National Audit Office

REPORT BY THE COMPTROLLER AND AUDITOR GENERAL

HC 63
SESSION 2013-14

10 MAY 2013

Ministry of Defence

Carrier Strike: The 2012 reversion decision

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Ministry of Defence

Carrier Strike: The 2012 reversion decision

Report by the Comptroller and Auditor General

Ordered by the House of Commons
to be printed on 9 May 2013

This report has been prepared under Section 6 of the National Audit Act 1983 for presentation to the House of Commons in accordance with Section 9 of the Act

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8 May 2013

HC 63 London: The Stationery Office £16.00

This report examines the Ministry of Defence's delivery of Carrier Strike and the decision to revert to the short take-off and vertical landing of the Joint Strike Fighter.

Printed in the UK for The Stationery Office Limited on behalf of the Controller of Her Majesty's Stationery Office

2559526 05/13 PRCS

Contents

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This report can be found on the National Audit Office website at www.nao.org.uk/carrier-strike-2013

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Key facts

2020

planned in-service date of Carrier Strike after both the 2010 and 2012 decisions

£1.2bn

Department's estimate of cost savings, over the next ten years as a result of the 2012 reversion decision

150%

increase in the Department's 'cats and traps' cost estimate, since the 2010 Strategic Defence and Security Review

£0.6 billion	Department's estimate of cost savings, over the next 30 years as a result of the 2012 reversion decision. This halves the savings estimated over the first ten years, as the decision increases some costs between years 11 to 30
£74 million	Departmental estimate of the write-off of spend as a result of the 2012 reversion decision
55 per cent	increase in the Department's estimate to procure two aircraft carriers, between 2005 and 2012
100 per cent	increase in the estimated cost of each Joint Strike Fighter aircraft, between 2001 and 2012
3 years	delay (from 2020 to 2023) to the Department's planned carrier variant option delivery, arising between the 2010 and 2012 decisions
2 years	delay (from 2018 to 2020) to the Department's planned STOVL option delivery, arising between the 2010 and 2012 decisions
2 years	between the Department's planned STOVL option delivery (in 2020) and its current plans to deliver the third element of Carrier Strike – Crowsnest, a helicopter-based radar system (in 2022)

Summary

Context

1 Carrier Strike capability comprises the Queen Elizabeth Class aircraft carriers, the Joint Strike Fighter aircraft that operate from them and a helicopter-based radar system (known as 'Crowsnest'). The Ministry of Defence defines the principal role for Carrier Strike as being to provide an expeditionary offensive air capability to contribute to focused intervention, power projection and peace enforcement operations. Carrier Strike is an integral part of the Ministry of Defence's (the Department's) plan to build the force structures – known as Future Force 2020 – to meet the policy in the 2010 Strategic Defence and Security Review.[1]

2 The most important factor in planning the delivery of Carrier Strike is the choice of aircraft, as this affects much of the carriers' design. The Department judges that the Joint Strike Fighter, a US-led collaborative programme, is the only aircraft that can meet its operational needs. When it made the main investment decision on the carriers in 2007, the Department planned to procure the Short Take-Off and Vertical Landing (STOVL) variant of the aircraft, which can take off and land on the aircraft carriers unaided. As part of the 2010 Strategic Defence and Security Review the Department decided to procure the carrier variant of the Joint Strike Fighter. This required the ship to be fitted with launching equipment (catapults), and landing recovery equipment (arrestor gear) from the US.

3 We reported on the Department's decision to change to the carrier variant of the Joint Strike Fighter in two reports published in 2011[2] and concluded that:

> "The Strategic Defence and Security Review decision introduced significant levels of technical, cost and schedule uncertainty; thinking on the way the carriers will be used in operation is still evolving and there are major risks reconstituting Carrier Strike capability after a decade without it. We note that the Department will not have matured its understanding of the consequences of implementing the Review decision until two years after it was taken. At that point, it will more fully understand whether it has been able to develop delivery plans to enable it to achieve value for money from an investment in Carrier Strike which will significantly exceed £10 billion."

1 HM Government, *Securing Britain in an Age of Uncertainty: The Strategic Defence and Security Review*, October 2010.

2 Comptroller and Auditor General reports, *Carrier Strike,* Session 2010–2012, HC 1092, National Audit Office, July 2011 and *Carrier Strike: Supplementary Report*, Session 2010–2012, HC 1657, National Audit Office, November 2011.

4 On 10 May 2012, the Secretary of State for Defence announced[3] that the Department was reverting to procuring the STOVL variant of Joint Strike Fighter. This report examines how that decision was taken. It is in three parts:

- How the Department worked to understand the implications of the 2010 decision to procure the carrier variant of the Joint Strike Fighter – the Conversion Development Phase.
- The robustness and completeness of the information given to decision-makers.
- The risks to achieving the benefits anticipated by reverting to the STOVL.

5 The Department is continuing to negotiate with its commercial and international partners the necessary changes to the aircraft and carrier projects to reflect the 2012 reversion decision. Until this process concludes, the overall financial data underpinning the decision remains commercially sensitive. Our analysis in this report therefore focuses on how the Department understood and presented the differences between the carrier variant and STOVL options. Overall costs will be included in future Major Projects Reports.

Key findings

Conversion Development Phase

6 The October 2010 decision was based on immature data and a number of flawed assumptions, partly because the Department decided not to involve commercial and industrial partners in the process. The carrier variant option could not be delivered until 2023, three years later than thought; a delay the Chief of Defence Staff judged was unacceptable. The Department also found that, contrary to its expectations in 2010, there would be practical limitations to the warfighting interoperability with allies offered by the carrier variant option (paragraphs 1.4 and 2.10 to 2.14, and Figure 1).

7 By February 2012, the Department's conversion cost estimate had increased by 150 per cent, from £800 million to about £2 billion. These estimates were based on the Electromagnetic Aircraft Launch System (EMALS). The most significant cost increases occurred in late 2011 and early 2012, as the US provided updated information. The increases occurred after the Department had selected, in March 2011, the EMALS system over the steam-based system, which it estimated to cost £500 million. This steam-based estimate would probably also have increased, but the Department did not continue to develop it because it judged that EMALS offered a flexible, advanced capability with lower fatigue on aircraft launched; and that the steam option, due to obsolescence and integration issues, was not a viable alternative (paragraphs 1.5 to 1.9 and Figures 2 and 3).

