This article is based on material gathered in 2006 and 2007 and published in various forms in Australian Defence Magazine and Defense News. It has been integrated and updated to provide an overview of Project Air 6000 and the issues surrounding the development and introduction to service by the RAAF of the F-35A Lightning II Joint Strike Fighter. GF

RUMOUR CONTROL
Australian air power and the Joint Strike Fighter

In late-2007 the recently appointed Minister for Defence, Joel Fitzgibbon, announced a review of Australia's Air Power Capability Options would be held in early-2008 as a precursor to a new Defence White Paper which will be published in late-2008 or early-2009. While it seems unlikely the recently elected Labor government of Prime Minister Kevin Rudd will withdraw from the Joint Strike Fighter (JSF) program and abandon its plans to acquire up to 100 F-35A Lightning II JSFs, the review will subject the program to close scrutiny before its goes to the Federal cabinet in October 2008 for 2nd Pass Approval.

Gregor Ferguson *Rumour Control*

Under Project Air 6000 Defence plans to spend some AUD$11.5-15.5 billion replacing its current fleet of 21 F-111C strike aircraft, 71 F/A-18A/B Hornets with up to 100 F-35A Lightning II Joint Strike Fighters. Defence will also spend a further AUD$5 billion or so replacing its sole remaining Boeing 707 tanker with five Airbus KC-30B multi-role tanker/transports, and acquiring six Boeing 737 Wedgetail Airborne Early Warning & Control (AEW&C) aircraft and a new ground-based air defence command and control system.

The F-111s will be retired around 2010 and to prevent a 'capability gap' emerging before the F-35A becomes operational, the former Minister for Defence, Dr Brendan Nelson, unexpectedly announced late in 2006 the RAAF would acquire 24 F/A-18F Super Hornet Block 2 fighters under a US Foreign Military Sales (FMS) agreement. These so-called 'bridging fighters' will enter service in 2010 at an additional cost of some AUD$6 billion – including operating costs - for a RAAF career that's not intended to exceed about 10 years.

The Super Hornet purchase helped escalate the already strident war of words over the composition of Australia's front-line air combat force which has ranged over the key issues of capability, cost, schedule and supportability.

Dr Brendan Nelson re-affirmed in early-2007 the then-Liberal National Coalition Government's unswerving support for the F-35A Joint Strike Fighter. And he stated then that Initial Operational Capability (IOC) of the RAAF's first squadron of F-35A Lightning IIs is still expected in 2014/15.

But his revelation in December 2006 that he was considering the acquisition of 24 Boeing F/A-18F Super Hornets to forestall any potential capability gap seemed to add credence to the suggestion that the JSF might be delayed significantly, resulting in the development of a capability gap that needs a short-term plug. Nelson signed the US Foreign Military Sales (FMS) deal for the Super Hornets in April 2007.

Despite speculation the Super Hornet could become a permanent addition to the RAAF's order of battle, the Chief of Air Force, Air Marshal Geoff Shepherd, has referred to it repeatedly as a 'bridging fighter' and still talks of an all-JSF force (see "$6B for Super Hornet" elsewhere on this site).

The haste and apparent lack of process involved in the Super Hornet purchase prompted Nelson's successor, Joel Fitzgibbon, to commission the review of the RAAF's future air combat capability options. The review will examine all of Defence's current plans and likely will be completed by mid-year so that it can inform the new Defence White Paper which will be published late in 2008 or in early-2009.

The uncertainties for defence planners arising from the review are significant: what will be the outcome of the Federal government's 2nd Pass examination of Air 6000 – New Air Combat Capability (NACC), currently planned for October 2008? Will the government continue with the purchase of the Super Hornets under Project Air 5349? And will the review recommend significant changes to some of the ADF's enabling air power capabilities, such as the purchase of the KC-30B tankers and Wedgetail AEW&C aircraft?

At the time of writing the schedule and terms of reference for the review hadn't been set, and nor had anybody been commissioned, either internally or externally, to carry it out. Fitzgibbon's office said only: "The Government has undertaken to conduct a thorough review of the Air Combat Capability options available to Australia. The mechanics of this review are currently being considered; however the review will commence as soon as practicably possible."

A fuller examination of the Review is contained in the article "Air Combat Capability Options Review to examine RAAF Air Power options" elsewhere on this web site. However, it seems probable that it will help gather sufficient information to assess realistically the costs and risks associated with the F-35A prior to 2nd Pass Approval.

