has Air Force responsible for Operational Maintenance, and BAE SYSTEMS responsible for all other in-service support tasks such as Deeper Maintenance, logistics management, engineering, software support and training support.

3.33 Figure 3.7 shows the number of annual hours the Hawk fleet flew versus the number of planned flying hours. The yearly average from July 2002 to July 2006, was 2 720 less than the 9 000 flying hours per year originally planned by Air Force.

Figure 3.7

Hawk fleet flying hours, December 1999 to July 2006.



Source: Defence Materiel Organisation, Tactical Fighter Systems Program Office.

[31] DMO's financial policy also states that if a contract allows the Australian Government to accept compensatory work, that compensatory work becomes a contractual obligation, but it is not a debt due to the Australian Government (Defence Materiel Organisation, Finance Instruction 3/2002, 25 February 2003, p. 2.). Also, if compensatory work is not provided for in the contract, but is proposed by the Contractor in satisfaction of a debt (liquidated damages), it would be regarded as a payment in kind.

3.34 This shortfall is in part attributed to decreases in Hawk operational demand resulting from the delayed delivery of the Hawk aircraft radar simulation and emulation systems needed for Hawk pilot training and ADF support missions. Delivery of these systems was due with the Hawk aircraft by July 2001. The flying hour shortfall is also partly due to technical personnel shortfalls.

3.35 Radar simulation consists of aircraft equipment and software that produce simulated radar-contact images on the Hawk Multi Function Display. This provides the pilot with a simulated Beyond Visual Range sensor capability, without the need for an on-board radar system. Given this is not a significant change to the aircraft's design, its incorporation and Service Release are decided by a Configuration Control Board containing representatives from ACG and Tactical Fighter SPO. The development of the Radar Simulation system and its logistic support neared completion in October 2006, and its Design Acceptance was certified by Tactical Fighter SPO's Chief Engineer in his capacity as the Hawk aircraft Design Acceptance Representative. Service Release was expected to occur by late 2006. The delayed delivery of this capability has resulted in the Hawk aircraft initially not being capable of providing the full range of Beyond Visual Range air combat manoeuvre training originally envisaged for the Hawk aircraft.

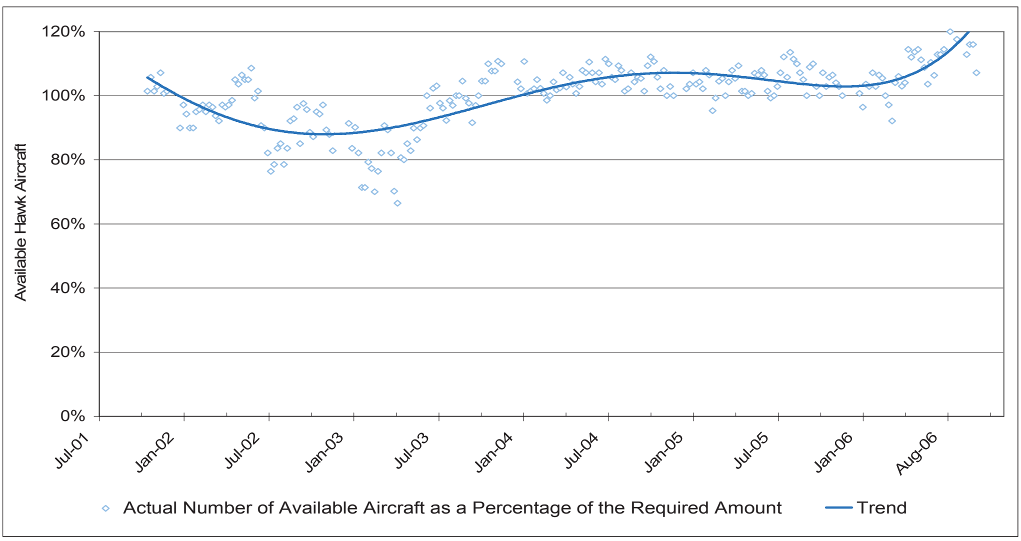
3.36 The Hawk radar emulation capability consists of a radar-transmission simulation pod attached to the Hawk aircraft fuselage that emulates a variety of radar signals. This capability assists ADF units with their radar threat detection and counter measures training, and is particularly useful to Navy. The radar emulation system requires a major change to the Hawk aircraft type design. Hence, ACG and Tactical Fighter SPO are required to provide submissions to the Hawk Airworthiness Board so that it can advise and make recommendations to the Chief of Air Force on Supplemental Type Certification, Service Release and in-service management of the radar emulation system. In October 2006 the radar emulation system and its logistics support neared completion, and Tactical Fighter SPO's Chief Engineer had certified the system's Design Acceptance. At the same time Tactical Fighter SPO and ACG had made submissions to the Hawk Airworthiness Board regarding the radar emulation system's type certification and Service Release. The delayed delivery of this capability has resulted in the Hawk aircraft being used predominately for jet pilot training, but not for the originally planned full range of ADF unit training functions.

3.37 The shortfall in flying hours is also attributed to shortfalls in the number of serviceable mission worthy Hawk aircraft on the flightlines. The shortfalls are a result of Operational Maintenance issues for the most part related to a structural imbalance between the number of experienced and fully-qualified technical personnel and the number of trainees. This imbalance may be expected in the initial years of supporting a new fleet of aircraft, when the skills and the number of personnel required to support the fleet are being established and validated. Since mid 2006 the fleets have experienced improved Operational Maintenance and this is reflected in the increased number of serviceable aircraft available for operations.

3.38 Figure 3.8 shows that for most of the period prior to November 2003, the number of available Hawk aircraft fell short of contractual requirements. That shortfall occurred mainly because of latent defects in the aircrafts' hydraulic system connectors and on board oxygen generation system. BAE SYSTEMS has since resolved these issues and as at October 2006 was delivering more Hawk aircraft to the squadrons than the minimum required under the contract.

Figure 3.8

Hawk average available aircraft per day, December 2001 to September 2006.

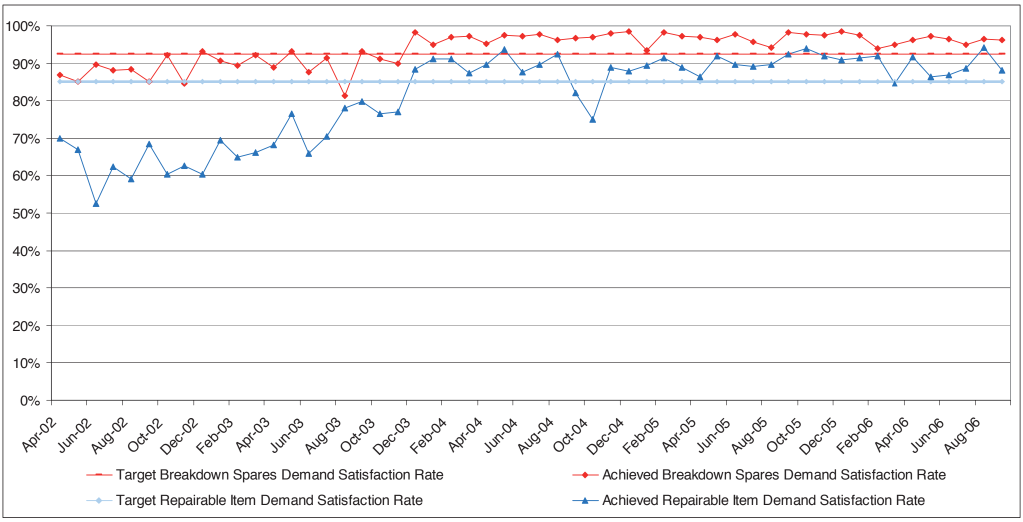


Source: Defence Materiel Organisation, Tactical Fighter Systems Program Office.

3.39 BAE SYSTEMS is responsible for both assessing the spares requirements, acquiring the initial spares inventory, repairing Repairable Items and replenishing the stock of Breakdown Spares. Figure 3.9 shows BAE SYSTEMS has achieved gradual improvements in Hawk spares Demand Satisfaction Rates for Hawk Repairable Items and Breakdown Spares, to the extent that since December 2004, the satisfaction rates have largely exceeded the targets for Repairable Items (85 per cent) and Breakdown Spares (92.5 per cent). The figure indicates the Hawk supply chain has achieved a satisfactory level of efficiency and assurance of supply, particularly for Repairable Items.

Figure 3.9

Hawk spares demand satisfaction rates, April 2002 to September 2006.

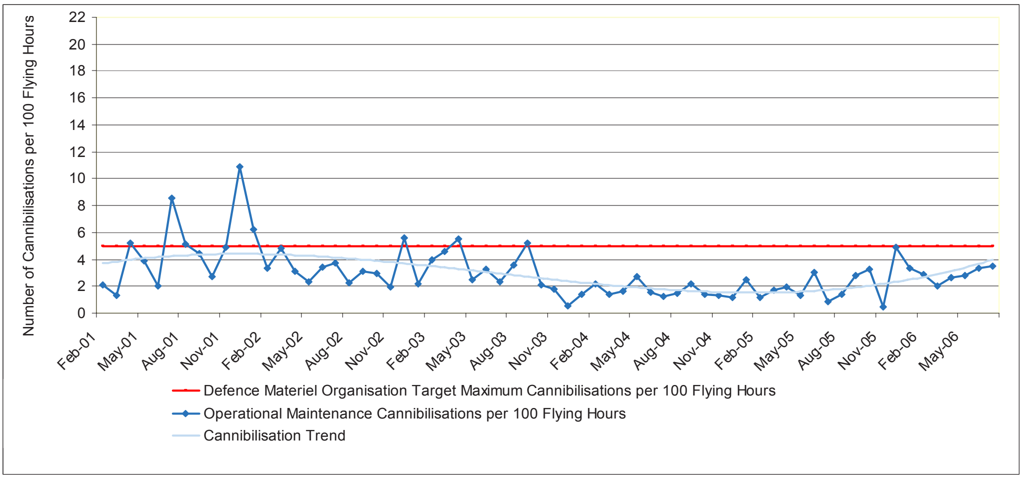


Source: Defence Materiel Organisation, Tactical Fighter Systems Program Office.

