Australian Government
Department of Defence

Senate Standing Committee on Foreign Affairs, Defence and Trade Inquiry into the Planned Acquisition of the F-35 Lightning II Joint Strike Fighter

Department of Defence
Written Submission

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Executive Summary

1. To provide the most capable and cost effective solution for Australia's future air combat requirements, the Australian Government has approved the acquisition of 72 F-35A aircraft along with associated weapons, spares, support equipment, and infrastructure. The Australian Joint Strike Fighter (F-35) Program has two fundamental goals:

   a. to deliver a new air combat capability that will meet Australia's air combat needs; and

   b. to deliver a strong industry base that supports the global F-35 capability and provides Australia with long-term economic benefits.

2. The F-35 Program was established in 2002. In 2010, the US Department of Defense identified some serious problems with the F-35 Program and undertook a major re-baseline of cost, schedule and capability outcomes. However, since the F-35 Program was re-baselined in early 2012, it has gained momentum and significant progress has been achieved. The F-35 Program is currently in the developmental phase and remains technically challenging with further issues expected to be encountered, which is to be expected when developing technically complex and sophisticated military platforms.

3. The Australian F-35 Program draws substantially from the United States (US) led global F-35 Program with an emphasis on integration of the F-35 capability into the Australian Defence environment.

4. The Australian F-35 capability is achieving positive progress and is on track towards meeting Australia's initial operational capability requirements by December 2020 and final operational capability in 2023. A key milestone prior to achieving initial operational capability is the arrival of the first two aircraft in Australia in late 2018. The timeline to establish the required support for initial operations in Australia is challenging, but the risks are manageable.

5. The recent release of the Director of Operational Test and Evaluation[1] (DOT&E) 2015 report has provided a perspective of issues confronted by the F-35 Program during test and evaluation. These issues are well known and being managed by the F-35 Joint Program Office, prime contractors, and partner nations. As highlighted in the report, schedule pressure of 6-12 months is clearly evident for the completion of the System Development and Demonstration phase late in 2017. Defence assesses that Australia can still achieve initial operational capability by December 2020 fully cognisant of the issues raised in the report.

6. In assessing the level of risk, it is important to understand the context in which the risk is being managed. The F-35 Program is one of the most technologically advanced and complex development programs ever undertaken in the defence aviation environment.

[1] The United States Director, Operational Test and Evaluation releases a public report covering the major systems under operational test and evaluation each year covering the major systems under operational test and evaluation each year.

7. The F-35 Program overall is maturing and gaining momentum with Prime contractor Lockheed Martin and Pratt & Whitney having now delivered more than 150 F-35s with a further 110 aircraft currently in various stages of assembly at the F-35 production plants in Fort Worth, Texas and Cameri, Italy. In 2015, a total of 45 F-35s were delivered on schedule, which represents a 25 percent increase in the production rate over the previous year.

8. The F-35 is now operating from eight US bases and has flown more than 50,000 flight hours. By the end of 2016, around 200 F-35s will be in operational service and by 2035 the global fleet is expected to grow to over 3,000 aircraft. To date more than 240 pilots and 2,400 maintainers have been trained. Two Australian pilots are now F-35 qualified and instructing at the international F-35 Pilot Training Centre, at Luke Air Force Base, Arizona.

9. The first two Australian F-35 aircraft were delivered late 2014 and are proving to be some of the most reliable and available in the aircraft pool at the international F-35 Pilot Training Centre. Australia's next eight aircraft will be delivered in 2018 and two of these aircraft will ferry to Australia to begin the ramp-up of Australian operations.

10. As an F-35 partner, Australian industry has the opportunity to contribute to capability outcomes and as at December 2015 has already received US$554.5 million in F-35 production contracts. Australia has also been assigned regional F-35 depot maintenance responsibilities for airframe and engine.

11. Defence is confident that the F-35A is the most capable and cost effective solution for meeting Australia's air combat requirements and that an informed re-examination of the alternatives would reach the same conclusion. This confidence comes through Defence's close day-to-day engagement in the F-35 Program as a strong ally and key partner, and is reinforced by the commitment that other partners and foreign military sales customers are demonstrating through their aircraft orders. Defence acknowledges that executing the remainder of the F-35 Program is not without risk.

Program Background

12. Project AIR 6000 was established in 1999 to acquire a new air combat capability to replace the capability provided then by the Royal Australian Air Force's (RAAF) F/A-18A/B and F-111C/G aircraft. Defence sought formal requests for information on a list of prospective candidates, including the F-35 Joint Strike Fighter (JSF).

13. In 2002, the US Government invited close allies, including Australia, to invest in the System Development and Demonstration Phase of the F-35 Program. The System Development and Demonstration phase is a developmental phase where capability is developed, tested and evaluated resulting in capability expansion over time.

14. In June 2002, the Australian Government decided, in conjunction with a decision to join the F-35 System Development and Demonstration program, that the F-35A was the preferred aircraft to provide Australia's new air combat capability. Defence undertook to monitor other prospective candidates should the F-35 Program not develop as expected.

15. In making this decision Australia recognised the benefits of standardisation, rationalisation and interoperability associated with a cooperative program to satisfy similar operational requirements more affordably, as well as to provide industrial participation opportunities in global supply chains.

16. The F-35 partner nations are the US (Project Lead), United Kingdom (UK), Italy, Netherlands, Australia, Turkey, Canada, Denmark and Norway. The F-35 is also being purchased by non-partners Israel, South Korea, and Japan through foreign military sales. Interest is also being shown by at least five other potential foreign military sales customer nations.

17. The single engine, single seat F-35 is being manufactured in three variants:

a. F-35A - CTOL – conventional take-off and landing;

b. F-35B - STOVL – short-take off and vertical landing; and

c. F-35C - carrier variant.

18. Australia is purchasing the F-35A variant.

19. A key tenet of the F-35 Program was the adoption of a very capable design that aimed to improve affordability by taking advantage of the economies of scale that comes from common parts and processes.

20. The F-35 design itself is a product of war fighter requirements which considered the relative importance of specific fighter characteristics in the execution of the intended missions. The importance of stealth, payload, range and combat manoeuvrability, obtained through weapons, fuel and sensors being carried internally, outweighed other potential design choices.

21. Networked with advanced datalinks and sensors, a combat configured F-35 has the manoeuvrability, stealth and superior situational awareness to enable the

engagement of air and surface targets while delaying and defeating an adversary's attack.

22. The above characteristics of lethality, survivability, affordability and supportability define the F-35 as a fifth-generation fighter. Defence understands the design parameters for the F-35A and the combined effect of its fighter characteristics in the battlespace, and is confident that this variant of the F-35 design will meet Australia's war fighting needs.

23. In 2006, the Australian Government considered the First Pass for the AIR 6000 Phase 2A/B and agreed to Defence committing to the F-35 Production Sustainment and Follow-On Development Memorandum of Understanding, which provides the framework for ongoing partner engagement and obligations through the life of the F-35 capability following the completion of the System Development and Demonstration phase.

24. The US-led F-35 Joint Program Office manages the F-35 Program and contracts with prime contractor Lockheed Martin and engine manufacturer Pratt & Whitney on the behalf of partners under arrangements defined in the System Development and Demonstration and Production Sustainment and Follow-On Development Memorandums of Understanding.

25. In November 2009, the Australian Government approved AIR 6000 Phase 2A/B Stage One (Second Pass) of the Australian Program to acquire 14 F-35A aircraft and the associated support elements necessary to establish the initial training capability in the US at a cost of A$3.2 billion. At Stage One, an initial operational capability of 2018 was also agreed. Government also agreed that Defence seek approval in 2012 to procure (at least) a further 58 F-35A aircraft, with a further phase (Phase 2C) for an additional 28 aircraft to be considered in the context of the Force Structure Review that informed the new Defence White Paper.