Notwithstanding a vocal campaign marshalled by the lobby group Air Power Australia to cancel the F-35A and Super Hornet acquisitions and acquire instead aircraft such as the F-22A Raptor and F-15E Strike Eagle, and extend the lives of the F-111s, many analysts believe it's unlikely Australia will back out of the JSF program. It's less certain, however, whether or not the Rudd government will continue with the Super Hornet purchase.

In an interview with Australian Defence Magazine in September 2007 Fitzgibbon said, "I can't envisage a circumstance where we wouldn't remain … committed to the JSF.

Having said, that we have a responsibility to ensure we're getting value for money and that the final product is capable of meeting the government's and the country's requirements."

However, Fitzgibbon has been a vocal critic of the Super Hornet purchase because of both its cost and Defence's failure to follow its own Kinnaird process in identifying a capability requirement and then selecting a suitable aircraft to match it.

The head of Project Air 5349, Group Captain Steve Roberton, says the Super Hornet was chosen for the bridging fighter role because it was the most capable fighter available to Australia in the shortest timeframe and with the least disruption to the RAAF. In the medium term, he emphasises, the service remains committed to the JSF as its single combat aircraft type - and despite some media speculation to the contrary the RAAF has no intention of acquiring further Super Hornets or F/A-18G 'Growler' electronic warfare variants.

Subject to the outcome of the Review, on current plans the Super Hornets will sustain the RAAF through the introduction of the first two tranches of the F-35. When the 3rd tranche is acquired, some time in the next decade, these aircraft will replace the Super Hornets.

As to the question of retiring the F-111s, Dr Nelson stated in 2006 the F-111s will be withdrawn in the 2010-12 timeframe, with a decision on the exact timing expected 'soon'. This decision, too, will undoubtedly be examined in the Review, but the Cabinet, the RAAF and the Defence Materiel Organisation (DMO) all acknowledge that the critical path towards a safe withdrawal is strewn with obstacles.

First, the current AUD$2.2 billion Hornet Upgrade (HUG) program must be completed: under Phase 2.2, the Hornets are currently being fitted with a secure Link 16 Tactical Data Link (MIDS), full colour cockpit displays and digital moving map system, an upgraded Counter-Measures Dispensing System (CMDS), and the Joint Helmet-Mounted Cueing System (JHMCS).

Phase 2.3 will see the Hornets equipped with Raytheon's ALR-67(V)3 Radar Warning Receiver (RWR), a new supplementary CMDS and a new jamming system. Phase 2.4 will see a number of Hornets equipped with the Rafael/Northrop Grumman Litening laser and infra red targeting pod to provide a day and night precision targeting system. Phase 2 has also seen the commissioning by Raytheon of new flight simulators at the RAAF's Williamtown and Tindal bases which match the configuration of the upgraded Hornets.

Phase 3 of the HUG will see some 49 Hornets (at this stage) undergo a centre barrel replacement – the replacement of the centre fuselage section to which the aircraft's wings are attached. Depending on accrual of fatigue across the fleet, and the anticipated schedule for introduction of the F-35 (or acquisition of Super Hornets), this figure could change.

The RAAF's critical path also includes the introduction of the AGM-158 Joint Air-Surface Standoff Missile (JASSM); like the Litening targeting pod, this needs to be fully integrated with the Hornet, and isn't integrated with the Super Hornet – the US Navy favours the Raytheon AGM-154 Joint Stand-Off Weapon (JSOW), which the RAAF will acquire for its own Super Hornets. Full operational capability of JASSM isn't scheduled until 2009, at this stage.

The next potential stumbling block on this critical path is the introduction of the Wedgetail Airborne Early Warning & Control (AEW&C) system. The first two Wedgetail aircraft were scheduled for delivery in January 2007; they will not now arrive until at least March 2009, with Initial Operational Capability (IOC) scheduled for the following year. This revised schedule seems achievable but leaves little room for further delay – see "Project Wedgetail Backgrounder" elsewhere on this site.

Another pre-condition for retirement of the F-111s, according to the RAAF, is the introduction of its five new Airbus A330-200 Multi-Role Tanker Transports (now increasingly referred to by their US designation, KC-30B). The first of these is at EADS-CASA's Getafe plant near Madrid where its new centre line Aerial Refueling Boom System (ARBS), control station and under wing hose/drogue pods have been installed. The flight testing and certification process is under way with delivery to the RAAF scheduled for 2009. The remaining four tankers will be modified in Brisbane by Qantas Defence Services, starting in 2008. Again, this schedule leaves little room for unforeseen delays.

