

# The Plane That Ate the Canadian Military

Life-Cycle Cost of F-35 Fleet  
Could Reach \$126 Billion

Michael Byers





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# The Plane That Ate the Canadian Military

Life-Cycle Cost of F-35 Fleet Could Reach \$126 Billion

I hope no one is assessing [the F-35 procurement] as low risk.

– Auditor General Sheila Fraser, October 2010<sup>1</sup>

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## Summary

The Harper government anticipates a total project cost of \$45.69 billion for a fleet of 65 F-35s, including an operating cost of \$19.857 billion. However, those figures are based on the operating cost of CF-18s rather than the actual operating cost of F-35s. Information on the latter is readily available from the U.S. government. ***The actual operating cost of a fleet of F-35s would be \$29.786 billion, leading to a total project cost of \$55.619 billion.***

The Harper government has also failed to acknowledge the considerable “cost risks and uncertainty” associated with a fleet of F-35s — risks that are amplified by the developmental character and the unusually high operating and sustainment costs of these particular aircraft. ***Once “cost risks and uncertainty” are taken into account, the total project cost of a fleet of F-35s could be as high as \$126 billion.***

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## 1. Introduction

In August 2013, the Department of National Defence (DND) released the “Next Generation Fighter Capability Annual Update” (“DND Update”).<sup>2</sup> The DND Update anticipates a total project cost of \$45.69 billion for a fleet of 65 F-35s, including an operating cost of \$19.857 billion. The DND Update does not provide any information on the cost of aircraft other than the F-35.

Moreover, the DND Update makes the mistake of using the operating cost of CF-18s to project, on a dollar-to-dollar basis, the operating cost of F-35s. In fact, the operating cost of CF-18s is approximately one-third *less* than the operating cost of F-35s (as projected by the U.S. government).<sup>3</sup>

The actual operating cost of a fleet of F-35s would be \$29.786 billion, leading to a total project cost of \$55.619 billion. In other words, correcting just this error adds approximately \$10 billion to the total project cost of a Canadian fleet of F-35s.

The Harper government has also failed to include a number of other costs, including the full cost of munitions as well as the cost of modifying Canada’s mid-air refuelling fleet and adding drag chutes to the F-35s to enable them to use Arctic runways. Together, these costs add \$1.055 billion, bringing the total project cost (including the actual operating cost) to \$56.674 billion.

Last but not least, the Harper government has failed to acknowledge the considerable “cost risks and uncertainty” associated with a fleet of F-35s. Some of these risks would apply to any model of aircraft, but they are amplified because the F-35 is still under development and has higher operating and sustainment costs than alternative aircraft. As this report demonstrates, higher operating and sustainment costs make the F-35 especially vulnerable to changes in exchange rate, inflation, cost of aviation fuel, and yearly flying rate.

This report builds upon a section on “cost risks and uncertainty” in the DND Update. Specifically, it extrapolates DND’s information and analysis into two entirely possible “moderate” and “serious” scenarios.

It is important to realize that neither of the scenarios even approaches a “worst-case” scenario, which might involve — for example — a 60-cent dollar, 10 percent inflation rate, and \$3/litre aviation fuel. But they do demonstrate how an accumulation of much smaller changes could easily cause the cost of an F-35 procurement to more than double.

It is also important to realize that the greatly increased costs resulting from the accumulation of small changes in the “moderate” and “serious” scenarios could just as easily result from a single large change to a single

factor, such as the exchange rate or inflation rate, within the historic parameters of a 60-cent dollar or 10 percent inflation rate.

“Cost risks and sensitivity” are exceedingly important when planning a procurement that will stretch over more than a decade and involve many billions of tax dollars. Of course, cost sensitivities can also lead to positive outcomes, such as better exchange rates and lower inflation, that would result in a lower overall project cost. However, from a planning perspective it is more sagacious to assess and guard against negative risk. “Cost risks and sensitivity” take on even greater importance in light of reports that the Harper government is postponing the decision on the replacement of Canada’s CF-18s until after 2015, which would stretch the time frame for the procurement further.<sup>4</sup>

A line-by-line explanation of the financial implications of this report’s “moderate” and “serious” scenarios is provided in Appendix II. But the bottom line is this: ***Once actual operating cost and “cost risks and uncertainty” are taken into account, a fleet of F-35s could cost \$126 billion. That is \$81 billion more than the \$45 billion currently projected by the Harper government.***

An additional \$81 billion in unplanned cost could destroy the Canadian military, which would be forced to carry most of that cost through reduced expenditures on other equipment, maintenance, infrastructure, salaries and training. Even the “moderate” scenario, which carries an additional \$45 billion in unplanned cost, would have profoundly negative, across-the-board impacts on the men and women who serve.

