Submission No 20 Part 1

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Inquiry into Australian Defence Force Regional Air Superiority

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Joint Standing Committee on Foreign Affairs, Defence and Trade
Foreign Affairs Sub-Committee

The.Firm

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Subject:	AIR POWER AUSTRALIA SUBMISSION - APA-SUB-2006-01

To:

The Hon Bruce Scott
Chair, Defence Sub Committee
Joint Standing Committee on Foreign Affairs, Defence and Trade

Dear Mr Scott,

Air Power Australia is pleased to provide our submission entitled, 'Attaining Air Superiority in Region' as our contribution to your Committee's inquiry into Australian Defence Force regional air superiority and the public debate we advocate now needs to happen.

For both Dr Carlo Kopp and myself, this has been a struggle of enormous proportions, spanning over half a decade, which has changed forever the way we view those grouped within the upper echelon of our otherwise outstanding armed forces. Sadly, this is not how it could nor should have been. Your committee should not have been required to inquire into this matter and every Australian should now be asking the question, "Why?"

The issue before us all and, moreover, the answer to this question, keenly brings into focus the words of our Prime Minister, the Hon John Howard, when he said –

'I believe that each generation of Australians is obliged to leave our country in better shape than they found it'.

We wish the Committee every success in its endeavours and stand willing to assist should our services be needed.

Yours sincerely,

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"Air Power Australia - Defining the Future"

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Attachments: This document employs a large number of charts, plots and diagrams. These have been implemented in full colour to improve readability. While we have invested a lot of effort into ensuring best possible contrast when printed in black and white, in general colour rendering still reads better. We strongly request that any hard copy distributed to the committee be printed in colour.

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Inquiry Into Australian Defence Force Regional Air Superiority: Attaining Air Superiority In the Region

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Attaining Air Superiority in the Region

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February 17, 2006

Submission to the
JOINT STANDING COMMITTEE ON FOREIGN AFFAIRS, DEFENCE AND TRADE DEFENCE SUBCOMMITTEE

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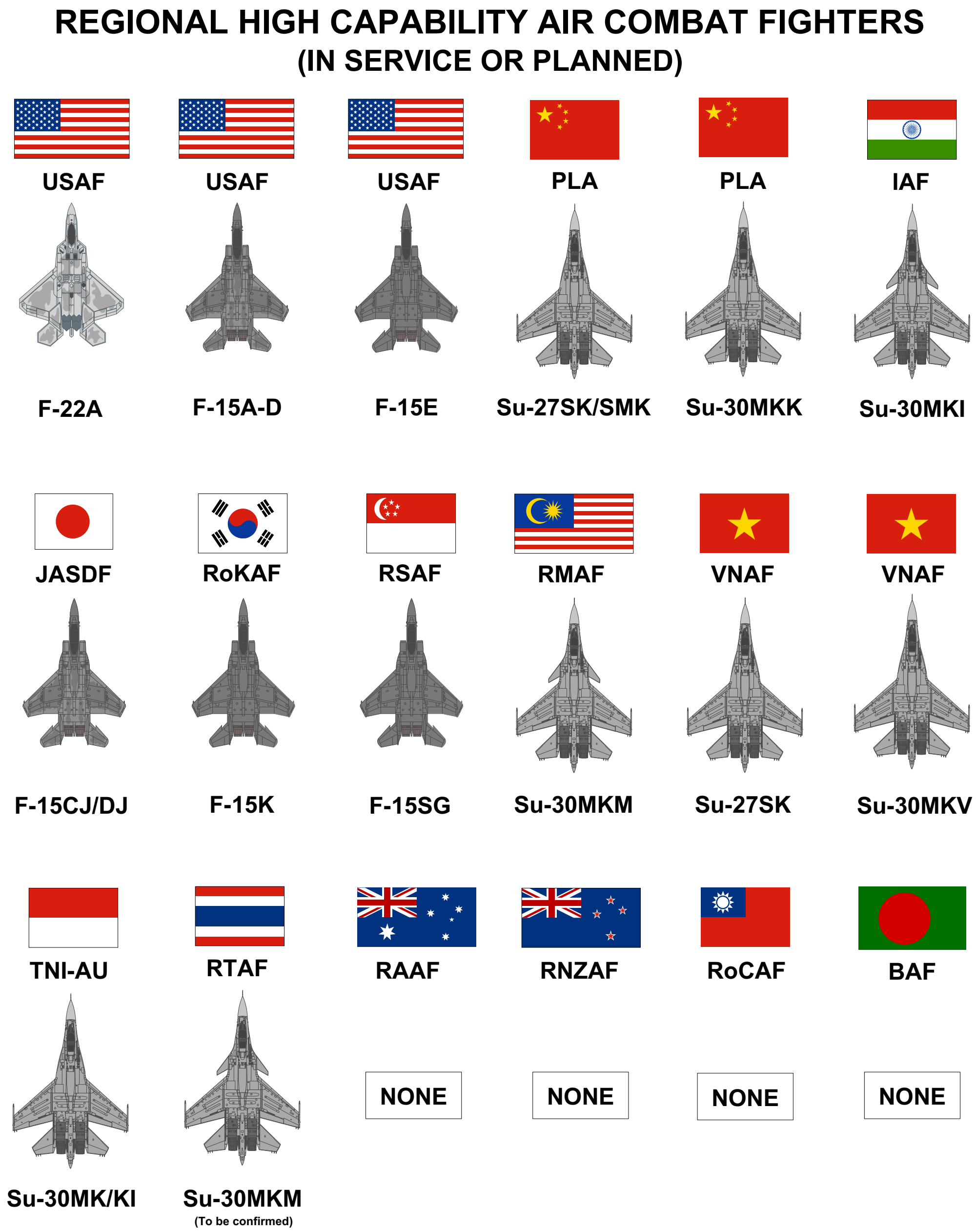

Figure 1: *Perhaps the most visible change in the region following the end of the Cold War has been the proliferation of large 'high capability' category air superiority fighters. This chart illustrates which types have been acquired or deployed by regional nations. Australia currently operates the smaller 'low capability' F/A-18A and plans to acquire the small 'low capability' Joint Strike Fighter. This places Australia firmly in the same force structure planning bracket as Taiwan, Bangladesh and New Zealand. This division of fighters into 'high capability' and 'low capability' categories is based on the United States Air Force 'High - Low Mix' model, abbreviating the more formal 'high capability and performance category' and 'low capability and performance category'. Examples of the 'high capability' category include the F-14, F-15 and F-22, examples of the 'low capability' category include the F-16, F/A-18 and planned Joint Strike Fighter. (C. Kopp).*

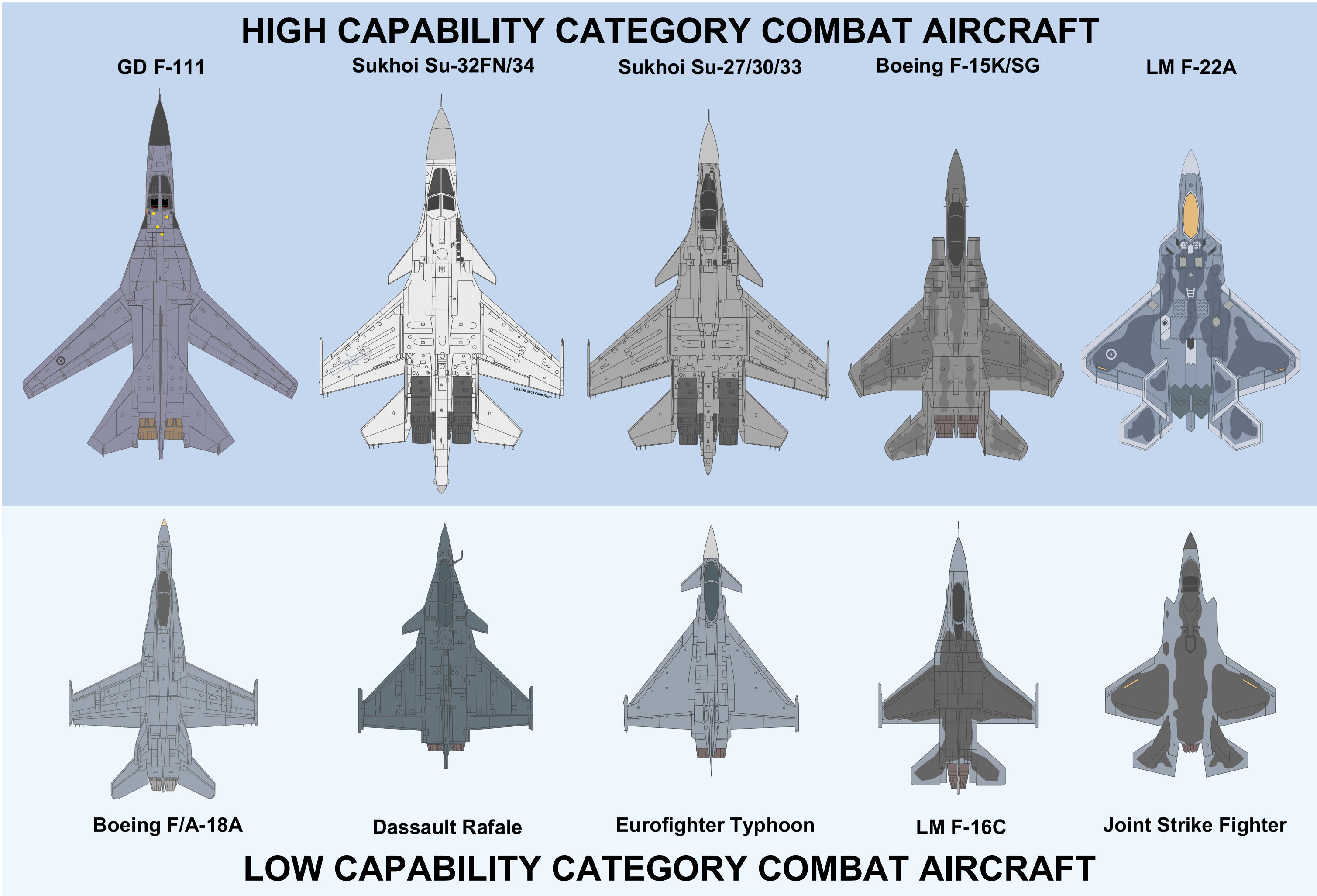

Figure 2: *Relative size comparison of high capability category and low capability category combat aircraft. Typically, high capability category combat aircraft are about 50% larger and significantly more capable than low capability category designs. Historically, low capability category designs were built as supplements to high capability category designs and intended for less demanding roles (C. Kopp).*

Contents

Executive Summary

Australia at this time stands at an important crossroad, and choices to be made in the near future will determine Australia's strategic relevance in the region, and globally, for decades to come.

The choices in question are those which determine what kind of air force Australia will possess over coming decades, and the ability of this air force to achieve air superiority in a regional conflict.

Air superiority is defined as the ability to achieve and maintain control of the air, which is the ability to conduct aerial operations without hindrance by an opponent, and the ability to deny the same to an opponent. Air superiority is achieved by a combination of superior fighter aircraft, strike aircraft, weapons, surveillance aircraft, aerial refuelling tanker aircraft, as well as superior pilot ability and training.

Of all of the goals a defence force might aim to achieve in conflict, air superiority is by far the most difficult. Without air superiority, an opponent can hold at risk or destroy air, land and naval forces, critical national infrastructure, industrial plant, and finally, aerial and maritime lines of communication. Air superiority is the precondition for all other military operations of significant scale.

This submission analyses current planning for the RAAF's future, against funding and risk measures, and developing or deployed regional capabilities for air superiority. It draws the following series of conclusions:

The planning model devised for the Joint Strike Fighter capability is not viable, both in terms of return on investment in capability, credible delivery timelines, and risk.

The planning model for the interim F/A-18A capability is not viable as the return on investment in capability and additional service life is very poor, while incurring significant risk.

Analysis of acquisition costs and operational economics indicates that a force mix of F-22A and upgraded F-111 fighters is both cheaper and more capable than the proposed plan based on service life extension of the F/A-18A and acquisition of the Joint Strike Fighter.

There are compelling strategic, technological, operational and budgetary reasons why the F-22A Raptor is a better choice than the Joint Strike Fighter as a replacement for Australia's F/A-18A Hornets. These include unchallenged lethality and survivability, affordable return on investment in capability, and very long effective service life.

The industrialisation of Asia, especially China, has resulted in an unprecedented growth of national wealth, and thus in the largest arms buying spree globally, since the last decade of the Cold War. Therefore, in any substantial future regional contingency, Australia will likely have to confront the full spectrum of modern air force capabilities, including high capability category fighters, aerial refuelling tankers, Airborne Early Warning and Control (AEW&C) systems, advanced smart weapons, cruise missiles, missiles designed to destroy AEW&C systems, digital networks, support jamming systems, and should China be involved, strategic bombers.

The United States is confronting serious 'strategic overstretch', and faces budgetary problems which will impact its long term modernisation plans and available force size. Therefore, the United States may have serious difficulty in responding quickly to Australia's needs, with the required force strength. Therefore, Australia needs to plan to perform independent operations in the region, especially when confronting regional air power.

The notion that regional contingencies geographically outside South East Asia would only be dealt with as part of a US led coalition is neither realistic nor supportable.

Dealing with future regional contingencies will require that Australia develop the capability to decisively defeat advanced Russian Sukhoi fighters, strategic bomber aircraft, subsonic and supersonic cruise missiles, and the capability to execute 'counterforce' long range strikes to a distance of at least 2,500 nautical miles, with a credible number of aircraft.

Therefore Australia will have to invest in a high capability category air combat fighter, the F-22A, retain the high capability category strike capability, currently in the F-111, acquire additional Wedgetail systems, acquire additional aerial refuelling tankers, acquire airborne support jamming systems, acquire much more intelligence, surveillance and reconnaissance capabilities, restore lost support capabilities, and upgrade the aviation fuel replenishment infrastructure of northern airfields.