Assuming the Hornet Upgrade, Wedgetail and tanker programs meet their current schedule, the next big variable facing the RAAF is the JSF program schedule. The risk factors here are the US Congress, on the one hand, and potential technical problems on the other.

The program survived a Congressional threat to delay funding for Low-Rate Initial Production (LRIP) and has made the vital transition from development into production status, a key US program milestone. The first LRIP batch of two F-35As (compared with the original five planned) was approved in late-2006; these will be delivered in early-2010. Full funding for the second LRIP batch of 6 F-35As and 6 F-35B STOVL variants was approved in late 2007, as was long-lead funding for the 16 aircraft planned for LRIP 3; under the US procurement system long-lead funding for the F-35 is required three years before deliveries while full funding is required two years before deliveries.

Deliveries of the second, third and fourth LRIP batches are scheduled for late 2010, 2011 and 2012, respectively. The LRIP program consists of seven batches of around 400 aircraft in total.

On current plans Australia's first F-35A will be manufactured as part of the fifth batch of Low-Rate Initial Production (LRIP) F-35s and delivered in 2013. Due to the pressing need to replace its F-111s, Australia will be one of the first of the eight international

partners to receive its aircraft and the RAAF's first F-35A squadron will – on current plans - be fully operational back in Australia in 2015.

Australia's initial aircraft will be delivered in Block 3 configuration –the full functionality of the weapons, sensors and mission systems to be delivered under the SDD contract. Upgrade Blocks are planned to be delivered biannually.

There remains significant potential for development delays during flight test and systems integration. To mitigate these, prime contractor Lockheed Martin and the Joint Program Office have applied lessons learned from the F-22A Raptor program. One of the key advantages the JSF have is that many people working on the JSF are the same people that worked on the F-22, only 10 years later,

Like the F-22, the F-35 will be supported by an airborne test bed, the Cooperative Avionics Test Bed (CATBird). This consists of a Boeing 737 modified by BAE Systems in the USA with a complete F-35 cockpit and avionics inside the main cabin along with workstations for some 20 test and integration engineers. External modifications include the addition of a genuine F-35 nose cone, containing its Northrop Grumman APG-81 AESA radar, a 42-foot-long spine on the top, a 10-foot bay on the lower fuselage to accommodate electronic equipment, and twin 12-foot sensor wings that replicate the leading edge of the F-35's wings. These external strakes and aerofoils replicate exactly the positional relationships, cable runs and power supplies of the F-35's sensor suite.

The CATBird will develop and verify the F-35's ability to collect data from multiple sensors, and particularly the Electro-Optical Targeting System and Defensive Aids Sub-System, and fuse it into a coherent situational awareness display for the pilot. As a risk mitigation measure the CATBird is vital: it enables Lockheed Martin and its partners to concurrently develop and integrate mission system hardware and software well before it is installed on the F-35 itself.

The CATBird made its maiden flight on 23 January 2007 and began flight testing the first F-35 mission system module, the Communications, Navigation and Identification (CNI) sub-system in December 2007.

A major investment has also been made in the JSF system integration laboratory in Fort Worth. This represents another important lesson from the F-22 program. The F-22 employed three separate avionics, sensor and integration laboratories, at Marietta, Ft Worth and Seattle; for the F-35 all the various labs and the CATBird will be collocated at Ft Worth to ensure stovepipes don't develop and lessons and information pass as quickly as possible between them.

All of the major components are now under test and have flown already on various test beds, but never as an integrated whole. The F-35's APQ-81 active phased array radar has begun flight testing aboard manufacturer Northrop Grumman's BAC-111 airborne test bed at Baltimore. Similarly, flight testing of the DAS has already commenced at Edwards

Air Force Base aboard a modified F-16 and flight test of the Lockheed Martin Electro-Optical Targeting System (EOTS) has commenced in Florida.

As far as the F-35A itself is concerned, the first aircraft, F-35 AA-1, had made 25 flights at the time of writing. It resumed flight testing in December 2007 after a seven month lay-up caused in part by unexpected electrical problems during the 19th test flight in May 2007. Lockheed Martin used the opportunity to implement a number of mission and platform system software and hardware upgrades suggested by the previous flight tests.

