The Auditor-General
Audit Report No.5 2012–13
Performance Audit

Management of Australia's Air Combat Capability– F/A-18 Hornet and Super Hornet Fleet Upgrades and Sustainment

Department of Defence
Defence Materiel Organisation

Australian National Audit Office

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Canberra ACT
27 September 2012

Dear Mr President
Dear Mr Speaker

The Australian National Audit Office has undertaken an independent 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, to the Parliament. The report is titled *Management of Australia's Air Combat Capability–F/A-18 Hornet and Super Hornet Fleet Upgrades and Sustainment.*

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 (RAAF)
ADF	Australian Defence Force
AEO	Authorised Engineering Organisation
AMO	Authorised Maintenance Organisation
AMTC	Australian Military Type Certificate
ARDU	Aircraft Research and Development Unit (RAAF)
ASHPO	Australian Super Hornet Project Office (DMO)
CDG	Capability Development Group (Department of Defence)
Defence	Australian Defence Organisation
DGTA	Director General Technical Airworthiness
DMO	Defence Materiel Organisation
DSTO	Defence Science and Technology Organisation
FLEI	Fatigue Life Expended Index
FMS	Foreign Military Sales
HSACP	Hornet Structural Assurance Consolidation Program
HUG	Hornet Upgrade
IOC	Initial Operational Capability
IFOSTP	International Follow-On Structural Test Project
JSF	Joint Strike Fighter (also known as F-35 Lightning II)
MRD	Maintenance Requirements Determination

PWD	Planned Withdrawal Date
RAAF	Royal Australian Air Force
SPO	Systems Program Office (DMO)
SRP	Structural Refurbishment Program (part of the Hornet Upgrade)
STC	Supplemental Type Certificate
T&E	Test and Evaluation
TAA	Technical Airworthiness Authority
TAR	Technical Airworthiness Regulator

Summary

Summary

Background and context

1. In successive Defence White Papers since 1976, Australia has outlined its defence strategy, which includes the control of the air and sea approaches to Australia. In this context, the Defence White Paper 2009 stated:

> Our military strategy is crucially dependent on our ability to conduct joint operations in the approaches to Australia—especially those necessary to achieve and maintain air superiority and sea control in places of our choosing. Our military strategic aim in establishing and maintaining sea and air control is to enable the manoeuvre and employment of joint ADF [Australian Defence Force] elements in our primary operational environment, and particularly in the maritime and littoral approaches to the continent.[1]

2. This audit examines the upgrade and sustainment of the Royal Australian Air Force's (RAAF's) fleet of 71 F/A-18A/B Hornet aircraft and the sustainment of 24 F/A-18F Super Hornet aircraft. These aircraft form the basis of the RAAF's air combat and airborne ground-attack capability, and are to be replaced by F-35 Lightning II aircraft to be acquired from the United States Department of Defense by the Australian Department of Defence's (Defence's) AIR 6000 New Air Combat Capability project.[2] The F-35 acquisition arrangements, and progress achieved by the F-35 aircraft development and production phases, are the subject of a companion audit, ANAO Audit Report No.6 2012–13, *Management of Australia's Air Combat Capability—F-35A Joint Strike Fighter Acquisition*, 27 September 2012.

3. At the time the Defence White Paper 2009 was developed, the RAAF's air combat capability consisted of a fleet of 21 F-111C fighter-bomber aircraft and 71 F/A-18A/B Hornet aircraft. At the same time, the acquisition process to replace the F-111 fleet with 24 F/A-18F Super Hornets was underway.

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1 *Defending Australia in the Asia Pacific Century: Force 2030. Defence White Paper 2009*, Canberra, 2009, paragraph 7.3, p. 53.

2 The Defence Portfolio consists of a number of component organisations that together are responsible for supporting the defence of Australia and its national interests. The three most significant bodies are: the Department of Defence, the Australian Defence Force (ADF) and the Defence Materiel Organisation. In practice, these three bodies have to work together closely and are broadly regarded as one organisation known as Defence (or the Australian Defence Organisation). All three of these component organisations are involved in the F-35A acquisition.

4. The RAAF's 71 F/A-18A/B Hornet aircraft are assigned to three operational squadrons and a training squadron.[3] The Hornets entered service during the period 1985–90, and were originally planned to be withdrawn from service in 2010–15. However, Government decisions made in 2006 and 2009 extended the withdrawal period to 2017–20, and in May 2012 the need for a possible further extension arose, because of the Government's decision to better align the delivery of Australia's F-35A aircraft with the US Department of Defense's F-35 production and acquisition schedule.[4] Consequently, the precise timing of the F/A-18A/B withdrawal from service is dependent upon the delivery of the F-35A aircraft under schedules that are yet to be finalised.

5. At the time of the audit, the Hornet aircraft were nearing the completion of a two-decade series of systems and weapons upgrades and airframe structural refurbishments, on which some $3.678 billion (then-year dollars) will have been spent by 2015. The structural refurbishments will remain ongoing, as these aircraft are in the latter stages of their service life, and so require steadily increasing structural maintenance. By July 2012 the Hornet fleet had accumulated up to 27 years of operational service, including over 306 000 flying hours.

6. The RAAF's 24 F/A-18F Super Hornet aircraft were acquired in 2010, and are operated in two squadrons.[5] These aircraft replaced the RAAF's 21 F-111 strike/reconnaissance aircraft, which were withdrawn from service in 2010.[6] Currently, the Planned Withdrawal Date for the Super Hornets is 2025.

7. The two Hornet fleets make a significant contribution to Australian Defence Force capability, and as shown in Table S 1, successive Governments have invested heavily in acquiring, upgrading and sustaining these fleets, and significant amounts remain in forward estimates for fleet sustainment.

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3 The F/A-18A/B 'classic' Hornet fleet is operated by 81 Wing's No.3 and No.77 Squadrons and No.2 Operational Conversion Unit, which are located at RAAF Base Williamtown, New South Wales, and No.75 Squadron, located at RAAF Base Tindal, Northern Territory.

4 *Prime Minister, Minister for Defence, Minister for Defence Materiel—joint press conference—Canberra*, media transcript, 3 May 2012.

5 The F/A-18F Super Hornet fleet is operated by 82 Wing's No.1 and No.6 Squadrons, which are located at RAAF Base Amberley, Queensland.

6 The retirement of the F-111 fleet had been planned for the period 2015–20, but in 2003 the RAAF advised the Government that, once several other capabilities had been achieved, the F-111 could be withdrawn from service by 2010. The United States had retired all of its F-111 aircraft by 1998, leaving Australia as the only country still operating that aircraft.

Table S 1

Hornet and Super Hornet fleets' capability expenditure and forward estimates to 2021

Capability		Expenditure and Forward Estimates ($ million)
F/A-18A/B Hornet		
Acquisition	(See Chapter 2)	4 440
Capability upgrades 1995–2015	(See Chapter 2)	3 245
Structural refurbishments completed	(See Chapter 4)	433
Structural refurbishments forward estimate to 2021	(See Chapter 4)	288
Sustainment 2000–12	(See Chapter 3)	1 411
Sustainment forward estimate to 2021	(See Chapter 3)	1 552
F/A-18F Super Hornet (see Chapter 5)		
Acquisition to 2012		2 762
Sustainment to 2012		177
Sustainment forward estimate to 2021		1 380
Total		**15 688**

Source: ANAO analysis of Department of Defence data.

Note: This table aims to be indicative of expenditure on the Hornet and Super Hornet fleets, rather than providing complete life-cycle costing; for example, it does not cover the early sustainment of the Hornet fleet. These amounts have not been adjusted for inflation.

Audit objectives and scope

8. The audit objective was to assess the upgrade and sustainment of the F/A-18A/B Hornet fleet, and the sustainment of the newly acquired F/A-18F Super Hornet fleet.

9. The ANAO commenced the audit in September 2011. Audit fieldwork was conducted from October 2011 to June 2012, in Melbourne at the Australian Defence Force's (ADF's) Directorate General Technical Airworthiness (DGTA) and the Defence Science and Technology Organisation (DSTO), and at the Defence Materiel Organisation's (DMO's) Tactical Fighter Systems Program Office (SPO) in Williamtown NSW and Amberley QLD. Tactical Fighter SPO is the organisation responsible for the day-to-day management of the RAAF's F/A-18 Hornet and Super Hornet upgrades and sustainment.

10. In March 2012, the ANAO conducted interviews and collected documents on F/A-18 Hornet sustainment from US Department of Defense organisations located in Maryland, USA.

11. The audit examined:

- the sustainment aspects of the F/A-18A/B Hornet and F/A-18F Super Hornet fleets, including the achievement of specified operational availability; and
- the structural-refurbishment arrangements that provide a level of assurance that the F/A-18A/B Hornet aircraft will remain serviceable until their current Planned Withdrawal Date of 2020.

Overall conclusion

12. The RAAF F/A-18A/B Hornet air combat fleet is now in a period of transition similar to the transition from the Canberra bomber fleet to the F-111 fleet in the early 1970s, or from the Mirage fighter fleet to the Hornet fleet in the mid-1980s. The Hornet fleet has already been in operational service for up to 27 years, while the F-35A JSF aircraft, which is to eventually replace both the F/A-18A/B Hornet and F/A-18F Super Hornet fleets, is not currently expected to enter Full-Rate Production until 2019, by which time the oldest RAAF F/A-18 would have been in service for 34 years. Assessing the capability upgrade and sustainment status of both F/A-18 fleets is therefore fundamental to understanding the risks of an air combat capability gap occurring between the withdrawal from service of Australia's F/A-18A/B fleet and the entry into service with the RAAF of the F-35s. Accordingly, this audit focused on that key issue.

13. This audit report draws attention to the risks inherent in the management of aged combat aircraft. These risks are wide-ranging and require ongoing, prudent management if the Tactical Fighter SPO and the RAAF's Air Combat Group (ACG) are to ensure that the F/A-18A/B Hornet fleet remains capable of satisfying approved operational commitments, while it undergoes aircraft and weapons systems upgrades, airframe structural refurbishments, periodic Deeper Maintenance and Operational (flight-line) Maintenance.

14. Since 1995, there has been an extensive program of RAAF F/A-18A/B aircraft and weapon-system upgrade projects that have budgets totalling $3.245 billion. By May 2012, expenditure on these projects totalled $2.784 billion, and as a result, the RAAF's F/A-18A/B aircraft are now significantly more capable than they were when introduced into service between 1985 and 1990.

15. These upgrades have been undertaken by firms under contract to Defence, and have progressed within an effective system of technical-airworthiness regulation, which has been established and managed by the RAAF and the ADF's Directorate General Technical Airworthiness since 1993. The regulations encompass the release into operational service of new and modified aircraft, as well as the maintenance of ADF aircraft by RAAF, DMO and contractor personnel.

16. In recent years, Tactical Fighter SPO and the ACG have implemented a range of initiatives designed to ensure that the Hornet fleet can meet its operational requirements out to its Planned Withdrawal Date, which at the time of the audit was 2020.[7] Defence records indicate that, while F/A-18A/B operational availability and logistics support satisfy DMO's agreement with the RAAF, this is becoming increasingly difficult to achieve, because significant aged-aircraft issues are resulting in maintenance durations and costs becoming less predictable. Annual spending to sustain the Hornet fleet has averaged $118 million since 2000–01, but is trending towards $170 million per annum over the next several years. The cost of airframe corrosion-related repairs has also increased significantly, from $721 000 in 2007 to $1.367 million as estimated in 2011.

17. The F/A-18A/B Hornet was designed for a safe life of 6000 airframe hours under specified flight profiles. Defence data indicates that, at the current rate of effort of 13 000 airframe hours per year for the fleet (reducing to 12 000 hours from 2013–14), the Hornet fleet as a whole will not exceed 6000 flying hours for each aircraft until after the current Planned Withdrawal Date of 2020. That said, all but nine aircraft have experienced structural fatigue above that expected for the airframe hours flown, leading the ACG to take steps to conserve the remaining fatigue life of its F/A-18A/Bs to ensure they remain operable up to the safe life of 6000 airframe hours.

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[7] As a result of the US decision to move the F-35 Full-Rate Production decision out by three years to 2019, and the Australian Government's consequent May 2012 Budget decisions to delay the acquisition schedule for the F-35 aircraft, the Planned Withdrawal Date is likely to be extended. ANAO Audit Report No.6 2012–13, *Management of Australia's Air Combat Capability—F-35A Joint Strike Fighter Acquisition,* 27 September 2012.

18. The most recent additions to the RAAF's air combat capability are the 24 Super Hornets that were progressively delivered to RAAF Base Amberley, near Brisbane, between March 2010 and October 2011. In December 2010 the Super Hornet fleet achieved the Initial Operational Capability milestone, a week after the retirement of the RAAF's F-111 fleet. The Super Hornet acquisition and its in-service support are largely based on US Government Foreign Military Sales arrangements that are designed to maximise commonality with US Navy F/A-18F sustainment arrangements. The RAAF's F/A-18F Operational Maintenance squadrons are therefore organised as 'pseudo' deployed US Navy Super Hornet squadrons, drawing assistance from the supplier/repair-vendor network used by the US Navy.

19. At the time of the audit, the Australian Super Hornet sustainment arrangements were in their formative stage, and adjustments to maintenance policy and support arrangements to achieve better alignment with the US Navy's arrangements were ongoing. Tactical Fighter SPO statistics indicated that the Super Hornet support system was steadily improving, but required further improvement. Tactical Fighter SPO and its Super Hornet maintenance contractor are working with the US Navy to achieve improvements ahead of the Super Hornets' Final Operational Capability milestone, which is scheduled for December 2012.

20. The ANAO found that Defence has implemented sound managerial control over the upgrade and sustainment of its F/A-18 Hornet and Super Hornet fleets. Management statistics indicate that both fleets are meeting their operational requirements, within the context of a complex mix of factors including:

- Defence funding priorities, which determine 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 carried out by RAAF operational-maintenance personnel;

- capability-upgrade requirements, which are determined by the need to maintain control of the air and sea approaches to Australia. These dictate the frequency and extent of aircraft capability upgrades; and
- the extensive maintenance demands of advanced combat aircraft, which increase as aircraft near their airframe safe-life hours and structural-fatigue margins.

21. The key risks to the F/A-18 fleets' fulfilment of their operational requirements until their replacement by the F-35A Lightning II (Joint Strike Fighter) revolve around Defence's ability to maintain the present levels of Hornet sustainment and structural-integrity management. Defence data indicates that this will require steadily increasing financial investment, with F/A-18 Hornet sustainment costs estimated by Defence to peak at $214 million per year in 2018–19. By 2011, Hornet Deeper Maintenance service costs had risen 73 per cent, from $750 000 to $1.3 million per aircraft, over the previous few years. This reflects the effort needed to keep an aged and complex fleet airworthy and operational. Super Hornet sustainment costs are estimated by Defence to peak at $180 million in 2017–18, as these aircraft are expected to be withdrawn from service before costly aged-aircraft maintenance or structural-fatigue-related maintenance is required. These Defence sustainment estimates are based on the F/A-18 Hornet and F/A-18 Super Hornet Planned Withdrawal Dates of 2020 and 2025 respectively.

Overall summary

22. As indicated in paragraph 8, the audit objective was to assess the upgrade and sustainment of the F/A-18A/B Hornet fleet, and the sustainment of the newly acquired F/A-18F Super Hornet fleet. Defence's management approach to the F/A-18 fleets has been effective thus far in identifying, in a variety of dimensions, the risks to their continued delivery of the required capability until their current Planned Withdrawal Dates. Defence has also been active in putting in place mitigation measures for these risks. However, the report outlines the significant risks that will require close management by Defence in the final stages of sustainment of the F/A-18A/B fleet in particular, when airframe hours flown and fatigue-life expended will be greatest.

23. These risks include:

- the increasing emergence of airframe corrosion and fatigue issues which make maintenance of the F/A-18A/B fleet more difficult and more expensive;

- the need to closely manage annual flying hours, given the approaching safe-life limits for the F/A-18A/B fleet (6000 hours for the airframe) and the potential requirement for an expansion of the safety-by-inspection regime to include airframe structures that are increasingly susceptible to wear or corrosion-initiated fatigue-cracking;
- the need to manage for a moderate reduction in the rate at which F/A-18A/B aircraft are accumulating structural fatigue to avoid their fatigue life being expended before they reach their safe life of 6000 airframe hours, given that most of the aircraft in the Hornet fleet have exceeded an optimum amount of accumulated structural fatigue according to their airframe hours flown; and
- the likelihood that the Planned Withdrawal Date for the F/A-18A/Bs will be extended as a result of the US decision to move the F-35 Full-Rate Production decision out by three years to 2019, and the Australian Government's consequent May 2012 Budget decisions to delay the acquisition schedule for the F-35 aircraft.[8] Extending the F/A-18A/B fleet's Planned Withdrawal Date beyond 2020 may well require the fleet to undergo an expanded, and hence more costly, safety-by-inspection regime, structural modifications program and capability upgrades.

24. At the time of the preparation of this report, the Planned Withdrawal Date for the F/A-18A/B fleet was 2020. Following US and Australian Government decisions that have delayed earlier F-35A delivery intentions, the ANAO asked Defence for advice on its consequent contingency planning. Defence advised that it will be presenting options to the Government later this year on managing the air combat capability, including a limited extension of the Planned Withdrawal Date for the F/A-18A/Bs, as the RAAF transitions from the current fleet to a predominantly F-35A fleet.[9] Defence indicated that this would include strategies to reduce the risks associated with the likely

8 This decision delayed delivery of 12 of the first 14 F-35A aircraft and postponed a decision on the next 58 aircraft until beyond 2013.

9 Currently, the RAAF's 24 Super Hornets (the F/A-18Fs) have a Planned Withdrawal Date of 2025, and so will form part of Australia's air combat capability even after the planned entry into service of the F-35As and the withdrawal of the F/A-18A/Bs. In August 2012, the Government also announced its decision to acquire the Growler electronic warfare system for 12 of the Super Hornets, with the total capital cost estimate for this acquisition around $1.5 billion. Accordingly, the Planned Withdrawal Date for the Super Hornets may be reviewed.

extension of the F/A-18A/B fleet's operational life, and to minimise risks associated with progressing to the F-35A's Initial Operational Capability.

25. The ANAO has not made any formal recommendations for administrative improvements in Defence's management of the ADF's air combat capability in this audit report (or in its companion report, Audit Report No.6 2012–13, *Management of Australia's Air Combat Capability—F-35A Joint Strike Fighter Acquisition*). This is because, in the context of this complex transition in capability from the F/A-18 fleets, which includes the increasingly aged fleet of F/A-18A/Bs, to a future capability based on a next-generation multi-role aircraft being developed and produced by another nation, the approach by successive Australian Governments and the Defence organisation to both the upgrade and sustainment of the F/A-18A/B Hornet fleet and the acquisition and sustainment of the F/A-18F Super Hornet fleet has been measured, and based on appropriate information and planning.

26. Nonetheless, achieving the planned transition to an F-35-based air combat capability in the required timeframe, such that a capability gap does not arise between the withdrawal from service of the F/A-18A/B fleet and the achievement of full operational capability for the F-35, remains challenging. As indicated in paragraph 24, following US and Australian Government decisions that have delayed earlier F-35A delivery intentions, the F/A-18A/B fleet's operational life is likely to be extended beyond the current Planned Withdrawal Date of 2020. Defence financial data indicates that the achievement of such an extension beyond 2020 will involve additional costs and will require detailed planning and close management by Defence. Defence's capacity to accommodate any further delays in the production and/or acquisition of F-35s through a further extension to the life of the F/A-18A/B fleet, beyond the limited extension currently being considered, has limits, is likely to be costly, and has implications for capability. That said, decisions in relation to capability for the ADF, including Australia's acquisition of F-35As, properly rest with the Australian Government, informed by advice from Defence.

Key findings by chapter

Chapter 2—F/A-18A/B Hornet fleet capability upgrades

27. The RAAF's fleet of F/A-18A/B Hornet combat aircraft, delivered in the late 1980s, could not be expected to retain its original relative capability over three decades without significant weapons and systems upgrades. The Hornet fleet has therefore received upgrades of both its weapons and mission systems since the mid-1990s. These upgrades were intended to maintain the fleet's effectiveness until a replacement was available that could provide a 'quantum leap' in capability.

28. The RAAF uses two engineering processes to manage the implementation of aircraft upgrades: Design Acceptance ensures that upgrades are technically airworthy, and is followed by Service Release, which verifies that RAAF units are ready to conduct operations with the new capability. Both of these processes are overseen by independent organisations within the RAAF: the Director General Technical Airworthiness (DGTA) oversees Design Acceptance, while the ADF's Airworthiness Coordination and Policy Agency (ACPA-ADF) establishes Airworthiness Boards to oversee the annual Service Release for each ADF platform.

29. Once the Design Acceptance process has verified that a new capability can operate safely, the process concludes with the issue of an Australian Military Type Certificate or a Supplemental Type Certificate, stating that the modified weapon or aircraft meets technical-airworthiness standards. This is the military equivalent of the airworthiness certification of civilian aircraft by the Civil Aviation Standards Authority. The annual ACPA Airworthiness Board verifies that all the systems are in place for a fleet's safe operation, and makes Service Release recommendations to the Chief of Air Force in his role as the ADF Airworthiness Authority. These engineering processes provide a sound basis for concluding that the RAAF has in place robust systems for the verification and management of its fighter aircraft and their upgraded weapons and systems.

30. The new weapons capabilities acquired for the Hornet fleet under the upgrade program include new short-range and medium-range air-to-air missiles, precision-bombing capability, and long-range cruise missiles for ground-strike operations, specifically:

- the AIM-132A Advanced Short Range Air-to-Air Missile (ASRAAM);
- the AIM-120B and AIM-120C5 Advanced Medium Range Air-to-Air Missile (AMRAAM);
- the Joint Direct Attack Munition (JDAM) air-to-ground bomb-guidance system; and
- the AGM-158A Joint Air-to-Surface Standoff Missile (JASSM).

31. The aircraft themselves have received significant mission-system upgrades, including:

- upgrades of voice communications, the Identification Friend-or-Foe (IFF) system, and the inertial navigation system, as well as software for the radar-warning receivers, radars and new operational software;
- new fire-control radar, and electronic-protection techniques for the radar;
- a LINK 16 secure data link, an upgraded counter-measures dispenser, colour displays, an upgraded digital moving-map system, the Joint Mission Planning System, and a helmet-mounted cueing system;
- replacement of the radar-warning receiver, supplementation of the counter-measures dispenser and of jammer capability, and enhancement of the aircraft's data-recording capability;
- an upgraded target-designation system;
- a GPS protection system; and
- a Variable Message Format data system.

32. The RAAF has also received updated flight-training simulators that take account of the upgrades to the aircraft and weapons.

33. The ANAO has established that these upgrades of Hornet weapons and systems have been introduced into service under the RAAF's Design Acceptance and Service Release processes, which provide a rigorous systems-engineering framework that is required to underpin adequate levels of assurance that new systems will work safely and effectively.

34. The upgrade of all 71 RAAF F/A-18A/B Hornet aircraft is due for completion by 2015, at a total cost of $3.245 billion. Together with the fleet's original acquisition cost of $4.44 billion, the total acquisition cost of the F/A-18A/B Hornet fleet amounts to some $7.685 billion over the period 1985–2015, covering the aircraft, aircraft upgrades and weapons upgrades.

Chapter 3—F/A-18A/B Hornet fleet sustainment

35. Once an aircraft's airworthiness and weapons are assured, it becomes the task of an integrated logistic support system to make available the number of aircraft specified by the RAAF's operational requirements. Hornet fleet integrated logistic support is managed by DMO's Tactical Fighter SPO, with maintenance and repair activities carried out by Air Combat Group's squadron maintenance personnel, as well as by BAE Systems Australia and Boeing Defence Australia.

36. Two key measures of the outcomes enabled by the logistics system are the number of hours flown by the Hornet fleet and the number of aircraft made available for operational purposes. Defence records show that the number of flying hours increased during 2009–10 and 2010–11, exceeding the hours achieved in the early 1990s. Flying hours were affected during 2009–10 and 2010–11 by aged-aircraft issues and Hornet upgrades, as well as some structural refurbishments. In 2011–12, the authorised flying hours were not achieved, largely due to a shortfall in the ratio of experienced pilots to junior pilots.

37. At present, Tactical Fighter SPO continues to make available to the RAAF the number of operational aircraft required by the Chief of Air Force, and this performance measure has been holding steady in recent years at a level above that of the period 2002–05. Moreover, in the four years to May 2012, there were only 17 months in which the target was not met or exceeded—a significant improvement from the previous four-year period, when there were 34 months when the target was not met.

38. These two achievements—substantial flying hours and an increased rate of availability—have been delivered in the context of recent initiatives by Tactical Fighter SPO and the RAAF's Air Combat Group. These initiatives have included:

- the introduction of a new level of Deeper Maintenance;[10]
- substantial reform of the timetable for Deeper Maintenance;
- consolidation of Deeper Maintenance into a single combined Defence/contractor workshop at RAAF Williamtown; and
- establishment of a Hornet Fleet Planning Cell to optimise the use of aircraft according to their maintenance schedule and their amount of accumulated structural fatigue.

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10 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.

39. The duration of Deeper Maintenance services has varied markedly over the last decade, as a result of the wide range of types of service to be undertaken, from periodic services to comprehensive upgrades or modifications. Defence statistics indicate that, in recent years, maintenance of the Hornet fleet has become more difficult and more expensive, with the increasing emergence of airframe corrosion and fatigue issues. The general trend is for Deeper Maintenance services to exceed the targeted duration of 12 weeks, and as the fleet grows older, this trend is expected to continue.

40. The provision of spares to the F/A-18A/B Hornet fleet shows a moderate level of improvement over the last decade, with targets for demand-satisfaction generally being met, and delayed spares being supplied within reasonable margins. Tactical Fighter SPO is also managing carefully the variable costs and benefits of cannibalising parts versus replacing them.

Chapter 4—F/A-18A/B Hornet fleet structural integrity

41. The Hornet fleet's structural integrity is the key to its ability to remain in service until the current Planned Withdrawal Date of 2020.[11] The structural integrity of aircraft is assured by a combination of maintenance regimes applied to airframe structures. While the integrity of most Hornet airframe structures is managed according to a safe-life regime based on airframe hours flown, the integrity of certain structures is managed through a safety-by-inspection regime. When a particular airframe structure has reached its safe-life limit according to hours flown, it may continue to be maintained under a more intensive—and therefore more expensive—safety-by-inspection regime. This regime seeks to locate, monitor and repair aircraft structures subject to fatigue cracking caused by repeated loading over time.

42. One of the principal objectives of the Deeper Maintenance services is to ensure that the structural integrity of the Hornet fleet is being assessed, and appropriate risk-reduction activities are being undertaken. Tactical Fighter SPO, in consultation with the RAAF's Air Combat Group and the DSTO, and subject to approval by DGTA, implements an F/A-18A/B Aircraft Structural Integrity Management Plan, designed to provide a sound basis for aircraft

[11] Structural integrity is the ability of a structure to withstand its operational service conditions safely and reliably throughout its planned lifetime.

structural-inspection programs, structural-life limits, and component retirement times.

43. The F/A-18A/B Hornet was designed for a safe life of 6000 airframe hours. At the current fleet flying rate of 13 000 hours per year, reducing to 12 000 from 2013–14, there is capacity on that basis for the Hornet fleet to continue flying until the end of 2020. However, this would require continuing close management of flying hours, to ensure that safe-life limits are not exceeded, and an expansion of the safety-by-inspection regime to include airframe structures that are increasingly susceptible to wear or corrosion-initiated fatigue-cracking. Using the fleet beyond 2020 may well require an expanded, and hence more costly, safety-by-inspection regime, structural modifications and capability upgrades.

44. At the time of this audit, Defence was considering the extent to which the Planned Withdrawal Date for the F/A-18A/Bs may need to be varied as a result of the US decision to move the F-35 Full-Rate Production decision out by three years to 2019 and any potential impacts of the Australian Government's May 2012 Budget decisions to delay the acquisition schedule for the F-35 aircraft. Accordingly, the issues involved in any extension of the Hornets' life beyond 2020 were not examined in this audit, although the principles involved in determining an aircraft's safe life continue to apply.

45. Any consideration of the safe life of the F/A-18A/B Hornet (6000 airframe hours) also needs to factor in the fatigue stress the aircraft have experienced. While the Hornet fleet is operating within its safe life in terms of airframe hours, the rate at which it is accruing fatigue stress also requires effective management to ensure that the Hornet fleet can achieve its current Planned Withdrawal Date or indeed any extension to this.

46. Most of the aircraft in the Hornet fleet have exceeded an optimum amount of accumulated structural fatigue according to their airframe hours flown. Therefore their rate of fatigue accrual will have to be moderately reduced, or their fatigue life will be expended before they reach their safe life of 6000 airframe hours.

47. The RAAF's Air Combat Group has informed the ANAO that rates of fatigue accrual have declined in recent years, with the advent of precision weaponry lessening to some extent the need for high-g manoeuvres, which increase aerodynamic loads on critical airframe structures. Nevertheless, the development and maintenance of tactical skills still requires air-combat training that includes high-g manoeuvres. In this light, continuous and effective management of fatigue accrual by Defence is required to underpin adequate levels of assurance that the fleet can meet its Planned Withdrawal Date without structural fatigue limits being exceeded.

48. The structural-refurbishment programs for the Hornet fleet since 2003 have played a large role in enabling the extension of the Planned Withdrawal Date to 2020. These programs have included centre barrel replacements on ten aircraft, as well as ongoing structural modifications to the remainder of the fleet. By December 2010, expenditure on these programs amounted to $433.04 million. At that time, the Hornet Structural Assurance Consolidation Program was approved, at a budgeted cost of $288.2 million. This program focuses on structural issues to ensure continued airworthiness through to December 2020.

49. Corrosion is also a significant threat to the continued airworthiness of aged aircraft, over and above the limitations imposed by airframe hours and fatigue. While not yet affecting airworthiness, corrosion can be expected to pose the most significant risk to the achievement of the Planned Withdrawal Date of 2020.

50. The incidence of discovery of airframe corrosion in the Hornet fleet is increasing, and the annual cost of corrosion-related repairs has increased significantly, from $0.721 million in 2007 to $1.367 million as estimated by Defence records in 2011. Corrosion-related maintenance has reduced the availability of the fleet by some 1381 aircraft days annually, up from 573 days in 2007.

51. Efforts to control airframe corrosion at RAAF Williamtown have been adversely affected by the closure of its Corrosion Control Facility in early 2009, when it became the subject of a Comcare Prohibition Notice. At the time of the audit, refurbishment activities to support the reopening of this facility were to commence in October 2012 and to be completed in May 2013, subject to approvals, funding and the resolution of Comcare issues. The aircraft wash-down facility at Williamtown, first proposed in 1998 and commissioned in 2011, will assist in efforts to control the growth of corrosion, as will current initiatives to repaint the Hornet fleet along with other RAAF aircraft.

Chapter 5—F/A-18F Super Hornet fleet sustainment

52. The decision in 2007 to acquire 24 F/A-18F Super Hornets, and their delivery in 2010–11, was intended to bridge the capability gap between the early retirement of the F-111 fleet (advanced from 2015–20 to 2010) and the eventual acquisition of the F-35 Lightning II Joint Strike Fighter. In the defence context, the period of four years between the decision to acquire the Super Hornet fleet and its arrival in Australia constituted a very short timeframe for the establishment of such a significant and complex capability.

53. To ensure that the Super Hornet fleet's ongoing support and capability development occur cost effectively, Defence is seeking to maintain close commonality with the US Navy in terms of Super Hornet operation, maintenance and support. This is being achieved through a combination of commercial contracting and the acquisition of maintenance items and technical support via US Foreign Military Sales agreements.

54. However, at the time of the audit, the Super Hornet sustainment arrangements were in their formative stage, and adjustments were ongoing. At times, Tactical Fighter SPO has been unable to fulfil the squadrons' demands for maintenance spares within specified timeframes. This has affected the availability of aircraft as specified in Materiel Sustainment Agreements between the RAAF and DMO.

55. Work is under way to implement a fatigue-monitoring system for the Super Hornet fleet, similar to the one that is in operation on the Hornet fleet. This system will enable a Structural Life Assessment that will help the Super Hornet fleet to achieve its Planned Withdrawal Date of 2025.

Summary of agency response

56. Defence provided the following response to this report and the companion report:

> Defence welcomes the ANAO audit reports on the Management of Australia's Air Combat Capability. These extensive reports demonstrate the complex and evolving nature of Australia's air combat systems which are at the forefront of Australia's Defence force structure.
>
> These reports also highlight a number of challenges that Defence faces in transitioning from its current 4th and 4.5th generation fighters into the 5th generation F-35A.

Defence has made significant progress towards increasing efficiencies and maximising combat capability over a decade of continuous air combat upgrades and acquisitions. The experience gained stands Defence in good stead for the acquisition of future air combat capabilities through a strong collegiate approach across the various areas of Defence, the Defence Materiel Organisation and external service providers. This experience will ease the burden during what will be a carefully balanced transition to the F-35A.

Defence acknowledges that there is scope to realise further improvements through process alignment and business practice innovation, and will continue to build on the work that has already been undertaken. Defence is committed to managing the complexities of its various reform programs whilst continuing to assure Australia's future air combat capability requirements.

57. The formal response from Defence is included at Appendix 1.

58. Report extracts were also provided to BAE Systems Australia and Boeing Defence Australia, and their comments were taken into account in the report. The formal response from Boeing Defence Australia is included at Appendix 2.

Audit Findings

1. Introduction

This chapter sets out the high priority Australia places on its air combat capability. It explains the long lead-times involved in aircraft development and sustainment, and outlines this audit's approach and methodology.

Background

1.1 Since its formation in 1921, the role of the Royal Australian Air Force (RAAF) has been to raise, train and sustain an air combat capability to protect Australia and its national interests. In successive Defence White Papers since 1976,[12] Australia has outlined its defence strategy, which includes the control of the air and sea approaches to Australia. In this context, the Defence White Paper 2009 stated:

> Our military strategy is crucially dependent on our ability to conduct joint operations in the approaches to Australia—especially those necessary to achieve and maintain air superiority and sea control in places of our choosing. Our military strategic aim in establishing and maintaining sea and air control is to enable the manoeuvre and employment of joint ADF [Australian Defence Force] elements in our primary operational environment, and particularly in the maritime and littoral approaches to the continent.[13]

1.2 At the time the Defence White Paper 2009 was developed, the RAAF's air combat capability consisted of an aging fleet of 21 F-111C fighter-bomber aircraft and 71 F/A-18A/B Hornet aircraft. At the same time, the acquisition process to replace the F-111 fleet with 24 F/A-18F Super Hornets was underway.

1.3 The RAAF fleets are now in a period of transition similar to the transition from the Canberra bomber fleet to the F-111 fleet in the early 1970s, or from the Mirage fighter fleet to the Hornet fleet in the mid-1980s.[14] In 2010 the then remaining fleet of 21 F-111C long-range strike and reconnaissance

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12 Defence White Papers have been published in 1976, 1987, 1994, 2000 and 2009.

13 *Defending Australia in the Asia Pacific Century: Force 2030. Defence White Paper 2009*, Canberra, 2009, paragraph 7.3, p. 53.

14 For the history of RAAF acquisitions of combat aircraft, see Table 1.1 in the companion audit, ANAO Audit Report No.6 2012–13, *Management of Australia's Air Combat Capability—F-35A Joint Strike Fighter Acquisition*, 27 September 2012.

aircraft was withdrawn from service,[15] while the current fleet of 55 F/A-18A (single-seat) and 16 F/A-18B (dual-seat) Hornets has been in operational service for up to 27 years. However, the F-35A JSF aircraft, which is to replace both F/A-18 fleets, is not expected to enter Full-Rate Production until 2019,[16] by which time the oldest RAAF F/A-18 would have been in service for 34 years. The F-35 acquisition arrangements, and progress achieved by the F-35 aircraft development and production phases, are the subject of a companion audit, ANAO Audit Report No.6 2012–13, *Management of Australia's Air Combat Capability—F-35A Joint Strike Fighter Acquisition*, 27 September 2012.