26. In March 2010, the US Department of Defense advised that the F-35 Program had breached certain US Government requirements[2]. This, coupled with the impact of the Global Financial Crisis, led to a re-baselining of the F-35 Program, including the deferral of production commitments. Subsequently, the F-35 Program aimed to complete the System Development and Demonstration phase with an initial warfighting capability by the end of 2017. As a consequence, the procurement of the Australian F-35 Program was deferred by two years resulting in initial operational capability moving from 2018 to 2020.

27. The Australian Government approved second stage (Second Pass) funding for the next 58 Australian F-35A aircraft in April 2014 at a cost of A$12.4 billion. The combined stage one and two budget for the cost of 72 F-35As, support systems including information systems, training, weapons, infrastructure and contingency funding was A$15.5 billion. The total approved acquisition budget for Australia's F-35A Program is routinely adjusted for variances in the US/Australia exchange rates. Based on exchange rates the approved budget was A$17.8 billion as at January 2016. Government also agreed to an operating and support budget of A$4.6 billion out to financial year 2024/25 at this time.

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[2] The Nunn-McCurdy Act requires the US Department of Defense to report to Congress whenever a Major Defense Acquisition Program experiences cost overruns that exceed specified thresholds.

28. Australia plans to ferry the first two F-35A aircraft to Australia in late 2018. Initial operational capability is planned for 2020 with the establishment of 3 Squadron (3SQN) to be followed by 2 Operational Conversion Unit (2OCU) and supporting systems and infrastructure at RAAF Base Williamtown. Final operational capability is planned for 2023 with the establishment of 77SQN at RAAF Base Williamtown and 75SQN at RAAF Base Tindal.

29. Since the F-35 Program was re-baselined by the US Department of Defense in 2012, it has stabilised and matured, remaining within the re-baselined budget, schedule and capability parameters. Much of the ongoing reporting on the F-35 Program cost growth and schedule slippage has been based on issues that occurred earlier in the Program and led to the breach in 2010. The F-35 Program is currently on track to complete the System Development and Demonstration phase in late 2017, but this is not without some risk. The schedule risk for Australia is discussed later in the paper.

30. The F-35 Program is executing the System Development and Demonstration phase through a developmental test and evaluation program, which evaluates the aircraft and supporting systems, leading to acceptance of these systems. There is schedule risk associated with the completion of the test and evaluation program and incorporation of fixes to meet the scheduled completion of the System Development and Demonstration phase by the end of 2017. The completion of test and evaluation is a critical precursor to the conduct of operational test and evaluation, which aims to test these systems in an operationally representative environment.

31. Prime contractor performance continues to improve, with Lockheed Martin and Pratt & Whitney having now delivered more than 150 F-35s under annual Low Rate Initial Production contracts and a further 105 are currently in various stages of assembly at the F-35 production plant in Fort Worth, Texas. In 2015, a total of 45 F-35s were delivered on schedule, which represents a 25 percent increase in the production rate over the previous year.

32. Further demonstrating program maturity, the US forces currently have over 150 aircraft operating from eight bases conducting test and evaluation, training and operations. International F-35s are currently being operated by Australia, the UK, Italy, the Netherlands, Norway and Israel, with Italy in 2015 becoming the first partner nation to fly an F-35 outside of US air space. Japan's first aircraft is currently in production and due to fly in 2016. The global fleet will grow to an estimated 3,000 aircraft by about 2035.

33. In February 2016, the F-35 aircraft surpassed 50,000 flying hours and were operating from 12 different locations worldwide. To demonstrate a maturing program, the first 25,000 flight hours took six years and six months to achieve between June 2008 and December 2014, and the second 25,000 flight hours were reached only one year and two months later. The F-35 Program Executive Officer has acknowledged that the next 50,000 hours will be achieved much more quickly as the size of the F-35 fleet doubles worldwide over the next three years.

34. While positive progress has been made, the F-35 remains a programmatically difficult and technically complex program. The System Development and Demonstration phase is characterised by a model of concurrent design, production and in-service operations: the Program is designing and developing the capability,

manufacturing aircraft, testing the aircraft, and starting the support phase for operational aircraft all at the same time.

35. For a program of this complexity, test and evaluation is expected to identify issues and during ongoing testing, additional issues are likely to emerge. These issues have been specifically highlighted in the recent 2015 Director of Operational Test and Evaluation report and are discussed later in this submission. Identified technical issues have been subject to detailed analysis with solutions developed and incrementally implemented across production lines and in-service fleet. As noted earlier, completion of the test and evaluation program and the delivery of the required warfighting capability is on the critical path to complete the System Development and Demonstration phase by the end of 2017 and schedule pressure is evident.

36. The ability to resolve these issues in a timely fashion is the mark of a mature program. This maturity is reflected in the management and resolution of issues surrounding the helmet mounted display, a serious engine fire and ejection seat limitations, for which an update is provided at Annex A.

37. While a large focus is on acquisition of the F-35 aircraft, critical to the capability is the F-35 support system. The Joint Program Office is developing the global support solution for the international F-35 fleet. The F-35 global support solution is based on a global fleet so Partner nations benefit from increased capability, availability and affordability through economies of scale, interoperability and international cooperation.

38. An important part of planning for the integration of the F-35 capability into the Australian Defence Force (ADF) will be the design of an Australian F-35 support solution, which is being refined as the global support solution framework gains clarity. While the Australian solution will heavily leverage global support solution services, it must assure sovereign support requirements that are strategically important to satisfy capability, national security, self-reliance or other factors, are provided in Australia. A key issue will be the affordability of the global and Australian support solution. While modest progress has been made by the Joint Program Office in reducing the estimated support costs, and initiatives are underway to reduce these costs further, they remain high and the economies of scale are not yet evident. These issues have been factored into the Australian operating support costs of A$4.6 billion approved by the Government at project approval in early 2014. Defence will return to the Government in 2020 when the global support solution is expected to have matured with refined operating support costs.

39. From an industry perspective, in 2012, the Joint Program Office conducted a study which determined options for assuring the F-35 global fleet capability and availability. An outcome of this study was to locate depots in each of the three major regions for F-35 operations being North America, Europe, and the Asia Pacific. As a partner Australian industry is benefiting from the global supply chain. Details are presented later in the submission.

Why the F-35?

40. Australia is procuring the F-35A as the most advanced, affordable multi-role fighter capable of meeting Australia’s strategic need for a highly effective air combat capability.

41. Australia's air combat capability is currently provided by the RAAF fleets of F/A-18 Classic Hornet (air control and strike) and F/A-18F Super Hornet. The F-35A will replace the ageing F/A-18 A/B, which will be progressively withdrawn from service between 2018 and 2022 as the useful limit of capability and airframe life are reached. Coordinated with the drawdown of Classic Hornet, the F-35A will transition into service in Australia from 2019 to ensure continuity in Australia's air combat capability.

42. Australia's air combat capability needs have been derived through extensive and detailed consideration of a strategic baseline that reflects Government's expectations of the air combat force. For Australia, these expectations require an air combat capability equally capable of defeating airborne threats, prosecuting attacks against surface targets, both on land and at sea, and supporting Australia's land and maritime forces. The environment within which these expectations must be met is characterised by increasingly capable threat systems that are highly effective against combat aircraft that do not have the advantages of the F-35.

43. The advantages of the F-35 are achieved through a design that combines very low observability with combat configured manoeuvrability and advanced integrated avionics systems. The F-35 has advanced integrated sensors that collect and fuse data to generate unparalleled situational awareness. This awareness, combined with advanced weapons and countermeasures, makes the F-35 highly survivable and lethal when confronting advanced threats in air, land and sea environments. As well as exchanging data with other F-35s, tactical information can be exchanged with other platforms to enhance overall situational awareness across the battle space.

44. The ability of the F-35A to satisfy the Government's expectations of the air combat force was subject to a comprehensive analysis involving the full scope of available tools and techniques conducted over many years, including thousands of simulation runs and a series of human-in-the-loop mission simulator experiments. The best available performance data for both the F-35A and advanced threat systems were employed for these efforts. The combined results of this analysis indicated that the F-35A would be able to meet the Government's air combat requirements over the period of its service life.

