



## The Joint Strike Fighter: overview and status

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## Introduction

The F-35 Lightning II, commonly known as the Joint Strike Fighter (JSF), is a so-called fifth generation multi-role aircraft designed with both fighter (air-to-air) and strike (air-to-ground) capabilities. The single seat aircraft is developed to fly at supersonic speeds for short periods of time. As a fifth generation aircraft it is expected to feature more advanced stealth technology than most other military aircraft and greatly improve pilot situational awareness through the use of more advanced radar and avionics. The technology is intended to give the pilot 360 degree tracking and targeting—in other words, the pilot does not have to see, nor does the aircraft have to be pointed at, a target in order to engage it.

Three variations of JSF aircraft are being developed by prime contractor Lockheed Martin: F-35A conventional takeoff and landing (CTOL), F-35B short take-off and vertical landing (STOVL) and the F-35C carrier based type. These variants aim to allow the United States (US) Government to supply its Air Force, Marine Corps, and Navy with a strike aircraft suitable for each service, based on a common airframe and using as much shared technology as possible. Australia intends to purchase the F-35A CTOL variant to replace the Royal Australian Air Force's (RAAF) F/A-18A/B Hornet aircraft.

What follows is an overview of the development of the project and some commentary on its successes and failures. This Background Note is necessarily selective as the JSF program is a very complex topic. Therefore the purpose of this publication is to highlight Australia's involvement in the program and provide a succinct status update.

## Background

### United States

The JSF program emerged from the US Joint Advanced Strike Technology (JAST) program which began in 1993.

The idea was to use a common platform, suitably modified to combine air-to-air and air-to-ground combat capabilities. Moreover, the aircraft was intended to meet the divergent needs of the US military to replace the Air Force's fleet of F-16 and A-10 fighter/attack aircraft (with the F-35A variant); the Marine Corps' Harrier STOVL aircraft (with the F-35B variant), and the Navy's carrier borne aircraft (with the F-35C variant). Three companies competed in the JAST concept development phase with Boeing, Lockheed Martin and McDonnell Douglas (teamed with British Aerospace and Northrop Grumman) providing aircraft designs.<sup>1</sup> On 16 November 1996, the US Department of Defense chose Boeing and Lockheed Martin to build and demonstrate two aircraft; one CTOL design

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1. C Bolkcum, *F-35 Joint Strike Fighter (JSF) Program: background, status, and issues*, United States Congressional Research Service, Washington, 2 June 2006, p. CRS-2, viewed 4 July 2012, [http://dpl/Books/2006/CRS\\_JointStrikeFighter.pdf](http://dpl/Books/2006/CRS_JointStrikeFighter.pdf)

and one STOVL design for the JSF.<sup>2</sup> Lockheed Martin won the competition, and on 26 October 2001 was selected to design and manufacture the suite of aircraft.

The technological innovation of the JSF program was to be matched by a new approach to acquisition, which was to include an emphasis on joint development, concurrent development and cost and performance trade-offs in order to control costs. The JSF program also used a project management concept called 'cost as an independent variable' (CAIV) which enabled trade-offs between performance and cost where the former was pushing up the latter in an unacceptable manner.

While the United States is the driving force behind the JSF, other countries are part of the program and most have contributed funds to the System Development and Demonstration Phase (SDD phase) and are intending to purchase versions of the aircraft at some point in the future. The JSF Program countries are:

- the United Kingdom (signed 17 January 2001 for US\$2 billion)
- Italy (signed 24 June 2002 for US\$1 billion)
- the Netherlands (signed 17 June 2002 for US\$800 million)
- Turkey (signed 11 June 2002 for US\$175 million)
- Canada (signed 7 February 2002 for US\$150 million)
- Australia (signed 31 October 2002 for US\$150 million)
- Denmark (signed 28 May 2002 for US\$125 million), and
- Norway (signed 20 June 2002 for US\$125 million).<sup>3</sup>

In addition, Israel and Singapore are involved as Security Cooperation Participants.<sup>4</sup> More recently, Japan has announced that it too will purchase the JSF, with plans to eventually acquire 42 aircraft.<sup>5</sup>

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2. Ibid., p. CRS-2.

3. United States Department of Defense F-35 Lightning II Program website, viewed 4 July 2012, [http://www.jsf.mil/program/prog\\_intl.htm](http://www.jsf.mil/program/prog_intl.htm)

4. Ibid. Security Cooperation Partners will purchase the JSF through the Foreign Military Sales program with the Defence Security Cooperation Agency acting as an intermediary rather than the purchaser dealing directly with Lockheed Martin.

5. K Takahashi, 'Lockheed Martin F-35A wins Japan's F-X competition,' *Jane's Defence Weekly*, 4 January 2012, p. 5, viewed 4 July 2012, <http://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;query=Id%3A%22library%2Fjrnart%2F1380185%22>

On 29 June 2012 Japan signed a contract to purchase the first four of its JSFs and additional equipment for US\$756.5 million. The unit cost of each aircraft is reported to be US\$128.6 million.<sup>6</sup>

The SDD phase was initially planned to run until 2012 but schedule slippage occurred as a result of issues around weight gain (of which more later) so the schedule was pushed back to 2016.