1.4 In order to ensure that Australia continues to have the capability outlined in the 2009 Defence White Paper, the service life of the F/A-18A/B fleet has been extended until 2020, and a fleet of 24 F/A-18F Super Hornets has been acquired to replace the F-111s.

Organisational arrangements

1.5 The importance placed on the ADF's air combat capabilities, and the consequent need to develop a highly reliable organisational capacity to properly sustain those capabilities, have resulted in the following organisational relationships:

- Chief of Air Force is responsible for exercising oversight and coordination of all the elements necessary to introduce the full level of operational capability into service within the scope, cost, workforce, schedule and risk parameters agreed to by Government. This includes exercising the role of the ADF airworthiness regulatory authority responsible for:

  (a) operating aircraft within approved structural operating limits;

15 The four F-111As acquired in 1982 had been converted to F-111C configuration, making a total of 28 F-111Cs. By 2010, this fleet had been reduced by attrition to 21.

16 The achievement of the Initial Operational Capability (IOC) milestone by the RAAF's F-35A variant was originally planned for 2012–14, but by 2011 it had slipped to 2018. Until recently, it was expected that the US Air Force IOC would be achieved in early 2018, and that the RAAF IOC would occur after that. However, the US Services have requested a delay in establishing IOC dates, anticipating that they will identify these dates in 2013, after observing additional test results during 2012. After the May 2012 Budget decisions, and subject to further Defence planning, Australian IOC was initially projected to occur in 2020. *Defence Capability Plan 2004–2014*, p. 45; *Defence Capability Plan 2011*, p. 57; *Selected acquisition report (SAR): F-35, as of December 31, 2011*, Washington DC, pp. 6, 63.

(b) providing timely promulgation of role and environment changes via proposed amendments to the Statement of Operating Intent;

(c) conducting structural maintenance and repair of aircraft in accordance with authorised procedures and processes;

(d) collecting aircraft and engine usage and condition-monitoring data as detailed in the aircraft and engine structural integrity programs; and

(e) informing the Director General Technical Airworthiness of in-service issues that have the potential to affect the structural integrity of an aircraft or engine.[17]

- The ADF's Directorate General Technical Airworthiness (DGTA), formed in 1998, develops and audits the implementation of technical regulations covering the 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. The DGTA concentrates on the approval of organisations and the processes they follow, rather than approving the work itself.[18]
- The Airworthiness Coordination and Policy Agency (ACPA) was formed in 1998 and, on behalf of the Chief of Air Force, provides high-level oversight and audit of the technical and operational airworthiness of ADF aircraft. 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 the type certification, Service Release and in-service management of ADF aircraft.
- The Systems Program Offices (SPOs) in the Defence Materiel Organisation (DMO) manage the acquisition, through-life logistics support and disposal phases of Defence's capital-equipment life cycle. Tactical Fighter SPO is responsible for those aspects of Hornet and Super Hornet fleet management, and it was formed in August 2000

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17 Department of Defence, Defence Instruction (LOG) 4–5–016, *Management of aircraft and engine structural integrity*, September 2010, p. 5.

18 DGTA evolved from the RAAF's Directorate of Technical Airworthiness, which was formed in 1993.

within DMO's Aerospace Combat Systems Branch.[19] At the time of the audit, Tactical Fighter SPO's workforce included 256 military and civilian personnel at RAAF Bases Williamtown and Amberley, and 12 personnel in Canberra.

- The New Air Combat Capability Integrated Project Team (NACC IPT), located in Canberra, comprising 99 personnel drawn from several Defence organisations, is responsible for acquisition of the F-35 aircraft and their transition into service.
- Air Force operational units provide overall fleet management in terms of flying operations and safety management, fleet-usage coordination and management of aircraft serviceability. The RAAF's Air Combat Group (ACG) provides the air combat capability, presently based on three F/A-18A/B squadrons,[20] two F/A-18F Super Hornet squadrons,[21] an Operational Conversion Unit, and two Hawk lead-in fighter squadrons.[22]
- Defence industry contractors provide Deeper Maintenance of aircraft fleets,[23] in cooperation with the SPOs and Air Force Groups.

1.6 The organisational arrangements that support the air combat fleet are shown in Figure 1.1.

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19 As at September 2011, the organisations within the Aerospace Combat Systems Branch were: Tactical Fighter SPO, Disposal and Aerial Target Office (DATO), and Executive & Support. Since June 2010, the Australian Super Hornet Project Office (ASHPO) has been a unit of Tactical Fighter SPO.

20 The F/A-18A/B fleet is operated by 81 Wing, comprised of No.3 and No.77 Squadrons and No.2 Operational Conversion Unit at Williamtown, New South Wales, and No.75 Squadron at Tindal, Northern Territory.

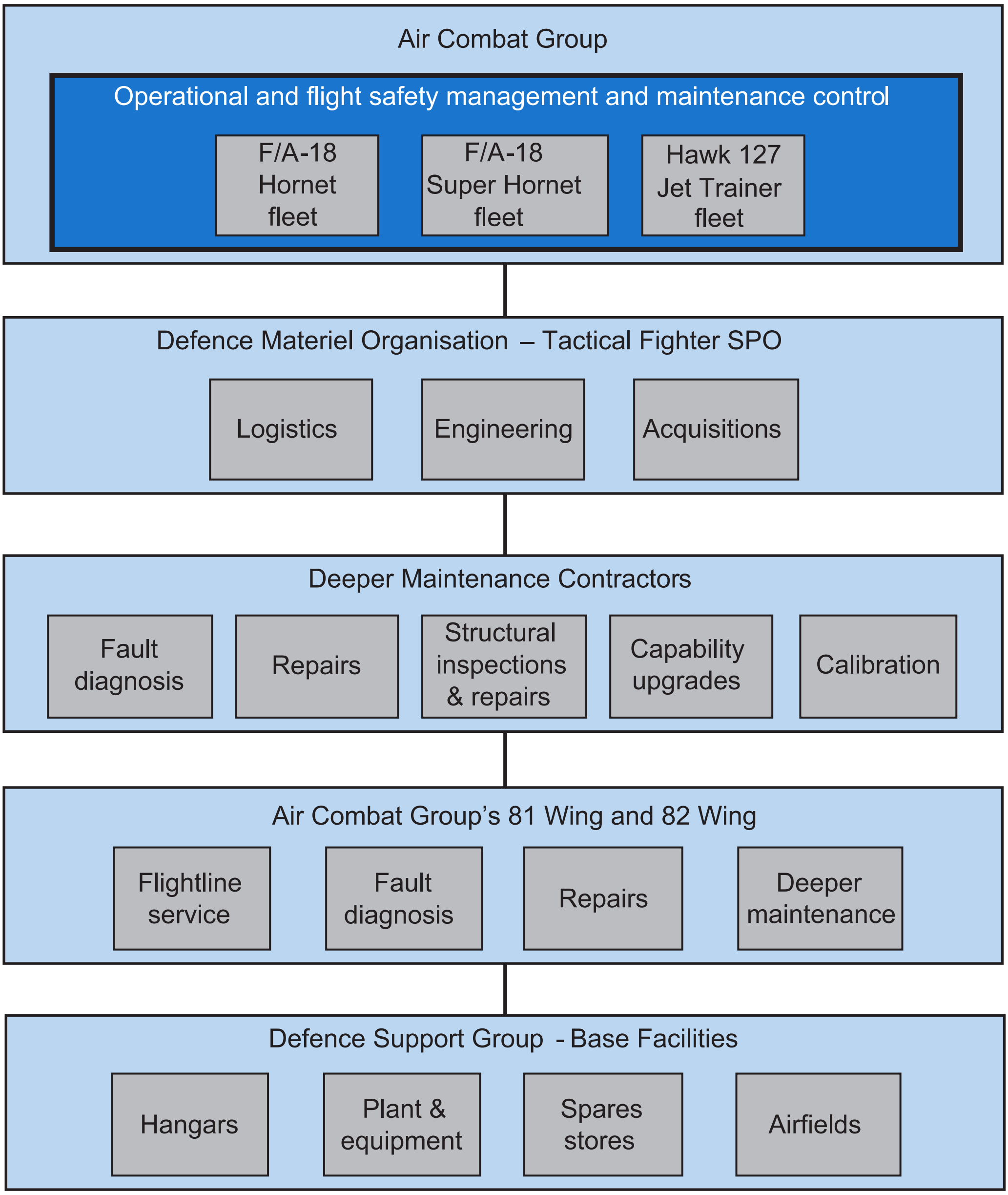
21 The F/A-18F fleet is operated by 82 Wing, comprised of No.1 Squadron and No.6 Squadron at Amberley, Queensland. 82 Wing also comprises other platforms that are outside the scope of this audit: the Pilatus PC-9/A for tactical air support (No.4 Squadron), the Heron unmanned aerial vehicle (No.5 Flight), and elements of an intelligence squadron (No.87 Squadron).

22 The Hawk fleet is operated by 78 Wing, comprised of No.76 Squadron at Williamtown, and No.79 Squadron at Pearce, Western Australia. Defence acquired the Hawk fleet between 1997 and 2000. Being primarily used for initial or lead-in fighter training to prepare aircrew for operational conversion to the F/A-18 Hornet fighter, the Hawk fleet is not within the scope of this audit. 78 Wing also includes No.278 Squadron, which provides technical training in support of Air Combat Group operations.

23 Deeper Maintenance covers the most extensive maintenance which can be performed on an application or item. It includes overhaul and major repair of items, and tasks involving major disassembly and repair of an application, as well as some application servicing. Deeper Maintenance normally requires a wide range of special and general support equipment and facilities. Australian Defence Force, *ADF aviation maintenance management manual (Book 2 of 2)*, Australian Air Publication 7001.059, 18 May 2011, Glossary. For a more detailed explanation of Deeper Maintenance, see Appendix 5: Hornet Deeper Maintenance.

Figure 1.1

Air combat fleet support structure



Source: Australian National Audit Office.

Audit objective and scope

1.7 The audit objective was to assess the upgrade and sustainment of the F/A-18A/B Hornet fleet, and the sustainment of the newly acquired F/A-18F Super Hornet fleet.

1.8 The audit scope focused on:

- the sustainment aspects of the F/A-18A/B Hornet and F/A-18F Super Hornet fleets, including the achievement of specified operational availability (Chapters 2, 3 and 5); and
- the structural-refurbishment arrangements that provide a level of assurance that the F/A-18A/B Hornet aircraft will remain serviceable until their current Planned Withdrawal Date of 2020 (Chapter 4).

1.9 The ADF's air combat fleet is supported by Airborne Early Warning and Control aircraft, air-to-air refuelling aircraft, lead-in fighter training aircraft, air bases, and command, control and surveillance capabilities.[24] These support systems are not included in the audit's scope. Also not included are possible issues arising from any future extension of the F/A-18A/B fleet's Planned Withdrawal Date beyond 2020 as a result of the Government's May 2012 Budget decision to delay acquisition of the F-35.

1.10 The audit fieldwork was conducted from October 2011 to June 2012 in Melbourne at the Australian Defence Force's Directorate General Technical Airworthiness (DGTA) and the Defence Science and Technology Organisation (DSTO), and at DMO's Tactical Fighter Systems Program Office in Williamtown NSW and Amberley QLD.

1.11 The ANAO also conducted fieldwork for the audit in the United States during March 2012. This included interviewing the RAAF's F/A-18 Technical Liaison Office, at Lexington Park, Maryland, USA.

1.12 The following high-level audit criteria have been applied in this audit:

- The DMO's Tactical Fighter SPO verifies that its F/A-18 sustainment activities are successful in ensuring that the RAAF's operational requirements for both the F/A-18 fleets (the classic Hornet and Super Hornet fleets) are being met; and

[24] *Defending Australia in the Asia Pacific Century: Force 2030. Defence White Paper 2009*, Canberra, 2009, paragraph 8.22, p. 61.

- DMO, in conjunction with DSTO, assesses the risks involved in extending the service life of the F/A-18A/B fleet to its Planned Withdrawal Date, and has implemented appropriate risk-reduction activities based on international F/A-18 structural-refurbishment experience.

1.13 The audit approach involved the collection and analysis of key project-management documents concerning the F/A-18 sustainment and structural-refurbishment projects. The audit also included interviews with key Defence personnel responsible for managing the F/A-18 sustainment projects.

1.14 The audit was conducted in accordance with the ANAO auditing standards at a cost to the ANAO of $304 300.[25]

Report structure

1.15 The remainder of this audit report is structured into four chapters.

- Chapter 2 examines recent capability upgrades to the F/A-18A/B classic Hornet fleet from the perspective of airworthiness certification, including Design Acceptance and Service Release.
- Chapter 3 focuses on the sustainment of the F/A-18A/B classic Hornet fleet, and examines the achievement of flying hours and other key indicators of the effectiveness of the Hornet fleet's maintenance and spares support.
- Chapter 4 examines the F/A-18A/B classic Hornet fleet's Aircraft Structural Integrity Program, which seeks to provide adequate assurance that the Hornet fleet's service life can be extended until its Planned Withdrawal Date, currently 2020.
- Chapter 5 examines the developing sustainment of the F/A-18F Super Hornet fleet. The acquisition of this fleet was announced in 2007, with final delivery occurring in 2011, under project AIR 5349, Bridging Air Combat Capability. The chapter discusses the Super Hornets' logistics-support philosophy, and provides key statistics on achievements to date. It also discusses the management of the fleet's structural integrity.

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[25] As mentioned in paragraph 1.3, this report is a companion to ANAO Audit Report No.6 2012–13. The combined cost was $676 100.

2. F/A-18A/B Hornet Fleet Capability Upgrades

This chapter examines recent capability upgrades to the F/A-18A/B classic Hornet fleet from the perspective of airworthiness certification, including Design Acceptance and Service Release.

Background

2.1 The decision to acquire Australia's fleet of 75 'classic' F/A-18A/B Hornet aircraft was announced on 20 October 1981. Australia was to acquire 57 single-seat F/A-18As and 18 dual-seat F/A-18Bs. The dual-seat F/A-18Bs are an aircrew trainer version of the F/A-18A, in that the displays and controls in the F/A-18B's aft cockpit replicate those in the front cockpit.

2.2 The 75 aircraft entered service in Australia between 1985 and 1990.[26] The initial approved budget for the 75 F/A-18 aircraft was $2.43 billion (August 1981 prices), but by the time all the aircraft were received, the cost amounted to some $4.6 billion (June 1990 prices).[27]

2.3 The Planned Withdrawal Date (PWD) of the Hornet fleet has thrice been extended from the original target of 2010–15[28]: in 2006 the date was

26 Two aircraft of each variant have since been lost to attrition, with individual aircraft lost in 1987, 1990, 1991 and 1992. For details of the losses, see *ADF aircraft serial numbers: RAAF A21 McDonnell Douglas F/A-18A/B Hornet*, http://www.adf-serials.com/3a21.shtml.

27 Although all the aircraft had been delivered by May 1990, the project also covered some continuing activities, including the International Follow-On Structural Test Project (IFOSTP; see Appendix 6: International Collaborative Programs and Aircraft Structural Audits). The AIR 15 project to acquire the Hornet fleet remained open until 2001, due to delays in the development of the Integrated Avionics System Support facility, and was finally closed in 2008 as part of an accelerated project-closure process which had recently been agreed upon by the DMO and Defence's Capability Development Group (CDG). The final project cost, as agreed in May 2008, amounted to $4.44 billion (January 2008 prices). Senator Peter Baume, 'Defence equipment: ministerial statement', *Senate Hansard*, 20 October 1981, p. 1416; Department of Defence, *Annual report 1981–82*, p. 18; Department of Defence, *Annual report 1989–90*, p. 71; Department of Defence and Defence Material Organisation, *Project closure certificate: implementation of AIR 15–procurement of the F/A-18 Hornet*, May 2008.

28 For the original Planned Withdrawal Date of the Hornets, see: ANAO Audit Report No.40 1999–2000, *Tactical fighter operations*, p. 75; *Defending Australia: Defence white paper 1994*, p. 46; *Australia's strategic policy*, 1997, p. 61; *Defence new major capital equipment proposals 1998–2003*, p. 39; *Defence capability plan 2001–2010*, p. 23; The Hon. De-anne Kelly, MP, Minister for Veterans' Affairs, 'Fighter aircraft', *House of Representatives Hansard*, 23 May 2005, p. 167.

extended to 2015–18,[29] in 2009 it was extended to 2017–20,[30] and in May 2012 the need for a possible further extension arose, because of the Government's decision to better align the delivery of Australia's F-35A aircraft with the US Department of Defense's F-35 production and acquisition schedule.[31] Consequently, the precise timing of the F/A-18A/B withdrawal from service is dependent upon the delivery of the F-35A aircraft under schedules that are yet to be finalised. By July 2012 the F/A-18A/B fleet had accumulated up to 27 years of operational service, including over 306 000 flying hours.[32]

2.4 The F/A-18 Hornet program has implemented an evolutionary upgrade path, rather than remaining relatively static in configuration for most of the program's life.[33] By the time the last F/A-18A/Bs were assembled in Australia, follow-on development of the US F/A-18 had resulted in US production of F/A-18s already shifting to the next model, the F/A-18C/D. Accordingly, the RAAF conducted an upgrade of the fleet between 1990 and 1992, based on regional threats and cost considerations.[34]

2.5 Later in the 1990s, Defence was faced with the need to replace the Hornet fleet with a more advanced aircraft, or upgrade it with more advanced and reliable systems and weapons. The then Government agreed to the upgrade option, mainly for the following reasons:

- there was no available replacement aircraft that would give the ADF the 'quantum leap' sought. Any replacement aircraft available at that

29 For the 2006 revision of the Planned Withdrawal Date, see: Defence Materiel Organisation, Tactical Fighter SPO, *Project AIR 5376 Phase 4 Structural Assurance Consolidation Program. Project management plan*, March 2011, p. 3.

30 For the 2009 revision of the Planned Withdrawal Date, see: Department of Defence, *Annual report 2009–10*, Vol. 2, p. 69; the Hon. Greg Combet AM MP, Minister for Defence Materiel and Science, *F/A-18 Classic Hornet centre barrel replacement program completion*, media release, 29 June 2010; Defence Materiel Organisation, Tactical Fighter SPO, *Project AIR 5376 Phase 4 Structural Assurance Consolidation Program. Project management plan*, March 2011, p. 3.

31 *Prime Minister, Minister for Defence, Minister for Defence Materiel—joint press conference—Canberra*, media transcript, 3 May 2012.

32 Defence Materiel Organisation, Tactical Fighter SPO, Hornet Usage Monitoring System (HUMS). In Australian service, the F/A-18A/B is designated the A21.

33 'AIR 5376, Background', *Hornet upgrade program*, Department of Defence intranet page, August 2011.

34 'AIR 5376, Background', *Hornet upgrade program*, Department of Defence intranet page, August 2011. The JSF Program has implemented a similar follow-on development and upgrade strategy, which at the time of the audit had taken the form of modifications and upgrades to Low-Rate Initial Production F-35 aircraft (see ANAO Audit Report No.6 2012–13, *Management of Australia's Air Defence Capability—F-35A Joint Strike Fighter Acquisition*, 27 September 2012, paragraphs 4.27 to 4.45).

time would soon be superseded by the next generation of aircraft such as the Eurofighter, the F-22 Raptor or the Joint Strike Fighter. The large investment in new aircraft could therefore be of limited long-term benefit;

- most of the short to medium-term capability gaps identified could be rectified by upgrades to various components, systems and weapons, many of which were available 'off the shelf' from suppliers; and
- the strategic outlook did not justify the replacement of the aircraft.

2.6 Accordingly, Defence began an upgrade program that would bring the Hornet fleet's capability broadly into line with that of the US Navy's F/A-18C/D models. Given the classified nature of the Hornet upgrade program, the ANAO examined the capability upgrades from the perspective of airworthiness certification, in order to assess the effectiveness of Tactical Fighter SPO's management of the F/A-18A/B Hornet upgrades.

Airworthiness certification

2.7 To ensure the airworthiness of ADF aircraft and systems prior to their acceptance by Defence, the Technical Airworthiness Regulations specify that only designs properly approved via the issue of Design Approval certification may receive Design Acceptance certification.[35] Design Approval is generally performed by Design Authorities, typically Original Equipment Manufacturers or Prime Contractors. Only approved designs are permitted to be incorporated into existing ADF aircraft and their support systems. For aircraft acquisitions, Design Approval certificates are prerequisites for the issue of an Australian Military Type Certificate (AMTC) for newly acquired aircraft, or a Supplemental Type Certificate (STC) for aircraft that are the subject of significant design changes.[36]

Design Acceptance

2.8 The Type Certification process begins at the commencement of acquisition activities for new aircraft or major changes to the type design of

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35 Australian Defence Force, *Technical airworthiness management manual*, Australian Air Publication 7001.053(AM1), 21 October 2010, Section 1, Chapter 2, p. 6.

36 For more detail on the military airworthiness system, see Appendix 4: Type Certification and Service Release.

aircraft in service, and it provides the basis for establishing the airworthiness status of ADF aircraft. The primary contributor to the Type Certification of ADF aircraft is the Design Acceptance process, which determines the technical acceptability of the aircraft and so provides confidence to ADF agencies and staff that the aircraft is safe and fit for service.

2.9 The Design Acceptance process comprises four phases:

(a) *Specification of requirement.* The ADF's requirements must be articulated via a specification document providing a suitable basis for Design Acceptance in that the requirements are sufficiently complete, verifiable and attainable. The specification document is referred to within the regulations as forming part of the ADF Statement of Requirements (SOR);

(b) *Determination of competency*. The organisation performing the design must be assessed as having, and must be judged to have applied, the necessary quality systems and competence to complete the design and development with acceptable levels of technical risk. The Technical Airworthiness Regulator's method of recognising organisational competence is through certification of an organisation as an Authorised Engineering Organisation (AEO) to an appropriate level and scope;

(c) *Verification of requirement satisfaction*. Before accepting a product, the Commonwealth must ensure that its requirements are satisfied. Therefore Design Acceptance requires verification that the test and evaluation results produced by, or presented to, the Commonwealth provide adequate evidence that the design complies with the specification; and

(d) *Certification of requirement satisfaction.* Design certification is required from the design agency stating that the design meets the specification. The regulations refer to this as Design Approval certification.[37]

2.10 Managing the Design Acceptance process is the responsibility of a Design Acceptance Representative, although certain activities within the process may be delegated to staff or commercial organisations. The Chief of Air Force, in his capacity as the ADF Airworthiness Authority, issues

[37] Australian Defence Force, *Technical airworthiness management manual*, Australian Air Publication 7001.053(AM1), 21 October 2010, Section 1, Chapter 2, pp. 5, 6.

Australian Military Type Certificates to signify the completion of sufficient design, test and certification activities to meet established airworthiness standards to operate safely within specific configurations, roles and environments.[38]

Service Release

2.11 Service Release is a declaration by the ADF Airworthiness Authority that the infrastructure, personnel training and availability, organisations and supporting arrangements are sufficient to support operations within the designated roles at a sustained rate of effort of the new or upgraded aircraft or system.[39] This occurs after advice from an independent Airworthiness Board that all requirements for safe operation have been satisfied. The Service Release is normally renewed annually after an Airworthiness Board hearing.[40]

2.12 The coverage of the ADF's Technical Airworthiness Regulations also includes the design, production and maintenance of ordnance systems fitted to ADF aircraft, and aircraft-related systems.[41]

Certification of significant aircraft modifications

2.13 The ADF's Technical Airworthiness Regulations require the RAAF to conduct a Type Certification and Service Release process for all significant aircraft avionics and weapons upgrades. Type Certification and Service Release are to be conducted in accordance with a Project Design Acceptance Strategy (PDAS) and Test and Evaluation Master Plan (TEMP) approved by the Chief Engineer of DMO's Aerospace Systems Division under delegation from the DGTA. These documents describe the acceptance-into-service

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38 Australian Defence Force, *Technical airworthiness management manual*, Australian Air Publication 7001.053(AM1), 21 October 2010, Glossary, Section 1 Chapter 4, Section 3 Chapter 12.

39 Australian Defence Force, *ADF airworthiness manual*, Australian Air Publication 7001.048(AM1), 4 March 2009, MILAVREG 3.3 and Section 3, Chapter 4.

40 Service Release may be constrained to allow limited operational flight activity under an Australian Military Type Certificate or Supplemental Type Certificate, where the full requirements for Service Release are not complete but there is sufficient operational and logistic support to allow limited operations in approved roles. The purpose of constraining a Service Release is to ensure that operators and maintainers are adequately trained, have access to required support equipment and have access to adequate data, including appropriate operating instructions. (MILAVREG 3.3, and Defence intranet page, *ACP–ADF, Airworthiness instruments: definitions*, 2011).

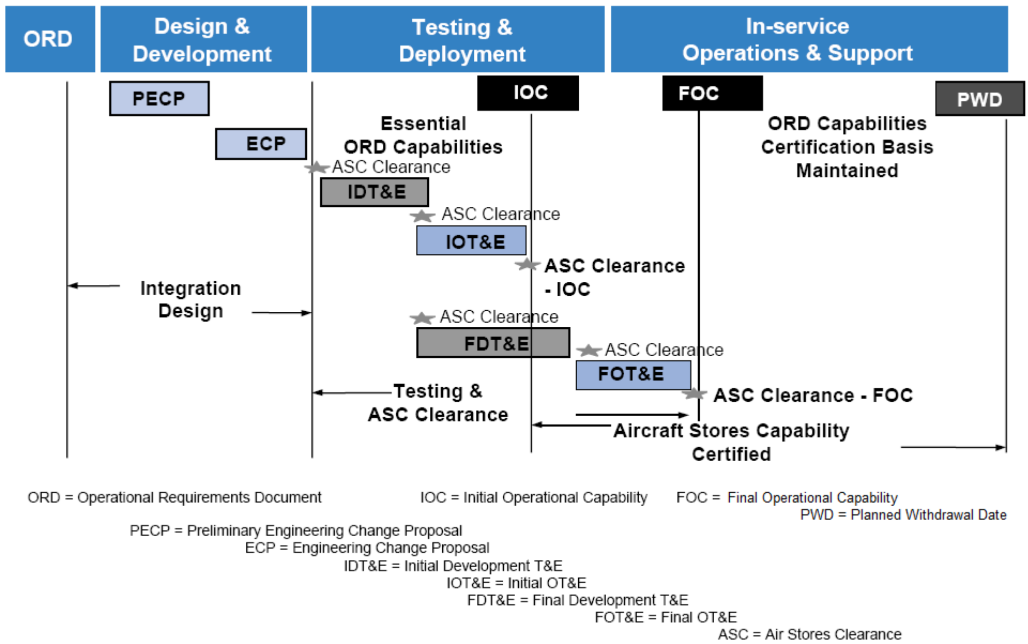
41 DGTA, *Development of an ADF technical airworthiness management system*, presentation to the ANAO, April 2002.

process, including the roles of the organisations involved with Type Certification and Service Release.

2.14 Figure 2.1 shows Test and Evaluation (T&E) applied to each phase of the aircraft capability-development cycle.

Figure 2.1

Aircraft capability-development cycle—Test and Evaluation



Source: RAAF Aircraft Research and Development Unit.

2.15 Development Test and Evaluation (DT&E) and initial and final operational T&E (IOT&E and FOT&E) are scheduled into the phased introduction of a capability so that Force Element Groups may start training their operational and support personnel from the time the capability is initially released into service, at the Initial Operational Capability (IOC) milestone.

2.16 Once an aircraft type has received Type Certification and Service Release, the relevant DMO SPO is responsible for ensuring that each aircraft's approved configuration is maintained. Throughout the service life of ADF aircraft, modifications to the original designs may become necessary to upgrade an aircraft or associated systems capability, or to accomplish repairs to structures degraded by fatigue or corrosion.

2.17 Modifications require design approval by the aircraft's Design Authority, and design acceptance by the Defence officer holding Design Acceptance Representative delegation.[42] Once modification designs are accepted, the SPO raises Modification Orders, and modifications are incorporated by relevant Authorised Engineering Organisations (AEOs)[43] through an Engineering Change Proposal process.[44] Once the modifications are incorporated, the modified aircraft are the subject of a Supplemental Type Certification and Service Release process (in the case of extensive capability-upgrade modifications) or Service Release alone (in the case of less significant modifications such as structural repairs).

Organisational arrangements

2.18 Organisations that have responsibilities for Design Acceptance and Service Release are DMO SPOs with ADF aircraft-engineering responsibilities. Each aircraft type has a Design Acceptance Representative (DAR), who is delegated responsibility for the process of Design Acceptance by the ADF's Directorate General Technical Airworthiness (DGTA). This delegation entails determination of the technical acceptability of aircraft and aircraft-related equipment for ADF use. Design Acceptance Certification may only be performed by a Defence employee.[45]

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42 Australian Defence Force, *Technical airworthiness management manual*, Australian Air Publication 7001.053(AM1), 21 October 2010, Section 2, TAREG 3–Authorised Engineering Organisations, p. 17, paragraph 3.5.6.c.

43 See footnote 46 for more information on AEOs.

44 Australian Defence Force, *ADF aviation maintenance management manual (Book 2 of 2)*, Australian Air Publication 7001.059, 18 May 2011, Section 4, Chapter 5. The general nature of Engineering Change Proposals varies according to organisational arrangements adopted to incorporate the modifications. Extensive equipment upgrades or complex repairs are normally incorporated through acquisition contracts or maintenance contracts respectively.

45 The DGTA, in his capacity as Technical Airworthiness Regulator, considers that Design Acceptance is a critical step in the design control process, essential to ensuring the airworthiness of all designs to be implemented on aircraft or aircraft-related equipment. Thus, the regulations require that:

(a) all designs and design outputs are subject to Design Review (no matter how simple or limited in scope);

(b) Design Review must be independent, that is, design reviewers must not have participated in the development of the design or design output; and

(c) for designs judged as Significant, two professional engineers are to be involved in the development or review of the design.

Footnote continued on the next page…

2.19 The relevant DMO SPO is responsible for engineering support for the aircraft type, and following an evaluation by DGTA, each SPO is awarded AEO certification.[46] The Tactical Fighter SPO is the in-service AEO for the Hornet fleet, and in February 2010 its AEO scope was expanded to include the Super Hornet fleet.[47]

2.20 The RAAF's Aircraft Research and Development Unit (ARDU) performs the full spectrum of military flight-testing, including the integration of foreign and locally acquired or adapted products into Air Force and Army aircraft, and monitoring their effectiveness, suitability, and performance.[48] The RAAF's Aircraft Stores Compatibility Engineering Squadron (ASCENG) manages the weapon-testing and stores-compatibility programs for ADF aircraft,[49] in partnership with the test and evaluation community, DMO SPOs and ADF Force Element Groups.

When a person other than an authorised Design Engineer develops a design judged as Significant, the person providing the Design Approval certification (that is, a Senior Design Engineer, Deputy Senior Design Engineer or specifically authorised Design Engineer) must not have participated in either Design Development or Review and must provide a second level of review as part of the Design Approval process. Australian Defence Force, *Technical airworthiness management manual*, Australian Air Publication 7001.053(AM1), 21 October 2010, Section 1, Chapter 2, p. 3.

46 Certification as an AEO provides high confidence that an organisation has:

- technical management systems appropriate to the type of work being performed. These include quality management systems that conform with ISO 9001, engineering management systems, design support networks, and configuration management systems. The organisation must also have a Senior Design Engineer, responsible to the Senior Executive, for ensuring compliance of the organisation with the regulations, and for assigning Engineering Authority to individuals within the organisation;
- personnel with appropriate authority, training, qualifications, experience, demonstrated competence and integrity to undertake the activities required;
- processes that are documented, controlled and approved for all the organisation's engineering activities. These include procedures and plans to specify and define technical activities, which must be controlled and approved by an appropriately qualified individual, nominated within the quality system; and
- data applied to, and derived from, technical activities that are accessible, authoritative, accurate, appropriate and complete.

Adapted by the ANAO from Australian Defence Force, *Technical airworthiness management manual*, Australian Air Publication 7001.053(AM1), 21 October 2010, Section 3, Chapter 1.

47 DGTA-ADF, *Letter of engineering authority DGTA050–Tactical Fighter Systems Program Office*, 11 February 2010.

48 Navy has its own flight-test organisation: the Aircraft Maintenance and Flight Trials Unit (AMAFTU), situated at HMAS Albatross, near Nowra.

49 This includes weapons carriage and release certification. Weapon-testing and stores-compatibility programs are important elements of Operational Test and Evaluation (OT&E). However, some T&E activity—such as SPO-sponsored T&E events—is performed outside of the ASCENG environment.

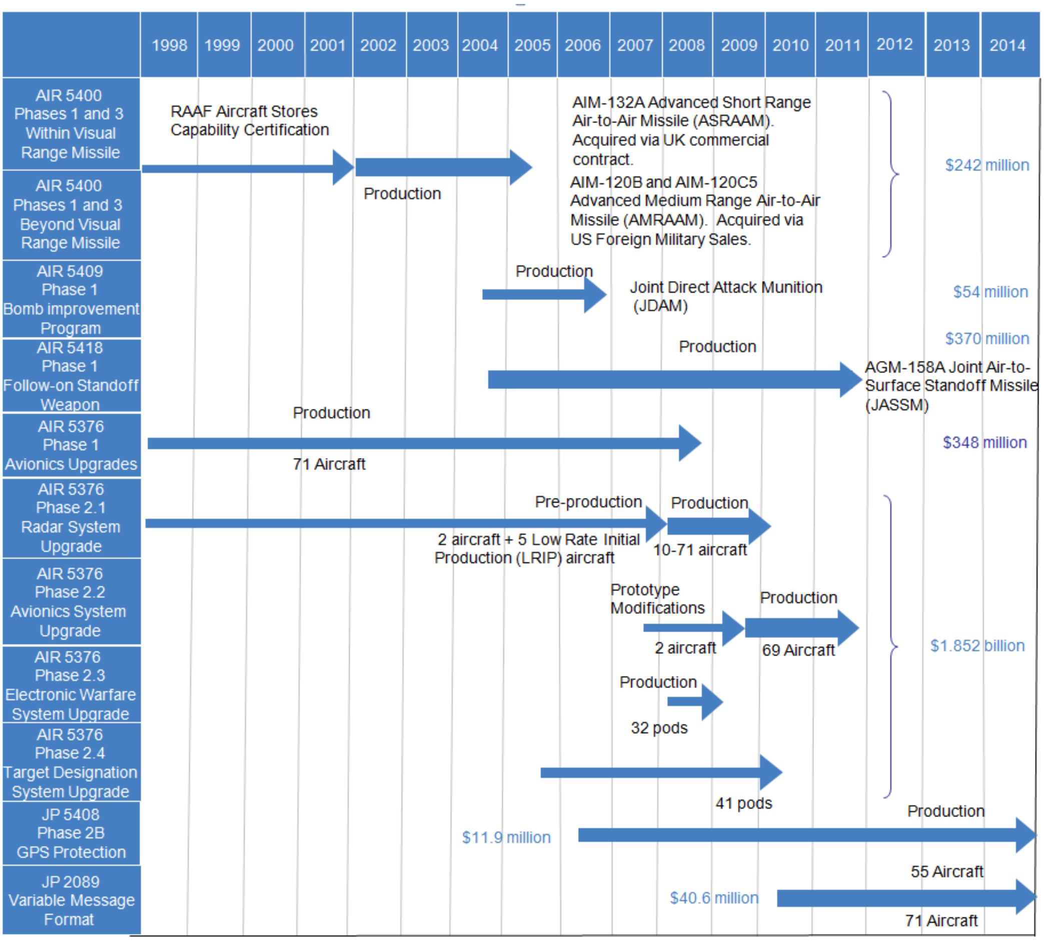
2.21 The Design Acceptance and Service Release processes, together with the RAAF's organisational arrangements for oversight of these processes, provide adequate levels of assurance that changes to ADF aircraft designs are carried out by approved organisations using approved methods, and are certified as meeting the ADF's airworthiness and operational requirements.

