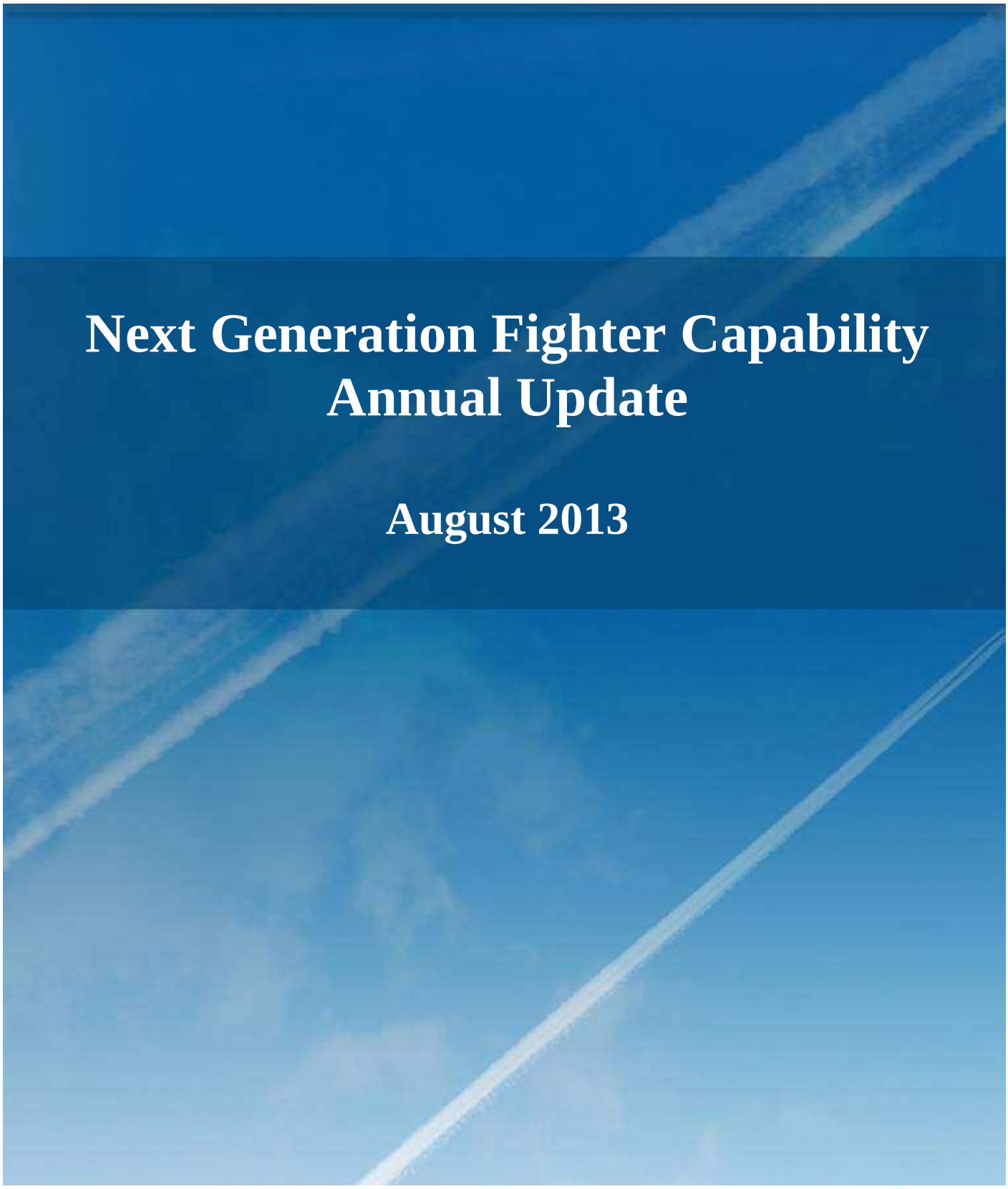
National Defence / Défense nationale



Next Generation Fighter Capability Annual Update

August 2013

Canada

TABLE OF CONTENTS

Executive Summary

Introduction

In response to the Auditor General's Spring 2012 Report on *Replacing Canada's Fighter Jets,* the Government of Canada implemented a Seven-Point Plan to assist the government in making the best possible decision on sustaining a Canadian Armed Forces fighter capability well into the 21st century. Since the launch of the Seven-Point Plan, funding for the acquisition of a replacement fighter has been frozen.

One element of the Seven-Point Plan requires National Defence, through the National Fighter Procurement Secretariat, to provide annual updates to Parliament on the cost estimates of the F-35, and to continuously refine its full life-cycle costs estimates and make these estimates available to the public. On 12 December 2012, the Department of National Defence released its first Next Generation Fighter Capability Annual Update to Parliament.

The Department of National Defence presents herein its second Annual Update on the cost to potentially replace the CF-18 fleet with a fleet of F-35A Joint Strike Fighter aircraft. These costs cover program development through delivery and operations, to withdrawal from service. Canada's planning assumptions used to prepare this update are unchanged from those contained within the 2012 Annual Update.

Raymond Chabot Grant Thornton completed an independent review of National Defence's estimated life-cycle costs presented in this Annual Update. This updated cost estimate has been prepared in accordance with the framework documented in the KPMG report *Next Generation Fighter Capability: Life-Cycle Cost Framework*, 27 November 2012.

Cost Methodology and Estimates

For the annual updates to Parliament the Department uses two distinct data sources to derive the acquisition cost estimate for a fleet of Canadian F-35A aircraft and the associated life-cycle costs estimates. The F-35 Joint Program Office provides estimates for over 90 per cent of the acquisition and sustainment cost data. The remainder of the life-cycle cost data is dependent on how Canada would operate its fleet, and the cost estimate is based on data from Canadian sources. National Defence also takes into account actual and projected differences between the Canadian and United States currencies, and other such economic factors that affect cost estimates.

Canada received a bilateral cost estimate from the F-35 Joint Program Office on 7 June 2013. The bilateral sustainment cost estimate provided to Canada

showed a significant year-over-year decrease in cost, in the order of 12%. However, this 12% reduction contrasted with the Selected Acquisition Report 2012 (SAR 12) that the US Department of Defense tabled in Congress on 23 May 2013, which showed no significant change in the sustainment cost estimate. The SAR sustainment estimate did not change because it was based on the 2011 estimate prepared by the office of the Cost Analysis and Program Evaluation (CAPE), an independent US Government agency, which wasn't updated in 2012. The CAPE estimate is a more conservative position and does not take into account 2012 updates to the technical baseline and estimate inputs, whereas the F-35 program office estimate does. In SAR 12:

- the acquisition cost estimate is based on F-35 Joint Program Office calculations; and
- the most recent F-35 Joint Program Office sustainment cost estimate has not yet been reviewed by CAPE. As a result, the SAR 12 sustainment costs are essentially unchanged from the SAR 11 estimate.

In order to mitigate the situation wherein the 12% reduction in sustainment costs reported by the F-35 Joint Program Office were not independently confirmed by CAPE nor reported to Congress in the SAR 12 report, National Defence has significantly increased sustainment contingency, such that it is comfortably in the range recommended by KPMG and significantly higher than last year's provision.

The table below presents a side-by-side comparison of the 2012 and 2013 life-cycle cost estimates, including development, acquisition, 30-years of sustainment and operations for each aircraft, and disposal. The life-cycle cost estimate presented is a risk-adjusted "point estimate" of the full life-cycle cost of a Canadian fighter acquisition program. It is important to consider the accompanying sensitivity, risk and uncertainty analysis contained in Section V. That analysis provides a sense of the possible variations in the cost estimate.

Comparative Estimate ($ CAD Million in Budget Years, including contingency)			
Cost Element	2012 LCC Estimate	2013 LCC Estimate	Variance
Development	565	606	41
Acquisition	8,990	8,990	0*
Sustainment	15,240	15,055	-185
Operating	19,960	19,857	-103
Disposal	65	168	103
Total LCC	44,820	44,676	-144
Attrition (note 1)	982	1,015	33
Total	**45,802**	**45,691**	**-111**

Note 1: It is estimated that seven to eleven aircraft could be lost over the useful life of the fleet and the cost to replace these lost aircraft could be in the order of $1 billion. However, this cost is not part of the Life-Cycle Cost estimate.

* See description of Acquisition cost breakdown on page iv

Details on changes to the cost estimate since the 2012 Annual Update can be found within Part VI, Section 2 of this report (beginning on page 42). In general the cost differences within each major cost element are attributable as follows:

- Development: The vast majority of the increase in development costs results from updated foreign exchange and inflation rates.

- Acquisition: Although the overall acquisition cost estimate remains unchanged since the 2012 Annual Update at $9 billion, the estimated unit recurring flyaway cost for 65 F-35A has increased by $195 million as a result of updated production cost estimates and changes to Partner's buy profiles. In addition, incremental refinements were made to the remainder of the acquisition cost model to ensure the most current cost data is used. Finally, the foreign exchange forecast was updated. Overall, the estimated acquisition contingency has been reduced from $602 million in 2012 to $342 million in 2013. The overall acquisition contingency was adjusted downwards in order for the overall acquisition estimate to remain within the $9B ceiling.

- Sustainment: The reduction in cost is based on a significant change in the baseline sustainment estimate received from the F-35 Joint Program Office, as well as adjustments to inflation and foreign exchange factors. In order to be prudent DND has increased sustainment contingency because the reduction in cost shown within the base estimates has not been independently verified by CAPE.

- Operating: Operating estimates have decreased marginally to reflect additional CF-18 operations cost data (which has been used as the basis for estimating notional Canadian F-35A operating costs), changes in forecast inflation rates, and refinements in the input data for the estimate process, including responding to observations contained in the 27 November 2012 KPMG report: *Independent Review of Life Cycle Cost*.

- Disposal: The methodology for calculating Disposal cost estimates has been changed. Previously the estimate was based on a 1997 US Government Accountability Office study. Defence now has a preliminary disposal plan for the CF-18 fleet, which is used as the basis for estimating the eventual disposal costs of a new fleet.

- Attrition: The increase in attrition cost is due to an increase in URF costs based on the current Canadian buy profile and updated foreign exchange forecast.

Risks and Uncertainty

Programmatic: Consistent with previous fighter aircraft developmental programs, F-35 flight testing is revealing areas where refinements to the design are required. Meanwhile, software continues to be a challenging technical risk for this program, and the F-35 Joint Program Office has taken steps to manage this risk.

Some of the Program's current instability is related to the concurrency of development, test, and production. Concurrency results from design and tooling changes and altered manufacturing processes concurrent with developmental testing. However, while this remains a concern, the aircraft design is expected to continue to stabilize as it approaches full rate production.

As the F-35 program matures, manufacturing and supply processes are improving, and efforts are under way to try and lower annual operating and support costs. In its latest report on the Joint Strike Fighter program, the United States Government Accountability Office noted that considerable progress has been achieved in addressing technical risks[1]. The bulk of developmental testing remains, however, and additional deficiencies are expected to be uncovered as the program continues to mature. Royal Canadian Air Force personnel within the F-35 Joint Program Office continue to track and monitor the development closely.

Anticipated United States budget restrictions and their potential effects on F-35 prices remain an area of risk, as do the current forecasts for sustainment and operating costs, which would put pressure on future budgets.

Contingency: The current estimate includes $342 million for acquisition contingency, a reduction of $260 million since the 2012 Annual Update, and $3,496 million for sustainment contingency, an increase of $1,546 million. While the overall contingency provisions fall within the range recommended in the KPMG Framework, the provision for acquisition contingency could be considered low for a project of this scope and size. As a result, any option moving forward will be informed by the Government's current $9 billion acquisition cap to acquire next generation fighter aircraft to replace the existing fleet of CF-18s. Taking into account the above adjustments to contingency and the fact that the overall cost estimate has not changed materially from the previous estimate, the provision for contingency remains consistent with known risks.

[1] F-35 Joint Strike Fighter: Restructuring Has Improved the Program, but Affordability Challenges and Other Risks Remain. 19 June 2013 http://www.gao.gov/assets/660/655295)

Conclusion

As part of the Seven-Point Plan for replacing Canada's fighter aircraft, the Department of National Defence has completed an analysis of the estimated life-cycle cost for a notional F-35A fleet, based on updated cost data received from the F-35 Joint Program Office in June 2013. This analysis compares current life cycle cost estimates with those reported in the 2012 Annual Update. While cost estimates continue to be refined based on the evolution of the Joint Strike Fighter Program, the comparative analysis generally indicates marginal changes in various sub-elements and an overall decrease of 0.3% between the life-cycle cost estimates calculated in 2012 and 2013.