### **Australia's involvement in the JSF program**

The decision to purchase Joint Strike Fighters (which in Australian Defence procurement nomenclature is known as project AIR 6000—New Air Combat Capability (NACC)) has its origins in the 1990s. AIR 6000 first appeared in the *Defence new major capital equipment proposals 1998–2003* (the forerunner to the *Defence Capability Plan*). At this time new capabilities were to be acquired to replace the RAAF's F/A-18A/B fighter aircraft when they reached their life-of-type around 2012–15, and the F-111 strike/reconnaissance aircraft when they reached their life-of-type in 2020. Phase 1 of AIR 6000 was a Capability Definition Study which would consider options for a single aircraft type to replace both combat aircraft and 'other options for strike capability'.<sup>7</sup>

The 2000 Defence White Paper confirmed the Government's commitment to consider new air combat capability options stating that '[u]p to 100 new air combat aircraft' would be acquired. The acquisition phase was expected to start in 2006–07 with 'the first aircraft entering service in 2012'.<sup>8</sup>

According to an Australian National Audit Office (ANAO) report, Defence issued a Market Survey in November 2001 'to ensure the broadest possible range of force mix options would be considered'. In December 2001, Defence issued a Request for Information 'seeking additional information on nine potential Air Combat options'.<sup>9</sup> However, according to Defence's advice to the ANAO, this process was overtaken in early 2002:

In early 2002 an opportunity existed for Australia to join the [US] Joint Strike Fighter System Development and Demonstration (JSF SDD) program and Defence sought Ministerial approval to prepare a business case. In Jun 2002 the NSC [National Security Committee of Cabinet] considered the business case and authorised Defence to enter into Negotiations to enter the JSF partnership.

In Oct 2002 following successful negotiations NSC approved entry by Australia into the JSF SDD program and at the same time formally terminated any further consideration of other combat

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6. A Shala-Esa, 'US Japan sign deal on first four F-35 fighters,' *Reuters*, 29 June 2012, viewed 4 July 2012, <http://www.reuters.com/article/2012/06/29/us-lockheed-fighter-japan-idUSBRE85S0VE20120629>

7. Department of Defence, *Defence new major capital equipment proposals 1998-2003*, Commonwealth of Australia, Canberra, 1999, p. 39.

8. Ibid.

9. Australian National Audit Office (ANAO), *Planning and approval of Defence major capital equipment projects*, Performance Audit no. 48 2008–09, Commonwealth of Australia, Canberra, 30 June 2009, pp. 88–89, viewed 4 July 2012, [http://www.anao.gov.au/uploads/documents/2008-09\\_Audit\\_Report\\_48.pdf](http://www.anao.gov.au/uploads/documents/2008-09_Audit_Report_48.pdf)

platforms. Notwithstanding, ongoing monitoring of the wide option set was maintained by DSTO.<sup>10</sup>

The negotiations committed Australia to 'an investment of up to US\$150 million over 10 years to join as a level three partner'.<sup>11</sup> This was not a formal decision to acquire the JSF, but a decision to participate in the 'development and *expected* acquisition' of the JSF (emphasis added).<sup>12</sup> It was expected that partnership in the SDD phase would enable Australian companies to bid for work on the development of the JSF on a best value basis, which has since occurred.

In November 2006 the Minister for Defence announced that the Government was granting First Pass Approval to AIR 6000.<sup>13</sup> In December 2006, Australia signed onto the second phase of the JSF international development program, with the signing of the JSF Production, Sustainment and Follow-on Development (PSFD) Memorandum of Understanding (MoU).<sup>14</sup> Australia was the fourth international partner to sign the PSFD MoU after the Netherlands, Canada and the United Kingdom.

Concerned about the possibility of a capability gap once the F-111 was retired in 2010 rather than the previously assumed 2020 date, the Government decided to acquire twenty four F/A-18F Block II Super Hornet multi-role aircraft at a total cost of approximately \$6 billion for acquisition and support over ten years.<sup>15</sup> In his announcement of this decision in March 2007, the then Minister for Defence, Brendan Nelson, stated that the acquisition would 'ensure the transition to the F-35 Joint Strike Fighter'.<sup>16</sup> The Minister said:

The JSF is the most suitable aircraft for Australia's future combat and strike needs. Australia remains fully committed to the JSF. But the Government is not prepared to accept any risk to air combat and strike capability during the transition to the JSF...This in no way diminishes our commitment to the JSF Program subject to final Government approval in 2008. Current planning is for Australia to acquire its first JSF in 2013.<sup>17</sup>

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10. Ibid., p. 89.

11. There are three levels of international cooperation which roughly correspond to the amount of money the partner country puts into the development phase and their subsequent rights in purchasing the finished product, as well as the capacity of local industry to participate in production. R Hill (Minister for Defence) and I Macfarlane (Minister for Industry, Tourism and Resources), *Negotiations completed for Australia's entry into JSF program*, media release, 23 October 2002, viewed 4 July 2012,

<http://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;query=Id%3A%22media%2Fpressrel%2F23P76%22>

12. Ibid.

13. B Nelson (Minister for Defence), *The Joint Strike Fighter*, media release, 10 November 2006, viewed 4 July 2012,

<http://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;query=Id%3A%22media%2Fpressrel%2FNFFL6%22>

14. B Nelson (Minister for Defence), *Australia enters next phase of the JSF program*, media release, 13 December 2006, viewed 4 July 2012,

<http://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;query=Id%3A%22media%2Fpressrel%2FPNSL6%22>

15. The F-111s were retired during 2010.

16. B Nelson (Minister for Defence), *\$6 billion to maintain Australia's regional air superiority*, media release, 6 March 2007, 4 July 2012,