3.40 Figure 3.10 shows BAE SYSTEMS has achieved satisfactory Hawk supply chain effectiveness since February 2002, as measured by the cannibalisation rates remaining within the maximum rate of five cannibalisations per 100 flying hours. This is the DMO acceptable limit for the Hawk fleet. 3

Figure 3.10

Hawk cannibalisations per 100 flying hours, February 2001 to September 2006.



Source: Defence Materiel Organisation, Tactical Fighter Systems Program Office.

Figure 3.11

F-111 in turn-off motion.

Source: Royal Australian Air Force, Air Combat Group.

4. F-111 In-Service Support

This chapter discusses the effectiveness of the F-111 in-service support management processes.

Background

4.1 The F-111s were acquired prior to the introduction of the current ADF Airworthiness Management System. The F-111 aircraft received an Australian Military Type Certificate in March 1997, based on prior certification of the F-111s by the US Air Force, and on the outcome of a Chief of Air Force mandated review and endorsement of the satisfactory airworthiness of the F-111 fleet. Since then the F-111s have received several Supplemental Type Certificates covering the Avionics Upgrade Program (1997), the Digital Flight Control System upgrade (1999), the TF-30 engine variant changes (1999 and 2000), the Electronic Counter Measures Pod upgrade (2004) and the AGM-142E upgrade (2006).

4.2 The last Airworthiness Board review of the F-111 was held in August 2005, with Service Release being extended for another year. In July 2006, Strike Reconnaissance SPO coordinated an Airworthiness Review of the F-111 in lieu of the annual Airworthiness Board Review.

4.3 In 1995 Air Force commenced a study to identify and address the relevant issues, risks and resource implications of the logistics support of its F-111 fleet. At that time, the US Air Force F-111 fleet was scheduled for retirement by 1998, leaving Air Force as the sole operator and maintainer of F-111 aircraft. The study identified 22 major logistics support issues, resource requirements and cost risks associated with retiring the F-111 fleet in either 2005, 2010, 2015 or 2020. It concluded that the F-111 fleets' life could be cost-effectively extended to 2020, despite the early retirement of the US Air Force fleet, and furthermore, that planned withdrawal date of 2020 would represent the best return on the F-111 capability investment.

4.4 The study also noted that investment in indigenous support capability, such as bonded panel repair and Cold Proof Load Testing, would ameliorate certain technical risks associated with extending the fleet to 2020. The Cold Proof Load Test is designed to test the strength of the F-111s' high-strength steel structures under controlled load and at very cold temperatures. The aim of this test is to revalidate an F-111's structural integrity. Similarly, the on-going acquisition of excess US Air Force spares was expected to result in spares availability only likely to become an issue approaching 2020. However, the study team considered the engineering risks associated with ageing F-111 aircraft remained unquantifiable, and that these risks would increase as the aircraft approached their planned withdrawal date.[32]

4.5 As at September 2006 the F-111 fleet's withdrawal from service was contingent upon following projects being completed and their deliverables released into service:

- AIR5409 Bomb Improvement Program – this $75 million to $100 million program seeks to improve the stand-off capability and accuracy of the ADF's inventory of Mk80- series bombs;
- AIR5418 Follow-on Stand-off Weapon – this $350 million to $400 million project seeks to acquire improved ADF air-to-surface weapons for the Hornet aircraft;
- AIR5376 Hornet Upgrade Phase 2 – this project seeks to replace the Hornets' fire control radars, enhance the performance of a range of Hornet data processing and display systems, and upgrade the Hornets' active and passive electronic warfare systems;
- AIR5077 Airborne Early Warning & Control (AEW&C) project – this $3.6 billion project is to provide the ADF with an AEW&C capability based on six Boeing 737 AEW&C aircraft and associated systems; and
- AIR5402 Multi-role Tanker and Transport project – this $1.4 billion project is to provide the ADF with an F/A-18, F-111, AEW&C refuelling capability and a strategic airlift capability.[33]

4.6 Figure 4.1 shows that from 1991 to 2006, the F-111 fleet flew almost all of its authorised flying hours. Flying hour shortfalls occurred from 1995 to 1997 when aircraft unavailability occurred during major system upgrades. Most significant shortfalls occurred from 2000 to 2003, when the fleet

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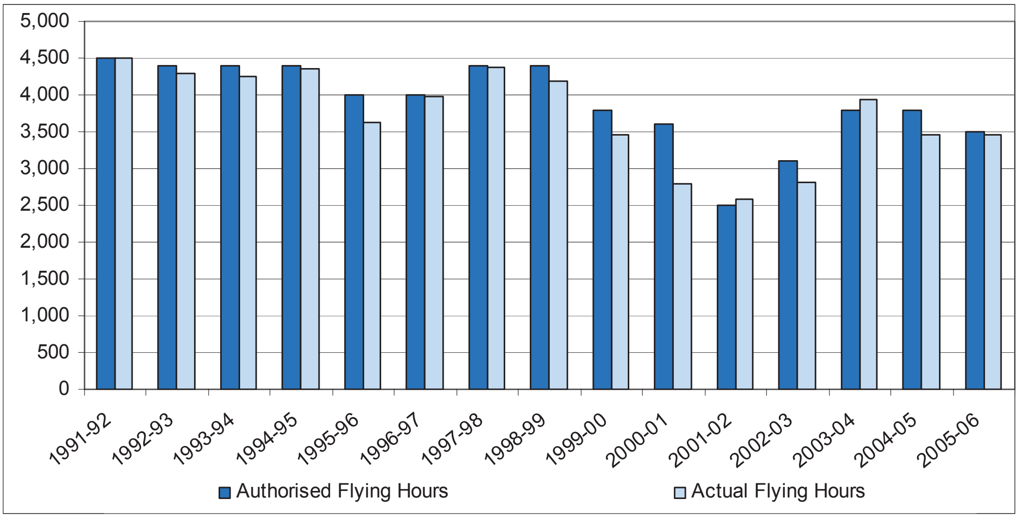
[32] Royal Australian Air Force, *F-111 Support Study*, 31 July 1996.

[33] *Materiel Sustainment Agreement DMO – Air Force*, 20 April 2006. Also, *F-111 Weapon System Support Plan*, 9 August 2005.

experienced reduced availability as a result of wing and fuel tank airworthiness and safety certification issues.[34]

Figure 4.1

F-111 fleet flying hours, 1991 to 2006.



Source: Defence Materiel Organisation, Strike Reconnaissance Systems Program Office.

4.7 The airworthiness and safety certification issues affected both the authorised and actual flying hours, with the worst case being 2000–01 when there was a 22 per cent shortfall between authorised flying hours and actual flying hours. By September 2002 these issues were resolved, and there were no remaining technical issues that prevented the on-going airworthiness certification of the F-111 fleet.

4.8 Overall, in the 14 years to August 2006 the average yearly shortfall between authorised F-111 flying hours and actual flying hours was 183 hours, or 2.2 weeks per year at standard flying rates. That equated to five per cent shortfall in the provision of serviceable mission worthy F-111 aircraft.

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34 During that period, reliance on the F-111 mission simulator was increased so that aircrew competencies were maintained at satisfactory levels.

In-service support organisational structure

Operational Maintenance

4.9 82 Wing's No. 1 Squadron and No. 6 Squadron carry out Operational Maintenance on the flightline. This involves fault repair by replacement of faulty Line Replaceable Units. These squadrons also conduct workshop-based repair, maintenance, testing and calibration of F-111 Repairable Items, assemblies and systems associated with TF30 jet engines, Electronic Warfare system maintenance and alternate mission equipment such as Pavetack pods, and wing pylons.

4.10 ACG conducts periodic internal audits of No. 1 and No. 6 Squadrons' maintenance practices and instructions, as part of Air Force's Maintenance Quality Management System. As at August 2006, 13 corrective action requests remained outstanding from previous audits. Four of these had been actioned and their closure by ACG had been sought, and the remaining nine were still being addressed.

4.11 At the time of the audit fieldwork, the number of F-111 aircraft undergoing scheduled and unscheduled maintenance remained within reasonable limits, given three recent F-111 serviceability issues that were beyond Strike Reconnaissance SPO and ACG's control.