Importantly, the contingency provision for the sustainment cost estimate has been significantly increased to ensure it remains conservative given the F-35 Joint Program Office sustainment cost estimate has not been independently verified by CAPE. This contingency provision will be re-evaluated after updated, independently calculated sustainment estimates are presented to a US Defense Acquisition Board meeting.

Planning assumptions and the associated estimates will continue to be refined in future annual updates. Raymond Chabot Grant Thornton completed an independent review of National Defence's estimated life-cycle costs presented in this Annual Update. Their report concluded that the 2013 Annual Update provides a reasonable and comprehensive presentation of key issues related to the Life Cycle Cost estimate, and that there were no deviations from the Framework that would result in any material changes to the overall life-cycle cost estimate.

Next Generation Fighter Capability

Annual Update

2013 Report

I. What This Report Is About

In June 2012, the National Fighter Procurement Secretariat embarked on its mandate to ensure that due diligence, oversight, and transparency are applied to the process of acquiring fighter aircraft for the Royal Canadian Air Force. The Secretariat is achieving this goal through the implementation of a Seven-Point Plan. This report meets one element of the Seven-Point Plan: National Defence, through the National Fighter Procurement Secretariat, will provide annual updates to Parliament.

The Department of National Defence presents herein its second Annual Update to Parliament on the cost estimates for the F-35. This Update is based on program-level costing, as defined in KMPG's *Life-Cycle Costing Framework*[1]. It covers the cost of a replacement fighter aircraft capability for Canada, from program development through delivery and operations to withdrawal from service.

Based on updated cost estimates and current planning assumptions, this report by the Department communicates clearly and frankly with the Canadian people and Parliament, and contributes valuable information with which to facilitate and enhance Canadians' ongoing understanding of the future replacement of the CF-18 aircraft.

The next section, Part II, discusses the importance of replacing Canada's aging CF-18 fighter aircraft fleet if the Canadian Armed Forces are to continue to fulfill the roles identified in the *Canada First* Defence Strategy.

[1] KPMG Next Generation Fighter Capability: Life-Cycle Cost Framework, 27 November 2012

II. Replacing Canada's Fighter Aircraft

1. The Canada First Defence Strategy

The *Canada First* Defence Strategy provides for the replacement of the CF-18 fighter. According to the Strategy, announced in May 2008, "First and foremost, the Canadian Forces must ensure the security of our citizens and help exercise Canada's sovereignty." In addition to this role of defending Canada, the Strategy outlines two other roles of the Canadian Armed Forces: defending North America and contributing to international peace and security. The Strategy was developed, in part, to ensure that the Canadian Armed Forces have the right equipment and other resources needed to fulfill these three roles.

Two key and related responsibilities of any national government are exercising the country's sovereignty and securing the population from harm. Defending Canada, in the widest sense, extends to preventing and confronting possible terrorist attacks, human and drug trafficking, and foreign encroachments on Canada's natural resources.

Ensuring excellence in the domestic role paves the way for Canada's role as a reliable military partner at the continental level. North America's common defence and security requirements find expression in the continued validity, viability and success of the North American Aerospace Defence Command, commonly known as NORAD, a bi-national command structure with the United States.

Internationally, Canada remains a robust contributor to the maintenance of peace and security, which, in turn, is crucial to Canada's interest as a global trading nation. Canada plays an active military role in the United Nations, the North Atlantic Treaty Organization, and the Organization for Security and Co-operation in Europe. Canada also participates actively in special coalition arrangements, as deemed appropriate by the Canadian government, in response to an ever-changing global security environment.

The Canadian Armed Forces must therefore be a flexible military, capable of playing a variety of roles and responding to a broad range of threats to our security and prosperity. To deliver on this wide range of missions, the Canadian Armed Forces use various resources at sea, on land and in the air.

For the past 25 years, the CF-18 has been the cornerstone of Canada's ability to fight in the air. At home and in North America, Canadian fighters operate through NORAD to ensure both sovereignty and air defence of Canada and the United States. NORAD aircraft are prepared to respond to any potential threat to North America, every hour of every day. They conduct approximately 200 such missions each year. Fighters also provide an important contribution to joint operations with the Royal Canadian Navy and the Canadian Army.

Canada is also committed to providing fighter aircraft in support of NATO if required. In the past, Canada's fighters have deployed as part of multinational operations, as they did during the First Gulf War and the Kosovo campaign, both in the 1990s. Most recently, CF-18s were deployed to southern Italy to participate in a multinational response to the crisis in Libya.

2. Replacing Canada's CF-18 Fighter Aircraft

When the CF-18 aircraft fleet entered into service in 1982, it was expected to be in service until 2003. Proactive aircraft management, including structural airframe repair programs, has since extended the life of this aircraft. The CF-18 has also undergone a comprehensive modernization of its systems. These initiatives have ensured the CF-18 aircraft has remained capable and relevant.

Nevertheless, spare parts will become increasingly scarce and expensive as its aircraft systems and airframe continue to age, and aircraft availability will become increasingly limited. Furthermore, as more sophisticated equipment comes into service internationally, CF-18s will be less compatible with other fleets, and will lose their ability to support coalition operations.

3. The Seven-Point Plan

The objective of the Seven-Point Plan that the Government put in place in April 2012 is to ensure that Canada has the fighter aircraft needed to complete the core missions of the Canadian Armed Forces. The Plan will also help to ensure public confidence in, and the transparency of, the process to replace Canada's fleet of CF-18s.

One element of the Seven-Point Plan requires National Defence, through the National Fighter Procurement Secretariat, to provide annual updates to Parliament on the cost of an F-35 option to replace the CF-18.

This report, together with the results of the independent review is the second Annual Update to Parliament since the Plan was put in place.

Issues related to life-cycle cost estimates are dealt with further in the next two parts of this update. Part III addresses life-cycle costs generally; Part IV does so with specific regard to the life-cycle costs of the F-35A as a possible replacement for the CF-18.

III. Estimating Life-Cycle Costs

This third part of the Annual Update focuses on the life-cycle costing methodology used to prepare this report. Part III also examines the uncertainty associated with life-cycle cost estimating, and outlines some of the steps to refine these estimates as a project progresses. It also provides an overview of the project management process in the Department of National Defence.

1. Life-Cycle Costs

A life-cycle cost estimate calculates all costs associated with a product, project or program from initial concept through operations to retirement and disposal.

The focus of life-cycle costing is to develop cost estimates that are driven by the purposes of the decision maker. Life-cycle costing is used in part to enhance decision making about acquisition and affordability. It can also support budgetary decisions, key decision points, milestone reviews and investment decisions.

Life-cycle costing is fundamentally a forecasting activity, and is therefore imprecise, uncertain and highly sensitive to many factors that may be difficult to quantify at the time the life-cycle costing is being developed. As a program matures, costing estimates become better informed and more reliable.

As shown in the following table from the KPMG report, *Next Generation Fighter Capability: Life-Cycle Framework*, the total cost to the government of acquisition and ownership of a system over its useful life includes costs related to the phases of a program. These are: development, acquisition, sustainment and operations, and disposal.

Typical Phase	Phase Description
Development	All activities necessary to achieve expenditure approval
Acquisition	All activities necessary to introduce assets into operational service
Sustainment & Operations	Ongoing operations and maintenance of the assets
Disposal	Removal of assets from service and retirement, with any potential financial liabilities

Development Costs: All activities necessary to achieve expenditure approval. This includes the establishment of a Project Management Office and, for the F-35A, payments under the various Joint Strike Fighter Memoranda of Understanding.

Acquisition Costs: Acquisition costs are one-time costs associated with bringing a new or replacement equipment into service. For the replacement of the CF-18 fleet, the acquisition cost estimate includes: the cost of aircraft and engines, ancillary equipment, initial spares and set-up of maintenance support, set-up of

mission software reprogramming capability, project management, directly related infrastructure modifications, and initial training.

Sustainment Costs: Sustainment estimates include the costs of contracted in-service support activities for the life of an operational fleet. For the replacement of the CF-18 fleet, sustainment cost estimates include contracted labour and materials costs related to the major repair, overhaul, and upgrade of the aircraft and equipment, the management of the supply chain, and training-support management.

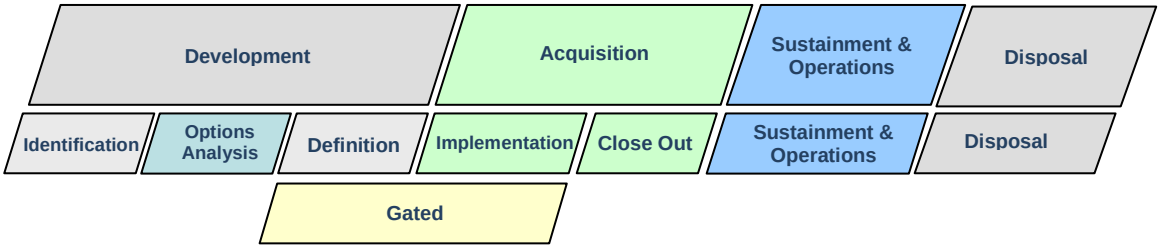
Operating Costs: Operating costs are expenses that the Department of National Defence incurs in the course of delivering its programs. For a fighter fleet, the operating cost estimate includes salaries, fuel, first-line maintenance, and base-support costs.

Disposal Costs: Disposal costs include the costs of demilitarizing the aircraft, removing hazardous materials, storage and final disposition of the airframe.

2. Project Management Cycle

As will be seen later in this document, there is a strong link between life-cycle costing as practised by National Defence and the Department's project management cycle. A brief look at the latter will therefore be helpful.

The Department of National Defence project management cycle aligns with the life-cycle costing Framework program phases, and reflects standard practices derived from the *Project Management Body of Knowledge*[2]. There are four project-approval phases: Project Identification, Options Analysis, Project Definition, and Project Implementation, which includes project closeout.



The diagram above depicts the relationship between program life-cycle phases used for cost estimating and the project-management cycle. By necessity, these cycles often overlap. Depending on the complexity of the project, additional governance may be achieved through a gated expenditure approval process for Project Definition and Implementation.

[2] A Guide to the Project Management Body of Knowledge (PMBOK Guide) - Fourth Edition. Project Management Institute

Gated approval simply means that expenditure and contract authority may be granted in phases as definition work progresses and substantive cost estimates are produced.

The implementation of the CF-18 replacement aircraft is expected to be phased over a period of years. As a result, a number of new aircraft will be operational while other aircraft are still being acquired.

National Defence's project cycle has four phases as depicted in the table below.

IDENTIFICATION	OPTIONS ANALYSIS	DEFINITION	IMPLEMENTATION
- Identify capability deficiency.	- Formulate options. - Discard invalid options. - Assess benefits of remaining options. - Examine risks. - Decide which option should be pursued. - Develop rough order of magnitude and indicative cost estimate.	- Confirm option choice. - Prepare detailed review, risk assessment and costing of selected option. - Undertake implementation planning. - Develop substantive cost estimate.	- Proceed with implementation. - Proceed with implementation management. - Do implementation monitoring. - Present reports on status of implementation. - Do operational handover. - Proceed with close out.

Project Identification takes place when one of the operational branches of the Canadian Armed Forces – the Canadian Army, the Royal Canadian Navy, or the Royal Canadian Air Force – identifies a need based on a capability deficiency.

The Options Analysis phase enables senior management to make an informed decision on the best way to implement the project to meet the identified need. This phase includes work on a project charter, a statement of operational requirements, project risk assessments, and a project management plan for the next phase of the project, the Definition phase.

Life-cycle cost estimates for development, acquisition, sustainment and operating are prepared during the Project Identification and Options Analysis phases of a project. These estimates arise from a large number of planning assumptions based on prior and/or ongoing experience with the same or similar products or technology and the use of parameters and variables to develop cost-estimating relationships. Cost estimates during these early phases of a project are generally characterised as rough order of magnitude.

The Project Definition phase marks the transition from determining what should be done to determining how the preferred option will be implemented. The objective of the Definition phase is to complete studies to refine the way forward for the selected option. This work leads to a more refined cost estimate of the proposal using a 'bottom-up' approach (direct estimation of a particular cost element by examining products component by component). This includes the investigation of project management and risk-management strategies, and the development of a project management team. At each phase, departmental

costing experts must validate all project costs. During Project Definition, cost estimates become increasingly substantive.

A project moves into the Implementation phase after receiving the authorities required to enter into contracts and to make commitments of approved project resources. At this point, the goal is to achieve an operational capability within the scope, schedule and approved cost limits. During the implementation phase, full life-cycle estimates continue to be refined as actual costs are realized.

Project Closeout is triggered when a project achieves what is called full operational capability – that is, when it fully achieves its objectives. Project closeout also allows departmental authorities to close the books and the accounts for the project, releasing any unused resources for reassignment. Following project closeout, sustainment and operations for the asset are managed through standard equipment management and operational capability business processes.