Because AA-1 hasn't got the optimized airframe structure resulting from the 2004-05 weight loss program it is being used to focus on vehicle systems performance, aerodynamic testing and flight envelope expansion. It is also being used to conduct initial assessment of the Autonomic Logistics sustainment system which was activated in 2007. Naturally, it lacks the full avionics suite as well, being equipped with the flight control system, Integrated Power Pack (IPP - a new all-in-one Auxiliary Power Unit, Environmental Control System and Emergency Power System) and an interim suite of conventional flight instruments. Even getting AA-1 flying, however, required completion of around 50% of the final airborne software.

The second F-35 to enter the flight test program will be F-35 BF-1 which is scheduled to fly in May 2008. This is the first of the STOVL variants – and the first weight-optimised JSF - and will focus on STOVL flight envelope expansion.

The first drop of mission system software, Block 0.5, will be tested on the CATBird before being installed in the first F-35 mission system test aircraft, F-35 AF-3, late in 2008, to allow flight testing to begin in early-2009.

There will be 13 flight test aircraft in all (carrying an F designation) and six ground test airframes (with a G designation) which will be used for things like drop testing, fatigue testing and Radar Cross Section (RCS) measurement.

Of the flight test aircraft five will be F-35As (including AA-1), five will be F-35B STOVL variants and three will be F-35C carrier variants. Like the CATBird, those aircraft devoted to avionics testing will start small, testing individual sub-systems, such as the CNI, radar, DAS and EOTS, before testing combinations of these, and then the entire ensemble. Later in the flight test program weapons carriage and release trials and live firings will take place.

This process will be complicated by the need to develop and prove the avionics in successive Blocks. Block 1 is a stepping stone to operational capability. Block 2 will be the first combat-capable avionics suite, enabling use of AMRAAM air-air missiles and JDAM GPS-guided bombs. The US Marine Corps plans to declare IOC of its F-35Bs in 2012 with the Block 2 capability. Even Block 2 will be superior to the RAAF's upgraded 'classic' Hornets, according to Australian defence sources, but is reckoned by Boeing and the US Navy to be inferior to that of the Super Hornet Block II in terms of networking and sensor fusion capability.

Block 3, which the RAAF, USAF, US Navy and the other international partners have signed up for, is the full contractual capability and will be available in 2013. This is intended to bestow sensor performance, data fusion and networking capabilities superior to that of any other combat aircraft in service. It will incorporate a wide range of weapons: exactly which weapons won't be known until mid-2008, but the armoury is expected to include JDAM, JSOW, Small Diameter Bomb (SDB) the Paveway series and possibly JASSM as well, which has an anti-ship capability under development – but no dedicated anti-ship missile.

This is an important issue for the RAAF which needs an effective anti-ship missile. At present its main anti-ship weapon is the Harpoon, in both Block 1 and 2 forms, neither of which are scheduled for integration on the F-35. A maritime strike version of JASSM might be sufficient for many contingencies but the RAAF does want a proper anti-ship missile; until one is available for the F-35A it will have to continue operating the Hornet or Super Hornet as a Harpoon 'shooter'. As another option, Defence has also been working with the Norwegian Air Force to investigate the integration of the Kongsberg Joint Strike Missile (JSM) – the successor to the successful Penguin missile - onto the JSF.

The news in 2006 that Lockheed Martin and Kongsberg have teamed to promote the Norwegian company's JSM – an air-launched version of its new Naval Strike Missile (NSM) –suggests that this could be available with Block 4, in about 2016-17; there's no suggestion at this stage it will be available for Block 3.

Meanwhile, Lockheed Martin and the Pentagon, like the RAAF, are planning on the basis that there will be fully operational F-35s in frontline service around 2014.

Stealth, and Mass Production

The major investment by Lockheed Martin, Northrop Grumman and BAE Systems, along with the various sub-contractors and suppliers, in advanced design and manufacturing technology looks set to pay off. In particular, they have reported an order of magnitude drop in the number of design changes required during prototype assembly and testing, and production tolerances can be tightened up considerably – this is vital for Low Observable (LO) performance.

As a rough measure, legacy aircraft such as the F-16 require about 19 manufacturing hours per pound of weight; the F-35 AA-1 required just 14, and Lockheed Martin estimates that at full production the F-35 family will require about 9. Similarly, AA-1 threw up some 38 defects per 1,000 man-hours in production; legacy aircraft are currently throwing up 77, nearly double that, while in full production the F-35 family defect rate is expected to drop to 19 per thousand man-hours. Similarly, the supply chain lead time should fall from 66 weeks for today's legacy aircraft to about 28 once the F-35 is in full production. This should all help keep the cost of the F-35 down and hasten the ramp-up to full production.