Should Australia fail to develop these capabilities, it would most likely not achieve air superiority in a regional conflict, with concomitant losses in ADF equipment and personnel, and subsequently, significant material losses to economic infrastructure, especially in the mining and energy industries.

Extensive analysis indicates that the Joint Strike Fighter is not suitable for the kind of operations likely to be encountered in the region, as it is being designed for less demanding roles, especially supporting ground troops on the battlefield.

Australia's best choice both in strategic, budgetary and risk terms is to invest in the F-22A Raptor as its future air combat fighter.

Structure of Submission

The issues which contribute to an assessment of Australia's capability to achieve air superiority in the region are complex in detail, even if simple in concept. Three aspects are of paramount importance - Funding and Risk, Regional Capability Growth and means to Achieving Air Superiority. Accordingly, this submission is structured in three parts, each dealing with a specific aspect of the problem.

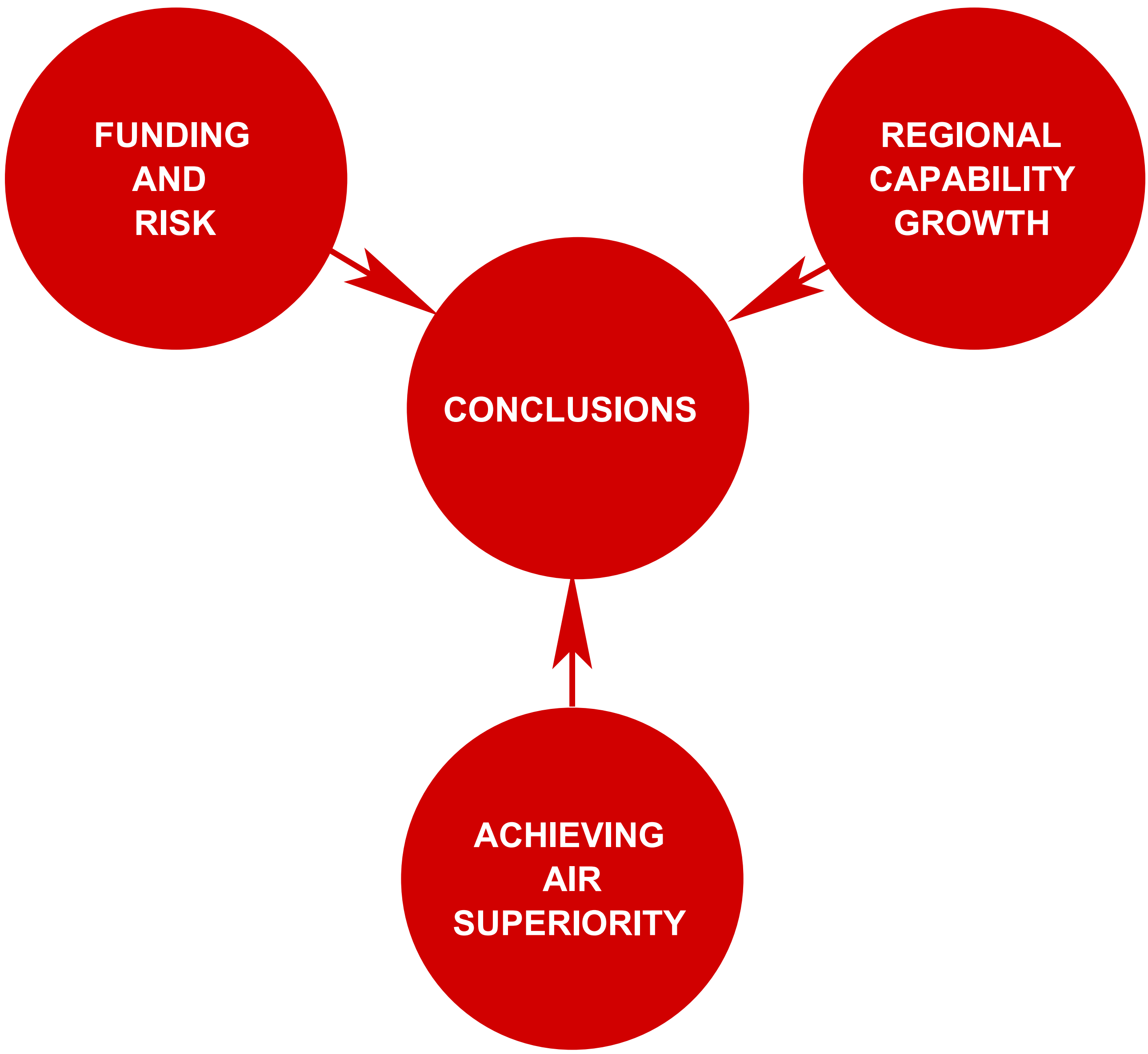

Figure 3: *Submission structure.*

In addition, several Annexes are included, containing references and supporting materials.

1 Funding and Risk

This section analyses the funding and risk factors which will significantly influence and thus constrain the intended acquisition of the Joint Strike Fighter, and interim Air Combat Capability to be provided by upgrades of the F/A-18 Hornet. It then outlines the single most capable and cost effective alternative strategy, and summarises extensive analytical findings.

1.1 Why the Joint Strike Fighter Funding Model is Not Viable

Senator FAULKNER - *Let me put the question to you this way, because we are very short of time. I ask you directly: what is the estimated cost per (JSF) aircraft now?*

Air Chief Marshal Houston - *It is $US45 million. . . . *. . . The most recent estimate of the average unit recurring flyaway cost of the JSF conventional takeoff and landing aircraft is approximately $US45 million.*

Senate Supplementary Budget Estimates Hearing, 02 November 2005

An important aspect of any financial analysis or funding model (or any analysis, for that matter) lies in the accuracy and the precision of the language employed to define the terms that are used. The obvious corollary to this is equally important, being the correct use of the correct terminology and definitions in the correct sense.

Finance and schedule issues form the basis of any funding model. The public representations of Defence officials on the finance and schedule aspects of the Joint Strike Fighter (JSF) and how they relate to the New Air Combat Capability (NACC) Project (AIR 6000) are replete with omissions of fact, imprecise language, and the incorrect use of terminology and definitions. As to whether such omissions, imprecise language and incorrect usage are intentional behaviour aimed at encouraging inferences of perceptions rather than facts, or representative of people who don't know what they don't know trying to deal with things they don't understand is for others to determine.

Therefore, putting the matter of cause (or blame) to one side, the above extract from Hansard is but one example of the results arising from such forms of behaviour. The Chief of the Defence Force (CDF) is representing to the Australian Parliament (and, thus, the people of Australia) that the estimated cost to Australia for the JSF, on a per aircraft basis, is $US45million. This was certainly what Senator Faulkner was asking and one could be forgiven for inferring this was the intention of CDF's response.

However, the actual cost to Australia, on a per aircraft basis, will be significantly higher for the following reasons:

1. The figure of $US45million is in 2002 dollars [1] or Base-Year Dollars [2] which does not take

into account economic inflationary effects or, moreover, the costs that will apply at the time of procurement, currently planned for 2012.

2. The term "*average unit recurring flyaway cost of the conventional takeoff and landing aircraft*" represents only a portion of the average unit flyaway cost which, in turn is only a part of the average unit procurement cost which is defined as –

   Average Unit Procurement Cost (AUPC) *is calculated by dividing total procurement cost by the number of articles to be procured. Total procurement cost includes flyaway, rollaway, or sailaway costs (that is, recurring and non-recurring costs associated with production of the item such as hardware/software, Systems Engineering (SE), engineering changes and warranties) plus the costs of procuring Technical Data, training, support equipment, and initial spares.*[3]

   A diagrammatic representation of this costing hierarchy is shown in Figure 4. Note this definition does not include any costs for research, development, test and evaluation (RDT&E) which, in US DoD budgeting terms, are costed and funded differently to the procurement budget.

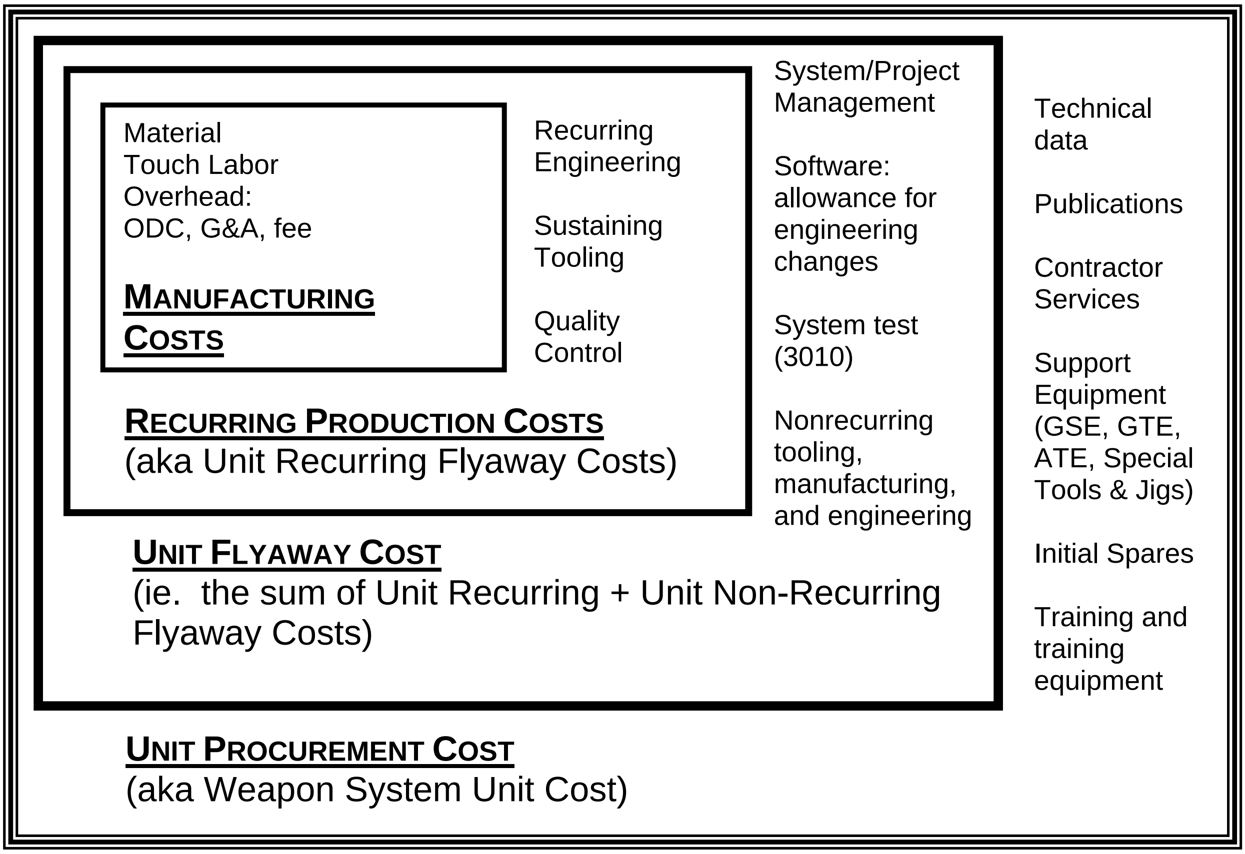

Figure 4: *Graphical representation of costing terminology used (globally) in defence acquisitions (P.A. Goon).*

3. The word '*average*' refers to the whole of the presently planned production of conventional takeoff and landing (CTOL) aircraft; some 1,763 units according to the September 2005

JSF Project Office Briefing or, put more simply, the unit recurring flyaway cost of a unit somewhere after CTOL aircraft number 880 rolls off the production line. In relation to the cost to Australia, some of the significance of the use of this term '*average*' may be gleaned from the following extract from Hansard which was interposed at the asterisk (*) in that above –

Dr Gumley - *Provided they are not the very first aircraft coming out. The very first ones coming out of the production factory are dearer than that. Once the production line settles down at Lockheed Martin, it comes down to $US41 million <sic>.*

4. Based on the various reports on JSF Program costings to the US Congress, in particular those in the US DoD Budget Papers and the Defense Acquisition Executive Summary Selected Acquisition Reports (SARs) since 1998, the following information may be derived :

   (a) As a result of the Defense Acquisition Executive (DAE) Milestone B approval, the JSF Program entered the SDD Phase in October 2001, and $US196,600.0 million of procurement funding for 2,866 production aircraft were added to the budget, in addition to the already allocated development (SDD) costs. Therefore, in 2001 current year dollars, the estimated average unit procurement cost for the program (across all three planned types) was $US68.6 million. This was in 2001, before Australia committed to join the SDD Phase of the JSF Program.

   (b) The US DoD split acquisition program costs into two main budget lines - the Procurement Budget, being the funding for those items that are to be delivered to the department; and, the RDT&E Budget, being for funding what can be termed, collectively, as the 'development costs'. The budget for the SDD Phase of the JSF Program is a good example of the latter. The SDD Budget is reported under the RDT&E Budget line for the JSF Program and is presently sitting at around $US42,000 million. The RDT&E budget expenditure for developing the F-22 (Raptor) was around $US24,800 million in FY2002 dollars.

   (c) In December 2004, the SAR showed that for the reduced number of 2,458 production aircraft, the Procurement Budget line for the JSF was $US214,617.6 million. Using the correct definition, this results in an estimated average unit procurement cost for the program (across all 3 planned types) of $US87.3 million in current year (2004) dollars.

   (d) Current (2005) production plans under the US DoD Procurement Budget for the JSF Program are for 1,763 CTOL aircraft for the USAF and a combined total of 680 aircraft, made up of 260 carrier variant (CV) and 420 short takeoff and vertical land (STOVL) aircraft, for the Department of Navy. The CTOL build numbers being the larger will skew any cost averages across the three planned types. A simple interpolation shows the estimate of the average unit procurement cost for the CTOL variant to be $US81.3 million in 2004 dollars.

   (e) Representations by senior defence officials to the Australian Parliament are that current plans have acquisition of the JSF commencing around 2012. The following table shows the effect of economic inflation factors from 1% to 3% per annum on the above estimated average unit procurement cost (AUPC) for the CTOL variant of the JSF for procurement in FY2012.