<http://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;query=Id%3A%22media%2Fpressrel%2FKZEO6%22>

17. Ibid.

This statement confirmed that Second Pass Approval for AIR 6000 was expected to occur in 2008, at which time the Government would formally commit Australia to acquiring the JSF. However, on 18 February 2008, the new Rudd Government announced that it would conduct a review of air combat capability. The purpose of the review was to look at Australia's air combat needs out to 2045 and specifically, to consider 'the relative capabilities of current and projected fourth and fifth generation combat aircraft such as the Joint Strike Fighter' and 'the case for and against acquiring the F-22' (something that, under current conditions, is impossible because US law forbids the sale of the F-22 and the US ceased production of the aircraft in December 2011).<sup>18</sup>

The Rudd Government's 2009 Defence White Paper, *Defending Australia in the Asia Pacific Century: Force 2030*, stated the Air Combat Capability Review had concluded that the JSF is the 'preferred solution to provide Australia with an effective and flexible air combat capability to 2030'.<sup>19</sup> The 2009 Defence White Paper stated that Australia would acquire around 100 F-35 JSFs as well as supporting systems and weapons. Three operational squadrons of 'not fewer than 72 aircraft' would be acquired in the first stage, with the acquisition of the remaining aircraft undertaken 'in conjunction with the withdrawal of the F/A-18F Super Hornet fleet...timed to ensure that no gap in our overall air combat capability occurs'.<sup>20</sup>

On 25 November 2009 the then Minister for Defence, Senator John Faulkner, announced that Australia would purchase 14 JSFs in the Conventional Take-Off and Landing (CTOL) variant at a cost of \$3.2 billion.<sup>21</sup> Australia was (and is) contractually obligated to purchase only two of the 14 aircraft; the remaining twelve were (and are) an intention. The Minister's media release foreshadowed the Government's intention to make the decision about the next (and much larger) batch of aircraft in 2012. However, by the time the 2011 Defence Capability Plan was released the initial operating capability (IOC) for the first JSF squadron had slipped from 2015 to 2018.<sup>22</sup>

The US Government Accountability Office (GAO) recently pointed out to the US Congress that the United States Department of Defense has deferred JSF procurement numbers for the last three years and that a fully integrated F-35 is unlikely to be tested before 2015.<sup>23</sup> Since 2002, the US has

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18. J Fitzgibbon (Minister for Defence), *Review of Australia's air combat capability*, media release, 18 February 2008, viewed 4 July 2012, <http://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;query=Id%3A%22media%2Fpressrel%2FGOPP6%22>
  19. Department of Defence, *Defending Australia in the Asia Pacific Century: Force 2030*, Defence White Paper 2009, Commonwealth of Australia, Canberra, May 2009, p. 78, viewed 4 July 2012, [http://dpl/Books/2009/defence\\_white\\_paper\\_2009.pdf](http://dpl/Books/2009/defence_white_paper_2009.pdf)
  20. *Ibid.*, pp. 78–79.
  21. J Faulkner (Minister for Defence), *F-35 Joint Strike Fighter—Australia's next generation air power*, media release, 25 November 2009, viewed 4 July 2012, <http://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;query=Id%3A%22media%2Fpressrel%2FKPBV6%22>
  22. Defence Materiel Organisation and the Capability Development Group, *Defence Capability Plan (Public Version)* (2011 DCP), Commonwealth of Australia, Canberra, 2011, p. 57, viewed 4 July 2012, [http://www.defence.gov.au/dmo/id/dcp/html\\_aug11/wp-content/uploads/2011/07/Defence-Capability-Plan-2011.pdf](http://www.defence.gov.au/dmo/id/dcp/html_aug11/wp-content/uploads/2011/07/Defence-Capability-Plan-2011.pdf)
  23. M J Sullivan, *Joint Strike Fighter: restructuring added resources and reduced risk, but concurrency is still a major concern*, Government Accountability Office, Washington, 20 March 2012, viewed 4 July 2012,

reduced the number of aircraft it intends to purchase by 2017 from 1591 to 365.<sup>24</sup> Full rate production is now scheduled for 2019, six years behind the revised baseline set in 2007.

The US Air Force has already taken steps to extend the lives of more than 300 late-model F-16 fighter aircraft and possibly some F-15 fighter aircraft 'to fill the gap caused by delays to the Lockheed Martin F-35 Joint Strike Fighter program'.<sup>25</sup> Likewise, the Marine Corps has acquired 74 retired Harrier jets from the British Royal Air Force to provide spare parts for its AV-8Bs (the US version of the Harrier Jump Jet), which could help extend their life until the JSFs are delivered.<sup>26</sup>

Australia has committed to purchasing an initial consignment of two aircraft for testing and training purposes, to be delivered in 2014–2015.<sup>27</sup> In line with the US decision to defer the purchase of 150 aircraft, Australia's pre-budget decision, announced on 4 May 2012, to delay the purchase of the second consignment of 12 JSFs by two years might be characterised as a straightforward recognition of reality with obvious benefits to the budget bottom line. Indeed, the current Minister for Defence has confirmed that Australia is 'now essentially on the same timetable for delivery of our first batch of JSFs as the US'. In essence, this decision defers around \$1.6 billion from the Defence budget over the Forward Estimates.<sup>28</sup>

Some commentators seem to agree with the Minister. For example, Derek Woolner (visiting fellow at the Australian National University's Strategic and Defence Studies Centre) states that:

... the \$1.6 billion to be saved by delaying acquisition of the F-35 joint strike fighter has few implications for policy...It is probably a sensible step to ensure what should be a less troublesome purchase.<sup>29</sup>

Of course, no path is without problems, and ASPI have pointed out that this delay pushes Australia's IOC much closer to that of the United States (leaving less time to benefit from US testing and

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[http://dpl/Books/2012/GAO\\_Joint%20StrikeFighter.pdf](http://dpl/Books/2012/GAO_Joint%20StrikeFighter.pdf). This report provides an assessment of the JSF program in the United States. A review of how these issues impact on Australia can be found in: A Davies, *What's Plan B: Australia's air combat capability in the balance*, Australian Strategic Policy Institute, Canberra, 11 May 2011, viewed 4 July 2012, [http://www.aspi.org.au/publications/publication\\_details.aspx?ContentID=292&pubtype=-1](http://www.aspi.org.au/publications/publication_details.aspx?ContentID=292&pubtype=-1)

24. Sullivan, *Ibid*, verso of title page.

25. G Warwick, 'USAF to extend lives of F-16s to cover F-35 Delays,' *Aviation Week*, 8 November 2011, viewed 4 July 2012, [http://www.aviationweek.com/Article.aspx?id=/article-xml/asd\\_11\\_08\\_2011\\_p01-02-391169.xml](http://www.aviationweek.com/Article.aspx?id=/article-xml/asd_11_08_2011_p01-02-391169.xml)

26. C Cavas, V Muradian and A Chuter, 'US to buy decommissioned British Harrier Jets', *Defence News*, 13 November 2011, viewed 4 July 2012, <http://www.defensenews.com/article/20111113/DEFSECT01/111130302/U-S-Buy-Decommissioned-British-Harrier-Jets>

27. J Gillard (Prime Minister) and S Smith (Minister for Defence), *Transcript of Joint Press Conference*, Canberra, 3 May 2012, viewed 4 July 2012, <http://www.minister.defence.gov.au/2012/05/03/prime-minister-minister-for-defence-minister-for-defence-materiel-joint-press-conference-canberra/>

28. *Ibid*.

29. D Woolner, 'Budget cuts under fire', *Australian Financial Review*, 4 May 2012, p. 50, viewed 4 July 2012, <http://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;query=Id%3A%22media%2Fpressclp%2F1608539%22>



evaluation) as well as bringing us closer to the end of the lifespan of the FA-18 Hornets (requiring the RAAF to further extend that life or to accept a smaller air force).<sup>30</sup>

## **Industry involvement**

Australia's accession to the JSF program has allowed Australian industry to access the JSF Industrial Participation Plan (the Plan, which is run by Lockheed Martin and the US Department of Defense is the means by which industrial opportunities are allocated). The value of involvement by Australian industry has been projected at between \$2 and \$3 billion over the life of the program.<sup>31</sup> Australia completed negotiations for industry's entry into the JSF program in October 2002. The then Industry Minister, Ian MacFarlane, said on this issue:

Based on initial indications, we expect Australian firms to capture work in excess of our entry cost in the development phase alone. They will also be positioned well for substantial work in longer term production and support.<sup>32</sup>

By the time the then Defence Minister, Brendan Nelson, had announced First Pass approval for the JSF on 10 November 2006, twenty Australian companies had won work on the program at an estimated value of US\$90 million.<sup>33</sup>

In November 2009, Lockheed-Martin signed two MoUs with three more Australian companies for the supply of some of the vertical tail and various fuselage components. The companies are Marand Precision Engineering Pty Ltd, Quickstep Holdings Ltd and BAE Systems (Australia).<sup>34</sup>

The overall value has now grown to around \$310 million with approximately 30 companies 'making parts or providing services' under the Plan.<sup>35</sup>

## **Cost**

The exact overall official cost to Australia for the purchase of up to 100 JSFs is unclear. This is partly because the Government has not released the detail of its cost estimates and partly because the cost of the aircraft is not yet fixed and will depend on, amongst other things, how many Australia

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30. A Davies, 2011, op cit., p. 6.

31. 'JSF: Australian industry participation,' *Asia Pacific Defence Reporter*, April 2010, viewed 4 July 2012, <http://www.asiapacificdefencereporter.com/articles/1/JSF-Australia-Industry-Participation>

32. R Hill (Minister for Defence) and I Macfarlane (Minister for Industry, Tourism and Resources), *Negotiations completed for Australia's entry into JSF program*, media release, 23 October 2002, viewed 4 July 2012, <http://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;query=Id%3A%22media%2Fpressrel%2F7TQ76%22>

33. B Nelson (Minister for Defence), *The Joint Strike Fighter*, media release, 10 November 2006, viewed 4 July 2012, <http://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;query=Id%3A%22media%2Fpressrel%2FNFFL6%22>

34. G Combet (Acting Minister for Defence), *Progress on securing major opportunities for local industry on the JSF*, media release, 4 November 2009, viewed 4 July 2012, <http://www.defence.gov.au/minister/94tpl.cfm?Currentid=9667>

35. Senate Foreign Affairs, Defence and Trade legislation Committee, Air Vice Marshall K Osley, Testimony, Defence Portfolio, Estimates 2012–13, 29 May 2012, viewed 4 July 2012, <http://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;query=Id%3A%22committees%2Festimate%2F5983d2c-c610-48df-8346-fef20a95b740%2F0001%22>

decides to buy and at what stage in the production cycle it buys them. One thing is certain; the cost has grown over the lifetime of the program, including the last five years.