45. Aircraft considered to be alternatives to the F-35 were also analysed extensively by Defence. Alternatives considered included the Super Hornet, Eurofighter, Rafale and Gripen. The capabilities of the F-22 were assessed but it did not meet Australia's multi-role requirements due to its limited air to surface capability, noting also that US policy would not allow the F-22 to be sold to other nations. This extensive analysis identified where alternative platforms would be unable to meet all of Australia's requirements and highlighted the vulnerabilities of some of these platforms to advanced threats that F-35 capabilities overcome. In addition, the available alternatives were shown to have limitations in the ability to be modernised over their service life to defeat more complex threats beyond 2030.

46. The ability to modernise the F-35 over its service life is built into the F-35 Program and includes periodic software and hardware updates to add new capabilities in response to advancing threats. The F-35 follow-on modernisation program will be specifically used to provide additional F-35 capability required for the declaration of final operational capability in 2023, including the integration of advanced weapons still undergoing development. Additionally, mission specific software will be updated

in faster cycles through the reprogramming of mission data files to be conducted in collaboration with the US and UK at Eglin Air Force Base, Florida, US.

47. Affordability and supportability were also critical factors in the selection of the F-35. With reliability and maintainability in mind these factors influenced the design of the aircraft and support systems, which will employ system diagnostics, prognostics and health management capabilities. These capabilities are still evolving but are already demonstrating improved in-service reliability. The first two Australian aircraft delivered in late 2014 are proving to be among the most reliable and available in the aircraft pool at the international F-35 Pilot Training Centre.

48. The F-35 support systems are fully integrated and when combined with effective performance based contracts will be critical in driving down support costs. The Autonomic Logistics Information System is a key element of the support system. Autonomic Logistics Information System provides for off-board aircraft data collection, data analysis and decisions support, which support sophisticated prognostics and health management that will be key to ensuring available and mission effective aircraft. While acknowledging that both the aircraft and support system maturity is still developing, these systems continue to mature and improvements are becoming increasingly evident at operational units.

49. The selection of the F-35A and participation as a Partner nation in the F-35 Program affords Australia capability benefits beyond the acquisition of an advanced air combat capability. In addition to satisfying Australia's specific needs for a multi-role fighter, the F-35A can be readily integrated into a joint or coalition force with other F-35s and specialised air combat and defence aircraft, as demanded by the nature and scale of operations.

50. Defence is planning the integration of the F-35 in the context of RAAF's Plan Jericho - RAAF's pathway to ensure that Australia is equipped with a decisive air combat advantage that fully exploits each weapon system in a fully integrated and networked force. The advanced multi-role F-35A is a cornerstone and catalyst for change for Australia's future air combat and joint capability under Plan Jericho. Under Plan Jericho, the F-35 will enhance the effectiveness of other ADF elements, such as the Airborne Early Warning and Control platforms, Air Warfare Destroyer, and ground forces requiring precision support. Integration with other key Australian air defence capabilities is already underway, noting the successful air-to-air refuelling certification of the Australian KC-30 and F-35A in late 2015.

51. While the F-35A has been selected as the most suitable combat aircraft for meeting Australia's independent requirements, the ability to work in a networked force in the joint environment and with other nations is a key strength. The F-35 puts Australia in a sound strategic position to work effectively in future coalition air, land, and sea operations to combat future threats to Australia or its wider interests.

52. The F-35 Program is also providing Australia opportunities to identify and participate in collaborative opportunities which deliver positive affordability and capability outcomes for F-35 partners that may otherwise not be realised. For example, Australia and Norway are working together to develop an advanced maritime strike weapon ideally suited for employment by the F-35A, which will be, subject to the Government's consideration, potentially integrated under the follow-on modernisation program post 2020.

53. The F-35 characteristics of lethality, survivability, affordability and supportability are the hallmarks of fifth-generation capability and are what sets the F-35 apart from legacy platforms. Defence remains confident that F-35 capability will continue to improve through the remainder of the development program and will meet Australia's requirements to support initial operations and declaration of initial operational capability in 2020 and important capability milestones for decades beyond.

International commitment

54. Australia is not alone in its decision to procure the F-35. All partners remain actively engaged in the program with the majority of nations having placed orders for the aircraft.

55. In December 2015, the UK confirmed its commitment to buy 138 F-35s, and brought forward the acquisition of 24 aircraft. Around the same time, Norway committed funding to authorise the purchase of their next six F-35 aircraft for delivery in 2020.

56. Growing confidence in the F-35 Program is also underlined by an additional three nations, Japan, Israel, and South Korea, already committing to buy the aircraft through the foreign military sales program. Late in 2015, Israel committed to the purchase of an additional 11 aircraft to take its total to 33 aircraft. Interest is also being shown by at least five other potential foreign military sales customer nations.

Australian industry benefits

57. The global nature of the F-35 Program extends to industry participation. As well as delivering the capability outcome, the Australian F-35 Program has a goal to deliver a strong industry base that supports the F-35 capability and provides Australia with long-term economic benefit.

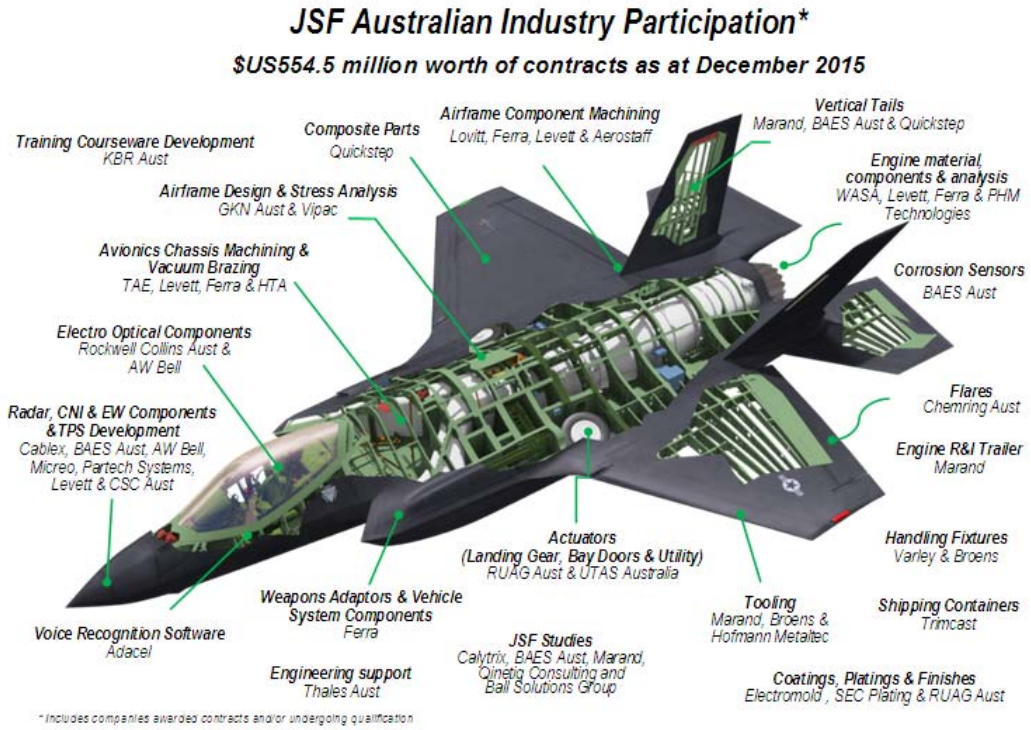
58. As a partner in the F-35 Program, Australian industry is afforded opportunities to compete on a 'best value' basis in F-35 global supply chains. Partner nation industry participation in the F-35 Program started under the System Development and Demonstration Memorandum of Understanding in 2002. Australian industry subsequently secured over US$300 million in contracts on the back of the Australian Government's US$150 million initial participation investment. Amplifying background on the subsequent F-35 industry participation is attached at Annex B.

59. Australian industry is already exceeding the performance expectations of international F-35 manufacturers in design and production having secured US$554.5 million of work by December 2015 with more opportunities to come as production triples over the next four years.