As mentioned before tighter manufacturing tolerances enable achieving a lower RCS without major rework – a major affordability factor compared with the F-22. The challenge for Lockheed Martin and its partners has been to develop a stealthy aircraft which requires the minimum of LO refurbishment between sorties and the maximum tolerance of damage.

The F-35, like the F-22, derives its low RCS from its shape, internal carriage of weapons and sensors, as well as from exotic surface coatings and treatments. Coatings need to be applied to features such as the leading edges of aerofoils and engine air intakes as well as around access doors and panel joins. Higher production tolerances have enabled Lockheed Martin to design innovative treatments for things like panel shut lines which maintain a low RCS but don't require the same inspection and restoration between flights as earlier LO aircraft. Importantly, the JSF has been specified to achieve its RCS performance at the end of its 8,000 hour fatigue life.

This design approach has meant the LO characteristics of the aircraft are far more damage-tolerant than before, a robustness which has been demonstrated on the F-22 in operational service. ADM understands that minor damage (not defined, for obvious reasons) shouldn't reduce LO characteristics below the design specification. And even battle damage repairs are possible down at flight line level using something akin to an iron-on patch.

As a measure of how robust modern LO technology is, the original F-117 required some 50 man-hours per flying hour to maintain its stealth characteristics; after intensive development work this came down to 1.9; the F-22 has brought this figure down to 0.7 and the goal for the F-35 is just 0.3.

Flight testing will show just how durable the F-35's LO capabilities are when confronted with the need to sustain three sorties a day for realistic periods of time, and how much support is required to maintain the aircraft's RCS.

However, the key question of re-certifying the aircraft's RCS and LO characteristics following repair and deep maintenance remains unanswered. Lockheed Martin's RCS measurement facility at Ft Worth will be used initially to check all aircraft coming off the assembly line there. The RCS measurement facility enables the company and the Pentagon to measure the quality and consistency of the manufacturing and maintenance processes, and their effect on the aircraft's LO characteristics, and also affords the opportunity to certify the aircraft's LO performance before delivery to its customer.

Any operator whose F-35 suffers serious damage or which requires major disassembly will probably want its LO performance re-certified and at present there are no plans for another RCS measurement facility, which means customers either return their aircraft to Ft Worth or invest in such a facility themselves.

The F-35's VLO performance will create new operational and support challenges for most of its operators. Lockheed Martin has refused steadfastly to comment in detail on

the aircraft's stealth capabilities, except to say it has all-aspect stealth for both air-air and air-ground operations. The VLO performance of the aircraft was specified by the Pentagon and is reportedly a demanding requirement; the partner nations have been given undertakings on the VLO performance of their aircraft without any guarantee that these will match the VLO performance of aircraft ordered by the Pentagon.

One of the challenges for the company, and the Pentagon and the US State Department, has been to develop a stealthy platform which satisfies the capability requirements of all of its customers but doesn't compromise the USA's technology lead in this area. This is complicated by the need for export customers to maintain their own aircraft and the integrity of their LO capabilities during routine operations without compromising the USA's pre-eminence in either combat capability or the underlying technology.

The JSF will replace no less than seven different 3rd and 4th generation aircraft types operated by the eight international partners, making future coalitions more interoperable and mutually supportable. This in turn suggests that too great a difference between the capabilities, and especially the RCSs, of the US and 'export' variants, and too much dependence on US support for the LO capability, would work against the concept of coalition warfare in the future.

The capabilities bestowed by all-aspect stealth, sensor data fusion, new-generation optical and radar sensors and the inherent networking 'connectivity' of the F-35 have made it possible to develop all-new tactics for the aircraft which exploit its capabilities to the maximum.

The Pentagon would like its coalition partners to use aircraft with similar performance and RCS to the USAF, Marines and Navy, along with the same tactics, procedures and mission planning protocols, which suggests that major differences between US and export aircraft will be unacceptable.

This issue will be the subject of further, more detailed, analysis by Rumour Control.

A new capability

It would be rash to suggest the software development, systems integration and flight test program will be trouble-free: experience shows this is very rarely, if ever, the case. One justification for the acquisition of Super Hornet bridging fighters is Australia's experience of major software-intensive defence projects in the past: previous assurances that delays won't happen have proven false so Defence doesn't want to be caught out by an unforeseen delay in the JSF program at a time when it is unable to mount a swift response.