3 Statement made by the Rt. Hon. Philip Hammond to the House of Commons, available at: www.parliament.uk/business/news/2012/may/statment-on-carrier-strike-capability/

8 Deciding the future of the Carrier Strike programme was central to the Department's efforts to balance its ten-year equipment budget. When the Department understood the implications of the 2010 decision, it acted quickly to create a unique, streamlined, approvals structure, with focused attention from senior officials. This was crucial to the pace of decision-making (paragraphs 1.10 and 1.11).

9 The Department expects to write-off approximately £74 million as a result of the reversion decision. This figure does not include the unquantified costs in the Department, the Armed Services and industry from the prolonged period of uncertainty arising from the 2010 decision. Making the reversion decision in May 2012 meant the Department did not spend £123 million to complete the conversion studies or have to make approximately £500 million of long-lead investments on the aircraft and carrier projects (paragraphs 1.12 to 1.14 and Figure 4).

Information for decision-makers

10 In May 2012, the Department gave decision-makers two options: to continue converting to the carrier variant, or revert to the STOVL variant. The Department did not present further options because it had not changed its view on the capability advantages of the Joint Strike Fighter variant options over alternative, cheaper but non-stealth aircraft. Similarly, it still believed that the alternative steam-based catapult and arrestor gear was not a viable option. The Department advised decision-makers to make a swift decision between the two options, to avoid the substantial increase in commitments to the carrier variant option outlined in paragraph 9 (paragraphs 2.1 to 2.2).

11 The Department's understanding of the differences between the two options was more mature than in October 2010, but there were still a number of uncertainties that it made clear to decision-makers. The Conversion Development Phase studies were not complete and the Department had ceased work to further understand the STOVL option. The Department made extensive use of its Cost Analysis and Assurance Service to provide independent challenge and to give confidence in its cost estimates. It is unlikely that, even cumulatively, the scale of any potential errors would have completely eroded the cost difference between the two options (paragraphs 2.4, 2.5 and 2.7 and Figure 5).

12 The Department estimated that over the next ten years the STOVL option would be £1.2 billion cheaper than the carrier variant. This difference halves to £600 million over 30 years. The short-term difference was largely due to the 150 per cent cost increase to install EMALS (rather than steam) on one carrier. Over 30 years the difference reduces because of the higher costs of the STOVL aircraft. The Department judged that the outstanding technical risks of the two variants were equal. This judgement has been borne out by developments since the decision in May 2012 (paragraphs 2.6 to 2.9 and Figures 5 and 6).

13 The Department's statement that it will accept a gap in its Deep and Persistent Offensive Capability (DPOC) is a key factor in the potential long-term cost advantage of the STOVL option. The carrier variant has a greater range and payload and would provide a more effective strike capability and meet the DPOC requirement in a way the STOVL cannot. The Department has stated that it will not seek to reinstate this requirement until it replaces Typhoon in the 2030s (paragraph 2.9).

14 The STOVL option offers some potential advantages but achieving these will depend on future funding and policy decisions. The capability differences between the two options are finely balanced and where the greatest advantage lies is a matter of military judgement, which we do not question. The STOVL option could be available in 2020, three years earlier than the carrier variant. Also, STOVL creates the option to operate Carrier Strike from the second carrier and provide a continuous capability. By contrast, the carrier variant could only operate from the one carrier installed with 'cats and traps'. It could therefore only provide capability 70 per cent of the time, owing to scheduled maintenance periods. Risks to both these potential advantages are set out in Part Three of this report (paragraphs 2.10 to 2.14).

Risks to delivery

15 The Department plans to deliver Carrier Strike by 2020; three years earlier than planned with the carrier variant option. After the reversion decision, on 14 May 2012, the Department announced that it had balanced its Equipment Plan 2012–2022. As part of this announcement, however, the Department delayed investment in the third key element of Carrier Strike – the Crowsnest airborne early warning system – which is now not scheduled to be fully operational until 2022. The Department has also delayed funding decisions on a number of other projects, such as its legacy Solid Support Shipping fleet, which will be required for Carrier Strike as well as the rest of the Royal Navy fleet (paragraphs 3.4 to 3.6).

16 The Department will also have to find money to bring the second carrier into operation. The STOVL option offers the potential advantage of operating Carrier Strike from both carriers. However, the Department currently still plans to build, but not operate, the second carrier. It has deferred identifying funding and making the decision to change this policy until the 2015 Strategic Defence and Security Review (paragraph 3.7).

17 There are risks to the timely delivery and the affordability of the Joint Strike Fighter over which the Department has limited control. The aircraft is being procured through a US-led collaborative programme. The production cost of the aircraft has not yet been finalised. Costs could increase further if other partner nations change the numbers of aircraft they buy, or the timing of their orders. There are technical risks from the concurrency of design and production and the amount of software. These issues are common between the variants. Testing is slipping and early production aircraft are likely to have less capability than planned (paragraphs 3.8 to 3.11 and Figures 8 and 9).

18 The highest risk phases of carrier construction and integration are yet to come. Success will depend on the Department negotiating revisions to the carrier contract and its wider maritime industrial agreements, and better incentivising its commercial partners and controlling subsequent risks and costs. These issues are common between the variants. We expect costs will increase from the £5.46 billion reported in the *Major Projects Report 2012*. The Department has budgeted for this (paragraphs 3.12 and 3.13).

19 The Department will have to actively manage technological risks to the cost-efficient delivery of Carrier Strike in adverse weather conditions. The STOVL variant is unable to land vertically on to a carrier in hot, humid and low pressure weather conditions without having to jettison heavy loads. The Department advised decision-makers of this risk but stated that it is confident that the solution it is developing, called Ship-borne Rolling Vertical Landing, will be ready by 2020 (paragraph 3.10).