In 2007, the Howard Government announced that around \$12 billion would be spent to purchase the proposed fleet of 100 JSFs.<sup>36</sup> In July 2008, the Rudd Government announced that the cost of Australia's new air combat capability could reach around \$16 billion.<sup>37</sup>

The then CEO of the Defence Materiel Organisation, Stephen Gumley, provided more detail in 2008 when he informed the Joint Standing Committee on Foreign Affairs, Defence and Trade:

I would be surprised if we paid more than about \$75 million a copy for the aircraft, measured in 2008 dollars and assuming we buy at least 75, or three squadrons. As you are aware, there are proposals for 75 and 100. Whichever quantity we may buy, it is a white paper decision and I will not speculate there, but it is of that order. Even if one were to buy 100, \$75 million times 100 is \$7.5 billion, which is well within the project's upper limits of \$12 to \$14 billion in the DCP at the moment. So as I sit here today, the JSF is affordable. I do not have any significant issues with the cost.<sup>38</sup>

Dr Gumley's figure of \$75 million per aircraft is presumably a flyaway cost and does not include through life costs.

In June 2012 the Minister for Defence provided more detail about funding of the JSF:

With reference to the acquisition of the first two F-35s:

(a) Australia's first two aircraft are likely to cost about \$130 million each in 2012 prices at a 1.03 United States exchange rate<sup>39</sup>

(b) The acquisition includes materiel and support to facilitate United States-based training operations, and includes, but is not limited to:<sup>40</sup>

(i) base and range support;

(ii) fuel, oils and other consumables;

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36. B Billson (Minister Assisting the Minister for Defence), *Address to the JSF advanced technology and innovation conference*, transcript, Melbourne, 26 March 2007, viewed 4 July 2012, <http://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;query=Id%3A%22media%2Fpressrel%2FT4FO6%22> and B Nelson (Minister for Defence), *Correcting the record on JSF*, media release, 9 July 2007, viewed 4 July 2012, <http://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;query=Id%3A%22media%2Fpressrel%2FNHNM6%22>
37. J Fitzgibbon (Minister for Defence), *Visit to Lockheed Martin in Texas to view progress on the US-led Joint Strike Fighter (JSF) program*, media release, 11 July 2008, viewed 4 July 2012, <http://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;query=Id%3A%22media%2Fpressrel%2FOYYQ6%22>
38. S Gumley (Chief Executive Officer, DMO), Department of Defence Annual Report 2006-07, Joint Standing Committee on Foreign Affairs, Defence and Trade, 10 July 2008, viewed 4 July 2012, <http://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;query=Id%3A%22committees%2Fcommjnt%2F10930%2F0001%22>
39. It should be noted that this is probably a flyaway cost.
40. If the above is a flyaway cost then the following list will add additional costs.

(ii) training expendables (weapons and countermeasures); and

(iii) student training courses.

(2) With reference to the acquisition of a further 12 F-35s:

(a) The average cost for the first 12 F-35s is expected to be about \$110 million each (2012 prices at a 1.03 United States exchange).

(b) The acquisition comprises:<sup>41</sup>

(i) additional pilot training in the United States;

(ii) initial spares associated with 12 aircraft;

(iii) auxiliary mission equipment (such as weapons adaptors);

(iv) training equipment and simulators to support operational testing;

(v) weapons to support commencement of operational testing;

(vi) support equipment associated with 12 aircraft;

(vii) facilities design and environmental planning activities;

(viii) initial contributions to a mission systems reprogramming facility;

(ix) information technology integration;

(x) initial contributions to shared Joint Strike Fighter Program costs;

(xi) ongoing Defence Science & Technology Organisation support activities;

(xii) operational test activities in Australia; and

(xiii) ongoing industry support initiatives.

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(c) Assuming an operational life out to 2046, the estimated through life and operating cost of the first 14 F-35s (including capability upgrades but not including acquisition cost) will be approximately \$9 billion (Then Year).<sup>42</sup>

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41. Again, presumably these would add to the cost.

42. B Carr (Minister representing the Minister for Defence in the Senate), 'Answer to Question on Notice, Question no. 1621, Defence: Joint Strike Fighter,' [Questioner: Senator D Johnston], Senate, *Debates*, 18 June 2012, p. 166, viewed 4 July 2012  
<http://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;query=Id%3A%22chamber%2Fhansards%2Fc14ef4e9-d2d8-4c93-bfee-992b83540b06%2F0382%22>

And in relation to the remaining—possibly 86— JSFs, when these are purchased:

In broad terms the operational cost of each aircraft as a component of a mature fleet of three squadrons would be in the order of \$200–250 million (using a reasonably conservative exchange rate) over a 30 year life at the currently expected rate of effort or about \$2.8–3.5 billion for the 14 aircraft currently approved...Operational costs for a total fleet of about 100 aircraft would be in the order of \$20 billion over a 30 year life based on the currently expected rate of effort and assuming the economies of scale of an eventual all Joint Strike Fighter fleet. Proportionally the final 86 aircraft would cost in the order of \$17 billion.<sup>43</sup>

In March 2012, the head of the NACC project, Air Vice-Marshal Kym Osley, assured a Parliamentary committee that despite a recent 'US decision to defer 179 US aircraft over the next six years' (effectively increasing the cost of Australia's 14 aircraft), project AIR 6000 remained 'within the cost envelope' originally approved by Government.<sup>44</sup> The 'cost envelope' was set by the Government in 2009 but the figure has not been revealed.