Deeper Maintenance

4.12 The following contractors are responsible for F-111 Deeper Maintenance:

- Boeing Australia Limited is engaged as the 'limited prime contractor' from August 2001 to August 2011 with options to extend at five year intervals to a maximum of 20 years. Boeing has logistics responsibilities for F-111 systems integration, modifications and Deeper Maintenance; airframe and hydraulic system maintenance including R4 and R5 servicing; the Weapon System Support Facility and the F-111 Mission Simulator maintenance. Boeing also maintains a Design Support Network (DSN) to source additional support as required from agencies such as DGTA and DSTO. Total expenditure on this contract for 2005–06 was $80.1 million;
- Raytheon Australia Pty Ltd is engaged for the period February 2001 to February 2011 with options to extend at five-year intervals to a maximum of 20 years. Raytheon has logistics responsibility for the

F-111 avionics components, associated support and test equipment and avionics training aids. Total expenditure on this contract for 2005–06 was $25.9 million;

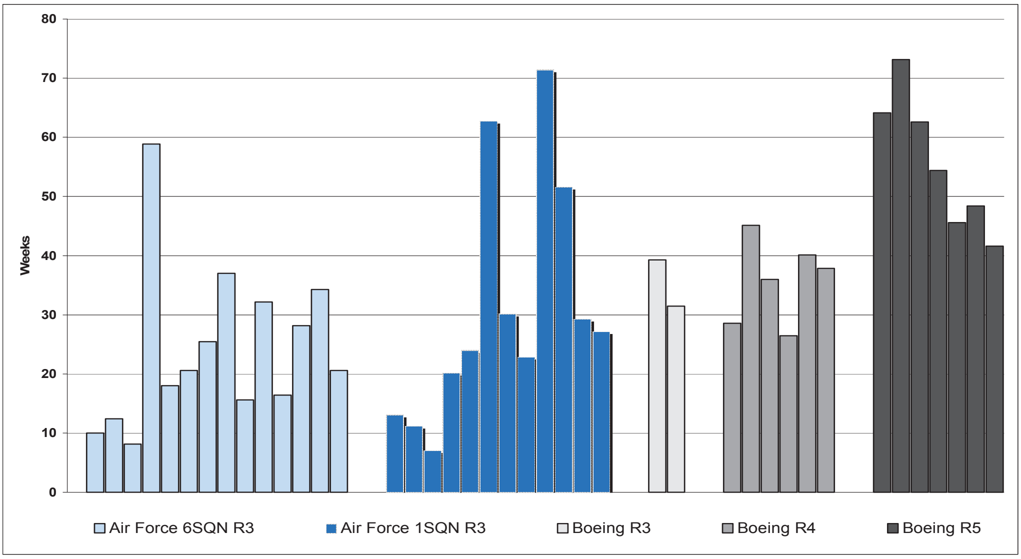
- Tasman Aviation Enterprises is engaged for the period March 2000 to April 2011 with an option to extend the contract by periods of up to 10 years to a maximum of 20 years. Tasman Aviation Enterprises provides metal machining, general engineering and electroplating services to 82 Wing and the other contracted Business Units. Total expenditure on this contract for 2005–06 was $8.3 million;
- In September 2006 the scope of Tasman Aviation Enterprise's contract was extended to include TF30 jet engine Deeper Maintenance; associated support and test equipment, and engine test cells and training aids. The scope extension also requires Tasman Aviation Enterprises to maintain the link to the engines' manufacturer Pratt and Whitney. This contract covers the period October 2006 to June 2010 with options to extend to 31 December 2012 or 1 July 2013. The contract price is $80.87 million (excluding GST), plus provision for survey and quote of $2.57 million (excluding GST). Prior to September 2006, the work included in the scope extension was done by DMO under an in-house arrangement. Total expenditure on this activity for 2005–06 was $6.9 million.
- Rosebank Engineering Pty Ltd provides maintenance of F-111 hydraulic flight control components. Total expenditure on this contract for 2005–06 was $1.22 million.

4.13 82 Wing's No. 1 Squadron and No. 6 Squadron also carry out aircraft R3 servicing, which involves the maintenance of hydraulic assemblies, undercarriage assemblies, aircraft structures and the F-111 Electronic Warfare system. The squadrons also maintain alternate mission equipment such as Pavetack pods, and wing pylons.

4.14 Figure 4.2 shows the completion rates of F-111 Deeper Maintenance routines. These involve inspections of aircraft structures, flight controls, engines, avionics and hydraulic system. They also involve maintenance and repairs at successively more extensive, intrusive and complex levels of servicing, as specified in F-111 R3, R4 and R5 servicing procedures.[35] The agreed target completion rate for the R3 services ranges from 14 weeks to 32 weeks depending on operational needs. The agreed target completion rates for R4 and R5 services are considerably longer and prior to 2006, often included capability upgrade work.

Figure 4.2

F-111 Deeper Maintenance durations, 1991– 2006.



Source: Defence Materiel Organisation, Strike Reconnaissance Systems Program Office.

4.15 The large variations in R3 and R4 completion rates result from varying amounts of repairs required by each aircraft, particularly fuel tank repairs. It also results from the change in workforce that accompanied the commercialisation of Air Force's 501 Wing in 2001. In 2001, 501 Wing was disbanded and its F-111 maintenance role was taken over by Boeing. Since commercialisation, Boeing has reduced the time taken to complete the deepest level of F-111 servicing which are known as R5 servicings (see Figure 4.2). The

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[35] Since the mid 1980s, the F-111 fleet has been subjected to more extensive Deeper Maintenance than the Hornet fleet, because the design philosophy for the Hornet aircraft aimed to remove the need for extensive Deeper Maintenance. F-111 R3 servicings are similar to the Hornet R3 services in that they focus on aircraft preservation activities and some structural integrity inspections. The F-111 fleet also have R4 and R5 servicings. R4 servicings involve more extensive preservation, structural integrity inspections and repair and wing overhauls. R5 servicings involve extensive fuselage and wing disassembly, structural integrity inspections, preservation and repairs.

variation in Boeing's R5 servicings are caused by modifications being conducted as part of the R5s. Variations in the squadrons' R3s are caused by resource and planning issues.

4.16 The squadrons have at times experienced difficulty in maintaining a sound Deeper Maintenance capability, which is indicated by data showing large variations between the time taken to complete the R3 servicing and the agreed schedule for those services. The squadrons' difficulties result from a combination of:

- increased commercialisation of fleet maintenance support, which leads to ADF personnel acquiring less depth and breadth in experience, skills and supervision;
- changes in technical workforce training arrangements, which increased the scope of technical workforce trainee supervision and mentoring at the squadrons; and
- Air Force qualified technical workforce shortages, relative to increases in flying hours; the technical workforce training policy; and the increased demand for skilled maintenance that occurs with ageing aircraft.

4.17 ACG is seeking to address these Deeper Maintenance issues through its Quality Management System. As at August 2006, DGTA was monitoring the situation and was satisfied that there were no unacceptable risks to F-111 airworthiness. Both ACG and DGTA maintain a continuing schedule of audits covering squadron compliance with airworthiness standards.

In-service support statistics

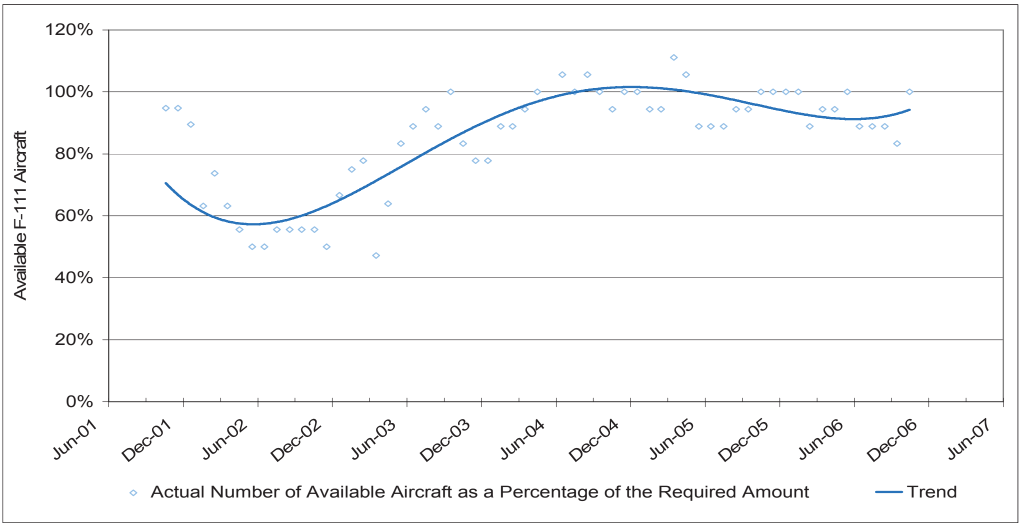
4.18 Strike Reconnaissance SPO developed its performance measurement system in line with DMO reporting requirements. It reports its key performance indicators monthly to DMO's Senior Executives, Air Force's ACG, and to Defence Capability Development Group Executives.

4.19 The current F-111 Materiel Sustainment Agreement between Air Force and DMO requires Strike Reconnaissance SPO to make available to Air Force a classified number of F-111 aircraft. As shown in Figure 4.3, in November 2006, the number of F-111 available to the squadrons had achieved the required amount agreed with Air Force. This availability figure was achieved at a time when two F-111s were undergoing long-term unscheduled Deeper

Maintenance. One had sustained structural damage caused by a mid-air main fuel tank explosion in 2002, and the other was damaged by a forced wheels-up landing in 2006. These aircraft are expected to be made airworthy and available to the squadrons in 2007. The shortfalls in availability from 2001 to 2003 mainly resulted from wing and fuel tank airworthiness and safety certification issues (see paragraph 4.7).

Figure 4.3

F-111 aircraft availability, September 2001 – November 2006.



Source: Defence Materiel Organisation, Strike Reconnaissance Systems Program Office.