One key advantage Australia has in the JSF Program has, however, is that it plans to achieve Initial Operational Capability (IOC) approximately two years after the USAF plans to achieve IOC. A much lower risk situation than projects in which Australia is the lead or, even worse, is the only customer.

Whenever it arrives, however, advocates of the JSF maintain it will be worth the wait.

As part of its Quadrennial Defense Review in 2005/06, the Pentagon carried out a Joint Air Dominance Study (JADS) which examined current and projected air combat threats and counters. It concluded that LO was the key to survivability in future air combat. It also concluded that 5th generation fighters – which combine a unique blend of VLO, fighter performance, and advanced sensor information and fusion – will provide a dominant advantage over earlier generation aircraft.

The precise advantages offered by 5th generation aircraft such as the F-22 and F-35 have not been quantified in public, for obvious reasons. However, these were examined by a number of think tanks and analysts as part of the JADS and compared with representative 4th generation aircraft, particularly variants of the formidable Russian Sukhoi Su-27 family.

It was estimated the F-35 would deliver a relative loss-exchange ratio of 4:1 when put up against such an aircraft in air-air combat. It was eight times more likely to place lethal ordnance on a defended ground target; and it was assessed as offering better than a 3: 1 advantage in ISR (Intelligence, Surveillance and Reconnaissance). And Lockheed Martin believes the F-35 will cost the equivalent of a current model F-16 while costing around 20 per cent less to operate. The USAF has taken these estimates seriously; it plans never to order another 4th generation aircraft.

The current benchmark for 5th generation combat capability is the F-22 whose formidable capabilities, as US aviation magazine Aviation Week & Space Technology revealed in January 2007, were displayed in EX Northern Edge, an air defence exercise conducted in Alaska during the previous northern summer.

As expected, the F-22 shone as an air superiority fighter. It scored 144 simulated kills for no loss against F-15s, F-16s and F/A-18s. Interestingly, however, it also proved an important command and control asset, able to sit above the battle at altitudes of 65,000ft and detect incoming targets at long range. It could then engage these targets from well outside the victims' missile engagement zone, or download massive amounts of highly accurate active and passive sensor data to other fighters, airborne early warning aircraft and ground-based control centres. And that includes SIGINT information gathered through its EWSP suite.

The F-22 could also lead an element of F-15s or F/A-18s, sitting above them, detecting targets and then cueing its partners to engage while still well out of even radar range.

The F-35 will embody similar or superior sensor capabilities, thanks to its fully integrated EOTS and its Active Electronically Scanned Array (AESA) radar system which integrates Identification, Friend & Foe (IFF) as well as Electronic Attack capabilities. Now officials are talking of 'non-traditional ISR', using F-35s to gather surveillance and

reconnaissance data, as well as electronic order of battle data for coalition forces. In this arena, the F-35 is designed from the outset to be superior to the F-22.

In straight air-air combat, the F-22 has an undeniable advantage with super cruise at Mach 1.5 and a capacity for six internally mounted AMRAAMs, compared with the F-35's four. However, while lacking the F-22's super cruise capability the F-35A can carry as much fuel internally as the bigger F-22, according to Lockheed Martin chief test pilot Jon Beesley; this will enable the F-35A easily to exceed its combat radius target of 600nm.

Critics of the F-35 claim its isn't as stealthy as the F-22, but its advocates point out the F-22 was designed almost 20 years ago: "Do you think we haven't learned anything new about stealth over the past decade?" the author was asked. It is also smaller than the F-22 which has inherent advantages in terms of RCS.

This is as close as anybody has come to comparing the LO capabilities of the F-35 with those of the F-22. The impression received by ADM has been that, even if the F-22 has RCS advantages compared with the F-35, the differences between them are significantly less than those between the F-35 and the best of the 4th generation fighters. That difference between 4th and 5th generation aircraft, as disclosed to a select few, would seem to have been a key factor in the USAF committing to only VLO combat aircraft for its future fleet and for keeping the international partners engaged with the F-35 program, and even lobbying the US Congress to maintain funding for the LRIP phases to avoid program delays.

Defence Minister Joel Fitzgibbon's Review will presumably address the benefits a LO aircraft offers, including whether there is a significant difference between the F-22 and F-35, along with the relative capabilities of the Super Hornet and whether or not the RAAF could, or should, operate a mixed fleet of Super Hornets and F-35s beyond 2020.

Much will depend on the Review's assessment of the cost, capabilities and schedule of the F-35 program, and the risks overshadowing each of these aspects.