60. Defence estimates the potential total contracted value of the opportunities currently being worked by Australian industry could reach US$2 billion by 2023, assuming businesses are able to maintain globally competitive levels of performance on price, schedule and quality. If Australian companies continue to remain competitive in production then contracts to the value of US$4 billion are feasible out to the end of production in 2035.

61. Australian industry has and will continue to benefit from the growing capability and capacity opportunities associated with the size and scale of the F-35 global enterprise. Contracts secured to date range from the provision of treated raw materials to high-end manufacturing of components and sub-assemblies, software development and production of sensitive technologies. The nature and scale of the contribution is illustrated in Figure 1 below.

Figure 1: F-35 Program Australian Industry Participation



62. In addition to the industry outcomes from design and production, as the only Partner nation located in the Asia Pacific, Australia expects that its strong defence industry base will be used to contribute to an affordable F-35 global support solution.

63. In early 2015, the US Government made regional assignments for F-35 depot maintenance for airframe and engines. BAE Systems Australia, based in Williamtown in New South Wales, was assigned regional F-35 airframe maintenance for the South Asia Pacific region. TAE, based at Amberley in Queensland, was assigned regional maintenance for F-35 engines for the Asia Pacific region. Collaborative planning is well underway so that Australia is ready to meet regional demand for depot airframe and engine maintenance by the end of 2018. Defence estimates that Australian industry will have the potential to gain between A$6-9 billion of work in support of the Australian F-35 across its 30 year life, not including the additional work that may be achieved in support of the global supply chain.

64. The Joint Program Office has indicated that as more aircraft arrive in the Asia-Pacific region, Australia's depot maintenance capability may eventually be supplemented by Japan.

65. As part of the developing global support solution for the international F-35 fleet, the Joint Program Office will be assigning responsibilities to F-35 partner nations and

ers Australia's sovereign support requirements and industry competitive strengths.

66. The Australian Government has also played a pivotal role in supporting Australian industry to obtain the aforementioned benefits. More detailed information on Government support provided including the New Air Combat Capability Industry Support Program grant funding and associated industry outcomes are attached at Annexes B and C.

Cost

67. Historically, the F-35 Program has attracted significant public attention regarding cost and schedule, particularly in the lead up to the breach in 2010.

68. The F-35 Program has stabilised and remained within the approved budget since the program was re-baselined in 2012. The Australian F-35 Program remains within budget and on track to deliver an F-35A capability to meet Australia's 2020 initial operational capability.

69. As at December 2015, Australia's F-35 Program total approved budget is A$17.8 billion (adjusted for exchange rates as at January 2016). This includes the cost of the 72 F-35A aircraft as well as support systems, including information systems support, training, weapons, and contingency funding. The total approved budget also includes A$1.5 billion for F-35 facilities at RAAF Bases Williamtown and Tindal and other forward operating and support bases.

70. Acquisition affordability remains one of the highest priorities for the F-35 Program. Importantly, the global program is incentivising industry to drive costs out of the production program. The Joint Program Office and prime contractors are working collaboratively with F-35 Partners, and their participating industries, in a Blue Print for Affordability Program. This aims to reduce the unit recurring flyaway cost of the F-35 to a price that compares with current fourth-generation fighters.

71. Australian aircraft unit recurring flyaway cost is reducing significantly. This is largely due to production progress along the learning curve and the increasing economies of scale from rising production. As a result, contracted costs have been reducing by three-four percent annually and this will be further amplified when the program achieves full rate production in 2020. The contracted costs are currently tracking at around nine percent less than US Government estimates. Based on current projections, the expected average unit cost of an Australian F-35 is US$90 million. This is similar to the price of the latest version of the F/A-18 Super Hornet, a less capable fourth-generation aircraft based on an airframe first developed in the 1990s.

72. F-35 support costs are less well defined noting the global support solution is developing and maturing. While the design of the global support solution has been subject to greater focus in recent years the global support concepts that underpin the global support solution are still evolving. In particular, the assignment of the Government and industry responsibilities and the commercial and local/regional/global support arrangements that make up the global support solution are still developing. The finalised global support solution arrangements will ultimately define operating and support costs. Greater certainty of operating and

support costs is expected post 2020. Similar to acquisition affordability, there is a program to reduce operating and support affordability cost by 30 percent compared to 2012 estimates.

Schedule

73. The F-35 Program schedule is structured to address the resources required to deliver a highly technical and complex program.

74. Consequently the System Development and Demonstration phase is characterised by a concurrent design and production model. Put simply, the F-35 Program is designing and developing the capability, manufacturing aircraft, testing the aircraft and starting the support phase for operational aircraft all at the same time. This level of concurrency has introduced some risk to the F-35 Program, evidenced by the 2012 Program re-baseline and issues that have been evident during test and evaluation.

75. Similar to cost, the F-35 Program schedule has stabilised since the re-baselining in 2012 with any movements being managed through schedule margins built into the Program.

76. After re-baselining coupled with the global financial crisis, the procurement of the Australian F-35 was deferred by two years resulting in initial operational capability moving from 2018 to 2020. The Australian program remains on track to deliver initial operational capability on schedule.

77. A key milestone prior to Australia's initial operational capability is the arrival of the first two aircraft at the end of 2018. The schedule for establishing the required support to meet this timeframe is challenging.

78. Defence's confidence in achieving initial operational capability is reinforced by the achievement of key milestones. The US Marine Corps achieved initial operational capability for the first squadron of F-35B (STOVL variant) in July 2015 demonstrating the growing maturity of the F-35 Program. The US Air Force initial operational capability declaration scheduled for late 2016 is on track and will be a key milestone for Australia as it has the same F-35A variant and similar initial warfighting capability needs, noting that software stability and support system maturity risks still need to be mitigated.

79. Software development is effectively complete and is now the main focus of the ongoing test and evaluation program. In January 2016, the final software build had completed 50 percent of baseline test points, however, significant test points are yet to be undertaken and issues found will need to be rectified. As noted earlier, completion of the test and evaluation program and ensuring the required warfighting capability at the completion of the System Development and Demonstration phase carries schedule risk that will need to be carefully managed by the Joint Program Office. In order to meet Australian initial operational capability in 2020, Defence is closely monitoring test point achievement and software maturity and has built in additional schedule margin to manage this risk.

80. The F-35 capability will continue to develop post the System Development and Demonstration phase through a follow-on modernisation program, which will ensure the F-35 remains relevant, affordable and capable of countering emergent threats. The

follow-on modernisation program will be critical to achieving final operational capability in 2023, but is yet to be fully defined and is not without schedule risk.

81. Australia's F-35A delivery profile is as follows:

2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Total
2	0	0	0	8	8	15	15	15	9	72

Testing the F-35 capability

82. The significant capability of the F-35 means the complexity of the test and evaluation process cannot be underestimated. The infrastructure, assets and supporting equipment required to be available to test the spectrum of capability is complicated and poses some schedule risk. Only the US Department of Defense is capable of harnessing all of these resources.

83. Developmental test and evaluation is the process by which aircraft capability is tested against program contract specifications. Operational test and evaluation is the process by which the operators test the capability against their operational requirements. The System Development and Demonstration phase is scheduled to be completed in 2017 and is linked to the completion of developmental test and evaluation. This milestone signifies the delivery of a specified level of warfighting capability across the suite of F-35 systems.

84. The F-35 test and evaluation program is currently employing a "fly-fix-fly" approach. While this methodology is appropriate to the complexity of the F-35 software, it has introduced some schedule risk to the program. The US Department of Defense acknowledged this risk in 2014 and curtailed and rationalised the F-35 test and evaluation program to better focus resources on the testing of the final software to be delivered under the System Development and Demonstration phase in 2017. Notably, in 2015, the program achieved all planned test points, some 1,374 test flights and 9,582 test points.