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## 2. History

The cost of F-35s first became an issue in July 2010 when the Harper government announced it would purchase 65 of the aircraft for \$9 billion, with \$7 billion in maintenance cost bringing the total cost to \$16 billion over a 20-year period.<sup>5</sup>

In March 2011, the Parliamentary Budget Office (PBO) released a report examining the increasing weight of fighter jets and the cost-per-pound of their production. These historic trends were then used to estimate a total project cost of \$29.3 billion for the F-35s.<sup>6</sup> The PBO number includes \$11.4 billion in acquisition cost and \$17.9 billion in sustainment cost and upgrades over a 30-year period — a decade longer than the period used by the Harper government in July 2010.

The Harper government responded harshly to the PBO report, with MP Laurie Hawn, then Parliamentary Secretary to the Minister of National Defence, dismissing the analysis as “speculative” and “illogical”.<sup>7</sup> Two weeks later, the government’s refusal to provide Parliament with details about the cost of F-35s contributed to its defeat in a non-confidence vote.<sup>8</sup>

In April 2012, Auditor General Michael Ferguson produced a report that criticised DND for having failed to “exercise due diligence in managing the process to replace the CF-18 jets.”<sup>9</sup> He concluded: “Full life-cycle costs were understated in the estimates provided to support the government’s 2010 decision to buy the F-35. Some costs were not fully provided to parliamentarians.” More specifically, the Auditor General found that the Harper government had been operating with two numbers: citing a number of \$14.7 billion when responding to the 2011 PBO report publicly, while using a number of \$25.1 billion internally. Finally, he noted that the Harper government had chosen not to include operating cost in its public estimate, despite this information being specifically required by DND and the Treasury Board, and requested by Parliament in 2010.

The Harper government responded to the Auditor General’s report by suspending the F-35 procurement, ordering the Royal Canadian Air Force (RCAF) to conduct an “options analysis” re-evaluating the F-35 and alternative aircraft, and setting a \$9 billion limit for the acquisition cost.<sup>10</sup> An “Independent Review Panel” was established and tasked with overseeing the RCAF report.<sup>11</sup>

The Harper government also commissioned accounting firm KPMG to clarify the cost of an F-35 procurement. In November 2012, the firm released “Next Generation Fighter Capability: Independent Review of Life Cycle Cost” (“KPMG Review”). The KPMG Review projects a 30-year life-cycle cost of \$45.8 billion, including \$982 million for “attrition”, i.e. the replacement of aircraft lost through accidents.<sup>12</sup> It also includes an operating cost for the F-35s, though it bases this cost on the operating cost of Canada’s existing fleet of CF-18s.

The DND Update, released in August 2013, applies the KPMG methodology and 30-year time frame to the full life-cycle cost of the F-35s.<sup>13</sup> Like the KPMG Review, the DND Update bases the operating cost of the F-35 on the operating cost of the CF-18. The DND Update then estimates the total project cost of the F-35s at \$45.6 billion, including \$1 billion for attrition.

Significantly, the DND Update includes a section on “cost risks and uncertainty” that examines some of the cost sensitivities involved in the possible purchase of F-35s, such as changes in the Canada-U.S. exchange rate,



inflation rate, cost of aviation fuel, yearly flying rate, and rate of aircraft production by Lockheed Martin.

The present report addresses the actual operating cost of F-35s as well as several other costs overlooked in the DND Update. It also extrapolates from the DND Update's tentative foray into "cost risks and uncertainty", extending its information and analysis into "moderate" and "serious" scenarios. The two scenarios involve entirely possible circumstances that are far from "worst-case". Yet they are sufficient to raise serious questions about the wisdom and financial feasibility of an F-35 procurement, as well as the Harper government's lack of attention to substantial financial risks.

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### **3. Operating and Other Costs Not Acknowledged by DND**

#### **(a) Actual Operating Cost of F-35s**

The 2012 Auditor General's report, the 2013 KPMG Review and the 2013 DND Update all assume that the operating cost of F-35s will be the same as that of CF-18s. For example, the KPMG Review states that the operating data used for the calculation of F-35 operating cost "is based on CF-18 data and, in most cases, it has not been normalized/adjusted to reflect F-35 differences."<sup>14</sup> It further states — presumably relying on Lockheed Martin's early projections that the operating cost of the F-35 would be lower than that of the aircraft it would replace — that "based on the nature of these adjustments and DND's preliminary analysis, the adjustments would likely reduce the operating cost estimate."<sup>15</sup>

The DND Update explains that:

The operating cost estimate for the CF-18 has been used as an analog for the operating costs of the F-35A.... 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.<sup>16</sup>

The use of the CF-18 operating cost is fanciful. Although the F-35 was originally expected to have lower sustainment and operating costs than legacy aircraft like the CF-18, the costs based on evidence to date have become significantly higher than those of legacy aircraft, including the CF-18.