3. The Importance of Understanding Differences in Terminology

A clear understanding of terminology is essential when reporting on costs, particularly when more than one country is involved in the acquisition. This understanding is also crucial in the public discourse on the future of the CF-18. The following information on terminology is presented to meet both needs.

Different governments sometimes use different terms to mean the same thing. For example, Canada uses the term “buy profile” to refer to the schedule on which it might want to receive and pay for the F-35A, a schedule that could change the overall cost by millions of dollars. The United States program office uses the term “bed down plan” to mean the same thing. Meanwhile, a company which is understandably focused on the manufacturing aspect of a plan may refer to this as a “production profile.”

On the other hand, governments–and, of course, industry–sometimes use the same term to refer to entirely different or even opposite concepts. When Canada says an aircraft will cost $X million (Canadian) in “BY” it is referring to Budget Year, which in the United States would be referred to as Then Year (TY). Canada is therefore communicating that those are dollars complete with calculations for inflation. On the other hand, when the United States says “BY,” it means Base Year, what Canadians would call “Constant Year” (CY). In this report, unless otherwise noted, all figures are presented in Canadian Budget Year dollars.

Another term often used by different jurisdictions, organizations or individuals to mean different things is unit cost. When Canadian authorities use the term “unit cost”, they usually mean “Unit-Recurring Flyaway” Cost, known as URF or URFC. As the name suggests, unit recurring flyaway cost includes costs for an aircraft to be flyable, including the costs of the engine and the mission systems.

When the United States speaks of unit cost, however, it is more likely to be referring to average production unit cost (APUC) or program acquisition unit cost (PAUC). Average production unit cost involves all the items covered by unit recurring flyaway costs plus such expenditures as those for ancillary mission equipment, and initial spares as well as technical data, publications and support and test equipment. Program acquisition unit cost includes all the costs included in average production unit cost, plus the costs for facility construction, and for research, development, test and evaluation.

The program acquisition unit cost of a single aircraft could be almost twice as much as—and therefore millions of dollars more than—the unit recurring flyaway cost for the same aircraft. Any reference to the “unit cost” of an aircraft, or any comparison between the stated unit cost for one aircraft and the stated unit cost for another—must, therefore, be clear about what is included in the estimate.

IV. Life-Cycle Cost Estimates for the F-35A

1. Reporting Back on the Cost of the F-35A Program

Under the Government's Seven-Point Plan, the Department of National Defence continues to evaluate options to replace the CF-18 fleet, which provides Canada's current fighter capability. The Government will not make a decision on the replacement for the CF-18 until the Plan has been completed and the conclusions are presented to Ministers. The ongoing full evaluation of options will provide the best available information about the range of choices that could meet Canada's needs for a fighter capability.

This part of the report provides a comprehensive description of the planning assumptions that underpin the cost estimate for the F-35A, which remains one of the options being evaluated. These planning assumptions reflect the program Cost Breakdown Structure identified within the *Next Generation Fighter Capability: Life-Cycle Cost Framework*[3], developed by KPMG, including the addition of new cost elements for Concurrency Modifications and Diminishing Manufacturing Sources. To put these cost estimates in context, Part IV also provides information on Canada's participation in the United States-led Joint Strike Fighter Program, under which the F-35A is being developed.

2. Canada and the Joint Strike Fighter Program

As in the case of Canada, a number of like-minded countries are in the process of replacing their fighter fleets. Nine of them, including Canada, have signed the Joint Strike Fighter Production, Sustainment and Follow-on Development Memorandum of Understanding.

The Joint Strike Fighter Program is a United States-led multinational cooperative effort to build an advanced combat aircraft equipped to fulfill multiple roles. Planners intend the Joint Strike Fighter Program to run until at least fiscal year 2051/2052 and to produce approximately 3,100 F-35 Lightning II aircraft for purchase by Joint Strike Fighter partners by 2035. The actual number of aircraft produced may increase as additional aircraft are purchased through United States Foreign Military Sales legislation by countries not part of the Program, such as Israel and Japan, which have already committed to acquire aircraft.

Canada's participation in the Joint Strike Fighter Program is managed through the Next Generation Fighter Capability Project Management Office, which is part of the Department of National Defence. Royal Canadian Air Force personnel are also embedded, alongside personnel from the eight other Partner Nations, in the F-35 Joint Strike Fighter Program Office, in Washington D.C.

[3] KPMG Next Generation Fighter Capability: Life-Cycle Cost Framework, 27 November 2012

3. Phases in the Joint Strike Fighter Program

Canada has been an active participant in the Joint Strike Fighter Program since 1997. This country joined the Concept Demonstration Phase with a contribution of $15.2 million ($10.6 million U.S).

Canada also joined the second phase, System Development and Demonstration, in 2002 by contributing an additional $139.4 million ($94.4 million U.S.). Additionally, this country invested $77.9 million ($50 million U.S.) in Canadian aerospace industries through Industry Canada's Strategic Aerospace and Defence Initiative (SADI), formerly Technology Partnership Canada. Contributions made under the SADI program are repayable to Canada by Industry.

Canada's participation in these early phases of the Joint Strike Fighter Program provided Canada with access to technologies and data, new management and engineering approaches, and increased opportunities for Canadian industry to bid for Joint Strike Fighter contracts.

In December 2006, Canada became a partner in the third phase of the Joint Strike Fighter Program by signing the Production Sustainment and Follow-on Development Memorandum of Understanding. This Joint Strike Fighter Memorandum of Understanding provides a framework that allows participants to cooperate effectively in the production, sustainment and follow-on development of the F-35. Signing the Memorandum of Understanding in 2006 did not commit Canada to buy the F-35A.

Should Canada decide to acquire the F-35A, the primary benefits of participation in this phase of the Joint Strike Fighter Program are continuing opportunities for Canadian industry, a projected reduction in acquisition costs and potential savings in sustainment costs as a result of the collective purchase and management of available spares within a global sustainment system. Additional benefits include continuing access to, and use of, Joint Strike Fighter Program information; the opportunity to influence the Joint Strike Fighter Program and to share future development costs; and closer interoperability between Canada and the eight other partner nations.

Contributions made to the Production Sustainment and Follow-on Development Memorandum of Understanding pay for costs shared by Joint Strike Fighter Program participants, such as for program administration and the development of future modifications and upgrades to the aircraft. The current ceiling for Canada's participation in this phase is $551.6 million U.S of which Canada has so far contributed $167.5 million ($162.7 million U.S.). This includes a payment of $37.5 million ($36.6 million U.S.) made by the Department of National Defence

on 30 April 2013 for continuing participation in the Joint Strike Fighter Program through U.S. fiscal year 2013. A participating country's maximum contribution amount may only be increased through an amendment to the Memorandum of Understanding.

To date, Canada has invested $322.1 million ($267.7 million U.S.) as its share of the Joint Strike Fighter Program, and committed $77.9 million ($50 million U.S.) to Canadian aerospace companies through Industry Canada programs under the System Development and Demonstration Phase of the Program. As explained in the Spring 2013 update to Industry Canada's report on *Canadian Industrial Participation in the F-35 Joint Strike Fighter Program*, Canadian companies have so far secured $488 million U.S. in contracts as a result of Canada's participation in the Joint Strike Fighter Program. This is an increase of $50 million U.S. over the results reported in December 2012.

4. Cost Methodology and Estimates

For the annual updates to Parliament the Department uses two distinct data sources to derive life-cycle costs estimates. The F-35 Joint Program Office provides estimates for over 90 per cent of the acquisition and sustainment cost data. The remainder of the life-cycle cost data is dependent on how Canada would operate its fleet, and the cost estimate is based on data from Canadian sources. National Defence also takes into account actual and projected differences between the Canadian and United States currencies, and other such factors that affect cost estimates. Part V provides details on these factors and the assumptions underlying them. For planning purposes, the costs are then expressed in Budget Year Canadian dollars, that is, future dollars adjusted for inflation.

Canada received a bilateral cost estimate from the F-35 Joint Program Office on 7 June 2013. The sustainment cost element of that estimate showed a significant year-over-year decrease in cost, in the order of 12%. However, this contrasted with the Selected Acquisition Report 2012 (SAR 12) that the US Department of Defense tabled in Congress on 23 May 2013 which showed no decrease in the sustainment cost estimate. The SAR sustainment estimate did not change because it was based on the 2011 estimate prepared by the office of the Cost Analysis and Program Evaluation (CAPE), an independent US Government agency, which wasn't updated in 2012. The CAPE estimate is a more conservative position and does not take into account 2012 updates to the technical baseline and estimate inputs, whereas the F-35 program office estimate does. In SAR 12:

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In order to mitigate the situation wherein the 12% reduction in sustainment costs reported by the F-35 Joint Program Office were neither independently confirmed by CAPE nor reported to Congress in the SAR 12 report, National Defence has significantly increased sustainment contingency, such that it is comfortably in the range recommended by KPMG and significantly higher than last year's provision.

At this phase of the project to replace the CF-18, these costs should be considered as rough order of magnitude approximations based on initial planning assumptions and maturing Joint Strike Fighter Program costs. As the project progresses and as plans are defined and assumptions confirmed, the methods used to cost the individual elements will also progress to reflect actual and more detailed costs.

5. National Defence Planning Assumptions

The project to replace the CF-18 is currently in the Options Analysis phase. The cost estimates done during this phase are meant to lead to approval to begin more refined planning during the Definition phase. These estimates are underpinned by a number of preliminary planning assumptions. In this document, estimates are presented on the basis of the acquisition of a fleet of 65 F-35A aircraft, the Conventional Take-off and Landing (CTOL) variant. However, many of these same cost elements would apply to the development, acquisition, sustainment and operations, and disposal of any fleet of replacement fighter aircraft.

Program Assumptions

The following assumptions are used to support program cost estimates. These assumptions and the associated estimates will continue to be refined in future Annual Updates on costing for replacement of the CF-18.

Project Approval: Even though Project Approval has not yet been sought from Treasury Board, this program life-cycle cost estimate captures cost elements since Fiscal Year 2010-2011. Current cost estimates will be amended to reflect the final decision on a CF-18 replacement as they pertain to planning for aircraft deliveries, project management requirements, and on cost considerations such as unit recurring flyaway costs and inflation.

Aircraft Life Cycle: The F-35A has been designed for 30-years or 8,000 flying hours. For planning purposes, the F-35 Joint Program Office and a number of

other F-35 partners have elected to base their cost estimates on a 30-year aircraft life cycle.

Program Life-Cycle: National Defence has implemented the framework for calculating program life-cycle cost outlined in the KPMG Life-Cycle Cost Framework. National Defence's program life cycle begins with the start of the Next Generation Fighter Capability Program in 2010 and ends following the expected disposal date of the last F-35.

The life-cycle cost calculation is based on the following: development from 2010 to 2016; acquisition of the aircraft from 2017 to 2023; and 30 years of operations for each aircraft, recognizing there are overlap years when Canada would be both acquiring and operating the aircraft. Planned disposal would occur following 30 years of operation of each aircraft.

Transition between CF-18 and F-35A: The retirement of the existing CF-18 fleet will be coordinated with the delivery of the replacement fleet in order to maintain required operational capability during the transition. Details of the transition between fleets will be refined through the Definition phase as training plans are developed for the initial cadre of pilots and support personnel.

Canadian Modifications: At this point, no unique Canadian modifications to the aircraft are planned, and there are no provisions in the estimate for costs for such modifications as the F-35A meets all operational requirements.

Attrition Aircraft: It is anticipated that the Canadian Armed Forces will lose fighter aircraft to accidents throughout the lifetime of the aircraft fleet. It is recognized that the loss of aircraft over the life of the fleet would result in a diminished capacity to undertake and sustain discretionary operations. Therefore, operational risk will need to be managed, partly through the assignment of additional flying hours to the remaining aircraft, if lost aircraft are not replaced.

Rather than planning for the acquisition of more aircraft than are required to fill current needs, planners have recognized that the Government will retain the option to acquire replacement aircraft in the future if they choose to do so. In the case of the F-35A, production is planned to continue until at least 2035. Assuming the loss of two to three aircraft for every 100,000 hours of flying, seven to eleven aircraft could be lost over the fleet's lifetime[4]. Should a decision be taken by the Government to replace lost aircraft, the cost would depend on the budget year(s) in which the replacement aircraft were purchased. While the cost impact of replacing attrition aircraft has not been included in the life-cycle cost estimate, it is currently estimated to be approximately $1 billion.