85. Given the complexity of the F-35 software it would be unrealistic to assume that problems will not be encountered during test but the measure of a mature program is the ability to effectively prioritise and resolve these issues. The Joint Program Office continues to demonstrate that the safety of the F-35 Program and the delivery of critical warfighting capability to be delivered in the initial software by the end of the System Development and Demonstration phase will not be compromised. Similarly, it is unrealistic to expect complex programs to achieve 100 percent of requirements, but it can reasonably be expected that some lower priority functionality may be deferred to a later phase.

86. As a partner in the F-35 Program, Australia has insight into the prioritisation of any issues identified during test and evaluation and the potential impact on Australia's warfighting requirements. While Australia has some additional schedule margin to the achievement of initial operational capability in 2020, these program risks and flow on effects to the Australian program are being closely monitored.

87. Simulation has played an important role in developing the F-35 up to this point of the System Development and Demonstration phase and is vital in assessing how well the F-35 will actually perform within the anticipated threat environment. The F-35 is technically very complex and it is difficult to test all of the F-35 capability in

the real world. Therefore, simulation is key to replicating the threat environments that the F-35 is expected to be employed in and must be refined through test and evaluation and real world employment. The development of a highly accurate simulation environment that can effectively be used to test the F-35 has been challenging and the path forward is currently being determined by the US Department of Defense.

88. A real measure of the F-35 maturing capability is the functionality that is being fielded in training and operational units, who are experiencing incremental in capability as more advanced software is fielded. This view is reinforced by a qualified Australian F-35 pilot currently operating the aircraft and instructing F-35 international students at Luke Air Force Base.

> *"While my experience to date is with F35 System Development and Demonstration phase software and hardware configurations, the potential for capability growth down-track is readily apparent and during the last 12 months I have witnessed significant gains being made across this maturing program."*
>
> *Squadron Leader Andrew Jackson*
> *F-35A pilot and instructor and F/A-18 Hornet pilot*

89. Recent media reports around flight test highlighted an event which occurred during the conduct of the F-35 test and evaluation program and related to the manoeuvring performance of the F-35. This reporting was in regard to one test flight taken out of context from a larger test and evaluation program. Again, an experienced Australian F/A-18 pilot now flying F-35A at Luke Air Force Base drew this observation.

> *"In my experience flying more than 140 hours in the F-35 so far, it is better in performance and manoeuvrability than a representatively configured F/A-18 while remaining easy to fly."*
>
> *Squadron Leader Andrew Jackson*
> *F-35A pilot and instructor and F/A-18 Hornet pilot*

90. Australia will leverage the US developmental and operational test and evaluation programs to the maximum extent. Australia has had test and evaluation expertise embedded in both these programs. This insight has enabled Australia to understand the implications of issues as they arise and to put them in the broader context of the test and evaluation program. More importantly, this insight is helping to inform the development of the Australian operational test and evaluation program, which will focus on demonstrating the suitability of the F-35 capability in the Australian environment.

91. The Defence Science and Technology Group (DST Group) has played a key role in managing and providing insight into technical risk. DST Group personnel have been embedded in key risk areas across the program and have been very influential in resolving a range of issues, detailed at Annex D. In particular, DST Group has played a key role in conducting independent modelling and simulation, which has supported Defence's understanding and choice of the F-35 capability. In 2010, DST Group assessed that there were 140 technical risks of which 30 were assessed as high. Today only two high risks remain and these risks are tracking towards resolution, in particular the Helmet Mounted Display System.

2015 Director Operational Test and Evaluation Report

92. The United States Office of the Secretary of Defense, Director of Operational Test and Evaluation (DOT&E) released the 2015 DOT&E report on the F-35 to Congress on 2 February 2016. The challenges raised in the report are well known and being managed by the Joint Program Office, Prime Contractors, and Partner nations. The F-35 remains programmatically and technically challenging and further issues will be identified during the test and evaluation program.

93. The Director of Operational Test and Evaluation report focuses on the schedule pressures associated with the test and evaluation programs as it relates to the US Department of Defence and its Services. The report highlights technical issues for the US Program and concludes there are implications for US Services' initial operational capability. However, the report must be interpreted for the Australian program.

94. The Joint Program Office has acknowledged the schedule risk associated with problems identified during test and evaluation. As reflected in the Director of Operational Test and Evaluation report, most remaining development risk is in software. The Joint Program Office believes that schedule margin exists to develop further software releases, if required, without compromising capability requirements.

95. Defence believes that this schedule risk is clearly evident and that a delay of between six-12 months to the completion of the System Development and Demonstration phase is likely. Due to the significant gap between the Australian initial operational capability milestone being four years later than the US Air Force initial operational capability (2016) milestone and two years later than the US Navy initial operational capability (2018), Defence assesses that the Australian Program remains on track to achieve initial operational capability in 2020, fully cognisant of the issues raised in the report.

96. Importantly, the Australian Program is also focussed on other strategic risks, consistent with those reported by the Australian National Audit Office in their examination of the Australian F-35 Program and detailed in their 2014-15 Major Projects Report tabled in Parliament on 15 January 2016. For example, risks associated with integration of the capability into the Australian environment including the global support solution, maintenance and pilot training, information systems and the ability to develop mission data files.

Transparency in reporting

97. The F-35 Program is subject to a range of annual independent and US Department of Defense reports such as the US Director of Operational Test and Evaluation and US Government Accountability Office reports which are made available publicly. In addition US Department of Defense reports, such as the Selected Acquisition Report, F-35 Report and the House of Armed Services Committee testimonies, provide insight to different facets of the F-35 Program and are all made public.

98. In the Australian context, the Major Projects Report requires the Australian National Audit Office to conduct an independent annual review and report into the Program which is made publicly available.

99. Defence also provides detailed briefings to the Government on the more classified elements of the F-35 Program. Defence includes relevant information from the US independent reports such as the US Director of Operational Test and Evaluation report and the US Government Accountability Office report in relation to the Australian F-35 Program context.

100. This level of reporting provides an opportunity for a robust public discussion of the progress as well as the issues. Defence welcomes this opportunity to provide an informed and balanced view of the F-35 Program.

Annex A to
Defence F-35 Senate Inquiry Submission
dated 26 February 2016

F-35 Escape System

Overview

1. The United States (US) F-35 Program has identified an increased risk of neck injury to light weight pilots during low speed ejection. In August 2015, the US Services restricted F-35 pilots weighing less than 136 pounds (62 kilograms) from operating the aircraft. Currently, no F-35 pilots, including Australian pilots, are impacted by this restriction.

Solution and Progress

2. Safe escape risks are being reduced by:

   a. installing a switch on the seat for lightweight pilots that will slightly delay parachute deployment and lessen parachute opening forces;

   b. designing a lighter helmet; and

   c. mounting a head support panel, which is a fabric panel sewn between the parachute risers which will protect the pilot's head from moving backwards during the parachute opening.

3. The head support panel and the ejection seat sequencer switch for lighter weight aircrew members are currently being tested as part of the seat qualification which is planned to be completed in October 2016. It is expected that modification kits to retrofit seats currently in operation will be available by November 2016 for F-35 fleet implementation.

4. Testing will also support the design and certification of a lighter version of the Generation 3 Helmet Mounted Display System and allow the production of these helmets to begin with initial deliveries scheduled to begin in October 2017. At that time, the services will be able to implement all three parts of the complete solution to lift the weight restriction for pilots less than 136 lbs and mitigate neck injury risks for all F-35 pilots.

5. The Generation 3 helmet also reduces the risk of neck injury for light aircrew and is planned for introduction to service in Low Rate Initial Production 10 scheduled for delivery in 2018. The lighter weight helmet will be available to support Australia's F-35 initial operational capability. The aim is to reduce the Helmet Mounted Display System weight from 5.06 lbs (2.3 kg) to 4.63 lbs (2.1 kg).

6. The F-35 escape system was designed to reduce ejection stresses and be able to accommodate the widest range of both aircrew weight and sizes, providing for the safe escape for pilots weighing from 103-245 lbs (47 to 110 kgs).

7. The designed safe escape range is greater than legacy fighter ejection seats.

F135 Engine

Overview

1. On 23 June 2014, a serious engine incident and subsequent engine fire occurred as a US Air Force F-35A was preparing to take off.