In 2011, the U.S. Government Accountability Office (GAO) wrote:

Current JSF [Joint Strike Fighter or F-35] life-cycle cost estimates are considerably higher than the legacy aircraft it will replace; this has major im-

plications for future demands on military operating and support budgets and plans for recapitalizing fighter forces.<sup>17</sup>

More recently, the U.S. GAO identifies a cost of US\$35,200 per flying hour for the F-35.<sup>18</sup> Similarly, the U.S. Department of Defense's latest "Selected Acquisition Report" for the F-35 identifies a cost of US\$31,900 per flying hour.<sup>19</sup>

In comparison, the latest "Selected Acquisition Report" for the Boeing Super Hornet enables one to identify an operating cost of US\$15,600 per hour for that aircraft<sup>20</sup> – based on an annual cost in 2000 dollars, divided by flying time, and then converted to 2012 dollars.<sup>21</sup>

Boeing, which also manufactured the CF-18, told the CBC in 2013 that Super Hornets are 25 percent less expensive to operate than CF-18s.<sup>22</sup> By extrapolation, this means CF-18s cost approximately US\$20,800 per flying hour to operate. In 2012, MP Laurie Hawn, a former CF-18 squadron commander and Parliamentary Secretary to the Minister of National Defence, told the Hill Times that the CF-18 operating cost is approximately \$19,000 per flying hour.<sup>23</sup>

The 25 percent difference in operating cost between the Super Hornet and the CF-18 makes sense given that the CF-18s are at the very end of their lifespan and in need of more day-to-day maintenance.

The present report multiplies the DND Update's number for the operating cost of an F-35 fleet (i.e. the operating cost of the existing CF-18 fleet) by 1.5 to provide a more realistic estimate; one that is based on the roughly 2-to-3 ratio of CF-18 to F-35 operating cost identified above. The resulting estimate – \$31,200 per hour – is still conservative, compared to the US\$35,200 from the U.S. GAO and the US\$31,900 from the U.S. Department of Defence.

Moreover, even the U.S. numbers for the operating cost of the F-35 could be low, given the serious, ongoing uncertainties concerning new stealth materials and complex computing – including 24 million lines of code, fused sensors, and a head-up display helmet.

## **(b) Munitions**

Initially, DND anticipated spending \$270–300 million on weapons and bombs to equip a fleet of F-35s.<sup>24</sup> But in 2013, that amount was reduced to \$52 million, with the DND Update stating:

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.<sup>25</sup>

The approach taken in the DND Update is misleading. Any weapons that foreseeably need to be acquired for the F-35s during their operational life-span should be included within the total life-cycle cost of the fleet rather than treated as separate projects. For this reason, this report uses the low end of DND's initial estimate for weapons (\$270 million), which, after deducting the current estimate of \$52 million, results in the addition of \$218 million to the tabulations below.

### **(c) Refuelling Modifications**

In September 2012, a briefing note prepared for then Defence Minister Peter MacKay warned that the ability to refuel fighter jets in mid-air is “critical to the defence of Canada” and should be “closely linked” to the purchase of any replacement for the CF-18s.<sup>26</sup> Of all the possible replacements for the CF-18, the F-35 is the only aircraft that is incompatible with Canada's existing refuelling fleet.

According to Postmedia, which obtained the briefing note through an Access to Information request, DND previously indicated that it would cost \$420 million to modify Canada's refuelling fleet to make it compatible with the F-35.<sup>27</sup> This figure should therefore be included in the total life-cycle cost of an F-35 fleet. The alternatives that are sometimes invoked — relying on the U.S. Air Force or private companies to provide this essential service — can hardly be taken seriously.

### **(d) Drag Chute**

Canada's CF-18s are equipped with tail hooks that enable them to land on short and often icy runways at “Forward Operating Locations” such as Inuvik and Rankin Inlet. There is no tail hook on the F-35A, the version Canada has been planning to purchase, although tail hooks are standard on all the alternative aircraft. For this reason, both Canada and Norway would likely add a drag chute to the F-35A.<sup>28</sup> The actual cost of the drag chute is not yet known, and it is possible that Canada will simply adopt a design developed in Norway. But even just installing Norwegian designed drag chutes would

add to the life-cycle cost of Canada's fleet. For this reason, \$200 million has been added to the tabulations below.

### **(e) Computer Programming Facility**

If Canada chooses the F-35, it will pay one-third of a \$650 million computer programming facility for the software intensive aircraft.<sup>29</sup> The facility, which is already being developed by Britain and Australia with the participation of Canadian military officers, was the subject of a September 2012 briefing note written for then Associate Defence Minister Bernard Valcourt and obtained by David Pugliese of the Ottawa Citizen through an Access to Information request. As Pugliese points out, Canada's share of the cost "will be included in a submission to the Treasury Board for a new fighter aircraft once the government finishes its review of that purchase."<sup>30</sup> However, the programming facility would not be counted as part of the acquisition cost of the aircraft themselves, and therefore would not fall within the strictures of the Harper government's \$9 billion limit. Just as significantly, no such programming facility would be required for the other possible replacements for the CF-18s. For all these reasons, \$217 million (one-third of the \$650 million cost of the facility) has been added to the tabulations below.