20 The Department has improved its governance arrangements but risks remain. There is now a Senior Responsible Owner for Carrier Enabled Power Projection (of which Carrier Strike forms an integral part) with a clearer mandate and budgetary authority. There is also a full-time senior official accountable for Carrier Strike. However, Carrier Strike is a complex programme drawing upon both air and navy forces. Managing the potentially divergent views of both these services will be key to the successful delivery of the Carrier Strike capability (paragraphs 3.14 to 3.15).

Conclusion on value for money

21 When the Department realised the extent to which the 2010 decision had been underpinned by immature information and false assumptions it acted quickly to provide decision-makers with significantly improved information.

22 The single most important factor driving the timing of the 2012 reversion decision was the need to balance the ten-year defence equipment budget at the same time as the timely delivery of associated military capabilities.

23 In the longer term, to achieve value for money the Department must introduce a degree of consistency not previously apparent on the programme to work within the financial and capability assumptions which underpinned the reversion decision.

24 Key to realising value from its investment will be bringing the second carrier into operation and the delivery of Carrier Strike capability by 2020. However, successful and timely delivery of the capability will require the Department to manage significant affordability and technical challenges. There are cost, schedule and technical risks across the Joint Strike Fighter programme over which the Department has limited control. The highest risk phases of carrier construction and integration are yet to come and the Department must successfully conclude complicated negotiations with commercial partners before it can be confident it will deliver value for money on the carriers programme overall.

Part One

Conversion development phase

1.1 Following the October 2010 Strategic Defence and Security Review decision to procure the carrier variant of the Joint Strike Fighter, the Department planned an 18-month Conversion Development Phase which was due to end in December 2012. The purpose of the phase was to understand the risks and costs associated with converting a carrier to operate the carrier variant aircraft by installing catapults and arrestor gear.

1.2 The progress of the Conversion Development Phase was slow; with four separate decisions by the Investment Approvals Committee to release funding on an incremental basis. This cautious approach reflected concerns at senior levels about the maturity and cost of the work programme being proposed by the Carrier project team. The decision was prudent but meant it was difficult for industry to form an expert project team to conduct the work without a guaranteed work stream.

1.3 In the event, the Conversion Development Phase was not concluded and, on 10 May 2012, the Secretary of State for Defence announced the Department would revert to the STOVL variant of the Joint Strike Fighter. This part of the report examines how the Department matured its understanding of the implications of the Strategic Defence and Security Review decision and why it decided to end the Conversion Development Phase early.

The October 2010 decision was based on a number of erroneous assumptions

1.4 In October 2010, the Department's understanding of the costs and capabilities of the carrier variant option were immature.[4] **Figure 1** sets out the key weaknesses underpinning the Department's assumptions. The following paragraphs set out how the Department's forecast costs of converting a carrier to operate the carrier variant aircraft rose by 150 per cent to £2 billion in February 2012.

4 Comptroller and Auditor General, *Ministry of Defence*, *Carrier Strike*, Session 2010–2012, HC 1092, National Audit Office, 7 July 2011.

Figure 1

How the Department's understanding of the carrier variant option changed

	October 2010	May 2012
Overall affordability	Carrier variant option is affordable within the overall Defence budget.	Carrier variant option is not affordable without cancelling or delaying other capabilities.
Cost of conversion	£500 million to £800 million.	£2,000 million (paragraphs 1.5 to 1.9).
Timescales	Carrier Strike with the carrier variant planned for around 2020.	Conversion issues would delay carrier variant option until 2023. The Chief of Defence Staff judged that, in the emerging security environment, it would be undesirable to extend the gap in Carrier Strike capability beyond 2020. The Department estimated that the STOVL option should be operational by 2020. Part Three sets out risks to this timescale.
International collaboration	The carrier variant option and the installation of 'cats and traps' would allow US and French aircraft use of UK carriers and vice versa.	Limited interoperability regardless of the variant of the Joint Strike Fighter operated. All three countries use different weapons and there were security considerations operating from the French carrier. The Department therefore assessed that its strategic alliances, notably with the US, would be strengthened most by the STOVL option and its ability to use both UK carriers to provide continuous Carrier Strike capability.[1]
Investment decision timing	Work to investigate the cost of the option was planned to be complete by the end of 2012.	Reverting to STOVL after May 2012 would have meant additional nugatory costs of £679 million (see paragraph 1.14).

NOTES

1 The STOVL variant does not require the installation of catapults and arrestor gear which the Department had planned to install on only one aircraft carrier. This means the STOVL option will allow the use of both aircraft carriers for Carrier Strike capability (subject to future policy and affordability decisions covered in Part Three of this report) whereas the carrier variant could only have used one.

2 The cost of conversion is the cost of installing catapults and arrestor gear on to one aircraft carrier so that it can operate the carrier variant aircraft.

Source: National Audit Office analysis of departmental data

The estimated costs of conversion increased significantly

1.5 In 2010, the Department lacked technical information on equipment and system design and was therefore unable to accurately estimate the costs of installation on to its aircraft carriers. The greatest uncertainty surrounded the innovative Electromagnetic Aircraft Launch System (EMALS) which is being designed for the US military and the Department did not have immediate access to technical and cost details due to commercial and security restrictions.

1.6 The Department was more certain of the costs of steam-catapult technology which was well established, reliable and the risks were well understood. This technology provided the basis for the Department's lower cost estimate of £500 million. It would, however, have become obsolete during the life of the carriers. The production of steam to power the mechanism would also have required additional equipment being fitted on the carriers making installation more intrusive on the carrier infrastructure which could have led to an increase in the Department's cost estimate.

1.7 The EMALS technology would, on the other hand, potentially provide a much more controllable launch mechanism, capable of adapting to a range of aircraft. There were also potentially significant benefits in terms of the effect on the fatigue life of the aircraft being launched, as the load on the launching aircraft is much lower than with a steam catapult. In October 2010, the Department estimated the costs of EMALS to be £800 million.

1.8 In March 2011, the Department decided to focus its resources on developing a detailed understanding of the costs and risks of EMALS as its preferred option rather than the legacy steam-based system. In May 2011, the Department signed a contract with the US to provide the Department with access to data on the EMALS equipment, and installation and support requirements. **Figure 2** shows that the Department's estimate increased significantly in late 2011 and early 2012 as the US released updated cost information.