2. Flying immediately ceased temporarily while all aircraft were inspected. Aircraft were returned to flying operations on 14 July 2014, with flying restrictions and a mandatory inspection regime for safety while further investigations were done.

3. The subsequent Accident Investigation Board report confirmed that the root cause of the fire was a result of excessive rub at the seal between the rotating fan component and the engine casing.

Solution and progress

4. The engine manufacturer Pratt &Whitney has developed a solution to the problem, whereby the rubber seal components are pre-trenched. The solution is now being implemented at the manufacturer's expense on all F-35 aircraft, including Australia's first two currently operating at Luke Air Force Base, Arizona.

5. This issue will not impact the acquisition of the remaining 70 F-35A aircraft as the solution will be built in to the production.

Helmet-Mounted Display System

Overview

1. A series of enhancements to the currently fielded Generation 2 Helmet Mounted Display System have been implemented to address improvements required regarding 'green glow', jitter, night vision quality and optical targeting accuracy.

Solution and progress

2. **Green Glow**. During night operation testing, the minimum brightness of the Helmet Mounted Display System optic driver in no-light or low-light conditions created a green glow. The Generation 2 Helmet Mounted Display System was determined acceptable in most conditions, but was too bright for some carrier operations. The brightness has been adjusted in the Generation 3 Helmet Mounted Display System. Reports from testing thus far indicate some improvements. Additional adjustments to the brightness have been made and will undergo testing in first quarter of 2016.

3. **Jitter**. The Helmet Mounted Display System is designed to accommodate the buffet flight envelope of the aircraft. The buffet effect makes the pilot's head move so that symbology is difficult to read or illegible. The name for this effect is 'jitter.' Changes were made in the Generation 3 helmet tracker to improve buffet jitter performance and testing in 2015 showed acceptable results.

4. **Aided Night Vision Acuity**. The Generation 2 Helmet Mounted Display System had night flight restrictions due to insufficient contrast in low light conditions.

The display processing software and Distributed Aperture System capability were changed. There are now no night flight restrictions with the Generation 2 or Generation 3 Helmet Mounted Display System.

5. **Alignment/Optical Targeting Accuracy**. The Generation 2 meets the required symbology alignment accuracy for F-35 Block 2 capabilities. The Generation 3 Helmet Mounted Display System improves alignment accuracy with the addition of an Optical Tracker and Adaptive Alignment processes to achieve alignment accuracy requirements for F-35 Block 3 and up, which are driven by gun strafe capability requirements.

Annex B to
Defence F-35 Program Senate Inquiry Submission
dated 26 February 2016

Amplification on F-35 Australian Industry Participation - Background, Outcomes and Forecasts

Background

1. Partner nation industry participation in the F-35 Program commenced under the banner of the System Design Demonstration Memorandum of Understanding in late 2002. Australian industry ultimately secured over US$300 million in contracts on the back of the Australian Government's US$150 million initial participation investment.

2. Subsequently, the Production, Sustainment and Follow-on Development Memorandum of Understanding was agreed between Partner nations in 2006. The Production, Sustainment and Follow-on Development Memorandum of Understanding enshrines the importance of partner nation industry participation within its objectives by stating:

> "*To promote new, as well as continued, involvement of the industries of the nations of the Participants in the production, sustainment and follow-on development of the JSF Air System*".

3. The Production, Sustainment and Follow-on Development Memorandum of Understanding requires the Partners to ensure that prime contractors provide timely notification of competitive opportunities and to implement a transparent industrial participation process with visibility of the results of competitive processes. The prime contractors are not signatories to the Production, Sustainment and Follow-on Development Memorandum of Understanding, however, in December 2006 the Australian Defence Force (ADF) signed Memorandums of Understanding with Lockheed Martin and Pratt & Whitney on Australian industry participation in the F-35 Program. Each Memorandum of Understanding is supported by an Industry Participation Plan containing a schedule of potential design and production opportunities to be pursued in partnership with Australian industry.

4. Recognising the benefits of a diverse and vigorous global supply chain, the F-35 Program has deliberately invested in the partner nation industry base through Technical Planning and Assistance agreements between the Joint Program Office and Lockheed Martin. These Technical Planning and Assistance agreements recognise and resource Original Equipment Manufacturers to undertake activity needed for an overseas company to become qualified to perform specified packages of work on the F-35 system. The majority of Australian firms who have won contracts have benefited from Technical Planning and Assistance funding, in that their qualifying agent has had a level of United States (US) Government support.

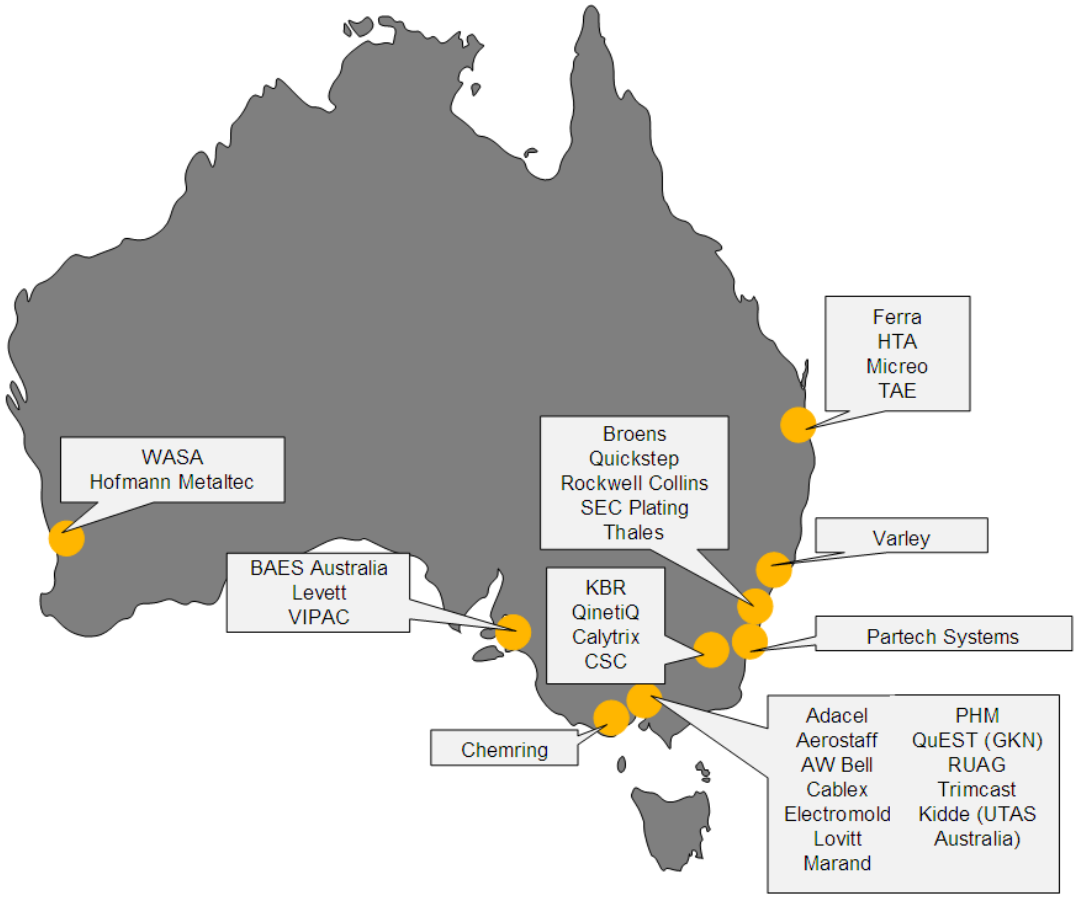
5. The Technical Planning and Assistance agreements will not be extended beyond Low Rate Initial Production 8 and companies who have not achieved qualification by this time are likely to find the cost of entry into the Program prohibitive. Conversely, those companies who have consolidated their position in the supply chain are now

well placed to benefit from their and the Program's investments leading in to Full Rate Production.