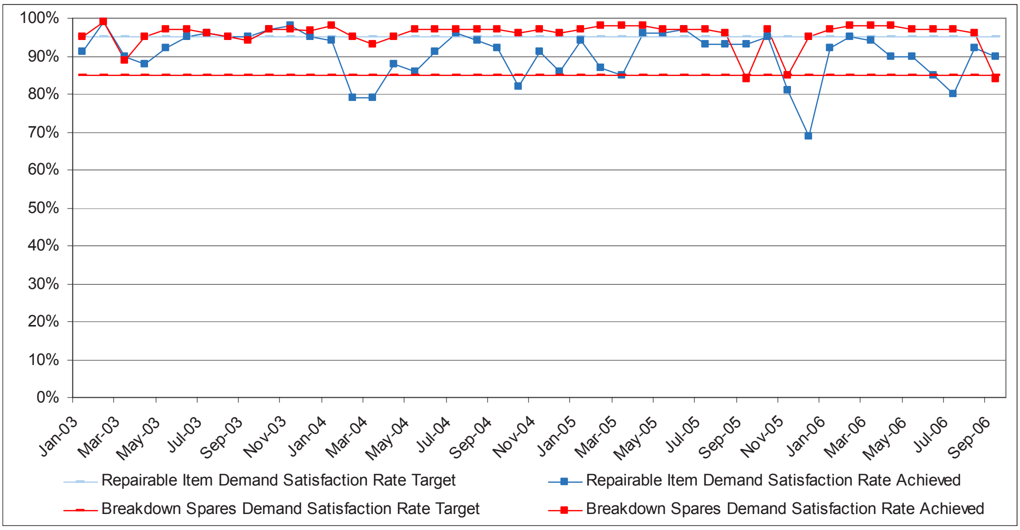
4.20 From the available fleet, ACG's Operational Maintenance squadrons are required to maintain on the flightline a specified number of serviceable mission worthy aircraft. During 2005–06, AGC's performance against F-111 fleet serviceability targets was marginally below expectations. This resulted from increasing unscheduled maintenance issues combined with the Deeper Maintenance technical workforce issues.

Spares support demand satisfaction rates

4.21 Figure 4.4 shows that demand satisfaction rates for F-111 Breakdown Spares remained predominantly 10 per cent above the target rate of 85 per cent. In contrast, the Repairable Item demand satisfaction rate was on average five per cent below the target rate of 95 per cent.

Figure 4.4

F-111 spares demand satisfaction rates, January 2003 to October 2006.



Source: Defence Materiel Organisation, Strike Reconnaissance Systems Program Office.

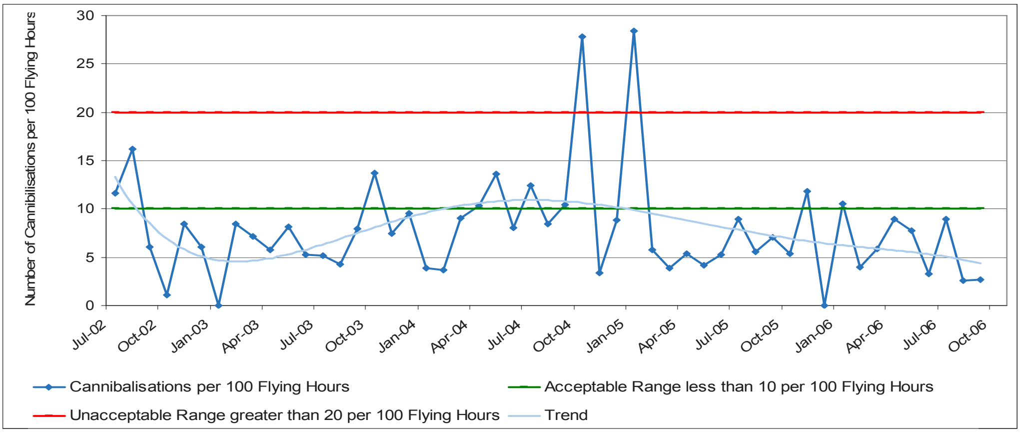
4.22 The most significant shortfalls in Repairable Item demand satisfaction rates occur when major F-111 deployments coincide with ongoing flight training sorties from Amberley. Deployment preparations include the assembly of flyaway kits of spares that accompany these deployments. This results in spares demands exceeding overall supply chain performance capacity. However, as shown in Figure 4.4, demand satisfaction rates return to the target level once the deployments are complete and serviceable flyaway spares are returned to the Operational Maintenance Stores.

F-111 cannibalisation rates

4.23 Figure 4.5 shows the post July 2002 total number of serviceable Repairable Items per 100 hours flight time, which have been removed from one aircraft to replace a faulty item in another aircraft. The figure shows for the majority of the time, the number of cannibalisations has been within the acceptable range and that the trend is improving.

Figure 4.5

F-111 cannibalisations per 100 flying hours, July 2002 to October 2006.



Source: Defence Materiel Organisation, Strike Recognisance Systems Program Office.

4.24 A reduction in cannibalisation rates can be achieved by Strike Reconnaissance SPO purchasing additional Repairable Items, or speeding up the Repairable Item repair rates. This is a logistics cost-benefit decision that Strike Reconnaissance SPO would make in consultation with ACG.

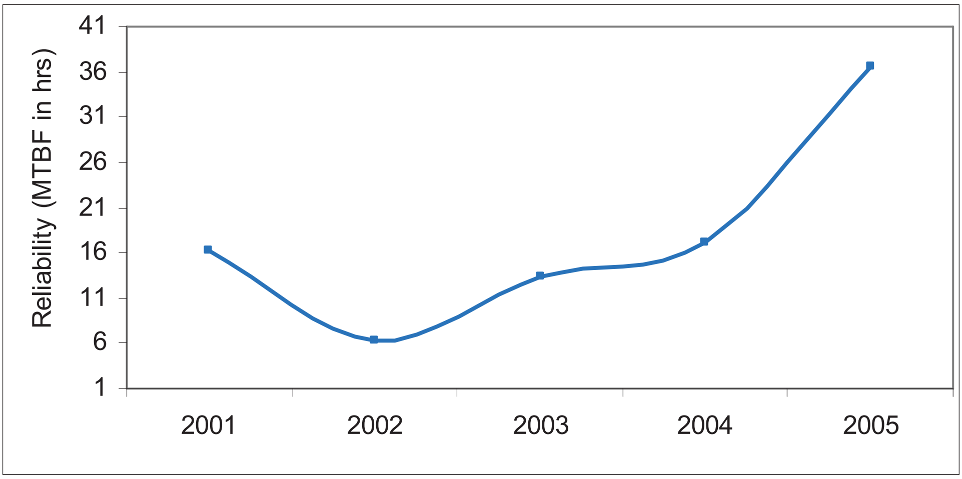
F-111C systems reliability

4.25 Figures 4.6 and 4.7 provide the results of Boeing's reliability analysis of all F-111C systems, based on Defence's NetMAARS maintenance reporting system.[36] For the period 2001 to 2005, F-111C mission critical and safety critical systems reliability data respectively show these systems to have experienced improved reliability. For example, the F-111C mission critical systems had a six-fold improvement in mean time between failures since 2002 (see Figure 4.6).

[36] The NetMAARS system is used by F-111 engineering personnel to analyse aircraft defects and reliability trends, based on data gathered from CAMM2.

Figure 4.6

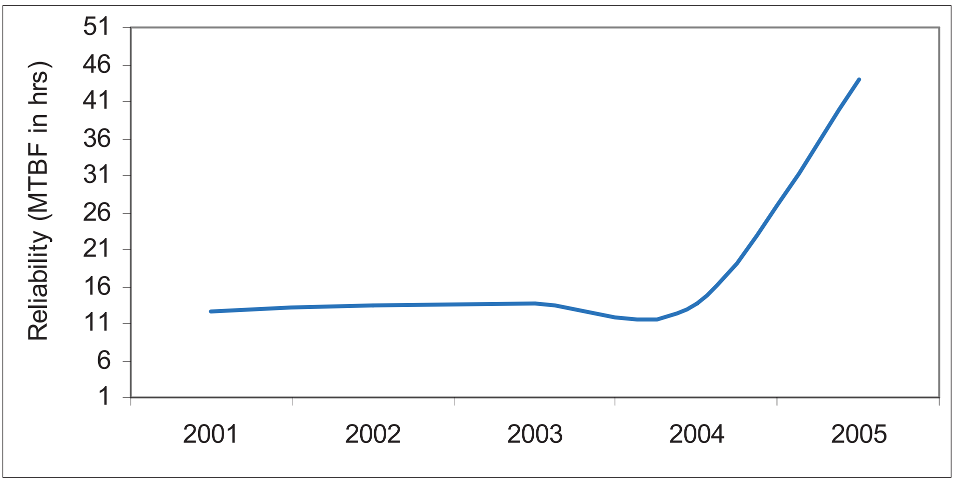
F-111C fleet reliability trend – all mission critical systems: 2001 to 2005.



Source: Boeing Australia Limited.

Figure 4.7

F-111C fleet reliability trend – all safety critical systems: 2001 to 2005.



Source: Boeing Australia Limited.