Hornet aircraft capability upgrades, 1998–2014

2.22 As noted in paragraph 2.5, in the late 1990s Defence commenced a major program to upgrade the F/A-18A/B Hornet aircraft and their weapons, to broadly align the aircraft capability to that of the F/A-18C/D fleet operated by the US Navy. This program is outlined in Figure 2.2.

Figure 2.2

Schedule and approved budgets of Hornet capability-upgrade projects, 1998–2014



Source: Australian National Audit Office, adapted from Defence Materiel Organisation, Tactical Fighter Systems Program Office records.

Note: The amounts shown in this figure are the total amounts *approved* for the projects, rather than the final amount spent. See Table 2.1 on page 54 for budget and expenditure details.

Air-to-air missiles–AIR 5400 Phases 1 and 3

2.23 Project AIR 5400 has upgraded the Hornet's air-to-air weapons capability. Phase 1 involved DMO acquiring the AIM-132A Advanced Short Range Air-to-Air Missile (ASRAAM), and the AIM-120B and AIM-120C5 Advanced Medium Range Air-to-Air Missile (AMRAAM), and integrating them into the RAAF's 71 F/A-18A/B aircraft.

2.24 The AIM-132A ASRAAM acquisition required modification of both the Hornet aircraft and the pilot training simulators. By 2002 this work had been completed in the US, but further ASRAAM performance testing was conducted in Australia during 2002–03, and operational testing was completed in 2004. Service Release of the ASRAAM occurred in July 2004, and transition to the in-service management agencies was completed by December 2005.[50]

2.25 The AIM-120 AMRAAM first entered service with the US Navy in 1991, and its introduction into RAAF service did not involve extensive modifications to the F/A-18 aircraft or to the pilot training simulators. The US Navy provided test and evaluation data and flight-clearance documentation, which supported the AMRAAM Stores Clearance certification and Operational Test and Evaluations by the Aircraft Stores Compatibility Engineering Squadron (ASCENG).[51]

2.26 Initial deliveries of the AIM-120B AMRAAM missile took place during 2001, with Service Release of the capability occurring in December 2001. In late 2001, the United States Government granted approval for the Australian acquisition of a more advanced AIM-120C5 model of the AMRAAM. Initial deliveries of the AIM-120C5 were completed in 2004, and Service Release occurred in 2005.[52]

2.27 Replenishment stocks of the ASRAAM and AMRAAM were acquired under AIR 5400 Phase 3.

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50 ADF Airworthiness Authority, *Service release: ASRAAM operational and telemetry missiles for F/A-18 Hornet*, 5 July 2004; Department of Defence, *Annual report 2004–05*, pp. 280–1.

51 For a description of ASCENG's role, see paragraph 2.20.

52 Department of Defence, *Annual report 2004–05*, pp. 280–1.

2.28 The ASRAAM is not intended to be used on the F/A-18F Super Hornet, which is armed with the AIM-9X Sidewinder as a short-range air-to-air missile. The Super Hornet does however use versions of the AMRAAM.

Bomb Improvement Program–AIR 5409

2.29 Project AIR 5409 has upgraded the F/A-18 Hornet aircraft's bombing capability, through the acquisition of the Joint Direct Attack Munition (JDAM) air-to-ground bomb-guidance system and its integration into the RAAF's 71 F/A-18A/B aircraft.[53] The JDAM kit, when strapped around a dumb bomb, converts the bomb to a GPS-guided, all-weather precision weapon.

2.30 Service Release for various types of JDAM was achieved in May and August 2011.

2.31 The JDAM is also used by the F/A-18F Super Hornet.

Follow-on Standoff Weapon–AIR 5418

2.32 Project AIR 5418 has upgraded the F/A-18 Hornet's long-range air-to-ground strike capability. It has involved the acquisition of the Lockheed Martin AGM-158A Joint Air-to-Surface Standoff Missile (JASSM), and the integration of the missile into the RAAF's 71 F/A-18A/B Hornet aircraft.[54] The JASSM is a 1-ton ground-strike cruise missile with a range of over 300 kilometres. Australia is the first country outside the USA to purchase it, and the only country to operate it from the F/A-18A/B Hornet.

2.33 Aircraft stores compatibility testing was conducted from 2006–08 to allow a flight-test carriage and employment envelope to be authorised for JASSM on the F/A-18A/B aircraft. This work was conducted by DSTO and the RAAF Aerospace Operational Support Group. F/A-18A/B software development was conducted by the US Navy's Air Weapons Laboratory in China Lake, California, supported by a Defence Resident Project Team (RPT) which provided Australian test aircraft and air/ground test crews. In December 2010, the live-fire of an inert JASSM represented the culmination of the JASSM integration into the F/A-18A/B 21X software. Operational Test and Evaluation

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53 Department of Defence, *Annual report 2001–02*, pp. 189, 196. See also Department of Defence, *Portfolio additional estimates statements 2001–02, Defence portfolio*, pp. 60, 64.

54 Defence Materiel Organisation, 'Missile Away! Australian team celebrates successful launch', *On target*, July 2008.

was successfully conducted in July 2011 at the Woomera Test Range, with two JASSM firings with high explosive warheads at two hardened targets.

2.34 Service Release of the JASSM capability occurred on 1 November 2011, with Final Operational Capability expected to be declared by the end of 2012.[55]

2.35 The JASSM is not intended to be used by the F/A-18F Super Hornet.

Hornet avionics upgrades–AIR 5376 Phases 1 and 2 (Hornet Upgrade (HUG) Phases 1 and 2)

2.36 AIR 5376 Phase 1 was approved in April 1995, and installation of upgraded equipment was complete in June 2002.[56] This project increased the capability of the F/A-18A/B Hornet fleet by improving the following avionics systems:

(a) voice communications (to improve their resistance to jamming);

(b) Identification Friend-or-Foe (IFF) system and an on-board interrogator transponder;

(c) inertial navigation system;

(d) software for the radar warning receivers;

(e) computers and internal aircraft electronics to support the new Phase 1 systems;

(f) radars (originally approved as part of Phase 2, but separated and brought forward to immediately follow Phase 1); and

(g) updated operational flight program (OFP).[57]

2.37 AIR 5376 Phase 2 is upgrading the F/A-18A/B fleet in four phases:

- AIR 5376 Phase 2.1 incorporated enhancements that enabled the aircraft to more effectively perform their air-defence role. This included provision of a new fire-control radar, and an Electronic Protection

55 Defence Airworthiness Authority, *Service Release for A21 F/A-18A/B Hornet aircraft and AGM-158 JASSM capability*, 1 November 2011.

56 Department of Defence, *Annual report 1997–98*, October 1998, p. 263; Department of Defence, *Annual report 2002–03*, October 2003, p. 275.

57 ANAO Audit Report No.40 1999–2000, *Tactical fighter operations*, p. 85.

Collaborative Development Program with the US Navy to develop Electronic Protection techniques for the radar.

- AIR 5376 Phase 2.2 provided aircrew with enhanced situational awareness, by upgrading the avionics suite with installation of the following equipment:
    - (a) LINK 16 secure data link. The particular LINK 16 equipment to be fitted to the F/A-18 is known as the Multifunction Information Distribution System;
    - (b) an upgraded Counter Measures Dispenser Set;
    - (c) Multi-Purpose Display Group Upgrade (colour displays);
    - (d) upgraded digital moving-map system known as the Tactical Air Moving Map Capability;
    - (e) Joint Mission Planning System; and
    - (f) Joint Helmet Mounted Cueing System.
- Air 5376 Phase 2.3 provided additional aircraft self-protection by:
    - (a) replacement of the Radar Warning Receiver with an updated Raytheon Radar Warning Receiver for the whole fleet;
    - (b) supplementation of the Counter Measures Dispenser System capability with a SAAB Counter Measures Dispenser System, thereby increasing expendable capacity;
    - (c) supplementation of the jammer capability with the Elta jammer pod; and
    - (d) enhancement of the aircraft's data-recording capability.[58]
- Air 5376 Phase 2.4 provides the Hornets with an upgraded target-designation system.

2.38 Air 5376 Phase 2 also includes replacement of obsolete Hornet Operational Flight Training Simulators with Tactical Operational Flight Trainers.

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58 ANAO Audit Report No.20 2011–12, *2010–11 Major projects report: Defence Materiel Organisation*, November 2011, p. 282.

GPS protection system–JP 5408

2.39 Joint Project (JP) 5408 Phase 2B seeks to enhance the ADF's ability to protect platforms and equipment from Global Positioning System (GPS) electronic attack. For the F/A-18A/B Hornet aircraft, this system is scheduled to be installed when aircraft are unavailable for operations, such as during AIR 5376 Phase 2.3 equipment installations or Deeper Maintenance R3 and R4 services (see paragraph 3.5), so as to not unduly affect the number of serviceable aircraft available to Air Combat Group.

2.40 Installation is scheduled to commence in June 2012, with Initial Operational Capability in 2013 and Final Operational Capability in 2015.

VMF system–JP 2089

2.41 Joint Project (JP) 2089 Phase 2B seeks to provide a Variable Message Format Tactical Data Link capability to F/A-18A/B Hornet aircraft and associated ground-support systems.

2.42 Initial Operational Capability (15 aircraft) is scheduled for 2012, and Final Operational Capability (71 aircraft) for 2014.

Budgets and costs of Hornet capability-upgrade projects

2.43 Table 2.1 shows the original approved budgets of the Hornet capability-upgrade projects outlined in this chapter, their current budgets, and expenditure to 30 April 2012.

Table 2.1

Budgets and costs of Hornet capability-upgrade projects

Project	Original approved budget	Original approval date	Current budget (February 2012)	Expenditure to 30 April 2012
AIR 5400				
—Phase 1	$76.58 million; increased by $128 million in May 1997	Aug 1996	N/A	$295.548 million to closure in March 2011
—Phase 3	$165 million	Sept 1999	$181.195 million	$153.748 million
AIR 5409 Phase 1	$54.468 million	June 2004	$58.367 million	$43.386 million
AIR 5418 Phase 1	$14.88 million, increased by $355.3 million in May 2006	Sept 2004	$341.422 million	$276.329 million
AIR 5376 Phase 1	$140.2 million; increased by $50.8 million in Feb 1997, and by another $28.4 million in Feb 1999	April 1995	N/A	$284.53 million to closure in August 2008
AIR 5376 Phase 2	$1.3 billion, increased by $412.485 million in Nov 2007	April 1998	$1.877 billion	$1.602 billion
AIR 5376 Phase 2.4	$140 million	Sept 2004	$152.439 million	$115.737 million
JP 5408 Phase 2B (air element only)	$11.9 million	April 2006	$14.1 million	$4.685 million
JP 2089 Phase 2B	$40.614 million	April 2010	$41.185 million	$8.445 million

Source: Budget approvals information from relevant Project Cost Approval History reports; Spend to 30 April 2012 information obtained from DMO Monthly Reporting System (MRS).

2.44 Total expenditure on the Hornet capability upgrades discussed in this chapter, to 30 April 2012, amounted to $2.784 billion, with an additional $461.38 million budgeted to completion by 2015. These amounts consist of $2.369 billion for aircraft upgrades and $876 million for weapons upgrades, making a total upgrade cost of some $3.245 billion for Hornet weapons and systems by 2015.

Airworthiness status of Hornet capability upgrades

2.45 Table 2.2 sets out the progress achieved over time by the various Hornet capability-upgrade projects, in terms of satisfying airworthiness requirements and achieving Supplemental Type Certification and/or Service Release.

Table 2.2

Airworthiness status of Hornet capability upgrades, 1998–2014

Project	Design Approval	Design Acceptance	Supplemental Type Certification	Service Release
AIR 5400 Phase 1 –ASRAAM within visual range air-to-air missile	September 2003	1 June 2004	5 July 2004	5 July 2004
–AMRAAM beyond visual range air-to-air missile (AIM-120C5)	13 September 2004	26 May 2005	N/A—Minor change of type†	26 May 2005
AIR 5409 Phase 1– Bomb Improvement Program—JDAM (tailkits GBU-31, GBU-32 and GBU-38 for various sizes of bomb)	21 January 2008–27 May 2011	20 January 2009–27 May 2011	N/A—Minor change of type	4 May 2011, 12 August 2011
AIR 5418 Phase 1– Follow-on Standoff Weapon—JASSM	22 August 2011	7 September 2011	1 November 2011	1 November 2011
AIR 5376 Phase 1– Avionics Systems Upgrade	27 October 2000	13 December 2000	18 December 2001	18 December 2001
AIR 5376 Phase 2.1– Radar System Upgrade	30 October 2001	16 May 2002	2 July 2002	2 July 2002
AIR 5376 Phase 2.2– Avionics System Upgrade	14 November 2005	11 November 2005	8 February 2006	8 February 2006
AIR 5376 Phase 2.3– Electronic Warfare System Upgrade	7 August 2009–24 October 2011	7 August 2009–4 November 2011	Planned for October–November 2012	Planned for October–November 2012
AIR 5376 Phase 2.4– Target Designation System Upgrade	20 January 2009	18 February 2009	N/A–Minor change of type	18 February 2009
JP 5408 Phase 2B– GPS Protection	2 June 2011	2 June 2011	N/A–Minor change of type	July 2012
JP 2089– Variable Message Format	16 September 2011	Planned for September 2012	N/A–Minor change of type	Planned for October 2012

Source: ANAO analysis of Defence documents.

Note: † For exemption from Supplemental Type Certification, see paragraph 2.17.

Conclusion

2.46 This chapter examined recent capability upgrades to the F/A-18A/B classic Hornet fleet from the perspective of airworthiness certification, including Design Acceptance and Service Release. The ANAO found that Defence has implemented an extensive set of design acceptance, certification and Service Release processes, resulting in the Hornet upgrades progressing within an effective system of technical-airworthiness regulation. Further, these processes provide a sound basis for concluding that the RAAF has in place robust systems for the management of its fighter aircraft, including the verification of their weapons and systems upgrades. As indicated by the status of the RAAF F/A-18A/B capability upgrades listed in Table 2.2, Defence has implemented the F/A-18A/B capability upgrades approved by the Government, for the period 1998 to 2014.

3. F/A-18A/B Hornet Fleet Sustainment

This chapter focuses on the sustainment of the F/A-18A/B classic Hornet fleet, and examines the achievement of flying hours and other key indicators of the effectiveness of the Hornet fleet's maintenance and spares support.

Background

3.1 The acquisition of the Hornet fleet between 1984 and 1990 occurred prior to the introduction of the current ADF Airworthiness Management System in 1993. The Hornet aircraft received an Australian Military Type Certificate on 31 January 1992,[59] 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 Service Release reviews by ADF Airworthiness Boards since 1998. These boards assess the airworthiness management of each ADF aircraft type, in terms of sustainment and operations. They 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 May 2012, and the Tactical Fighter SPO submission was that there were currently no logistics or engineering issues which might compromise the validity of the F/A-18A/B Hornet AMTC and Service Release.[60]

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 Joint Air-to-Surface Standoff Missile (JASSM), and was issued in November 2011.[61]

3.4 In assessing the effectiveness of Tactical Fighter SPO's management of Hornet fleet sustainment, the ANAO examined the organisational

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59 RAAF, *F/A-18 A/B Hornet aircraft structural integrity management plan*, 2011, vol. 1, section 2, chapter 5, p. 1; RAAF, *Aircraft Type certificate: F/A-18 Hornet*, 31 January 1992.

60 Officer Commanding Tactical Fighter SPO, *Airworthiness Board submission*, May 2012, p. 3.

61 *Australian Military Supplemental Type Certificate: F/A-18A/B Hornet JASSM capability*, November 2011.

arrangements and financial investment, improvements in sustainment management, and sustainment statistics.

Organisational arrangements

3.5 DMO has overarching responsibility for providing the Air Force with project management of Hornet fleet engineering, logistic support and acquisition. In-service support of individual F/A-18A/B aircraft is provided at two levels:

- Operational Maintenance undertaken by Air Combat Group's (ACG's) No.3, No.75 and No.77 Squadrons and No.2 Operational Conversion Unit. This includes aircraft flight-line servicing and fault diagnosis, and aircraft condition inspections and repairs at the Line Replaceable Unit level.[62]
- Deeper Maintenance undertaken both by contractors and by the ACG personnel employed in the 81 Wing F/A-18 Deeper Maintenance Combined Workshop at Williamtown. Deeper Maintenance involves structural inspections and repairs and the overhaul, repair, calibration, testing and alignment of Repairable Items and aircraft systems.

3.6 The primary aim of Operational Maintenance is to make aircraft fully serviceable for flying operations. Operational Maintenance tasks are predominantly carried out on the flight lines,[63] but may involve the limited use of workshop facilities. Operational Maintenance includes maintenance and minor rectifications that can be accomplished and certified as complete under deployed conditions.[64]

3.7 Deeper Maintenance includes scheduled maintenance, unscheduled maintenance and repairs. It requires the use of specialised facilities, test and

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62 Line Replaceable Units (LRUs) are equipment units that can be readily diagnosed for faults and replaced at the equipment site. They include items such as electronic modules and assemblies designed to be removed from an aircraft parked on flight lines.

63 A flight line is an area of an airfield or airport on which aircraft, especially military aircraft, are parked and serviced.

64 Tactical Fighter Systems Program Office, *F/A-18 Hornet tailored maintenance requirements determination review. Phase 3 report: servicing content*, October 2009, p. 9.

repair equipment, and the availability of personnel who have extensive engineering and technical skills.[65]

3.8 Each level of F/A-18 maintenance support has access to a Design or Maintenance Support Network,[66] consisting of the Defence Science and Technology Organisation, Original Equipment Manufacturers, the ADF's Directorate General Technical Airworthiness (DGTA) and the RAAF's Aircraft Research and Development Unit (ARDU). These organisations provide assistance with scientific, engineering and equipment-manufacturing support, aircraft design, maintenance policy and management guidelines, and test-and-evaluation support for aircraft and related systems.

Role of Tactical Fighter SPO

3.9 Tactical Fighter SPO's primary responsibility is to make available to Air Force the number of Hornet, Super Hornet and Hawk aircraft specified within Materiel Sustainment Agreements between DMO and Air Force. This requires the SPO to manage its program within a complex mix of factors, most of which are beyond its control. These factors include:

- Defence funding priorities, which determine 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 carried out by RAAF operational-maintenance personnel;
- capability-upgrade requirements, which are determined by the need to maintain control of the air and sea approaches to Australia. These dictate the frequency and extent of aircraft capability upgrades; and
- the extensive maintenance demands of advanced combat aircraft. These aircraft are designed to strict weight limitations and demanding

65 For a more detailed explanation of Deeper Maintenance, see Appendix 5: Hornet Deeper Maintenance.

66 Australian Defence Force, *Technical airworthiness management manual*, Australian Air Publication 7001.053(AM1), 21 October 2010, Section 1, Chapter 3, pp. 1, 4.

performance requirements, which reduce the scope for extensive structural-integrity margins through heavy construction, and require extensive system safety margins through backup systems. Maintenance demands increase as aircraft near their airframe safe-life hours and structural-fatigue margins.

3.10 The SPO's day-to-day activities range from program-management tasks to 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 senior management. Since a significant amount of the air combat fleet's Deeper Maintenance is contracted out, the SPO is responsible for monitoring the performance of its contractors, as well as maintaining close working relationships with the squadrons of 81 Wing, which conduct the fleet's Operational Maintenance and selected Deeper Maintenance.

3.11 Tactical Fighter SPO conducts Hornet spares assessments, Repairable Item contract management, engineering assessments, technical-airworthiness assurance, airworthiness compliance auditing and engineering-data management. It 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.

Contract arrangements for Hornet support

3.12 Most Hornet in-service support is provided by Tactical Fighter SPO through some 28 contracts which the SPO directly manages, seven other contracts managed by DMO's Aerospace Materiel Systems Program Office (AMSPO),[67] and 15 Hornet-specific Foreign Military Sales (FMS) cases to the value of $25 million in 2010–11. There were also three FMS cases shared with other Defence activities.[68]

67 Defence Materiel Organisation, Tactical Fighter SPO, *Contract register*, November 2011.

68 The US Department of Defense's Foreign Military Sales (FMS) program is a program that allows foreign governments to purchase defence articles, services, and training, as well as design and construction services, from the US Government. This program is operated on a 'no profit/no loss' basis to the US Government, and requires an authorised representative to submit a Letter of Request (LOR) to the US Government for desired defence articles and services. Acquisition by FMS purchasers will be in accordance with US Department of Defense regulations and procedures. This affords the foreign

Footnote continued on the next page…

3.13 These FMS cases are agreed with the US Government, and cover engineering and logistics support of Hornet systems. The US Navy and Marines also operate Hornets, and the FMS cases allow Tactical Fighter SPO to purchase Hornet spares as part of the US Government's 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.

3.14 Two prime contractors, BAE Systems Australia and Boeing Defence Australia (BDA), provide Tactical Fighter SPO with Deeper Maintenance services.[69] There are also a range of other contractors that provide Tactical Fighter SPO with specialised engineering and maintenance support. Nine of these contractors hold AEO certificates. There are also 13 contractors who hold AMO certificates, nine of which are audited for their regulatory compliance by Tactical Fighter SPO.[70]

Hornet subsystems

3.15 While the F/A-18A/B Hornet is itself considered a weapons system, it also contains many subsystems that need specific management. These

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purchaser the same benefits and protection that apply to Department of Defense procurement, and is one of the principal reasons why foreign governments and international organisations prefer to procure through FMS channels. FMS requirements may be consolidated with US Government requirements or placed on separate contract, whichever is more expedient and cost effective. US Defense Security Cooperation Agency, *Security assistance management manual*, 3 October 2003, section C6.3.1.

69 The RAAF itself undertakes 12 Deeper Maintenance services per year, with Tactical Fighter SPO contracting industry to undertake the remainder. Currently, this industry work is undertaken by BAE Systems Australia following a competitive selection process in 2008. Boeing Defence Australia is also undertaking a small number of Deeper Maintenance activities via a HUG Phase 2.3 contract. A new competitive Request for Tender (RFT) to undertake Deeper Maintenance work was released to industry on 12 April 2012, with tenders closing in July 2012, and the contract to commence in April 2013. It is planned that the new contract will be a long-term arrangement to support Deeper Maintenance of the Classic Hornet fleet to its Planned Withdrawal Date. Defence Materiel Organisation, *Request for tender for AF/A-18A and AF/A-18B deeper maintenance support*, DMO ASD/RFT0025/2012, 12 April 2012; Defence Materiel Organisation, Tactical Fighter Systems Program Office, *Weapon system support plan: F/A-18 A/B Classic Hornet capability system*, 24 August 2011, p. 11.

70 Defence Materiel Organisation, Tactical Fighter SPO, AEO and AMO Registers and AEO Surveillance Audit Reports. Defence organisations and contractors involved in ADF aircraft maintenance are required to attain Authorised Maintenance Organisation (AMO) certifications based on Maintenance Management Systems, authorised maintenance and storage facilities, authorised Senior Maintenance Managers, and on successful audits by DGTA. Australian Defence Force, *Technical airworthiness management manual*, Australian Air Publication 7001.053(AM1), 21 October 2010, Section 3, Chapter 1, and Section 4, Chapter 1.

subsystems are sustained via a variety of commercial, FMS and in-house arrangements, specifically:

- *Hydraulics and Undercarriage.* These systems are supported by a combination of Tactical Fighter SPO, 81 Wing and Rosebank Engineering (RBE). The majority of support has transitioned from Defence to RBE, with RBE contracted to perform depot-level repair and engineering activities. 81 Wing's workshops also carry out repair and overhaul activities for hydraulic components via the use of the Southcott Test Bench and the Servocylinder Test Station (STS).
- *Engines*. The engine system previously required the largest sustainment budget for spares inventory management. In December 2008, support for the F404 engine was transitioned from Defence to General Electric under a Through Life Support (TLS) contract, comprising engineering, training, spares and maintenance services. This contract also includes support of the Australian Super Hornet F414 engine. The Engine Service Life Monitoring Program (ESLMP) is used to manage the service life of Hornet engine components.71
- *Radar*. In 2007, support for the APG-73 radar was transitioned from Defence to Raytheon Australia (RA). RA is contracted to provide a range of maintenance, engineering, supply support and management services to achieve an asset availability performance level. Unlike in the F404/414 TLS contract with General Electric, procurement of spares is not included within the contract price, and remains a responsibility of Tactical Fighter SPO.
- *Avionics Repair Support.* Avionic components (such as mission computers, displays, Embedded Global Positioning System (GPS)/Inertial Navigation System (EGI), communications, etc.) are largely repaired by 81 Wing's workshops, FMS workshops (US Fleet Readiness Centres), and via a Spares and Repairs Support contract with Boeing Defence Australia. This contract leverages Boeing Defence Australia's Maintenance Support Network to ensure that all repairs are

[71] F/A-18A/B Hornet engine-reliability records indicate that in the three years between December 2008 and December 2011, there were eight in-flight shutdowns arising from engine problems, with all eight in-flight shutdowns commanded by the aircrew as a precautionary measure. On that basis, as the F/A-18A/B Hornet has two engines, those statistics equate to one in-flight shutdown for every 9000 engine flight-hours.

carried out by either the Original Equipment Manufacturer (OEM) or an OEM-approved maintenance, repair and overhaul facility. With the introduction of HUG 1 and 2 subsystems (see paragraphs 2.36 and 2.37), the support for these items has increasingly transitioned to a direct contractor-maintenance concept.

- *Ageing Aircraft Wiring.* In recent years, there has been a recognisable decline in the serviceability state of the Hornet wiring. This degradation is primarily due to ageing-aircraft factors (for example, wearing and chafing) and maintenance-induced activities. In many cases, the condition of aircraft wiring is indirectly affected by modifications done to other aircraft components. A review has been conducted of all management practices in relation to Hornet wiring, and the resulting Ageing Aircraft Wiring Management Plan (AAWMP) forms part of the wider Ageing Aircraft Management Plan.
- *Alternate Mission Equipment (AME).* Hornet AME is managed by a number of Defence agencies, including Tactical Fighter SPO. Fatigue, age and the high-stress operational environment in which the AME is employed have resulted in an increased level of structural and electrical failures in recent times. Tactical Fighter SPO continues to monitor emerging ageing-aircraft issues in relation to AME, and to document actions to correct deficiencies through individual get-well plans.
- *Operational Flight Program (OFP).* The regular software updates that have increased the Hornet's capability over its life have been acquired as part of the Hornet upgrade projects, and Australian-unique components have been developed by Tactical Fighter SPO's Hornet Training and Software Systems team (formerly Ground Systems and the Weapon System Support Flight).
- *Automatic Test Equipment (ATE).* Like the aircraft itself, ATE is also ageing and becoming difficult to support. This is particularly so regarding the continuation of Intermediate Automated Test Set (IATS) and Hybrid Test Set (HTS) operations, as these sets suffer obsolescence and are no longer supported by their Original Equipment Manufacturer. A United States Navy-led FMS 'trusted community' working group is considering how to best support these test sets in future years, and Tactical Fighter SPO is represented in this forum by Technical Liaison Office (TLO) staff located in the USA.

3.16 Tactical Fighter SPO's primary maintenance-management system is the Computer Aided Maintenance Management version 2 (CAMM2). CAMM2 contains records of the physical state of each aircraft and associated systems (except the Hornet engine and engine components), in terms of scheduled maintenance and maintenance resulting in the removal or installation of aircraft items.[72]

Financial investment in Hornet fleet sustainment

3.17 Over the last decade, Tactical Fighter SPO's F/A-18A/B sustainment expenditure has shifted to predominantly long-term contracts. Currently, 70 per cent of the SPO's sustainment budget, provided for within Defence's ten-year Defence Management and Finance Plan (DMFP), is allocated to existing contracts, and the majority of these contracts are based on fixed monthly fees. The remaining 30 per cent of Tactical Fighter SPO's sustainment budget is allocated to the purchase of Breakdown Spares and Repairable Item repairs, the majority of which are acquired via US Government FMS arrangements.

3.18 At the time of the audit, Tactical Fighter SPO's F/A-18A/B sustainment cost drivers included:

- the engine and airframe systems, Breakdown Spares replacements, Repairable Item repairs, and non-scheduled contracted maintenance. These items constituted approximately 28 per cent of the SPO's F/A-18A/B sustainment expenditure. The cost of maintaining the F404 Hornet engine amounted to some 60 per cent of the Repairable Item expenditure.[73]
- scheduled maintenance services (known as R3 and R4 services) conducted by contractors, which constitute 9 per cent of the SPO's F/A-18A/B sustainment expenditure. The cost of these services has increased over the last few years from approximately $750 000 per service to about $1.3 million for current R3 and R4 services, an increase

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72 Defence Materiel Organisation, Tactical Fighter Systems Program Office, *Weapon system support plan: F/A-18 A/B Classic Hornet capability system*, 24 August 2011, pp. 10–11.

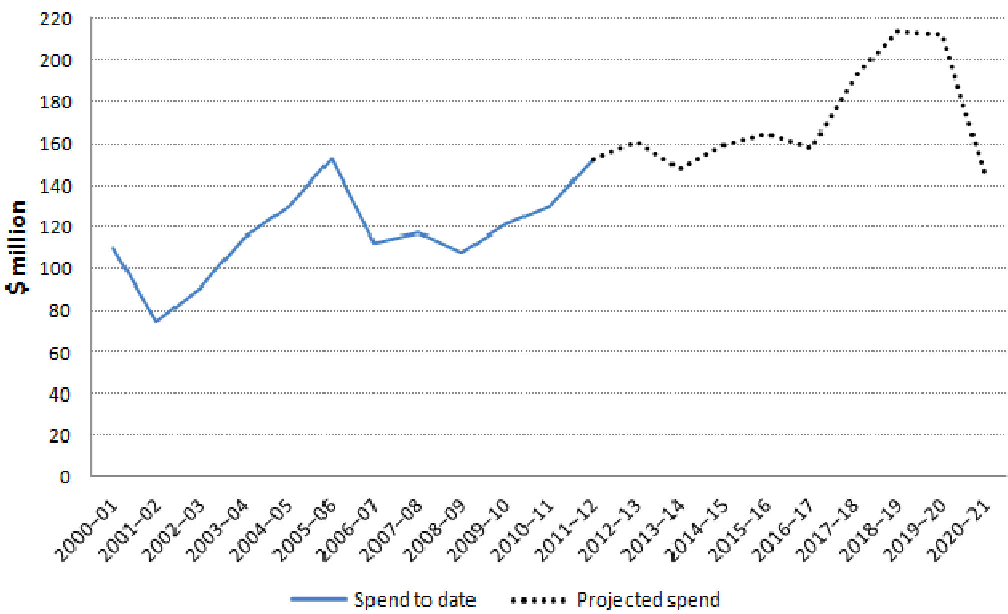
73 Tactical Fighter SPO advised that it now has greater financial certainty under the contract for F404 maintenance, as payments are linked to the Hornet fleet's rate of effort, with agreed labour and materials inflation indices, and agreements on exchange-rate variations. Defence Materiel Organisation, Tactical Fighter SPO, *Classic Hornet sustainment narrative*, 18 May 2011, p. 2.

of 73 per cent. This increase is attributed predominantly to an increase in the scope of emergent maintenance work being discovered during the R3 or R4 services, rather than due to cost increases in the stand-alone R3 or R4 services themselves.[74]

3.19 Figure 3.1 shows expenditure on sustainment of the Hornet fleet over the last 12 years, as well as projected budget provisions to 2021. Sustainment expenditure from 2000 to 2012 amounted to $1.41 billion, and was expected to amount to $1.55 billion for the period 2012 to 2021. Annual spending to sustain the Hornet fleet has averaged $118 million since 2000–01, but is projected to trend towards $170 million per annum over the next several years, and a greater amount thereafter, tapering off in the final operational years of the fleet as aircraft are retired.

Figure 3.1

Hornet sustainment expenditure and future budgets, 2000–21



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

[74] Defence Materiel Organisation, Tactical Fighter SPO, *Classic Hornet sustainment narrative*, 18 May 2011, p. 2.

Note: Figures for 2000–11 are in then-year terms, and budget provisions from 2012–21 are in out-turned dollar terms.[75] The figure for 2011–12 is an estimate as at mid-June 2012. The projected spend for 2013–21 was subject to change before the end of June 2012, because Tactical Fighter SPO had requested some reprogramming during recent Defence financial planning.

3.20 In regard to the financial ramp-up effect in the outer years of the Classic Hornet sustainment budget, Tactical Fighter SPO advised the ANAO in February 2012 that this arises because a number of delays to Defence Capability Plan projects were agreed to in 2009–10, in the context of finalising the Defence White Paper 2009 and work on balancing the Defence budget. Also agreed during this process was the subsequent funding for the flow-on effect to sustainment, in this case the Classic Hornet (CAF02) budget, as reflected in Figure 3.1. While these funds have been allocated against Classic Hornet, it is not anticipated that they will be used towards the final years of Classic Hornet support.[76]

3.21 Defence further informed the ANAO in May 2012 that the funds reflected in Figure 3.1, and currently programmed to be spent on the Classic Hornet, are subject to annual reviews as part of the Budget cycle and consequently are subject to further refinement of costs and requirements as the aircraft's final operational years come closer. Factors that Defence considers will affect the planned activities undertaken, and hence Classic Hornet sustainment costs, include:

- any further changes to the Planned Withdrawal Date of the aircraft;
- approved flying hours required to meet the Air Combat Capability requirements for Defence;
- the date of planned introduction into service of the JSF aircraft;
- changes to sparing and maintenance requirements;
- obsolescence;
- fatigue; and
- the rate of structural fatigue experienced by each F/A-18 aircraft.

75 Then-year dollars are based on the cost of labour and materials and currency exchange rates at the time the expenditure occurred. Out-turned dollars include the estimated effects of labour and materials variations and currency exchange-rate movements.

76 Department of Defence, Chief Finance Officer Group, *DCP slippage impact on the sustainment budget: divisional allocations*, 22 October 2010.

3.22 Tactical Fighter SPO's F/A-18A/B sustainment budget includes provision for savings targets established by the Defence Strategic Reform Program.[77] These savings targets increase from $10 million in 2011–12 to some $20 million in 2018–19.[78]

3.23 From 2011–12, a budgetary provision has been made for expenditure on the Hornet Structural Assurance Consolidation Program. In 2011–12, the significant cost-drivers for this program include:

- structural repairs yet to be completed that were once allocated to Hornet Upgrade program Phases 3.1 and 3.2;
- Deeper Maintenance activities related to ageing-aircraft issues; and
- an Ageing Aircraft Systems Audit that is to be undertaken.

Recent initiatives to improve Hornet availability and serviceability

3.24 In recent years, Tactical Fighter SPO and ACG have implemented a range of initiatives designed to ensure that the Hornet fleet can meet its operational requirements out to its Planned Withdrawal Date, which at the time of the audit was 2020.

