By Andrew Mok

The latest round of cost increases and delays for the F-35 Joint Strike Fighter programme brings further ill tidings for the UK's replacement for the carrier-based Harrier: the F-35B. Last week, a report from the Pentagon to the Congress officially declared a critical "Nunn-McCurdy breach," which means that the average unit costs have grown more than 50% since 2002. Secretary of Defence Robert Gates told the Congress on March 30 that despite previous "overly rosy" cost estimates, he was confident the latest set of cost increases will also be the final ones. In the UK, the Chief of Defence Materiel, General Sir Kevin O'Donoghue, told the Commons Defence Committee that after 2015, F-35 deliveries "will come off quickly" in line with the completion of the new Queen Elizabeth class carriers. These assurances, however, seem very optimistic as well because of a high risk of further delays and cost overruns. Along with uncertainty about when the fighter will actually become operational, the rising costs mean the UK's MoD may wind up with less carrier-based fighters than originally planned. Or perhaps it may wind up with a different plane than the F-35B. And that could be quite a wise decision.

The story so far

The current development and design phase of the F-35 project began back in 2001 when the US, with 8 allies including the UK, selected Lockheed-Martin's design for its future strike fighter aircraft. The fighter will replace planes like the F-15, F-16, and F-18, and for the UK the Harrier jumpjet STOVL, the mainstay for the Royal Navy's aircraft carriers. Initially, the project was hailed as an industry first. It was touted for its extensive use of computer simulations for design and testing, supposed to cut time and costs, as well as the great bang-for-the-buck price for an advanced 5th-generation aircraft of around $50 million in 2002. It would also come in 3 variants (the conventional take-off F-35A, the short-takeoff-and-vertical landing F-35B similar to the Harrier, and the catapult-takeoff F-35C) with cost-saving common characteristics.

Since then, there have been several setbacks. After the Pentagon restructured the program in 2003 and 2007, total development costs had risen to $44.8 billion or 23% above original estimates, and are expected to surpass $49 billion in the next fiscal year. From 2007-2008, government auditors' estimates for the dates for the completion of development testing, where the aircraft is test-flown and its systems tried out before full production can begin in earnest, slipped from October 2012 to October 2013. Costs rose from an initial $69 million per aircraft to $82 million in 2004 and $104 million by December 2007, excluding sunken development costs. Particularly troublesome has been the F-35B short-take-off-and-vertical-landing (STOVL) variant, which Britain, along with the US Marines and Italy, plans to acquire.. The initial design proved too heavy, and the redesign to reduce weight was a significant factor in upping costs and causing delays. Last year, the Pentagon's attempt to cut funding for an alternative GE-Rolls-Royce engine, developed to reduce risk and keep costs down by ensuring competition for Pratt and Whitney one, generated much political controversy in Washington.

The new bad news

This year, the bad news continues. Using constant 2010 dollars, the Defense Department admitted in March that the F-35 per-unit cost rose from the targeted $59 million to $90 million now, an 80% increase! In the Government Accountability Office's (GAO) then-year dollars projections, the JSF unit costs have sprung from $69 million in 2001 to the current $112 million or from $81 to $131 million including R & D costs. Since then, new reports hint that April's revised estimates may rise to $134 million even without R & D costs.

What is the reason behind these increases? First, there have been problems with the aircraft's software, which involves even more lines of code than the state-of-the-art F-22 fighter. Then there are risks associated with simulated testing done in labs, once hailed as a ground-breaking innovation saving hours of expensive flight testing. Some labs, according to the GAO, are not yet accredited, which raises the need to revert to costlier flight tests. Flight tests, however, are facing delays already. Because of production problems, Lockheed had only delivered only 4 of a planned 13 test aircraft by the end of 2009, and the F-35 had completed a dismal 120 of 1431 planned flight tests last year. Development testing has also revealed technical issues related to engine heat and runway damage during take-off. These problems, while not insurmountable, have taken extra development time and money to solve.

Looming above these development problems is the "compressed" production schedule that leaves very little room for error. The February 2010 new Pentagon plans now plans to finish flight-testing in March 2015, with full production being possible by April 2016. However, even with additional resources being allocated to testing, government auditors expressed concerns about the ability to meet such a tight schedule with so much left to do. While defense officials have cut the next five years' buys by 120 aircraft to ease pressure on the production line, production will begin even before development testing, which is supposed to identify any design problems, is complete. Furthermore, current production projections assume that the required labor-hours to manufacture an F-35 will drop sharply as production line workers become more familiar with the process, saving time and money on future aircraft. However, required labour hours have not dropped as much as originally envisioned. This raises doubts about whether Lockheed can actually deliver 564 aircraft over the next 5 years.