As noted above, the Minister and the Department of Defence have maintained for some time that an adequate degree of contingency has been built into Australia's cost estimates for purchasing the JSF. Although unwilling to discuss publicly what those contingencies are, they have stated that the cost, while at the upper end, is still within the original estimates.<sup>45</sup>

## Problems with the JSF

### Schedule and budgetary slippage

In a 2001 report the RAND Corporation opined:

The JSF is inherently difficult to develop. It is the first aircraft to combine stealth signatures with supersonic flight and the ability to perform short takeoff and vertical landings (STOVL). Mission systems integration across the three platforms also poses new challenges, and the JSF contains an unprecedented level of sensor fusion, requiring development of large amounts of software code.<sup>46</sup>

It is therefore unsurprising that there have been serious problems with the development of the aircraft and that many of them are a reflection of the attempt to gain commonality out of disparate needs. This has been exacerbated by decisions taken by Lockheed and the US Government about the

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43. Ibid.

44. K Osley (Program Manager New Air Combat Capability), *Review of the Defence Annual Report 2010–2011: Submission no. 8*, Joint Standing Committee on Foreign Affairs, Defence and Trade, 9 March 2012, viewed 4 July 2012, [http://www.defence.gov.au/dmo/publications/review\\_JSf.pdf](http://www.defence.gov.au/dmo/publications/review_JSf.pdf)

45. See for example: S Smith (Minister for Defence), 'Answer to Question without notice: Defence,' [Questioner: A Wilkie], House of Representatives, *Debates*, 17 August 2011, p. 8345, viewed 4 July 2012, <http://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;query=Id%3A%22chamber%2Fhansard%2F1649454-4f8a-46f2-898e-301fe4e49278%2F0121%22>

46. I Blickstein, et al., *Root cause analysis of Nunn-McCurdy breaches*, volume 1, RAND National Defence Research Institute, Washington, 2011, p. 36, viewed 4 July 2012, [http://dpl/Books/2012/RAND\\_RootCauseAnalyses.pdf](http://dpl/Books/2012/RAND_RootCauseAnalyses.pdf)

management of the project. The JSF has a high degree of what is called concurrency—this means that later stages of a project (that is, aircraft production), are taking place while some aspects of research and development are ongoing. The RAND report, quoted above, estimates that 25 per cent of the total project is concurrent and notes this is the largest rate of concurrency in any US military aircraft project.<sup>47</sup> This increases the risk that problems will be discovered after the aircraft have been produced. In December 2011, US military JSF program director, Vice Admiral David Venlet, admitted that concurrency:

... was a miscalculation...You'd like to take the keys to your shiny new jet and give it to the fleet with all the capability and all the service life they want. What we're doing is, we're taking the keys to the shiny new jet, giving it to the fleet and saying, 'Give me that jet back in the first year. I've got to go take it up to this depot for a couple of months and tear into it and put in some structural mods, because if I don't, we're not going to be able to fly it more than a couple, three, four, five years.'<sup>48</sup>

Vice Admiral Venlet went on to state that he did not consider that issues such as cracks in the aircraft frame and stress hot spots constitute a problem with the design. However, problems resulting from concurrency errors create tension between the need to slow production to fix the problem and the desire to ramp it up in order to reduce the cost. A March 2012 US GAO report on the JSF estimates the additional cost of the extra work to deal with these problems at US\$373 million.<sup>49</sup> Recent testimony to the US Congress by the Department of Defense puts this figure even higher:

Unfortunately, the cost growth problem persists. As of March 2012, DOD estimates total concurrency costs for LRIP-1 at \$50.1 million; LRIP-2, \$300.3 million; LRIP-3, \$319.1 million; and LRIP-4, \$523.3 million.<sup>50</sup>

(LRIP is Low Rate Initial Production which is the pre-large scale production phase of the JSF program.)

JSF milestones have been consistently missed almost from the start of the program. The chief initial cause was the need to improve the thrust produced by the engine for the STOVL version (F-35B). As a consequence, the engine has grown larger and the weight of the aircraft has increased. In turn, this led to problems with maintaining the stealth profile of the aircraft; as a result the STOVL version has

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47. Ibid., p. 37.

48. R Whittle, 'JSF's Build And Test Was 'Miscalculation,' Adm. Venlet Says; Production Must Slow,' *AOL Defense*, 1 December 2011, viewed 4 July 2012, <http://defense.aol.com/2011/12/01/jsf-build-and-test-was-miscalculation-production-must-slow-v/>

49. M Sullivan, *Joint Strike Fighter: restructuring, added resources and reduced risk, but concurrency is still a major concern: testimony before the Subcommittee on Tactical Air and Land Forces, Committee on Armed Services, House of Representatives, United States Government Accountability Office*, US Government Accountability Office, Washington, March 2012, viewed 4 July 2012, <http://www.gao.gov/products/GAO-12-525T>

50. United States Senate, Committee on Armed Services, *National Defense Authorization Act for Fiscal Year 2013 report*, 4 June 2012, viewed 4 July 2012, [http://insidedefense.com/index.php?option=com\\_iwppfile&file=pdf12/06052012\\_sasc.pdf](http://insidedefense.com/index.php?option=com_iwppfile&file=pdf12/06052012_sasc.pdf)

a reduced weapons payload. Weight issues also slowed the Research and Development work on the CTOL version.<sup>51</sup>