3.25 In 2009, in a joint initiative, Tactical Fighter SPO and ACG's 81 Wing—through a Maintenance Requirements Determination (MRD) review—investigated the factors contributing to F/A-18A/B aircraft availability and serviceability.[79] That review identified several initiatives to improve aircraft serviceability and to better meet the requirements of the Materiel Sustainment Agreement between DMO and Air Force. The review resulted in the following changes to the Hornet Deeper Maintenance arrangements:

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77 The Strategic Reform Program (SRP) was established as part of decisions outlined in the Defence White Paper 2009, *Defending Australia in the Asia Pacific century: Force 2030*. Over the decade to 2019, the SRP is intended to provide $20 billion in savings for reinvestment in the Defence capabilities set out in the White Paper.

78 Defence Materiel Organisation, Tactical Fighter SPO, *Classic Hornet sustainment narrative*, 18 May 2011, p. 6.

79 An available aircraft is an aircraft which is available to operational maintenance units to maintain as a serviceable asset. A serviceable aircraft is an aircraft which has been released from maintenance activities. Defence Materiel Organisation, Tactical Fighter SPO, *F/A-18 Hornet tailored maintenance requirements determination review. Phase 3 report: servicing content*, October 2009, p. 9.

- the move to a servicing schedule based on usage rather than calendar days; and
- the establishment of a more extensive Deeper Maintenance R4 service in addition to the existing R3 service.

3.26 Other recent initiatives to improve availability and serviceability have resulted in:

- the consolidation of Deeper Maintenance into a single combined Defence/contractor workshop at Williamtown RAAF base;
- the conversion of Technical Publications to an electronic format; and
- the development of a Hornet Fleet Planning Cell provided with an improved fleet-management information system.

Hornet service changes

3.27 Until 2010, the primary form of F/A-18A/B Deeper Maintenance was an R3 service, which involved the completion of a defined set of planned maintenance and inspection packages covering aircraft structures, flight controls, jet engines, avionics and hydraulic systems. The target completion rate for each Hornet R3 service, if undertaken in isolation, is 12 weeks. However, with the inclusion of aircraft modifications and of emergent work to correct corrosion and structural fatigue, R3 services typically take longer than 12 weeks.

3.28 In 2009, the MRD review determined that the R3 services would need to be supplemented by the addition of a more extensive service, known as an R4 service, which takes the place of every second R3 service.[80] The target completion rate for each R4 service is also 12 weeks.[81]

3.29 The MRD review also applied an interval of 400 airframe hours or 1095 calendar days (three years) between R3 or R4 services, with effect from March

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80 Defence Materiel Organisation, Tactical Fighter SPO, *F/A-18 Hornet tailored maintenance requirements determination review. Phase 3 report: servicing content*, October 2009, p. 18.

81 Tactical Fighter SPO and 81 Wing, *Options to increase F/A-18 serviceability: decision brief*, August 2011, p. 9.

2010. Later in 2010, the intervals were expanded from 400 to 440 airframe hours, or 1095 calendar days, whichever occurs first.[82]

Combined workshop

3.30 Up until 2009, Hornet Operational Maintenance was carried out independently of each other by ACG's No.3 Squadron, No.75 Squadron, No.77 Squadron and No.2 Operational Conversion Unit, all of which performed both flight-line maintenance activities and Deeper Maintenance activities.[83] However, following the 2009 MRD review, the squadrons' Deeper Maintenance tasks were transferred to a Combined Workshop located within 81 Wing at Williamtown. This resulted in the conduct of regular Deeper Maintenance R3 and R4 services being centralised within 81 Wing.[84] No.75 Squadron, located at RAAF Base Tindal in the Northern Territory, continued to perform both Operational and Deeper Maintenance, but was scheduled to cease its Deeper Maintenance activities in January 2012.[85]

3.31 As noted previously (see footnote 69 on page 62), there are two contractors that conduct R3 and R4 services. One of these, Boeing Defence Australia (BDA), which conducts R3 and R4 services via a HUG Phase 2.3 contract, was brought into the centralised R3 and R4 service facility at Williamtown, which is provided to BDA as a Government-Furnished Facility. This centralised facility arrangement was designed to optimise Deeper Maintenance activities, while simplifying fleet planning and maintenance scheduling.[86] The prime contractor, BAE Systems Australia, has retained separate service facilities for the F/A-18A/B Hornet and Hawk aircraft.

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82 Defence Materiel Organisation, *F/A-18 A/B Classic Hornet maintenance requirements determination management plan*, version 6.0, 13 October 2011, p. 17.

83 In 2007 the ANAO reported that the squadrons had 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 flight-lines. This lengthened the time taken to complete R3 services, which in turn reduced the number of aircraft available for flying operations. ANAO Audit Report 2006–07 No.27, *Management of air combat fleet in-service support*, February 2007, p. 55.

84 Tactical Fighter SPO and 81 Wing, *F/A-18 availability and serviceability brief*, 1 October 2009.

85 *Materiel Sustainment Agreement DMO–Air Force*, version 7.0, 2011, p. 14.

86 Tactical Fighter SPO and 81 Wing, *F/A-18 availability and serviceability brief*, 1 October 2009.

Electronic technical publications

3.32 Technical publications are a significant contributor to the task of maintaining aircraft, and maintaining compliance with ADF Aircraft Technical Regulations and Instructions. Tactical Fighter SPO and 81 Wing rely on some 750 technical publications to maintain the Hornet aircraft at their approved configuration and maintenance state. Each publication has an average distribution of some 25–30 copies, and therefore it was a significant task to ensure that each hard copy was maintained at the approved amendment state.[87]

3.33 During 2010–11, the suite of technical publications used in Hornet maintenance was transferred to electronic format, and ruggedised laptops were issued to the various Hornet maintenance facilities, resulting in the removal of 1630 hardcopy publications from circulation.[88]

3.34 Recovery of a backlog in technical publication tasks was sufficiently progressed by November 2011 that the Supplemental Airworthiness Board held in that month agreed to close the related Airworthiness Corrective Action Request (ACAR) regarding technical publications.

3.35 Air Force considers that the transition from paper-based publications to an electronic format and distribution system has resulted in significant reductions in the cost and time spent in maintaining publications to their approved amendment state.[89]

Fleet planning cell

3.36 In January 2010, Air Force formed a Hornet Fleet Planning Cell, staffed by Tactical Fighter SPO and 81 Wing, to centralise the planning of aircraft usage and maintenance.[90] This cell is assisted by a fleet-management software

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87 Despite the transfer of many publications to electronic format, there are still a large number of hardcopy publications. These publications are distributed to the RAAF's five Hornet maintenance locations, involving several workshops and several contractors. Tactical Fighter SPO advised that there are still approximately 50 Operational Maintenance publications that have an average distribution of 20 copies each. There are also approximately 580 other publications covering Deeper Maintenance and workshop procedures, and these have an average distribution of 10 copies each.

88 Air Force Improvement, *TFSPO publications and amendments: activity evaluation report*, August 2011.

89 Air Force Improvement, *TFSPO publications and amendments: activity evaluation report*, August 2011; Officer Commanding Tactical Fighter SPO, *Airworthiness Board submission*, May 2011, p. 1.

90 Defence Materiel Organisation, Tactical Fighter SPO and 81 Wing, *F/A-18 availability and serviceability brief*, 1 October 2009; Tactical Fighter SPO, *Presentation on Hornet Fleet Planning Cell*, 14 September 2011.

program known as VIXEN, which provides integrated fleet-management functions that include:

- forecasting of Deeper Maintenance and Operational Maintenance for individual aircraft;
- aircraft allocation, and reporting of availability and serviceability; and
- profile reporting of the Hornet fleet's Fatigue Life Expended Index (FLEI) and Airframe Hours (AFHRs), to assist fleet-fatigue and airframe-hours management (see paragraphs 4.13 to 4.50).[91]

3.37 In late 2011, Defence formed the Classic Hornet Integrated Logistics & Operations Group (CHILOG) in order to improve coordination arrangements between ACG, Tactical Fighter SPO and contractors.[92] This group, which meets monthly, comprises representatives from DMO and RAAF engineering, logistics, operations and maintenance units, as well as industry. A number of ad hoc working groups are formed from these organisations to address issues such as supply chain and schedule management, management of Ground Support Equipment, and specialist engineering, maintenance and commercial issues.[93]

Hornet-fleet flying hours

3.38 The system used by the RAAF to allocate flying hours seeks to achieve agreed levels of military capability, to reduce resource costs to the minimum amount required to achieve those levels, and to ensure that aircraft reach their Planned Withdrawal Date. Accordingly, in determining annual flying hours allocations, the RAAF looks to ensure that it achieves in a cost-effective manner not only the required total flying hours but also the types of flying and the usage of weapons sufficient to meet safety and training requirements.

3.39 Figure 3.2 provides a fundamental basis for assessing that sustainment of the classic Hornet fleet, from the perspective of annual flying hours used by serviceable aircraft predominantly for the purpose of pilot training, was

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91 Defence Materiel Organisation, Tactical Fighter SPO, *Presentation on Hornet Fleet Planning Cell*, 14 September 2011.

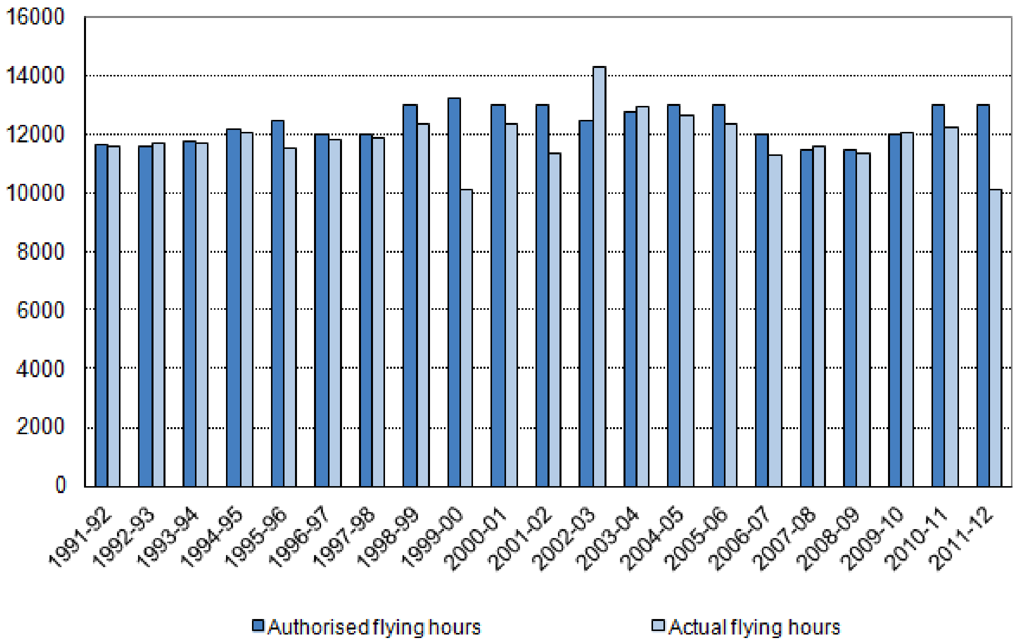
92 Defence Materiel Organisation, Tactical Fighter SPO, Classic Hornet Integrated Logistics & Operations Group, *Business rules* and *Working Group guidance*, 20 October 2011.

93 Defence Materiel Organisation, Tactical Fighter SPO, *Hornet management structure*, August 2011.

generally successful. The figure shows that, for the period July 1991–May 2012, the Hornet fleet's flying hours were largely in line with Air Force planning and ACG's operational requirements.

Figure 3.2

Hornet-fleet flying hours, July 1991–May 2012



Source: Actual flying hours are sourced from Defence's Networked Maintenance Activity Analysis and Reporting System (NetMAARS) data; these data show some variation from those published in Department of Defence Annual Reports. Air Force has been advised of the apparent difference between the Air Force data in the Defence Annual Report and the NetMAARS database, and will conduct an investigation in conjunction with DMO to identify the discrepancy. Targets for authorised flying hours, including revised targets, are sourced from Department of Defence Annual Reports.

Notes: Some of the variations during 2001–02 and 2002–03 were caused by support for Operations Bastille and Falconer in Iraq, and the recovery effort in 2003–04.
Data for 2011–12 covers the period only to the end of May 2012.
The target for F/A-18A/B Hornet flying hours in 2012–13 is 13 000 hours, reducing to 12 000 hours in the following three financial years. *Portfolio budget statements 2012–13: Defence portfolio*, p. 55.

3.40 Actual flying hours increased during 2009–10 and 2010–11, exceeding the hours achieved in the early 1990s. According to ACG, these increases occurred despite this being a period when significant numbers of Hornets were taken offline, largely due to ageing-aircraft issues, Hornet upgrades under AIR 5376, as well as some structural refurbishments. The improved availability recently as compared to the early 1990s coincides with the implementation of the fleet management initiatives outlined above at paragraphs 3.24 to 3.26.

3.41 During 2011–12 the approved level of Hornet flying hours (13 000 hours) has not been achieved.[94] ACG has informed the ANAO that this is largely due to a shortfall in the ratio of experienced pilots to junior pilots.[95] Specific ratios are required to ensure adequate supervision and tactical skills development during the conduct of flight training—an issue that had been somewhat masked during the previous three years by the unavailability of aircraft.

Hornet servicing statistics

3.42 Tactical Fighter SPO has a performance measurement system which systematically gathers statistics on the support of all significant Hornet aircraft subsystems, such as engines, hydraulics and structures. The system seeks to identify performance trends and to predict future performance outcomes. This has enabled the SPO to intervene early to ensure that the desired outcome—serviceable aircraft provided to ACG—is reliably achieved.

3.43 The analysis in the remainder of this chapter draws upon a sample of the data sets used by Tactical Fighter SPO to manage its in-service support of the Hornet fleet.

Deeper Maintenance durations

3.44 Since 2008 there has been a significant increase in emergent work, with major issues including corrosion of the No. 1 fuel-tank and surface corrosion, and more recently, cracking of the engine mount and support formers. This has

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[94] Note that the data in Figure 3.2 is valid to the end of May 2012, rather than the end of June 2012.

[95] The RAAF uses a combat-pilot skills-categorisation scheme, which has the following levels:

- 'A' category Fighter Combat Instructors are combat-ready, can fulfil the role of multi-formation lead, and require less than 180 hours of flying per annum to remain competent;
- 'B' category pilots are combat-ready, can fulfil the role of Flight Supervisor and require less than 180 hours per annum to remain competent. Hornet pilots should attain the level of B category at the completion of about 30 to 36 months of Hornet flying;
- 'C' category pilots are combat-ready and capable of fulfilling the role of flight-lead. Hornet pilots should attain the level of C category at the completion of six to nine months of Hornet flying, and require 180–200 hours of flying per annum to remain competent; and
- 'D' category pilots have completed initial Hornet training at 2 OCU. On graduation from 2 OCU, they are posted to one of the three operational Hornet squadrons. These pilots are combat-ready and capable of fulfilling the role of wingman under the supervision of a category B pilot. They require more than 200 hours of flying per annum to remain competent.

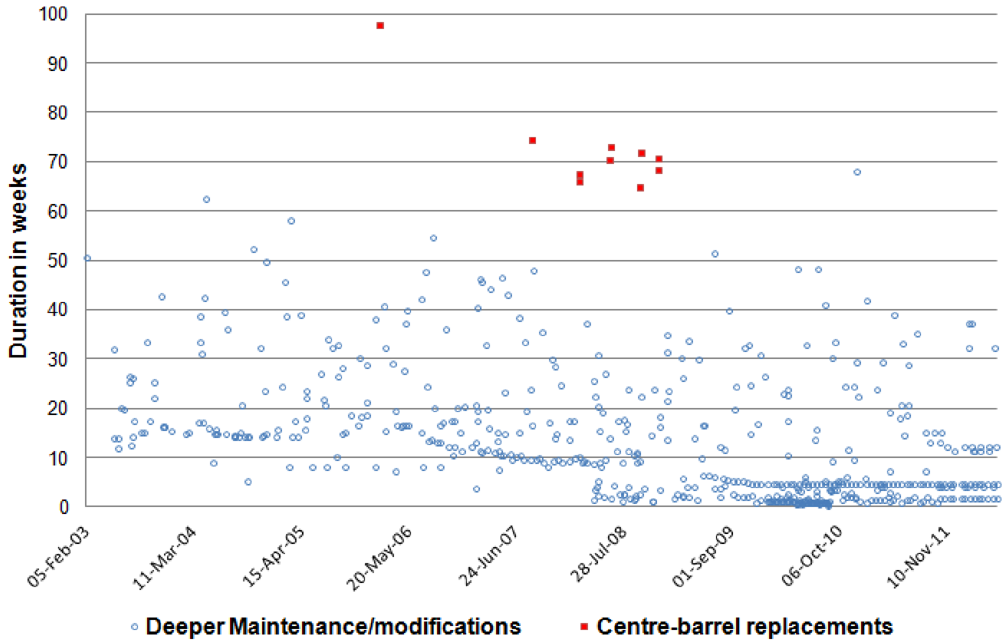
See also ANAO Audit Report No.47 2003–04, *Developing Air Force's combat aircrew*, pp. 38–40.

led to an increase in demands upon engineering assessments and technical skill in the development and application of structural repairs, and a general increase in logistics support requirements. Consequently, there have been large variations in the time taken to complete Deeper Maintenance activities on individual aircraft.

3.45 Figure 3.3 shows the completion rates of all Hornet Deeper Maintenance and modification activities commenced since February 2003.

Figure 3.3

Duration of Hornet Deeper Maintenance and modifications, February 2003–May 2012



Source: ANAO analysis of Tactical Fighter Systems Program Office data.

3.46 Each point in Figure 3.3 shows how long a particular aircraft was taken out of service during the conduct of Deeper Maintenance activity and modifications. These activities frequently included simultaneous capability modifications (undertaken as part of the Hornet upgrade projects—see Chapter 2) and structural refurbishments (see Chapter 4).

3.47 During 2006–10, a major modification activity was undertaken to replace a number of Hornet centre barrels.[96] The duration of centre barrel replacements is shown as a separate series in Figure 3.3. Initially up to 49 RAAF classic Hornet aircraft were to undergo a centre barrel replacement procedure. However, based upon investigations by DSTO into the condition of centre barrels removed from RAAF aircraft, and the development of a new crack-growth model, Defence determined there was only a need for ten aircraft to undergo that procedure, in order to remain serviceable until their Planned Withdrawal Date of 2020 (see paragraph 4.28). Figure 3.3 shows that after the initial aircraft had undergone this major modification—involving dismantling and reassembling the middle portion of the fuselage—the succeeding aircraft experienced centre barrel replacement durations of some 65 to 75 weeks.

3.48 The trends shown in Figure 3.3 demonstrate that Deeper Maintenance services, when combined with the simultaneous incorporation of modifications, have been averaging more than 20 weeks—well over the 12-week target for a stand-alone R3 service.[97] The longer durations of these services are partly explained by the time taken to incorporate critical structural modifications, which are a part of the structural refurbishments discussed in Chapter 4. They also included a special service, in lieu of a complete R3 service, which was needed as part of the preparations for replacement of the centre barrel assemblies in the ten F/A-18A/B aircraft that had the highest level of fatigue consumption.[98]

3.49 The R3 services carried out from 2008 to 2010 included inspections that required entry into the Hornet's No. 1 fuel-tank compartment. Those inspections revealed corrosion and significant structural-refurbishment requirements, especially in the dual-seat F/A-18B Hornets, which resulted in R3 service durations of up to 40 weeks. Tactical Fighter SPO consequently released a Special Technical Instruction in June 2010 requiring entry and inspection of the No. 1 fuel-tank compartment of all aircraft in the F/A-18B

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[96] For a diagram of a centre barrel, see Figure 4.2 on page 95.

[97] The recently introduced R4 service also has a 12-week completion target.

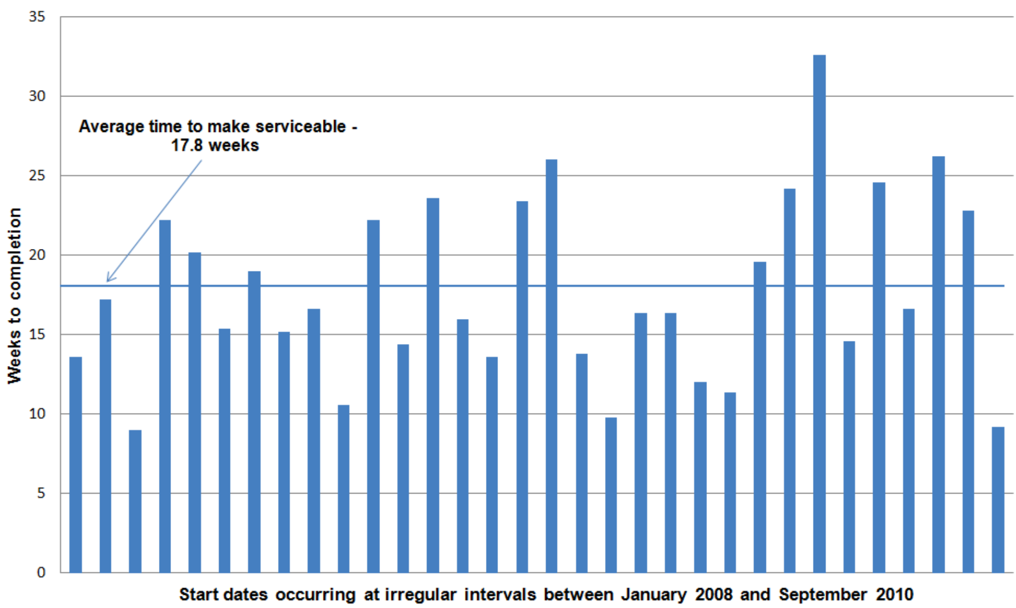
[98] This service was known as the S158 service.

fleet.[99] In January 2012, the requirement for this inspection was extended to the F/A-18A fleet.[100]

3.50 Figure 3.3 also shows a large number of short-duration services conducted over the last three years. These occurred as a result of the implementation of the Hornet Upgrade Phase 2.3 program, involving installation of upgraded avionics. Since this upgrade required each aircraft to be taken off the flight-line, the opportunity was also taken to implement a simultaneous two-week maintenance program. For Tactical Fighter SPO, the elements described in the preceding paragraphs are examples of how different the maintenance program is now from what it was in 2003.

Figure 3.4

Duration of Hornet stand-alone R3 services, January 2008–September 2010



Source: ANAO analysis of Tactical Fighter Systems Program Office data.

[99] Defence Materiel Organisation, Tactical Fighter SPO, *Special Technical Instruction: STI-Hornet-1162-Tank 1 floor & bulkhead inspection*, June 2010.

[100] Defence Materiel Organisation, Tactical Fighter SPO, *Special Technical Instruction: STI-Classic Hornet-1254-Tank 1 floor & bulkhead inspection*, January 2012.

3.51 Figure 3.4 shows the duration of stand-alone R3 services commenced by Boeing Defence Australia and BAE Systems Australia from January 2008 to March 2010, and by the squadrons of 81 Wing and its Combined Workshop from November 2009 to September 2010. A stand-alone service is one that is not combined with aircraft systems upgrades such as those discussed in Chapter 2. The time to complete the stand-alone R3 services averaged 17.8 weeks, some six weeks above the target of 12 weeks. Boeing Defence Australia commented that while the trend in increased deeper maintenance turnaround times should stabilise in the coming years, the employment of best commercial practices, lean principles and schedule commitment will be vital to keep or reduce these minimal turnaround times.[101]

3.52 Some of the lower turn-around times for stand-alone R3 services may be attributed to the fact that most aircraft have now completed several R3 services and the structural-refurbishment modifications since 2001,[102] and many of the corrosion and structural repair issues likely to be identified through stand-alone R3 services have surfaced and been dealt with. Moreover, once an initial engineering solution has been developed, approved and accepted for a particular problem, subsequent occurrences are fixed much more quickly, in accordance with the approved solution.

3.53 Figure 3.5 below shows the stand-alone R4 services conducted during 2010–12, and it indicates that the average turn-around time for standalone R4 services is two and a half weeks longer than the average turn-around time for R3 services.

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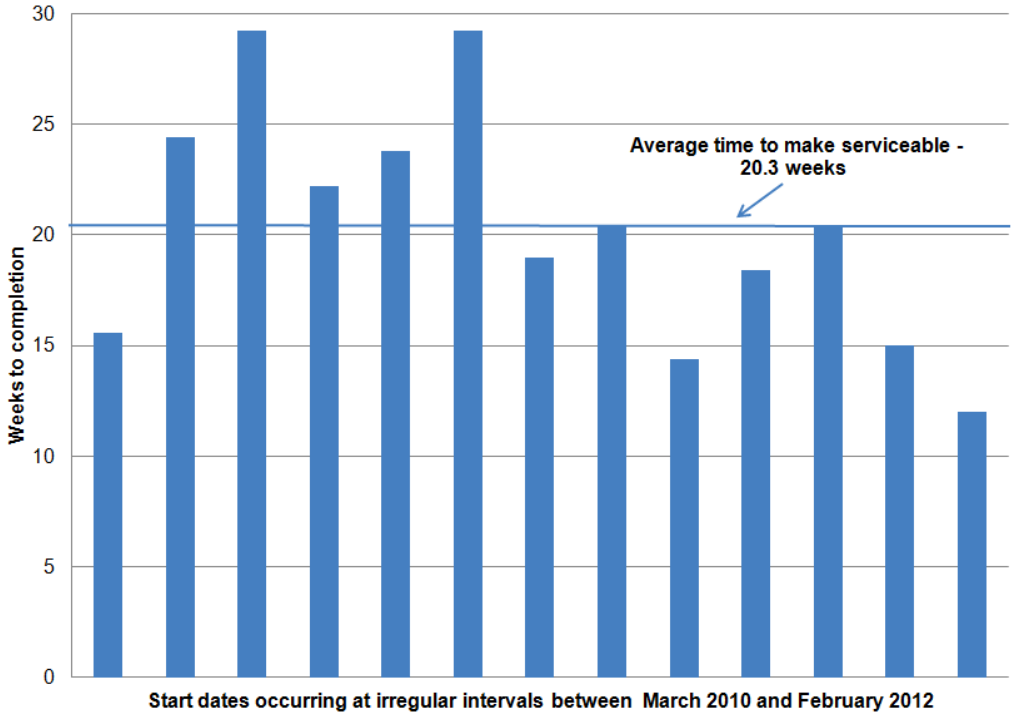
101 Boeing Defence Australia, September 2012.

102 Moreover, 39 aircraft had received the newly introduced R4 service by April 2012.

Figure 3.5

Duration of Hornet stand-alone R4 services, March 2010–February 2012



Source: ANAO analysis of Tactical Fighter Systems Program Office data.

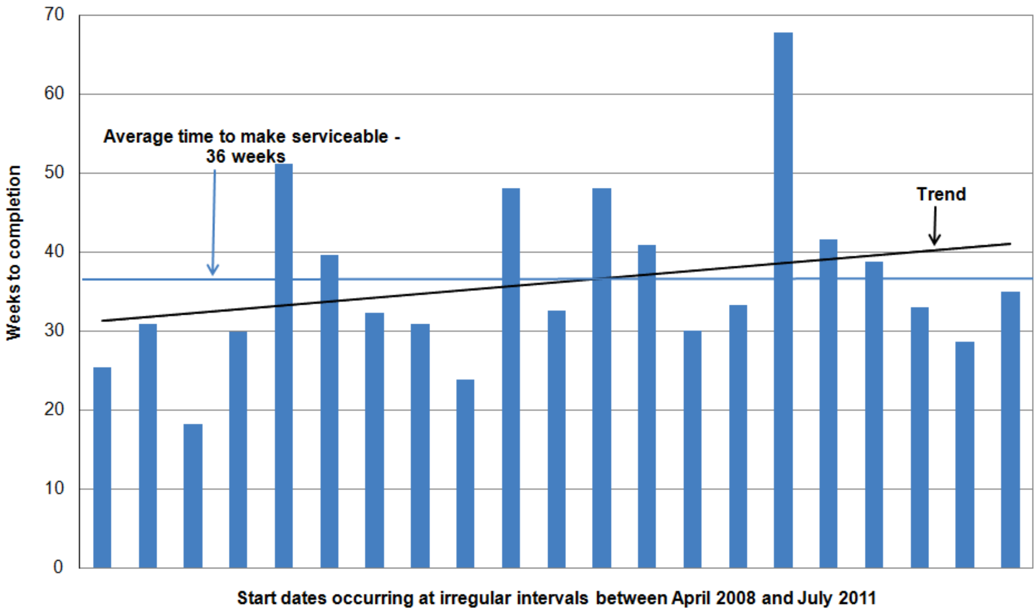
3.54 Figure 3.6 below shows that over recent years, Tactical Fighter SPO has moved away from stand-alone R3/R4 services, in an effort to gain greater efficiencies by combining them with the modifications and repairs required to address corrosion and metal fatigue. The figure shows the weeks taken to complete routine Deeper Maintenance inspections and services, and to complete structural modifications under the Structural Refurbishment Program (the SRP is part of the Hornet Upgrade program—see Chapter 4). Defence estimates the cost of the combined SRP1D/R3/R4 work for the 14 aircraft yet to undergo SRP1D modifications at $38 million, as against an estimate of $18 million if only R3/R4 services were to be carried out on these aircraft.[103] Figure 3.6 indicates a linear trend towards taking longer to make serviceable each F/A-18A/B when major services are undertaken. This is a

[103] Tactical Fighter SPO and 81 Wing, *Options to increase F/A-18 serviceability: decision brief*, August 2011, p. 7.

consequence of the increasing levels of emergent work identified during these services that is needed to repair defects caused by metal corrosion and metal fatigue.

Figure 3.6

Duration of Hornet combined SRP1/1D/R3/R4 services, 2008–12



Source: ANAO analysis of Tactical Fighter Systems Program Office data.

Hornet availability and serviceability

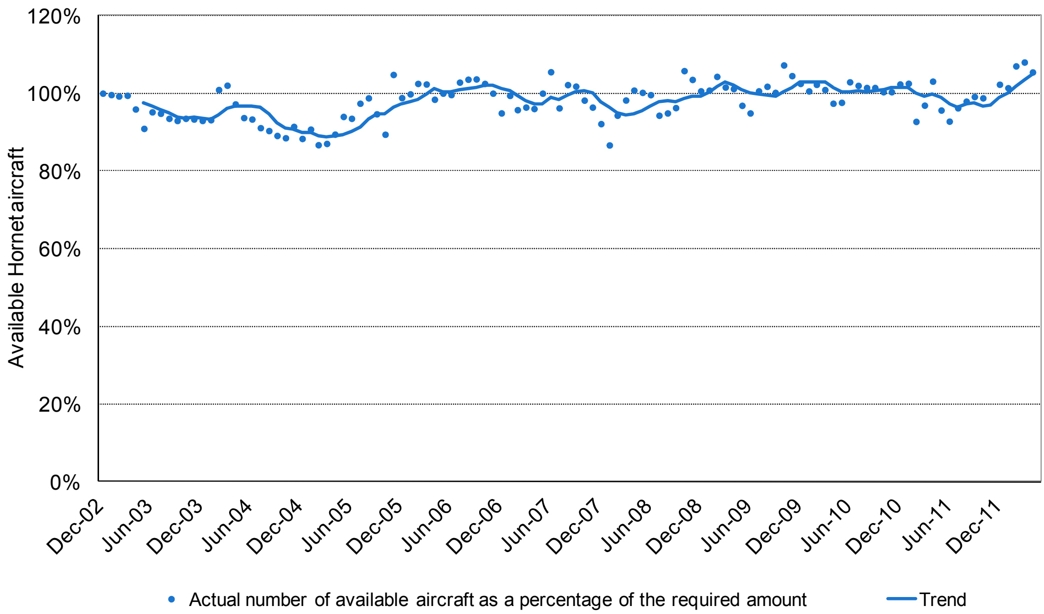
3.55 The terms 'availability' and 'serviceability' describe an aircraft's operational readiness status. When an aircraft has completed Deeper Maintenance, and has been delivered by Tactical Fighter SPO to ACG, it is classified as being 'available' to be made 'serviceable' by ACG's operational-maintenance unit. All serviceable aircraft are considered to be Fully Mission Capable. Aircraft held by ACG that require less than four hours Operational Maintenance by one maintenance crew to be made serviceable are classified as Potentially Mission Capable. Aircraft requiring more than four hours maintenance by one maintenance crew are classified as Not Mission Capable.

All aircraft undergoing Deeper Maintenance by Tactical Fighter SPO's contractors are classified as unavailable.[104]

3.56 Figure 3.7 shows that since 2007, the number of Hornet aircraft made available to ACG's operational-maintenance unit by Tactical Fighter SPO has generally approximated the number specified in the Materiel Sustainment Agreement between ACG and Tactical Fighter SPO. This is a significant improvement over the approximately 10 per cent shortfall that had occurred in the preceding years, when aircraft became unavailable for long periods as a result of being inducted into the Hornet Upgrade program (see Chapter 2). Moreover, Tactical Fighter SPO data shows that, in the four years to May 2012, there were only 17 months in which the aircraft availability target was not met or exceeded—a significant improvement from the previous four-year period, when there were 34 months when the aircraft availability target was not met.

Figure 3.7

Hornet aircraft availability with respect to the number required, January 2003–May 2012



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

[104] Air Combat Group, *Hornet squadron maintenance reporting requirements*, Special Instruction (Logistics) SI(LOG) 3-3-30, Annex B, as at 2011.

3.57 The number of aircraft awaiting Tactical Fighter SPO action, and so being classified as unavailable for extended periods, has remained relatively steady at two to three per month over recent years, with a peak of seven in March 2011. This is a positive result for Tactical Fighter SPO, given the amount of engineering support the Hornet aircraft require during the current phase of their service life.

3.58 From the available fleet, ACG's Operational Maintenance squadrons are required to maintain on the flight-line a classified number of Fully Mission Capable aircraft.

3.59 During 2010 and 2011, the number of Fully Mission Capable F/A-18A/B aircraft improved from historical averages that were slightly below the requirements determined by the Chief of Air Force. Tactical Fighter SPO has taken a number of measures that have further remediated the maintenance schedules,[105] resulting in overall achievement of the Chief of Air Force's requirements in this period.

Spares support

3.60 Tactical Fighter SPO's primary day-to-day in-service logistics responsibility is to ensure that demands placed by Hornet Operational Maintenance personnel for Repairable Items and Breakdown Spares are satisfied within priority timeframes.[106] Figure 3.8 shows the demand-satisfaction rates of Hornet Repairable Items[107] and Breakdown Spares.

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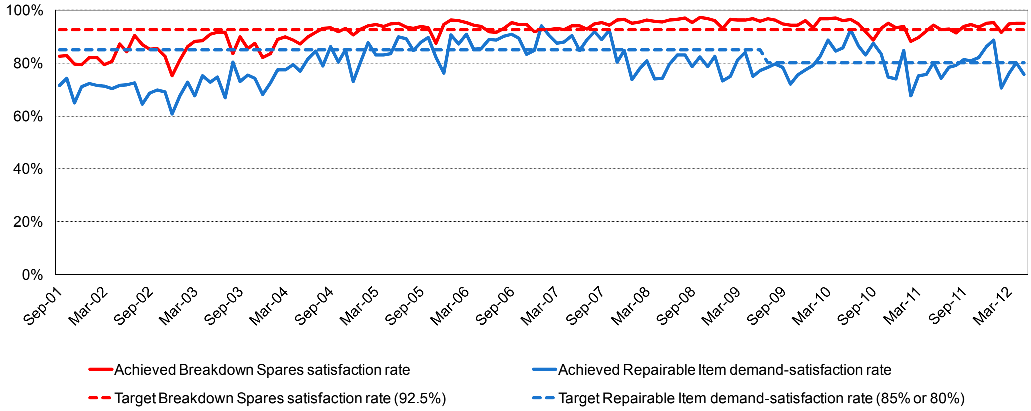
105 Tactical Fighter SPO and 81 Wing, *Options to increase F/A-18 serviceability: decision brief*, August 2011.