4.26 In recent years F-111 reliability has improved as indicated by increasing Mean Time Between Failure (MTBF) trends (see Figures 4.6 and 4.7). Strike Reconnaissance SPO considers that the results indicate no significant negative

System Safety trends of airworthiness concern. Strike Reconnaissance SPO also considers that improved F-111 reliability results from:

- the replacement of ageing systems by the F-111 Avionics Update Project, which was completed in October 1999 at a cost of some $455 million (December 1999 prices);
- the nearly completed F-111 Block Update Project, which included a $634.66 million upgrade to the fleet's electronic warfare self protection and stand-off weapons capability; and
- from extensive improvements in F-111 Deeper Maintenance organisational structures, management processes and industrial capability since commercialisation.

F-111 Maintenance Facilities

4.27 The provision of authorised maintenance and storage facilities that comply with appropriate standards is an integral part of the ADF's technical airworthiness management system. DMO and the Services rely on the Defence Support Group (DSG) to maintain the ADF's aircraft maintenance and storage facilities to approved standards. The ANAO noted the F-111 facilities at Amberley required maintenance to address general deterioration and deviation from contemporary standards.

4.28 As part of the F-111 fleet withdrawal from service options analysis carried out by Air Force and DMO in 2004, most F-111 maintenance facilities were identified as needing essential work between 2005 and 2010. The initial cost estimate of this work was $38 million. This was considered by the Defence Capability Investment Committee in late 2004, and this Committee noted that the F-111 facility issues would be pursued in the infrastructure program.

4.29 By November 2006, minimal progress had been made to attend to the F-111 facilities work identified in 2004, for reasons unclear to the ANAO. The Strike Reconnaissance SPO in November 2005, contributed to DSG's infrastructure maintenance program by setting aside $3.04 million, from the F-111 in-service support budget, to address immediate Organisational Health and Safety issues in facilities occupied by F-111 contractors. At that time, a building appraisal report on the F-111 Engine Workshop at Amberley, commissioned by RAAF Amberley's Comprehensive Maintenance Service Contractor, identified fire safety, building condition, and fixed plant and equipment deficiencies that need to be addressed. The Contractor's indicative cost estimate for this work was $1.11 million. As at November 2006, Strike Reconnaissance SPO remained concerned about the F-111 maintenance facilities, and the ANAO was advised that of the $3.04 million set aside by the SPO for F-111 facilities work in August 2005, only $0.55 million had been expensed by November 2006.

4.30 Air Combat Group in 2006 reported that facilities support at RAAF Amberley continued to be under-resourced. In its F-111 Annual Airworthiness Board Submission of July 2006, Air Combat Group reported that none of 82 Wing's infrastructure support requests submitted during the last reporting period were supported, through some related to hazardous substances.[37]

4.31 The ANAO noted that challenges remain in ensuring more effective liaison and role clarity between DSG and its clients. DSG faces increasing role difficulties in instances where contractors occupying Defence facilities carry out work for several DMO SPOs, or for commercial entities in line with Defence's industry support objectives. DMO and Air Force manage such difficulties through performance measurement and reporting systems, and through increased stakeholder liaison in the form of support management boards, integrated management teams and working groups.

4.32 The ANAO reviewed the Customer Supplier Agreement between the Air Force and DSG, and the Base Support Agreement between DSG's South Queensland Region and RAAF Amberley's Base Commander. The ANAO found both agreements would benefit from more viable performance measurement and reporting mechanisms of the kind already established between Air Force and DMO.

4.33 In February 2007 Defence advised the ANAO that Agreements between DSG and each Defence Base Commander that streamline and standardise the DSG interface with its clients already exist, and agreements are operational at many bases. Defence also advised that there are Customer Supplier Agreements in place between DSG and each customer Group, including the three Services.

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[37] Strike Reconnaissance SPO raised workplace health and safety, and environmental concerns about the electroplating and engine workshop facilities in its 2006 F-111 Air Worthiness Board Review. These were the subject of Defence OHS Incident Reports, Hazard Reports and other written correspondence dating from 2001.

4.34 The ANAO considers that Defence would benefit from reviewing these agreements to ensure they contain facility management policy and procedures that clarify Defence Support Group's role and responsibilities and improve its interface with its clients; and also contain performance measures and reporting mechanisms that facilitate improved facilities outcomes.

5. Structural Integrity Management

This chapter discusses each fleet's structural integrity management, and the steps taken by the Defence organisation to ensure each fleet's service life meets or exceeds its planned withdrawal dates.

Background

5.1 The ADF's Aircraft Structural Integrity (ASI) program seeks to enable air operations to be conducted within acceptable levels of risk regarding aircraft and engine structural failures. Since the early 1970s Air Force has managed the structural integrity of its aircraft at the design, construction and maintenance phases, using the Aircraft Structural Integrity Program (ASIP) concept. DGTA's Aircraft Structural Integrity Section is responsible for regularly reassessing ADF aircraft certified life limits, inspection intervals, and physical condition. This involves:

(a) establishing, evaluating and substantiating the structural integrity of ADF aircraft;

(b) acquiring, evaluating and utilising operational usage and aircraft structural condition data to provide continual assessment of the in-service integrity of individual aircraft structures; and

(c) using aircraft structural integrity data as a basis for determining and planning aircraft modifications, maintenance and replacement.

5.2 An aircraft's structural integrity is initially established through the application of design principles, full-scale structural load tests and fatigue tests. These allow designers to determine an aircraft's structural Life of Type. The risk of an aircraft experiencing a structural failure from fatigue is managed throughout its service life by the application of the following structural integrity management regimes:

- the Safe Life regimes, which involve the use of fatigue test data and aircraft usage spectrums to produce a Safe Life duration against which aircraft operational usage is compared. A Safe Life regime is usually applied to aircraft that are difficult to inspect, such as fighter aircraft that have compact structures; and

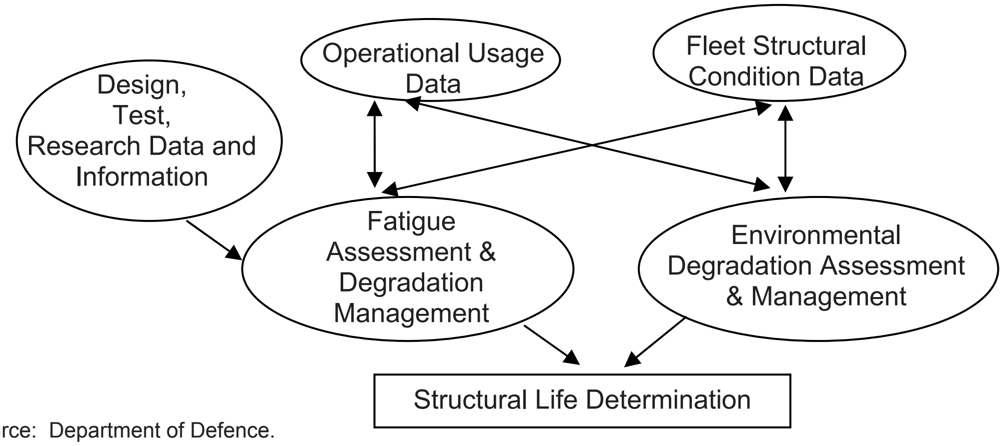
- the Safety By Inspection regimes, which involve aircraft potential failure locations, derived through fatigue tests and analysis, being periodically inspected for cracking. Continued inspection is allowed until the probability of widespread cracking becomes too great, and modification action or aircraft retirement is required.

5.3 When an individual aircraft reaches its type's Safe Life, it may be transitioned to a Safety By Inspection regime provided its structures can be inspected. Safe Life regimes are preferred over Safety By Inspection regimes because they do not attract the costs and aircraft unavailability generated by structure inspection and analysis processes. However, Safe Life regimes have the disadvantage of requiring Safe Life aircraft to be retired earlier than may be the case under a Safety By Inspection program. The various airworthiness standards that detail Safe Life and Safety By Inspection processes provide a cumulative risk of structural failure of approximately 1 in 1 000 for each aircraft over its entire life.

5.4 The rate at which individual ADF aircraft deteriorate throughout their life is influenced by aircraft's usage, by environmental degradation such as corrosion, by accidental or battle damage, and by the interaction between repairs. DGTA has an ASI program for each ADF aircraft type, which are tailored for aircraft complexity and risk exposure. The individual programs typically involve periodic structural life assessments based on aircraft load measurements, structural condition monitoring and action taken to reduce or repair structural deterioration. Figure 5.1 provides a simplified illustration of DGTA's Aircraft Structural Integrity management process.

Figure 5.1

The Aircraft Structural Integrity management process.



Source: Department of Defence.

Hornet structural integrity management

Structural fatigue management

5.5 Hornet aircraft were originally designed and manufactured by McDonnell Douglas (now The Boeing Company), to a US Navy specification with a structural fatigue Safe Life of 6 000 airframe hours of US Navy usage. Similar to other fighter aircraft, the Hornet suffers from fatigue cracks that increase in size and numbers as load stresses are applied during flying operations.

5.6 Air Force introduced the Hornets into service in 1985, under an interim structural Safe Life pending an assessment of the RAAF operational environment. Early assessments by Air Force and DSTO identified significant differences in usage type and severity between RAAF and US Navy Hornet operations. Consequently in the mid 1990s, Australia and Canada commenced an International Follow-On Structural Test (IFOST) program, with the aim of achieving improved Hornet Safe Life management of their fleets.

5.7 The IFOST results, based on centre fuselage, aft fuselage and wing structural fatigue tests and evaluations, confirmed that the RAAF Hornets would require major mid-life structural refurbishment and modifications to maintain safe operations until their planned withdrawal date of 2012 to 2015. It also confirmed the need for careful management of Fatigue Life Accrual Rates and Fatigue Life Expended Indices for each RAAF Hornet aircraft.