JSF CTOL AUPC FY2004	Annual Inflation Factor	JSF CTOL AUPC FY2012
$US81.3 million	1%	$US88.0 million
$US81.3 million	2%	$US95.2 million
$US81.3 million	3%	$US103.0 million

Table 1: The Effect of Economic Inflation on Costs of Planned Australian Buy

(f) Though the JSF Program is still in the SDD Phase, monies from the Procurement Budget line will be accessed, as has been the case in other US acquisition programs, such as the F-22. The recently released DoD 2007 budget seeks provision of some $US770 million (that is, $US1,015.0 million minus the $US245.0 million for "the advance procurement of 8 CTOL . . . aircraft") from the USAF line of the Procurement Budget in order to fund the "procurement of the first lot of 5 Conventional Takeoff and Landing (CTOL) aircraft for the Air Force". To this must be added the $US118.4 million funding in the FY2006 budget authorised last year for the advance procurement of these aircraft. Once again, applying the correct definition results in an average unit procurement cost across this lot of five (5) aircraft of $US177.7 million per aircraft.

(g) The US DoD 2007 budget papers also show the average unit procurement cost for a buy of 24 production F-22 Raptor aircraft in 2006 as $US156.9 million per aircraft in current year dollars. The previous buy of 24 aircraft in FY2005 was at an average unit procurement cost across this lot buy of $US170.6 million per aircraft. This demonstrates the descalation in costs that can usually be achieved when an aircraft is in full rate production. From a risk management perspective, the F-22 Program is over the 'risk hump' and on what is called the 'front side of the risk curve'. Similarly, an aircraft program that is still in the early stages of development, such as the JSF, is referred to as being 'on the backside of the risk curve'. As history and the experiential based rules of Norm Augustine[4] and Kelly Johnson[5] show as well as prudent risk management methodologies consider, costs are bound to increase during the 'backside of the risk curve' phase of a project. The more complex the project, the more marked the cost increases. In a similar vein, based upon the experience and wisdom of those who have gone before, cost estimating of those elements in a project which require project maturity to better define (eg. technical data, training, support equipment and initial spares) are quite 'rubbery' early in the project's life. Again, history and empirical measures show that the estimates of Unit Procurement Cost (UPC) early in a development project invariably end up more closely resembling the Unit Flyaway Cost estimate in the latter part of the development phase.

(h) Since money is a general measure of the resources and levels of effort required to sustain a project through to an outcome then, by definition, costs cannot be independent of the outcome. The notion of cost as an independent variable (CAIV), though a laudable project management philosophy for raising consciousness on costs, is mostly unsupportable, mathematically and logically, and presents a serious propensity for skewing risk management into the realm of the naïve. According to senior defence officials such as the CDF and the chief architects of the JSF decision, AVM (R'td) Ray Conroy, Mr

Mick Roche and the former Head of Industry Division, Mr David Learmonth, CAIV is meant to elevate cost to the status of a performance parameter. As such, it is meant to promote the optimisation of project goals early in the project by trading off the variables of cost, schedule, risk and performance. Even the most basic of common sense considerations shows there are serious incompatibilities between the parameters of cost, schedule and risk which all seek minima and the parameter of required performance which unlike the other three is supposed to be the primary driver of any program. In fact, of all four of these parameters, the required functions and performance (ie. war fighters' needs) is what a program is all about to begin with and the basis upon which the other three are determined and developed through the application of estimating and risk management methodologies. Poor initial estimating and flawed or incomplete risk assessment/management of this parametric trilogy should not be reason for downgrading or otherwise minimising the matching of capability to the war fighters' needs.

5. The results of an independent, parametric cost projection of an Australian buy of 100 Production Block 2 and/or Block 3 JSF aircraft in 2012 were provided to Defence in 2003 and again in 2005. This analysis assumes the development and production schedules being advised by Defence can be maintained. The analysis estimates the unit procurement cost will be somewhere between $US112 million and $US120 million per aircraft in FY2012 dollars.

6. In terms of these estimated costs in Australian dollars, a prudent approach would be to convert these amounts to Australian dollars using the Australian Reserve Bank (ARB) forward projection of the exchange rate in 2012 minus a risk hedge of, say, five points. Unfortunately, such an ARB projection is not readily available. However, an indication can be gleaned by applying the same methodology to an anecdotal mean of the exchange rate over the past 12 months of 0.7500, resulting in estimates of the unit procurement cost being between $A160 million and $A171.4 million per aircraft in FY2012 dollars. For a procurement of 100 CTOL JSF aircraft, this would require the expenditure of between $A16,000 million and $A17,140 million in order to purchase the aircraft with the requisite "*Technical Data, training, support equipment, and initial spares*", though, as highlighted earlier, experience shows that early UPCs more closely resemble the actual UFCs determined in the latter stages of the development phase. What are not included in these estimates are the costs for project management, any Australian unique integration requirements, in-country infrastructure/facilities or any consideration of life cycle support and operational costs.

7. This analysis takes into account the higher price that will have to be paid in buying early in the production from the Low Rate Initial Production (LRIP) phase of the JSF Program. It also considers an economic inflation factor of 1% per annum over the period 2004 to 2012. What this analysis does not consider are the effects of the reported "*guaranteed waiver of at least the SDD investment (*$US150million*) from the Non-Recurring Engineering cost*" nor any waiver resulting from Australia acquiring aircraft through the Production, Support and Follow-on Development MOU which has been reported by Defence to be "*valued at as much as US$1billion*"[6]. These two aspects are addressed later in this section. The analysis also does not take into consideration any effects on cost due to any reduction in overall production build numbers in the JSF Program.

8. In recent times, there have been some interesting statements forthcoming on the effect of

reductions in the production numbers on costs. The prime manufacturer has been reported as saying –

"There's a couple of different ways to look at flyaway costs," Burbage continued. *"One is, the number that you read about is average unit recurring flyaway cost, that's a number which is build rate and quantity dependent, where if you put all the airplanes on a curve, you can find an average. You may not find any airplane which actually costs that amount, but about half the airplanes will be more than that and about half will be less. As the unit recurring flyaway cost moves around, let's say the (US) Air Force decides to buy a few less airplanes and we bring the program in a little bit, the average unit recurring flyaway cost may go up, but the actual cost of any airplane doesn't change, it's just the average number on the curve. Sometimes people think the cost of their airplane is going up if the air force buys fewer airplanes – its really not the case unless you're buying airplanes on the very end of the buy."*

Tom Burbage, JSF Program Head, Interview with Andrew McLaughlin,
Published in Australian Aviation (Nov 05)

The content of this statement, as reported, may not be intuitively obvious to some and may invoke in the mathematically minded the question of "How can this be?". However, as the graphical representation in Figure 5 shows, this statement is, as far as it goes, quite correct. Any reduction in build numbers will come off the back end of the production run. Since the URFC is the recurring cost of production for a given aircraft and, though a reduction in production numbers may cause the average URFC to increase, the recurring cost for producing a particular unit or aircraft tail number within the remaining production run should not change.

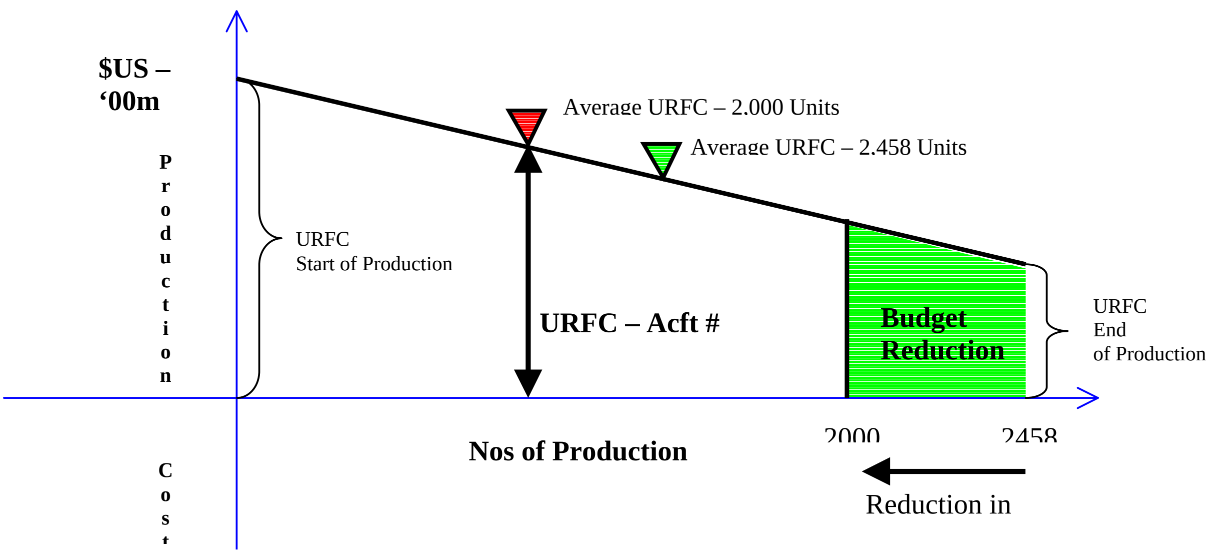

Figure 5: *JSF Unit Recurring Flyaway Cost (URFC) model (P.A. Goon).*

9. However, unit recurring flyaway cost is only a part of the overall cost of production, let alone procurement, of a weapon system. What has not been included, to date, in the representations

from Defence is the non-recurring costs of production which, when combined with the unit recurring flyaway costs (URFC), make up the unit flyaway cost (UFC). Therefore, Figure 5 and the related word picture is only part of the story on costs.

10. The diagram in Figure 6 provides a more complete picture, in a simplified graphical sense, of the JSF Costing Model up to what is termed the Unit Flyaway Cost. In this example, the reduction in budget that is achieved comes from not having to expend the URFC of the last 458 aircraft in the original planned production run. This budget saving is represented by the green area under the curve.

    However, the unit non-recurring flyaway cost (UNRFC) is originally derived by taking the non-recurring costs of production and amortising these across the total build number. If, as in this example, the build numbers are reduced, then the non–recurring costs of production (plant and equipment, system/project management, tooling, allowance for engineering changes, system test, etc.), in the main, still have to be met. This is achieved by amortising UNRFC of the 458 aircraft removed from the production across the remaining number of units to be built, as shown in red in the above figure.

11. In terms of total procurement, the costs for training and training systems, technical data, support systems, initial spares, contractor fees and government charges needs to be added to the UFC to determine the unit procurement cost (UPC). Further, by adding in the costs for project management, Australian unique integration requirements, in-country infrastructure/facilities, and life cycle support and operational costs, the total project unit cost (TPUC) can be derived. Multiplying the TPUC by the number of aircraft procured, the resulting figure should, at least in theory, match the budget in the Defence Capability Plan (DCP).

12. Clearly such a matching cannot be achieved using the figures and advice provided by the Department of Defence. A strong indicator of how this situation has come about may be seen in a letter[7] dated the 7^{th} of December last, in which the former Defence Minister's Chief of Staff, Mr Andrew Buttsworth, advised that :

    "Defence has provided the following information:

    - *Cost as an Independent Variable (CAIV) is a philosophy which elevates cost to the status of a performance parameter. CAIV promotes the optimisation of project goals early in the project by trading off the variables of cost, schedule, risk and performance.*
    - *The average unit recurring flyaway cost is the average cost of the aircraft over the entire buy. That is total cost of aircraft purchased divided by total aircraft purchased.*
    - *The unit recurring flyaway cost is the cost of an individual aircraft purchased within a specific year.*

    The Defence Capability Plan has allocated approximately $A12 billion for up to 100 Joint Strike Fighters. This equates to an average total project cost of approximately $A 120 million per aircraft. Apart from the cost of the aircraft themselves, approximately 60 per cent of project cost, this amount includes a range of broader project costs including, but not limited to, training systems, support systems, integration requirements, project management costs and facilities requirements."

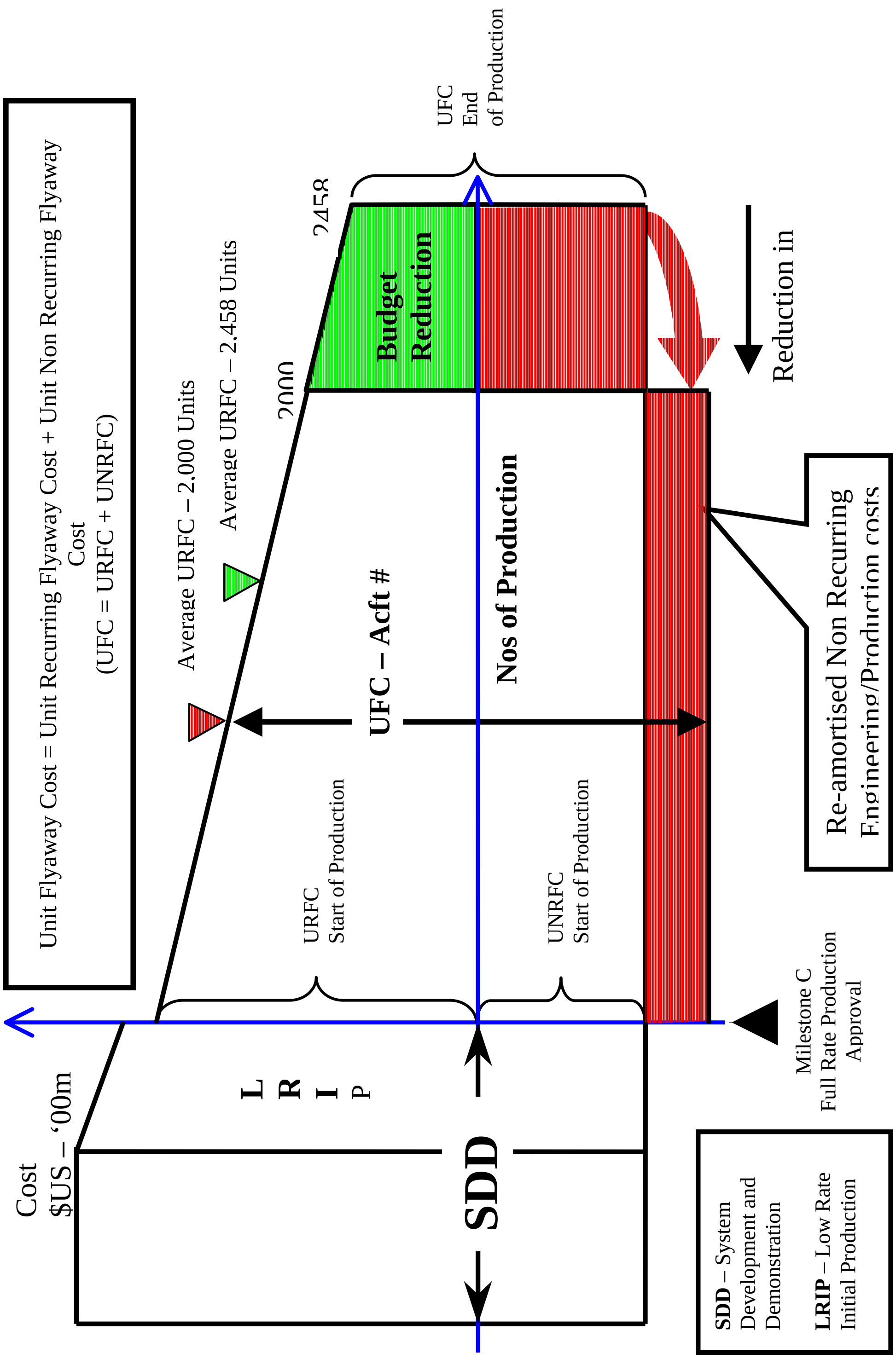

Figure 6: *Graphical representation of JSF Unit Flyaway Cost (UFC) model (simplified for clarity) (P.A. Goon).*