[4] Hunter, D.G. (2011) Preliminary Estimate of Likely Bounds of Peacetime Attrition for Future Fighter Aircraft DRDC

Force Structure: Canada conducts day-to-day fighter operations out of two Main Operating Bases located at 3 Wing Bagotville, Quebec and, 4 Wing Cold Lake, Alberta with each of these bases supporting one tactical fighter squadron. In addition, 4 Wing Cold Lake supports an operational training unit for CF-18 pilot training. Five forward operating locations and four deployed operating bases are also in place with dedicated infrastructure and services to support domestic fighter operations. At this point, it has been assumed that this force structure will not change. When a decision has been made on a replacement for the CF-18, concepts of operations, training and support will be defined to reflect the unique aspects of the associated technology, and cost estimates will be updated accordingly.

Development Phase Assumptions

Costs related specifically to the Development phase include those for activities necessary to bring a project to the Implementation phase and, consistent with the KPMG Framework, are included in the life-cycle cost estimate.

Project Management: To support the planning and delivery of a major capability such as a new fleet of fighter aircraft, the Department of National Defence must establish a Project Management Office. This office interacts with various Government departments, such as Public Works and Government Services Canada and Industry Canada, to ensure that procurement activities meet the various objectives, policies and principles of the Government.

Development costs incurred prior to project approval are funded from the Department's existing baseline budget. These costs include salaries and travel for National Defence, Public Works and Government Services Canada and National Fighter Procurement Secretariat staff.

Joint Strike Fighter Memorandum of Understanding: Contributions under the Joint Strike Fighter Production, Sustainment, and Follow-on Development Memorandum of Understanding pay for agreed-upon common elements of the Joint Strike Fighter Program, such as program administrative support and, eventually, the follow-on development of modifications and upgrades to the aircraft. Forecast Memorandum of Understanding payments from July 2010 to the end of the program life cycle are included in the Development cost estimate.

Acquisition Phase Assumptions

Acquisition costs include the price Canada will pay to acquire CF-18 replacement aircraft. Included in acquisition costs are the one-time costs associated with acquiring aircraft, ancillary equipment, infrastructure, information systems, mission software reprogramming capability, initial aircrew and ground crew training, weapons, support equipment, initial spares and project management. Current assumptions related to acquisition costs are elaborated on below.

Unit Recurring Flyaway: Based on the capability of modern aircraft and simulator technology, it is expected that a fleet of up to 65 aircraft will provide sufficient capacity and flexibility to meet and sustain Canada's defence commitments at home and abroad. The current estimate for the acquisition of a replacement for the CF-18 is based on the forecast acquisition cost of 65 F-35A Conventional Take-off and Landing aircraft. The unit-recurring flyaway cost includes the costs for aircraft to be flyable, including the costs for the engine, mission systems such as the radar, radios, and other electronic equipment, and the vehicle systems such as the landing gear, flaps, and ailerons.

Diminishing Manufacturing Sources: The term diminishing manufacturing sources is used to describe the loss of the source of supply for parts or raw materials needed in the development, production or post-production support of an aircraft or equipment. Such a loss of supply occurs when a manufacturer stops producing a part or raw material for business reasons.

An example would be when a certain computer chip is no longer needed in the wider market and the manufacturer considers its production exclusively for military purposes to be unprofitable. Such a loss of supply might also occur when a new health, safety, environmental or other legislation restricts the production of an item—for example a certain type of adhesive—needed for an aircraft or equipment.

Timely solutions to diminishing manufacturing sources are usually difficult and expensive. Investments in diminishing manufacturing sources help to ensure that a country can acquire and sustain its aircraft as needed.

In the case of the Joint Strike Fighter Program, the potential cost to Canada resulting from diminishing manufacturing sources has two separate elements: the cost of redesigning a replacement part and the cost to purchase a sufficient quantity of the old part to support production until the replacement part is available ("Bridge Buys"). The cost of Bridge Buys is expected to be offset by reductions in future Unit Recurring Flyaway costs and are therefore not included in the acquisition cost estimate. The redesign costs cannot be offset and therefore have been included in the estimate.

Ancillary Equipment: Ancillary equipment includes items such as the aircrew's specialized life-support equipment, the helmet-mounted display, external fuel tanks, and pylons for carrying weapons internally and externally. This equipment is included in the acquisition costs.

Sustainment Set-Up: This cost element includes the purchase of the equipment and services required to support the F-35A aircraft:

Training Devices: To meet long-term training needs, planners currently assume that existing CF-18 operating locations will be upgraded with the addition of various F-35A training simulators (flight simulators, aircraft maintenance training aids, etc). The procurement of eight flight simulators, various aircraft maintenance training aids, and the related infrastructure are included in the current estimate.

Support Equipment: Aircraft support equipment and tooling currently in the Canadian Armed Forces inventory that are compatible with the new fleet will be retained. The Project will procure only the necessary equipment and tools, such as aircraft ground power units, hydraulic test stands, aircraft cooling units, and specialized aircraft maintenance tools, to meet the support requirements associated with operations while in Canada and while deployed. The requirement for support equipment is included in the current estimate.

Autonomic Logistics Information System: The F-35's integrated information management system is the Autonomic Logistics Information System. This system consists of computers, network infrastructure and software programs required to provide globally integrated support to the F-35A aircraft.

The Autonomic Logistics Information System impacts all support aspects of the F-35, including maintenance, logistics, training management, and operations support. The implementation of an F-35A fleet would require the acquisition of a suite of the Autonomic Logistics Information System hardware, as well as integration within the National Defence Information Management architecture. These elements have been included in the cost estimate.

Depot Stand-up: Aircraft and equipment repair beyond the capability of operational bases is performed at Government or commercial depot facilities. The cost associated with developing unique depot repair procedures and tools necessary for F-35A sustainment are accounted for in Depot Stand-up costs, and shared amongst all Joint Strike Fighter Program participants. Depot Stand-up costs are included in the current estimate.

Air System Labour: Labour resources required to procure and deliver the F-35A sustainment solution are included in the calculations for Sustainment Set-Up. This encompasses contractor resources necessary to plan and coordinate the introduction of the new fleet into service, including the supply chain, sustaining engineering, Autonomic Logistics Information System support, or software maintenance. The labour costs associated with these activities are included in the estimate.

Initial Spares: To support the operation of a new fleet, an initial acquisition of spare parts is required. These spares include aircraft replacement parts (for example gear box assemblies, heat exchangers), as well as consumable items such as tires and lubricants. The specific quantity of parts is determined by currently anticipated reliability and maintenance information, as well as operational parameters, such as the number of aircraft and operating locations, and the operating environment such as cold-weather operations.

A cost estimate for the establishment of this initial base-level inventory is included in acquisition cost estimates. However, requirements will continue to be refined as Canadian operating and support concepts for a replacement fleet become clearer, and cost estimates will be refined accordingly.

Reprogramming Lab: Like all modern fighter aircraft, including the CF-18, the F-35A is equipped with sensors (e.g. radar, electro-optical, infra-red, communication, etc.) that detect threats in the air or on the surface. These sensors must be reprogrammed so that they continue to recognize and properly categorize what they are detecting. In the case of advanced aircraft such as the F-35A, programming also ensures that the output of the full suite of sensors is reconciled, or 'fused' into a single source of information for the pilot.

This software reprogramming effort and the equipment required to support an advanced system exceed the Canadian Armed Forces' current capabilities. In order to reduce costs while meeting Canada's operational requirements, a collaborative effort has been considered with other Joint Strike Fighter Program partner nations to deliver this capability. The current cost estimate for this shared software reprogramming capability is included in the cost estimate for the potential acquisition of a Canadian F-35A fleet.

Infrastructure: New construction as well as upgrades to existing infrastructure is required for two Main Operating Bases, in Bagotville, Quebec and Cold Lake, Alberta and for the five Forward Operating Locations in Inuvik and Yellowknife in the North West Territories; Iqaluit and Rankin Inlet in Nunavut; and Goose Bay in Newfoundland and Labrador. A preliminary cost estimate to potentially accommodate an F-35A fleet has been developed based on a number of planning assumptions related to operational concepts in Canada and the current understanding of facility requirements published by the F-35 Joint Program Office.

This estimate encompasses construction and upgrades that would be essential to the introduction of the F-35A in order to achieve a full operational capability. Also it includes requirements such as the modification of hangars to enable the use of new equipment, the building of required secure facilities and modifications to existing information technology infrastructure. The current estimate for infrastructure requirements has been included in the total cost estimate for the

potential acquisition of a Canadian F-35A fleet. The current estimate does not include costs related to routine infrastructure recapitalization.

Weapons/Ammunition: Weapons currently in the Canadian Armed Forces inventory that can be employed on the F-35A fleet will be retained. In the case of the F-35A, the project acquisition cost estimate provides for the acquisition of an initial stock of gun ammunition and countermeasures (e.g., flares), as the existing stock of CF-18 gun ammunition and flares are incompatible with the F-35A. Over the life cycle of the replacement fleet, the acquisition of newer weapons will be considered and funded as separate projects.

Initial Training: The introduction of any new fleet of aircraft requires the establishment of initial training for the transition of aircrew and support personnel, as well as continuation training to ensure the safe and efficient operation and support of the fleet for its entire life cycle. Within the Joint Strike Fighter Program, training centres located in the United States will provide an initial capability for all F-35 operators to meet their initial training requirements.

Canada's current planning assumption is that this capability will be used to train an initial cadre of pilots, and aircraft maintenance and support personnel, to build the necessary 'critical mass' before transferring the training to Canada.

To meet long-term training needs, planners currently assume that existing CF-18 operating locations will be upgraded with the addition of various F-35A training simulators (flight simulators, aircraft maintenance training aids, etc). Training costs associated with initial training in the United States are included in the current acquisition cost estimates.

Project Management Office: To support the acquisition phase, the Department must continue to provide resources for a Project Management Office. Project management costs include elements such as: salaries and benefits for National Defence personnel, both military and civilian; professional services for the conduct of definition studies; Public Works and Government Services Canada fees and service charges; and office costs such as travel, information technology, office equipment, accommodation, and translation etc. Once a project is approved, these expenses are funded from the acquisition budget until the replacement fleet achieves full operational capability and the Project Management Office is closed. These costs have been included in the acquisition cost estimates.

Other: This final acquisition cost element category includes Government-supplied material; developing an interface between the Autonomic Logistics Information System and the National Defence material management system; aircraft familiarization and test flights; the construction of a secure facility to store classified F-35A data; and other miscellaneous items. These costs have been included in the acquisition cost estimates.

Sustainment Phase Assumptions

Sustainment costs are those associated with sustaining fighter aircraft over the course of their life cycle. These include materials consumed, major overhauls and repairs, contractor support, sustaining support, and software reprogramming. Current assumptions related to sustainment costs are elaborated on below.

Sustainment Costs: The F-35 Joint Program Office provided almost 100 per cent of the cost estimate data for this cost category. To note, the current F-35 Joint Program Office estimate has not been independently verified by CAPE. As actual costs for sustainment are not yet mature, these estimates are still largely based on parametric analyses and should therefore be considered as rough order of magnitude. As noted in Section V (Cost Risks and Uncertainty), as experience is gained with the global F-35A fleet, these sustainment cost estimates will continue to mature, and will be based on actual experience. In accordance with the F-35 Joint Program Office assumptions and related data provided, aircraft will not undergo major repairs in their last year of life; hence, no sustainment costs are included in the estimate for the last year of aircraft operations.

Yearly Flying Rate: A significant cost driver for sustainment costs is the yearly flying rate. The yearly flying rate is described as a number of flying hours. This estimate uses a planned yearly flying rate of 11,700 hours – approximately 20 per cent less than the currently planned CF-18 yearly flying rate – or 15 hours per month per aircraft. In new aircraft fleets, the use of increasingly advanced simulation is maximized in an effort to reduce the costs associated with sustainment and operations, and in order to maximize the service life of the aircraft. As concepts for operations and training are further refined during the Definition phase of the project, the extent to which yearly flying rates can be reduced will be better understood. Cost estimates will be refined accordingly.

Unit Level Consumption: This cost element represents the ongoing cost of the maintenance and repair of the aircraft and associated systems. This includes replacement parts, consumable items and associated labour costs. In addition to the initial purchase of spare parts mentioned under acquisition, the cost of materiel consumed in the operation and maintenance of an aircraft is included in Sustainment costs. These include costs for aircraft systems, propulsion systems, and support equipment replacement parts. They also include consumable items that are procured on an ongoing basis to maintain an appropriate inventory to meet domestic and deployed operations. The anticipated annual requirements for all replacement assets are included in the sustainment cost estimates.

Depot: Throughout the life of a fleet there will be requirements for major overhauls or maintenance of aircraft and engines, their components, and associated support equipment. These functions will be performed at central repair depots, contractor repair facilities, or on-site by depot teams. The

anticipated annual costs of labour, materiel and overhead incurred in performing these activities are included in the sustainment cost estimates.