5.8 The Fatigue Life Expended Index (FLEI) is a measure of the proportion of the certified structural Safe Life of the aircraft which has been consumed. A FLEI of 1.0 normally indicates that an aircraft has accumulated fatigue at the outer limit of its Safe Life range, where modelling fatigue testing and associated analysis deem the aircraft to be airworthy. FLEI consumption greater than 1.0 may require an aircraft to transition to an Safety By Inspection program or be withdrawn from service.

Hornet fleet structural fatigue monitoring

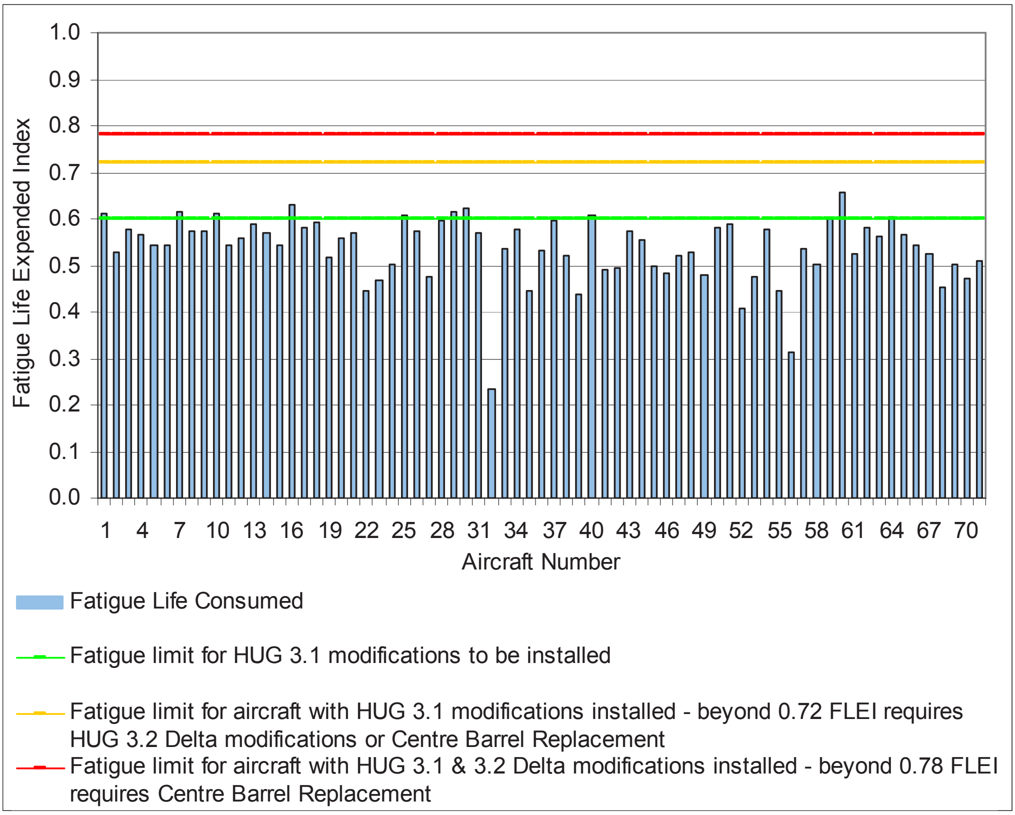
5.9 Since 1985 Defence has engaged contractors to produce monthly and quarterly Hornet fleet fatigue consumption reports for ACG and DGTA which, amongst other things, provided an analysis of each aircraft's structural fatigue accrual. The reports are used by ACG to ensure Hornet fleet Fatigue Life Accrual Rates are maintained within agreed limits.[38]

5.10 Figure 5.2 shows the Hornet fleet's FLEI as at June 2006. It indicates that on average 0.536 FLEI of each aircraft's structural Safe Life has been consumed. The figure also shows the FLEI limits beyond which certain structural modifications or refurbishments need to have occurred. If these modifications or refurbishments are not carried out then the aircraft will need to be withdrawn from service. For accessible structure, a Safety By Inspection program can be implemented to maintain the required level of safety. However, structure that is either inaccessible or unable to be inspected, requires modification or replacement.

[38] Each Hornet has a data recording system, which measures both flight parameters and loads on the aircraft continuously throughout its life. Tactical Fighter SPO and its supporting Contractor have RAAF Hornet flight data extending from each aircraft's introduction into service through to the present day.

Figure 5.2

Hornet fleet structural fatigue consumption, as at June 2006.



Source: Adapted by the ANAO from Tactical Fighter Systems Program Office data.

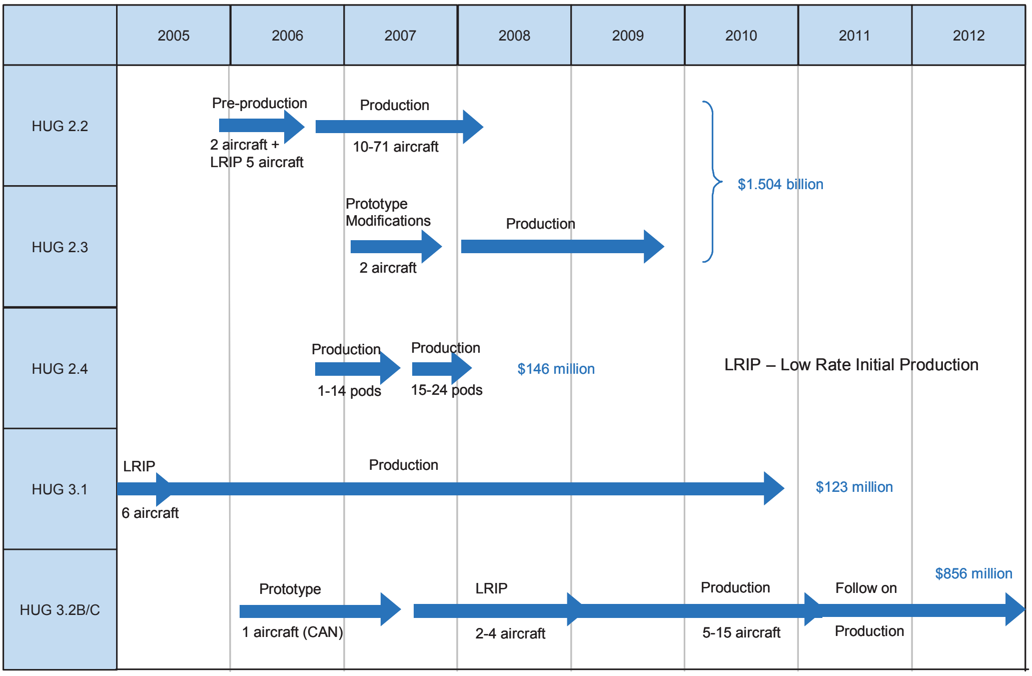
Hornet structural refurbishment program

5.11 Structural integrity issues identified and assessed by the Hornet structural integrity management process, combined with an annual two to three per cent fatigue life expenditure rate across the Hornet fleet, has led to Government approval of Phase 3 of the Hornet Upgrade project (HUG Phase 3). This phase is an integral part of the three phase $2.92 billion HUG project which is scheduled for completion by 2012.

5.12 HUG Phase 3 project aims to provide assurance that the Hornets will remain serviceable until their planned withdrawal date, which at the time of the audit was 2012–2015. The project has two parts, Phase 3.1 is in its early production phase and Phase 3.2 is in its prototype phase (see Figure 5.3). Tactical Fighter SPO and its contractors are able to implement the lessons learnt from similar US Navy and Canadian Air Force projects. They are also managing the project's risks by using prototyping and Low Rate Initial Production approach to acquiring knowledge and industrial capacity to effectively deliver the intended outcomes. Phase 3.2, which is the largest and most complicated phase, faces a highly-ambitious production schedule.

Figure 5.3

Hornet Upgrade Project Schedule, as at October 2006.



Source: Australian National Audit Office, adapted from Tactical Fighter System Program Office records.

HUG Phase 3.1

5.13 The $123 million HUG Phase 3.1 project is to deliver a wide range of safety inspections and some 22 discrete structural modifications to all 71 Hornets. It is required to be conducted between 0.53 and 0.60 FLEI on each aircraft, and its goal is to enable safe operations to 0.72 FLEI. Several additional work packages, known as the HUG 3.2 Delta modifications, are to be incorporated in select aircraft to extend their structural airworthiness through to 0.78 FLEI. This will delay or possibly avoid the need for the major centre barrel replacement program in Phase 3.2.

5.14 HUG Phase 3.1 was originally approved in July 2001 at a cost of $45.34 million, with implementation to occur between January 2003 and January 2005. Since then, revised cost estimates and increased work scope have resulted in the Government approving a real cost increase of $69 million, thus taking funding approval to $114.34 million. Production and installation of the modifications commenced in April 2004, and this is now expected to be completed by August 2011 with project closure expected in 2012. As at July 2006, Tactical Fighter SPO had spent $87.57 million on Phase 3.1 and the project's scheduled completion was extended from 2008 to 2011. This extension seeks to accommodate other elements of the HUG program (Phase 2.2 and 2.3), whilst maintaining aircraft availability targets.