A review of correspondence, media releases, public statements, and submissions to the Parliament reveals that this letter is the first time most of these statements have been seen, outside the Department. Even a cursory look at this advice from senior defence officials to the Office of the Minister for Defence shows there are omissions of fact, imprecise language and the incorrect use of standard terminology and definitions.

13. For instance, if one were to take these definitions provided to the Minister at face value and then use them for assessing the US DoD Budget Papers then, by rights, the total US DoD Procurement Budget for the JSF could be slashed by more than half the existing figure. Clearly this is not the case. However, two additional pieces of useful information may be derived from this letter.

14. As stated, approximately 60 per cent of the average total project cost of approximately $A120 million is for the aircraft themselves or some $A72 million per aircraft. At a current exchange rate of, say, 0.7500, this equates to an average cost per aircraft of some $US54 million. It is unlikely numeral displacement or dyslexia are to blame for this mismatch with the CDF's advice to the Parliament of the figure of $US45 million.

15. In the corollary, approximately 40 per cent of the project budget, that is some $A4,800 million total or $A48 million per aircraft, has been estimated by senior defence officials for "*a range of broader project costs including, but limited to, training systems, support systems, integration requirements, project management costs and facilities requirements*". At this point in the JSF Program and because earlier identified risks are now materialising, a prudent approach to costing in the Defence Business Case for the JSF would be as follows –

    (a) Take the best estimate of unit procurement cost (UPC) from the JSF Program costing/budget documentation from the USA;

    (b) Consider this '*early in the program*' estimate of UPC as what will ultimately be the unit flyaway cost (UFC) at the end of the development phase of the project; and,

    (c) Add to this the unitary figure derived from the best estimate of costs for all those additional aspects which, when added to the UFC, will result in the total project unit cost (TPUC).

16. Clearly, a more accurate way to do this would be to use the data from the JSF Program Office costing models. However, since we do not have access to an approved version of this data, a reasonable approximation can be derived from the figures above, as follows:

    - Average UPC – CTOL (FY2004 dollars) $US81.3 million
    - Currency conversion at exchange rate = 0.7500 $A108.4 million
    - Add costs for determining TPUC ($A48 m) $A156.4 million

    This approach has resulted in a project unit cost figure of $A156.4 million dollars per aircraft for prudent budgetary purposes. However, the reader should note that this figure is in the 'current year dollars' of the base figures from which it has been derived, nominally 2004 year dollars.

LSN	COST ITEM	AMOUNT		UNITS	TOTAL OVER 10 YEARS	PER ANNUM	PER DAY
		USD	AUD				
1.0	**SDD TOTAL EXPENDITURES**			**Sum**	**$317,790,714**	**$31,779,071**	**$122,227**
1.1	SDD Investment	$150,000,000	$214,285,714	1	$214,285,714	$21,428,571	$82,418
1.2	Manpower Cost- (1) Sub Total:			54	$81,500,000	$8,150,000	$31,346
1.2.1	NACC Project Office		$150,000	10	$15,000,000	$1,500,000	$5,769
1.2.2	DMO - Other		$150,000	5	$7,500,000	$750,000	$2,885
1.2.3	RAAF HQ		$200,000	1	$2,000,000	$200,000	$769
1.2.4	Capability Group		$150,000	2	$3,000,000	$300,000	$1,154
1.2.5	DSTO		$150,000	30	$45,000,000	$4,500,000	$17,308
1.2.6	DITR		$150,000	2	$3,000,000	$300,000	$1,154
1.2.7	Dept of Finance and Admin		$150,000	2	$3,000,000	$300,000	$1,154
1.2.8	Professional Service Providers		$150,000	2	$3,000,000	$300,000	$1,154
1.3	Aggregate Overhead as % of Labour (2)			27%	$22,005,000	$2,200,500	$8,463
2.0	**PROJECTED EARNINGS**			**Sum**	**$107,142,857**	**$10,714,286**	**$41,209**
2.1	Industry Contracts (Gross Revenue) (3)	$500,000,000	$714,285,714	1	$714,285,714	$71,428,571	$274,725
2.2	EBITDA @ 15% (4)		$107,142,857	1	$107,142,857	$10,714,286	$41,209
3.0	**PROJECTED RETURN/(LOSS)**				**($210,647,857)**	**($21,064,786)**	**($81,018)**
4.0	**CURRENT EARNINGS**						
4.1	Contracts to Date (Gross Revenue) (5)	$60,000,000	$85,714,286	1	$85,714,286	$8,571,429	$32,967
4.2	EBITDA (@ 15%)	$9,000,000	$12,857,143	1	$12,857,143	$1,285,714	$4,945
5.0	**CURRENT RETURN/(LOSS)**				**($304,933,571)**	**($30,493,357)**	**($117,282)**

Simplified Analysis of Defence JSF SDD Business Case: Return through Industry Earnings Basis

Notes:
1. Estimates of total costs of employment.
2. Mid range estimate of overhead expressed as percentage of employment costs.
3. Based on advice provided in JSF Project Office Brief circa 2002 – "*on offer are between $300m to $500m worth of contracts in SDD/LRIP Phase*".
4. Earnings Before Interest, Tax, Depreciation and Amortisation – mid to high performance.
5. Department of Defence Answers to Question W6 on the JSF Development and Procurement, Pages 20 – 31, Questions on Notice from the Supplementary Budget Estimates Hearing of 02 November 2006.

Figure 7: *Simplified JSF Business Case.*

17. One of the reasons why Australia joined the SDD Phase of the JSF Program and, thus, had committed $US150 million dollars to the program was to have access to the project data. Therefore, Air Power Australia recommends a similar exercise to the above prudent costing approach be undertaken, using the JSF Program Office (USA) costing models as the costing basis along with the costing data on the Australian specific aspects from the NACC Project Office. A worthwhile thing to do then would be to compare the resulting figure with that determined in the funding model of the original Defence Business Case for the JSF, circa 2002.

18. On the Defence JSF SDD Business Case, a number of observations can be made and conclusions drawn. The principal one of these is that by any measure, the NACC-JSF Program is following a loss-lead business model of enormous proportions. That is, in addition to the acquisition program itself, significant investments are being made and losses are being allowed to accrue by Defence and other government departments as well as Industry. Like all applications of the loss-lead business model, the aim is for such investments and resulting accrued losses to be offset and then recovered (and, significantly so), by the benefits that should accrue from the project in which the investments are being made and the losses accrued, initially. Loss-lead business models are effective where significant initial investments are needed but commensurately large returns are assured due to such things as the generation of a strong, sustainable demand on the business and/or clear and unambiguous means for converting risks into opportunities that yield such returns. One needs to ask if Australia's involvement in the JSF Program meets the requisite criteria for application of such a model?

19. The table in Figure 7 is a simplified analysis, on a return through Industry earnings basis, of the JSF Business Case which relies upon the information presented by Defence in JSF briefings, media releases, and submissions to the Australian Parliament [8].

20. This simplified analysis does not include a number of related considerations such as the Business Development Budgets of Industry members who bid but are unsuccessful. The cost of bidding generally ranges between 1 per cent to 3 per cent of the gross value of the target contract. Therefore, over the ten year period, these costs could range from zero to $A20m+, depending on how successful and committed the bidders are in the project. Also, this analysis does not consider any benefits that may arise from the agreements on the financial provisions in the JSF SDD Memorandum of Understanding (MOU) since any such benefits would accrue after the 10 year period to which this analysis applies. That said, these benefits are briefly described and discussed at the end of this section.

21. Even with these limitations, this analysis clearly shows that, on a return from Industry earnings basis, the Defence JSF SDD Business Case was, at best, courageous and, on merit, far from compelling. To embark on a 10 year program that would result in a negative '*return on investment*' ratio let alone one that approaches a ratio of minus two would have required some heroic assumptions in its justification. To continue in the same vein some four years into the program when the empirical indicators show this ratio heading further south would be more than heroic. This is not to say participation in the JSF SDD should be terminated, though that is certainly one of several solution options. However, the full potential of this loss/lead business model would appear not to have been fully explored let alone canvassed as an option, particularly in the area of turning risks into opportunities where the means for

mitigating such risks are so inherent in Australia's unique assets, capabilities and people skilled in the aerospace and systems sciences and engineering. [9]

22. Returning to the JSF SDD MOU and the benefits that may arise from the agreements on the financial provisions. Senior defence officials have advised that -

"(viii) Australia obtains a range of benefits from its investment in the JSF program. These benefits include:

- *the unprecedented opportunity for Australia to participate in the development of an advanced fighter aircraft;*
- *the opportunity for Australian industry to be part of the global supply chain of the world's largest defence project;*
- *privileged access to JSF project information;*
- *priority for acquisition of the JSF aircraft; and*
- *guaranteed waiver of at least the SDD investment from Non-Recurring Engineering costs (guaranteed full waiver if Australia acquires aircraft through the Production, Support and Follow-on Development MOU, valued at as much as US$1 billion)."*

Department of Defence Answers to Question W6
JSF Development and Procurement, Pages 20 – 31,
Questions on Notice from the Supplementary
Budget Estimates Hearing of 02 November 2006.

<table>
<tr><th colspan="2">Value of contributions
Level III Partner</th><th>National deputy</th><th>JSF Program Office staff</th><th>Data use rights</th><th>Benefits during production</th></tr>
<tr><td rowspan="3">Australia•</td><td rowspan="3">U.S. target: approximately 1-2 percent or $250-500 million

Negotiated contribution: $150 million</td><td rowspan="3">Reports to the JSF international director</td><td rowspan="3">One integrated staff, who performs both national deputy duties and participates on the C4I IPT</td><td rowspan="3">Project purposes: includes use for the performance of project activities under SDD MOUs</td><td>Delivery priority based on level of SDD contributions</td></tr>
<tr><td>Consideration for waiver of all non-recurring research and development costs</td></tr>
<tr><td>Levies from sales to nonpartners based on level of SDD contributions</td></tr>
</table>

Australian Contributions and Benefits:
Extract from GAO Report No GAO-03-775

Figure 8: *Australian Contributions and Benefits: Extract from GAO Report No GAO-03-775*

23. Whereas, in a report titled, "Joint Strike Fighter Acquisition: Cooperative Program Needs Greater Oversight to Ensure Goals Are Met" dated 21 July 2003, the US Government Audit Office listed the contributions and benefits in the MOU for Australia's participation in the SDD Phase of the JSF Program as per Figure 8.

24. Clearly, some more work needs to be done and some discussions held in relation to the terminology, definitions and the language used to determine what really are the Australian contributions and, moreover, benefits as a Level III Partner in the SDD Phase of the JSF Program. For instance, the use of '*Non Recurring Engineering costs*' in place of the MOU wording of non recurring *'research and development costs*' could lead to some confusion, particularly as to which US DoD budget line any '*consideration for waiver*' may be drawn. Similarly, to what does the '*as much as US$1billion*' refer?

25. Finally, the JSF Program Office is reporting the milestone for Defense Acquisition Board approval into Full Rate Production (FRP) as currently scheduled for the first QTR of CY2014. Analysis in FY2004 dollars indicates that the Average Unit Procurement Cost (UPC) for a buy of 100 x JSF aircraft at the beginning of CY2014 could be in the order of $US100.0 million (FY2004). Estimating when delivery could start and at what rate is somewhat problematic but as a Level 3 Team Member, Australia is behind Italy, Netherlands, Turkey and, possibly, Canada in the priority pecking order for full rate production CTOL aircraft. Acquiring earlier build LRIP (low rate initial production) units has always been the intention of the Director, NACC Project Office. However, these units, traditionally, would cost more (≈$US110 million per unit) and require additional expenditure to upgrade to the full rate production configuration.

26. Analysis in FY2004 dollars indicates that the Average Unit Procurement Cost (UPC) across a buy of 55 x F-22A aircraft in 2010, at the end of the current planned production of 183 units, will be about $US126.0 million (FY2004 dollars). Since this would be at the end of the current USAF production run, delivery to Australia could be seamless, starting in 2010 at Aircraft #184 at a rate to be determined, but 20 to 25 per annum could be possible.