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## **4. Acquisition Cost Sensitivities and Risk**

### **(a) Exchange Rate and Acquisition Cost**

The DND Update identifies an acquisition cost of \$8.99 billion, just under the limit of \$9 billion set by the Harper government. In achieving that number, it uses a long-run exchange rate of \$1 Canadian = \$0.92 U.S., which was the rate in May 2013.<sup>31</sup> At the same time, it acknowledges that:

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.

The DND Update explains that, if the Canadian dollar were valued at 78 cents per U.S. dollar, instead of 92 cents, this would add \$1.6 billion to the acquisition cost of an F-35 fleet.<sup>32</sup> This report uses the 78 cents per U.S. dollar exchange rate for its "serious" scenario estimate. For its "moderate" scen-

ario estimate, this report uses an exchange rate of 85 cents per U.S. dollar, which would add \$800 million to the acquisition cost.

### **(b) Inflation and Acquisition Cost**

The DND Update relies on May 2013 inflation data from the F-35 Joint Program Office in the United States and from the National Defence Economic Model in Canada. It explains that a 1 percent increase in the inflation rate would add approximately \$500 million to the acquisition cost of a fleet of F-35s.<sup>33</sup> It does not consider the possibility of higher increases in inflation.

Like exchange rates, inflation rates are unpredictable, especially for a purchase that will stretch over a decade. Although Canada has recently benefited from overall inflation rates of around 2 percent, inflation rates have exceeded 10 percent several times within the past fifty years.

Therefore, a 1 percent increase in inflation is a rather optimistic measure of risk. In this report, the “moderate” scenario uses a 2 percent increase that adds approximately \$1 billion to the acquisition cost. The “serious” scenario uses a 4 percent increase that adds approximately \$2 billion to the acquisition cost.

### **(c) Shifting of Some Development Cost from the U.S. to Canada**

The Harper government claims the U.S. government will pay almost all of the development cost of the F-35 — now over US\$55 billion — and that Canada would only pay the production cost of the planes acquired.<sup>34</sup> If so, U.S. taxpayers would effectively be providing Canadian taxpayers with a massive subsidy, which raises the question as to whether the U.S. Congress would tolerate this. The question is highly relevant because Canada would be purchasing the planes through the U.S. government, not directly from Lockheed Martin.

Moreover, if development problems were to extend into the period during which aircraft were being delivered to Canada, that development cost might be re-categorized as “sustainment cost” — adding to the numbers discussed in the section on sustainment cost below. If so, that added cost would not be subject to the protection the Harper government claims from the rising development cost of the F-35.

In this report, the “moderate” scenario assumes the Harper government is correct, and that no significant portion of the development cost would be shifted to Canada. However, the “serious” scenario foresees that a por-

tion of the development cost would be shifted to Canada. For the purposes of generating actual numbers, it assumes a relatively conservative amount of \$1.8 billion, or the equivalent of a 20 percent increase in the acquisition cost of an F-35 fleet.

#### **(d) Lower Than Expected “Learned and Production Efficiency” Factors**

A single F-35 currently costs \$170–180 million to produce.<sup>35</sup> However, the Harper government claims it could obtain each F-35 at the much lower cost of \$75 million, as the planes would be produced during a period of “peak efficiency”.<sup>36</sup> The reduction in actual per-plane cost is supposed to result from an incremental “learning effect” whereby experience accumulated by producing the same system year after year leads to efficiencies and reduced cost. However, the F-35 program is experiencing serious, ongoing problems with the airframe, head-up display helmet, and especially software that could limit – or at least delay – the cost reductions achieved through the learning effect.<sup>37</sup> Consequently, Canada could end up purchasing its aircraft while the production cost-per-plane is still significantly higher than the projected \$75 million.

Conceivably, Canada could delay purchasing F-35s until the price drops. However, doing so would risk a capability gap after the aging CF-18s are retired in 2020. Alternatively, it is possible that the lifespan of some of the CF-18s could be extended through further upgrades, though this too would be costly and would not address the growing risk of metal fatigue. In any event, every delay in replacing the CF-18s adds to the eventual acquisition cost of replacements through inflation. Delays combined with inflation (and inaccurate projections of inflation) have recently caused major problems in another Canadian military procurement, namely the Joint Support Ship project.<sup>38</sup>

The DND Update explains that just a 3 percent decrease in learning effect would increase the acquisition cost by approximately \$1.6 billion.<sup>39</sup> This report uses that 3 percent decrease (a \$1.6 billion cost increase) in its “moderate” scenario, doubling it to 6 percent and \$3.2 billion for its “serious” scenario.

#### **(e) Reduction in Overall Number of F-35s Ordered**

Per-plane acquisition cost depends on economies of scale, which differ from learning effect in being size-driven rather than time-driven.