5.15 DMO has sole-sourced HUG Phase 3.1 design, prototype, low rate initial production and modification kit manufacture from L-3 Communications Military Aviation Services Canada (L-3 MAS). The production installation program has been sole sourced from the Hornet Industry Coalition. The work is planned to be undertaken at Williamtown, with the exception of the prototype modification installation on one aircraft, which was completed in January 2004 by L-3 MAS in Mirabel, Canada.

HUG Phase 3.2

5.16 This $856 million project involves additional Hornet structural modifications and the replacement of each aircraft's centre barrel structure. The centre barrel is the primary load bearing structure in the fuselage as it withstands the loads induced by the wings and the main undercarriage. Replacement centre barrels are required to extend the service life of Hornet aircraft beyond 0.72 FLEI, or beyond 0.78 FLEI in the case of aircraft that have received the HUG 3.2 Delta modifications. The Hornet lead aircraft are expected to reach an FLEI of 0.72 in November 2007, and an FLEI of 0.78 in July 2012, at their current Fleet Fatigue Life consumption rate. Aircraft having an FLEI of 0.78 will require centre barrel replacements or be withdrawn from service, as a safety-by-inspection program involving the centre barrel is not considered practical.

5.17 Phase 3.2 was first approved in October 2003. Subsequently, this phase has been expanded to include more centre barrel replacements needed to accommodate possible extensions to the Hornet planned withdrawal date. In August 2006, the expanded Phase 3.2 received Government approval, thus bringing its estimated cost to between $600 million and $856 million. The final cost depends on the extent to which the Hornet planned withdrawal date is to be extended. As November 2006, Tactical Fighter SPO had spent $58 million on HUG 3.2. The centre barrel replacements, combined with the other structural refurbishments specified in HUG Phase 3.1, are expected to provide the Hornet fleet with approximately seven additional years of life.

5.18 Phase 3.2 modification design, prototype, and discrete modification kit manufacture have been sole-sourced from L-3 MAS. Prototype modification activities commenced in April 2006, and are expected to be completed by July 2007. Centre barrel replacement installations in Australia are expected to commence in October 2007 and to be completed in 2014.

5.19 The relatively even distribution of fatigue consumption throughout the Hornet fleet shown in Figure 5.2, combined with a likely centre barrel replacement implementation schedule of approximately 13 months per aircraft (during the mature rate production program), will result in the Phase 3.2 program having extremely demanding implementation schedules, with little capacity to absorb unplanned delays or work scope increases. Tactical Fighter SPO is mitigating the schedule risks by aligning the Phase 3.2 modifications with Deeper Maintenance service schedules, and by prioritising individual aircraft modifications according to their fatigue consumption.

Environmental degradation management

5.20 The Hornet fleet, like other combat aircraft fleets, is subject to periodic Deeper Maintenance inspections and servicing, which entail the removal of inspection panels and engines in order to inspect areas for structural degradation. In the case of the Hornet fleet, these Deeper Maintenance activities, known as R3 services, are scheduled to take 14 weeks to complete and are conducted at intervals of 750 days. Any structural degradation identified is repaired as necessary and included in non-conformance reports and entered into Tactical Fighter SPO's Structural Condition Monitoring System. This system is used for trend analysis and reporting to DGTA as required by the Hornet Aircraft Structural Integrity Management Program.

5.21 In recent years, Tactical Fighter SPO has implemented a corrosion prevention and control program, due to the amount of Hornet structural corrosion occurring at Williamtown. This program has three aims: to ensure the Hornets remain airworthy until their withdrawal from service; to ensure sufficient aircraft remain available for flying operations; and to reduce ownership costs. The program involves the future use of dehumidifiers and a surface finish restoration program.

5.22 Tactical Fighter SPO and ACG commenced a Hornet surface finish restoration program in 2005 which involves paint removal, surface surveys and repairs, and surface repaints. By September 2006 the program's eight-aircraft Low Rate Initial Production phase was nearing completion, in terms of surface restoration process development and the establishment of a full production capability. The program's full production phase is scheduled to commence in February 2007, with the last aircraft to be fully restored by December 2011.

5.23 81 Wing and Tactical Fighter SPO have a long-held requirement for an automated aircraft Clear Water Rinse Facility at RAAF Williamtown, in order to reduce airframe corrosion by removing salt concentrations on aircraft surfaces. The Wing raised a Business Case for such a facility in November 1998. In November 2002 Tactical Fighter SPO, as part of its efforts to expedite the project, offered to transfer $1.5 million of its funding to Corporate Services and Infrastructure Group (CSIG - now known as Defence Support Group - DSG), which was responsible for managing the project at that time. In February 2004 a budget allocation of $2.4 million was transferred to DSG to fund the project. By August 2006 the project remained unapproved, and by then a Clear Water Rinse Facility was also required for the AEW&C aircraft scheduled for delivery in 2008. Consequently, the project's scope was expanded to accommodate the AEW&C requirements and DMO agreed to fund the project at an estimated cost of $5.59 million.

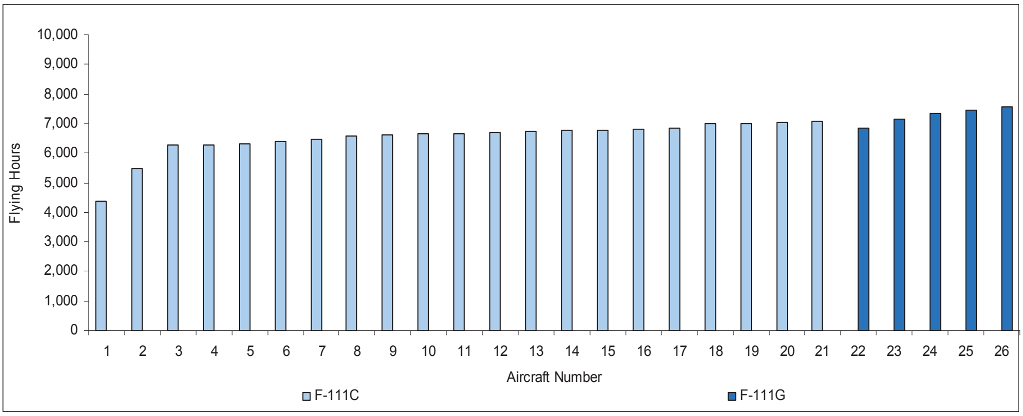
5.24 DSG obtained the Defence Infrastructure Sub-Committee endorsement of the project in September 2006, and the Minister for Defence's approval in October 2006. The project's design and construction phases are scheduled for completion by December 2006 and October 2007 respectively.

F-111 structural integrity management

5.25 The original structural integrity fatigue design philosophy for the F-111 was Safe Life. However, after material flaws resulted in a catastrophic structural failure in a US Air Force aircraft in 1969, the F-111s were transitioned to a Safety By Inspection philosophy, with a confidence limitation of approximately 10 000 airframe hours. Figure 5.4 shows the F-111 fleet's flight hours expended by July 2006.

Figure 5.4

F-111 fleet flight hours consumed, as at July 2006.



Source: Defence Materiel Organisation, Strike Reconnaissance Systems Program Office.

5.26 Deficiencies discovered in the Original Equipment Manufacturer's certification practices for the RAAF F-111C long-wing configuration required DGTA to re-evaluate and redefine the F-111C wing structural integrity management philosophy, F-111 wing certification basis and Life of Type. As at October 2006 the F-111 structural integrity certification was based on a combination of Original Equipment Manufacturer's tests, Cold Proof Load Tests of completely assembled F-111 aircraft, periodic inspections, and wing economic life determinations.

5.27 A key part of DGTA's F-111 structural integrity management program is the F-111C Wing Damage Enhancement Test, which DSTO commenced in March 2000. The F-111C wing test is required to validate the F-111 fleet's structural integrity program to the planned withdrawal date of the aircraft. In February 2002, a wing under test suffered an unexpectedly early catastrophic structural failure after 13 507 simulated flight hours, rather than after 30 000 hours as DSTO had expected. Subsequent analysis indicated that the equivalent airframe hours was close to the 10 000 airframe hours Safety By Inspection confidence limitation. The wing failure invalidated the F-111 wing Safety By Inspection certification at that time, because until then there were no targeted inspections of the wing at the failure location. DGTA responded by limiting the F-111C wings to a Safe Life of 5 900 flying hours and, in conjunction with DSTO, developed a targeted non-destructive inspection procedures specific to F-111C wings. DGTA also recommended the replacement of all F-111C wing sets with modified F-111D and F-111F wing sets.

5.28 DGTA commissioned DSTO to conduct further tests to verify the structural integrity of F-111F and F-111D wings purchased from the US to replace the F-111C wings. This test is known as the F-111F Wing Economic Life Determination (F-WELD) fatigue test. By November 2006, the F-WELD test wing had achieved over 29 100 simulated flying hours without catastrophic failure, and was expected to achieve a target of 30 000 hours by December 2006.

5.29 Assessments conducted in late 2006 indicate that, from a technical integrity perspective, the F-111 fleet's currently planned withdrawal date can be achieved based on current test progress and supplemental inspections. If the F-WELD test wing fails prior to 30 000 hours, additional inspections, modifications or wing replacements will likely be required prior to the planned withdrawal date. DGTA has scheduled detailed assessment of the F-111 fleet's structural integrity in 2007.

5.30 Between 2004 and 2006, Strike Reconnaissance SPO purchased 36 former US Air Force F-111D and F-111F wing sets, and had them systematically inspected, refurbished and fitted to RAAF F-111C aircraft at their R3, R4 and R5 servicing. As at November 2006, all but two of the original F-111C wing sets had been replaced at a cost of approximately $1.18 million per wing set. This was funded from Strike Reconnaissance SPO's in-service support budget.