However, generating more thrust with a given engine size requires more airflow, which requires larger engine inlets. This action conflicts with stealth measures, which limit the size of engine inlets to reduce aircraft signature

Dealing with these issues meant that all of the initial milestones were missed by approximately two years. Since a major part of the plan for affordability was that high rate production would be reached early—just six years after first flight—this was a real problem. There are a number of reasons for the delays and cost increases in the program. The previously mentioned RAND report lists initial unrealistic cost estimates, an aggressive program schedule that did not allow for the complexity of the project, immature technology and insufficient allowance for having to integrate the technology as the main contributing factors to schedule delays and cost increases.<sup>52</sup>

In 2010 this resulted in a so-called Nunn-McCurdy breach and subsequent re-base lining of the program. A Nunn-McCurdy breach is named for Senator Sam Nunn and US Congressman David McCurdy who moved an amendment to the Department of Defense Authorization Act of 1982 which sought to have programs with serious budget overspends cancelled unless the Secretary of Defense certified that they were vital to the national security of the United States. A fuller explanation can be found in the RAND report.

The 2010 breach was one of the outcomes of a major review by the Department of Defense of all aspects of the program and resulted in a major restructuring of the JSF program. This included the deferment of the purchase of 122 aircraft so that additional money could be put towards testing, the replacement of the senior military officer running the program and the recognition that the SDD phase would take a further 13 months to complete.

The most recent 2012 GAO report provides the following data on cost growth and procurement quantities.<sup>53</sup> The costs contained in the following table reflect a new (as at March 2012) acquisition baseline for the program.

	2001	2012
<b>US Procurement quantities</b>	2852	2443
<b>Total program acquisition cost estimates</b>	US\$233 billion	US\$395.7 billion
<b>Average procurement unit cost</b>	US\$69 million	US\$137 million

It should be noted that the figures for costs are in constant dollars and that the procurement numbers are for the US only and Lockheed Martin expect to sell around 700 more worldwide.<sup>54</sup>

51. I Blickstein, et al., op. cit., pp. 48-49.

52. Ibid., p. 42.

53. M J Sullivan, *Joint Strike Fighter: DOD actions needed to further enhance restructuring and address affordability risks*, United States Government Accountability Office, Washington, June 2012, p. 5, viewed 4 July 2012, <http://www.gao.gov/products/GAO-12-437>

The March 2012 GAO report stated that 2011 flight testing was basically on track but noted that, as at the end of 2011, while 21 per cent of flight test points had been completed, some of the most challenging were still to come.<sup>55</sup> Flight testing of a fully integrated JSF (that is, one with usable combat and flight systems) is unlikely before 2015.

The GAO also expressed concern about software development for the JSF. There are 24 million lines of software code necessary to make the JSF work in the manner it is supposed to (9.5 million on the aircraft itself)—six times the number required for the Super Hornet. As such, development is ‘taking longer to complete than expected’ and is a pressing issue for the JSF program.<sup>56</sup>

At present, the first JSF variant to reach initial operating capability should be the F-35B which the Marine Corps hopes will reach this important stage by 2015.<sup>57</sup>

In Australia, the Minister for Defence has stated that the Government is looking at other options for ensuring Australia maintains satisfactory air capability as a result of the delays in the JSF program—‘Super Hornets is an obvious example or an obvious option to contemplate. But we’ve made no judgments or conclusions about that’.<sup>58</sup> The Minister has indicated that a decision will be made during 2012.<sup>59</sup>

It should be noted that it is normal for complex and groundbreaking programs like the JSF to run over schedule and over budget. The F-22 Raptor, generally thought to be the best existing fighter aircraft in the world, suffered many problems during production (and continues to be plagued by issues with availability and high maintenance costs).<sup>60</sup> So too did the much loved F-111, which was widely portrayed as a disaster through much of its development.<sup>61</sup>

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54. T Burbage, Testimony, Joint Committee on Foreign Affairs, Defence and Trade: Department of Defence Annual Report 2010–11, 20 March 2012, viewed 4 July 2012, <http://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;query=Id%3A%22committees%2Fcommjnt%2F3cb4e326-70e4-4abd-acb7-609a16072b70%2F0001%22>
  55. M Sullivan, *Joint Strike Fighter: DOD actions needed to further enhance restructuring and address affordability risks*, op. cit., p. 9.
  56. *Ibid.*, p. 11.
  57. G Gertler, *F-35 Joint Strike Fighter (JSF) Program*, United States Congressional Research Service, Washington, 16 February 2012, p. 6, viewed 4 July 2012, [http://dpl/Books/2012/CRS\\_F-35JointStrikeFighter2012.pdf](http://dpl/Books/2012/CRS_F-35JointStrikeFighter2012.pdf)
  58. S Smith (Minister for Defence), *Transcript of press conference*, media release, 30 January 2012, viewed 4 July 2012, <http://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;query=Id%3A%22media%2Fpressrel%2F1382077%22>
  59. S Smith (Minister for Defence), ‘Answer to Questions without notice: Defence,’ [Questioner: A Wilkie] House of Representatives, *Debates*, 14 February 2012, p. 1115, viewed 4 July 2012, <http://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;query=Id%3A%22chamber%2Fhansard%2Fa65a0414-5b1f-4110-8b65-7577b8aa9d55%2F0021%22>
  60. D Isby, ‘Raptor reality: F22 production ends: problems remain,’ *Air International*, February 2012, pp. 84–89, viewed 4 July 2012, <http://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;query=Id%3A%22library%2Fjrnart%2F1407618%22>
  61. A Stephens, *The Australian Centenary History of Defence, Vol. II, The Royal Australian Air Force*, Oxford University Press, Melbourne, 2001, pp. 285–290.