The DND Update acknowledges that the United States and its allies have reduced the numbers of F-35s they are ordering, with possible cost conse-

quences for Canada: “[I]f 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.”<sup>40</sup> The DND Update assesses the maximum decrease in purchases at 250 aircraft, which would “result in an increase in the acquisition cost for Canada of approximately \$600 million.”<sup>41</sup>

However, the reduction in total orders could be larger. The United States has dramatically reduced the number of F-35s it is purchasing in the early years of the program, which could lead to a significant reduction in its planned total of 2,443 aircraft.<sup>42</sup> It bears remembering that only 187 of 750 originally planned F-22s were ever built, with the production line for the F-35’s sister aircraft shut down for budgetary reasons in 2009.<sup>43</sup>

The United Kingdom has indicated that it will purchase fewer than the 138 F-35s it originally planned, and some reports suggest it might only acquire 50 aircraft.<sup>44</sup> The Netherlands has gone from 85 to 37 aircraft and Italy from 131 to 90.<sup>45</sup> Denmark and Turkey have gone from decided purchasers to undecided potential purchasers.<sup>46</sup> Australia originally planned to purchase 100 F-35s, but then purchased 24 Super Hornets, which may well lead to a reduction in its F-35 order.<sup>47</sup> In April 2014, Australia announced the purchase of 58 F-35s, taking its total to 72 F-35s – still short of the 100 F-35s originally planned.<sup>48</sup>

The uncertainty is increased by the existence of some movement in the opposite direction, with South Korea announcing in March 2014 that it will purchase F-35s rather than Boeing F-15 Silent Eagles.<sup>49</sup> But only 40 F-35s will be bought, down one-third from an initially planned 60 aircraft.

This report, in its “moderate” scenario, uses the same 250-plane reduction that DND concluded would lead to an increase of \$600 million in the acquisition cost. In its “serious” scenario, this report uses a 500-plane reduction that would add \$1.2 billion to the acquisition cost.

#### **(f) Attrition Cost Should Be Included in Acquisition Cost**

Unlike every other national government involved in the F-35 program, the Harper government does not consider attrition cost to be part of the acquisition cost of a fleet of F-35s.<sup>50</sup> Its approach to this issue is contrary to the expert advice of DND’s research branch, Defence Research and Development Canada, which in 2011 predicted that some of the F-35s would be lost before all 65 of the aircraft could be delivered.<sup>51</sup> This means attrition planning

must be a necessary and integral part of achieving the minimum number of planes necessary for an operational fleet.

The DND Update follows the Harper government's approach of excluding attrition cost from acquisition cost, while noting that between 7 and 11 replacement aircraft would likely be required over the lifespan of any fleet, at an additional acquisition cost of approximately \$1 billion.<sup>52</sup>

This report follows the approach taken by the other countries, consistent with the advice from Defence Research and Development Canada. Attrition cost is a necessary and integral part of the acquisition – and, for this reason, this report subjects the \$1 billion attrition cost to the same extrapolations of financial risk as were applied to the initial 65 aircraft earlier in this section. This generates an additional cost of \$1 billion (total \$2 billion for attrition) for the “moderate” scenario and an additional cost of \$1.9 billion (total \$2.9 billion for attrition) for the “serious” scenario.

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## 5. Sustainment Cost Sensitivities and Risk

Sustainment cost includes the repair, modification and upgrading of aircraft over their operational lifespans. The DND Update identifies a sustainment cost of \$15.06 billion for an F-35 fleet. However, uncertainties concerning that sustainment cost pose substantial financial risks for Canada.

### (a) Exchange Rate and Sustainment Cost

The DND Update explains that an exchange rate of 78 cents would add \$2.1 billion to the sustainment cost.<sup>53</sup> This report uses an exchange rate of 78 cents in its “serious” scenario.

In its “moderate” scenario, this report uses an exchange rate of 85 cents that adds \$1.05 billion to the sustainment cost.

### (b) Inflation and Sustainment Cost

The DND Update explains that a 1 percent increase in inflation would increase the sustainment cost by almost \$3.1 billion over the 30-year life cycle of an F-35 fleet.<sup>54</sup> This report, in its “moderate” scenario, uses a 2 percent increase in inflation that adds \$6.2 billion to the sustainment cost. In its “serious” scenario, this report uses a 4 percent increase that adds \$12.4 billion to the sustainment cost.



### **(c) Yearly Flying Rate and Sustainment Cost**

The DND Update explains that the CF-18 fleet has a planned yearly flying rate of approximately 15,000 hours, and that the planned yearly flying rate of an F-35 fleet would be about 11,700 hours.<sup>55</sup> The lower number of hours is based on the assumption that more of the F-35 training will be done in simulators. But planning to park the planes may provide false economies. The F-35 development program already made the mistake of relying on computer simulation for much of the testing process, only to discover many unforeseen problems following actual flights.<sup>56</sup> Moreover, international tensions could easily lead to an increased training tempo or increased patrols, and therefore a higher yearly flying rate.