Environmental degradation management

5.31 The F-111 fleet is also subject to Deeper Maintenance servicing, which requires removal of various panels and jet engines etc, in order to inspect areas of structural significance and for airframe preservation. These Deeper Maintenance activities are known as R3, R4 and R5 servicings. The most common servicing is the 17 week-long R3 servicing, which is conducted on average each 525 flying hours or 2 years. Every second R3 is replaced by a more extensive 30 week R4 servicing, and every second R4 service is replaced by an even more extensive 42 week R5 service.

5.32 The F-111 fuselage structures are subjected to non-destructive and potentially destructive testing. The non-destructive element involves the periodic inspection of critical structure using instrumented techniques to detect cracks. The potentially destructive element of the program is the Cold Proof Load Test, which is designed to revalidate an F-111's structural integrity. The test is conducted after the R5 service, which is scheduled every 2 025 flying hours or 8 to 10 years. As at October 2006, 17 RAAF F-111s had passed the Cold Proof Load Test without any structural failures; the test program commenced at Amberley in December 2000. Prior December 2000 RAAF F-111s were flown to the US for Cold Proof Load Tests.

F-111 Sole Operator Program

5.33 Following notification that the US Air Force was to retire its F-111 fleet by mid 1998, the RAAF and DSTO undertook a detailed study to identify and address the relevant issues, risks and resource implications of continued support for the RAAF F-111 fleet in a sole operator environment. This was required because at the time the RAAF F-111 structural integrity program relied heavily on Original Equipment Manufacturer support, engineering experience gained from the older and more extensive US Air Force F-111 program, and the relatively low hours flown by the RAAF's F-111 fleet. The study concluded that the F-111 fleet was supportable to a planned withdrawal date of 2020, but that operation beyond 2010 would require an expansion of the F-111 structural integrity program and the associated design support network.[39]

5.34 Defence launched its F-111 Sole Operator Program in February 1997. This program was designed to establish the necessary in-country Design Support Network infrastructure to support the F-111 Aircraft Structural Integrity Program, including knowledge, data, and analytical tools. The Sole Operator Program aims to:

- constrain the risk of structural failures to acceptable levels;
- achieve the planned rates of aircraft availability;
- avoid unforeseen aircraft refurbishment costs; and
- achieve aircraft planned withdrawal dates.

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39 AAP F-111 Aircraft Structural Integrity Management Plan (ASIMP) Vol 1 Section 2 Chapter 11.

5.35 Experience to-date indicates the Sole Operator Program is successfully achieving its aims.

F-111 Ageing Aircraft Audits

5.36 DSTO commenced an Ageing Aircraft Audit in June 1998, which involved the dismantling and materials analysis of a former US Air Force F-111A fuselage. The fuselage had completed 5 067 hours of operation in a role considered to be marginally more severe than the RAAF operations. The aim was to determine and assess the extent of hidden corrosion, fatigue and corrosion cracking of all material types and aluminium honeycomb bonded panel degradation. DSTO was then required to correlate that assessment with an F-111 fleet condition audit undertaken in 2000.[40] The subsequent DSTO report indicates that these aims were fully achieved.

DGTA's F-111 overall structural integrity assessment

5.37 DGTA has assessed the F-111s' structural integrity to be acceptable for the short term, with shortcomings well understood and appropriate development activities in place to address identified deficiencies. However, overall risk levels remain higher than that normally accepted for long-term operations. DGTA expects the level of risk to reduce to that normally accepted for long term operations by the end of 2006 following the:

- withdrawal of remaining two sets of F-111C wings from service;
- further progression of the F-WELD fatigue test;
- introduction of additional inspections for the F-111F and F-111D wings; and
- the continuation of the F-111 structural integrity program's remaining elements.

Hawk structural integrity management

5.38 The Hawk contract requires BAE SYSTEMS to provide Defence with Hawk 127 aircraft each having a Safe Life of 10 000 flying hours and 20 000

[40] The F-111 fleet condition audit was conducted by Aerostructures Technologies in February of 2000. The audit covered a total of 8 507 Requests for Deviation's/Waivers, defect and Non-Destructive Inspection records and Aircraft Structural Repair Section records, covering the period 1977 to 1999.

landings over a 25 year period, when operated in accordance with agreed flying profiles and conditions. As at March 2006 the ADF was operating the aircraft under an interim fatigue clearance, until the 10 000 airframe hour Safe Life is verified by a full-scale fatigue test being conducted by DSTO under contract from BAE SYSTEMS. This interim clearance is limited to 3 000 air frame hours, which Defence expects will not be reached by an ADF Hawk aircraft prior to the full-scale fatigue test being completed.

5.39 Each Hawk aircraft has a Health and Usage Monitoring System (HUMS). This provides structural fatigue consumption information on individual aircraft and individual pilot's flying characteristics based on several structural item measurements.[41] This information is passed to Tactical Fighter SPO, 76 Squadron and 79 Squadron for fleet-wide structural fatigue management, mission and aircraft manoeuvre planning, and pilot performance assessment purposes. It is also used as the basis for annual Hawk Structural Life Assessments, and to identify individual aircraft requiring dedicated structural fatigue consumption management.

5.40 Figure 5.5 shows the ADF Hawk 127 fleet's tailplane structure fatigue usage by April 2006. These aircraft are experiencing rapid fatigue consumption in their tailplanes. Consequently, DSTO, Tactical Fighter SPO and DGTA consider this component to be the most critical from a fatigue management perspective. DGTA has specified the tailplane as having an interim fatigue life index of 60, pending completion of a tailplane test being conducted by BAE SYSTEMS in the UK.

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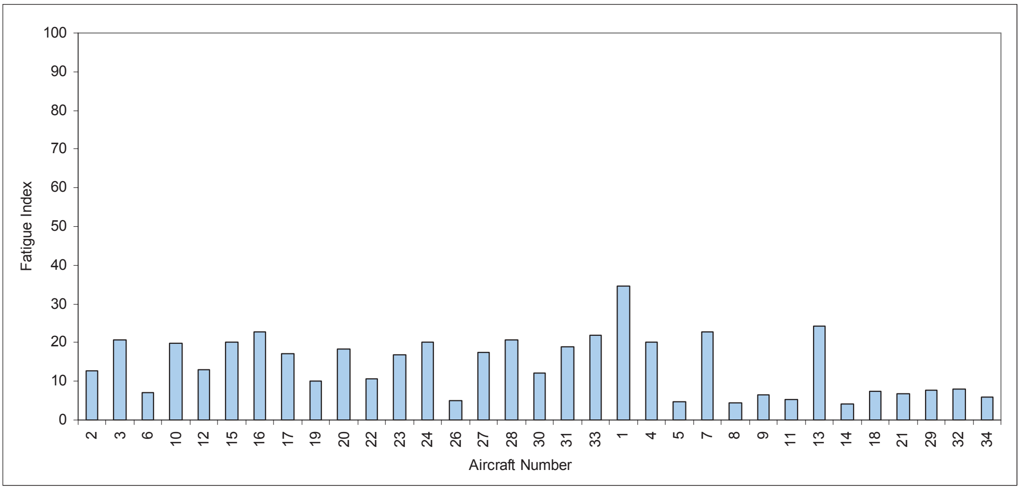
[41] Six Hawk aircraft are equipped with an enhanced HUMS containing a greater number of structural strain gauges, and these aircraft are used for Operational Loads Measurement (OLM) flying. The OLM data are passed to DGTA for analysis and review. BAE SYSTEMS is required to ensure that there are no less than two OLM Hawk aircraft continually available at each of 76 Squadron and 79 Squadron.

Figure 5.5

Hawk fleet tailplane structure fatigue consumption, as at April 2006.



Source: Defence Materiel Organisation, Tactical Fighter Systems Program Office.

5.41 BAE SYSTEMS has found corrosion within Hawk structures before significant structural damage has occurred. The firm has management processes in place that seek to prevent further environmental degradation and to safeguard the economic life of the Hawk fleet. These processes include a fleet repaint program scheduled to commence in 2007, periodic aircraft wash downs using manual effort, and increased structural surveillance.

5.42 Indications are that Tactical Fighter SPO, ACG, DGTA and DSTO are closely monitoring BAE SYSTEMS management of its Hawk 127 fatigue and corrosion issues.

Ian McPhee
Auditor-General

Canberra ACT
21 February 2007

Appendix

Appendix 1: Agency Response

ANAO Proposed Recommendation and Defence and DMO Response

Reference	Recommendation	Department Response
Recommendation No. 1	The ANAO recommends that Defence and Defence Material Organisation consider the cost and benefits of upgrading its Standard Defence Supply System to include foreign currency processing capability for repairable items.	Agreed with qualification. Defence and DMO note that the ANAO report outlines (Para 2.20) issues that arise from the use of both ROMAN and SDSS to manage the procurement of repair services from an overseas Defence agency. Current protocols mandate the use of ROMAN as the procurement tool. SDSS is not required to support overseas procurement and therefore it has not been fitted with FOREX capabilities. DMO will conduct a cost benefit study of the viability of conducting overseas procurement of repairable items through the Military Integrated Logistics Information System, the system replacing SDSS under JP2077.

Defence and DMO comments to be included in brochure:

Defence notes the overall positive assessment of the Management of the Air Combat Fleet In-Service Support. The areas identified for improvement are known and have either already been addressed or are being addressed.

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