"No miracles required"

The chances of the F-35A meeting the RAAF's schedule, budget and capability targets are "good and getting better", according to Tom Burbage, Executive Vice President of Lockheed Martin Aeronautics.

Burbage was bullish in a presentation to Australian journalists at Lockheed Martin's Fort Worth plant in Texas in early-December 2006. But he acknowledged the uncertainty created by the Pentagon's Quadrennial Defence Review (which was impending at that time) and the annual horse-trading between the Pentagon, Congress and the White House over US defence budgets when he added that Lockheed Martin, as prime contractor for the Joint Strike Fighter, has no control over political processes currently under way which could affect the JSF program.

Nevertheless, he stated that no miracles are needed for the F-35 to meet Australia's schedule, budget and capability requirements and that he personally was very optimistic.

In late-2006 the Unit Recurrent Flyaway Cost of a Conventional Take-Off and Landing (CTOL) F-35A is about US$45 million in FY2002 dollars, but Lockheed is aiming to bring this down, Burbage said.

However, the JSF program is to an uncomfortable extent the victim of the way the US funds its defence programs: early production aircraft tend to be very expensive because they are ordered in much smaller numbers; if the resulting 'sticker shock' results in further reductions in planned orders, the unit price can seem to rise still higher in a so-called 'death spiral' which played a key role in reducing production orders for the B-2 stealth bomber and the F-22A.

In the case of the JSF, Congress proposed a reduction in funding in the FY 2008 budget for the ramp-up to full production of the F-35A. This will see the USAF get 48 a year through 2013, rather than the 110 a year it wants. The USAF is prepared to settle for 85 a year, but hasn't cut its planned total buy of 1,763 aircraft.

It's acknowledged that later production F-35s will be significantly cheaper, but somebody needs to buy the expensive ones first so the program can reach this point – and even the US appears reluctant to do this.

A number of international program partners, including Australia, are understood to be lobbying for a 'package' price which would make early production aircraft more affordable: considerably lower than the actual production cost, but slightly higher than the whole of program average unit cost. Some sort of agreement on this may need to be struck between the RAAF (and possibly other international partners), Lockheed Martin and the Pentagon during 2008 in order to allow a trouble-free 2nd Pass Approval process in late-2008.

Notwithstanding JSF price pressure caused by delays (both technical and Congressionally induced), the DMO stated in 2006 that the JSF was still 'very much at the lower end' of the price range of the original contenders for Project Air 6000. Estimates of the unit cost of a Eurofighter Typhoon, for example, varied around this time from US$65 million to US$75 million, though precise comparisons are notoriously hard to estimate.

For further insight into JSF pricing issues, read the "JSF Cost Analysis" by Dr Andrew Davies of ASPI, which is elsewhere on this site.

In any case, the SDD, LRIP and Full Rate Production (FRP) schedules, and their effect on price, are an elaborate structure with many dependencies – US Congressional and Senate approval for budget requests are just two of them. None of the other international partners have signed an order for the F-35 as yet so numbers and schedules remain a moot point. Potential purchases by FMS customers will also affect the ultimate price: the more aircraft acquired, the lower the price.

The 19 test aircraft are being built initially under Lockheed Martin's SDD contract which has transitioned into the first LRIP contract so that production ramps up smoothly from one aircraft a month in 2009 to six a month in late-2011 (LRIP batch 3) and then building gradually to 15 aircraft a month in Full-Rate Production (FRP) by the end of 2015.

Block 1 avionics DT&E begins in 2009, ending in late-2010; DT&E of Block 2 avionics begins in 2010 and segues into Operational T&E in 2012; Block 3 DT&E begins in 2011 – OT&E begins late-2012 and all testing should be complete by late-2013.

Somewhat confusingly, Initial Operational Capability (IOC) for the US Marine Corps (F-35B), USAF and USN (F-35A and F-35C, respectively) precedes some of these milestones. The US definition of IOC varies between the Services. For the USMC it is when the first full squadron is fully combat ready; the USMC expects to reach that milestone with an interim combat capability in mid-2012 at the completion of Block 2 OT&E. The USAF will declare IOC in early/mid-2013 with its first full wing while Block 3 OT&E is still under way. The UK Royal Air Force and Royal Navy expect to declare IOC in late-2014.

These dates represent a slippage of over a year on the original schedule, due mainly to the F-35B weight loss program, which delayed the first flights of all three variants by a year or so as well.