106 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.

107 Repairable Items are all of those items whose resupply normally centres on maintenance processes formally authorised by the ADF to be carried out at authorised venues. Australian Defence Force, *ADF aviation maintenance management manual (Book 2 of 2)*, Australian Air Publication 7001.059, 18 May 2011, Glossary.

Figure 3.8

Hornet spares demand-satisfaction rates, September 2001–May 2012



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

3.61 The Tactical Fighter SPO data presented in Figure 3.8 shows that Defence is largely achieving Materiel Sustainment Agreement timeframes for satisfying demands on Breakdown Spares and Repairable Items. The agreed timeframes are used as the basis for measuring demand-satisfaction rates, with respect to the percentage of instances when deliveries are achieved within target timeframes. Figure 3.8 shows that, based on Tactical Fighter SPO data, the target Repairable Item demand-satisfaction rate of 85 per cent was reduced to 80 per cent from July 2009, and the target Breakdown Spares demand-satisfaction rate remained steady at 92.5 per cent. Defence records also indicate that the achieved satisfaction rates for Breakdown Spares have improved since 2001, and almost consistently exceed the 92.5 per cent target, but the achieved Repairable Item demand-satisfaction rate has been less successful in consistently exceeding the target. However, the data indicates that overall there have been substantial improvements in both categories since the end of 2003, which Defence attributes to:

- a $232 million increase in logistics funding in 2002–05;[108]
- a $2.5 million supply-chain-improvement project completed in 2005; and
- general improvements in management processes within Tactical Fighter SPO.

108 Of the $232 million increase in logistics funding, $12 million was to cover the logistics required for Operation Falconer (Iraq, 2003).

3.62 However, new pressures within the Defence organisation have the potential to affect Tactical Fighter SPO's performance in terms of demand-satisfaction rates for Hornet Repairable Items and Breakdown Spares. For example, Tactical Fighter SPO's F/A-18A/B sustainment budget includes provision for savings targets established by Defence's Strategic Reform Program. These saving targets increase over time from $10 million in 2011–12 to some $20 million in 2018–19.[109] 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 that the cost of improving its Breakdown Spares demand-satisfaction rate by one per cent would be about $1 million per year, with improvements above one per cent becoming exponentially more costly.[110] In an environment where further savings are required under Defence's Strategic Reform Program, Tactical Fighter SPO and ACG are required to work together on assessing the cost and benefits of making additional Hornet spares investments, which include the need to manage the risk of spares obsolescence—a major risk to any ageing platform.

3.63 During 2010–11, Tactical Fighter SPO achieved a Repairable Item demand-satisfaction rate of approximately 80 per cent. Although the raw data indicates that Tactical Fighter SPO remains slightly under the 80 per cent target, Tactical Fighter SPO advised the ANAO that causal analysis has indicated that when external data/process anomalies (such as data-entry errors that cause demand failures) are extracted, the target is in fact being achieved.

Delayed spares/dispositions

3.64 Although demand satisfaction is a useful indicator of the health of a logistics system, it does not reveal the issues that may arise when a critical spare part is not available. For this reason, data on delayed spares is an important supplementary indicator of the health of a logistics system. In Figure 3.9, the target for delayed spares is to be below the black line, and any figure

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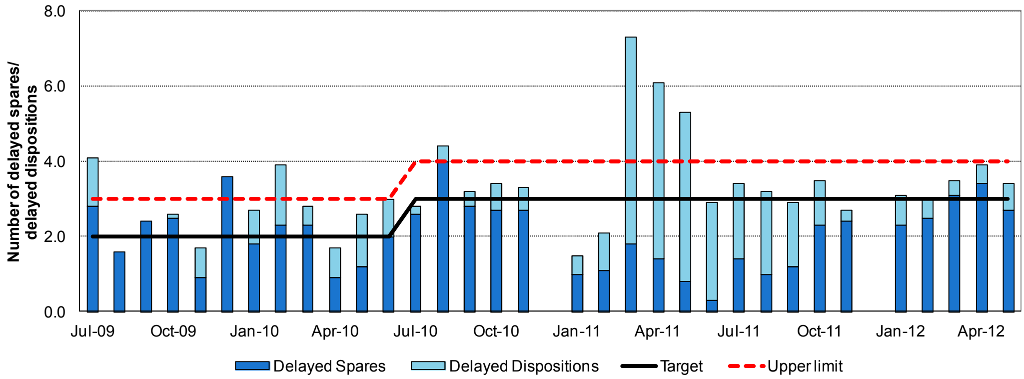
109 Defence Materiel Organisation, Tactical Fighter SPO, *Classic Hornet sustainment narrative*, 18 May 2011, p. 6.

110 ANAO Audit Report No.27 2006–07, *Management of air combat fleet in-service support*, p. 58.

above the red line should potentially be considered as a cause for concern and hence act as the trigger for deeper investigation and analysis.

Figure 3.9

Hornet delayed spares, July 2009–May 2012



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

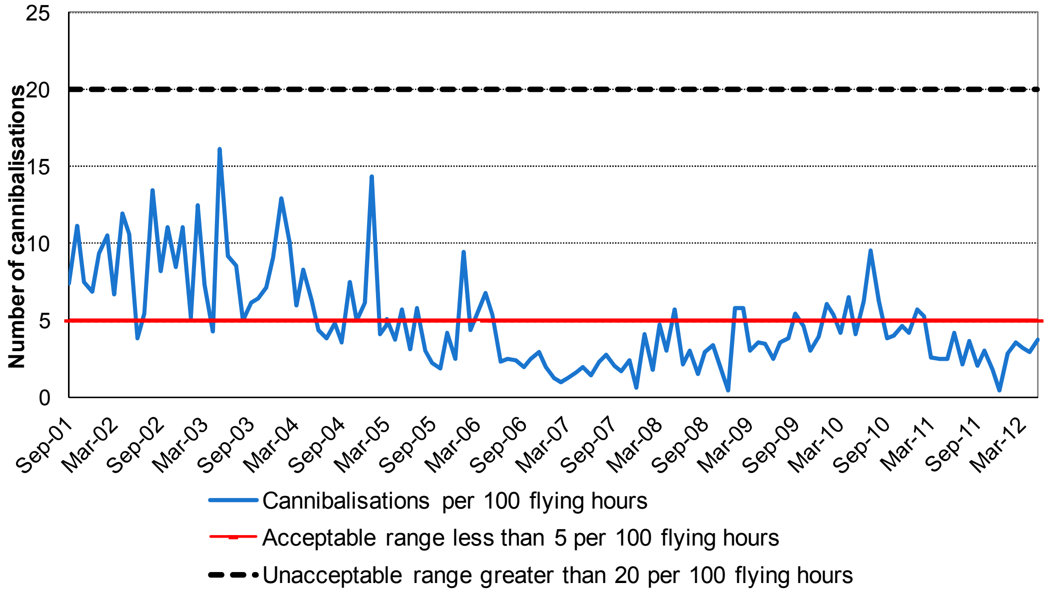
3.65 The figure demonstrates that performance has generally been either on target or below the upper limit. The early 2011 spike in delayed spares is attributed by Tactical Fighter SPO to the failure of a non-critical nose landing-gear component, and subsequent fleet-wide inspections and associated rectifications.

Cannibalisation rates

3.66 Figure 3.10 shows the number of serviceable components, per 100 hours of flight time, that since September 2001 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 flight-line. This is referred to as cannibalisation, and it is an inefficient use of maintenance effort, since it involves maintenance of two aircraft, rather than maintenance of only one.

Figure 3.10

Hornet component cannibalisations per 100 flying hours, September 2001–May 2012



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

3.67 The graph shows a long-term general downward trend in the cannibalisation rates since 2002, which coincides with Tactical Fighter SPO's increased logistics-support funding and Hornet supply-chain improvements.[111] In December 2004 Tactical Fighter SPO acquired an additional Repairable Item and Breakdown 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.

3.68 The mid-2010 spike in cannibalisations is attributed by Tactical Fighter SPO mainly to a Special Technical Instruction on the Emergency Oxygen System, with a subsequent requirement to cannibalise oxygen-system parts. In addition, there was an increase in recording the cannibalisation of external fuel tanks and pylons, due to a change in ACG's reporting requirements. In Tactical

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111 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.

Fighter SPO's view, these cannibalisations did not affect overall capability or DMO's supply performance.

3.69 Improvements in the cannibalisation rate 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 per module, whereas the cost of removing and using serviceable modules from aircraft undergoing long-term servicing or modification, or from fully serviceable major assemblies, may be in the order of $1500. 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.

3.70 The 2010 report of the Airworthiness Board on the F/A-18 classic Hornet fleet observed that the 'rolling' cannibalisations being experienced by 81 Wing were due to a number of cost-conscious procurement decisions not to purchase a fleet fit of expensive Repairable Items, including radars, gun packs and engines, thereby requiring cannibalisations of Deeper Maintenance aircraft to support on-line aircraft. In this context, Tactical Fighter SPO considered cannibalisations to be a reality for an ageing aircraft, and was measuring and managing Repairable Item trends to ensure that cannibalisation rates did not increase.[112]

Conclusion

3.71 Key indicators of the effectiveness of sustainment management include the flying hours achieved and the rate of aircraft availability to the RAAF. Over the period July 1991–May 2012, the Hornet fleet's annual flying hours were largely in line with Air Force planning and ACG's operational requirements. In particular, actual flying hours increased during 2009–10 and 2010–11, despite this being a period where significant numbers of Hornets

[112] ADF Airworthiness Coordination and Policy Agency, *Airworthiness Board report: A21 F/A-18 Hornet*, 23 June 2010, p. 2.

were taken off-line.[113] According to Air Force, a drop in flying hours in 2011–12 was largely attributable to a shortfall in the ratio of experienced pilots to junior pilots.[114] Tactical Fighter SPO has been successful in maintaining the rate of aircraft availability at a relatively steady level over recent years, notwithstanding the amount of engineering support the Hornet aircraft require during the current phase of their service life.

3.72 These achievements have been delivered in the context of recent initiatives by Tactical Fighter SPO and the RAAF's ACG to improve Hornet availability and serviceability, and have included substantial reforms of Deeper Maintenance timetables and processes, as well as establishment of the Hornet Fleet Planning Cell to optimise the use of aircraft.

3.73 The duration of Deeper Maintenance services has varied markedly over the last decade, as a result of the wide range of types of service to be undertaken, from periodic services to comprehensive upgrades or modifications. Defence data indicates that, in recent years, maintenance of the Hornet fleet has become more difficult and more expensive, with the increasing emergence of airframe corrosion and fatigue issues. The general trend is for Deeper Maintenance services to exceed the targeted duration of 12 weeks, and as the fleet grows older, this trend can be expected to continue.

3.74 The provision of spares to the F/A-18A/B Hornet fleet has shown a moderate level of improvement over the last decade, with targets for demand-satisfaction generally being met, and delayed spares being supplied within agreed priority timeframes. Tactical Fighter SPO is also managing carefully the variable costs and benefits of cannibalising parts versus replacing them.

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113 This was largely due to ageing-aircraft issues, Hornet upgrades under the AIR 5376 project, as well as some structural refurbishment.

114 Specific ratios are required to ensure adequate supervision and tactical skills development during the conduct of flight training.

4. F/A-18A/B Hornet Fleet Structural Integrity

This chapter examines the F/A-18A/B classic Hornet fleet's Aircraft Structural Integrity Program, which seeks to provide adequate assurance that the Hornet fleet's service life can be extended until its Planned Withdrawal Date, currently 2020.

Background

4.1 Structural integrity is the ability of a structure to withstand its operational service conditions safely and reliably throughout its planned lifetime. Since the mid-1990s, the ADF has implemented an Aircraft Structural Integrity Program (ASIP), which focuses on providing assurance that ADF aircraft structures (such as the fuselage, wings and engines) may safely withstand the static and cyclic loads and environmental conditions to which they are subjected during their operational service.[115] The central objective of the ASIP is to:

> enable air operations to be conducted with an acceptable level of risk of structural failure and to preserve the asset to its planned life of type.[116]

4.2 The Defence Instruction on the management of the structural integrity of ADF aircraft warns that structural-integrity inspections or refurbishment activities, if not properly forecast and efficiently implemented, can markedly reduce aircraft operational availability and increase costs, and have direct implications on Planned Withdrawal Dates.[117]

4.3 An aircraft's structural integrity is initially established through the application of design principles and production techniques, and is verified and validated through tests and evaluations of structural fatigue and degradation, conducted by aircraft designers and manufacturers. These activities allow

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115 Wing Commander D Zemel, *Managing aircraft structural integrity in the ADF* [Internet], Aircraft Airworthiness and Sustainment Conference 2010, available from <http://www.ageingaircraft.com.au/assc/docs/Zemel%2018th%20S6%20P3.ppt> [accessed 4 November 2011].

116 Wilson, ES, 'Developments in RAAF aircraft structural integrity management', in *ICAF 95: estimation, enhancement and control of aircraft fatigue performance*, EMAS, West Midlands, UK, 1995, vol. 1, p. 963.

117 Department of Defence, Defence Instruction (General) LOG 4–5–016, *Management of aircraft and engine structural integrity*, September 2010, p. 1.

designers to determine an aircraft's theoretical service life—known as its Life of Type. This is the period of time for which that type of aircraft may be flown, within its expected usage pattern, without an excessive risk of a catastrophic structural failure.[118]

4.4 The risk of an aircraft experiencing a structural failure is managed throughout its service life by the application of a combination of the following structural-integrity management regimes applied to its various structures:

- *a safe-life regime*,[119] which involves the use of fatigue-test data and aircraft-usage spectrums to produce a Safe Life Limit against which aircraft operational usage is compared. The limit may be measured in terms of Fatigue Life Expended (FLE) or Airframe Hours (AFHRS). A safe-life regime is usually applied to those aircraft structures that are difficult to inspect, which is often the case with fighter aircraft; and
- *a safety-by-inspection regime*,[120] which involves periodic inspections for structural-fatigue cracks and degradation in potential failure locations that have been identified through Development Test and Evaluation. A safety-by-inspection regime may continue until the probability of widespread cracking and degradation becomes too great and structural modification actions, or aircraft retirement, is required.

4.5 When an individual aircraft's structures reach their Safe Life Limits, these structures may be transitioned to a safety-by-inspection regime, provided they can be adequately inspected. Safe-life regimes are preferred over safety-by-inspection regimes, because they do not attract the costs and aircraft unavailability generated by the processes of structural inspection and analysis.

[118] For details of the international programs to assess the potential longevity of Hornet structures, see Appendix 6: International Collaborative Programs and Aircraft Structural Audits.

[119] Safe life: The safe life of an item is the life at which the weakest example just retains the required standard of strength, deformation, stiffness or mechanical function, until it is withdrawn from service at the end of a specified life, or an equivalent life having taken into account the actual usage. The minimum standard of strength is 80 per cent of the design ultimate. RAAF, *F/A-18 A/B Hornet aircraft structural integrity management plan*, 2011, vol. 1, Definitions, p. ii, relying on UK Ministry of Defence, Defence Standard 00-970.

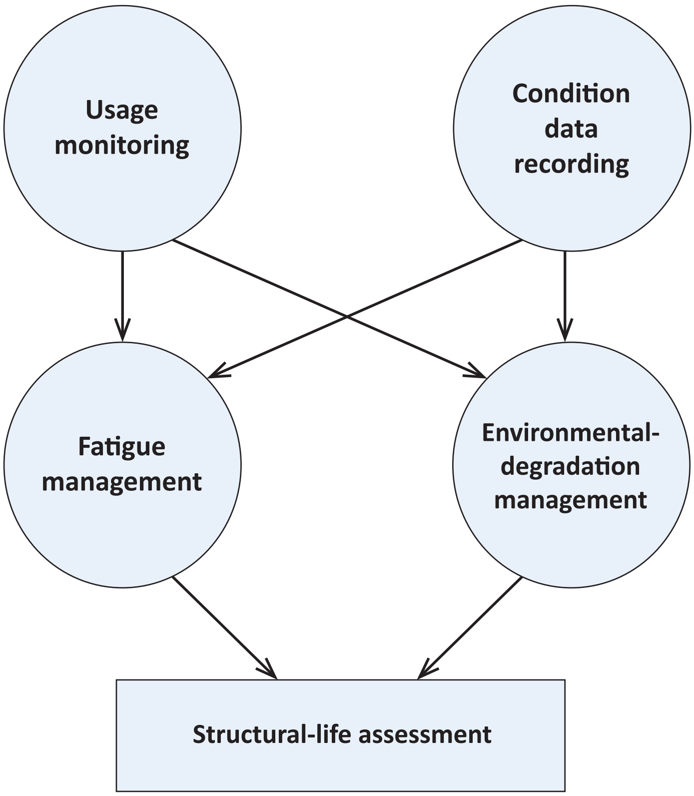
[120] Safety by inspection: A process for assuring continued structural airworthiness by repeated inspection of critical locations at designated periodicity to detect significant defects prior to imminent failure.
Safety-by-inspection management: Safety-by-inspection management means that the risk of failure is constrained by a program of inspections which regularly assess the integrity of the item. RAAF, *F/A-18 A/B Hornet aircraft structural integrity management plan*, 2011, Vol. 1, Definitions, p. iii.

However, safe-life regimes have the disadvantage of requiring aircraft to be retired earlier than may be the case under a safety-by-inspection program.

4.6 Figure 4.1 gives a simplified illustration of the ADF Aircraft Structural Integrity management process.

Figure 4.1

Aircraft Structural Integrity management process



Source: RAAF, *F/A-18 A/B Hornet aircraft structural integrity management plan*, 2011, Volume 1.

4.7 This chapter mainly focuses on structural-integrity management of the F/A-18A/B Hornet airframe, and largely omits discussion of the structural integrity of aircraft engine and aero-mechanical systems, as those systems are discussed in Chapter 3 (see paragraph 3.15).

4.8 The ANAO examined Defence's arrangements for assessing the risks involved in extending the service life of the F/A-18A/B fleet to its Planned Withdrawal Date, and the implementation of risk-reduction activities.

Organisational arrangements

4.9 The ADF's Directorate General Technical Airworthiness (DGTA) has an Aircraft Structural Integrity Section, which is responsible for regularly reassessing the certified Safe Life Limits, safety-by-inspection intervals, and the physical condition of ADF aircraft operated by all three Services. This involves:

- establishing, evaluating and substantiating the structural integrity of ADF aircraft;
- acquiring, evaluating and utilising data of operational usage and aircraft structural condition, to provide continual assessment of the in-service integrity of individual aircraft structures; and
- using aircraft structural-integrity data as a basis for determining and planning aircraft maintenance, inspections, spares, rotation and modifications.[121]

4.10 The rate at which an individual ADF aircraft expends its fatigue life is influenced by its operational use, by structural degradation such as corrosion, by accidental or battle damage, and by the interaction between structural repairs. The DGTA has an Aircraft Structural Integrity program for each ADF aircraft type, which is tailored for aircraft complexity and risk exposure. The individual programs typically involve periodic structural-life assessments based on usage monitoring, condition data recording, fatigue management and environmental-degradation management.

4.11 Aircraft Structural Integrity Management Plans (ASIMPs) are developed in order to provide a sound basis for aircraft structural-inspection programs, structural-life limits, and component retirement times. These plans are developed by DMO during the aircraft acquisition phase, in consultation with DGTA, DSTO and the aircraft's Force Element Group. ASIMPs must be authorised by DGTA.[122]

4.12 All three Services operate and maintain ADF aircraft through their respective Force Element Groups. Service Chiefs, as capability managers, are responsible for:

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[121] RAAF, *F/A-18 A/B Hornet aircraft structural integrity management plan*, 2011, vol. 1, Foreword, p. xiii.

[122] Department of Defence, Defence Instruction (General) LOG 4–5–016, *Management of aircraft and engine structural integrity*, September 2010, pp. 2, 4.

(a) operating aircraft within approved structural operating limits;

(b) providing timely promulgation of role and environment changes via proposed amendments to the Statement of Operating Intent;

(c) conducting structural maintenance and repair of aircraft in accordance with authorised procedures and processes;

(d) collecting aircraft and engine usage and condition-monitoring data as detailed in the aircraft and engine structural-integrity programs; and

(e) informing DGTA of in-service issues that have the potential to affect the structural integrity of an aircraft or engine.[123]

Safe-Life management

4.13 The aircraft design and airworthiness standard adopted by the ADF, for both safe-life and safety-by-inspection management, aims for achievement of a cumulative probability of catastrophic structural failure of less than 1 in 1000 for each aircraft at the end of its service life.[124]

4.14 The Hornet aircraft was originally designed and manufactured by McDonnell Douglas (now Boeing), to a US Navy specification, with a structural-fatigue safe life of 6000 airframe hours of US Navy usage.[125] Similar to other aircraft, Hornet aircraft suffer metal-fatigue cracks that increase in size and numbers as load stresses are applied during flying operations. Consequently, in addition to airframe hours, stresses applied to the Hornet structures also need to be measured, and periodic fatigue assessments need to be conducted. These assessments may lead to limitations on flying manoeuvres that produce excessive structural stress, and to structural refurbishments that treat the cumulative effects of structural fatigue.

4.15 In relation to structural fatigue, an aircraft's remaining safe life is measured by its Fatigue Life Expended Index (FLEI). The FLEI is a measure of

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[123] Department of Defence, Defence Instruction (General) LOG 4–5–016, *Management of aircraft and engine structural integrity*, September 2010, p. 5.

[124] UK Ministry of Defence, Defence Standard 00-970 (DEF STAN 00-970), *Design and airworthiness requirements for service aircraft,* Part 1, Section 3, Leaflet 35, 1999, paragraph 2.3; Wilson, ES, 'Developments in RAAF aircraft structural integrity management', in *ICAF 95: estimation, enhancement and control of aircraft fatigue performance*, EMAS, West Midlands, UK, 1995, vol. 1, p. 965.

[125] RAAF, *F/A-18 A/B Hornet aircraft structural integrity management plan*, 2011, vol. 1, Section 2, Chapter 2, p. 1.

the proportion of the certified safe life of a structure that has been consumed. A FLEI of 1.0 on a critical structure normally indicates that an aircraft has accumulated fatigue damage at the outer limit of its safe range. An aircraft with a structure having a FLEI consumption of greater than 1.0 may consequently have a probability greater than 1 in 1000 of experiencing a catastrophic structural failure. Hence such an aircraft may need to be withdrawn from service, be made subject to additional inspections, or alternatively undergo refurbishment of the structures that have a FLEI consumption approaching 1.0.

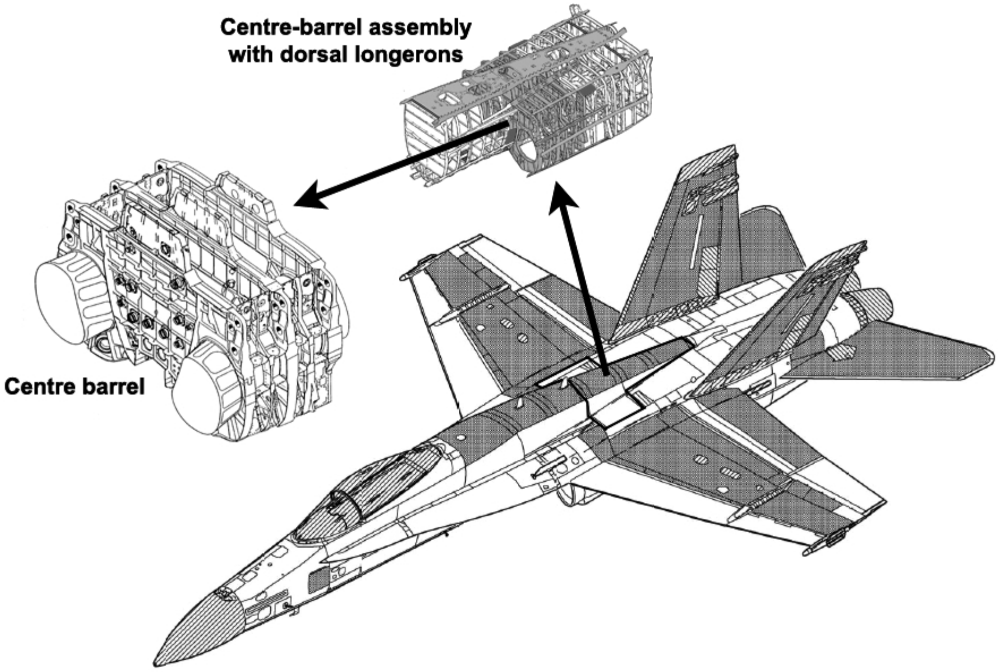
Hornet structural integrity

4.16 An F/A-18's most critical structure for flight safety is the fuselage centre barrel structure, shown in Figure 4.2. The centre barrel comprises three adjacent bulkheads that provide the points of connection between the fuselage, the wings and the main undercarriage. It is therefore subjected to high loads during high-g manoeuvres and during aircraft landings. Consequently, structural failure of the centre barrel is likely to lead to a catastrophic event, and so it is used as the source of Hornet FLEI data that has most bearing on the safe life of each Hornet aircraft.[126] FLEI data recorded at the centre barrel is known as Wing Root FLEI.

[126] The wing and centre-fuselage structures have been shown, by test and usage-monitoring, to be approaching their Safe Life Limits faster than other major structures. Landings, airframe hours, and the number of flights are other relevant life metrics, but these are less critical for the life of RAAF Hornet aircraft. RAAF, *F/A-18 A/B Hornet aircraft structural integrity management plan*, 2011, vol. 2, Section 1, Chapter 2, p. 1.

Figure 4.2

Hornet centre barrel



Sources: Department of Defence, Defence Science and Technology Organisation; Defence Materiel Organisation, Tactical Fighter Systems Program Office; adaptation by ANAO.

4.17 Each Hornet aircraft has a Maintenance Status Data Recording System (MSDRS), which provides information on the aircraft's structural-fatigue consumption and the aircrew's flying characteristics during each flight. This data is then processed by the Mission Severity Monitoring Program No. 2 (MSMP2), to provide FLEI data relevant to each mission, and to update the fatigue-life records of each aircraft. Tactical Fighter SPO uses this information to manage individual aircraft against their structural-life limits and to identify aircraft requiring close structural-fatigue consumption management and structural refurbishments. The information is also provided to ACG's 81 Wing for the purpose of structural-fatigue management, through mission planning and g-force management by pilots. This is to ensure that Fatigue Life Accrual Rates in the Hornet fleet are maintained within agreed limits while maintaining operational effectiveness.

4.18 Hornet aircraft have over 70 structures—such as the centre barrel—which are subjected to accumulated stress. Once their accumulated stress exceeds the structure's specified FLEI or airframe hours flown (AFHRS) limit, they require refurbishment, or the aircraft needs to be withdrawn from service or transitioned to a safety-by-inspection regime. At the time of the audit, the RAAF's classic Hornets have over 20 structures that are subject to a safety-by-inspection regime.[127] A register of these structures, their accumulated FLEI limits and their airframe hours flown limit is maintained in the Hornet Service Life Limit (SLL) register.[128]

4.19 Figure 4.3 shows the classic Hornet fleet's Wing Root FLEI[129] as at May 2012. The ten aircraft whose centre barrels have been replaced (the SRP2 modified aircraft represented by the red dots) have an average Wing Root FLEI of 0.755 and a maximum allowable FLEI of 1.0, while 59 others (the blue diamonds) have an average FLEI of 0.664 and a maximum allowable Wing Root FLEI of 0.85.[130] The two ARDU flight test aircraft, which at the time of the audit had less than 3500 airframe hours flown, have a maximum allowable Wing Root FLEI of 0.64.

4.20 The figure shows the consumption of FLEI for each of the RAAF's 71 F/A-18A/B Hornet aircraft, and their airframe hours flown. The dashed red line shows the ideal FLEI consumption for the 10 aircraft with centre barrel replacements, from each aircraft's entry into service in 1985 to their Planned Withdrawal Date of 2020. The dotted blue line shows the ideal FLEI consumption for 59 other aircraft (excluding the two ARDU aircraft). Ideally, each aircraft will reach its limit of 6000 airframe hours flown at the same time as it reaches its FLEI limit of either 1.0 or 0.85 (or, in the case of the two ARDU flight test aircraft, 0.64).

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[127] RAAF, *F/A-18 A/B Hornet aircraft structural integrity management plan*, 2011, Volume 2, Section 1, Chapter 4, Table 4.2, 'Through life management strategy for Damage Item Locations'. This chapter gives extensive details on each Damage Item Location and the associated management strategy.

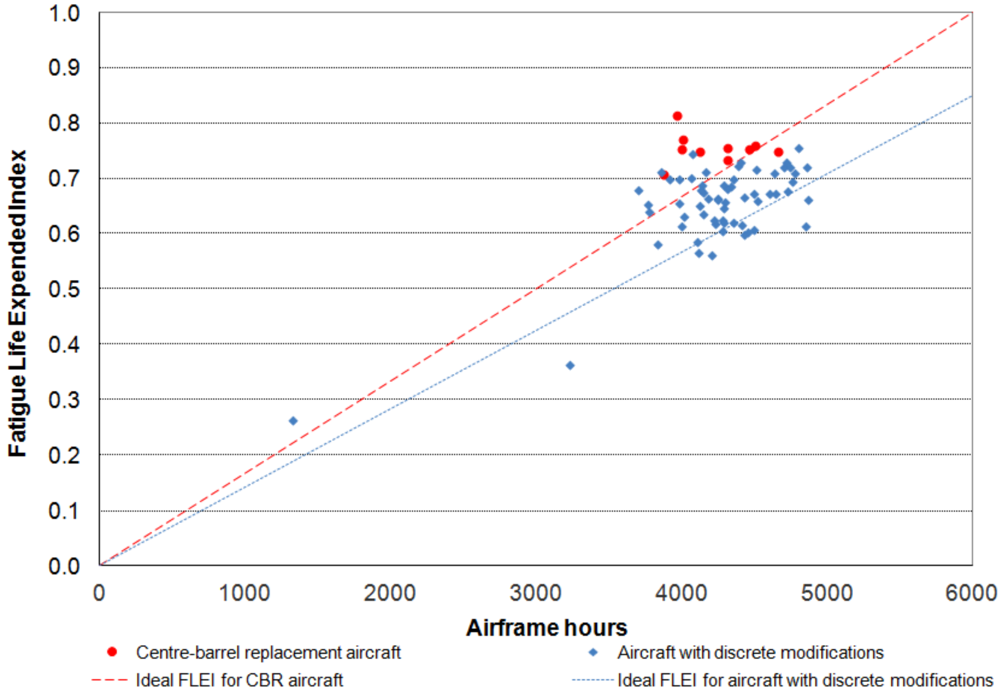
[128] The Hornet Service Life Limit (SLL) register is embodied within ASLMP.Net. ASLMP.Net (Aircraft Structural Life Monitoring Program) is an intranet website promulgating structural-life limits and publishing the latest fatigue reports.

[129] Wing Root FLEI is how the relevant FLEI for the centre barrel is referred to.

[130] The centre barrel and its replacement in ten aircraft are discussed in paragraphs 3.47, 4.16 and 4.28.

Figure 4.3

Hornet fleet consumption of airframe hours and Wing Root fatigue-life, as at May 2012



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

4.21 Defence data indicates that, at the current targeted rate of effort of 13 000 airframe flying hours per year (reducing to 12 000 hours from 2013–14),[131] the classic Hornet fleet as a whole will not exceed 6000 flying hours for each aircraft until after the current Planned Withdrawal Date of 2020. However, all but nine aircraft have experienced fatigue above that expected for the airframe hours flown.[132] Accordingly, ACG has taken steps to conserve the remaining fatigue life of its F/A-18A/Bs to ensure that they can remain operable up to the safe life of 6000 airframe hours (see paragraphs 4.46 to

131 The current and proposed rates of effort are outlined in *Portfolio budget statements 2012–13: Defence portfolio*, p. 55.

132 The nine aircraft are: one aircraft that has received a centre barrel replacement (the red dot below the red dashes); and eight aircraft that have not received a centre barrel replacement (the eight blue diamonds below the blue dotted line). There is also one other aircraft with a low FLEI of 0.36 below the blue dotted line: this is one of the two flight-test aircraft in service with the RAAF Aircraft Research and Development Unit (ARDU) .

4.50).[133] Once any aircraft exceeds its safe life of 6000 airframe hours, it may need to be withdrawn from service, be made subject to additional inspections, or alternatively undergo refurbishment of the structures that have a FLEI consumption approaching 1.0.

4.22 In June 2012, Tactical Fighter SPO was considering options for a further extension of the Planned Withdrawal Date of the F/A-18A/B fleet. This was consequent upon the Government's May 2012 decision, in the context of the 2012–13 Federal Budget, to postpone the acquisition of 12 of the first 14 F-35 aircraft by two years.[134] An extension past 2020 may well require an expanded, and hence more costly, safety-by-inspection regime, structural modifications and capability upgrades.

Hornet structural-refurbishment program—HUG Phase 3 and later

4.23 The design-life of an aircraft is determined by the number of hours it will be, or has been, flown and the estimated impact those hours will have on airframe fatigue. As noted in paragraph 4.14, the design-life of the F/A-18 was initially envisaged as being some 6000 hours of flight. This estimate was based on the US Navy's predicted use of the aircraft, which would entail catapult take-offs and arrested landings on aircraft carriers, creating great stresses on the undercarriage and fuselage.[135]

4.24 In RAAF service, however, the rate of fatigue accrual has been higher than that of the US Navy. This is due to the RAAF aircraft experiencing higher g and sustained-g loadings, which have consumed the fatigue life of certain

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[133] Note that although the Hornet fleet was authorised to fly 13 000 hours in 2010–11, for example, the actual hours flown were somewhat less than authorised, since flying hours are determined by operational and training needs. If this trend continues, the fleet will not exceed its 6000-hour limit until after 2021—which would make FLEI all the more important in determining a Planned Withdrawal Date.

[134] Defence Materiel Organisation, Tactical Fighter Systems Program Office, *F/A-18 A/B 'Classic Hornet' Planned Withdrawal Date considerations: risk assessment (airworthiness and supportability review)*, version 1, 1 June 2012.

[135] Since 1999, the US Navy has implemented a Service Life Assessment Program and a consequent Service Life Extension Program on its F/A-18 fleets. These have enabled successive increases to 8000, 8600 and 10 000 flight hours, through modification and inspection programs that will continue until 2018. Naval Air Systems Command Program Executive Officer–Tactical Aircraft Programs (PMA-265), briefing to the ANAO, March 2012. See also William McMichael, 'The plan to keep F/A-18s flying: Inspection, repair programs aim to extend aging fleet', *Navy times*, 28 February 2011, available from <http://www.navytimes.com/news/2011/02/navy-inspection-repair-programs-for-hornet-fleet-0228111w/> [accessed 8 August 2011].

airframe structures, particularly the centre barrel structure (see paragraph 4.16 and Figure 4.2).[136]

4.25 The RAAF Hornet fleet has consequently experienced annual fatigue-life expenditure ranging from 0.09 to 0.24 FLEI. Assessments arising from the Hornet structural-integrity management process led to government approval of AIR 5376 Phase 3, Hornet Upgrade—Structural Refurbishment (HUG Phase 3), which focused on sustaining the Hornet fleet's structural integrity, and hence its ability to maintain the approved level of capability.

4.26 The various components of HUG Phase 3, outlined in Figure 4.4, have resulted in the extension of the Planned Withdrawal Date of the F/A-18A/Bs from 2010–15 (as envisaged during the period 1985 to 2005) to 2017–20 (as envisaged since 2009).[137] The revisions of the retirement date have been planned with the intent of ensuring that the F/A-18A/Bs can continue operating until the F-35A JSF becomes operational, so that Australia has no 'capability gap' between the retirement of one fleet and the introduction of the next.