Contractor Support: Contractors may be used to provide fleet support such as for management, engineering and training. This element of sustainment costs also includes the repair of training centres, training simulators and business equipment, and global supply-chain management and support. All costs associated with contractor support are included in the sustainment cost estimates.

Sustaining and Other Support: The following costs are included under this cost element:

> Sustaining Support: Sustaining support encompasses a wide array of in-service support cost elements, such as software maintenance for information management systems and simulator support. For the Joint Strike Fighter Program in particular, sustaining support accounts for the acquisition and installation of system modifications and betterments required to sustain the capability of the fleet over its extended life time. This ongoing follow-on development program provides for regular improvements and enhancements rather than midlife upgrades.
>
> Reprogramming Lab Support: Reprogramming lab support includes support of the mission software reprogramming laboratory throughout the in-service life of the replacement fleet. This lab support accounts for contracted personnel involved with operating the laboratory, as well as the procurement of replacement laboratory equipment. The current sustainment cost estimate assumes the equal sharing of these costs among participants in the laboratory.

Operating Phase Assumptions

Operating Costs: Operating costs include all costs associated with operating the aircraft. These include salaries, base operating costs, materiel costs, and ammunition for training. As some of these costs are very specific to conditions in which a fighter fleet will be operated in Canada, they are not estimated for partner countries by the F-35 Joint Program Office. Canadian Armed Forces' experience with the CF-18 has been used to develop an analogy-based estimation for the new fleet's operating life-cycle cost estimate. Operating costs in the estimate have been phased in, based on a notional aircraft delivery schedule.

> Personnel: This element includes costs associated with all personnel that directly or indirectly support a fleet at base level, from pilots and aircraft maintenance personnel, to the medical or administrative staff to military

personnel involved in mission software reprogramming. The current personnel cost estimate is based on the structure of the CF-18 fleet.

Operations: Operations costs relate to operating and supporting a fleet including such costs as aviation fuel, training weapons and ammunition usage, and the provision of base-level support infrastructure, materiel (administration, medical, firefighting, etc.) and maintenance. Usage rates are based on current CF-18 data, and adjusted based on anticipated project planning parameters, such as the anticipated yearly flying rate.

Aviation Fuel: The CF-18 fuel burn rate has been adjusted based on information provided by the F-35 Joint Program Office on the expected fuel burn rate for the F-35A. For the purposes of the current cost estimate, specific F-35A fuel consumption rates, which are higher than for the CF-18, are used.

Unit-Level Operating Costs: This cost element includes operating budgets for squadrons, temporary duty costs and training ammunition.

Base-Support Costs: This cost element includes an apportionment of all fighter base support costs. The apportionment encompasses infrastructure (hangar and runway maintenance), materiel and personal support.

Given the current phase of the project, it is anticipated that some of the operating assumptions that underpin current operating cost estimates could change. For example:

- a smaller fleet of aircraft (up to 65 instead of the current 77 CF-18 aircraft) may allow for the reassignment of personnel;
- definition of maintenance and support concepts for a new F-35A fleet may provide opportunities to realize savings; and
- definition of a training concept may reveal an opportunity to further reduce fuel usage or training ammunition costs.

Further definition work is required to achieve greater confidence in the operating cost estimates.

Disposal Phase Assumptions

Canada does not yet have a disposal plan for the F-35A. Some potential disposal options could include selling airframes as surplus, either whole or for spare parts; storing them for later use; dismantling or otherwise destroying the aircraft; or providing them as artefacts for museums or display purposes. The F-35A has been designed for up to 8,000 flying hours. Based on the currently forecast fleet

flying rate and Canadian usage profile, a portion of this design life could remain at the time of disposal. The disposal cost estimate for the F-35A fleet was originally prepared using the principles outlined in the United States Government Accountability Office report *GAO/AIMD-98-9 - DOD's Liability for Aircraft Disposal Can Be Estimated.* However, as more information is being obtained on CF-18 disposal costs, the methodology for calculating the disposal cost estimate has been changed to rely on the current preliminary disposal plan for the CF-18 as a basis for the estimate.

6. Life-Cycle Cost Estimate

This report is based on program-level cost estimates, as recommended by KPMG[5]. Accordingly, the estimates in this document include the acquisition of a replacement fighter and the cost of making and keeping the replacement fighter capability ready and available for operational use. Costs related to deployed operations, for example with the United Nations or NATO, which are normally referred to as contingency operations and cannot be forecast at this time, are not included.

Unless otherwise noted, all figures in this cost estimate are stated in millions of Canadian dollars adjusted for inflation. As explained earlier, the standard terminology in the Government of Canada for an inflation-adjusted figure is Budget Year dollars ($BY). All costs are net of taxes.

This cost estimate uses the Government's 2010 announcement of its intention to acquire F-35As as the date on which to commence the accumulation of costs. Prior to that time, there was no formal decision to replace the CF-18, and any funds spent before then are considered to be outside the scope of the Program, as detailed in Table 1:

Item	$Million Budget Year	Fiscal Year	
		Start	End
Concept Demonstration Phase MOU	15.2	1997-1998	2000-2001
System Design and Development MOU	139.4	2001-2002	2006-2007
Production, Sustainment, Follow-on Development MOU	68.2	2006-2007	2009-2010
Defence Operating Budget (MOU related)	7.1	1997-1998	2009-2010
Total	**229.9**		

Table 1: Pre-Program Costs

[5] KPMG Next Generation Fighter Capability: Life-Cycle Cost Framework, 27 November 2012

Basis for Estimate

This estimate is based on the project plan as of May 2013. It includes foreign exchange and inflation data that are current as of May 2013. The acquisition and sustainment estimates are substantially based on the Canadian bilateral cost report prepared by the F-35 Joint Program Office and delivered to Canada in June 2013. The Development, Operating and Disposal portions of the estimate are based on Canadian developed source data and cost estimating methodologies.

Cost Estimate Maturity: The Next Generation Fighter Capability project is in the Options Analysis phase. National Defence has limited authority at this phase of a project to conduct studies and produce detailed costing information. Although there is a relatively high degree of fidelity around some cost elements such as for the aircraft unit recurring flyaway cost and other acquisition costs, overall this estimate must be considered a rough order of magnitude until the project completes a funded Definition phase. Rough order of magnitude is a type of estimate usually prepared early in the development of a project on the basis of preliminary information, and can be valuable in helping decision makers to determine whether to proceed with the project. In the context of the F-35, KPMG assessed the cost estimates to be better than ROM.

A specific activity, should Treasury Board grant expenditure authority and the project move into the funded Definition Phase, would be to improve the life-cycle costing to a substantive estimate through detailed studies and analysis of such factors as initial and long-term training requirements.

Foreign Exchange: United States dollars have been converted to Canadian dollars using the forecast provided by the independent forecasting firm *Consensus Economics*. The forecast provides annual forecast rates, with a stable long-run rate commencing in 2018. The long-run average exchange rate used in this cost estimate is $1 Canadian = $0.92 United States based on the *Consensus Economics* May 2013 report. To varying degrees, partner projects have strategies available to protect them from the effects of foreign exchange fluctuations. These strategies vary from a “no gain, no loss” regime with their national treasury, to a more limited in-year currency hedging strategy, to full exposure to foreign exchange fluctuations.

Inflation: Cost data provided by the F-35 Joint Program Office include inflation. In all other instances, inflation is based on the *National Defence Economic Model.*

Sources of Cost Data

The F-35 Joint Program Office is the source of much of the data for Canada’s F-35A cost estimates. However, there are some differences among the different

phases of the life cycle. The following summary indicates these differences, and comments on the level of reliability of the various estimates.

Development Cost Data: The development cost estimate includes two distinct data sources. These are Memorandum of Understanding payments data received from the F-35 Joint Program Office, and Canadian data related to project management costs.

Acquisition Cost Data: The F-35 Joint Program Office provides estimates for over 90 per cent of the acquisition cost data. As noted earlier, Canada's bilateral cost report from the F-35 Joint Program Office is based on the same data as the Selected Acquisition Report 2012. The F-35 Joint Program Office continues to refine its estimates, and will continue to update them at least annually. At this point, this estimate classifies the F-35 Joint Program Office cost estimates as rough order of magnitude.

However, the estimates are now being informed by actual production costs, and are therefore increasing in quality. The F-35 Joint Program Office estimates have been converted from United States dollars to Canadian dollars and re-aligned with Canadian fiscal years.

Sustainment Cost Data: The F-35 Joint Program Office provides almost 100 per cent of the cost estimate data for this cost category. These estimates are still largely based on parametric analyses, and should be considered as rough order of magnitude. Sustainment costs are phased in commencing with the delivery of the first aircraft. The base estimate is then converted from United States dollars to Canadian dollars and inflation factors are included.

The F-35 Joint Program Office sustainment estimate has not been independently reviewed by CAPE, giving us less certainty than we had in 2012. As a result, National Defence has increased sustainment cost contingency.

Operating Cost Data: Operating costs are phased in according to the purchase profile. Project Definition will provide a detailed operating concept for the CF-18 replacement. Without the benefit of Project Definition studies and empirical data on F-35A aircraft operations, these estimates use existing CF-18 operating costs as a substitute. The operating cost estimate is considered a rough order of magnitude.

Disposal Cost Data: The disposal cost estimate for the F-35A fleet has been prepared based on the CF18 Fleet Long Term Disposal Cost Estimates. The disposal cost estimate is considered a rough order of magnitude. At this time, there is no disposal plan for the F-35A, as disposal is not expected to occur until well into the future.

Full Life-Cycle Cost Estimate (2010-2052)

Table 2 summarizes the 2013 full program life-cycle cost estimate for a Canadian F-35A capability from the start of program development in 2010, through disposal of the last aircraft, following 30 years of operation of each aircraft.

LCC Phases	Cost Element		Estimate $Million CAD (BY)	
Development	Production, Sustainment, Follow-on Development MOU		499	
	Project Management Office		28	
	Contingency		79	
Development Total				**606**
Acquisition	Unit Recurring Flyaway Cost	F-35A Airframe	3,208	
		Vehicle Systems	764	
		Mission Systems	1,261	
		Propulsion System	846	
		Engineering Change Orders	108	
	URF Total			6,187
	Concurrency Modifications			24
	Diminishing Manufacturing Sources			70
	Ancillary Equipment			258
	Sustainment Set-Up	Training Devices	372	
		Support Equipment	428	
		Autonomic Logistics	72	
		Labour	196	
		Depot Stand-Up	0	
	Sustainment Set-Up Total			1,068
	Initial Spares			236
	Reprogramming Lab			219
	Infrastructure			244
	Ammunition			59
	Initial Training			116
	Project Management Office			123
	Other			44
	Contingency (Note 1)			342
Acquisition Total				**8,990**
Sustainment	Unit Level Consumption			4,818
	Depot Maintenance			773
	Contractor Support			2,115
	Sustaining and Other Support	Sustaining Support	3,164	
		Other Support	689	
	Total Sustaining Support			3,853
	Contingency			3,496
Sustainment Total				**15,055**
Operating	Personnel	Direct Personnel	5,809	
		Support Personnel	4,789	
	Total Personnel			10,598
	Operating	Aviation Fuel	4,330	
		Unit Level Consumption	1,704	
		Base Support Cost	3,225	
	Total Operating			9,259
Total Operating				**19,857**
Disposal	Disposal		129	
	Contingency		39	
Disposal Total				**168**
Full Program Life-Cycle Cost Estimate				**44,676**
Attrition Replacement (Note 2)				**1,015**
				45,691

Note 1: The full amount of acquisition contingency suggested by the Life-Cycle Cost Framework would be approximately $1,550 million (Table 4). If the full available contingency was required, the shortfall could be met by buying fewer aircraft.

Note 2. It is estimated that seven to eleven aircraft could be lost over the program life-cycle and the cost to replace these lost aircraft could be in the order of $1 billion. This cost is not included in the Life-Cycle Cost estimate. Sustainment and Operating estimates assume a constant number of 65 aircraft.

Table 2: 2013 Full Program Life-Cycle Cost Estimate

7. Independent Third-Party Review

KPMG concluded in their November 2012 report *Next Generation Fighter Capability: Independent Review of Life-Cycle Cost* that the methodology and cost model used to develop the life-cycle cost estimate contained in the 2012 Annual Update were appropriate. In addition to the overall conclusions, other findings and recommendations were noted; however, no significant quantifiable differences were noted as a result of these findings.

In response to the recommendations made by KPMG, since tabling its first Annual Update, National Defence has conducted regular reviews and updates of the LCC estimate which continue to result in refinement and improvement of the fidelity of the estimates over time.