The funding model for the JSF as presented by the Defence Capability Plan and representations to the Parliament by senior defence officials is not viable because :-

1. Unit costs advised by Defence over the past four years (a range between $US40m to $US45m) and upon which these representations are based are only a part, in fact, less than half, of what will be the unit procurement cost if Australia were to decide to buy the JSF.

2. Omissions of fact, imprecise language, and the incorrect use of terminology and definitions go to the credit and integrity of the model, highlighting its flawed nature and lack of rigour.

3. Time value of money (TVM) considerations do not appear in any of the representations.

4. The loss-lead Defence Business Case for joining the JSF SDD Phase was so extreme and embodied such high risk as to be,at best, courageous and, on merit, factually unsupportable and non-executable to any positive effect in its current form.

5. The disciplines of risk assessment, risk management and T&E are notable by their absence.

6. The total procurement cost for a fleet of 55 x F-22A aircraft is estimated at $US6,930.0 million (FY2004 dollars) and delivery could begin in 2010 and possibly earlier, subject to how well Australia is able to negotiate on both price and delivery.

7. The total procurement cost for a fleet of 100 x JSF CTOL aircraft could range between $US10,000.0 million and $US11,000.0 million (FY2004 dollars) - more if the total build numbers for the USAF are reduced, or the Department of Navy build numbers are reduced, or the UK build order is less than 150, or one of the variants is cut, or the program schedule slips by more than a year, or other identified and as yet unidentified risks to the program materialise.

1.2 Why the F/A-18 HUG Funding Model is Not Viable

The principal reasons why the F/A-18 replacement schedule should still follow the guidance given in the Defence 2000 White Paper and occur in the 2010-12 timeframe (if not earlier) are the same reasons and supporting issues that make the F/A-18 Hornet Upgrade (HUG) Program Funding Model non viable.

The F/A-18 'Classic' is a third generation, short range, low capability category – or Tier 2 -tactical fighter approaching the end of its economic and useful strategic life. The latter is being hastened, and increasingly so, by the strategic developments in our Region, which can best be described as unprecedented proliferation of offensive and defensive weaponry in the high capability or Tier 1 category.

The HUG Program is a collection of system and weapon upgrades as well as Air Vehicle Modifications and refurbishment programs, the latter being to extend fleet airframe life from 2012 out to about 2015. The former are intended to upgrade and enhance the aircraft's air combat capabilities, endeavouring to address the growing imbalance in regional air superiority and the resulting threats. At the same time, these programs are intended to provide interim, albeit lesser, strike/ reconnaissance / surveillance / air vehicle interceptor / close air support capabilities in place of the F-111s which Defence has recommended to be retired early, in 2010, rather than in 2020 following guidance given in Defence 2000. The threat to Australia's long standing position in regional air superiority is further exacerbated by features peculiar to the F/A-18 'Classic', and the Australian variants, as well as the maintenance and operational doctrines that have been applied to them since their introduction in the 1980s.

It is well known that the RAAF's usage of the aircraft has been to meet the requirements of the fighter as well as the ground attack/close air support roles. The result has been the application, until relatively recently, of a demanding load spectrum on the aircraft, beyond the design spectrum during its earlier life – in the language of the common man, somewhat akin to exposure to greater wear and tear. Again until relatively recently, the maintenance philosophy applied to the aircraft did not include a deeper level maintenance cycle wherein the aircraft would have been 'overhauled' on a periodic basis. In fact, many of the maintenance activities now planned as part of the deeper level maintenance servicing activities being done in association with HUG will be performed for the first time in the aircraft's life. Access will be gained and inspections will be carried out in areas on the aircraft that have not seen the light of day since original manufacture back in the 1980s. Structurally and, to a lesser extent, from an Air Vehicle Systems perspective, the RAAF fleet of Hornets is made up of two build standards, having been produced on two quite separate production lines with different production philosophies and standards. This history, variability and life cycle experiences are now making their presence known, as the HUG and deeper level maintenance activities proceed.

Effects due to Structural Refurbishment Programs. The significance of this is now becoming apparent with the implementation of the structural refurbishment program (SRP) associated with the HUG and the deeper level maintenance servicings. The primary basis of the SRP was the International Follow On Structural Test Program (IFOSTP) Program and the related Airframe Life Extension Program (ALEXP). These programs involved full scale fatigue analyses and testing being carried out on a limited number of test articles, though this is the norm because of the time and expense to do such work. These programs generated many hundreds of inspections and related repair techniques along with life extending modifications to the structure of the F/A-18 air vehicle. From their origins and, thus, statistically, these 'refurbishment' activities are based upon a fairly small sample of the F/A-18 'Classic' fleet. Though attempts have been made to generalise the activities for the range of aircraft, their applicability, relevance, and ability to capture all structural defects/issues before they become a problem are influenced by a large number of variables, including variations in aircraft configurations and build standards. As a result, the number of refurbishment activities needing to be applied to the RAAF fleet is increasing, the deeper and further the maintenance teams are now getting into the now multiple structural repair programs – SRP-1, SRP-1A, etc.

Effects due to Fuel System. The absence of a deeper level maintenance program for the bulk of the now extended life of the aircraft means that the fuel bladders, which have a finite life of around 17 to 20 years, are now perishing and in need of replacement. Attempts to repair such bladders are in vain, due to their deteriorated state and the damage that ensues in removal and replacement activities required in effecting any repairs. The fuel leaks on the F/A-18 aircraft appear to be worse than those observed arising on the F-111s back in the 1970s, prior to the introduction of the Deseal/Reseal Program.

Effects due to Surface Finish and Corrosion Protection Systems. In the main, the aircraft have not had their surface finish completely replaced at any time over their life. Progressive and more extensive repairs and more expansive refurbishment activities have been the norm. Experience suggests that complete stripping back to parent metal, complete repair, repriming and a full repaint will be required on the bulk, if not all, of the fleet. This is neither a trivial or non-hazardous task from the perspective of cost, time, scheduling, manpower, OH&S and environmental considerations.

Effects due to Corrosion and Deterioration Related Defect Accrual. The absence of a deeper level maintenance program means there are areas on the aircraft that have not been subject to regular inspections or been inspected at all (eg. wing skin faying surfaces, internal bulkheads, etc.). As a result, there is a medium to high probability of there being corrosion and/or other deterioration related defects in these areas. It would be reasonable and, given flagging of these possibilities earlier this decade, likely that the extent and consequences of any such defects are in the process of being determined through statistical sampling inspection methods in order to ascertain the extent/pattern of any such problems across the fleet.

Effects due to Electrical Wiring and Associated Looms. Kapton insulated wiring was used extensively in the manufacture of the RAAF F/A-18s. This wiring is particularly susceptible to age related deterioration and embrittlement of a form that has been known to cause wiring failures, arcing and fires, both whilst the aircraft is airborne and on the ground. Kapton has been implicated in several catastrophic losses of commercial airliners as well as military aircraft. On balance, there are mitigators to these effects that go to the way the wires are installed, supported and maintained overall. However, this is a particularly insidious age and operational environment related problem. Since the late 1980s, after much lobbying by experts both in and outside the organisations, an increasing number of operators and manufacturers around the world have banned its use in later build aircraft and in repairs/modifications to existing systems that use Kapton insulated wire. In fact, the Australian Directorate General of Technical Airworthiness (DGTA) in the 1990s was one of the few airworthiness regulatory authorities to have done so. The US Navy banned the use of Kapton back in 1988. The aim here is not to inflame or sensationalise what, in aerospace engineering circles, is now a well-known material hazard condition. The aim is to provide sufficient background to enable the following issue on the RAAF F/A-18s to be properly aired and appreciated.

This particular problem is aggravated by mechanical disturbance of individual wires and wiring looms as will happen in many of the modifications and structural inspections/repairs to be undertaken as part of the HUG and deeper level maintenance programs on the RAAF Hornets. This will especially be the case with the Fuselage Centre Barrel Replacement Program currently planned, since complete looms (some of which have lay undisturbed in the airframe since manufacture), will be required to be demounted and folded back out of the way. The prudent (though costly and time consuming) approach would be to replace all the Kapton insulated wiring in the aircraft since the integrity of the insulation can start to progressively and increasingly break down after about 15 years in service. Anecdotal evidence of this occurring can be seen in the increased amount of time being taken to effect electrical inspections, servicings and repairs during both scheduled and non-scheduled maintenance activities on the aircraft. Lead aircraft in the RAAF fleet are coming up to 25 years service. Fortunately, informal advice indicates that, from an ongoing maintenance cost and, ultimately, safety perspective, replacement action is finally being considered if not already determined in the affirmative. If true, this is welcome news, safety wise, but the likely timing should further bring into sharp relief the false economies in the reversal of the Defence 2000 White Paper guidance.

A footnote to the Bravo Zulu (aka Bouquet) for DGTA. Interestingly, but not surprising to those who know Defence today and how decisions are made today, recent selections of aircraft with projected lives well beyond 25 years contain Kapton insulated wiring. This is reminiscent of some other (in)famous Augustine sayings that would be apt to ponder while waiting for the responses, having asked the question, "Why?". [10]

Effects due to Risk Assessments and Risk Management.

In response to the questions -

(ii) What are the prerequisite projects associated with the Hornet upgrade?

(iii) In standard risk assessment terms such as those used in AS/NZS 4360:2004, what are the statistical probabilities for each of these projects being completed on schedule? What is the overall statistical probability that all these projects will be completed on schedule?

provided on notice by the Senate, following the Supplementary Budget Estimates Hearing on 02 November 2005, senior defence officials had this to say –

(ii) The prerequisite projects associated with the Hornet upgrade include the sub-elements of Air 5376 Hornet Upgrade (Helmet Mounted Cuing System, Link 16, Electronic Warfare Self Protection, and Structural Refurbishment), improvements to the Hornet's strike capability provided by Air 5409 Bomb Improvement Program and Air 5418 Follow On Stand-Off Weapon. The Chief of Air Force was also referring to the prerequisite elements of the air combat environment in which the Hornet

will operate such as B737 Airborne Early Warning and Control aircraft and the extended operating range provided by A330 air-to-air refuelling aircraft.

(iii) An understanding of risk is an integral part of Defence's management of upgrade and acquisition programs. Risk to schedule is one element of any project's overall risk profile and a schedule risk for each project is determined and treatments applied. Defence uses a combination of qualitative and quantitative measures to manage risk.

This exchange brings into focus two very important aspects that are fundamental to the disciplines of risk assessment and risk management, and provides a useful insight into the way that senior defence officials think about risk.

Importantly, the number, size and nature of the sources of risk must first be identified, along with the risks inherent in these sources, as the front end of the risk assessment. At this point, it is useful to organise the sources of risk into a form that considers and reflects the interrelationships between the sources and the risks they bring to the project. Where there are a number of activities that, for organisational, managerial, funding or other reasons, are separate in their own right but are interrelated through risk, a prudent and normal approach is to bring them under the purview of a master program – oftentimes referred to as a Capstone Program.

Secondly, the number, size and nature of the sources of risk need to be quantified, as do the risks themselves. This may be achieved through the application of various techniques that are intrinsic to the risk assessment discipline. The aim is for the sources of risks and the risks themselves to be 'objectified' to remove the inherent risk that ethereal subjectivity brings to risk management and the achievement of effective decision making. Flowery hyperbole and the wearing of rose coloured glasses (and not much else) have no place in the worlds of risk assessment and risk management.

Turning back to the exchange above. The first response lists out quite a number of projects which, within themselves, are quite complicated and challenging. The response states that they are interrelated and, moreover, there are other larger and more complex "*prerequisite elements of the air combat environment*" to which these projects are related. The response identifies some 8 projects that are interrelated but gives no indication as to how these interrelationships are to be managed. Common sense says that if these projects were being managed via an overarching process, such as a Capstone Program, this would be in the planning documents (eg. Defence Capability Plan) and would have formed part of this response, if for no other reason than for such approaches to be effective, they require resourcing and funding. Also, the response does not identify any of the other interrelated sources of risk, such as those outlined above.

The second response is 'flowery hyperbole' and indicates either a complete lack of understanding of the question or of the risk assessment discipline itself.

A simple and appropriate answer would have been to state the probability that has been calculated for each project to be completed within its planned schedule. This is a relatively simple thing to do. To answer the second part of the question, this is simply done by applying the product rule of probabilities[11] .

For example, the schedule risk for one of the projects may turn out to have a probability of success of $P_s = 0.93$. In other words, it has been determined through analysis of the risks that can effect schedule, that there is a 93% probability the project will be completed on time. For a complex aerospace project, this would be a good result from a robust risk analysis, particularly if this is the probability of successful completion on time that is determined at the start of the project. To give the reader some feel for what this means, the target Key Performance Parameter for reliability (ie. probability the aircraft will be available to fly) of the CTOL JSF is 93%.

If the final outcome that is being sought, say the early retirement of the F-111s, is dependent on all the projects being completed on time, then the probability of this being achieved is simply P_s^N where N is the number of projects. At this point, we don't have the probability for successful completion for any of the eight (8) project advised by Defence. However, to get some indication, a conservative approach would be to apply the above P_s of 0.93, since this would be a quite a good result for a robust risk analysis of any complex project. Taking this approach yields –

$$P_s^N = 0.93^8 = 0.56$$

What this is saying is that the probability of all eight projects which each have probabilities of successfully meeting their schedules of 93%, being completed on time is 56%.

This simple calculation, along with the above exchange and discussion, also permits several other observations to be made. Firstly, the senior defence official/s who provided the response to the question from the Senate Committee does/do not understand the risk assessment discipline and, therefore, the claims made in the second part of the response are not credible. Secondly, the probability of successful achievement of the plans being made by senior defence officials is low and these plans are high risk. Thirdly, in order to mitigate these risks and achieving the desired outcomes within the time that has been set, significant resources and funds will be needed to improve and manage the inherent risk profile. The resources required to achieve the desired outcomes will have to include requisite expert skills and competencies in risk assessment, risk management, and T&E (Test and Evaluation).

Effects due to Schedules and Co-ordination of Works.