## Is it the right aircraft?

Some commentators question the validity of the JSF concept. Essentially, their argument is that the aircraft places too much reliance on its radar and avionics and not enough on actual flying performance. It is claimed that there is better technology being developed and this will serve to make the plane an expensive mistake. Australia's leading critics of the JSF, Carlo Kopp and Peter Goon from Air Power Australia, claim:

- the aircraft is becoming less affordable as the program develops
- the stealth capabilities are of a lesser order than other fifth generation aircraft and are likely to decline in effectiveness as military radar technology continues to improve
- weapons payloads are insufficient for some of the tasks the aircraft will be required to fulfil and
- the aircraft is less aerodynamically capable (manoeuvrable) than it needs to be to perform adequately in a combat situation, especially against aircraft being developed by Russia (T-50 PAK-FA) and China (Chengdu J-20).<sup>62</sup>

It is difficult to assess these claims, because some of the arguments are of a highly technical nature and much of the data necessary to form an understanding of the performance of the JSF is classified and not available for public scrutiny. As journalist Andrew McLaughlin points out:

The question of whether the F-35 will have sufficient capability in order to be relevant against forthcoming Russian and Chinese systems is not easy to determine without access to classified test data to analyse...Analysis from such groups as Air Power Australia claim that the F-35 will not have the range, power to weight ratio, manoeuvrability, and weapons load to be able to engage these adversaries on a one to one basis. They also claim that the JSF's very low observability characteristics will soon be compromised by Russian low-frequency radar systems or infra-red trackers currently under development for ground based SAM systems...But these are claims which are not easily countered without revealing classified data.<sup>63</sup>

In response to recent and highly critical representations made to the Defence sub-committee of the Joint Standing Committee on Foreign Affairs, Defence and Trade by Air Power Australia and RepSim Pty Ltd, the Department of Defence stated:

- a. Cost is currently within the approved cost envelope.
- b. Capability is expected to meet RAAF's planned Initial Operational Capability requirements as advised to Government in 2009.

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62. C Kopp, '[Assessing JSF air combat capabilities](#),' *Air Power Australia Analysis*, 10 November 2008; for a more detailed explorations of these criticisms see the Air Power Australia website at: <http://www.ausairpower.net/jsf.html>

63. A McLaughlin, 'Joint Strike Fighter: scrutiny increasing,' *Australian Aviation*, November 2009, pp. 46–49, viewed 4 July 2012, <http://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;query=Id%3A%22library%2Fjrnart%2FRIOV6%22>



c. Schedule remains on schedule to deliver our first two aircraft in 2014 for US-based training.<sup>64</sup>

Defence's submission to the Committee goes on to say:

To comprehensively rebut many of APA's assertions in regard to F-35 performance would require release of highly sensitive U.S. data. As neither APA nor RepSim have access to the detailed classified F-35 data, their analysis is basically flawed through incorrect assumptions and lack of knowledge of classified F-35 performance information. Without this knowledge, APA and RepSim can only speculate on the F-35's capabilities and its ability to counter extant and evolving threats.<sup>65</sup>

In 2011 the US Department of Defense conducted a review of the technical data on the JSF in order to assess whether sufficient confidence could be placed in the program to warrant additional 'concurrent' purchases.<sup>66</sup> The report concluded that there were 'no fundamental design risks sufficient to preclude further production'.<sup>67</sup> Some major development issues were identified, the most important of which for Australia relates to the development of the Helmet Mounted Display System which has amongst other things, suffered from excessive jitter (making it difficult for the pilot to read the display).<sup>68</sup> This has led to the development of a second less advanced helmet, but whichever version is ultimately used will not be integrated until at least 2014.

## Conclusion

The controversy that has grown around the JSF results in part from the vociferous opposition to the aircraft by some commentators, but even more so because of the steady growth in cost and schedule slippage over the past decade. This comes at a time when governments around the world are responding to the extraordinary economic difficulties of the post global financial crises and, in the West at least, reducing defence spending. This has heightened sensitivity to the absolute cost of the aircraft and whether taxpayers are getting proper value for money out of what is by any measure a very expensive program. It is difficult to imagine that the United States will not see the program through to completion and that Australia will not purchase significant numbers of the JSF. Whether we will celebrate the JSF with the same enthusiasm that we have given to the F-111 at the time of its retirement is perhaps another matter.

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64. Department of Defence, *Submission to the Review of the Defence Annual Report 2010–11, New Air Combat Capability Program*, Department of Defence, Canberra, March 2012, viewed 4 July 2012, [http://www.defence.gov.au/dmo/publications/review\\_JSf.pdf](http://www.defence.gov.au/dmo/publications/review_JSf.pdf)

65. Ibid, paragraph 7.

66. D Ahern, et al., *F-35 Joint Strike Fighter: concurrency quick look review*, Department of Defense, Washington, 29 November 2011, viewed 4 July 2012, [http://dpl/Books/2012/USDoD\\_JSfConcurrencyQuickLook.pdf](http://dpl/Books/2012/USDoD_JSfConcurrencyQuickLook.pdf)

67. Ibid., p. 1

68. Ibid.

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