1.9 The Department's final EMALS cost estimate of £2 billion was 150 per cent more than its original EMALS-based estimate; which was, in turn, 60 per cent higher than the initial steam-based estimate. Further, this was only the latest estimate and, given that EMALS is an innovative technology, there was no guarantee that costs would not continue to increase. The scale of increase in the Department's cost estimate highlights the immaturity of all aspects of the estimates underpinning the Strategic Defence and Security Review decision (see **Figure 3** on page 14). In particular, excluding inflation, over half of the cost increases were for items for which there was no provision in the original estimate, such as Value Added Tax and the cost of the Conversion Development Phase. In some cases, notably the cost of design support from the United States and the Department's underestimation of the equipment required for safe operation, the scale of the potential costs only became clear in early 2012. In the latter case the number of aircraft carrier compartments the Department had estimated to be affected by the conversion increased by more than 600 per cent to nearly 500.

Figure 2

Cost estimates increased significantly following the release of revised cost information from the US in late 2011

Date	Event	Conversion cost estimate
October 2010	Strategic Defence and Security Review decision to procure the carrier variant.	£500–£800 million
March 2011	Estimate revised to include inflation and the cost of the Conversion Development Phase.	£950 million
	Decision to focus on developing the Electromagnetic Aircraft Launch System (EMALS) rather than the steam catapult.	
May 2011	Contract signed with US to provide the Department with access to data on the EMALS equipment, and installation and support requirements.	
December 2011	Estimate revised to include updated costs of installation, equipment and the inclusion of Value Added Tax on the US equipment.	£1,500 million
February 2012	Estimate revised following new information from US updating equipment costs and including the US design support costs for the first time.	£2,000 million

NOTE

1 The £2,000 million figure is higher than the £1,956 in Figure 5 because the latter is presented for investment decision purposes and therefore excludes sunk costs already spent on the Conversion Development Phase.

Source: National Audit Office analysis of departmental data

The speed of the Department's actions

1.10 Throughout 2011, the Department was making significant efforts to balance its ten-year equipment budget. Resolving the future of the Carrier Strike programme was a central element in the Department's deliberations and was the key driver of the May 2012 reversion decision. The issue became even more important as the costs of conversion rose significantly in December 2011.

1.11 The Department's regular investment approvals processes would not have enabled a decision to be taken within the relatively short timescales required. The Department therefore put in place a unique governance structure whereby only 15 senior departmental officials and ministers had sight of the information underpinning the decision. This streamlined approach, with focused attention from senior officials, was crucial to the pace of decision-making. Appendix Three shows who was involved.

Figure 3
Every element of the conversion cost increased significantly

Estimated cost (£m)	November 2010	February 2012	Reason for change
Equipment from the US	317	577	Original estimates assumed there would be greater savings by scaling down of the US carrier system from a four catapult system to the two required for the UK.
Technical assistance from the US	–	150	Original estimates did not include US technical assistance during the installation of the US equipment to the UK carrier.
UK VAT payable on items sourced from US	–	134	Original estimates assumed VAT would not apply but US national security considerations (not conclusively made clear to the Department until December 2011) required the use of the 'Foreign Military Sale' route which attracts VAT rather than the preferred direct procurement from the manufacturer.
Installation of equipment	569	675	Original estimates did not realise the extent of impact on the ship and the full cost involved for UK industry to install the equipment.
Testing and commissioning	–	63	Original estimates did not make any allowance for UK industry testing and commissioning which would be needed prior to operational delivery.
Conversion Development Phase	–	167	Original estimates did not include the costs required to plan and investigate the conversion of the carrier by the Department, and UK and US industries.
Inflation	–	234	Original estimates did not make any allowance for the cost of inflation and were stated in 2010 prices.
Total cost	**886**	**2,000**	

NOTES

1 No breakdown was produced for the October 2010 £800 million Strategic Defence and Security Review (SDSR) estimate. A breakdown was first produced in November 2010. Neither of these estimates took account of the cost of inflation.

2 The NAO estimate that inflation in the November 2010 estimate would have been around £100 million resulting in a total forecast cost of around £1,000 million at outturn cost. This estimate assumes a similar profile of spend as per the February 2012 estimate but with spending finishing earlier as per the plan from the SDSR.

3 The £2,000 million figure is higher than the £1,956 in Figure 5 because the latter is presented for investment decision purposes and therefore excludes sunk costs already spent on the Conversion Development Phase.

Source: National Audit Office analysis of departmental data

Nugatory expenditure

1.12 The Department expects to write-off approximately £74 million as a result of the reversion decision. This includes an estimate of £44 million for the cost of work performed on the Conversion Development Phase by both the US Department of Defense and the Aircraft Carrier Alliance. It also includes an allowance of £30 million for the work to replace STOVL specific items, such as the ramp, which had previously been removed from the carriers. The Department is working to reduce these estimated costs and final costs will not be confirmed until 2014 at the earliest as the Department's agreement with the US allows for reasonable rundown costs until that time.

1.13 This nugatory expenditure figure does not include the unquantified costs in industry from the prolonged period of uncertainty arising from the 2010 decision. Prior to the 2010 decision, the planned initial operating capability date for Carrier Strike was 2018. The Department is now planning on having an operational military capability with the same STOVL aircraft in 2020 representing a slip of two years. However, there is no counterfactual with which to accurately determine the extent to which slippage was inevitable. Final costs will be contingent on the mitigation of delivery risks and the outcome of the Department's renegotiation of the carriers contract and wider maritime agreement with industry.

1.14 When the Department originally began the Conversion Development Phase it did not understand the extent to which it would have to make long lead investments on the aircraft and carrier projects before the phase was due to end in December 2012. If the reversion decision had been taken after the conclusion of the full 18-month Conversion Development Phase as planned, nugatory costs could have been a further £679 million, making the total significantly higher at £753 million as shown in **Figure 4** overleaf. This spend would have wiped out the £592 million cost saving over 30 years associated with the STOVL option which is set out in Figure 6 in Part Two of this report.