More specifically, DND has:

- Formalized and documented its LCC Cost Plan through the production of a formal Cost Plan and Summary of Findings report;
- Continued to update key assumptions and the LCC estimate on a regular basis and has ensured that agreed changes are reflected in the LCC estimate in a timely manner;
- Continued to review and update the program cost breakdown structure to ensure that the LCC estimate includes all capability requirements;
- Refined and simplified the financial cost model used to prepare the LCC estimate so that the model is more flexible and traceable and so that it facilitates sensitivity analysis;
- Worked with the Department of Finance to investigate mechanisms to more proactively manage foreign exchange risk for the program. Consideration of this issue is continuing;
- Continued to further refine the estimate;
- Conducted further analysis and communicated key assumptions in regards to the effective use of aircraft life; and
- Continued to refine the calculation of contingency, including its allocation amongst the cost elements, while continuing to respect the Government's direction that the total acquisition cost cannot exceed $9 billion.

The Independent review of the 2013 Annual Update was conducted by Raymond Chabot Grant Thornton. Their report[6] concludes that DND has made good progress to improve and refine its cost estimating processes and methods. While the report identifies other findings and recommendations, no significant

[6] Raymond Chabot Grant Thorton, Independent Review: 2013 Department of National Defence Annual Update on Next Generation Fighter Capability Life Cycle Costs, August 2013

differences from the KPMG Framework were noted as a result of these findings that would result in any material changes to the overall life cycle cost estimate.

V. Cost Risks and Uncertainty

1. Explanation of Terms

This section on cost risk and uncertainty begins with an explanation of terms that will appear in Part V.

Point Estimate: A point estimate is a single figure that represents the best estimate of the cost element. A point estimate does not indicate its degree of precision or its level of uncertainty.

Cost Sensitivity and Sensitivity Analysis: The analysis of the cost sensitivity of the F-35A examines what would be the impact, negative or positive, on cost if there were changes, for example, in inflation or foreign exchange rates.

Confidence Interval: At this phase of the program and of the cost estimation process, there are considerable uncertainty and risk associated with the underlying assumptions and estimates. To provide a sense of the possible variation of costs around the point estimate, this cost report includes a sensitivity analysis around key cost elements. The reliability of a point estimate is often presented as a range of values known as a confidence interval which are normally stated as a percentage. A 90 per cent confidence means that 90 out of 100 times the true cost will fall within the confidence interval.

Buy Profile: As noted earlier, the buy profile is a country's plan for the purchase of the aircraft. The buy profile includes how many aircraft will be purchased, and how many the country wants delivered at what time or times. Because the acquisition cost of the aircraft varies from one delivery date to another, a country's buy profile is a crucial factor in the costing of the aircraft or the fleet.

Tornado Graph: A Tornado graph is a special type of bar chart, with the bars running from left to right instead of from top to bottom. It is called a Tornado graph because it is shaped like a tornado with the more numerous values at the top and the less numerous ones at the bottom. The horizontal bar graphs in this part of the document illustrate this point.

2. Introduction

The National Defence costing model is informed by acquisition and sustainment cost estimates provided by the F-35 Joint Program Office, the Selected Acquisition Report 2012 (SAR 12) and by the National Defence estimate of the cost of development, operating and sustainment, and disposal. The model yields a risk-adjusted "point estimate" of the full life-cycle cost of an F-35A program.

The following sections of this Part of the report describe the risks and uncertainties associated with each sequential phase of the program's life cycle.

There are, however, two risk factors, namely foreign exchange and inflation, that affect every phase of the life cycle, and these are generally described below.

Foreign Exchange: Foreign exchange is a major, uncontrollable risk to the program cost estimate. The Canadian/United States exchange rate is quite volatile, having fluctuated by over 40 per cent over the last 10 years, and has had swings of over 10 per cent in a single year. For the purposes of the cost estimate, United States dollars have been converted to Canadian dollars using a rate provided by an independent forecasting firm, *Consensus Economics*.

The long-run exchange rate used in this cost estimate is the firm's May 2013 rate where $1 Canadian = $0.92 U.S. Foreign exchange uncertainty applies to all phases of the program. The rate of $0.92 provides a confidence interval of approximately 70 per cent. Comparatively, parity provides a 50 per cent confidence interval while the rate of $0.78 provides a 95 per cent confidence interval.

Inflation: The project faces both domestic and international price variations. In addition, National Defence's specific goods and services, many of which are not generally purchased by the general population, respond to inflationary pressures not captured by broad national price indices[7]. These inflationary pressures are captured, however, by the F-35 Joint Program Office estimates and National Defence's Economic Model. For the purpose of this cost estimate, dollar amounts are expressed in Budget Year dollars, adjusted for inflation.

3. Development Cost Risk and Uncertainty

The Joint Strike Fighter Memorandum of Understanding payments are denominated in United States dollars. Shared costs paid on an annual basis by participants in the Memorandum of Understanding are used for non-recurring Joint Strike Fighter Program expenses related to production set-up (for example tooling), for non-recurring engineering activities related to follow-on development and for program administration until the expiration of the Memorandum of Understanding.

There is a possibility that economic factors, higher-than-expected costs or a change in Memorandum of Understanding participation will result in a need for an increase in the cost allocation that was originally forecast for Memorandum of Understanding partners in 2006. By the terms of the Memorandum of Understanding, the $551.6 million U.S. ceiling amount documented for Canada's participation in the Production, Sustainment, Follow-on Development Memorandum of Understanding can only be increased through a formal amendment.

[7] Solomon, Binyam (2003) Defence Specific Inflation: A Canadian Perspective Defence and Peace Economics, Volume 14(1) 19-36

4. Acquisition Cost Risk and Uncertainty

The Tornado Graph below graphically depicts the major risk factors, and their impacts on the acquisition cost estimate. Note that the second bar from the top shows the greatest impact and the one at the bottom the least impact, on the acquisition cost estimates. The green bars and the figures in brackets at the top left indicate reduced cost estimates. The red bars and the figures at top right indicate increased cost estimates.

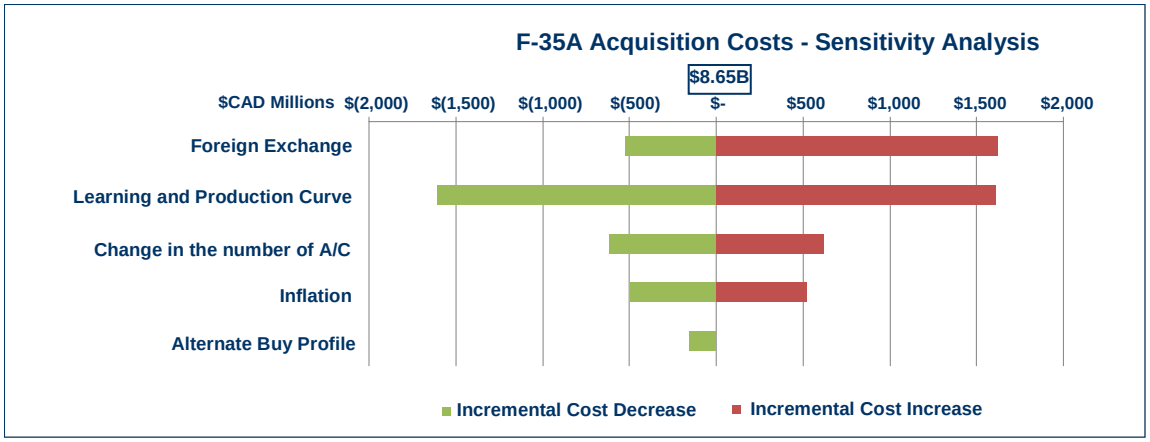

Figure 1: 2013 Acquisition Costs

Foreign Exchange: Figure 1 illustrates the possible impact of this volatility on the acquisition cost estimate. The rate of $0.92 provides a confidence interval of approximately 70 per cent and is the basis for the baseline cost estimate. Parity provides a 50 per cent confidence interval and would reduce the estimate by over $500 million while the rate of $0.78 provides a 95 per cent confidence interval and would increase the estimate by approximately $1.6 billion.

Learning and Production Curve: The unit recurring flyaway cost estimate provided by the F-35 Joint Program Office is based on a detailed engineering bottom-up approach based on commercial confidential data provided to the F-35 Joint Program Office by the contractor. Confidence intervals could be computed for low-level components and rolled up to obtain a confidence interval around the F-35 Joint Program Office unit recurring flyaway estimate. However this would require intricate knowledge of individual manufacturing processes and practices.

Alternatively, National Defence uses an independent top-down F-35A unit recurring flyaway cost estimating model to validate the F-35 Joint Program Office's unit recurring flyaway cost estimate and to conduct high-level sensitivity analysis.[8]

[8] Kaluzny B.L. (2011) The Unit Recurring Flyaway Cost of a Canadian Joint Strike Fighter DRDC CORA TM 2011-200

The learning effect assumes that a large quantity ordered over time will lead to accumulated experience in producing the same system year after year, thus reducing the unit cost. The notion behind a production effect is that the quantity of aircraft produced in a given time period will likely reduce the unit cost through greater operating efficiency and spread fixed costs over more units.

Figure 2 depicts the updated relationship between learning/production efficiencies and unit recurring flyaway costs[9].

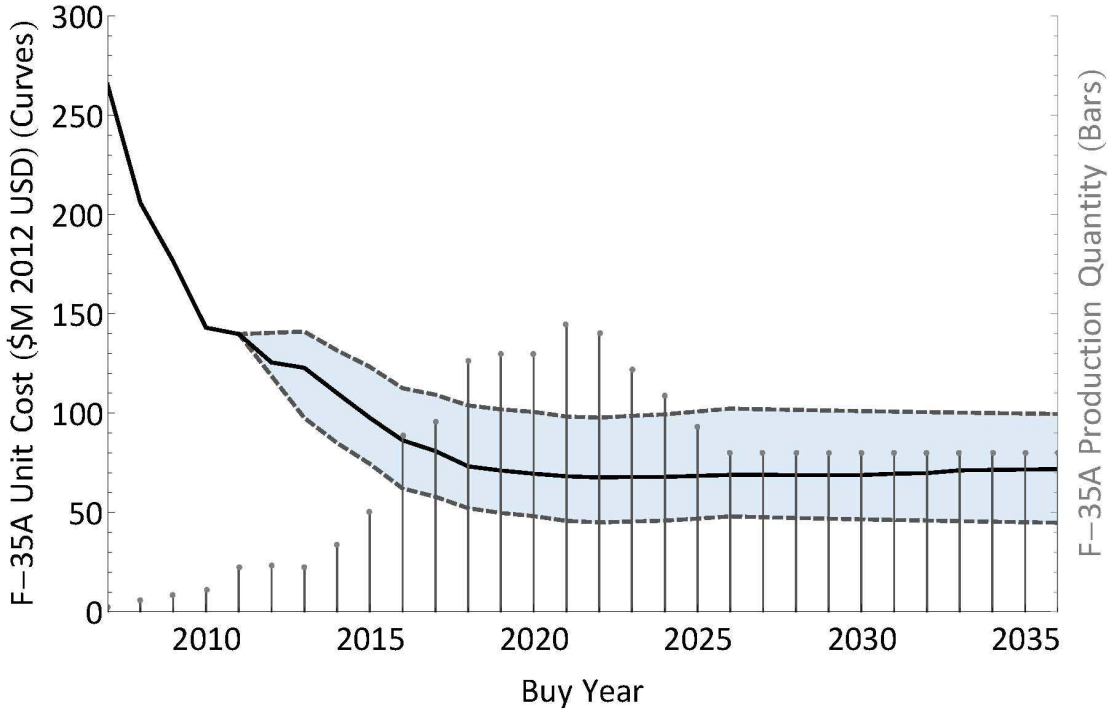

Figure 2: 2013 F-35A Unit Recurring Flyaway Cost Estimating Curve

The solid black line represents the F-35 Joint Program Office's estimated cost curve. The combined effect of a three per cent variation (which lies in the blue region) in both the currently forecasted learning and production efficiency factors, occurring prior to Canada placing its orders, would change the unit recurring flyaway cost by approximately 26 per cent. This translates to approximately $1.6 billion variation in the acquisition cost.

Change in the Number of Aircraft Produced: A key tenet of the Joint Strike Fighter Program is affordability achieved through high aircraft production rates. This is a multinational project, and the cost the partners pay for aircraft varies depending on the actual number of aircraft produced and sold. While baseline acquisition cost estimates are based on the buy profiles of the nine partner

[9] 3550-1 (DRDC CORA), Kaluzny B.L., 2013 Update on F-35A URF Cost Estimation, 17 July 2013

nations, these buy profiles, and actual purchasing patterns, may change over time.