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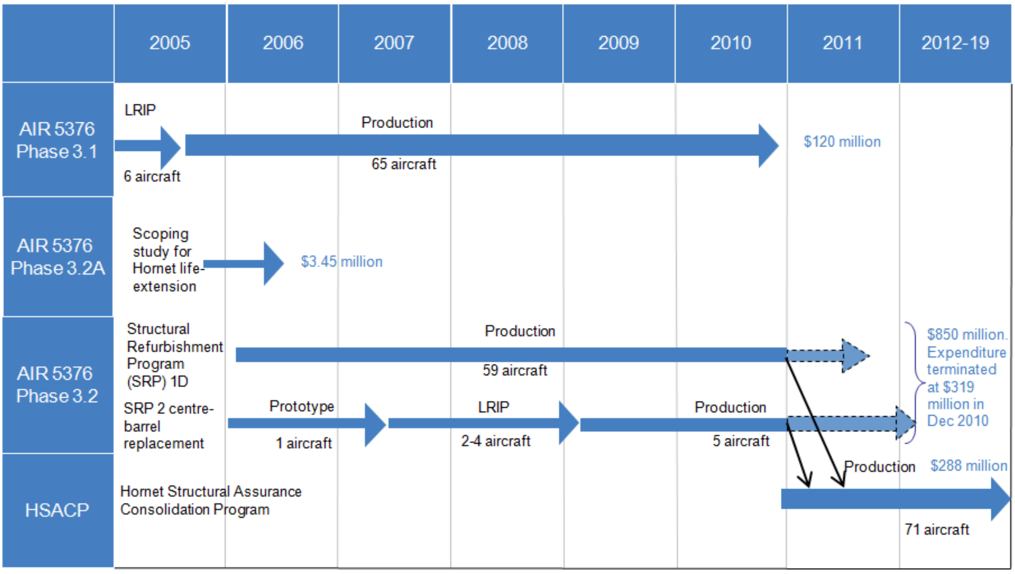
[136] Department of Defence, 'Phase 3 background', *Hornet upgrade program*, intranet page, August 2011.

[137] For details of the extensions of the Planned Withdrawal Date, see paragraph 2.3.

Figure 4.4

Schedule and budgets of Hornet structural-integrity projects, 2005–19



LRIP – Low Rate Initial Production

Source: Australian National Audit Office, adapted from Defence Materiel Organisation, Tactical Fighter Systems Program Office records.

Note: The amounts shown in this figure are the total amounts *approved* for the projects, rather than the final amount spent. Dollar values are as at the dates shown in paragraph 4.28.

4.27 The F/A-18A/B fleet has been undergoing a structural-refurbishment program since 2003 under HUG Phase 3.[138] The project's aim was to restore airframe structural life to enable the F/A-18A/Bs to remain airworthy until their Planned Withdrawal Date.

4.28 Delays in the JSF Program, combined with emergent ageing-aircraft issues, resulted in HUG Phase 3 becoming Defence's primary risk-treatment program for F/A-18A/B airworthiness. HUG Phase 3 consists of the following four components:

(a) *AIR 5376 Phase 3.1 (HUG 3.1)*. Approved by the Government in 2003 with a budget of $120 million (2005–06 prices)[139] this project involved the design, development and installation of minor structural

[138] ANAO Report No.20 2011-12, *2010-11 Major projects report: Defence Materiel Organisation*, November 2011, p. 333.

[139] Department of Defence, *Defence Annual Report 2004-05*, p. 276.

modifications and inspections, known as the Structural Refurbishment Program 1 (SRP1), to address the most immediate structural deficiencies, and ensure structural integrity through to HUG 3.2. This project was completed at a cost of $110.57 million (2011–12 prices).

(b) *AIR 5376 Phase 3.2A (HUG 3.2A)*. With an approved budget of $3.45 million (January 2005 prices), this was a scoping study to investigate options to restore fatigue-life to the Hornet airframe to ensure fleet airworthiness through to the Planned Withdrawal Date. This project was completed at a cost of $3.37 million (January 2009 prices).

(c) *AIR 5376 Phase 3.2 (HUG 3.2)*. The project scope of HUG 3.2, first approved by the Government in October 2003, and revised in August 2006, with the original budget of $156.6 million increased to $850.78 million, was to carry out two additional Structural Refurbishment Programs over that of HUG 3.1. These were primarily intended to achieve sufficient fatigue life for the Hornet fleet to remain in service until its Planned Withdrawal Date, which at that time was 2010–15. Structural Refurbishment Program One Delta (SRP1D) was a set of discrete structural modifications that built upon the structural-refurbishment modifications carried out under HUG 3.1 to further restore part of the aircraft's fatigue life, in order to delay or avoid the need for a much more extensive program.

That more extensive program, known as Structural Refurbishment Program Two (SRP2), restored the full design fatigue-life of the Hornet by replacing the centre barrel, and refurbishing all the other damage locations repaired under SRP1D, and also replacing several age-affected structural components.

AIR 5376 Phase 3.2 (HUG 3.2) Reassessment. A reassessment of available aircraft fatigue-life enabled a reduction in the number of aircraft required to undergo centre barrel replacement (CBR) from a potential 49 to 10. This reassessment, approved by the Government in December 2010, was made possible by destructive testing of retired RAAF centre barrels following their removal under SRP2,[140] revealing that the

[140] Centre barrels retired by the US Navy and Canadian Forces were also used, but testing of the RAAF centre barrels enabled greater fatigue-life extensions.

original fatigue-life assessments for the damage locations addressed by the SRP1 and SRP1D intermediate modifications were conservative.[141]

HUG Phase 3.2 was completed at a cost of $319.1 million (2011–12 prices), with residual HUG 3.1 and 3.2 work, costed at $60.6 million, transferred to the Hornet Structural Assurance Consolidation Program (see next paragraph).

- *AIR 5376 Hornet Structural Assurance Consolidation Program (HSACP)*. Most recently, in December 2010, the AIR 5376 Hornet Structural Assurance Consolidation Program (HSACP) was approved,[142] involving the consolidation of the remaining F/A-18A/B structural remediation work being conducted under HUG 3.1 and HUG 3.2 with ageing-aircraft assurance work that was presented to the Government as part of the re-scope of HUG 3.2. The re-scope included returning to the Defence Capability Plan $632 million that was originally approved for HUG 3.2 but was no longer required, and allocation of $288.2 million to HSACP. This program has two aspects:
  - addressing structural issues, such as corrosion and cracking, under an ongoing Structural Assurance Program (STRAP); and
  - ensuring continued airworthiness through to December 2020 through the conduct of an Ageing Aircraft Systems Audit (AASysA), to be conducted in 2011–12.[143]

4.29 Despite the significant funds already allocated to ensuring that the F/A-18A/Bs can continue flying until their current Planned Withdrawal Date of

[141] Department of Defence, *Capability proposal: concurrent pass for Project AIR 5376 Hornet Structural Assurance Consolidation Program*, February 2011, p. 1.

[142] This program was previously known as HUG 3.2 re-scope, HUG 3.3 and HUG 4.

[143] By May 2012, a desktop audit had been completed, and a physical audit of Hornet subsystems was about to begin. Any *new* structural issues discovered by the Ageing Aircraft Systems Audit would receive separate consideration by DMO, CDG and RAAF. A previous ageing-aircraft *structural* audit of the Hornet was conducted in 2000–09; see Appendix 6: International Collaborative Programs and Aircraft Structural Audits. QinetiQ, *F/A-18 A/B Classic Hornet ageing aircraft systems audit: TFSPO executive brief*, May 2012; Defence Materiel Organisation, Tactical Fighter SPO, *Project AIR 5376 Phase 4 Structural Assurance Consolidation Program. Project management plan. Project scope*, February 2011, p. 2; Defence Materiel Organisation, Tactical Fighter SPO, *Project AIR 5376 Phase 4 Structural Assurance Consolidation Program. Project management plan*, March 2011, p. 3.

2020, an April 2011 Gate Review[144] of the AIR 6000–New Air Combat Capability project[145] stated that 'The cost of extending the F/A-18A/B [Life of Type] is yet to be fully estimated'.[146] This reflects the uncertainty involved in preparing for emergent engineering work that can only be fully scoped as each aircraft is inducted into Deeper Maintenance.[147]

4.30 As part of the Structural Assurance Program, in May 2011 Tactical Fighter SPO received approval to procure four F/A-18A/B inner wings at a cost of $2.193 million. This procurement supplemented Defence's pool of spare Hornet inner wings, with the objective of enabling more RAAF Hornets to undergo wing replacements at any one time, should the need arise.[148] Other aspects of the Structural Assurance Program include outer-wing procurements, addressing corrosion and cracking during Deeper Maintenance, and remediation of various associated structural systems including the undercarriage.

Environmental-degradation management

4.31 Environmental-degradation management consists of the programs to monitor and manage environmental degradation of aircraft structures—for example, through a Corrosion Prevention and Control Program (CPCP)—and the ability to continually assess the effects of environmental damage on an

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144 Gate Reviews form part of DMO's internal assurance framework for capital acquisition projects. They are intended to improve project outcomes and ensure that DMO can provide high quality and reliable advice to Defence and to Government as to a project's health and outlook. DMO's objective in conducting Gate Reviews is to supplement regular management processes by: providing a degree of external scrutiny of projects; facilitating frank communication among stakeholders; and enabling DMO senior management to intervene with projects at critical times, and report to Government where necessary. See ANAO Audit Report No.52 2011–12, *Gate Reviews for Defence Capital Acquisition Projects*.

145 AIR 6000 is to deliver the ADF's new air combat capability through the acquisition of up to 100 F-35 Joint Strike Fighters, under a partnership arrangement with the United States.

146 *Gate Review Assurance Board meeting outcomes: AIR 6000 Phase 2A/2B Performance Gate Review*, 5 April 2011.

147 With a DMO commitment to perform R3/R4 Deeper Maintenance on 12 aircraft in 2011–12, it takes some six years to cycle the entire fleet through this process.

148 This procurement was conducted via the Worldwide Warehouse Redistribution Service through the US Government Foreign Military Sales (FMS) case AT-D-RAA. Defence Materiel Organisation, Tactical Fighter SPO, *Higher delegate submission for proposal, procurement method and contract approval for the procurement of surplus Canadian Forces F/A-18 A/B inner wings*, May 2011.

aircraft's structural integrity. Environmental-degradation management uses information on both the usage and condition of structures.[149]

4.32 As discussed earlier in this report,[150] the Hornet fleet, like other fleets of combat aircraft, is subject to periodic Deeper Maintenance inspections and services, which entail the removal of inspection panels and engines in order to inspect areas for structural degradation. Any structural degradation identified during an R3/R4 service is repaired as necessary, 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 Plan.[151]

4.33 Since 1994 Tactical Fighter SPO has implemented a Corrosion Prevention and Control Program, which aims to:

- ensure the Hornets remain airworthy until their withdrawal from service;
- ensure sufficient aircraft remain available for flying operations; and
- reduce ownership costs.

4.34 The program involves the future use of dehumidifiers and a surface-finish restoration program.

4.35 Tactical Fighter SPO has implemented an environmental-degradation management system to assimilate the environmental-degradation policy issued by DGTA in February 2007. As part of this environmental-degradation management system, an Environmental Degradation Assessment (EDA) is to be carried out biennially. The EDA is a formal analysis of in-service condition data pertinent to corrosion mechanisms, and provides the means to focus prevention strategies on the structural components most affected.

4.36 The second biennial Environmental Degradation Assessment of the Hornet fleet, completed in June 2011, covered the period 1 August 2007 to

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149 RAAF, *F/A-18 A/B Hornet aircraft structural integrity management plan*, 2011, vol. 1, section 2, chapter 10, p. 1.

150 See paragraphs 3.5–3.7 and 3.27–3.29; statistics on Hornet Deeper Maintenance are at paragraphs 3.42–3.54.

151 RAAF, *F/A-18 A/B Hornet aircraft structural integrity management plan*, 2011, vol. 1, section 2, chapter 8, p. 3.

31 December 2009. It found that corrosion-related damage represented 13 per cent of all Hornet structural defects for the period (up from 8 per cent in the 2009 report). The 20 structural components with the most reported corrosion damage accounted for 43 per cent of the total reports related to corrosion. Each of the top 20 structural components has been analysed to establish preventative-maintenance requirements and the success or otherwise of the current preventative-maintenance strategies. The 2011 Environmental Degradation Assessment recommended a preventative-maintenance strategy for four components.[152]

4.37 The incidence of discovery of airframe corrosion in the Hornet fleet is increasing, and the annual cost of corrosion-related repairs has increased significantly, from $0.721 million in 2007 to $1.367 million as estimated by Defence records in 2011. By 2011, corrosion-related maintenance had reduced the availability of the fleet by some 1381 aircraft days annually, up from 573 days in 2007. However, preventative maintenance applied to some structural components has produced annual savings of $90 000, and 64 additional days of fleet-wide availability. Tactical Fighter SPO informed the ANAO that there are significant opportunities to achieve further savings, as outlined in paragraphs 4.40 to 4.45 below.[153]

4.38 Environmental degradation does not appear to be affecting the airworthiness of the Hornet fleet, although further analysis of the components reported with any corrosion, and any consequent impact upon the aircraft's certification basis, should be undertaken as part of the Annual Fatigue Assessment. However, as the Hornet fleet continues to age, corrosion is expected to have more of an impact on the fleet's ability to reach its structural Life of Type (LOT) and Planned Withdrawal Date.[154]

4.39 Thus, although the aircraft's structural integrity has been extensively assessed and managed, environmental degradation is expected to pose the most significant risk to the achievement of the current Planned Withdrawal

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[152] QinetiQ, *F/A18A/B environmental degradation assessment, August 2007 through December 2009*, June 2011, p. 3; Department of Defence, *F/A-18 A/B Hornet aircraft structural integrity management plan*, 2011, Volume 1, section 2, chapter 10, p. 6.

[153] QinetiQ, *F/A18A/B environmental degradation assessment, August 2007 through December 2009*, June 2011, p. 3; Department of Defence, *F/A-18 A/B Hornet aircraft structural integrity management plan*, 2011, Volume 1, section 2, chapter 10, p. 6.

[154] QinetiQ, *F/A18A/B environmental degradation assessment, August 2007 through December 2009*, June 2011, p. 3.

Date of 2020, and to the Hornet sustainment costs and aircraft availability as discussed in Chapter 3. However, as long as corrosion is effectively managed by Defence so that it does not affect structural integrity, corrosion will remain a matter of budgeting and management rather than a threat to the capability.

Wash-down facility

4.40 Tactical Fighter SPO and 81 Wing 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.[155] 81 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. At August 2006, the project remained unapproved, and by then an Aircraft Clear Water Rinse Facility was also required for the Wedgetail Airborne Early Warning and Control (AEW&C) aircraft then 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.

4.41 DSG obtained the Defence Infrastructure Sub-Committee's endorsement of the project in September 2006, and the Minister for Defence's approval in October 2006. The project's design and construction phases were scheduled for completion by December 2006 and October 2007 respectively. Following construction and test and evaluation, the facility was commissioned in 2011, some 13 years after the business case was first raised.

4.42 In July 2012, Defence informed the ANAO that:

> With respect to the 13 year delay in commissioning the wash-down facility at RAAF Williamtown, the delay was in part due to the fact that the requirement was not as simple as had previously been constructed for the propeller aircraft (P-3 Orion at RAAF Bases Edinburgh and Pearce), but was in fact much more technically sophisticated and became even more so when other aircraft types were required to be added to address corrosion. The end solution involved a

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[155] ANAO Audit Report No.27 2006–07, *Management of air combat fleet in-service support*, p. 90.

significant amount of 'leading edge' investigation and analysis by DSTO which resulted in delays to final completion.

- The initial requirement documentation did not adequately specify the priority of the proposal and therefore did not attract sufficient funding priority.
- RAAF Base masterplanning to accommodate [New Air Combat Capability] and [Airborne Early Warning and Control (AEW&C)] facilities resulted in delay in siting the facility and additional costs associated with lead-in taxiways.
- While Clear Wash Facilities had been previously constructed for propeller aircraft (relying on propeller wash of water across surfaces), no such wash facility had previously been constructed for jet aircraft, leading to the requirement to engage DSTO to determine how best to develop a facility that would achieve the required results.
- The original TFSPO proposal was to address F/A-18 corrosion issues. Subsequently, it was determined that other aircraft at the base (Hawk and PC-9) should also be rinsed, the AEW&C aircraft was later also added. This resulted in the need for a complete redesign and resiting of the facility and increased cost.
- Variables such as weather (strong winds) and water pressure at nozzle heads meant that the design had to be modified a number of times to achieve an acceptable wash outcome, that is, water pressure across all surfaces was required to be sufficient to ensure that the molecular salt layer was broken but not the aircraft paint layer (this also required DSTO effort).
- Environmental issues such as water capture and recycling for the larger AEW&C aircraft meant redesign of components from pumps to wash pad.

Painting

4.43 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 development of a surface-restoration process and the establishment of a full production capability. The program's full production phase was scheduled to commence in February 2007, with the last aircraft to be fully restored by December 2011.[156]

4.44 However, in early 2009 the Williamtown Corrosion Control Facility was closed, and became subject to a Comcare Prohibition Notice. Specifically for the classic Hornets, the loss of this facility is limiting the ability to remediate the degraded surface finish of the aged fleet. In 2011, the most recent Surface Finish Condition Report highlighted an overall degradation of only three per cent, but a small number of individual aircraft were highlighted as being particularly degraded and in need of restoration. These particular aircraft were to be targeted for induction into the remaining RAAF Paint Shop at the Tindal base, where significant corrosion control work is being conducted, with only minor remediation tasks possible at Williamtown.[157] Continual degradation of aircraft surface condition remains a concern, with its associated effects on maintenance costs and structural integrity.[158]

4.45 Refurbishment activities to support the re-opening of the Williamtown Corrosion Control Facility are presently scheduled to commence in October 2012 and be completed in May 2013, subject to approval and funding, and the resolution of Comcare issues. The DSG is responsible for managing the refurbishment project. Further to the facilities refurbishment, DMO's Aerospace Systems Division (ASD) has implemented initiatives to address surface-finish requirements across all aircraft for which ASD has sustainment responsibility. A key element of these initiatives is to commercialise all repainting of aircraft, including of the Hornet. As of December 2011, industry responses to a Request for Tender had been received and were undergoing review to select the preferred tender.[159]

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156 ANAO Audit Report No.27 2006–07, *Management of air combat fleet in-service support*, p. 90.

157 RAAF 81 Wing, *2011 F/A-18 AwB–81WG SO1LOGENG Submission – Draft*, April 2011, p. 4; Airworthiness Board Report, *A21 F/A-18A/B Hornet*, 15 June 2011, p. 4.

158 RAAF 81 Wing, *2011 F/A-18 Airworthiness Board–81 Wing Combined Workshop Senior Maintenance Manager submission*, March 2011, p. 4.

159 The Request for Tender, DMO ASDRFT/0076/2011, was published on 16 September 2011, and closed on 28 November 2011. This RFT covers the surface finish of AP-3C Orion, C-130H Hercules, F/A-18 Hornet, PC-9/A and Hawk 127 aircraft.

Fatigue Life conservation

4.46 Ultimately it is the ongoing operational use of the fleet—particularly cycles of high-g manoeuvres which induce structural fatigue—which determines a combat aircraft's structural-life consumption. The Hornet fleet's current Planned Withdrawal Date of 2020 requires ACG to manage the operational use of each aircraft so that both fatigue life and airframe hours do not exceed their respective Safe Life Limits ahead of the Planned Withdrawal Date.

4.47 In November 2011, ACG advised the ANAO that active fatigue-management of the Hornet fleet commenced in the late 1980s, and was somewhat mature by the early to mid-1990s.[160] This management took the form of aircrews receiving monthly fatigue reports, which encouraged smooth and appropriate flying, while maintaining the development of tactical skills. Fatigue accrual during domestic portions of all missions was reduced to almost zero, while tactical portions of missions were flown to achieve required training objectives. This began to reduce fatigue accrual across the fleet. Also, where practical, fleet operations planners allocated high-structural-fatigue missions to aircraft having low accrued fatigue. There was also a significant reduction in the number of Basic Fighter Manoeuvres/Air Combat Manoeuvres training missions and air-to-ground missions, at ACG's No.2 Operational Conversion Unit and its operational squadrons. Both these types of sorties have historically high fatigue accrual.

4.48 In the mid-1990s, a conscious decision was made, after consideration of some unacceptable degradation in specific fighter-pilot skills, to increase the amount of training in Basic Fighter Manoeuvres/Air Combat Manoeuvres, and some bombing missions. In the late 1990s a further change in training occurred where weapon-delivery of dumb bombs, from both low and medium level, and pop-up attacks, were given less emphasis, with an increasing emphasis on the use of precision weapons. There has been a continued downward trend in fatigue accrual since the late 1990s. A significant drop in fatigue accrual in 2002–03 is directly attributable to Operation Falconer (Iraq), where long-endurance/low-fatigue missions were flown.

[160] The ANAO has previously reported that fatigue-management initiatives were first put in place in 1987. ANAO Audit Report No.40 1999–2000, *Tactical fighter operations*, p. 75.

4.49 Since 2003, the increased use of precision air-to-surface weapons and longer-range air-to-air weapons has contributed to a moderation of fatigue-accrual rates. This has been particularly the case with the recent upgrades to the Hornets' air-to-air missiles and target-designation and tracking systems, which have enabled further reductions in the need for high-g manoeuvres that induce high structural fatigue. However, air-combat training requiring high-g manoeuvres continues to be necessary in a fighter pilot's tactical skills development program.[161]

4.50 Nevertheless, the FLEI data shown in Figure 4.3 indicate that, overall, it will continue to be important that Defence effectively manages each Hornet's rate of fatigue accrual, to ensure that the Safe Life Limits of all the F/A-18A/Bs in the fleet are not exceeded prior to their Planned Withdrawal Date.

Conclusion

4.51 The ANAO examined Defence's arrangements for managing the structural integrity of the F/A-18A/B fleet, including the management of risks involved in extending the service life of the F/A-18A/B fleet to its current Planned Withdrawal Date of 2020. The ANAO found these arrangements to be extensive, and supported by well established structural-integrity data and structural fatigue-life management.

4.52 Defence's management approach to the F/A-18 fleets has been effective thus far in identifying, in a variety of dimensions, the risks to the continued delivery of the required capability by the F/A-18 fleets until their current Planned Withdrawal Dates. Defence has also been active in putting in place mitigation measures for these risks. However, significant risks remain that will require close management by Defence in the final stages of sustainment of the F/A-18A/B fleet in particular, when airframe hours flown and fatigue-life expended will be greatest.

161 This narrative tallies with Tactical Fighter SPO data on fatigue-life accrual rates for the F/A-18A/B Hornet fleet.

5. F/A-18F Super Hornet Fleet Sustainment

This chapter examines the developing sustainment of the F/A-18F Super Hornet fleet. The acquisition of this fleet was announced in 2007, with final delivery occurring in 2011, under project AIR 5349, Bridging Air Combat Capability. The chapter discusses the Super Hornets' logistics-support philosophy, and provides key statistics on achievements to date. It also discusses the management of the fleet's structural integrity.

Background

5.1 As early as 1991, a Defence *Force structure review* stated that:

> At present no affordable aircraft with the F-111C's capabilities is in prospect, and it is likely that the F-111C and F/A-18 will be replaced by a single aircraft type.[162]

5.2 The Defence Capability Plan 2001–10 included projects to enhance the sustainability and capability of Australia's F-111C fleet through to its then Planned Withdrawal Date of around 2015–20.[163] However, in November 2003, the then Government announced that the F-111C fleet could be withdrawn from service by 2010,[164] once several other capabilities had been achieved.[165]

5.3 The possibility of a capability gap between the planned retirement of the F-111C fleet in 2010 and the eventual acquisition of the Joint Strike Fighter led to a government directive to Defence in November 2006 to develop options

162 Department of Defence, *Force structure review 1991*, Canberra, 1991, p. 28.

163 The projects were AIR 5404 Phase 2, F-111 Strike Capability Enhancement, and AIR 5416 Phase 3, EWSP Enhancements for F-111.

164 By 2002, Australia was actively seeking a successor to the F-111: in June 2002, the National Security Committee of Cabinet had agreed that Australia would commence negotiations with the United States to join the development phase of the Joint Strike Fighter, and by September 2002 the RAAF was reportedly exploring ways to fill any capability gap arising from early F-111 retirement, including the possibility of leasing aircraft. Senator Robert Hill, Minister for Defence, *Defence Capability Review*, media release, 7 November 2003, p. 4; 'Air force eyes rent-a-fighter option', *The Australian*, 10 September 2002, p. 1.

165 These capabilities were: the introduction of the Airborne Early Warning and Control (AEW&C) aircraft, new air-to-air refuellers, completion of the F/A-18 Hornet upgrade programs including the Bomb Improvement Program, and the successful integration of a stand-off strike weapon on the F/A-18s and AP-3C Orion.

to reduce the risk during the transition from one capability to the next.[166] The then Government decided in March 2007 that Defence—through project AIR 5349, Bridging Air Combat Capability—would purchase 24 F/A-18F dual-seat Super Hornets, at an estimated cost of approximately $6 billion over 10 years, with the aircraft to be operational by 2010, when the F-111s were expected to be withdrawn from service.[167]

5.4 In assessing the effectiveness of Tactical Fighter SPO's management of the sustainment of the F/A-18F Super Hornet fleet, the ANAO examined the organisational arrangements and financial investment, improvements in sustainment management, and sustainment statistics.

F/A-18E/F Super Hornet

5.5 The F/A-18E/F Super Hornet is significantly different from—and some 25 per cent larger than—the classic Hornet, as shown in Figure 5.1. It has new engines, greater range (enabled by a significant increase in internal and external fuel capacity), and two additional weapon stations, as well as new tactical sensors, a new electronic-warfare system and new cockpit technologies.[168]

5.6 The F/A-18F Super Hornet is a more advanced aircraft than the F/A-18B classic dual-seat Hornet especially in that it has an improved air-combat and ground-target situational-awareness capability, enabled by more capable sensors, and has the aft cockpit configured as a Weapons Systems Operator (WSO) position. The WSO can perform functions independently of the pilot, and each person is provided with the displays of the air and ground situation that he or she needs in order to perform separate but complementary functions, particularly in a combat environment.

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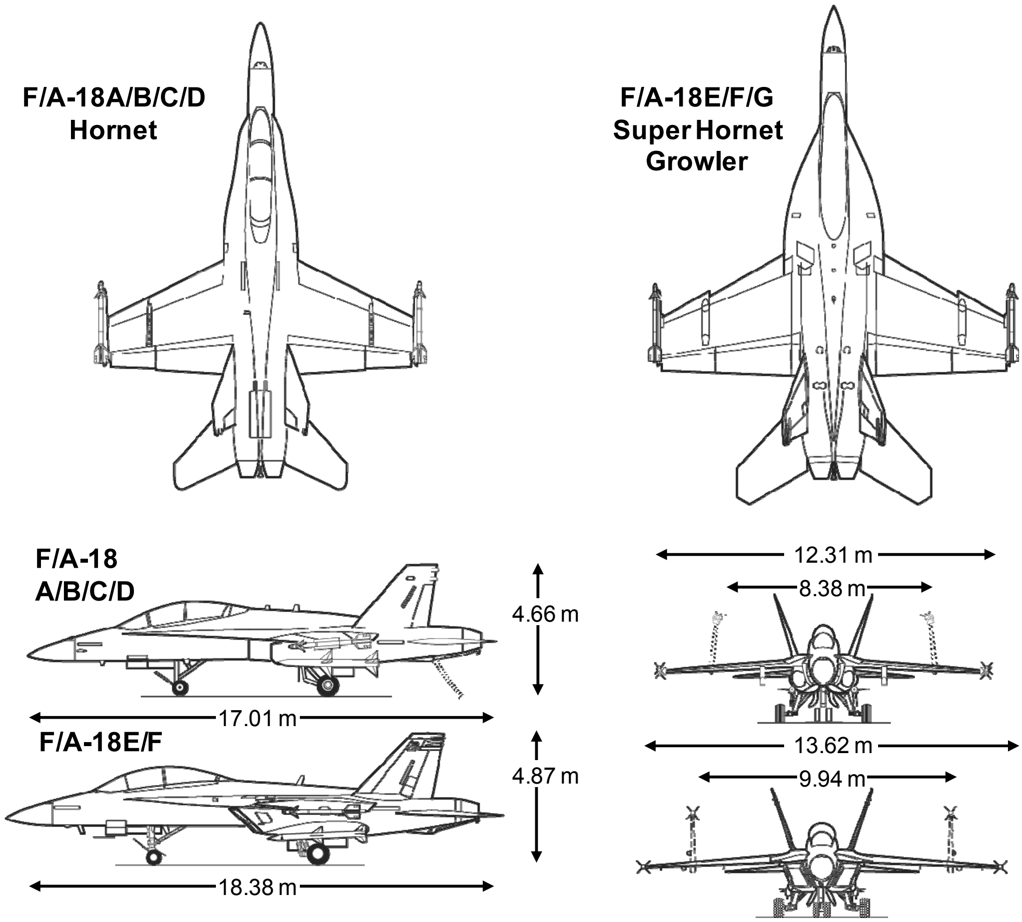
[166] Department of Defence and Defence Materiel Organisation, *Materiel Acquisition Agreement for AIR 5349 Phase 1, Bridging Air Combat Capability*, April 2011, p. 4.

[167] The Hon. Brendan Nelson MP, Minister for Defence, *$6 billion to maintain Australia's regional air superiority*, media release, 6 March 2007. The first acquisition contract amounted to A$2.9 billion. Department of Defence, *Super Hornet acquisition contract signed*, media release, 3 May 2007. See also Defence Materiel Organisation, *Project AIR 5349, Australian F/A-18F Super Hornet: accomplishment summary for Australian Military Type Certification and Service Release*, October 2010, p. 5.

[168] The F/A-18E is a single-seat variant, and the F/A-18F a dual-seat variant, of the same model aircraft. The F/A-18E/F is informally referred to as the Rhino, to distinguish it from the F/A-18A/B/C/D classic Hornet. In Australian service, the F/A-18F is designated the A44.

Figure 5.1

Comparison of classic F/A-18A/B/C/D Hornet with F/A-18E/F Super Hornet



Source: The Boeing Company, December 2011.

5.7 The first flight of a Super Hornet occurred in November 1995, and it achieved Initial Operational Capability (IOC) with the US Navy in 2001. Since then the F/A-18Fs have been the subject of a spiral development program (now termed Flight Plan),[169] which has provided incrementally improved capability without the need to remove aircraft from service for long durations, as typically occurs during traditional 'block upgrades'. The F/A-18E/F Super Hornet is presently operated only by the US Navy and the RAAF. In the US Navy, the Super Hornet is to operate as a complement to the F-35 Lightning II Joint Strike Fighter.[170]

5.8 There is also an EA-18G Growler variant,[171] designed for electronic-warfare missions, which has been operated solely by the US Navy since 2009. The final 12 Super Hornets ordered by Australia have been assembled with wiring to enable a later upgrade to the EA-18G Growler electronic-warfare specification if required by Government. The cost of pre-installing the wiring was $35 million, and on 29 March 2012 the Minister announced the purchase of long-lead items for potential conversion of 12 Super Hornets to Growler configuration, at a cost of more than $19 million.[172] The US Congress was notified of the potential sale in May 2012, but the final project cost has yet to be determined (depending on options selected).[173] In August 2012, the Government announced that Australia will acquire the Growler electronic warfare system at a cost of around $1.5 billion, and that the Growler aircraft would be available for operations from 2018.[174] Defence advised the ANAO that the Growler acquisition would include:

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169 The spiral development method employs risk-management techniques to guide multi-stakeholder concurrent development of software-intensive systems. It has two main distinguishing features. The system develops through incremental definitions of its objectives, strategies, design and implementation alternatives and validation methods. The other distinguishing feature is the setting of critical milestones for ensuring stakeholder commitment to feasible and mutually satisfactory system solutions. Boehm, B and Hansen, WJ, *Understanding the spiral model as a tool for evolutionary acquisition* [Internet], Technical Reports, Center for Systems and Software Engineering, University of Southern California, January 2001, p. 2 available from <http://csse.usc.edu/csse/TECHRPTS/2001/usccse2001-501/usccse2001-501.pdf> [accessed 7 February 2012]; Blanchard, BS, *Systems engineering management*, 2nd edn, Wiley, New York, 1998, pp. 19–21.

170 *Selected acquisition report (SAR): F-35, as of December 31, 2011*, Washington DC, p. 4.

171 The designation EA signifies Electronic Attack, rather than F/A for Fighter/Attack.

172 The Hon. Stephen Smith MP, Minister for Defence, *Growler electronic warfare aircraft—long lead item equipment purchase*, media release, 29 March 2012.

173 US Defense Security Cooperation Agency, *Australia—EA-18G Airborne Electronic Attack (AEA) Aircraft Modification Kits*, media release, Washington DC, 22 May 2012; US Department of Defense, '36(b)(1) Arms Sales Notification', *Federal Register*, Washington DC, 1 June 2012, pp. 32595–7. The estimated value of the sale, which generally includes a level of contingency, was stated as US$1.7 billion. Defence estimated the cost at $1 billion–$2 billion. *Defence Capability Plan 2012*, pp. 32–3.

174 Minister for Defence and Minister for Defence Materiel, *Acquisition of the Growler electronic attack capability*, media release, 23 August 2012.

- acquisition and installation of Growler modification kits to modify 12 of Australia's 24 F/A-18F Super Hornet aircraft to EA-18G Growler configuration;
- associated flight testing, jamming pods, an anti-radiation missile training capability; a ground-based electronic warfare threat emitter training system for aircrew in flight training;
- upgrade of Super Hornet training devices and mission planning systems to also support Growler; spare and repair parts; support and test equipment; publications and technical documentation;
- personnel training and training equipment; US Government and contractor engineering, technical and logistics support services; US Foreign Military Sales (FMS) fees;
- project management costs;
- facilities; and
- a related collaborative program between Australia's Defence Science and Technology Organisation (DSTO) and the US.

5.9 The acquisition of the Super Hornet's AIM-9X air-to-air missile, the AGM-154 Joint Standoff Weapon (JSOW), and additional stock of the AIM-120 AMRAAM air-to-air missile is occurring under Phase 2 of project AIR 5349, Bridging Air Combat Capability. This phase is managed by the Guided Weapons Branch and the Munitions Branch in DMO's Explosive Ordnance Division, as these branches are responsible for the acquisition and introduction into service of guided weapons and explosive ordnance. Activities related to Design Acceptance of the integration of these missiles onto the F/A-18F aircraft are managed by Tactical Fighter SPO.[175]

5.10 The ADF Airworthiness Board in November 2010 recognised the US Navy's Flight Clearance process as being akin to the ADF Type Certification process. The US Navy provides a Flight Clearance Recommendation (FCR) which, together with the associated signature sheets, confirms Military Airworthiness Authority (MAA) compliance findings.[176] On that basis, and combined with consideration of other wide-ranging regulatory and policy

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175 Defence Materiel Organisation, Project Air 5349, *Project design acceptance strategy*, version 4.0, February 2010, p. 2.