Figure 4

Reverting to STOVL after May 2012 could have resulted in ten times more nugatory costs

Reason for nugatory costs (£m) as a result of reverting to STOVL		Decision date	
		May 2012	December 2012
Nugatory STOVL work	Work to replace STOVL specific items, such as the ramp, which had previously been removed from the carriers.	30	30
Carrier Development Phase	This work is of no value following the reversion decision. Further work was planned to complete the Carrier Development Phase by December 2012.	44	167
Catapult and Arrestor Gear – long lead items	To meet the production schedule and timeline for conversion, the Department was due to purchase equipment by April 2012.	–	156
US Weapon integration to aircraft	In April 2012, the Department was due to contractually commit to carrier variant weapons integration. Subsequently reverting to STOVL would mean the aircraft could initially only use US weapons. This cost is to purchase a supply of these weapons and obtain the necessary safety clearances.	–	300
Carrier variant test aircraft purchase	The Department was due to purchase a carrier variant test aircraft by June 2012. Any delay to the decision could have left the Department with an aircraft with limited operational utility.	–	100
Total		**74**	**753**

NOTES

1 The reversion decision was made on 8 May 2012 by the National Security Council.

2 There would also have been additional, unquantified costs if the Department subsequently sought to integrate its own weapons to the aircraft.

Source: National Audit Office analysis of departmental data

Part Two

Information for decision-makers

2.1 On 8 May 2012, the National Security Council, chaired by the Prime Minister, made the reversion decision on the basis of a paper prepared by the National Security Secretariat. The paper drew extensively on analysis undertaken by the Department and compared two options – continue to procure the carrier variant of the Joint Strike Fighter (JSF) and modify one carrier with 'cats and traps'; or revert to procuring the STOVL version of the Joint Strike Fighter. The Department advised decision-makers of the need for a swift decision to avoid the substantial increase in commitments to the carrier variant option outlined in Part One of this report.

2.2 The Department had considered alternative, fast jets to the Joint Strike Fighter, including the F-18 and Dassault Rafale. However, while they are less expensive,[5] the Department ruled out these alternative jets because, they would still require catapults and arrestor gear and could not perform the same wide range of roles as the JSF which has stealth capabilities. The Department did not present decision-makers with the alternative steam-based catapult and arrestor gear because, while its cost estimate for EMALS had substantially increased since its decision to focus on this option in April 2011, the Department had not changed its view that steam was not a viable alternative.

2.3 The final decision was a matter of political judgement. This part of our report examines the robustness and completeness of the information presented to decision-makers. The Department is continuing to negotiate with its commercial and international partners the necessary changes to the aircraft and carrier projects. Until this process concludes, the overall financial data on which the decision was based remain commercially sensitive. Our analysis therefore focuses on the differences between the two options.

5 The F-18 was £53.6 million ($80.4 million converted at 1.5) in December 2011 as per the average procurement unit cost in the US Department of Defense, Selected Acquisitions Report, compared to £91 million for the Joint Strike Fighter (see Figure 9 on page 27).

How the Department generated its cost estimates

2.4 The Department was not due to complete the Conversion Development Phase until the end of 2012 and therefore, in early 2012, it did not have finalised cost estimates for the carrier variant option. In addition, the Department had not continued to develop a detailed understanding of the costs of the STOVL option following the 2010 decision to procure the carrier variant of the Joint Strike Fighter. Nonetheless, overall, the Department's understanding of the variances between the two options was far more mature in May 2012 than in October 2010.

2.5 The Department used its Cost Assurance and Analysis Service (CAAS) throughout the Conversion Development Phase to challenge the assumptions behind the emerging estimates and strengthen them where possible. Additionally, CAAS reviewed the final estimates and underpinning assumptions for both options before they were presented to decision-makers. This semi-independent assurance and costing expertise was key to giving decision-makers confidence in the cost information presented to them. **Figure 5** summarises the strengths and weaknesses in the cost information presented to decision-makers. The Department gave decision-makers a quantified explanation of the quality of the conversion cost estimate and rag-rated the quality of estimates relating to the Joint Strike Fighter. The following paragraphs explore the key differences between the costs of the options in more detail.

Short-term affordability

2.6 The cost of the Carrier Strike programme was central to balancing the ten-year defence budget and the timely, affordable delivery of wider planned military capabilities. As Figure 5 shows, compared to the carrier variant option, the Department estimates the STOVL option to be £1.2 billion cheaper over the next decade. Two-thirds of the savings fall within the next four years, the period during which the defence budget is most tightly stretched.

2.7 The dominant reason for the variance was the estimated £2 billion cost of fitting one carrier with 'cats and traps' (see Figure 3 in Part One). The analysis underpinning this figure was not as mature as it would have been if the Conversion Development Phase had been completed. For example, the Department had not yet explored any potential gaps or overlaps between the costs of design and installation work planned by UK and US industries. Uncertainty over the US costs meant that the Department included a 20 per cent contingency in its forecasts. The extent of this uncertainty was made clear to decision-makers. It is unlikely that, even cumulatively, the scale of any potential errors would have completely eroded the cost difference between the two options. For example, even if the Department had used the 2 to 5 per cent contingency level suggested by the US[6] rather than the 20 per cent it actually applied, the STOVL option would still be £0.9 billion cheaper over ten years.

6 United States Assistant Secretary of the Navy, Sean Stackley, in a letter to the United Kingdom Minister for Defence Equipment, Support and Technology, Peter Luff, in March 2012.