Specifically, if partner nations delay the timing of their purchases and/or reduce the number of aircraft they purchase up to and during, the period Canada would be purchasing its aircraft, the unit price for Canadian orders may be higher. Given the current fiscal constraints in the post financial crisis environment, the likelihood of this risk is considered higher than last year's. However, some of the risk is also reduced as more aircraft are produced and the notional Canadian buy period approaches. In addition, the availability of more information due to the maturity of the project has allowed a more precise and refined analysis that looks at the likely aircraft reductions before and during Canada's potential buy period. As a result, the assessed maximum impact based on the updated analyses is estimated at 250 aircraft, and would result in an increase in the acquisition cost for Canada of approximately $600 million.

Inflation: The life-cycle cost estimate incorporates both United States and Canadian inflation assumptions. While it is impossible to accurately forecast inflation rates until completion of aircraft delivery, this cost estimate relies on F-35 Joint Program Office inflation forecasts and the *National Defence Economic Model*. This factor assesses what would be the impact if the forecast rates of inflation built into the estimate vary by one per cent for the acquisition phase of the project, which translates to a variance of approximately $500 million in the acquisition cost.

Alternate Buy Profile: Joint Strike Fighter Program partner nations retain the flexibility to adjust the timing and number of aircraft they intend to buy. These adjustments feed into the Selected Acquisition Report and bilateral cost update preparation cycle.

The Canadian project intends to continue adjusting Canada's buy profile so that it continues to respect Government approval cycles and, at the same time, maximizes overall value for the Crown while respecting the notional timing for the phase-out of the CF-18 and phase-in of the F-35A.

The current cost estimate was prepared using the buy profile formally on file with the F-35 Joint Program Office in March 2013 (unchanged from July 2012), as shown in Table 3. Each aircraft is expected to achieve its estimated economic useful life on a straight line, first-in, first-out basis over the useful life of the fleet.

Selected Acquisition Report 2012 – Unit Recurring Flyaway Cost Estimate									
US Fiscal Year	Number of Aircraft								Weighted Average ($M US)
	2017	2018	2019	2020	2021	2022	2023	Total	
# aircraft	4	9	7	13	15	13	4	65	88.5

Table 3: Notional Canadian Buy Profile (March 2013)

National Defence has analysed the sensitivity of the current cost estimate to a change in its current notional aircraft acquisition plans. For example, delaying the buy profile by one year would result in an acquisition cost savings of approximately $160 million. There would, however, also be an associated increase in sustainment costs, as described in the next section, “Sustainment Cost Risk and Uncertainty”.

Other Acquisition Cost Risks: The cost risks associated with other acquisition costs such as the Project Management Office, infrastructure, sustainment set up, etc. are neither economic in nature nor related to airframe (unit recurring flyaway cost). The risks related to these other components can be estimated based on past projects with similar scope. In particular, the guidelines articulated in the DND Costing Handbook Second Edition, 2006 were used to develop the contingency amounts for these other acquisition cost risks. The risk profile of these components has not changed since the last Annual Update, even though two new cost elements have been added. The average contingency is 12 per cent, with a potential impact estimated at approximately $340 million.

5. Sustainment Cost Risk and Uncertainty

The F-35 Joint Program Office sustainment cost estimating model, while highly detailed and data-intensive, provides only point estimates, which, as noted above, lack the precision of confidence interval estimates. In order to construct confidence intervals around these point estimates, National Defence has to account for numerous variables, interdependencies and associated uncertainties. Currently, National Defence does not have sufficient information about these variables and their inter-relationships to construct bottom-up confidence intervals.

As an alternative, National Defence has used a top-down approach based on the assumption that given the same role and mission profiles, National Defence could use historical costs of the CF-18 fleet to model the ratio of sustainment requirement per flying hour to capital demand amortized over time for the F-35A fleet.[10]

The top-down sustainment model used in this report has been updated and now incorporates a full 30 years of sustainment cost data for the CF-18[11]. For consistency, and to improve the model's utility in forecasting sustainment costs, the top-down model forecasts costs over a 30 year period as well, extending 30 years beyond the delivery of the first F-35A aircraft.

[10] Desmier, P (2012) Forecasting National Procurement Costs for the Joint Strike Fighter DRDC CORA TR 2012-093

[11] 3550-1 (DMGOR), Desmier, P,E, *Forecasting Joint Strike Fighter National Procurement Costs based on selected Acquisition Report (SAR) 2012*, August 2013

The model shows that increases in F-35A sustainment costs relative to those of the CF-18 will be proportional to the higher F-35A acquisition costs, reflecting the technological advancements inherent in the aircraft. The model shows confidence intervals of 95% (the dotted red line), and that both National Defence's top-down sustainment cost estimate (the solid green line) and the F-35 Joint Program Office estimate (the solid blue line) fall within the 95% confidence bound.

Figure 3: 2013 Forecasted F-35A Annual Maintenance Costs

Figure 4 provides information on the sensitivity of the sustainment cost estimate to various assumptions about specific factors affecting it.

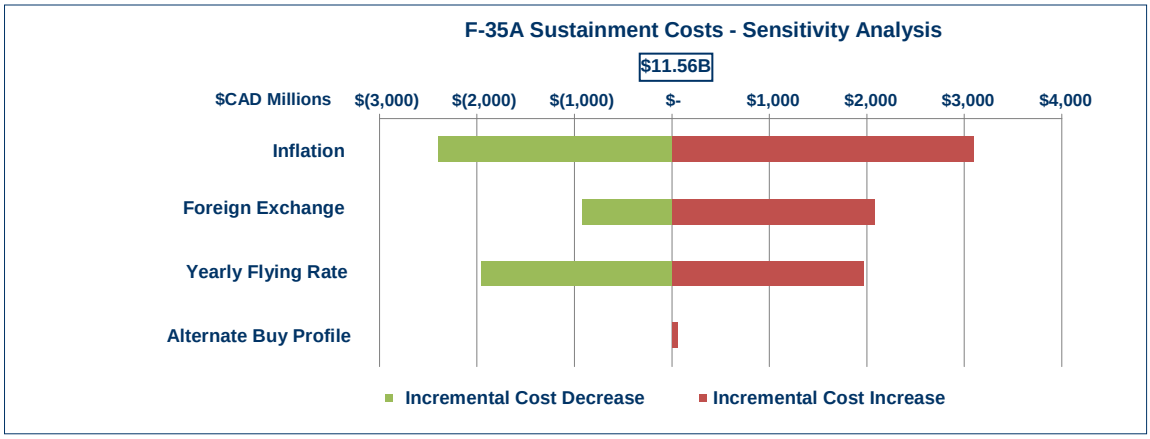

Figure 4: 2013 Sustainment Costs

Inflation: The sustainment cost estimate was subjected to a sensitivity analysis on a long-term annual average inflation rate adjusted by one percent from the rate used by the F-35 Joint Program Office. This analysis allows the planners to forecast the increased or reduced impact if inflation is one per cent higher or lower than the level projected by the F-35 Joint Program Office.

A one per cent cumulative increase in the inflation rate built into the estimate would increase the sustainment cost by almost $3.1 billion over the fleet life cycle. A one per cent decrease from that inflation rate would result in an approximate $2.4 billion reduction in the estimate. The difference between the two figures is attributable to the compounding effect of the two per cent spread.

Exchange Rate: A change in one cent (1¢) in the Canadian/United States dollar exchange rate will impact the sustainment cost estimate by approximately $110 million. For the rates considered, the potential increase would be $2.1 billion, and the potential savings are approximately $900 million.

Yearly Flying Rate: Another element of the sustainment sensitivity analysis is change due to variation in yearly flying rates. The current planned yearly flying rate for the CF-18s is approximately 15,000 hours while for the F-35A it is estimated at approximately 11,700 hours. Conducting the sensitivity analysis around planned F-35 flying hours shows that changing the yearly flying rate by 4,000 hours results in an increase or decrease in sustainment costs of approximately $2.0 billion.

Alternate Buy Profile: National Defence has analysed the sensitivity of the current cost estimate to a change in its current notional aircraft acquisition plans. For example, delaying the buy profile by one year would result in a sustainment cost increase of almost $55 million over the full fleet life-cycle. This increase is due to economic factors such as inflation affecting sustainment costs in later years.

6. Operating Cost Risk and Uncertainty

Figure 5 provides information on the sensitivity of the operating cost estimate to various assumptions about specific factors affecting it.

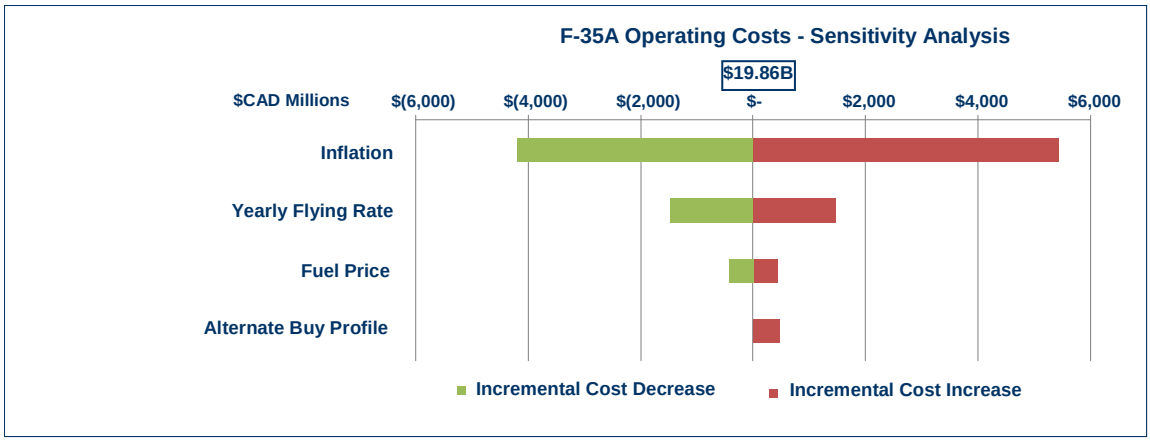

Figure 5: 2013 Operating Costs

Inflation: The cost estimate was subjected to a sensitivity analysis on a permanent one percent variance in the long-term forecast Canadian inflation for operating costs used in the estimate. A one per cent increase would increase operating costs by approximately $5.4 billion over the fleet life cycle, while a one per cent decrease would result in a $4.2 billion decrease in the estimate. The difference between the two figures is attributable to the compounding effect of a two per cent spread.

Yearly Flying Rate: Changing the annual number of hours flown by the aircraft fleet would impact the level of variable fleet operating costs, while not affecting the fixed operating costs. In this analysis, the yearly flying rate changes affect the amount of fuel used, as well as unit-level operating costs. The sensitivity analysis indicates that a permanent 4,000-hour change in the annual flying rate would result in a $1.5 billion variation in the cost estimate over the fleet life cycle.

Fuel Price: The volatility of aviation fuel prices relative to overall inflation required that a separate sensitivity analysis be conducted on this factor. For the purposes of this analysis, the average price of aviation fuel was assumed to be $0.879 per litre (excluding taxes), with a possible range of 10 per cent. The analysis shows a variation of about $430 million due to a 10% change in price.

Alternate Buy Profile: Changing the aircraft delivery schedule as described above would result in additional operating costs of approximately $470 million over the fleet life-cycle. This increase is mainly due to economic factors such as inflation affecting operating cost in later years.

7. Cost Risks and Contingency

Contingency allowances are normally included in estimates to provide for a financial reserve to offset cost increases that may arise from unknown or uncertain future events or risks. Various techniques exist to estimate contingency

allowances, ranging from statistical analysis to expert judgment or the use of past experience.

Contingency on Development: Within the Development Phase, costs are mostly based on estimated Memorandum of Understanding payments stipulated by the agreement. As a result, risk is relatively low, other than foreign exchange. A 15 per cent contingency was calculated using the guidelines articulated in the DND Costing Handbook Second Edition, 2006. The same percentage of contingency is maintained for this Annual Update since there have been no significant changes in the risk profile of this cost element.

Contingency on Acquisition: Acquisition contingency is primarily based on the statistical analysis technique of Expected Value. The Expected Value is the cost of a risk multiplied by the probability of the risk occurring. The maximum risk cost and probability of the occurrence of the risks considered in this analysis were updated from the 2012 Annual Update, as determined by a group of subject-matter experts.

The subject-matter experts, drawn from across National Defence, included representatives from the Royal Canadian Air Force, the Project Management Office, Chief Financial Officer staff, corporate risk management, operations research scientists, and defence economics specialists. For the acquisition estimate the subject matter experts analysed the following risk events:

- Foreign Exchange: that the value of the Canadian dollar would depreciate significantly more than the exchange rate already built into the cost estimate;
- Inflation: that the United States and Canadian inflation rates would exceed those already built into the cost estimate;
- Efficiency Gains: that the actual Production and Learning Efficiencies rates would be lower than those built into the F-35 Joint Program Office estimates;
- Aircraft Production: that the number of aircraft produced before or during the period of Canada's delivery profile would be lower, and this decrease would affect the unit recurring flyaway cost; and
- Other Cost Estimating Risks: Contingencies for other acquisition cost factors, such as ammunition, infrastructure, etc., were not calculated using the Expected Value method. Instead they were calculated using the guidelines articulated in the *DND Costing Handbook Second Edition, 2006*.