Between now and 2010, there are four years in which, under the plans of senior defence officials, the F/A-18 fleet must undergo an extensive amount of work. Some elements of this work are mutually exclusive of each other and, therefore, cannot be undertaken together on the aircraft at the same time; some need other elements done before they can proceed; some are dependent on work currently being done overseas; some are dependent on long lead time parts from overseas; some take a long time per aircraft; and, all are dependent on the availability of manpower, facilities and specialised equipment.

For example, the requirements for doing the Fuselage Centre Barrel Replacement (CBR) include a large special jig, a big replacement part from overseas (the fuselage centre barrel itself) and a multiplicity of other parts. In addition to these, there are the requirements for special tooling, about 10 calendar months to complete with the aircraft spending much of this time in the special jig, specially trained personnel, and a mountain of paper work to be gone through by a large number of people.

The level of effort required to plan and then co-ordinate and do the CBR modification is significant, in itself. But when the planning, co-ordinating and doing for CBR and all the other work that must be done to meet the plans of the senior defence officials in Canberra must happen in the same four year time window, this is challenging. However, when this planning, co-ordinating and doing has to consider, as it must, all the other work that will arise as a result of the condition of the fleet and the embryonic deeper level maintenance program, the effort and resources to do so effectively, in such a timeframe, are huge.

This incurs a high risk and will add significantly to the overall costs of the HUG Program in order to properly mitigate this risk– far more so if the funds and resources are not made available to effectively (and quickly) plan, then co-ordinate and do the work.

Effects due to Aircraft Availability.

While all this work is being done on the aircraft, there is something that is not happening as a result. The aircraft are on the ground. They are either in maintenance or being prepared and waiting to go into maintenance, or in the process of being released from maintenance and being prepared to return to service. Irrespective of where they are in this program, the aircraft are not flying and, moreover, are not available to fly.

This is one of the more insidious but less talked about outcomes of such a large grouping of maintenance activities – upgrades, first time deeper level maintenance servicings, structural refurbishment programs, corrosion repairs, fuel bladder replacements, repaints, rewirings, rectification of known defects, and allowing for unscheduled arisings – in such a relatively short time window. To perform all the work that is required on the fleet of 71 F/A-18 aircraft in the remaining four years, to meet the expectations of Canberra, will mean that aircraft availability will drop and remain low for the duration of these activities. Only seeing aircraft availability numbers in the mid to low teens, for extended periods of time, over the next four to six years is a real possibility. If this is allowed to become a reality, given the now considered normal happenings on RAAF F/A-18 flight lines, it would be hard to see how one could muster a five ship fly past, let alone be in a position to defend our Nation.

Senior defence officials have recently started talking publicly about the cost of not having a capability available. However, much of this talk is ethereal and highly subjective. There is a real cost that results from reduced aircraft availability and this needs to be measured by Defence and added to the HUG Funding Model. This cost is significant and, moreover, has far reaching and long term negative effects on defence capabilities.

Effects due to Costs.

Put simply, costs will be increasing and the probability of them continuing to increase is high to very high, and markedly so. This will become particularly obvious when the actual and complete costs of the HUG, deeper level maintenance, structural and other Air Vehicle repairs and refurbishments, operational level maintenance, unscheduled maintenance arisings, and engine sustainment are compiled and reported on a project basis, including the largest of all costs, manpower. The latter is rarely, if ever, reported in a way that allows costing attributions to be derived directly for the purposes of risk management, performance measurement and just good project management. Presently, cost reporting to the Parliament takes the form of a 'vanilla' and 'omnibus' manner. In relation to F/A-18 fleet costs, in the reports to Parliament such as the Defence Annual Report, these are rolled up with the costs of the F-111, Hawk and PC9 fleets and presented as an aggregate under the Air Combat Capability Group. The fiduciary performance of the directing and oversight levels of governance of the Department of Defence is being severely constrained and hampered by this method and form of reporting. It hasn't always been this way. [12]

Effects due to Primary Justification for Defence Reversal of White Paper Guidance.

As to whether the consequences for transparency that arise from the method and form of reporting discussed above are intentional or just an inadvertent outcome of short sighted or unthinking adherence to process is for others to determine. Certainly, our Government's Policy is one of declared openness and transparency – open government is the term that is commonly used - so it would be rather foolish, to say the least, of senior defence officials to intentionally breach Government Policy.

In not dissimilar circumstances, one needs to question senior defence officials' strident recommendations to the Government back in the 2001 to 2003 timeframe to cease the evaluations for Australia's new air combat capability under Air Project 6000 and effectively commit significant resources to the JSF. Similarly, their equally strident recommendations to retire the F-111 fleet early, before the F/A-18s. Both sets of recommendations effectively reversed the guidance in the publicly consulted Defence 2000 White Paper. The early retirement of the F-111s was being justified on the basis of occurrences that have been subsequently shown to have been problems incorrectly attributed to the aircraft and claims that persist today[13] that "*the [high] cost of maintaining that advantage (the F-111s) is distorting the shape of the force*"[14].

This claim was robustly challenged and roundly debunked back in 2005 without counter challenge or rebuttal from senior defence officials except within the secretive cloisters of Russell Offices where it would appear that blame is the game and groupthink dominates. The absence of any objective or constructive response was disappointing. The analysis [15] was openly and traceably based on Defence statutory reports and statements of senior defence officials responsible for the capabilities to which the analysis of costs and cost projections referred and had been previously provided. This was done in the spirit of continuous improvement and in response to the requests for feedback as may be found in the Defence Service Charter and the public pronouncements of these same senior defence officials.

The above series of effects on the viability of the HUG Funding Model should have encouraged even the most sceptical among us to ask, "Could it be that what the senior defence officials are planning for our future security and that of our children be less than optimal?". If further encouragement/enlightenment is needed, then read the following points and advice –

1. The RAAF Air Combat Capability Paper to the Joint Standing Committee on Foreign Affairs, Defence and Trade on 04 June 2004 states in Figure 2, titled 'F-111 Cost of Ownership –

Cash' that the total cost to operate, maintain, and upgrade the F-111 out to 2020, in keeping with the White Paper guidance, would be between $A2,500 and A$3,500, including personnel costs. However, the cashflow graph shows the total amount to be expended over the period 2004 to 2020 to be $A3,976.1 million. Discounting this cash flow back to 2004 on a present value (PV) basis yields a comparative PV figure of $A2,224.5 million in 2004 dollars.

2. The Defence Capability Plan (DCP) 2004-14 shows the budgetary estimates for the 'pre-requisite projects associated with the Hornet Upgrade (HUG)'. The aggregate of these, including Air 5418 – Follow On Stand Off Weapon and the Bomb Improvement Program, is A$2,725.0 million. This is for the capability upgrade acquisition projects, only. It does not include the costs for the preceding 'effects' nor the costs for operating and maintaining the fleet out to 2015 which is the life extension on the F/A-18s to be achieved through the HUG Program (as opposed to 2020 for the above F-111 costs). Presumably, though not clear, this figure does not include personnel costs – certainly not those for operating and maintaining the Hornet fleet nor for the 'effects'. Assuming, in the best case, that this figure is not as it would appear, namely, in 2004 dollars but actually the aggregate of the cash flows over the period in then year dollars. Then, using the schedule time lines in the DCP and applying the same present value discount factors (as for the F-111 analysis) yields a comparative PV figure of $A2,137.7 million in 2004 dollars.

3. A conservative estimate of F/A-18 operating and maintenance costs out to 2015, in PV 2004 dollars (for comparative purposes) would be $A3,002.7 million. Adding this to the capital costs for the HUG and associated upgrades and comparing this with the F-111 costs advised by the RAAF yields the following comparison in PV 2004 dollars –

Cost Capability Improvements and Related Savings

F/A-18 Fleet : Total Ownership Cost (Almost*) to 2015 $A3,002.7 million + $A2,137.7 million =	$A5,140.4 million
* Does not include costs of 'effects' et al that will be funded through Minor Item Submissions (MIS) and running system budgets.	
F-111 Total Ownership Cost of F-111 Fleet out to 2020	$A2,224.5 million
Result: 15 more years of long range strike capability plus savings of	$A2,915.9 million

4. In 2005, letters to the now Chief of Defence Force, ACM Angus Houston and the Chief of Capability Group, LtGen David Hurley, outlined the Industry Proposals of 2001/02 provided to senior defence officials in response to the requests from Defence for 'innovative, cost effective solutions to Australia's air combat capability needs' along with a way for implementing these proposals and saving the Australia tax payer over $A4,500 million dollars. A true 'win-win' outcome.

The funding model for the HUG Program as presented by the Defence Capability Plan and representations to the Parliament by senior defence officials is not viable because :-

1. The original model and business case failed to consider the effects of a considerable number of features unique to the Australian F/A-18 aircraft which have a significant negative impact on the cost, schedule and risks of the program.

2. The objective disciplines of risk assessment, risk management and T&E are notable by their absence.

3. The funding model does not consider the largest cost of all - being personnel costs.

4. In financial terms, the primary justification for the program was and continues to be seriously flawed.

5. Time value of money (TVM) considerations do not appear in any of the representations.

6. Senior defence officials had and continue to ignore the advice of independent experts and do so with prejudice to the experts, to the Parliament, and to the Nation, as well as their own credibility and the reputation of the Department of Defence.

1.3 Defining a Better Alternative

The following extract is from one of the letters referred to in the previous discussion:

"We are hopeful that you, along with the experts on your capability staff, will be prepared to engage us in discussions on the air combat capability options available under the force mix option entitled "The Evolved F-111".

This option was developed by members of the Defence Industry and provided to the Air 6000 Project Office in response to their Force Mix Option Market Survey 'Request for Proposals' run in the latter part of 2001. Following the Project Office's expressed interest in this option at a meeting in Adelaide in early 2002 and stated intention to recommend "The Evolved F-111 Option" for inclusion in Stage 3 of Air 6000, more detailed information and data were provided in the form of Unsolicited Proposals from Industry (UPIs). These UPIs were submitted to the Undersecretary of Defence Materiel (USDM) in accordance with the procedures in the Capability Systems Life Cycle Management Guide/Manual applicable at the time. Additional copies were provided to applicable stakeholders, including Industry Division of the DMO. These UPIs were also provided to the then newly formed UPI Desk within DMO Industry Division following Minister Peter Reith's policy statement on Unsolicited Proposals from Industry at the Defence/Industry Conference the previous year in June 2001.

As predicted and derived from the studies undertaken in the development of these Proposals, the 'Evolved F-111 Option' (aka: 'Enabling Cost Effective Acquisition of the F/A-22A Capability') offers unparalleled innovative benefits for Defence, the Australian Defence Industry and Australians as a whole, including –

1. *A far superior air combat capability and associated force structure than any other option presently available or considered; made up of the Raptor's air dominance and first day strike capabilities embodied in 50 platforms, complemented by the long range strike, reconnaissance/surveillance, battlefield airborne interdiction and close air support capabilities of 36 Evolved F-111s.*

2. *Opportunity to purchase fifty (50) F/A-22A Raptor aircraft systems plus five (5) attrition aircraft, at a later date, for somewhat less than $A10bn or; looking at this another way, more than $A3.5bn less than the median budget ($A13.5bn) provisions in the DCP for the NACC/AIR 6000 Project.*

3. *Ability to acquire this capability prior to 2010, thus avoiding any capability gap by filling it with an air dominance strike fighter capability and negating the need for doing expensive modifications to the F/A-18s which, if undertaken, would see F/A-18 availability fall to an all time low.*

4. *Total avoidance of the risks arising from dependence on a single product and general monopoly supplier situation that arises from a single aircraft type replacement strategy. (I refer you to the experiences that operators of the Chinook CH-47 helicopter are currently having with the resupply of such items as main transmission gear boxes.)*

5. *Negates the need to spend upwards of an additional $A10bn more to transition a lesser air strike capability onto the F/A-18s and keep them flying till 2015 than if the more capable air strike capability of the F-111 were realised, retained and progressively developed through to 2020+. Such development can be done in Australia by Australian Industry. This, in turn, provides additional benefits in relation to Industry capability development and the economy (ie. balance of trade, etc.) which would be further enhanced by remaining in the JSF Program for the longer term options it could present while helping retire JSF program risks using assets unique to Australia.*

Note: We would be happy to provide you with the basis and results of this analysis for you to have our work independently checked. FYI, the figures on which this analysis is based come from the Department's statutory financials, Defence Annual Reports, and departmental submissions to the Parliament. Like all these things, the actual analysis is a relatively simple, straight forward present value model used for comparing the cash flow profiles of projects over a given time line (in this case 2004 to 2015) on a TVM basis. In essence, this is the type of analysis that Dr Stephen Gumley alluded to when he pondered the question of the value of accrual accounting in Defence in his recent address entitled, 'Poacher turned gamekeeper'.

These and the other top ten reasons/benefits/advantages for considering the "Evolved F-111 Option" may be found on the Air Power Australia web site (www.ausairpower.net) on the Frequently Asked Questions page with further details contained in the relevant sections of the web site and on-line journal.

An executed copy of this E-Letter is attached and we look forward, with great interest, to your response and the opportunity to discuss, in detail, what has been proposed in keeping with Defence's entreaties to Industry "....... to come up with innovative, cost effective solutions for Australia's defence capability needs"."

In May, 1998, one of the authors of this document submitted a proposal to the then Minister for Defence, which identified deep and fundamental shifts in the character and scale of regional air power, largely arising from the influx of significant numbers of Russian Sukhoi fighters and supporting assets. This issue is discussed in detail in Section 2 of this submission. The key conclusion within the study that underpinned this proposal was that the only viable long term choice for replacing Australia's F/A-18A fleet was the new F-22A Raptor, for strategic, operational and technical reasons. Another conclusion was that the Joint Strike Fighter was not suitable for the air combat role, and would at best be viable as a strike oriented supplement to the much more capable F-22A.