Figure 5

The Department estimates £1.2 billion costs avoided over ten years by reverting to STOVL

Element	Quality of information	0 to 4 years	0 to 10 years
Costs avoided by reversion to STOVL shown as positive figures (£m)			
Catapults and arrestor gear	● Both US and UK cost elements were immature and work to find any gaps or overlap between the two was not completed.	979	1,956
Costs created by reversion to STOVL shown in brackets (£m)			
Joint Strike Fighter support and basing	● STOVL cost estimate not supported by detailed work but expected to cost 20 per cent more than carrier variant support.	(32)	(208)
Joint Strike Fighter production	● Based on latest US data for the cost of the STOVL aircraft. The Department judged that the technical and cost risks of the two variants were equal. Progress in the year since the reversion decision has borne out this judgement. While the STOVL variant is inherently more complex, its risks are being addressed earlier and it is further through testing than the carrier variant.	(45)	(197)
Carrier support costs (one carrier)	● Early year costs are more certain but later year costs are based on a simple extrapolation.	(47)	(116)
STOVL-specific carrier work	● Following the 2010 conversion decision, a range of STOVL specific items, such as the deck ramp needed to enable the STOVL 'short take off', were removed. This also includes work to be conducted by the Department on SRVL (see paragraph 3.10) and elements that weren't previously included in the pre Strategic Defence and Security Review STOVL cost estimate.	(83)[1]	(241)
UK industry	● Costs are uncertain as they are part of the renegotiation with industry.		
Overall impact of reversion to STOVL (£m)			
Total	**This is the total of all the above and shows that reverting to STOVL will avoid costs overall**	**772**	**1,194**

- ● Information was out of date and presented with little confidence of accuracy
- ● Information was based on data that had some weaknesses
- ● Information was accurate and robust

NOTE

1 STOVL-specific carrier work and United Kingdom industry costs have been merged due to commercial sensitivity.

Source: National Audit Office analysis of departmental data

2.8 In July 2009, the Department signed a Terms of Business Agreement with its main provider of warship-building capacity – BAE Systems. Among other things, the company agreed to sustain a set of quantified Key Industrial Capabilities and improve the efficiency of operations. In return the Department guaranteed a minimum level of warship building and support activity of around £230 million a year. If the workload falls below the required levels, the Department is liable for funding the shortfall to maintain the Key Industrial Capabilities. The carriers are the key shipbuilding work underpinning the Agreement and the Department took account of the effect of a change in the carrier design could have on its liabilities. The two options would involve different build strategies for sections of aircraft carrier. Crucially, the carrier variant option would involve an additional three years of work given the added complexity of the build. On this basis, the Department estimated the costs of the options in terms of its liability to maintain industrial capabilities. The precise cost difference is dependent on the outcome of the renegotiation of the carrier contract and wider maritime agreement with industry. The Department reported these dependencies to decision-makers.

Long-term costs

2.9 Looked at across a 30-year life cycle (**Figure 6**) the Department estimated the cost difference between the two options narrowed to £600 million. This estimate is underpinned by its statement that it will accept a gap in its Deep and Persistent Offensive Capability (DPOC). As part of the 2010 Strategic Defence and Security Review, the Department decided that the carrier variant, with its longer range and payload, could meet its DPOC (essentially a replacement for the Tornado GR4 aircraft) requirement in a way that the STOVL variant could not. In July 2010, the Department removed a £1 billion provision for DPOC from its ten-year budget. In deciding to revert to the STOVL variant, the Department stated that it would not reinstate DPOC and would accept the resultant capability gap until it replaces the Typhoon aircraft in the 2030s. In the meantime, the Department will rely on its allies to provide the necessary capability. Having changed its position on DPOC three times in two years, the Department must now introduce a degree of consistency in its decision-making not previously apparent in the programme, if it is to realise the potential savings offered by the STOVL option.

Figure 6

Over the next 30 years the Department estimates it has avoided costs of £0.6 billion by reverting to STOVL

Element	11 to 30 years (£m)	0 to 30 years (£m)	Notes
Carrier support (one carrier)	479	363	The carrier variant is more expensive to support on the carrier due to the greater manpower (approximately an extra 70 crew) and operating costs involved in using a carrier fitted with 'cats and traps'. This more than offsets the STOVL option initially costing more due to earlier operational service.
JSF support and basing	(793)	(1,027)	The Department estimated that the support costs for the more complex STOVL aircraft are on average 20 per cent higher than that of the carrier variant.
JSF production costs	(262)	(459)	The STOVL variant is more expensive to procure, by approximately £10 million per aircraft, largely due to the added complexity of its extra lift-fan engine.
Catapults and arrestor gear	0	1,956	All costs occur in years 0 to 10
STOVL-specific carrier work / UK industry	0	(241)	
Total	**(576)**	**592**	The STOVL option costs more between years 11 to 30 than the carrier variant option but less overall between years 0 to 30.

NOTES

1 Positive figures are the savings as a result of the STOVL option compared to the carrier variant option. Negative figures are shown in brackets and are areas where the STOVL option will cost more than the carrier variant option.

2 STOVL-specific carrier work and United Kingdom industry costs have been merged due to commercial sensitivity.

Source: National Audit Office analysis of departmental data

Capability factors

2.10 The capability differences between the two options are finely balanced and where the greatest advantage lies is a matter of military judgement which we do not question. However, it is apparent that the Department's understanding of the capability merits of the two variants and the operational risks it was prepared to accept evolved over the 18 months since the 2010 Strategic Defence and Security Review.

2.11 The 2010 decision to procure the carrier variant was partly based on the Department's judgement that:

> ''having the carrier variant instead of the STOVL variant with its greater range and payload would provide a more effective carrier strike capability. It is this capability, not large numbers of aircraft that is the critical requirement for precision strike operations in the future.''[7]

7 HM Government, *Securing Britain in an Age of Uncertainty*: *The Strategic Defence and Security Review,* 2010, page 23.

2.12 The Department is now planning to procure 48 STOVL aircraft in the first tranche in the same quantity and production profile as the carrier variant. Given that the STOVL variant will deliver an aircraft with less range and endurance over a target area compared to the carrier variant, the decision potentially represents a reduction in capability. However, since 2010, the Department has confirmed that it does not have plans to use weapons which would require the greater payload capacity of the carrier variant. Furthermore, the Department now recognises the benefits of the STOVL in providing greater flexibility over basing options, since it requires a shorter minimum runway than the carrier variant.