176 Airworthiness Board Report, *A44 F/A-18F Australian Super Hornet AMTC/SR 2010*, November 2010, p. 2.

issues contained within the ADF's *Technical airworthiness management manual*, the Airworthiness Board recommended that the F/A-18F receive Australian Military Type Certification and Service Release. This was approved by the Chief of Air Force in December 2010, in his capacity as the ADF Airworthiness Authority.[177]

5.11 Australia's 24 Super Hornets were progressively delivered to RAAF Base Amberley, near Brisbane, between March 2010 and October 2011.[178] In December 2010 the Super Hornet fleet achieved the Initial Operational Capability (IOC) milestone, a week after the retirement of the F-111 fleet.[179] This was less than four years after the decision was made to acquire the Super Hornet. The Super Hornet fleet is expected to achieve the Final Operational Capability (FOC) milestone in December 2012, when all mission and support systems, and facilities infrastructure, are scheduled to be in place.[180]

5.12 When the decision to purchase the Super Hornets was announced, the potential impact on future acquisition of the F-35A Joint Strike Fighter was made explicit, with the option of either maintaining a mixed fleet of F/A-18F and F-35A aircraft, or on-selling the Super Hornets and acquiring a fourth

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177 ADF Airworthiness Authority, *Service Release for A44 Australian Super Hornet aircraft*, December 2010, p. 1. The ADF has only limited capability and capacity to oversight major design activities. It therefore relies on the oversight efforts of other civil and military Airworthiness Authorities—collectively termed National Airworthiness Authorities (NAAs)—to the greatest extent practicable. Where the ADF is purchasing an existing design, the ADF can often leverage extensively off the design oversight provided by another NAA. Where the ADF is pursuing unique design work, another NAA may be engaged to provide some design oversight on the ADF's behalf. In either case, the efforts of the NAA in confirming that the design complies with the certification basis can substantially reduce the ADF's Design Acceptance burden. This is known as 'Recognition of Prior Acceptance (RPA)', because the ADF is relying partially or wholly on certifications provided by another NAA. (ADF, *Technical airworthiness management manual*, Australian Air Publication 7001.053(AM1), Section 3, Chapter 12, Annex D, p. 12D-1).

178 Twelve Super Hornets arrived at Amberley before the F-111Cs were withdrawn from service (Minister for Defence Materiel, *Two more Super Hornets arrive in Australia*, media release, 4 August 2011). To mark the completion of the fleet, a formation of 20 Super Hornets performed a sweep over northern NSW and south-east Queensland on 21 October 2011.

179 The Hon. Jason Clare MP, Minister for Defence Materiel, *Farewell to the mighty F-111s*, media release, 3 December 2010; the Hon. Stephen Smith MP, Minister for Defence, *Super Hornets ready for duty*, media release, 8 December 2010.

180 Defence Materiel Organisation, Project Air 5349, *Project design acceptance strategy*, version 4.0, February 2010, p. 1.

squadron of F-35As. The then Minister stated that this decision would need to be made around 2014.[181] In July 2012, Defence informed the ANAO that:

> The Super Hornet project (Project AIR 5349) was approved as a 10-year Bridging Air Combat Capability with an intention to sell the aircraft back to the US on completion of this period. Withdrawal of the F/A-18F Super Hornet fleet will be coordinated with the acquisition of additional JSF aircraft to ensure that no gap in our overall air combat capability occurs.

Budgets and costs of Super Hornet acquisition

5.13 The budgets for the Super Hornet acquisition projects, and their costs to date, are shown in Table 5.1.

Table 5.1

Budgets and costs of Super Hornet acquisition

Project	Original approved budget $ million	Original approval date	Current budget (Feb 2012) $ million	Expenditure to 30 April 2012 $ million
AIR 5349 Phase 1 (aircraft)	3545.810	July 2007	3274.775	2640.355
AIR 5349 Phase 2 (weapons)	182.406	July 2007	273.666	121.625
Total	**3728.216**		**3548.441**	**2761.980**

Source: RAAF.

Notes: Budget approvals information is from the relevant Project Cost Approval History reports. Spend to 30 April 2012 is from the DMO Monthly Reporting System (MRS).

Organisational arrangements

5.14 The Australian Super Hornet Project Office (ASHPO), previously known as the Bridging Air Combat Capability Phase 1 Project Office, resides within the Aerospace Systems Division of DMO. ASHPO is responsible for undertaking Phase 1 of project AIR 5349, which entails the acquisition and introduction into service of all materiel elements relating to capability, with the

[181] The Hon. Brendan Nelson MP, Minister for Defence, *$6 billion to maintain Australia's regional air superiority*, media release, 6 March 2007; the Hon. Brendan Nelson MP, Minister for Defence, *Joint doorstop interview with Chief of the Defence Force, Air Chief Marshal Angus Houston, and Chief of Air Force, Air Marshal Geoff Shepherd*, media release, 6 March 2007.

exception of guided weapons and explosive ordnance. ASHPO's Project Manager Mission Systems (PM MS) was delegated authority as the F/A-18F Super Hornet Design Acceptance Representative (DAR). ASHPO's design-acceptance role was transferred to Tactical Fighter SPO's Chief Engineer–Super Hornet in March 2010.[182] ASHPO responsibility for spares and support equipment was transferred to Tactical Fighter SPO's Super Hornet Logistics Management Unit with effect from October 2011. ASHPO now only retains responsibility for business, finance and acquisition of capability upgrades. DMO expects that by mid-2013, ASHPO will have acquired all the remaining F/A-18F materiel elements, such as spares and support equipment, and will have transitioned responsibility for all future F/A-18F materiel acquisitions to Tactical Fighter SPO. In July 2012, Defence advised the ANAO that it intended to transition capability upgrades to the Super Hornet Logistics Management Unit by October 2012.

5.15 Tactical Fighter SPO manages the through-life support of the F/A-18F Super Hornet fleet, with day-to-day logistics management undertaken by its Super Hornet Logistics Management Unit located at RAAF Amberley.[183]

5.16 Defence's approach to the acquisition of the Super Hornet was based on the premise that it was a proven Military-off-the-Shelf (MOTS) product, which was:

- provided with in-service support through an extension of the US Navy's Super Hornet support arrangements; and
- operated within the operational scenarios of the US Navy.

5.17 This acquisition solution requires the F/A-18F Australian fleet as far as practicable to maintain close commonality with the US Navy in terms of

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[182] From March 2010, Tactical Fighter SPO became the in-service Authorised Engineering Organisation (AEO) for the Super Hornet fleet, and is responsible for the commercial AEOs and Authorised Maintenance Organisations (AMOs) that support the Australian F/A-18F Super Hornet. These commercial AEOs and AMOs include:
- Boeing Defence Australia (BDA) Pty Ltd;
- Tasman Aviation Enterprises (TAE) Queensland Pty Ltd; and
- Raytheon Australia Pty Ltd.

Defence Materiel Organisation, *Australian F/A-18F Super Hornet type record and master record index*, October 2010, p. 2.

[183] Defence Materiel Organisation, Project Air 5349, *Project design acceptance strategy*, version 4.0, February 2010, p. 3; Defence Materiel Organisation, *Australian Super Hornet materiel sustainment*, presentation to the ANAO, November 2011; Defence Materiel Organisation, *Australian Super Hornet integrated logistics support plan*, version 1.1, August 2010, p. 36.

aircraft operation, maintenance and support environments, with a view to ensuring ongoing Super Hornet capability development at minimum cost of ownership.[184] The Super Hornet acquisition and its in-service support are largely based on five US Government Foreign Military Sales (FMS) cases,[185] designed to minimise sustainment costs through maximising commonality with the US Navy. That concept extends to the RAAF's F/A-18F Operational Maintenance squadrons, No.1 Squadron and No.6 Squadron, being organised as 'pseudo' deployed US Navy Super Hornet squadrons. These squadrons are assisted largely via the same US supplier/repair-vendor network as is used by the US Navy.[186]

5.18 Specific notes included within the sustainment FMS case AT-P-GQY specify the level of support and integration with the US Navy across a number of support elements. In addition, Program Letters have been received from the US Navy's Naval Air Systems Command Program Executive Officer–Tactical Aircraft Programs (PMA-265) to ensure ongoing engineering support through the Integrated In-Service System Safety Program, and ongoing Compliance Assurance support by providing access to the US Defense Contract Management Agency's Quality Assurance reports and meetings.[187]

5.19 The FMS arrangements also extend into a significant portion of the RAAF's F/A-18F off-aircraft Intermediate Level Maintenance and Deeper Level

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184 JE Jacobs, *Super Hornet sustainment: independent review report,* 30 September 2011, p. 1; Defence Materiel Organisation, *Australian Super Hornet integrated logistics support plan*, version 1.1, August 2010; Defence Materiel Organisation, *Australian Super Hornet in-service configuration management plan*, version 2.0, March 2010, p. 3.

185 The aircraft, mission and support systems were acquired primarily through five US Government FMS cases:

- The F/A-18F aircraft were acquired through AT-P-SAF, which is administered through the US Navy International Program Office (NIPO), and managed by Naval Air Systems Command (NAVAIR) Program Executive Officer–Tactical Aircraft Programs (PMA-265). AT-P-SAF also provides the first three years of Field Service Representative support for a number of aircraft systems.
- Four other FMS cases provide the fleet with sustainment support: AT-P-KMO for investing in pooled spares to gain access to US Navy repair pipelines, AT-P-KMP for Repairable Item Replacement Option (RIRO), AT-P-RBS for Breakdown Spares and Repair of Repairables (RoR, survey and quote) and AT-P-GQY for a range of support services from NAVAIR including engineering, software, training devices, information systems and publications. Defence Materiel Organisation, *Australian Super Hornet integrated logistics support plan,* version 1.1, August 2010, Annex F, pp. 75–6.

186 GRA Pty. Ltd, *Super Hornet supply chain review*, version 1.2, July 2011, p. 7.

187 Defence Materiel Organisation, *Australian Super Hornet integrated logistics support plan*, version 1.1, August 2010, p. 15.

Maintenance.[188] This is provided by the existing US Navy F/A-18F Maintenance Support System, comprising US Navy and US commercial authorised maintenance organisations and maintenance support networks, which are overseen by an entity akin to a National Airworthiness Authority.[189] Boeing Defence Australia also performs Intermediate Maintenance under a contract with Defence.[190]

5.20 The RAAF's F/A-18Fs are supported at the major repairable-assembly level through US Navy Repairable Item Replacement Option (RIRO) contracts covering more than 75 per cent of all F/A-18F assemblies. This is essentially a rotatable pool of Repairable Items (RIs) shared with the US Navy.[191] There is also a Repair of Repairables arrangement through FMS, allowing the inducted items to be tracked by serial number, ensuring that Defence receives only those assemblies acquired by Australia under the acquisition contract.

5.21 The sustainment of the RAAF's F/A-18F fleet requires not only the provision of repair items, but also the provision of information and technical data. To that end, the Australian Super Hornet Project Office established Third-Party Transfers of Data and Technical Assistance Agreements, to enable the sharing of information and data between the organisations authorised to provide integrated-logistics-support services for the RAAF's F/A-18F fleet. Compliance with the US Government's International Traffic in Arms Regulations (ITAR) required the granting of 15 Third-Party-Transfer Approvals and six Technical Assistance Agreements. Defence records indicate

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188 These forms of maintenance relate to Line Replaceable Units (LRUs), which are the lowest appropriate level of repairable item that can be readily diagnosed and replaced at the equipment site. They include items such as electronic modules and assemblies, designed to be removed from an aircraft parked on flight-lines.

189 Officer Commanding Tactical Fighter SPO, *AMO sponsor submission to A44 F/A-18F Super Hornet annual Airworthiness Board 2011*, 16 November 2011, p. 2.

190 The Hon. Greg Combet MP, Minister for Defence Personnel, Materiel and Science, *Super Hornet aircraft sustainment contract,* media release, 16 December 2009.

191 Officer Commanding Tactical Fighter SPO, *AMO sponsor submission to A44 F/A-18F Super Hornet annual Airworthiness Board 2011*, 16 November 2011, p. 2; Defence Materiel Organisation, *Australian Super Hornet integrated logistics support plan*, version 1.1, August 2010, pp. 38, 39.

that these were arranged through the Defence Export Control Office and US Department of State between September 2008 and April 2009.[192]

Sustainment processes

5.22 At the time of the audit, the sustainment mechanisms had reached various stages of development, as outlined in Table 5.2.

Table 5.2

Super Hornet sustainment processes

On-aircraft Depot Level Maintenance. The first scheduled on-aircraft Depot Level Maintenance for the Australian Super Hornets is scheduled for 2016, as defined by the US Navy's F/A-18F Planned Maintenance Inspection program. This program is being reviewed with a view to engaging Australia-based contractors in time for the first Australian F/A-18F to undergo on-aircraft Depot Level Maintenance in 2016.
Unscheduled on-aircraft Depot Level Maintenance. This is to be provided through the sustainment FMS case with the US Navy, which includes a provision for specialist engineering support from the US Navy Fleet Support Team as and if required.
Off-aircraft Depot Level Maintenance. The majority of off-aircraft Depot Level Maintenance for the Super Hornet Repairable Items is provided by the US Navy maintenance network, and funded through FMS. Access to the US-based contractors and US Navy Fleet Readiness Centers is also funded through FMS.
Engine sustainment. Sustainment of the Super Hornet F414 jet engine (and of the F404 Hornet jet engine) is provided through a Total Logistics Support (TLS) contract with General Electric International Incorporated (GEII), which has subcontracted Tasman Aviation Enterprises (TAE) to be its commercial Authorised Engineering Organisation (AEO) and Authorised Maintenance Organisation (AMO) for the F414 and F404 engines.
Component Depot Level Maintenance. This is being acquired through an FMS Cooperative Logistics Supply Support Arrangement case, which will largely utilise US Navy Performance-Based Logistics arrangements with commercial Depot Level Maintenance suppliers.

[192] Defence Materiel Organisation, *Australian Super Hornet integrated logistics support plan*, version 1.1, August 2010, pp. 14, 68–9. A Technical Assistance Agreement authorises a US company to disclose US technical data to a foreign person or to perform a defence service—but it does not confer manufacturing rights. While a hardware licence permits the export of hard-copy information, Technical Assistance Agreements allow discussions and information exchanges within the scope of the agreement. Director US Export Control Systems, Defence Materiel Organisation, *United States' defence export controls guidance for Australian companies*, August 2007, p. 6.
The average regulatory approval time for a Technical Assistance Agreement application is about three months, although some may take much longer. This does not include the time taken by the US exporter to develop the application, which itself may add months to the process. This creates significant project schedule difficulties. Director US Export Control Systems, Defence Materiel Organisation, *United States' defence export controls guidance for Australian companies*, August 2007, p. 12.

Off-aircraft Intermediate Level Maintenance, engineering services and supply support services. These are being acquired from The Boeing Company, which has subcontracted Boeing Defence Australia (BDA) to be its commercial AEO and AMO for the Super Hornets. BDA also performs aircraft washing under this contract. A three-year Super Hornet Aircraft Sustainment Contract (renewable to a maximum of ten years) was signed with The Boeing Company on 16 December 2009, which included scope for Intermediate Level Maintenance.[193]
Usage Monitoring. Usage monitoring involves the tracking of fatigue-damage accrual on F/A-18F aircraft structures as well as the tracking of life consumption on life-limited parts of the F414 engine. BAE Systems Australia (BAE) is responsible for providing usage monitoring and reporting services for the Super Hornet—and the classic Hornet—through the Hornet Usage Monitoring System Contract. BAE is a commercial AEO for the classic Hornet aircraft, and its AEO scope was expanded to include the Super Hornet aircraft in September 2010.
Operational Maintenance. This is conducted by ACG 82 Wing's No.1 Squadron and No.6 Squadron. Initial training of RAAF Super Hornet technicians occurred at Naval Air Station Lemoore, California, USA. Instructor personnel from the RAAF's No.278 Squadron have amended the Super Hornet technical training courseware to align with RAAF trades, and the first of the amended courses were delivered by No.278 Squadron instructors in conjunction with US Navy instructors. Following this initial training period, maintenance training is now provided by personnel of No.278 Squadron at RAAF Base Amberley.
Beyond Operational Level Repairs. This is being managed by Tactical Fighter SPO.
Support and Test Equipment. The majority of this equipment has been procured by the Australian Super Hornet Project Office from the US Navy via an FMS case, and provided to Boeing Defence Australia and GEII as Government Furnished Equipment. A small percentage of Support and Test Equipment has been procured commercially and is ADF-common. The majority of Support and Test Equipment is calibrated through the ADF Calibration Support Contract managed by Aerospace Materiel SPO (AMSPO).
Consumable spares. These will also be provided through a Cooperative Logistics Supply Support Arrangement FMS case with the US Navy, which will utilise The Boeing Company and the US Government's Defense Logistics Agency as its sources of supply.[194]

193 An invitation to register for a tender for Super Hornet sustainment services, to cover the period 2015–20, was released on 12 April 2012, and closed on 12 June 2012.

194 There are currently 14 994 stock codes identified in the Military Integrated Logistics Information System (MILIS) that are linked to the Super Hornet—either by direct management by the Super Hornet Logistics Management Unit as Stock Item Owner or Repair Manager, or by the Application Identifier 'A44'; 1177 of these items are Repairable while the remaining 13 817 are not Repairable and are mostly consumable in nature.

Field Service Representatives. Provision of Field Service Representatives has been funded for the first three years of operations (until December 2012) through FMS Case AT-P-SAF.[195] An F414 Field Service Representative has also been funded through the F404/F414 Engine Total Logistics Support Contract, which is currently in force to December 2020. At the time of the audit fieldwork, 82 Wing was determining the long-term requirements for Field Service Representatives, and the Super Hornet Logistics Management Unit was managing these requirements accordingly.
Super Hornet Training Support Services. A contract for training systems and services was awarded to Raytheon Australia in February 2010. This contract includes maintenance, logistics and training services for the Super Hornet aircrew flight simulators, and also maintenance training systems and electronic classrooms for Super Hornet maintenance personnel.

Source: ANAO analysis of Tactical Fighter Systems Program Office documentation.

Super Hornet sustainment—the formative stage

5.23 At the time of the audit, the Australian Super Hornet sustainment arrangements were in their formative years, and consequently adjustments to maintenance policy and support arrangements were ongoing. This situation was not unexpected: as early as 2008, Defence informed the Minister that comprehensive logistics support would not be available at the time of acceptance of aircraft into service, but would progressively ramp up until Full Operational Capability, to be achieved in December 2012.[196] The RAAF's Super Hornet operational authority, ACG's 82 Wing, has identified areas where there are differences in maintenance culture between the US Navy and the RAAF. These differences are leading to spares-demand profiles that are different to those anticipated from the US Navy data that was used to determine initial buys of spares. Consequently, spares procurements are presently being adjusted to adapt to the RAAF maintenance culture.[197]

5.24 Figure 5.2 shows expenditure on sustainment of the Super Hornet fleet since 2007–08, as well as projected budget provisions to 2021. Sustainment expenditure from 2007 to 2011 amounted to $91.2 million, was budgeted to cost

[195] Field Service Representatives are service engineering specialists whose role is to provide in-depth expertise in preventing and resolving in-service technical problems. The specialist assistance provided under FMS Case AT-P-SAF is listed as Contractor Engineering Technical Services, Logistics Technical Assistance, and Engineering and Other Technical Assistance.

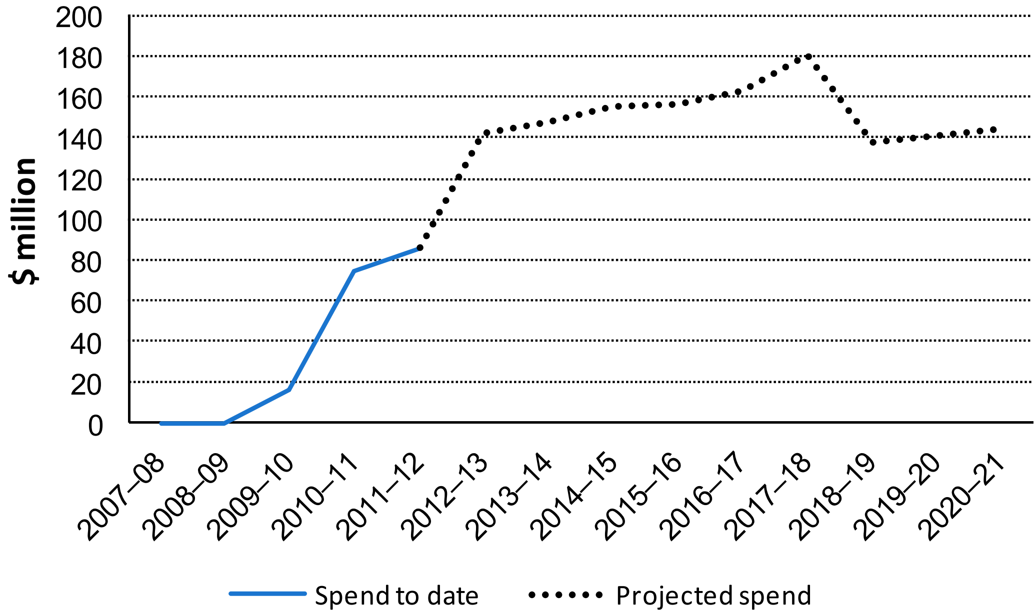
[196] Defence Materiel Organisation, *Update on planning for Super Hornet through life support*, ministerial submission, 18 December 2008.

[197] JE Jacobs, *Super Hornet sustainment: independent review report,* 30 September 2011, Annex F, pp. 4, 11.

$86 million during 2011–12, and was expected to amount to $1.38 billion for the period 2012 to 2021. In September 2012, Boeing Defence Australia advised the ANAO that the US Navy Super Hornet fleet continues to have the lowest overall average cost per flight hour for US tactical aircraft.[198]

Figure 5.2

Super Hornet annual sustainment expenditure and future budgets, 2007–21



Source: Royal Australian Air Force.

Notes: Actual expenditure is shown for financial years 2007–08 to 2010–11.
The 2011–12 Budget reflects the 2011–12 Portfolio Additional Estimates Statement.
The Future Budgets 2012–13 to 2020–21 reflect the Materiel Sustainment Agreement 2011–21 for the CAF 21 expenditure line.

5.25 Defence commissioned a review in mid-2011 of the Super Hornet supply chain, which reported that a comparison of stock levels of serviceable Repairable Items over the previous 12 months showed that stock-levels had been declining since the end of 2010. However, interviews conducted by the review team also revealed a general belief among the Super Hornet community at RAAF Base Amberley that:

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198 Boeing Defence Australia, September 2012.

- too narrow a range of stock codes had been purchased in the initial acquisition; and
- insufficient quantities had been purchased to support three years of ADF operations.[199]

5.26 With the Rate of Effort (number of flying hours) planned to increase significantly in 2011–12 after the arrival of the full complement of aircraft, there were concerns that the Super Hornet repair pipeline was already struggling to support much smaller increases in the Rate of Effort, as was experienced between March and June 2011.[200] However, at the time of the audit, ACG was still able to generate their flying program despite the reduced rate-of-effort and available aircraft.

Supply-chain maturity

5.27 Overall, Tactical Fighter SPO considers that the ability to sustain the Super Hornet fleet's operations at the planned Rate of Effort is heavily influenced by a number of maturity issues in the spares supply-chain, as outlined in the following paragraphs.

5.28 Aircraft availability is expected to be reduced for the next 12 to 15 months due to spares shortages, based on known delivery schedules. These include some spares lines that the US Navy is yet to place on contract with suppliers.

5.29 Late delivery of Support and Test Equipment, and this equipment's calibration and spares provisions, also continue to affect aircraft availability. The management of Support and Test Equipment is presently being transitioned from ASHPO to Boeing Defence Australia (the Aircraft Sustainment Contractor). Boeing Defence Australia is now dedicating a Support and Test Equipment Manager to ensure adequate planning of calibration requirements, and to ensure that alternate Support and Test Equipment/Calibration options are developed where mature sustainment requirements are not yet able to be met.

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[199] GRA Pty. Ltd, *Super Hornet supply chain review*, version 1.2, July 2011, p. 24.

[200] GRA Pty. Ltd, *Super Hornet supply chain review*, version 1.2, July 2011, p. 24.

5.30 Replacement times for some Repairable Items are exceeding the original forecasts, and the same items also feature on the US Navy's critical-items list. The US Navy is considering options to assist.

5.31 The rate of consumption for some non-Repairable Items[201] differs from that of the US Navy and from ASHPO forecasts, which were based on US Navy and Boeing advice. For non-Repairable Items, the rate of consumption also differs from US Navy modelling.[202] This may be explained by the RAAF practice of more often replacing consumables rather than re-using them, and applying a more strict application of wear limits, leading to more regular replacement of some items compared to US Navy practice.

5.32 Finally, spares requirements have not been fully defined, despite progress being achieved in recent years. There remains an underestimate of the level of demand for some spares, while other spares identified as required during maintenance activities have not been completely codified and catalogued.[203]

Supply-chain mitigation

5.33 A number of mitigation activities are being undertaken to address these supply-chain issues.

5.34 Boeing Defence Australia and Tactical Fighter SPO are working with the US Navy to produce a regular Critical Items List and to access US Navy supply-chain performance information to assist proactive planning to manage these items.

5.35 Tactical Fighter SPO initiated an independent review of the supply chain, which was completed in July 2011. The SPO, Boeing Defence Australia and the independent reviewers have developed actions and an associated schedule to address the issues identified.

5.36 Tactical Fighter SPO and its Super Hornet Logistics Management Unit remain engaged with the US Navy to address the delivery of remaining late-to-

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201 Non-Repairable Items are sometimes referred to as Breakdown Spares (BDS) by the RAAF and/or as Consumables by the US Navy.

202 In setting the initial consumables spares list and holdings levels, ASHPO adopted the recommended US Navy Minimum Spares List (MSL).

203 Officer Commanding Tactical Fighter SPO, *Submission to A44 F/A-18F Super Hornet annual Airworthiness Board 2011*, 16 November 2011, pp. 6–8.

need items and to identify opportunities to improve lead times in the Repairable Item pipeline. Some of the opportunities being considered include:

- additional resourcing of the US Naval Supply Systems Command, and the RAAF Support Liaison Office (Mechanicsburg, Pennsylvania) to assist US Navy contracting efforts and improve communication. (The Support Liaison Office's workload doubled following commencement of the Australian Super Hornet program, which added a fifth platform to those already being supported by the office);
- improvement of US Navy contracting strategies to include greater coupling with US Navy orders and the drafting of standing offers to reduce lead times; and
- more regular strategic engagement with the US Navy through sustainment Program Management Reviews, Integrated Logistics Support (ILS) Working Groups and weekly program-level discussions.[204]

Super Hornet availability and serviceability

5.37 The key sustainment statistics analysed in the remainder of this chapter show the formative stages of logistics support for the Australian Super Hornet.

5.38 From the Super Hornet's Introduction to Service in March 2010, 82 Wing has generally met its training and development objectives, to the extent that the fleet achieved the Initial Operational Capability milestone as scheduled in December 2010. However, achievement of the Final Operational Capability milestone, scheduled for December 2012, depends upon the resolution of some logistics constraints imposed by the immature support system, which have at times led to changes in the flying program and reductions in combat training activities.

5.39 Figure 5.3 shows that for the period 2010–12, the Super Hornet fleet's flying hours were largely in line with Air Force planning and ACG's operational requirements.

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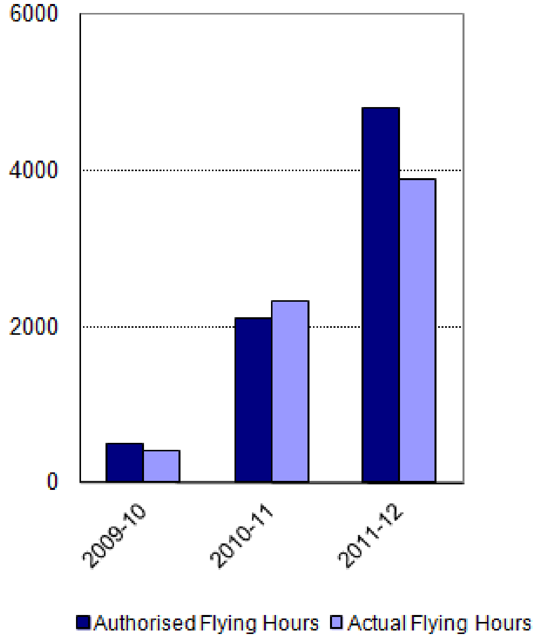
[204] Officer Commanding Tactical Fighter SPO, *Submission to A44 F/A-18F Super Hornet Annual Airworthiness Board 2011*, 16 November 2011, pp. 8–9.

Figure 5.3

Super Hornet fleet flying hours, 2009–12



Source: Department of Defence, Annual Reports; Defence Materiel Organisation, Tactical Fighter Systems Program Office.

Note: Data for 2011–12 is as at mid-June 2012.

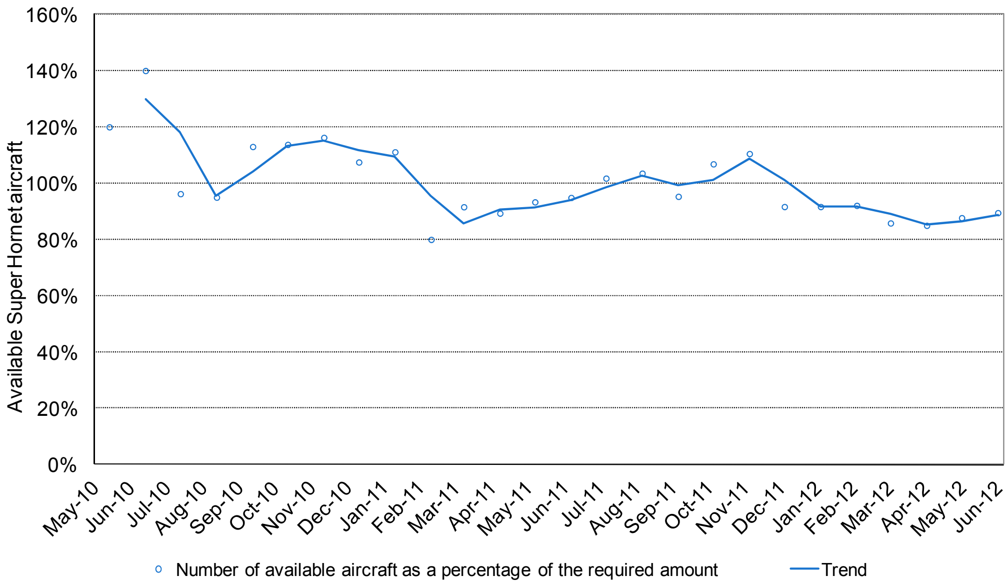
5.40 Figure 5.4 shows the achieved percentage of the target number of available aircraft specified within the Materiel Sustainment Agreement between the RAAF and DMO. Initially the target was exceeded because the fleet was small and new. As the number of Super Hornets grew, their logistics support was shown as maturing by the improving trend of aircraft availability from March to November 2011. However, the improvements were followed by a decline in availability during early 2012, as an underlying shortage of maintenance spares and Ground Support Equipment became apparent.[205] These shortages were resolved by developing work-around solutions with the

[205] RAAF and Defence Materiel Organisation, *Materiel Sustainment Agreement: Sustainment of F/A-18F Super Hornet weapon system*, June 2011. Defence informed the ANAO in May 2012 that no significance should be attached to exceeding the targeted number of flying hours, as occurred in 2010–11. Rather, that the Super Hornet sustainment system, even in a maturing state, could support this increased rate of effort to improve pilot conversion and training rates, and thus overall Super Hornet capability, should be treated as a positive.

assistance of Tactical Fighter SPO, the Classic Hornet community, Boeing Defence Australia and the US Navy. While these work-arounds often proved successful, they increased maintenance activity delay and consumed excessive staff time. The requirement to develop work-around solutions is expected to decrease as additional support equipment and spares are delivered, and additional personnel are employed within the logistics-management organisation.

Figure 5.4

Super Hornet aircraft availability with respect to the number required, May 2010–June 2012



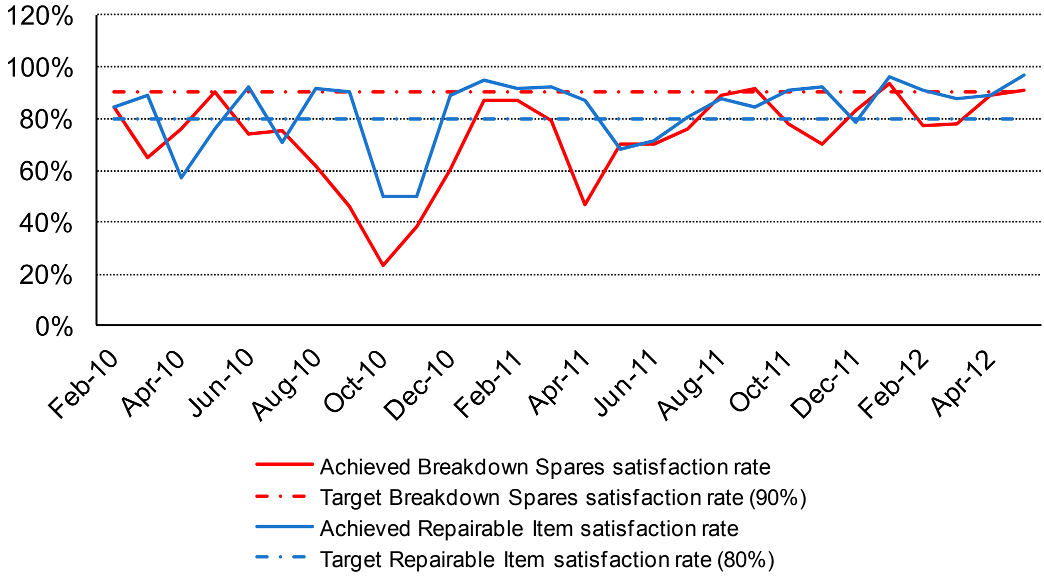
Source: Defence Materiel Organisation, Tactical Fighter Systems Program Office.

5.41 Figure 5.5 below shows that, to date, Tactical Fighter SPO has overall been unable to consistently achieve the demand-satisfaction rates specified in the Materiel Sustainment Agreement between DMO and Air Force.[206]

[206] RAAF and Defence Materiel Organisation, *Materiel Sustainment Agreement: Sustainment of F/A-18F Super Hornet weapon system*, June 2011.

Figure 5.5

Super Hornet spares demand-satisfaction rates, February 2010–May 2012



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

5.42 The demand-satisfaction rate relates to the delivery of maintenance support spares within specified timeframes, and so it is an indicative measure of a supply chain's effectiveness and maturity. The inconsistent results recorded in Figure 5.5 show the Super Hornet support system to be maturing. This is because the Super Hornet program, including the support elements, was established as an 'accelerated acquisition', which by necessity applied the best usage data available at the time. In the period since the Super Hornet entered service with the RAAF, some of the data and assumptions underpinning the supply-chain modelling have proven to be inaccurate, resulting in spares shortages.