The DND Update explains that increasing the yearly flying rate by 4,000 hours would add approximately \$2 billion in sustainment cost.<sup>57</sup> This report uses an increase of 4,000 hours in its “serious” scenario. In its “moderate” scenario, this report uses an increase of 2,000 hours that adds approximately \$1 billion in sustainment cost.

### **(d) Technology Transfer and Sustainment Cost**

Lockheed Martin has already said that it would not provide Canada with access to all of the key technological information, such as software code, needed for repairing and upgrading the F-35.<sup>58</sup> The company could therefore take advantage of a monopoly position to impose an artificially high sustainment cost. Although it is impossible to estimate the amount that might be overcharged, it is noteworthy that Dassault has offered to transfer all of the technology involved in the Rafale if the French-made fighter jet is chosen to replace the CF-18.<sup>59</sup>

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## **6. Operating Cost Sensitivities and Risk**

Operating cost includes fuel, day-to-day maintenance, and salaries for pilots, mechanics, and other necessary personnel. The DND Update identifies an operating cost of \$19.857 billion for a fleet of F-35s. Section 3(a) of this report has already explained the discrepancy between that estimate and the actual operating cost of a fleet of F-35s. This section explains how cost sensitivities concerning the operating cost of the F-35 pose substantial financial risks for Canada.

### **(a) Inflation and Operating Cost**

The DND Update explains that a 1 percent increase in inflation over the life cycle of an F-35 fleet would add approximately \$5.4 billion to the operating cost.<sup>60</sup> This report, in its “moderate” scenario, uses a 2 percent increase in inflation that adds \$10.8 billion to the operating cost. In its “serious” scenario, this report uses a 4 percent increase in inflation that adds \$21.6 billion to the operating cost.

### **(b) Yearly Flying Rate and Operating Cost**

The DND Update explains that increasing the yearly flying rate by 4,000 hours would add \$1.5 billion to the operating cost over the life cycle of an F-35 fleet.<sup>61</sup> This report uses an increase in yearly flying rate of 4,000 hours in its “serious” scenario. In its “moderate” scenario, this report uses an increase in yearly flying rate of 2,000 hours that adds \$750 million to the operating cost.

### **(c) Price of Aviation Fuel and Operating Cost**

The DND Update assumes an average price of \$0.879 per litre for aviation fuel over a 30-year period, while noting that a 10 percent increase in that average price would add \$430 million to the operating cost.<sup>62</sup> Given the decreasing availability of conventional oil, increases of more than 10 percent seem likely over a 30-year period. Indeed, the price of aviation fuel has doubled in the last decade.<sup>63</sup> This report, in its “moderate” scenario, uses a 50 percent increase in the average price of aviation fuel that adds \$2.15 billion to the operating cost. In its “serious” scenario, this report uses a 100 percent increase in the average price of aviation fuel that adds \$4.3 billion to the operating cost.

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## **7. Contingency Planning Is Inadequate or Absent**

### **(a) Acquisition Cost and Contingency Planning**

The implications of cost sensitivities for the acquisition cost of a fleet of F-35s were discussed in Section 4 of this report. Under the “moderate” scenario, the total acquisition cost rises to \$12.99 billion, or \$200 million per plane.

Under the “serious” scenario, the total acquisition cost rises to \$18.79 billion, or \$289 million per plane.

As the DND Update explains, the Harper government’s only contingency plan for increases in acquisition cost involves a reduction in the number of planes purchased.<sup>64</sup> In other words, if the cost-per-plane rises, Canada will purchase fewer planes in order to stay within the \$9 billion acquisition limit.

DND originally sought 80 F-35s; the reduction to 65 aircraft occurred in 2010.<sup>65</sup> DND has repeatedly stated that 65 is the minimum number of fighter jets needed for an operationally capable fleet.<sup>66</sup> If Canada decides to purchase F-35s, the possible increases in acquisition cost identified in this report could force a future government to choose between exceeding the \$9 billion limit in order to buy 65 F-35s, or settling for a smaller, operationally incapable fleet.

***Under the “moderate” scenario developed here, Canada could only purchase 45 planes while staying under the \$9 billion limit. Under the “serious” scenario, Canada could purchase only 34 planes.***

### **(b) Sustainment Cost and Contingency Planning**

In August 2013, DND increased the contingency for sustainment cost to \$3.496 billion, but only to take into account additional uncertainties concerning sustainment cost projections produced by the F-35 Joint Program Office in the United States. The increased contingency does not address the considerable “cost risks and uncertainty” identified in this report. As a result, the only contingency measure available for these risks, within the limits of the DND Update’s cost projections, would be to sustain only a portion of the fleet. This would amount to a post-purchase reduction in fleet size.

### **(c) Operating Cost and Contingency Planning**

There is no contingency included in DND’s numbers for operating cost, with the plan being to avoid any cost overruns through a reduction in flying hours. However, taking such an approach to cost overruns of 250–350 percent would result in almost no flying. The Canadian Forces would, instead, have to pay for a substantial portion of the cost overruns through reduced expenditures on other equipment, maintenance, infrastructure, salaries and training.