This study was followed by a research effort in late 1999, which explored requirements for aerial refuelling capability to enhance RAAF capabilities, and provide the ability to robustly defend the sea air gap. This research resulted in a monograph on aerial refuelling published by the RAAF early in 2000, and a companion document later submitted to the office of the then Minister for Defence. Key conclusions of this analytical research were that low capability or Tier 2 category fighters demanded prohibitive amounts of aerial refuelling support to perform adequately in Australia's geography, that heavy aerial refuelling tankers, especially derivatives of the Boeing 747, were preferable for economic, flexibility and capability reasons, and that the F-111's prodigious range and payload capability resulted in significantly lower operational costs in combat, due to reduced demand for expensive aerial refuelling.

By 2000, increasingly, reports from the DSTO F-111 Sole Operator Program (SOP) indicated that the aircraft had significant potential for life extension, at modest cost, beyond the previously accepted target retirement date of 2020. This opened up the opportunity to emulate the US Air Force strategy of economical bomber life extension, which is likely to see aircraft of similar construction ages and airframe technology to the F-111 operated until 2035, or later[16].

The two critical conclusions, in the terms of the RAAF fighter fleet, were that the F-22A was without doubt the best choice for the RAAF's F/A-18A replacement, and that long term retention of the F-111 would yield a significant payoff in capability, reduced aerial refuelling demand, and deferred cost of replacement with new aircraft.

This resulted in a series of engineering studies which explored specific upgrades to the F-111 intended to extend its service life, enhance its capability and reduce its long term operating costs.

The analysis at that stage was unambiguous – replacement of the F/A-18A with the F-22A would provide a decisive capability edge for decades, across the region, at low risk, and retention of an extensively upgraded F-111 would yield such savings in the acquisition budget, compared to a buy of even 100 low capability or Tier 2 new fighters, that any cost premium in the acquisition of the F-22A, and additional tanker aircraft, could be completely offset.

In 2001 an Australian Industry team was formed, and it submitted the 'Evolved F-111 Project' as an option to the AIR 6000 Force Mix Survey. This project proposed the acquisition of a force mix with up to 55 F-22A Raptors to replace the F/A-18A, extensive but low risk incremental upgrades to extend the life of the F-111, and acquisition of further mothballed surplus F-111s to enhance fleet strength. The model was designed to minimise risk, minimise 'spikes' in the acquisition budget, minimise balance of payments excursions, enhance Australian industry capabilities in key areas and provide a better capability per dollar, than any alternative.

The proposal became a shortlist contender during Stage 2 of the AIR 6000 evaluation, on its technical and strategic merit. It remains the most capable of any of the proposals devised to date for replacement of the existing RAAF fighter fleet.

The decision by the Defence leadership, in mid 2002, to effectively suspend AIR 6000 in favour of a single type Joint Strike fighter solution, was seen as peculiar, since the capability, risk and cost advantages of the F-22A/F-111 force mix proposal were compelling, and well understood due to the greater maturity of these programs, compared to the Joint Strike Fighter program.

Since 2002, evolving developments in the US, Australia and the region have strengthened the case for the F-22A/F-111 force mix model, and critically weakened any case which may have existed in 2002 for a single type Joint Strike Fighter solution.

Specific capability arguments for the F-22A are further detailed in Section 1.4, with supporting material in Annex A. Specific adverse consequences arising from early F-111 retirement are detailed

Proposal Metric	Australian Industry Solution (2001) Score	Current Defence Plan Score
Combat Capability Subtotal	+2	-10
Supersonic Cruise	0	-2
All Aspect Stealth	-1	-1
Phased Array Radar	0	-1
Internal Weapons 2 klb	0	-2
Max External Payload	+1	0
Int Weapons Payload	+1	-1
Combat Radius (Int Fuel)	0	-2
Cost Metrics Subtotal	+2	-6
Acquisition Cost	+1	-2
Acquisition Model	+1	-2
Life Cycle Costs	+1	-1
Return on Investment	0	-1
Risk Metrics Subtotal	+3	-13
Acquisition Risk	0	-2
Cost Risk	0	-2
Design Risk	0	-1
Strategic Risk	0	-1
Strike Capability Gap	+1	-2
Air Sup Capability Gap	+1	-2
Air Def Capability Gap	+1	-2
Net Assessment	+7	-29

Table 2: Summary table of assessment scoring for current defence NACC and interim planning against the 2001 Australian Industry solution. If a metric is met, the score is not incremented, if a metric is exceeded, the score is incremented by +1, if a metric is not met, the score is decremented by 1. The scores for the 'Current Defence Plan' aggregate the interim plan (2010-2018) and the NACC (2018 onward). Refer Annex B for detailed table (Authors).

in Annex D.

The F-22A/F-111 force mix model was designed to maximise capability per invested dollar, and involves using both aircraft types to exploit their strengths. The F-22A would be used to defeat opposing fighters, but also to penetrate heavy defences to bomb critical targets. The upgraded F-111 would retain most of its existing roles, but cede penetration to heavily defended targets to the F-22A. An additional role for the F-111 would be cruise missile defence, part of the original definition of the aircraft during the 1960s[17].

In practical terms the F-22A/F-111 force mix model uses both types as 'multirole' fighters, but uses the F-22A where the most capable threats are confronted, and the F-111 where its exceptional range and endurance are vital.

Proponents of the Joint Strike Fighter have argued extensively, in public and within Defence, that a single type solution based on the Joint Strike Fighter and an interim capability using the F/A-18A HUG, is an 'affordable' solution and one which is devoid of large risks due to the intention to build over 3000 Joint Strike Fighters.

There is no evidence to support any of these claims, and as the preceding analysis shows very clearly, the solution devised and adopted by Defence represents a very high risk and expensive solution.

It is illustrative to compare the solution planned for by Defence, using the F/A-18A HUG as an interim capability, and the Joint Strike Fighter as a long term capability, against the Australian Industry solution based on a force mix of F-22A and F-111 aircraft.

This comparative analysis was initially performed in 2001, and refined and updated annually since then. Table 2 summarises this analysis, using a broad spectrum of key metrics in the three categories of capability, cost and risk.

This analysis could be described as damning, insofar as in each category, and in the aggregate, the solution planned for by Defence is decisively inferior, despite the use of an analytical technique which effectively favours the Defence solution. In practical terms, Defence would like the Australian community to accept an inferior solution at a higher total cost and risk.

The difficulties in capability and cost observed in a basic but broad parametric analysis of the solution being pursued by Defence are also observed when other analytical modelling techniques are applied.

One such technique, used frequently by US entities such as the US Air Force or Defense Science Board, is to model 'operational economics'. This modelling technique is intended to look at the whole spectrum of operational costs incurred by a solution, in delivering its capabilities. As a result, hidden costs are exposed[18].

Air Power Australia performed such modelling initially in 2004, and revised and expanded the model in 2005.

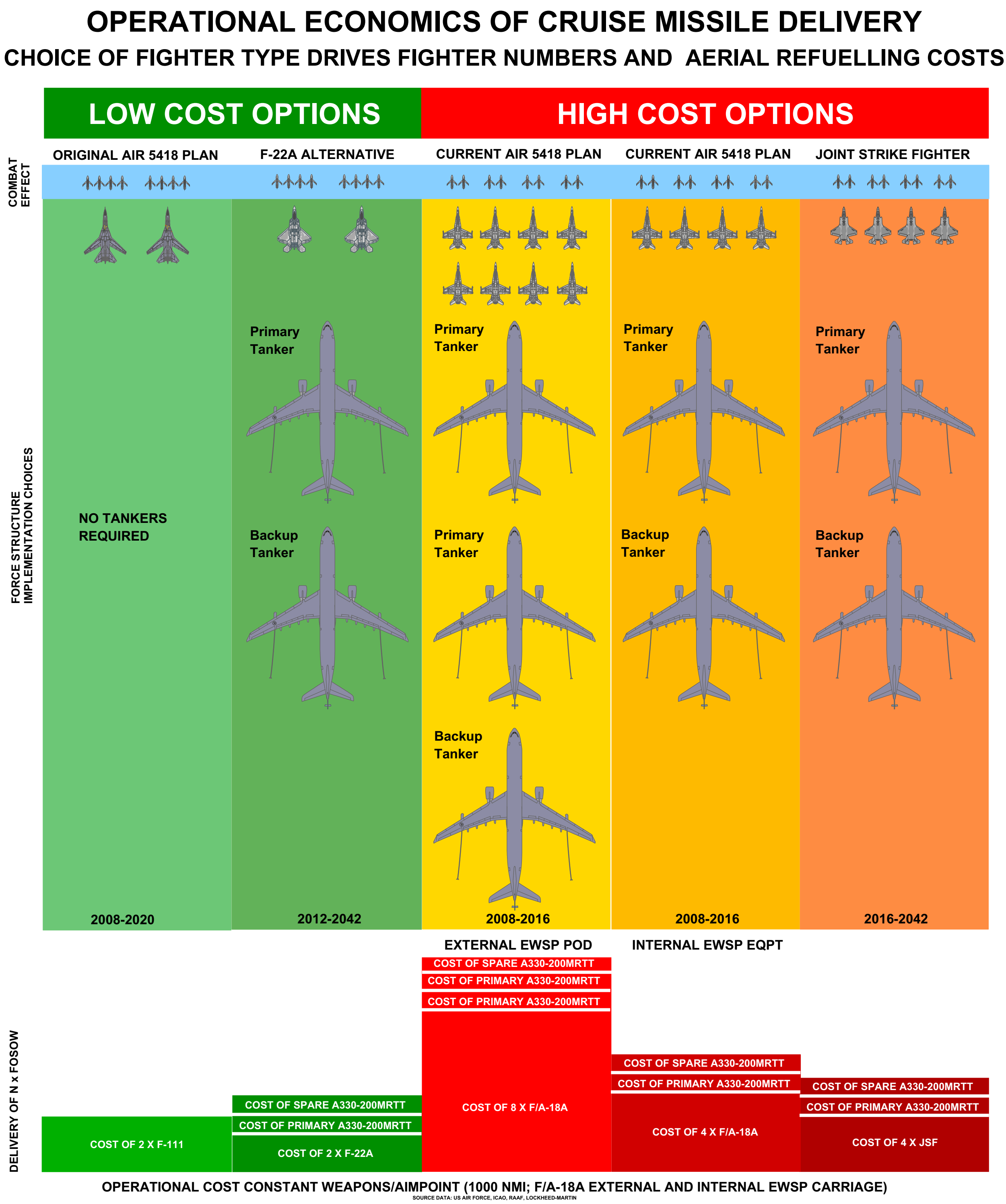

Figure 9: *The Joint Strike Fighter and F/A-18A are not operationally economical alternatives to the F-111 in the delivery of smart weapons, especially cruise missiles. This chart compares the delivery cost making the assumption that the F/A-18A can carry two cruise missiles and uses internal electronic countermeasures, or one cruise missile and external electronic countermeasures equipment (C. Kopp).*

The aim of this specific model was to look at the total cost in deployed aircraft to deliver eight AGM-158 JASSM cruise missiles to a target at a range of around 1,000 nautical miles. This is the same capability target used by Defence in the 2003 'blood chart' briefing, intended to justify early retirement of the F-111.

Applying publicly available unclassified performance figures and weapon payload figures indicates that the F/A-18A and Joint Strike Fighter incur significantly higher operational costs in numbers of deployed fighter aircraft, and numbers of supporting aerial refuelling tankers, compared to the F-111 and the F-22A.

Any incremental advantages the F/A-18A or Joint Strike Fighter might enjoy over the F-22A and F-111 in hourly operating costs are dwarfed by the significant hourly operating costs of the additional aerial refuelling aircraft required to simply get them close enough to their targets to launch weapons. If the distance to the target is increased further, these additional costs grow further. Refer Figure 9.

The commonsense reality and the mathematics of hard analysis agree completely. Small low capability or Tier 2 fighters like the F/A-18A and Joint Strike Fighter present false economies as they incur significant costs in supporting assets to match the inherent capabilities of large high capability or Tier 1 fighters, like the F-22A and F-111, and more low capability fighters, and thus crews, must be used to achieve the same combat effect.

The arguments via which such false economies are justified invariably revolve around concealing the additional costs in required numbers of fighters and supporting assets, and then arguing that the smaller less capable aircraft is 'cheaper to buy and run, therefore it is a cheaper solution'.

With a background of analytical studies spanning an eight year period, the Australian Industry solution based on the force mix of F-22A and F-111 is well understood, mature, and has been studied extensively from a multiplicity of perspectives.

As an alternative strategy for the replacement of the RAAF's existing fighter fleet, since it was conceived in 2000, the F-22A/F-111 force mix has become cheaper to acquire, due to cost creep in the Joint Strike Fighter over the last three years, and its capability advantages have grown as the US Air Force incrementally added capabilities to the F-22A, while Joint Strike Fighter performance was traded down to comply with CAIV objectives chasing a target production cost.

There are compelling budgetary, risk, timeline and industrial base reasons which favour the F-22A/F-111 force mix model over the single type model, using the F/A-18A HUG as an interim capability and the Joint Strike Fighter as a long term capability, regardless of the superior capability of the F-22A/F-111 force. Even if capability and strategic issues are to be regarded as less important than budgets, risks, timelines and industrial base capabilities, which they are not, then analysis decisively favours the F-22A/F-111 force mix.

1. In 2001 an Australian Industry team submitted a proposal for an F-22A/F-111 force mix as an alternative to the AIR 6000 force mix survey. This proposal was shortlisted in 2002 for further evaluation.
2. The F-22A/F-111 force mix is cheaper to implement than the plan devised by Defence, as only the F/A-18As need to be replaced with new fighters, and the existing investment in the F-111 and its extensive support base is exploited fully. There is no need to make extensive investments in the F/A-18A and incur the resulting poor return on investment.
3. The F-22A/F-111 force mix represents much lower risks in implementation since only the F/A-18A is being replaced, while the replacement F-22A is a now mature operational fighter in full rate production. The risks in extending the life of the F-111 are low, and well understood due to the extensive taxpayer investment in the Sole Operator Program.
4. The F-22A/F-111 force mix permits earlier replacement of the F/A-18As using the F-22A, with highly predictable timelines and acquisition costs.
5. The F-22A/F-111 force mix offers a more predictable expenditure profile, with a large block outlay only associated with the acquisition of the F-22A. Life extension upgrades on the F-111 permit scheduling of expenditures over an extended period, in small increments to address specific block upgrades.
6. The F-22A/F-111 force mix retains the extensive avionic systems integration and support expertise inherent in the current Amberley F-111 support base. This national asset is otherwise destroyed, should the strategy espoused by Defence be pursued.
7. The F-22A/F-111 force mix incurs significantly lower strategic and political risks than the strategy espoused by Defence. This is because the F-22A is and will remain the most capable fighter in the market, and its costs are known and predictable, while the F-111 is a well established and well understood capability in this region.