5.43 Remedial action being undertaken includes:

- accelerating the delivery of remaining logistics assets;
- re-validating the original spares analysis; and

- enhancing Intermediate Level Maintenance capability by procuring sufficient sub-component parts to facilitate local repair.[207]

Cannibalisation rates

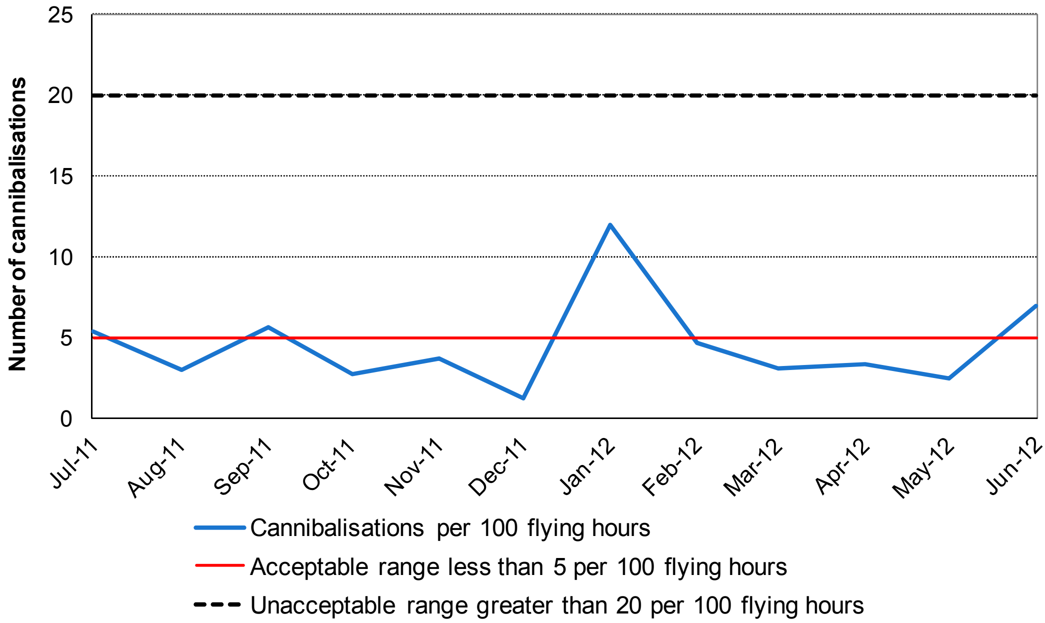
5.44 While longer-term supply-chain solutions are being developed and implemented, cannibalisation of parts between aircraft is an immediate solution available to the operational maintainers. This practice is not a preferred solution because of the wasted effort involved in removing and reinstalling serviceable components, and the risk of component damage during the process; however, it does provide an immediate solution to a supply-chain failure.

5.45 Figure 5.6 indicates that, after some initial instability, the cannibalisation rate is now close to the target level agreed in the Materiel Sustainment Agreement. 82 Wing minimises the detrimental impact of cannibalisations on aircraft availability, by consolidating cannibalisations where possible to a single airframe. The airframe being cannibalised is changed regularly, to prevent further maintenance issues that would arise if a cannibalised aircraft remained in long-term storage. The cannibalisation rate is expected to decrease as the support system matures.

[207] Officer Commanding Tactical Fighter SPO, *Submission to A44 F/A-18F Super Hornet annual Airworthiness Board 2011*, 16 November 2011, p. 12.

Figure 5.6

Super Hornet cannibalisations of Repairable Items per 100 flying hours, July 2011–June 2012



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

5.46 While the number of cannibalisations shown in the data does not appear significant, shortfalls in spares support have the potential to increase reliance on cannibalisation. At the time of the audit, the main cause of cannibalisations was the partial delivery of some Repairable Item stock.[208]

5.47 As noted in paragraph 5.43, Tactical Fighter SPO is undertaking a range of remedial actions.

Management of Super Hornet structural integrity

5.48 The Super Hornet aircraft was originally designed and manufactured, under US Navy Specification SD-565-3-2, with a structural-fatigue safe life of 6000 airframe hours of US Navy usage. However, the DGTA has applied

[208] Officer Commanding Tactical Fighter SPO, *Submission to A44 F/A-18F Super Hornet annual Airworthiness Board 2011*, 16 November 2011, p. 12. Repairable Items are all of those items whose resupply normally centres on maintenance processes formally authorised by the ADF to be carried out at authorised venues. Australian Air Publication 7001.059, *ADF aviation maintenance management manual* (Book 2 of 2), May 2011.

'knock-down' factors to account for a more severe RAAF usage spectrum, resulting in a current RAAF life of 2400 airframe hours, which will suffice for the current Planned Withdrawal Date of 2025. DGTA and DSTO are working to remove analytical conservatism and thereby increase the RAAF service life of the Super Hornet.[209]

5.49 At the time of the audit, the RAAF was not actively managing the Super Hornets' Fatigue Life Expended Index (FLEI) in a similar way to that applied to the Hornet, for the following primary reasons:

- The Super Hornet Usage Monitoring System's strain gauges, from which FLEI data is derived, are calibrated in flight, and these require some 200–300 hours of flight in order to become calibrated. Until then, the Usage Monitoring System is unable to provide statistically valid FLEI data that is suitable for fatigue-life management.
- DSTO, DGTA, ASHPO and Boeing Defence Australia are working together to tailor the Super Hornet Usage Monitoring System, delivered with the aircraft, to better satisfy Australian requirements. This work is not expected to be completed until December 2012.
- It is critical that aircrew believe that their behaviour in the cockpit is reflected in their individual fatigue-accrual record. For this reason, until the Usage Monitoring System has been tailored and the strain gauges calibrated, DGTA remains unwilling to publish Super Hornet fatigue data that may not be accurate.

5.50 DGTA's view is that, in the short term, these Usage Monitoring System issues will not be a problem, as there are no major structural-life limits directly related to FLEI that will expire for the next 20 years.

5.51 DGTA also informed the ANAO that in the longer term—when the Super Hornets' Usage Monitoring Systems have been tailored and calibrated, and the Super Hornet fleet's operational syllabus is stable (and representative of the fleet's long-term operational usage)—DGTA and DSTO will conduct a Structural Life Assessment on the basis of usage data. This assessment will determine the metrics needing close management, to enable the Super Hornets to best achieve their Planned Withdrawal Date. In the meantime, until the

209 RAAF, *F/A-18F Super Hornet aircraft structural integrity management plan*, 2010, Volume 1.

Structural Life Assessment is complete, no operational usage constraints, for the purpose of structural-fatigue management, are being applied to the Super Hornets, and DGTA's guidance to the RAAF aircrew is simply to fly the aircraft as operationally required.[210]

5.52 In December 2011, ACG informed the ANAO that active fatigue management of the Super Hornet aircraft commenced at the time of their delivery in 2009. This took the form of performing high-g manoeuvres only when necessary. In effect, since their introduction, the Super Hornets are being flown using Classic Hornet procedures that minimise fatigue accrual, whilst ensuring that tactical training objectives are still achieved.

Conclusion

5.53 At the time of the audit, the Australian Super Hornet sustainment arrangements were in their formative stage, and adjustments to maintenance policy and support arrangements to achieve better alignment with the US Navy's arrangements were ongoing. Tactical Fighter SPO statistics indicated that the Super Hornet support system was steadily improving, but required further improvement. This is not unexpected, given the technical complexity of the Super Hornets and their recent accelerated introduction into service with the RAAF. Tactical Fighter SPO has implemented supply-chain mitigation strategies, which according to available sustainment statistics are proving effective.

5.54 The audit objective was to assess the upgrade and sustainment of the F/A-18A/B Hornet fleet, and the sustainment of the newly acquired F/A-18F Super Hornet fleet. Defence's management approach to the F/A-18 fleets has been effective thus far in identifying, in a variety of dimensions, the risks to their continued delivery of the required capability until their current Planned Withdrawal Dates. Defence has also been active in putting in place mitigation measures for these risks. However, the report outlines the significant risks that will require close management by Defence in the final stages of sustainment of

[210] Defence informed the ANAO in May 2012 that operational usage prior to strain-gauge calibration would not impact the potential disposal value of the RAAF Super Hornet aircraft. Although the strain gauges used for fatigue tracking are not yet calibrated, raw strain data is recorded and stored for all flights. Upon recording an appropriate number of in-flight calibration points, calibration factors will be determined for each strain gauge on each individual aircraft and applied retrospectively to the stored strain data. Therefore, fatigue accrual for all flights will be accounted for. This will enable the RAAF to provide a complete fatigue history for each aircraft to the United States Navy for disposal action.

the F/A-18A/B fleet in particular, when airframe hours flown and fatigue-life expended will be greatest.

5.55 The companion audit report identifies that there remain significant challenges in Defence achieving the planned transition to an F-35-based air combat capability in the required timeframe, such that a capability gap does not arise between the withdrawal from service of the F/A-18A/B fleet and the achievement of full operational capability for the F-35. These challenges chiefly arise from the post-2010 movement of the US JSF Program's Full-Rate Production milestone decision from 2016 to 2019, and consequent Australian Government decisions to delay delivery of 12 of the first 14 aircraft for two years and postpone a decision on the next 58 aircraft until beyond 2013.[211] To accommodate these delays, the F/A-18A/B fleet's operational life is likely to be extended beyond the current Planned Withdrawal Date of 2020. Defence is accordingly preparing options for Australian Government consideration later this year. Defence financial data indicates that the achievement of such an extension beyond 2020 will involve additional costs and will require detailed planning and close management by Defence. Defence's capacity to accommodate any further delays in the production and/or acquisition of F-35s through a further extension to the life of the F/A-18A/B fleet, beyond the limited extension currently being considered, has limits, is likely to be costly, and has implications for capability. That said, decisions in relation to capability for the ADF, including Australia's acquisition of F-35As, properly rest with the Australian Government, informed by advice from Defence.

Ian McPhee — Canberra ACT

Auditor-General — 27 September 2012

[211] ANAO Audit Report No.6 2012–13, *Management of Australia's Air Combat Capability—F-35A Joint Strike Fighter Acquisition*, 27 September 2012.

Appendices

Appendix 1: Defence Response to the Proposed Report

AUDIT-IN-CONFIDENCE

GED
10 SEP 2012
2.20

Australian Government

Department of Defence

Chief Audit Executive
Audit and Fraud Control Division
CP3-2-005
PO BOX 7912
CANBERRA BC ACT 2610
Telephone: 02 6266
Facsimile: 02 6266

AFCD/CAE/OUT/2012/372

Dr Tom Ioannou TJ 10/9
Acting Group Executive Director
Performance Audit Services
Australian National Audit Office
GPO Box 707
CANBERRA ACT 2601

Dear Dr Ioannou

Australian National Audit Office (ANAO) Performance Audit of *Management of Australia's Air Combat Capability - F/A-18 Hornet and Super Hornet Fleet Upgrades and Sustainment*

I refer to your letter of 24 August 2012 which provided Defence with the Section 19 Report for the above mentioned audit, as well as the Section 19 Report on *F-35A Joint Strike Fighter Acquisition*.

Defence appreciates the opportunity to review and provide comment on the Section 19 Report. Defence's comments on the *F/A-18 Hornet and Super Hornet Fleet Upgrades and Sustainment* Section 19 Report are contained at **Annexes A** and **B**. As requested, Defence's response to the *F-35A Joint Strike Fighter Acquisition* Section 19 Report is provided in a separate correspondence (ref AFCD/CAE/OUT/2012/371). Noting connections between the two reports, the Agency Response for both Section 19 Reports is the same.

Defence welcomes the reports and believes that they present a balanced and detailed account that highlights the significant and continuing work that Defence undertakes in managing Air Combat Capability.

Should you have any queries, please do not hesitate to contact Ms Lynn Peever, A/Assistant Secretary Audit, on 02 6266 or myself directly on the number above.

Yours sincerely

GEOFFREY BROWN OAM
Chief Audit Executive
Audit & Fraud Control Division

6 September 12

Annexes:

A. Summary of Agency Response
B. Proposed Amendments and Editorials

AUDIT-IN-CONFIDENCE

Defending Australia and its National Interests

Appendix 2: Boeing Defence Australia Response to Extract from the Proposed Report

Boeing Defence Australia Ltd
(A.B.N. 64 006 678 119)
Level 1, 55 Blackall Street
Barton ACT 2600
GPO Box 397
Canberra ACT 2601
Australia

GED
17 SEP 2012
9.30

BOEING

14 September 2012

Dr Tom Ioannou
Acting Group Executive Director
Performance Audit Services Group
Australian National Audit Office (ANAO)
19 National Circuit
BARTON ACT 2601

Reference: 2011/1022 – Management of Australia's Air Combat Capability

Dear Dr. Ioannou,

Please find enclosed Boeing's response and review of the ANAO audit into the Management of Australia's Air Combat Capability.

We appreciate the opportunity to be included in this and believe that the report provides an accurate and thorough review of the current state of the Nation's Air combat capability management.

Boeing offers three specific comments for consideration as provided at Enclosure 1, which I believe provide some points to consider for inclusion in your report.

Please don't hesitate to contact me if you have any questions or concerns, and thank you again for allowing our participation in this review.

Sincerely,

William J. Profilet
Vice President Business Development
Boeing Defense, Space & Security

Appendix 3: Glossary of Terms

Airframe hours (AFHRS). The primary measure of aircraft operational time as recorded on CAMM2. Defined as take-off time to touch-down time plus 0.1 hr (taxi time). RAAF, *F/A-18 A/B Hornet aircraft structural integrity management plan*, 2011, vol. 1, Definitions.

Airworthiness. Airworthiness is a concept, the application of which defines the condition of an aircraft and supplies the basis for judgement of the suitability for flight of that aircraft, in that it has been designed, constructed, maintained and is expected to be operated to approved standards and limitations, by competent and authorised individuals, who are acting as members of either an approved or authorised organisation and whose work is both certified as correct and accepted on behalf of the Australian Defence Force. ADF, *Technical airworthiness management manual*, Australian Air Publication 7001.053(AM1), 21 October 2010.

Australian Military Type Certificate (AMTC). A certificate issued by Chief of Air Force, as the ADF Airworthiness Authority, for an aircraft type entered on the register of State aircraft. The AMTC signifies that the particular aircraft type has been assessed (undergone type certification) by the ADF as airworthy and supportable in its intended ADF role/s. ADF, *Technical airworthiness management manual*, Australian Air Publication 7001.053(AM1), 21 October 2010.

Breakdown Spares (BDS). In RAAF usage, a term equivalent to Non-Repairable Items; also equivalent to Consumables in US Navy usage.

Certification.

- The act of issuing a certificate that provides assurance that an entity, including product, service or organisation, complies with a stated specification, standard or other requirement. Defence Instruction (General) LOG 4–5–012, *Regulation of technical integrity of Australian Defence Force materiel*, September 2010.
- The end result of a process which formally examines and documents compliance of a product, against predefined standards, to the satisfaction of the certificating authority. ADF, *Technical airworthiness management manual*, Australian Air Publication 7001.053(AM1), 21 October 2010.

Certification basis.

- The suite of standards against which materiel is to be certified, derived from or judged to be equivalent to a subset of the materiel standards approved by a Technical Regulatory Authority (TRA). Defence Instruction (General) LOG 4–5–012, *Regulation of technical integrity of Australian Defence Force materiel*, September 2010.

- The set of standards which define the criteria against which the design of aircraft or aircraft-related equipment, or changes to that design, are assessed to determine their airworthiness. ADF, *Technical airworthiness management manual*, Australian Air Publication 7001.053(AM1), 21 October 2010.

Deeper Maintenance (DM). This level of maintenance includes tasks that are more complex than operational maintenance and normally require specialised equipment and technical skills and which relies on access to extensive support equipment and workshop facilities for successful conduct. ADF, *Technical airworthiness management manual*, Australian Air Publication 7001.053(AM1), 21 October 2010.

Design Acceptance. The process whereby a design or design change (that is, an output of the design process) involving aircraft or aircraft-related equipment is determined to be technically acceptable for ADF use based on a determination that the specified requirements and design standards are sufficient and applicable (to the ADF authorised configuration, maintenance policy and procedures, and operations) and that the quality of the design has been proven to the satisfaction of the responsible DAR. Generally, design quality is assured through approval of the design by an AEO against the approved design requirements and standards plus an acceptable basis of design verification. ADF, *Technical airworthiness management manual*, Australian Air Publication 7001.053(AM1), 21 October 2010.

Design Acceptance Certification. The final act of the Design Acceptance process whereby a DAR provides a certified record of the technical acceptability of a change to aircraft or aircraft-related equipment Type Design. ADF, *Technical airworthiness management manual*, Australian Air Publication 7001.053(AM1), 21 October 2010.

Design Acceptance Representative (DAR). A Commonwealth employee with delegated authority from the [Technical Airworthiness Regulator] to perform Design Acceptance certification of changes to aircraft or aircraft-related equipment. ADF, *Technical airworthiness management manual*, Australian Air Publication 7001.053(AM1), 21 October 2010.

Fatigue. The cracking or failure of an aircraft structure by repeated loading over time.

Fatigue Life Expended Index (FLEI). A measure of the accrued fatigue damage for each aircraft at locations dominated by Wing Root Bending

Moment (WRBM) loads, calibrated such that a FLEI equal to 1.0 is equivalent to 6000 hours of the IFOSTP FT55 (IARPO3a) test spectrum. The fatigue indices are calculated by the Aircraft Structural Life Monitoring Program (ASLMP) from data recorded by the Maintenance Status Data Recording System (MSDRS) wing-root strain gauge. RAAF, *F/A-18 A/B Hornet aircraft structural integrity management plan*, 2011, vol. 2, Definitions.

Life of Type. The upper limit of service life (in AFHRS, landings or cycles) which has been qualified either by test or calculation, or by requirement. RAAF, *F/A-18 A/B Hornet aircraft structural integrity management plan*, 2011, vol. 2, Definitions.

Operational Maintenance (OM). Tasks directly related to the preparation of equipment for immediate use, recovery and minor repair of the equipment after use. OM tasks require a limited range of support equipment and may involve the limited use of workshop facilities. ADF, *Technical airworthiness management manual*, Australian Air Publication 7001.053(AM1), 21 October 2010.

Planned Withdrawal Date. The date which has been promulgated for removal of the aircraft type from service. RAAF, *F/A-18 A/B Hornet aircraft structural integrity management plan*, 2011, vol. 1, Definitions.

Repairable Items. Repairable Items (RI) are all of those items whose resupply normally centres on maintenance processes formally authorised by the ADF to be carried out at authorised venues. ADF, *ADF aviation maintenance management manual (Book 2 of 2)*, Australian Air Publication 7001.059, 18 May 2011, Glossary.

Safe life. The safe life of an item is the life at which the weakest example just retains the required standard of strength, deformation, stiffness or mechanical function, until it is withdrawn from service at the end of a specified life, or an equivalent life having taken into account the actual usage. The minimum standard of strength is 80 per cent of the design ultimate. (DEF STAN 00-970). RAAF, *F/A-18 A/B Hornet aircraft structural integrity management plan*, 2011, vol. 1, Definitions.

Safety by inspection. A process for assuring continued structural airworthiness by repeated inspection of critical locations at designated periodicity to detect significant defects prior to imminent failure. RAAF, *F/A-18 A/B Hornet aircraft structural integrity management plan*, 2011, vol. 1, Definitions.

Service monitoring (Hornet-specific definition). All aircraft shall be fitted with instrumentation to monitor fatigue-life consumption. (DEFSTAN 970 Vol 1, Bk 1, Chap 201, para 4.1 and Leaflet 201/6). RAAF, *F/A-18 A/B Hornet aircraft structural integrity management plan*, 2011, vol. 1, Definitions.

Service Release. The approval to release an incorporated design change for use in service, based on the condition that all implementing instructions relating to the design change have been issued to user organisations. Service Release is granted by either the Chief of Air Force (for major type-design changes) or the Senior Executive of an AEO (for minor type-design changes). ADF, *Technical airworthiness management manual*, Australian Air Publication 7001.053(AM1), 21 October 2010.

Statement of Requirement (SOR). A document or documents defining the complete set of DAR [Design Acceptance Representative] requirements on a design agency to allow DAR acceptance of an aircraft or aircraft-related equipment design or design change. The SOR includes or references a Specification, which is the document defining the specific essential function and performance requirements for the product design or design change. ADF, *Technical airworthiness management manual*, Australian Air Publication 7001.053(AM1), 21 October 2010.

Structural integrity. The ability of all constituent parts of an aircraft's structure to withstand normal operating loads within approved flight limitations without collapse or unacceptable deformation. RAAF, *F/A-18 A/B Hornet aircraft structural integrity management plan*, 2011, vol. 1, Definitions.

Supplemental Type Certificate (STC). A certificate issued by Chief of Air Force for an aircraft which undergoes a major design change or role change that is beyond the type design defined in the original AMTC, but is not substantial enough to require a complete reinvestigation of compliance of the aircraft with the applicable airworthiness standards (that is, it does not require a new AMTC). ADF, *Technical airworthiness management manual*, Australian Air Publication 7001.053(AM1), 21 October 2010.

Type Certification. The process of: (i) prescribing and revising minimum standards governing the design of aircraft, engines, propellers and other aircraft equipment as may be required in the interests of safety; and (ii) administering a program to determine compliance with those prescribed standards and maintain certification integrity with a higher level of oversight, specification and compliance than the normal Design Acceptance process requires. Successful type certification activity leads to the issue of an AMTC. ADF, *Technical airworthiness management manual*, Australian Air Publication 7001.053(AM1), 21 October 2010.

Appendix 4: Type Certification and Service Release

1. The final steps in acquiring a fleet of aircraft (or any other major fleet of equipment) include certifying the aircraft as suitable for flight for Australia, in terms of design standards, construction standards, maintenance and operation. This aligns with the ADF's requirement to ensure that before an ADF aircraft is declared airworthy, all practical steps have been taken regarding the safety, fitness for service and environmental compliance (collectively referred to as 'technical integrity') of materiel introduced into and operated by the Services.

2. There are two key aspects of airworthiness described in the ADF Airworthiness Manual:

> Technical airworthiness management deals with all aspects of the design, manufacture and maintenance of an aircraft. Operational airworthiness management aims to ensure that aircraft are operated in approved roles, with correct mission equipment, by competent and authorised operators, according to approved procedures and instructions, under a system of supervision and monitoring. Neither aspect of airworthiness management can be treated in isolation.[212]

3. Military aviation differs from civil aviation in that the ADF is the owner, operator, maintainer and regulator of its aircraft and, at times, is also the designer of modifications. This can present challenges in divorcing the airworthiness-control function from the requirements of the other elements, so that an objective judgement on airworthiness can be made.

4. ADF aircraft on the State Register are not subject to civil aviation regulations. Thus, the ADF must independently promote adequate safety of air operations for the protection of both its personnel and the public. Confirmation of the adequacy of the design of an ADF aircraft is achieved through the ADF Type Certification process. The Type Certification concept has been taken primarily from the United States of America Federal Aviation Administration (FAA), which issues Type Certificates for commercial aircraft.

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[212] Australian Defence Force, *ADF airworthiness manual*, Australian Air Publication 7001.048(AM1), 4 March 2009, section 1, chapter 1, p. 2.

5. The ADF's system for managing airworthiness is established in two Defence Instructions (General), one on the Defence Aviation Safety Program and the other on the management of aircraft and engine structural integrity.[213] The first document appoints the Chief of Air Force as the ADF Airworthiness Authority, and provides the authority for issue of the ADF Airworthiness Manual. The Manual generally requires an Australian Military Type Certificate (AMTC) and Service Release (SR) for an aircraft system, and sets out various levels of regulatory responsibility. The Director General Technical Airworthiness is established as the ADF Technical Airworthiness Authority (TAA) and the Technical Airworthiness Regulator (ADF TAR), while the Deputy Chief of Air Force is the Operational Airworthiness Regulator. The procedural framework is detailed in a number of documents, including the *ADF airworthiness manual*, the *Technical airworthiness management manual*, and the *Airworthiness design requirements manual*.

[213] Department of Defence, Defence Instruction (General) OPS 02–2, *Defence Aviation Safety Program*, 26 September 2011; Defence Instruction (LOG) 4–5–016, *Management of aircraft and engine structural integrity*, September 2010.

Appendix 5: Hornet Deeper Maintenance

1. The resources needed during Deeper Maintenance servicing of single F/A-18A/B Hornet aircraft are not constant, and if the overall fleet-servicing program is not managed effectively, then shortfalls in serviceable Hornet aircraft occur. Consequently, Tactical Fighter SPO and 81 Wing together take account of the overall scope of Hornet Deeper Maintenance and upgrade requirements, which need to be completed within annual budget limits, available personnel, workshop facilities, support equipment, breakdown spares and work routines.

2. The sequence of effort within a Deeper Maintenance servicing of a Hornet aircraft includes the following activities:

- induction of the aircraft into the workshop, including a desktop review of its maintenance scope, generally carried out before the aircraft arrives;
- removal of airframe access panels—this requires a high level of resources over a short time;
- performance of zonal inspections for structural and mechanical faults and damage—this requires a high level of resources over a short time;
- general rectifications and unscheduled maintenance resulting from inspections—a lower level of resources involving different trades over an extended time.
- functional checks—a medium level of resources over a short time;
- replacement of airframe access panels—a high level of resources over a short time; and
- flight-tests and post-flight rectifications—a high level of resources over a short time.

3. The level of effort in a Hornet aircraft's Deeper Maintenance servicing generally peaks at the beginning and end of the servicing, with a trough sometimes occurring during the General Rectifications and Functional Checks phases. However, this trough may not occur, due to the discovery of unforeseen maintenance requirements. Also, some key milestones cannot be rescheduled beyond certain boundaries, such as placing aircraft on jacks for undercarriage functional tests.

4. The overall level of effort ideally takes the form of a bathtub curve, which enables 81 Wing to achieve improved workshop efficiency by avoiding coincident peaks in its level of effort through staggered inductions of aircraft into its workshops. However, this levelling of effort is often not achievable due to unforeseen maintenance requirements.

Appendix 6: International Collaborative Programs and Aircraft Structural Audits

International Follow-On Structural Test Project (IFOSTP)

1. The RAAF introduced the Hornets into service in 1985, and assessments of the load histories of the average RAAF aircraft soon identified significant differences in usage type and severity between Hornet operations by the RAAF and those of the US Navy, on which the Life of Type had been based. The RAAF therefore mandated an interim structural safe life of 4000 airframe hours (AFHRS), pending a follow-on test of the severity of the RAAF's operational usage.[214]

2. Similarly to the RAAF, the Royal Canadian Air Force (RCAF) had found that its use of the Hornet aircraft was also very different from that of the US Navy, and therefore the results of the original design tests were not directly applicable to its fleet either. Additionally, structural failures had occurred during fatigue testing and in-service, resulting in structural redesigns which in many cases had not been subjected to full-scale testing. The RCAF also had a requirement for a service-life extension beyond the aircraft's nominal design-life of 6000 flying hours. Both the RAAF and the RCAF therefore concluded that these concerns could only be addressed through a full-scale structural test, and that an international collaboration would be beneficial.

3. Consequently, in 1989 an agreement was signed between the governments of Australia and Canada to conduct postproduction or 'follow-on' testing of the F/A-18 airframe.[215] This collaborative program is known as the International Follow-On Structural Test Project (IFOSTP), and its aims were to verify that the RAAF and RCAF fleets,

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[214] RAAF, *F/A-18 A/B Hornet aircraft structural integrity management plan*, 2011, vol. 1, section 2, chapter 5, p. 1.

[215] *Supplement to Annex D* [1986] *of Memorandum of Understanding between the Royal Australian Air Force and the Canadian Forces* [1984] *concerning the F/A-18 International Follow-On Structural Test Project (IFOSTP)—Project definition*, May 1989.

with their increased severity of usage, could safely achieve 6000 hours.[216]

4. IFOSTP was the beginning of a succession of aircraft-fatigue studies carried out by the Defence Science and Technology Organisation (DSTO) since the late 1980s, in collaboration with the Canadian and United States authorities.

5. The IFOSTP results, based on structural-fatigue (durability) tests and evaluations of the centre fuselage, aft fuselage and wing,[217] confirmed that the RAAF Hornets would require major mid-life structural refurbishment and modifications to maintain safe operations until their then Planned Withdrawal Date of 2010–15. The results also confirmed the need for close management of Fatigue Life Accrual Rates and Fatigue Life Expended Indices (FLEI) for each RAAF Hornet aircraft.[218] The IFOSTP study formed the basis of the refurbishment programs under Hornet Upgrade Phases 3.1 and 3.2, described in Chapter 4, under which DMO had planned for up to 49 centre barrel replacements for the Hornet fleet, with an initial contract for ten. The Government approved this program in August 2006.

6. However, in July 2007 Tactical Fighter SPO's strategic assessment of the Hornet fleet raised (amongst other factors) concerns over availability of F/A-18 aircraft during the later years of the Hornet fleet's refurbishment program. Shortly thereafter the Director-General of Aerospace Combat Systems (the DMO branch of which Tactical Fighter SPO is a part) approached the DGTA and DSTO to consider the feasibility of re-evaluating the refurbishment program in the hope of achieving greater schedule flexibility and thus an increase in aircraft

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216 RAAF, *F/A-18 A/B Hornet aircraft structural integrity management plan*, 2011, vol. 1, section 2, chapter 5, p. 1.

217 The centre-fuselage test (designated FT55) and the wing test (FT245) were conducted in Canada, while the aft fuselage and empennage test (FT46) and two standalone Y488 centre-fuselage bulkhead tests (FT488/1 and FT488/2) were conducted in Australia.

218 RAAF, *F/A-18 A/B Hornet aircraft structural integrity management plan*, 2011, vol. 1, section 2, chapter 3, pp. 1–2.

availability.[219] DSTO consequently initiated the FINAL Hornet fatigue-evaluation study.

Flaw IdeNtification through the Application of Loads (FINAL)

7. Flaw IdeNtification through the Application of Loads (FINAL) is the DSTO program for fatigue testing of retired US Navy, Canadian and RAAF centre barrels.

8. The FINAL study, from 2007 onwards, provided fatigue information which enabled the DGTA to establish the following revised limits for the effective economic Life of Type of RAAF Hornets:

- for the two ARDU aircraft: 0.64 FLEI or 6000 hours of flight, whichever occurs first;
- for 59 aircraft: 0.85 FLEI or 6000 hours of flight, whichever occurs first; and
- for 10 aircraft whose centre barrels have been replaced: 1.0 FLEI or 6000 hours of flight, whichever occurs first.[220]

9. The FINAL testing program was conceived by DSTO originally to satisfy engineering caveats associated with development of the SRP1D package.[221] SRP1D originally extended the fatigue life of the centre barrel from 0.72 to 0.78 FLEI via a number of inspections and modifications to discrete centre barrel locations. At the time of SRP1D scoping, concerns were raised that any potential combination of in-service mechanical damage, environmental degradation and widespread fatigue damage might jeopardise the 0.78 FLEI Service Life Limit of SRP1D centre barrels. DSTO in response commissioned FINAL as a risk-mitigation activity involving inspections, fatigue testing and a comprehensive inspection and teardown of three retired high-life centre barrels.[222] Subsequent concerns about other centre barrel

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[219] DSTO, *The F/A-18 Hornet fuselage centre barrel life re-evaluation project* (draft), October 2011, Executive Summary.

[220] RAAF, *F/A-18 A/B Hornet aircraft structural integrity management plan*, 2011, vol. 1, section 2, chapter 12, p. 1; Tactical Fighter SPO, *Hornet fleet FLEI data*, May 2012.

[221] See paragraph 4.28.

[222] Molent, L, B Dixon, S Barter, P White, T Mills, K Maxfield, G Swanton and Squadron Leader B Main, 'The F/A-18 FINAL Fatigue Testing Program', 13th Australian International Aerospace Congress, Melbourne, 2009.

locations are being addressed with further testing. A total of 16 centre barrels have been tested, with five remaining.

Hornet outer wing, missile-launch rails and control surfaces

10. DSTO is continuing studies into related aspects of the Hornet's fatigue life. The outer-wing program (Hornet Outer Wing StAtic Test, HOWSAT), from 2009 onwards, concentrates on reducing the costs of outer-wing inspections. The structural testing stage of HOWSAT is underway, in conjunction with analysis to support structural-integrity management up to the Planned Withdrawal Date. The costs of the missile-launcher replacements (LAU-7 lifE Extension Program, LEEP) are being reduced by DSTO's development of a design modification to increase fatigue life.[223] Flight trials planned for late 2012 now precede RAAF incorporation. The development of second-stage modifications is in progress at DSTO, with the aim of seeking further fatigue-life benefits. Finally, the program on horizontal stabilators and other flight-control surfaces (Canadian/Australian Flight-control-surface Evaluation, CAFÉ), a collaborative project with Canada, is aimed at reducing the rejection rate due to in-service damage, so as to allow currently rejected items to return to service and existing in-service items to remain in service longer.[224]

Teardown inspections and Ageing-Aircraft Structural Audits (AASA)

11. The contributions of Deeper Maintenance and international scientific collaboration to the task of keeping ageing aircraft flying safely are supplemented by teardown inspections and structural audits.

12. An ageing-aircraft teardown inspection involves the destructive inspection of a complete aircraft or a component such as a wing.[225] The

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[223] Heller, M, J Calero, S Barter, RJ Westcott and J Choi, *Fatigue life extension program for LAU-7 missile launcher housings using rework shape optimisation*, DSTO-TR-2662, February 2012.

[224] Molent, L, S Barter, R Kloeden and G Needham, *DSTO testing in support of the sustainability of the Hornet's structural integrity as part of the SRP* [Internet], Aircraft Airworthiness and Sustainment Conference 2011, available from <http://www.ageingaircraft.com.au/assc/2011_papers/DSTO%20Testing%20in%20Support%20of%20Classic%20Hornet.pdf> [accessed 4 November 2011], p. 1.

[225] Boeing, for example, conducted a teardown inspection of the wing, centre section, forward fuselage and empennage of its 737 aircraft in 1987, and of its rear fuselage in 1988.

teardown is carried out to determine whether there are any as-yet-unknown defects within the aircraft or component which might impact on an operator's ability to operate its fleet of aircraft to the Planned Withdrawal Date. Particular issues that such an inspection is designed to identify include the level of hidden corrosion, fatigue cracking of all material types, and the overall extent of stress corrosion cracking. A teardown inspection, by revealing hidden problems, can lead to adjustment of inspection intervals, precipitation of modifications or refurbishments and the setting of an economic Life of Type for an aircraft.

13. The US Navy requires that at least one example of an aircraft type be torn down and examined in detail when the average damage accrual of the fleet reaches a Fatigue Index (FI) of 0.5. However, due to production structural changes, such a teardown inspection of an early US Navy Hornet may not provide the required information for RAAF structural management of its own Hornet fleet. Furthermore, the RAAF cannot afford to tear down a serviceable fleet aircraft because of the limited number of aircraft it has, and must seek other opportunities to conduct detailed examination of structures, such as from crashed aircraft. Such a teardown would be intended to validate fatigue-test results and the management approach in general.[226]

14. The impracticability of a teardown inspection makes an Ageing Aircraft Structural Audit (AASA) all the more important. The *Technical airworthiness management manual* specifies that an AASA is required when the fleet reaches its mid-life point or after 15 years in service. An AASA is effectively a strategically located more in-depth instance of the continuing assessment elements of an Aircraft Structural Integrity Program.[227]

[226] RAAF, *F/A-18 A/B Hornet aircraft structural integrity management plan*, 2011, vol. 1, Definitions, 'Teardown examination (Hornet-specific definition)'.

[227] Australian Defence Force, *Technical airworthiness management manual*, Australian Air Publication 7001.053(AM1), 21 October 2010, Section 3, Chapter 11.

15. An RAAF AASA of the Hornet fleet therefore fell due in 2000, and comprised the following activities:

- a desktop audit in 2001;
- a physical audit of one aircraft in 2003–04;
- a systems review of the management of fatigue, structural-condition monitoring, environmental degradation and maintenance, completed by the end of 2009; and
- a risk and gap analysis, carried out in 2008–09.

16. The recommendations from the AASA are presently being reviewed by the DGTA.[228]

17. An Ageing Aircraft Structural Audit is distinct from an Ageing Aircraft Systems Audit (AASysA), discussed in paragraph 4.28.

[228] RAAF, *F/A-18 A/B Hornet aircraft structural integrity management plan*, 2011, vol. 1, Section 2, Chapter 12, pp. 2–6.

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For aspects of the Hornet and Super Hornet aircraft, see sub-entries under those terms.

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