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## 8. Recommendations

***This report demonstrates that the Harper government is understating the total project cost of a fleet of F-35s by \$11 billion, even without taking “cost risks and uncertainty” into account. Once “cost risks and uncertainty” are taken into account, the possible total project cost rises to \$90 billion in a “moderate” risk scenario and \$126 billion in a “serious” risk scenario.***

With this information now at hand, the Harper government should:

- Update its cost projection by including the actual operating cost of F-35s, the full cost of munitions, and the cost of modifying Canada’s mid-air refuelling fleet, adding drag chutes to the F-35s, and paying Canada’s share of the computer programming facility;
- Expand the Department of National Defence’s tentative 2013 foray into the “cost risks and uncertainty” associated with the F-35 by conducting the type of analysis carried out in this report;
- Conduct the same analysis of “cost risks and uncertainty” with regard to alternative aircraft;
- Make those analyses available for public scrutiny and debate in advance of any decision to acquire F-35s.

# Appendix I

## Operating and Other Actual Costs Not Acknowledged in DND Update

### **Operating Cost**

Operating cost (DND Update, based on CF-18 fleet): \$19.857 billion

*Actual operating cost of F-35 fleet (add \$9.929 billion, based on numbers from Boeing, MP Laurie Hawn, U.S. GAO & U.S. DOD): \$29.786 billion*

Total project cost (DND Update): \$45.69 billion

***Adjusted total project cost (including actual operating cost): \$55.619 billion***

### **Other Actual Costs Not Acknowledged in the DND Update**

Munitions (added life-cycle cost): \$0.218 billion

Modifying mid-air refuelling fleet: \$0.42 billion

Adding drag chute to F-35s: \$0.20 billion

Computer programming facility: \$0.217 billion

*Total additional actual costs not acknowledged in DND Update: \$1.055 billion*

Total project cost (DND update): \$45.69 billion

***Adjusted total project cost (including all actual costs): \$56.674 billion***

# Appendix II

## Cost Risks and Uncertainty in 'Moderate' and 'Serious' Scenarios

Note: All **bold** numbers are taken from the 2013 DND Update; all *italic* numbers are extrapolated from the calculations of risk in that same document.

### **Development Cost (DND Update; already paid) — \$0.606 billion**

### **Acquisition Cost (DND Update) — \$8.99 billion**

#### MODERATE SCENARIO:

85 cent dollar — adds *\$0.8 billion*

2 percent inflation increase — adds *\$1 billion*

3 percent decrease in learning and production efficiency — adds *\$1.6 billion*

Reduction of 250 planes in initial orders — adds *\$0.6 billion*

Total adjusted acquisition (moderate scenario) = *\$12.99 billion* (\$200 million per plane)

#### SERIOUS SCENARIO:

78 cent dollar — adds *\$1.6 billion*

4 percent inflation increase — adds *\$2 billion*

Some development cost imposed on Canada — adds *\$1.8 billion*

6 percent decrease in learning and production efficiency — adds *\$3.2 billion*

Reduction of 500 planes in initial orders — adds *\$1.2 billion*

Total adjusted acquisition (serious scenario) = *\$18.79 billion* (\$289 million per plane)

### **Sustainment Cost (DND Update) – \$15.055 billion**

#### MODERATE SCENARIO:

85 cent dollar – adds *\$1.05 billion*

2 percent inflation increase – adds *\$6.2 billion*

Increase yearly flying rate by 2,000 hours – adds *\$1 billion*

Total adjusted sustainment (moderate scenario) = *\$23.305 billion*

#### SERIOUS SCENARIO:

78 cent dollar – adds *\$2.1 billion*

4 percent inflation increase – adds *\$12.4 billion*

Increase yearly flying rate by 4,000 hours – adds *\$2 billion*

Total adjusted sustainment (serious scenario) = *\$31.555 billion*

### **Operating Cost (DND Update) – \$19.857 billion**

Note: \$19.857 billion is the operating cost of the CF-18 fleet, which needs to be multiplied by 1.5 to reflect the actual operating cost of an F-35 fleet. This provides an operating cost of *\$29.786 billion*, without any of the adjustments below.