Outcomes to date

6. Australian industry has and will continue to benefit from the capability and capacity development opportunities associated with the size and scale of the F-35 global. Contracts secured (at December 2015) total US $554.5 million in work that ranges from the provision of treated raw materials to high-end manufacturing of components and sub-assemblies, software development and production of sensitive technologies. Figure 1 below demonstrates that Australian industry participation is geographically widespread.

Figure 1: F-35 Program Australian Industry Participation



7. The value of the associated contracts awarded to date is summarised in Table 1 below.

Table 1: Source and value of Australian industry contracts to date

Source	Value of contracts (US$ 'millions)	Number of existing / completed contracts
System Design and Development (SDD)	$171.9	62
Contracts arising from SDD opportunities: Lockheed Martin	$151.9	13
Production opportunities: Lockheed Martin	$199.7	34
Production opportunities: Pratt & Whitney	$21.6	7
Production opportunities: Other	$9.1	2
Sustainment	$0.3	1
Total	**$554.5**	**119**

8. To date, Industry Participation Plan coverage has been restricted to the design and production phases of the Program. In respect of sustainment, Australia has identified some sovereign sustainment needs that will be maintained in Australia to satisfy capability, national security, self-reliance or other factors that are strategically important. For those sustainment activities that are not sovereign, Australia as a global F-35 Partner can benefit from the standardisation, rationalisation and interoperability a global system can provide.

9. The Australian supply chain extends well beyond those companies that hold direct contracts within the global F-35 supply chain. For example, Ferra Engineering has engaged with, and continues to seek support from, over 30 Australian organisations comprising their supply chain.

10. A range of indirect benefits are flowing for Australian industry as a result of F-35 Program participation, including the opportunity to deepen capability within the high end technology sector, specifically through improved skills, and knowledge and technology transfer which builds on those established in other sectors (e.g. automotive manufacturing).

11. There has also been a growth in capacity and business process improvements which are being applied beyond F-35 product lines. This along with the credibility and visibility arising from F-35A performance is assisting Australian firms to capture and grow market share in other military and commercial applications, further enhancing the long-term economic benefit for Australia. Furthermore, this dynamic is driving a viable Australian industry base which is better positioned to support ADF capability requirements across multiple platforms.

Forecast

12. In 2015, under Low Rate Initial Production 7, three aircraft were delivered off the production line each month. This is forecast to increase to almost 8 per month by 2018 and, once Full Rate Production commences in 2020 the rate will jump to around

14 and then to 17 per month by 2023 when Australia receives the last of its current aircraft order.

13. The forecast total contract value profile over time for Australian industry participation in design and production is outlined below in Figure 2. This trajectory predicts the total value will increase to an estimated US$2 billion by 2023, based on the following assumptions:

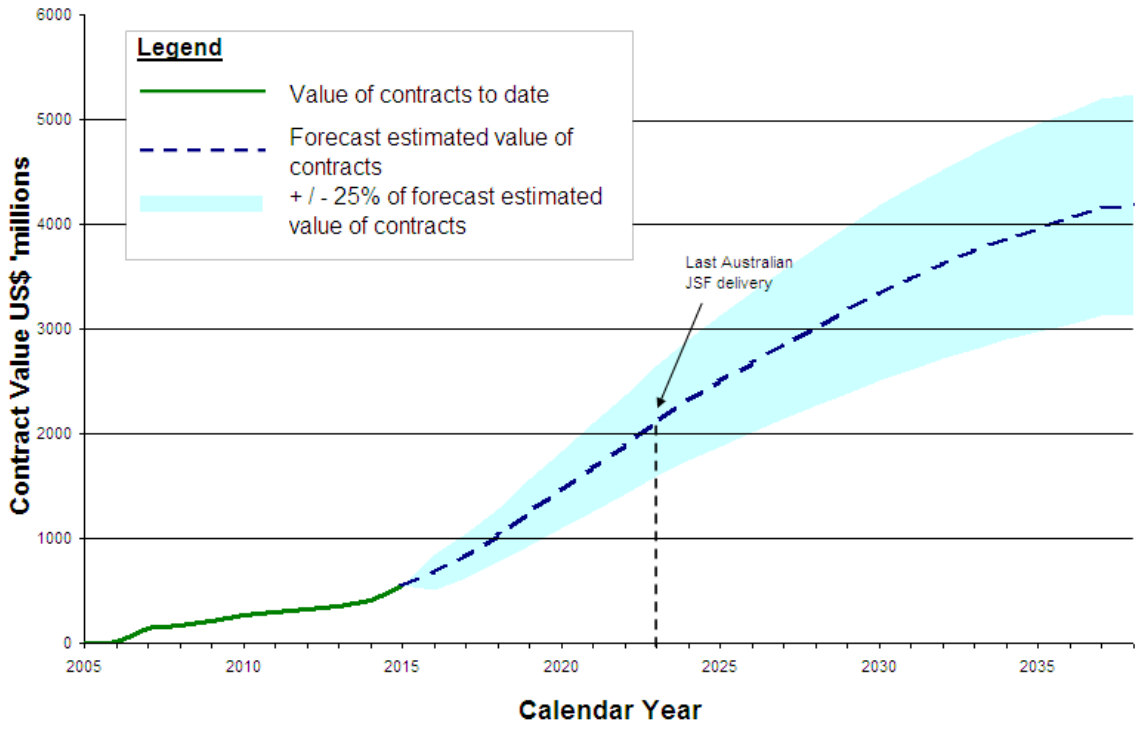
a. the US F-35 Joint Program Office forecast production profile remains stable;

b. Australian industry continues to perform and remains globally competitive on contracts for production secured to date; and

c. the US$171.9 million of contracts secured during the system design demonstration phase is non-recurring work and not included in any cumulative estimates.

14. The range of plus/minus 25 per cent reflects the forecast uncertainty associated with a variety of economic (e.g. exchange rates and interest rates for the cost of capital) and production (e.g. block buys and commitments by partner nation governments to purchase the F-35) factors which will influence the outcome, many of which are outside the direct control of Defence. Further, notwithstanding Australian firms are expected to be fully embedded in the global supply chains by 2023, once Australia's full aircraft order is completed, some leverage may be lost and the full potential of the opportunities may not be realised.

Figure 2: Forecast cumulative value of contracts secured by Australian Industry for F-35 design and production.



15. Separately, predicting the value of future global supply chain sustainment contracts is far more difficult, given the immaturity of the global support system commercial arrangements.

16. Assignment of responsibilities for maintenance, repair, overhaul and upgrade of F-35 aircraft components will commence in late 2016. Additional opportunities for assignment include sustainment of support equipment and warehousing.

17. Global opportunities for follow-on modernisation are also yet to be identified by the Joint Program Office. In keeping with RAAF's Jericho philosophy, the ADF is intending to work closely with the capability owners for the F-35 aircraft to ensure Australian industry is embedded in the ongoing global continuous improvement activities for the capability. This will assist in positioning Australian industry to continue to benefit from the long term follow-on modernisation activities undertaken to maintain and enhance capability.

Annex C to
Defence F-35 Program Senate Inquiry Submission
dated 26 February 2016

Australian F-35 Industry Participation Support

1. The Australian Government has played a pivotal role in supporting Australian industry to obtain the aforementioned benefits. Australian F-35 industry participants have availed themselves of a variety of Government programs including:

   a. Financial investment support provided by the Export Finance and Insurance Corporation.

   b. Skilling Australia's Defence Industry Program – aims to create pathways into the Defence sector and address any skills capability gaps which exist.

   c. Research and Development Tax incentive – provides a tax offset for eligible spending on Research and Development registered with the Department of Industry, Innovation and Science.

   d. The 'Next Generation Manufacturing Investment Programme' and 'Automotive Diversification Programme' - programs established to support Australian industry impacted by the closure of the car manufacturing industry by 2017.

   e. Early Stage Commercialisation – part of the Commercialisation Australia program providing funding and resources to accelerate the business building process for Australian businesses, entrepreneurs, researchers and inventors looking to commercialise innovative intellectual property.

   f. Researchers in Business (Enterprise Connect) – funding to support the placement of researchers from universities or public research agencies into businesses where it is identified that such a placement would help to develop and implement a new idea with commercial potential.

   g. Research and Development Start Program – funding to support the development of new or improved products, processes, or services.