As for political repercussions, it is highly unlikely that US lawmakers will discontinue funding the programme as a result of the cost growth and delays. As the only future combat aircraft for the US Air Force, Marine Corps, and Navy, the F-35 is indeed too big to fail. Despite Boeing's continued push for the Navy to procure more F-18 Super Hornets, these planes will only serve as stop-gap fighters until the carrier-based F-35B and C variants are delivered (Really?). However, continued appropriations in next year's defense budget will come at a political price. Secretary of Defense Robert Gates, who staked his case for terminating F-22 fighter production on the F-35, could find himself in political hot water. And of course, costs could continue to increase. If learning-curve savings do not materialize, the increased unit costs may force both US and partner countries to cut back on aircraft procured, which will further increase unit costs in a "death spiral" of fewer aircraft at more expensive unit prices.

And for the UK?

With a planned buy of over 100 F-35Bs and in a period of budget constraints, delays and cost growth will certainly impact upon UK procurement decisions for the Harrier replacement. First, the US Marines still plans to declare the F-35B operational in 2012, but the Pentagon and GAO state that aircraft testing will end by 2015 at the earliest, and that a decision to ramp up to full production will only come in April 2016. This of course optimistically assumes that no more delays are encountered from now on. Yet, if Lockheed Martin is already having trouble with assembling and delivering aircraft on time now, what will happen when it's time for full production, as the auditors worry?

Delays also mean that the MoD will have to spend even more funds to maintain and operate the ageing Harriers, and perhaps upgrade more Harriers to GR9 standard as stand-ins for delayed F-35s. MoD officials assured the Commons Defence Committee that the Harrier force will remain capable of flying until the end of the decade. However, just last December, the MoD also announced the early retirement of at least 1 Harrier squadron next year to make budget savings. Should the UK retire Harriers sooner but receive replacement F-35s later, and slower, the MoD may not have enough fighters to man the carriers in the coming decade in any meaningful way. Not having enough combat aircraft on its carriers will impair the UK's ability to project air power abroad. Officials have also claimed that JSF delays factored into their decision to delay the introduction of the new carrier(s), which the National Audit Office estimates will incur £674 million more in long-term costs.

Second, initial estimates of a 150 F-35 buy seem no longer plausible. At current estimates, a buy of 150 aircraft would require more than £11 billion. Without taking into account currency fluctuations the £10 billion presently allocated would procure approximately 136 aircraft. Including the UK's £2.5 billion contribution towards aircraft development, the unit cost would amount to £91 million, or $140 million, per UK F-35. In any case, "up to 150," the number given by the MoD for the Defence Committee's February report and still cited on the UK JSF industry webpage is no longer realistic without budget increases. Assuming that the new UK carriers will carry about 35-40 F-35Bs each, 136 is still enough for two embarked carrier air wings and a third readying for embarkation. Still, what would be interesting to know is if 150 F-35s was a minimum, optimal, or maximum number when originally proposed by defense planners and what reduced numbers would mean for the UK's expeditionary airpower capability.

Plan C?

So if the MoD does not wish to wind up with fewer fighters, is there another similar but cheaper aircraft? Perhaps. If the UK sticks to its vertical-landing requirement, the F-35B is the only 5th-gen STOVL aircraft available. However, the MoD could switch to a non-STOVL fighter, and a previous comparison by UKDF shows that these alternatives, in terms of range and payload capacity, would be more capable than the F-35B. Before selecting the F-35, the UK did consider a nasalized Euro fighter Typhoon. However, development of a naval Euro fighter will incur extra costs to strengthen the airframe and landing gear and add instrument aids for carrier landings. Such modifications may also add weight and reduce payload and range when all the R & D dust settles. The UK can also buy a readily available alternative to meet immediate capability needs. For instance, the Australian Defence Force is procuring 24 F-18 E/F Super Hornets until the F-35s become available. While the Super Hornet's airframe is not 5th generation, it offers some

key 5th-gen features such as advanced radars, and according to a study by US defense think tank RAND, it has superior agility with similar acceleration compared to the F-35. It would definitely represent a vast improvement over the shorter-range and lighter Harrier. And although operating a catapult-takeoff plane will increase cost risk and be a major change for the Fleet Air Arm, the new QE-class design is flexible, which could allow for the installation of catapults.

Another option is to purchase another variant of the F-35: the F-35C designed for catapult-assisted takeoff from a carrier. Reports that this was under consideration surfaced last fall. If the MoD could make the technically, and financially, courageous decision to transition to catapult-takeoff fighters, this option would be an improvement over the F-35B "jumpjet." To be sure, modifications to the QE-class flight deck design will be necessary and the Fleet Air Arm will have to make the transition to catapult instead of short-takeoff aircraft, which will take time and money. However, the UK would wind up with a cheaper, less complicated and more capable plane. The F-35C would cost less than the more technically complicated and troublesome STOVL B version. The B variant has proved the most troublesome, and heat problems revealed during testing show that significant risks to cost and schedule remain. Add to this the F-35C's longer range and larger payload capacity, not to mention a less complex engine, and switching to this variant starts sounding quite attractive. In any case, the most recent set of delays and cost overruns should make the MoD take a good, hard look at its options. From making do with fewer F-35Bs to purchasing a different, more effective plane, the UK needs some honest answers about expeditionary air-power requirements, capabilities, and costs. One thing is for certain: dithering until 2015 is not an option.