Subject-matter experts developed an agreement around the likelihood of each risk occurring. The maximum value for the risk was calculated from the sensitivity analysis described in the previous sections of this report. The expected value of the risk exposure to the acquisition cost estimate was $1,550 million, calculated as shown in Table 4.

Contingency Tables	Max Impact $Million	Mid-Point of Likelihood Ranges	Expected Value $Million
Foreign Exchange	1,600	30%	480
Inflation	500	30%	150
Learning/Production	1,600	10%	160
Number of Aircraft	600	70% (note 1)	420
Other Acquisition Cost Risks	n/a	n/a	340
Total	**4,300**		**1,550**

Note 1: Given the current fiscal constraints in the post financial crisis environment and the potential impact on the timing and quantity of partner nation's orders, the subject matter expert group rated the likelihood of this risk at 70%, up from 50% in the previous report.

Table 4: Contingency on Acquisition

Contingency on Sustainment: The expected value for contingency on sustainment is $3,496 million, as shown in Table 5.

Contingency Tables	Max Impact $M	Mid-Point of Likelihood Ranges	Expected Value $M
Foreign Exchange	2,100	30%	630
Inflation	3,100	50%	1,550
Prudence factor	N/A	N/A	1,316
Total	**5,200**		**3,496**

Table 5: 2013 Contingency on Sustainment

The DND Cost Risk Committee reviewed last year's sustainment risk assessment and concluded that the updated inflation forecast in this year's estimate reflects lower than anticipated rates for sustainment inflation. They recommended an increase to the likelihood factor from 30% to 50%, resulting in an increase in the contingency provision.

In addition, the F-35 Joint Program Office sustainment estimate has not been independently reviewed by CAPE, giving us less certainty than we had in 2012 when the sustainment cost estimate was reviewed by CAPE. As a result, National Defence has added a prudence factor of $1.3B to the provision for contingency in Table 5. This prudence factor represents over 11% of the base sustainment cost estimate, providing considerable flexibility should the CAPE review result in an estimate that is higher than the F-35 Joint Program Office's. Contingency for sustainment now stands at 30% of the estimated cost and is entirely within the recommended provision (20% to 40%) in the KPMG Life-Cycle Costing Framework.

Contingency on Operating: Contingency was not calculated for operating costs. Operating costs have been calculated using current CF-18 expenditures as a substitute. CF-18 expenditures are funded from National Defence's Parliamentary approved annual appropriation and are therefore included in the Department's reference levels. National Defence considers the operating cost estimate as a budget ceiling; future F-35A operations will be designed to respect the budget. As a result, a provision for contingency is not required.

Contingency on Disposal: Disposal contingency was calculated using the guidelines articulated in the Costing Handbook Second Edition, 2006 DND. The estimate has been updated from 2012 and is based on a study for the CF-18 fleet and within the standard 15%-30% contingency level for this type of estimate. Considering the timing of disposal and implied foreign exchange and inflation effect, the high end of the range (30%) has been applied.

Summary: Table 6 shows the total contingency amount for all phases in the life-cycle costing – from development to disposal. The data for Table 6 are derived from the application of the methods discussed above.

		Recommended	Resulting Rate	Available		
Phase	**LCC Estimate Without Contingency $M**	**Amount $M**	**Rate**	**Ceiling $M**	**Shortfall $M**	**Mitigation Strategy for Shortfall**
Development	527	79	15%	79	0	n/a
Acquisition	8,648	1,550	18%	342	(1,208)	Reduce number of jets purchased
Sustainment	11,559	3,496	30%	3,496	0	n/a
Operating	19,857	0	0%	0	0	n/a
Disposal	129	39	30%	39	0	n/a
Total	**40,720**	**5,164**	**13%**	**3,956**	**(1,208)**	**n/a**

Table 6: Contingency Summary

The table also displays the contingency amount that has been capped. The difference between the recommended contingency and the established expenditure ceiling constitutes a contingency shortfall of approximately $1.2 billion.

If the full available acquisition contingency was required, the remaining shortfall would be met by buying fewer aircraft.

VI. Cost Analysis

The following sections discuss affordability of the program, and compare the 2013 estimate to that reported in December 2012.

1. Affordability

National Defence has a long-term (20-year) budget which is updated periodically. The next version of this long-term budget, scheduled for presentation to Treasury Board in 2013, will include the latest estimate for replacing the CF-18 fighter fleet. Replacement of the CF-18 fleet is one of the keystones of the *Canada First* Defence Strategy, and the F-35 remains one of the Government's options.

Any option moving forward will be informed by the Government's $9 billion acquisition cap to acquire next generation fighter aircraft to replace the existing fleet of CF-18s. Should the Government decide to proceed with the purchase of 65 F-35A aircraft, it is forecast that the one-time acquisition cost is currently affordable within the $9 billion Canadian funding envelope.

The estimated sustainment cost for the F-35A is also affordable within the Department's long-term budget prorated over the entire life cycle of the fleet. To the extent that the sustainment costs could rise beyond the Department's long-term budget, despite the substantial contingency allowances built into the estimate, the Department will manage pressures through adjustments to the use of the aircraft and/or adjustments to the long-term budget.

The Department currently has an annual budget for operating the CF-18 aircraft which is funded from National Defence’s Parliamentary approved annual appropriation. The operating cost estimate for the CF-18 has been used as an analog for the operating costs of the F-35A. The current estimate, as independently reviewed by Raymond Chabot Grant Thornton is affordable within the Department's long-term budget. Should F-35 fleet operating costs be higher than expected, the Department has the ability to manage the costs through altering fleet operations or reallocating funds within its annual budget.

Cost estimates for a fighter capability will continue to be informed by the independently developed Life-Cycle Cost Framework that was commissioned by the Treasury Board Secretariat. To the extent possible, this same framework will be used to develop life-cycle cost estimates for other aircraft under consideration to replace the CF-18.

2. Cost Reports Comparisons

The 2012 and 2013 estimates are both based on the KPMG Life-Cycle Cost Framework and use a similar cost breakdown structure. The variance between the 2013 and 2012 Annual Updates are summarized in Table 7. An explanation

of the main factors behind the variance can be found immediately following Table 7.

Life Cycle Phase	Cost Element	2012 (millions)	2013 (millions)	Cost Variance
Development	Development	491	527	36
	Contingency	74	79	5
Development Total		**565**	**606**	**41**
Acquisition	URF	5,992	6,187	195
	Concurrency Modifications	n/a	24	24
	DMS	n/a	70	70
	Ancillary	246	258	12
	Sustainment Set-up	1,154	1,068	-86
	Initial Spares	259	236	-23
	Reprogramming Lab	216	219	3
	Infrastructure	244	244	0
	Ammunition	52	59	7
	Initial Training	65	116	51
	Project Management Office	120	123	3
	Other	40	44	4
	Contingency	602	342	-260
Acquisition Total		**8,990**	**8,990**	**0**
Sustainment	Unit Level Consumption	5,357	4,818	-539
	Depot Maintenance	791	773	-18
	Contractor Support	1,979	2,115	136
	Sustaining and Other Support	5,163	3,853	-1310
	Contingency	1,950	3,496	1546
Sustainment Total		**15,240**	**15,055**	**-185**
Operating	Personnel	10,257	10,598	341
	Operating	9,703	9,259	-444
Operating Total		**19,960**	**19,857**	**-103**
Disposal	Disposal	43	129	86
	Contingency	22	39	17
Disposal Total		**65**	**168**	**103**
Full Program Life-Cycle Cost Estimate		**44,820**	**44,676**	**-144**
Attrition Replacement		**982**	**1,015**	**33**
		45,802	**45,691**	**-111**

Table 7: 2013 versus 2012 Cost Estimate

Development ($41M):

- The cost estimate was increased by $36M, which is largely due to updated foreign exchange and inflation factors. The $5M increase in contingency is result of the application of the 15% factor on the increased development costs.

Acquisition ($0M):

- URF increased by $195M. Of this, $94M is due to changes to partners buy profiles, resulting in Canada's current buy profile to commence prior to the lowest-cost production years. The remainder of the variance is primarily due to revised foreign exchange forecast.

- The addition of two new cost elements ($94M):

    - Concurrency Modifications ($24M): This cost results from the concurrent design and production cycles. It represents the cost to retrofit early production aircraft to meet the final design standard.

    - Diminishing Manufacturing Sources (DMS) ($70M). The re-design portion of this cost element is not expected to offset future URF costs and is therefore included in the estimate.

- Ancillary, Sustainment Set-up, Initial Spares and Reprogramming Lab decreased by (-$94M): These cost items have been updated to reflect ongoing refinements to the F-35 Joint Program Office cost estimates as the project matures. These items have been updated to reflect the latest foreign exchange and inflation forecasts.

- Initial Training ($51M): The initial training cost estimate methodology has been updated by the F-35 Joint Program Office. Further fluctuations in this cost estimate are expected as the training concept continues to mature.

- Infrastructure, Ammunition, PMO and Other ($14M): These items reflect ongoing refinements to the Canadian based cost estimates, as well as the latest DND Cost Factors Manual and Economic Model.

- Contingency (-$260M): Contingency has been adjusted to reflect the remaining available space under the $9B cap for acquisition.

Sustainment (-$185M):

- Reduction in overall estimate (-$1,731M): The reduction is due to updated source data from the F-35 Joint Program Office and Canadian sources, refined cost estimating relationships, updated F-35 Joint Program Office

planning assumptions, as well as updated inflation and foreign exchange rates.

- Contingency (+$1,546M): A review by the DND Cost Risk Committee concluded that the updated inflation forecast in this year's estimate reflect lower than anticipated inflation rates for sustainment, and recommended an increase to the likelihood factor on sustainment inflation from 30% to 50%. This results in an increase in the contingency provision. Additionally, as the F-35 Joint Program Office sustainment estimate has not been independently reviewed, DND has increased contingency to compensate for the inherent increase in uncertainty. Overall, sustainment contingency continues to align with the KPMG Life-Cycle Costing Framework.

Operating (-$103M):

- Personnel ($341M): The cost increase results from an update of the source data to FY 12-13 reflecting current pay levels, unit establishments and updated inflation rates.

- Operating (-$444M): The cost decrease results from an update of the source data to FY 12-13 which revised the cost attribution of support costs. Additionally the fuel cost model was adjusted to account for the variance in fuel prices between Cold Lake and Bagotville as well as updated inflation rates.

Disposal ($103M):

- Disposal ($86M): The cost increase in Disposal costs reflects the impact of a change of cost estimating methodology. Previously the estimate was based on a 1997 US Government Accountability Office study. Defence now has a preliminary disposal plan for the CF-18 fleet. The CF-18 disposal plan is now used as an analogy for the eventual disposal costs of a new fleet.

- Contingency ($17M): Contingency has been set to 30% to reflect the rough order of magnitude nature of using the CF-18 disposal estimate as an analogy.

Attrition ($33M)

- The change to attrition cost is due to the combined effect of the current URF cost projections and updated foreign exchange and inflation factors.

VII. Conclusion

This second Annual Update provides the revised cost estimates of the F-35A, as called for in the Government's Seven-Point Plan, based on the application of the Life-Cycle Cost Framework developed by KPMG in November 2012 using international best practices, and reported in December 2012.

These revised estimates, and the assumptions underlying them, were reviewed by Raymond Chabot Grant Thornton, an independent third party in keeping with one of the points under the Seven-Point Plan.

The current program life-cycle cost estimate of $44,676 million (Canadian budget year dollars) represents a decrease of $144 million (0.3%) since the 2012 Annual Update. This report explains how and why current cost estimates differ from those reported in December 2012.

The current estimate includes $342 million for acquisition contingency, a reduction of $260 million since the 2012 Annual Update, and $3,496 million for sustainment contingency, an increase of $1,546 million. While these provisions fall within the range recommended in the November 2012 KPMG Framework, the provision for acquisition contingency could be considered low for a project of this scope and size. As a result, any option moving forward will be informed by the Government's $9 billion acquisition cap to acquire next generation fighter aircraft to replace the existing fleet of CF-18s.

National Defence remains committed to updating Parliament on these estimates and to providing the Government of Canada with appropriate information to make an informed decision on sustaining Canada's fighter capability. Planning assumptions and the associated estimates will continue to be refined in future annual updates.