2. Additionally, support has been provided by State Governments, including:

   a. South Australian Innovation and Investment Fund - grants to innovative job creation projects to strengthen South Australia's manufacturing and technology base following Mitsubishi Motors Australia Limited ceasing manufacturing operations in Adelaide.

   b. Geelong Region Innovation and Investment Fund – funding to support new investment to create new or additional business capacity.

3. The Defence Industry Innovation Centre also provides ongoing support to Australian firms participating in the F-35 Program. The Defence Industry Innovation Centre is staffed with advisors recruited by the private sector, but funded by the ADF. Their role is to assist Australian industry by providing valued and impartial advice to support successful outcomes for those firms in winning F-35 Program opportunities. This is undertaken by, for example, working with individual businesses to undertake reviews, benchmarking business productivity improvements and by targeting specific gaps within Australian industry as a whole.

4. In addition to the above support, a dedicated grant program, the New Air Combat Capability Industry Support Program, was established in conjunction with the Australian Government approval to acquire the F-35 JSF under Project AIR 6000. The program provides funding to Australian companies and research organisations to support the development of new or improved capabilities that may enhance the ability to win work in the production, sustainment and modernisation phases of the F-35 Program. The New Air Combat Capability Industry Support Program is jointly administered by Defence and the Department of Industry, Innovation and Science and provides A$21.9 million funding over 12 years.

5. A condition of the New Air Combat Capability Industry Support Program funding is that recipients must at least match the funding provided by the Australian Government and acquit this spending on a bi-annual basis to the Department of Industry, Innovation and Science.

6. Table 1 below provides a summary of the grant applications received and approved to date.

Table 1: New Air Combat Capability Industry Support Program as at January 2016

Type	Grand Total
Total number of applications received	30
Total number of applications approved	26
Total value of grant applications received	A$12,499,222
Total value of grants approved	A$10,045,531
Total value of grants paid to date	A$8,209,898

7. Some examples of the activities funded by the New Air Combat Capability Industry Support Program are:

a. Ferra Engineering Pty Ltd undertook product process improvements for Alternate Mission Equipment Weapons Adaptors, which resulted in a 38 per cent reduction in machining times, significantly above original projections and securing their competitive position in the global supply chain.

b. Electromold Australia Pty Ltd (Electromold) expanded their facilities and capabilities for F-35 airframe and related component non-destructive testing, surface treatment and finishing. The success of this has given Electromold the ability to meet production requirements for Low Rate Initial Productions 5 to 11.

c. Quickstep Operation Pty Ltd (Quickstep) developed a process for rapidly curing carbon fibre epoxy spars on the F-35 vertical tail. This will provide increased international competitiveness for Quickstep (and any other users of the technology). Additionally, this has furthered Australian industries expertise in exotic composite materials for Defence and commercial applications.

d. TAE Gas Turbines Pty Ltd (TAE) were able to successfully test, demonstrate their capability to deliver the required product and undertake qualification for the vacuum brazed electronics enclosure for the F-35 JSF Controller Chassis. TAE has been advised that upon final completion of

this activity, TAE will be in a favoured position to receive multi-year production purchase orders for the F-35 Program.

Annex D to
Defence F-35 Program Senate Inquiry Submission
dated 26 February 2016

Defence Science and Technology Group F-35 Program Involvement

Introduction

1. The Defence Science and Technology Group (DST Group) has been integrated into the F-35 Program, in Australia and overseas, since the project began. The science and technology advice provided by DST Group has led to improved confidence that the F-35 Program will deliver high technology capabilities for Australia which will significantly lower risk and through-life costs for the Australian F-35 capability.

2. The DST Group has provided science and technology advice and support to the F-35 Program since its inception. DST Group has played an integral role in supporting Defence's understanding in areas of modelling and simulation; technical risk acquisition support; engine prognostics & health monitoring electromagnetic compatibility; and industry engagement.

Modelling and Simulation

3. DST Group undertook an independent capability study involving a range of simulation tools validated at various degrees of fidelity to build a robust understanding of the Joint Strike Fighter (JSF) system. The simulation tools included:

a. seminar wargames, experiments, or Joint Military Appreciation Process (JMAP) exercises to provide insights into course of action;

b. campaign/mission level constructive simulation to examine potential vignettes from first point;

c. human-in-the-loop simulation;

d. detailed constructive simulation to examine the complexities of engagement level tactics;

e. engineering level simulation of sub-systems; and

f. hardware-in-the-loop and or mission system software-in-the loop simulations at the highest level of fidelity.

4. It is important to note that there is significant interaction between these levels of simulation. As the modelling and simulation detail increases so does the requirement to have accurate and detailed input data. Without access to detailed classified F-35 performance data it would be impossible to undertake a reliable F-35 capability study.

5. Modelling and simulation work is now underway in assessing the enhanced capability provided by the follow-on modernisation program.

Technical Risk Assessment

6. DST Group has determined that significant progress has been made by the F-35 Joint Program Office in mitigating risks over the past five years. The initial DST Group Technical Risk Assessment in 2010 contained 140 risks of which 30 were assessed as high. Through developments in the system design, there are now only two high risks remaining one of which is the Helmet Mounted Display System. Current flight test results are indicating that the Helmet Mounted Display System issues are being addressed by manufacturer, Rockwell Collins, and prime contractor, Lockheed Martin.

Project Acquisition Support

7. DST Group has contributed to the F-35 Program through a range of science and technology staff attachments. Since 2004, over 16 DST Group staff have been attached to various sections of the Joint Program Office. United States based staff are providing direct support to the Joint Program Office and Australia's research efforts in the areas of air vehicle sciences, electronic warfare, weapons and sensors, engine prognostics and health monitoring, affordability analysis, and electromagnetic compatibility.

Airframe Structural Assurance

8. DST Group has provided a higher level of structural assurance for the F-35 than any other aircraft we have acquired previously. Examples to support this are that DST Group:

a. advocated for 3rd life time fatigue test which was accepted. This means that the structural integrity of the airframe was tested over the equivalent of three times its intended lifecycle;

b. demonstrated to LM and then supported the development of revised design curves to account for various metallic surface finishes; and

c. provided support to verification and validation of the Lockheed Martin design stresses through the use of DST Group developed Thermoelastic Stress Analysis on the fatigue tests.

Engine Prognostics & Health Monitoring

9. Vibration-based prognostics and health monitoring technologies enable early identification and isolation of faults in a critical rotating component in the engine and provide a capability for consistently tracking fault progressions. DST Group developed technologies that were adapted to the F-35 Program to enhance engine prediction capability. These technologies were transitioned to F-35 engine manufacturer, Pratt & Whitney, who are in the final stages of verification and validation on the integration of DST Group vibration analysis algorithms. DST Group is working with BAE Systems to enhance the corrosion prognostic system to meet Australian environmental conditions.

Electromagnetic Compatibility studies

10. The F-35 is a fifth-generation aircraft with highly complex electronics, sophisticated software and a structural airframe made of composite materials. This exposes the aircraft to electromagnetic interference from both naturally occurring

phenomena and man-made sources, including telecommunication transmissions and radar.

11. DST Group has constructed a full-scale model of the F-35A to study the effects of electromagnetic compatibility and interference on the aircraft. Called Iron Bird, the model will be tested under simulated electromagnetic conditions during the acquisition and through-life sustainment of the F-35A.

12. DST Group's test methods provide a rapid, cost-effective means of assessing and monitoring the F-35's ability to withstand electromagnetic exposure and minimise any impact on its systems and performance.

Industry Engagement

13. As a global support program, technology innovation will be critical to ensuring Australian industry maintains and grows its share of the F-35 sustainment market. DST Group is engaging with current F-35 component suppliers and F-35 Regional Support Contractors, through its Strategic Alliance Program to develop and inject technology innovation.