There's no doubt the avionics integration and flight testing program represents one of the highest-risk elements of the whole JSF program and has the potential to inflict significant delays on the JSF schedule.

The same applies, though in a lesser degree, to the JSF platform and propulsion system. While the aerodynamic performance and handling of the aircraft can be predicted fairly accurately, along with the platform's LO characteristics, aviation history shows there are always surprises lying in wait. These can only be resolved by patient developmental flight testing.

PSFD MoU

The multi-lateral Production, Sustainment and Follow-on Development (PSD) MoU was signed by all nine JSF partners by February 2007.

The MoU endures for the 'Life of the Program', Burbage says – a 40-year commitment – and addresses the management structure, procurement process, contractual arrangements and financial commitments required of each partner. It also recognises the various partners' differing national processes for procurement and funding of major defence acquisitions.

Signing the PSFD MoU was a critical milestone for all partners, and for Lockheed Martin – when they signed it the partners provided a firm estimate of the number of aircraft they

need and their preferred delivery schedule. They also agreed to pay what Lockheed Martin terms a 'fair share' of the non-recurring costs associated with moving to full production.

It's uncertain what Australia's share will be at this stage: although the large majority of NREs are incurred in the SDD phase, says the DMO, commitment to the PSFD MoU does include an obligation to share some additional costs - primarily production tooling, project office expenses, sustaining engineering and NREs associated with follow-on development. These costs will generally be shared proportionally to the number of aircraft a partner is intending to procure.

With production under way, the LRIP program will run for seven phases and will see deliveries begin in late-2009. The first international partner deliveries will begin in 2011/12 under LRIP Phase 3 with the first Australian delivery currently scheduled for May 2013 under LRIP Phase 5. The first FRP deliveries will be in 2015/16.

By that stage Lockheed Martin's mile-long F-35 plant at Ft Worth will be building 15 aircraft a month for the Pentagon and existing international partners, with capacity for eight more a month. Unless some of those customers demand a higher delivery rate the unused capacity will enable Lockheed Martin and the Pentagon to seek additional US Foreign Military Sales (FMS) customers for the F-35, such as Israel and Singapore, with first deliveries as early as January 2014.

Australian industry is waiting for the major JSF opportunities to crystallise. While work won by Australian companies in the 19-aircraft SDD phase amounts currently to a little over AUD$160 million, this is expected to multiply in the 519-aircraft LRIP and subsequent Full Rate Production (FRP) phases. Beyond the work already won in SDD Australian industry is pursuing major additional opportunities – publicised by Lockheed Martin to be worth as much as AUD$9 billion in production alone - including second source opportunities that are expected to flow into LRIP/FRP contracts.

Australian industry has performed reasonably well in the SDD phase, but the fact that contracts are awarded in an internationally competitive environment means there are still no guarantees for local firms. Australian industry opportunities and performance on the JSF program will be addressed elsewhere on the Rumour Control web site.

JSF Air System sustainment arrangements were addressed as part of the PSFD MoU negotiation process, but these were generally 'in principle' agreements given the relative immaturity of the project. They did, however, provide sufficient confidence to Defence and the Federal Cabinet that either suitable support arrangements were in place or that there is an acceptable process for developing these arrangements to meet sovereign requirements.

Locally, BAE Systems heads an industry team seeking to secure the support capability for the Australian fleet and hopefully building on that to become a regional support base for the JSF in Australia. As Australia is (so far) the sole JSF customer in the Asia-Pacific

region there would appear to be no reason why Australia shouldn't have its own national maintenance hub, but Burbage has cautioned repeatedly that Australia, like all of the partners, will need to determine its sovereign national support capability requirements and so the level of support it needs to be able to undertake locally. This process is still under way.

"Should a Regional Support approach prove to be the most feasible … for providing JSF Air System support in the Australian region, then Australia is confident that the US would support such an approach," according to the DMO.

Conclusion

The F/A-22 Raptor has demonstrated that stealth enables a step change in air combat capability which results in total air dominance, says Lockheed Martin. How far this may be true also of the F-35 won't become apparent until well into its T&E program; and it must be said that the JSF international partners are taking a great deal on trust.

But if the F-35 is as good as its supporters predict, then it will probably serve Australia well. However, the Joint Strike Fighter program breaks new ground in both fighter technology and defence cooperation: US control over access to the aircraft and, through it, to the LO technology it embodies will become a key determinant of the air threat environment faced by the US and its allies during the first half of this century, and their ability to defeat it. Food for thought.

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