#### MODERATE SCENARIO, STARTING WITH \$19.857 BILLION (CF-18 COST):

2 percent inflation increase – adds *\$10.8 billion*

Increase yearly flying rate by 2,000 hours – adds *\$0.75 billion*

50 percent increase in price of aviation fuel – adds *\$2.15 billion*

Total adjusted operating cost (moderate scenario) =

*\$33.557 billion* (adjusted CF-18 operating cost)  $\times$  1.5 = *\$50.336 billion*

#### SERIOUS SCENARIO, STARTING WITH \$19.857 BILLION (CF-18 COST):

4 percent inflation increase – adds *\$21.6 billion*

Increase yearly flying rate by 4,000 hours – adds *\$1.5 billion*

100 percent increase in price of aviation fuel – adds *\$4.3 billion*

Total adjusted operating cost (serious scenario) =

*\$47.257 billion* (adjusted CF-18 operating cost)  $\times$  1.5 = *\$70.886 billion*

**Disposal Cost at End of Aircraft Lifespan (DND Update) – \$0.168 billion**

ADDITIONAL ACTUAL COSTS NOT ACKNOWLEDGED IN DND UPDATE

Munitions (added life-cycle cost): *\$0.218 billion*

Modifying mid-air refuelling fleet: *\$0.42 billion*

Adding drag chute to F-35s: *\$0.20 billion*

Computer programming facility: *\$0.217 billion*

Total additional actual costs not acknowledged in DND Update:

*\$1.055 billion*

**Total Life-Cycle Cost (DND Update) – \$44.676 billion**

Adjusted Total Life-Cycle Cost (moderate scenario): *\$88.46 billion*

Adjusted Total Life-Cycle Cost (serious scenario): *\$123.06 billion*

**Attrition (DND Update) – \$1.015 billion**

Adjusted Attrition (moderate scenario): *\$2 billion*

Adjusted Attrition (serious scenario): *\$2.9 billion*

**Total Project Cost (DND Update) – \$45.69 billion**

Adjusted Total Project Cost (moderate scenario): *\$90.46 billion*

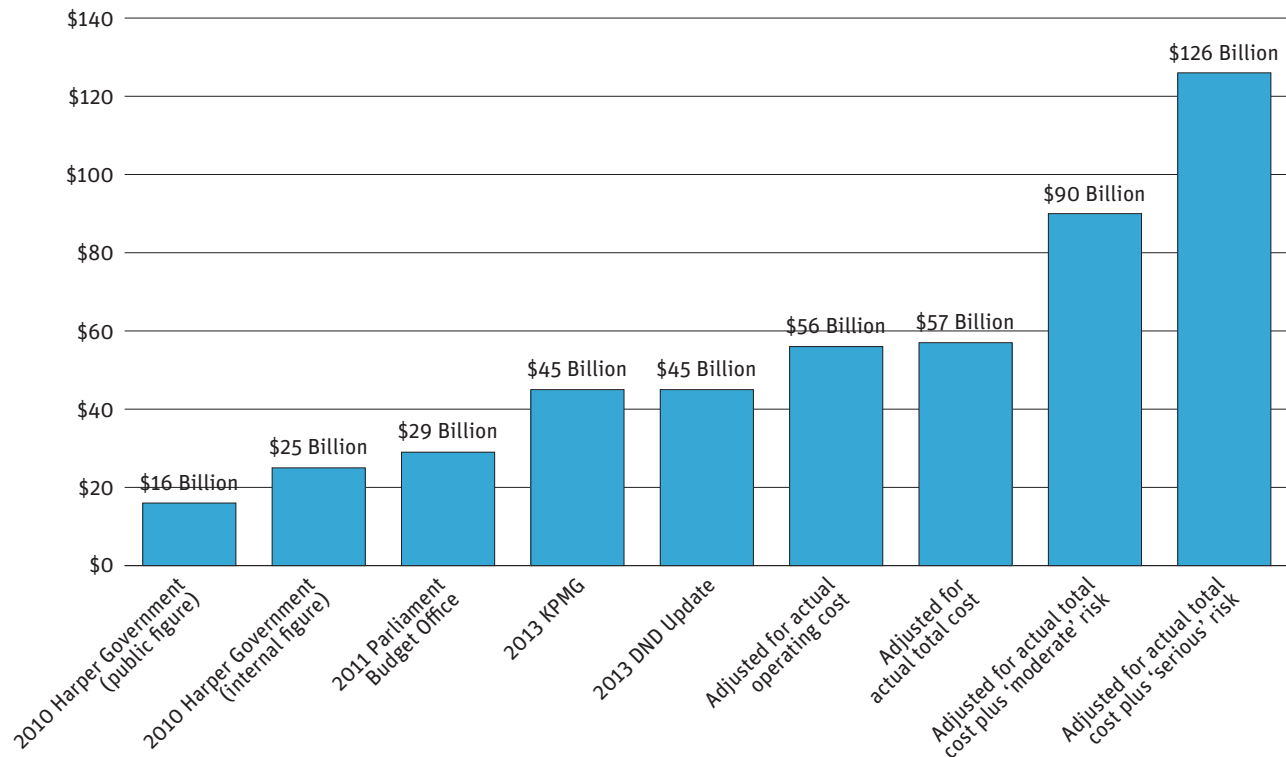
Adjusted Total Project Cost (serious scenario): *\$125.96 billion*



# Appendix III

## Total Project Cost Estimates for Canadian Fleet of F-35s

**FIGURE 1** Total Project Cost Estimates (Billions)



**Note** All figures rounded to nearest billion

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