2.13 Since the 2010 decision, the delivery of the carrier variant had slipped three years to 2023; with the risk of further slippage due to the innovative nature of the EMALS technology. The Chief of Defence Staff judged that, in the emerging security environment, it would be undesirable to extend the gap in Carrier Strike capability beyond 2020. The Department estimated that the STOVL option should be operational by 2020. Delivering Carrier Strike by this date, three years earlier than for the carrier variant option, would require Crowsnest to be fully operational by that date; contrary to current plans (paragraph 3.5). Carrier Strike capability may also be limited if the Department does not upgrade or replace a range of other capabilities such as Solid Support Shipping (paragraph 3.6). Part Three of this report sets out the affordability and delivery risks to the delivery of Carrier Strike by 2020.

2.14 Both the STOVL and carrier variant options would allow the Department to use the second carrier to support a broad range of amphibious operations. However, while operating two carriers is not currently funded within the defence budget (paragraph 3.7), only the STOVL option provides scope for both carriers to operate the Joint Strike Fighter. This would mean that, depending on decisions to be taken as part of the 2015 Strategic Defence and Security Review, the UK could have a Carrier Strike capability available all of the time, as opposed to 70 per cent[8] availability with the carrier variant.

Industrial factors

2.15 Based on advice from the Department for Business, Innovation & Skills, the National Security Secretariat briefed decision-makers on the importance of the Joint Strike Fighter programme to UK industry in sustaining 25,000 jobs. The relative industrial implications of each option were judged to be finely balanced with the greater work provided to the shipbuilding industry by the carrier variant option offset by Rolls Royce work on the STOVL option's lift-fan engine. Industrial factors were therefore not a discriminator between the options.

8 The need for maintenance means that one carrier only provides an at-sea capability of five years in seven.

Part Three

Risks to delivery

3.1 In announcing the reversion decision, the Secretary of State for Defence said:

> "This announcement delivers an affordable solution to securing that capability and, with two useable carriers, gives us the option of continuous carrier availability. It confirms the expected delivery of the first test aircraft this summer, of the first production aircraft in 2016, of the first carrier into sea trials in 2017 and of the first flight of the Joint Strike Fighter from the deck of the carrier in 2018, with an operational military capability in 2020."[9]

3.2 Having an operational military capability in 2020 is nearly three years earlier than if the carrier variant option had been pursued; a further delay which the Chief of Defence Staff had judged to be undesirable.

3.3 This part summarises the risks the Department must manage in meeting this date and delivering the benefits of the STOVL option. It also highlights a number of risks to the delivery of the Joint Strike Fighters and Queen Elizabeth Class carriers which would have been common between the STOVL and carrier variant options.

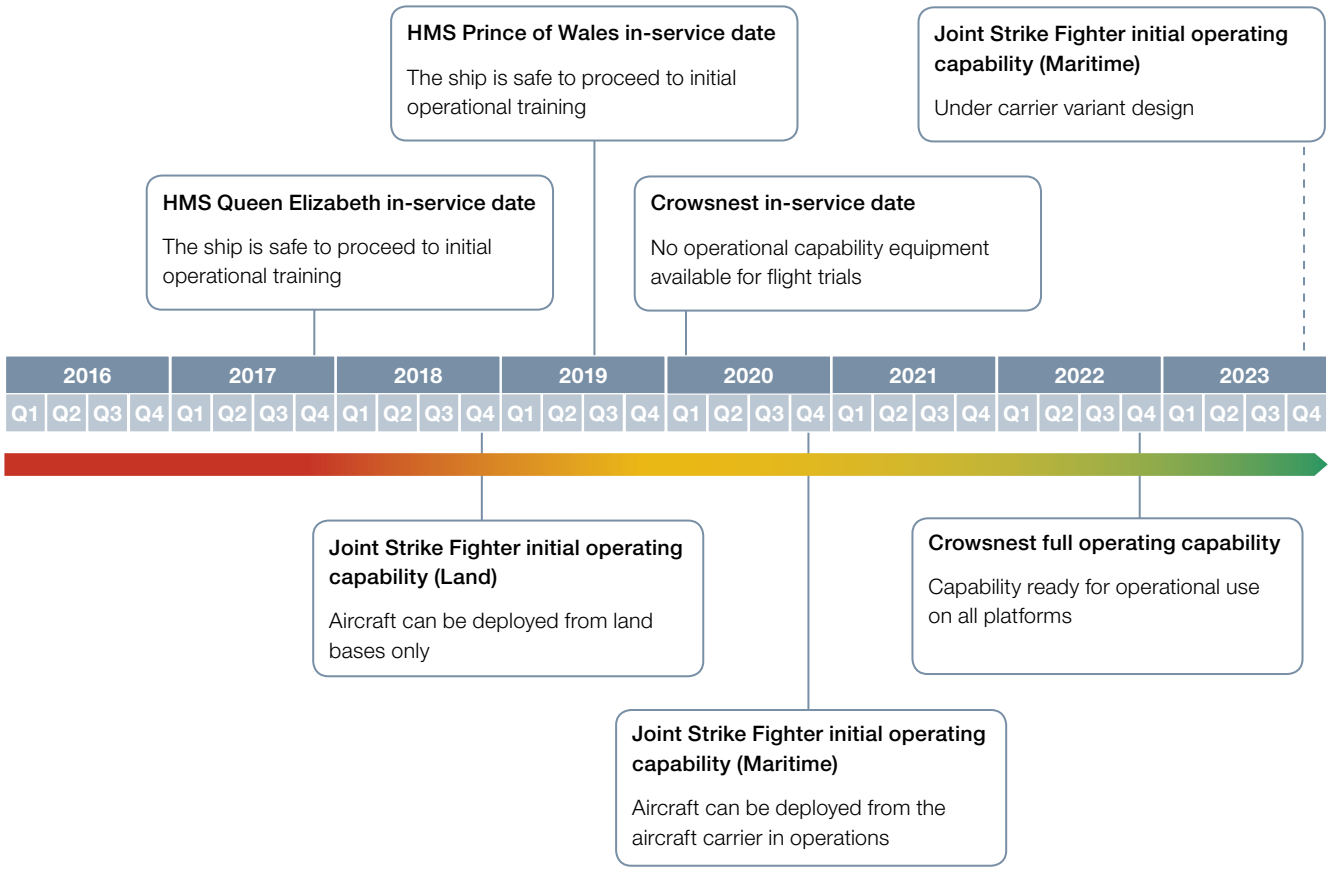
Future defence policy and affordability decisions

3.4 The timely and affordable delivery of the benefits envisaged by the 2012 reversion decision will depend, in part, on the outcome of future defence policy and affordability decisions set out in the following paragraphs. Choices will have to be made about the relative priority of these benefits and other capability needs in the light of a constrained defence budget.[10] Having announced in May 2012 that its ten-year Equipment Plan is now in balance these decisions could jeopardise ongoing affordability.