1.4 Why the F-22A to Replace the F/A-18A?

The F-22A is a revolutionary aircraft, with key capabilities possessed by no alternative, making it also unique.

Figure 10: *The F-22A is now in full rate production, and operational service with the US Air Force. The depicted aircraft belongs to the 27th Fighter Squadron based at Langley, Virginia, and was photographed in mid 2005 (US Air Force).*

It is the only combat aircraft in existence, and planned, which combines high stealth capability with supersonic cruise capability.

Stealth capability amounts to the ability to defeat opposing sensors, especially radar, thus effecting surprise in combat. Like all defensive capabilities, stealth performance varies widely across fighter types. At this time the F-22 has the best stealth performance of any high performance fighter in existence, or planned.

This kind of stealth capability has to be designed into an aircraft from the outset and cannot be added by upgrades.

Supersonic cruise capability is the ability to maintain supersonic speeds without the use of engine afterburners. Afterburners will burn a fighter's fuel many times faster than its engines burn fuel without the afterburner engaged. An engine with supersonic cruise capability allows a fighter to perform in the manner a fighter without this capability would, were it using its afterburner all the time. At this time the F-22 is the only production fighter which has been designed from the outset for supersonic cruise.

Supersonic cruise capability of this kind also has to be designed into an aircraft from the outset and cannot be added by upgrades. While Russia has started producing a supersonic cruise engine for the Sukhoi fighters, these fighters were not designed for sustained supersonic flight and will not be competitive against the F-22.

The F-22 is a genuine multirole fighter, in that it is designed to defeat opposing fighters, and to attack the most heavily defended surface targets with smart bombs.

When used as an air superiority fighter, the F-22 has no peer in Beyond Visual Range combat, as its combination of stealth and supersonic cruise provides it with the ability to engage and disengage at will, in a fashion no other fighter can. In mock engagements flown in the US, the F-22 has repeatedly won engagements in which a single F-22 was pitted against multiple F-15 fighters.

In close combat the F-22 has greater agility than any fighter other than the most advanced Russian Sukhois.

The F-22 carries the most powerful and longest ranging radar ever fitted to an air combat fighter. This allows it to detect and engage targets from greater ranges than opposing and competing fighter types. The radar is so powerful, that the US Air Force envisage using it as a microwave Directed Energy Weapon to disrupt the electronics in opposing aircraft and cruise missiles, at close ranges. The F-22 is designated as the primary fighter to be employed by the US Air Force in the planned cruise missile defence architecture, by virtue of its ability to better detect small low flying cruise missiles, compared to all other aircraft.

When used as a bomber, the F-22 has unchallenged survivability in the face of the most capable air defence missile systems known and envisaged. The combination of supersonic cruise at high altitude and high performance stealth puts the F-22 out of the reach of most Surface to Air Missile types, and makes it effectively invisible to those Surface to Air Missile types with the performance to reach it.

Supersonic cruise capability contributes to the F-22's productivity, as it can transit distances at twice the speed of any competing alternatives, even allowing for aerial refuelling, and thus it can produce more sorties per day than any other fighter.

The F-22 can carry two internal 450 kg smart bombs or up to eight internal 175 kg Small Diameter Bombs, and has the inherent capability to carry up to four 1,000 kg external smart bombs or cruise missiles on wing pylons[19].

The radar in the F-22 has been enhanced to provide high resolution ground attack capabilities comparable to other state of the art strike fighters, providing it with the same autonomy as specialised bomber aircraft[20].

The US Air Force also intend to use the F-22 as an intelligence, surveillance and reconnaissance asset, exploiting its superlative sensors and exceptional survivability. In this role the F-22's supersonic cruise capability allows it to gather intelligence twice as fast as a conventional fighter.

Used either as an air combat fighter, a bomber, or an intelligence, surveillance and reconnaissance asset, the F-22 is more productive by virtue of its supersonic cruise capability, thus allowing a single

F-22 to do the work of two or more less capable conventional fighters[21].

Why is the F-22 the best strategic choice for Australia to replace its F/A-18A Hornets?

1. **Capability:** The F-22A is over twice as capable as alternatives, including the Joint Strike Fighters, in most roles.
2. **Strategic Position:** The F-22A is the only aircraft which has the capability to decisively defeat superior numbers of advanced Russian fighters in the region.
3. **Regional Independence and Credibility:** The F-22A confers exceptional capability and thus credibility to the ADF in the region, reducing Australia's dependency on US forces.
4. **Value for Money:** The F-22A has so much more capability than any other alternative, that it is the best value for money buy in the market.
5. **Better Life Cycle Growth Capability:** The F-22A is a large aircraft with greater system growth potential than any alternative.
6. **Longevity and Return on Investment:** The F-22A will remain effective and thus strategically credible much longer than any alternative.
7. **Low Technical and Financial Risk:** The F-22A is a known commodity that is is in production and operational today, unlike the Joint Strike Fighter.
8. **Clearly Defined Schedule:** Acquiring the F-22A in the 2010-2012 time window allows the replacement of the F/A-18A earlier with no capability gap.

Submission Endnotes

[1] Refer to the Department of Defence Answers to Questions on Notice, Supplementary Budget Estimates Hearing, 2005-06

[2] **Base Year (BY)** - A reference period that determines a fixed price level for comparison in economic escalation calculations and cost estimates. The price level index for the BY is 1.000. US DoD Glossary of Acquisition Acronyms and Terms, 12^{th} Edition – July 2005

[3] US Department of Defence Glossary of Acquisition Acronyms and Terms, 12^{th} Edition – July 2005

[4] Norman R. Augustine – Past President of Martin-Marietta, Former Chairman and CEO of Lockheed Martin and author of "Augustine's Laws", 1983 – Sixth Ed. 1997.

[5] Clarence "Kelly" Johnson – one of the most highly acclaimed and honoured aircraft designers in history and principal driver behind the development of Lockheed Skunk Works and the aircraft that bear this pedigree.

[6] Department of Defence Answers to Question W6, Senator Bishop, on the Joint Strike fighter Development and Procurement, Pages 20 – 31, Questions on Notice from the Supplementary Budget Estimates Hearing of 02 November 2006.

[7] Letter from the Office of the Minister of Defence in response to an E-letter dated 21 Nov 05 concerning "the meaning of terms related to cost, and the cost of the Joint Strike Fighter".

[8]Including Department of Defence Answers to Question W6 on the JSF Development and Procurement, Pages 20 – 31, Questions on Notice from the Supplementary Budget Estimates Hearing of 02 November 2006.

[9] "The best way to make a silk purse from a sow's ear is to begin with a silk sow. The same is true of money." – Norman Augustine, former President of Martin Marietta and CEO of Lockheed Martin.

[10] "If a sufficient number of management layers are superimposed on top of each other, it can be assured that disaster is not left to chance." and
"Most projects start out slowly - and then sort of taper off." and
"Simply stated, it is sagacious to eschew obfuscation." Norman R. Augustine

[11] The 'product rule' or 'Lusser's product law' is a simple mathematical relationship, discovered during the late 1940s, which is widely used in risk analysis and reliability engineering. Both authors have used it extensively in industry, and one of the authors taught it at university level.

[12] Refer Defence Annual Report 1999-2000; URL - http://www.defence.gov.au/budget/99-00/dar/full.pdf

[13] "In fact, the high cost of keeping the F111 currently is distorting our Air Force's capability to transition to a networked systems based force." - AM Geoff Shepherd, Chief of Air Force, Senate Supplementary Budget Estimates Hearing, 02 November 2005, Hansard Page 87.

[14] RAAF Air Combat Capability Paper for Joint Standing Committee on Foreign Affairs, Defence and Trade, AM Angus Houston dated 03 June 2004, Para 37.

[15] 'A Farewell to Arms Revisited', P A Goon, 26 January 2005, Air Power Australia Web Site URL: http://www.ausairpower.net/FTAR-PAG-180404.pdf.

[16] Specifically, the US 'Bomber Roadmap' or *US Air Force White Paper on Long Range Bombers*, dated March, 1999. In this document the US Air Force maps out long term plans for its fleet of heavy bombers. The B-52H was to remain in service until 2038, the B-1B until a similar date. The significance of this model is that the B-1B uses similar construction techniques, and is similar in performance, to Australia's F-111s. While the current US Quadrennial Defense Review identifies a need for a new long range bomber, to enter service in 2018, historical experience suggests this program may not survive budgetary pressures, or may only result in partial replacement of the existing fleet. The B-1B for instance was to replace the B-52 with around 250 to built, but only 100 were made. The B-2A was to replace the B-52, with 132 to be built, but only 21 were funded.

[17] The naval F-111B was to have been a dedicated interceptor for fleet defence against long range bombers armed with cruise missiles. This variant was cancelled, but shared nearly all of its airframe design in common with Air Force variants - in part the reason why the F-111 airframe has such longevity. Provision of this capability requires a new radar and software to support suitable missiles such as the AIM-120 and AIM-132.

[18] Application of this technique two years ago identified significant economies in fuel burn if legacy B-52 aircraft were to be re-engined, as the reduced demand for aerial refuelling support rapidly offset the cost of the new engines. During the early 1990s, following the 1991 Gulf War, this technique showed the compelling cost advantages enjoyed by the F-117A stealth fighter and F-111 in combat operations, compared to the Tier 2 F-16 fighter. F-117A required few supporting assets due to its stealth, saving money, the F-111 required less aerial refuelling support, also saving money.

[19] For all intents and purposes this is the same internal payload typically envisaged for the planned Joint Strike Fighter, which is a purpose designed bomber.

[20] The high power rating of the F-22's APG-77 radar makes it the most difficult US fighter radar to jam by opposing defences, and the radar's power also allows it to surveil or map ground targets from greater ranges than any other fighter radar.

[21] This comparison applies also to the Joint Strike Fighter, which is being designed around the limited performance and speed capabilities of legacy fighters, specifically the F-16 and F/A-18.

[22]The Soviet buildup commenced during the late 1970s, as a range of new military technologies were introduced. In part these included systems patterned after US designs introduced during the 1970s, and in part systems based on US technology acquired from Vietnam and Iran. Of significance is that the Soviets deployed hundreds of new generation Su-27 and MiG-29 fighters, S-300 Surface to Air Missile systems, new radar systems like the 64N6 series, and a wide range of land and naval warfare systems.

[23]During the 1980s and 1990s Australia operated the F/A-18A and F-111C, while no regional nation operated comparable capabilities until the introduction of limited numbers of the MiG-29,

comparable to the F/A-18A. During the mid to late 1990s hundreds of Su-27 and Su-30 Flanker fighters were ordered across the region, with orders ongoing since.

[24] Hale provides an exhaustive survey and analysis in ‘China’s Growing Appetites’, The National Interest, also see Kenny in ‘China and the Competition for Oil and Gas in Asia’, Asia-Pacific Review.

[25] While modern anti-ship missile defence systems can be highly effective against small numbers of subsonic or supersonic anti-ship cruise missiles, they are all limited in how many inbound missiles they can engage and destroy concurrently. Accordingly, the Soviets developed a tactic during the Cold War based on saturating a warship’s defences with more cruise missiles than the system could defend against. This tactic has been actively exported in Asia and is detailed in contemporary Russian marketing materials.

[26] Contemporary literature often uses the terms ‘air dominance’ or ‘air supremacy’ rather than ‘air superiority’. The condition of air dominance or air supremacy is one where an opponent will not even attempt to contest for control of the air, or no longer has the capability to do so. In a condition of air superiority, an opponent may contest control of the air, but cannot achieve it. Some definitions of air superiority identify it as limited in time and geographical extent, ie air superiority exists only when the more capable force is present, and not otherwise. For instance, following this definition the UK achieved air superiority in the Falklands conflict, but only in those areas patrolled by Royal navy fighters. The practical consequence was that in areas not patrolled by fighters, the British fleet suffered significant losses to Argentinian air attack.

[27] High resolution radar mapping techniques using Synthetic Aperture Radar (SAR) technology can now produce ground maps with feature sizes of centimetres, whilst penetrating cloud, rain, haze and sandstorms, providing the capability to detect, identify, track and engage even small ground force units. Ground and Maritime Moving Target Indicator (GMTI, MMTI) capabilities are designed to detect slow moving surface targets, through weather, and thus provide the capability to detect, track and engage, and often identify, ground vehicles and even small boats. The expectation is that such radars will become the defacto standard in most combat aircraft over the coming decade. Advanced production variants of the Su-27 and Su-30 are being provided with or already have SAR, GMTI and MMTI capabilities.

[28] It is important to observe that this problem arises with all low capability category fighters, examples including the F-16C, F/A-18E/F, Eurofighter Typhoon, Dassault Rafale and SAAB Gripen. All of these have been canvassed or proposed at various times as replacements for the F/A-18A and all are now wholly non-viable choices.

[29] A major survivability issue now arising is the emergence of multiple seeker types in Russian long range air to air missiles. While radar stealth capability can defeat radar guided missiles, it is ineffective against heatseeking and passive anti-radar missiles. Russia is now exporting the semi-active radar homing R-27R/ER/ER 1 Alamo A/C, the heatseeking R-27T/ET/ET1 Alamo B/D, the anti-radiation R-27P/PE Alamo E/F, and the active radar guided R-77 Adder. The heatseeking R-77TE and anti-radiation R-77PE Adder variants have been reported. A fighter with limited stealth is exposed to long range shots using these weapons, and neither the heatseeking nor the anti-radiation seekers are easily defeated.