9 Ref: Daily Hansard debate: 10 May 2012 : C 142.
10 Comptroller and Auditor General, *Ministry of Defence, Equipment plan 2012–2022*, Session 2012-13, HC 886, National Audit Office, January 2013.

3.5 Crowsnest is a helicopter-based early warning radar system which can detect threats over the horizon. The Department considers that the operational use of Crowsnest is, along with the carriers and aircraft, a key element of Carrier Strike capability. One of the measures which the Department took in 2012 to better balance its ten-year Equipment Plan, announced on 14 May 2012, was to delay investment in Crowsnest. **Figure 7** shows the currently scheduled delivery milestones. Crowsnest will begin radar trials in 2020 but will only be fully operationally effective from late 2022.[11] Unless the Department is able to bring forward funding or finds a credible alternative which does not compromise capability,[12] when the Carrier Strike first becomes operationally available in late 2020, some operational tasks could only be undertaken with additional risks.

Figure 7
Full Carrier Strike capability will be delayed until 2022 by Crowsnest



NOTE

1 Dates are subject to future decisions being taken as part of the 2015 Strategic Defence and Security Review.

Source: National Audit Office analysis of departmental data

11 By the end of 2020, under current planning assumptions (which have not yet received investment approval) the Department will, in extremis, be able to deploy two Crowsnest systems without full mission capability, testing or clearance for operational use. The Department plans to deliver eight systems with full capability, testing and training, by the end of 2022.

12 If necessary this function could be performed by Joint Strike Fighter aircraft which is fitted with advanced radar equipment. However, to perform the function adequately would require a number of Joint Strike Fighters and this would limit the aircraft available to deliver Carrier Strike capability.

3.6 Appendix Four sets out the interdependencies between Carrier Strike and wider Navy and Air Force capabilities. The Department currently operates HMS Ocean and HMS Illustrious as helicopter carriers which require the majority of capabilities which will be necessary for Carrier Strike. However, such equipment and capabilities will need to be upgraded, maintained and ultimately replaced if the Department is to realise the benefits from its investment in Carrier Strike. For example, work will need to be done to adapt the Merlin helicopters for use aboard the new carriers and some Solid Support Shipping is over 30 years old. The Department will not make significant funding decisions until future Strategic Defence and Security Reviews.

3.7 The operational use of the second carrier is still to be determined. Unlike the carrier variant, the STOVL option has scope for both carriers to operate the Joint Strike Fighter. This would mean that the UK could have a Carrier Strike capability available all of the time, as opposed to 70 per cent[13] availability with the carrier variant. The briefing prepared for decision-makers stated that this additional availability was an important differentiator and that strategic alliances, notably with the US, would be strengthened most by the ability to use both UK carriers to provide continuous Carrier Strike capability. The Department's estimate for the costs for operating both carriers to provide continuous capability is £25 million per year. Simultaneous operation of both carriers would cost £60 million per year. Neither of these two options has been funded within the defence budget and a decision has been deferred until the 2015 Strategic Defence and Security Review.

Risks to the delivery and affordability of the Joint Strike Fighter programme

3.8 The Joint Strike Fighter is being procured through a collaborative programme being led by the US. The aircraft is highly innovative in its combination of advanced and emerging technologies in stealth, reconnaissance, agility, acceleration, and situational awareness. Risks are increased by the concurrency of design, production and testing and the amount of software (24 million lines of code) that is required. For example, half of the on-board software has yet to complete integration and testing – typically the most challenging phase of software development. **Figure 8** overleaf summarises the key risks. The US Department of Defense judged that in 2012:[14]

> "Overall progress within missions systems was limited. This was due to delays in software delivery, limited capability of the software when delivered… the lag in accomplishing the intended 2012 flight testing content defers testing to following years and, in the meantime, will contribute to the program delivering less capability in production aircraft in the near term."

13 Based on an at-sea capability of five years in seven.
14 From Department of Defense, Operational Test and Evaluation Directors annual report.

Figure 8
Technical risks on Joint Strike Fighter development programme

Design area	Importance	Risk
Helmet mounted display	Provides flight data, targeting, and other sensor data to the pilot.	The original design was found to be unfit for use and is currently undergoing redesign and testing. An alternative simpler design is also being developed in case the problems with the original cannot be corrected.
Software development	Essential to all aircraft capabilities.	Software providing essential JSF capability has grown in size and complexity, and is taking longer to complete than expected. More than half of test work and integration still remains.
Autonomic Logistics Information System	Tool to predict and diagnose maintenance and supply issues.	Current versions being used lack the capability desired, the programme is aiming to fix the identified shortcomings by 2015.
Aircraft bulkhead and ribs	Integral to the structure of the aircraft. Weaknesses could lead to the aircraft becoming dangerous or inoperable.	Ground testing has found that cracks develop over time. Redesign of the structures and modifications to existing aircraft is taking place.

Source: F-35 Joint Strike Fighter, GAO Report to Congressional Committees, March 2013

3.9 The Short Take-Off Vertical Landing (STOVL) variant is currently the only aircraft in production that can be deployed from a carrier without the assistance of catapults and arrestor gear. As such, the UK's timely and affordable delivery of Carrier Strike is now dependent on the success of the development of this variant. Development testing of the STOVL variant is more advanced than for the carrier variant. Development is planned to be complete by 2017 by which time early models of the variant will be in service with the US Marines, helping to manage the risks to the Department's planned delivery of a land-based Joint Strike Fighter capability by 2018.

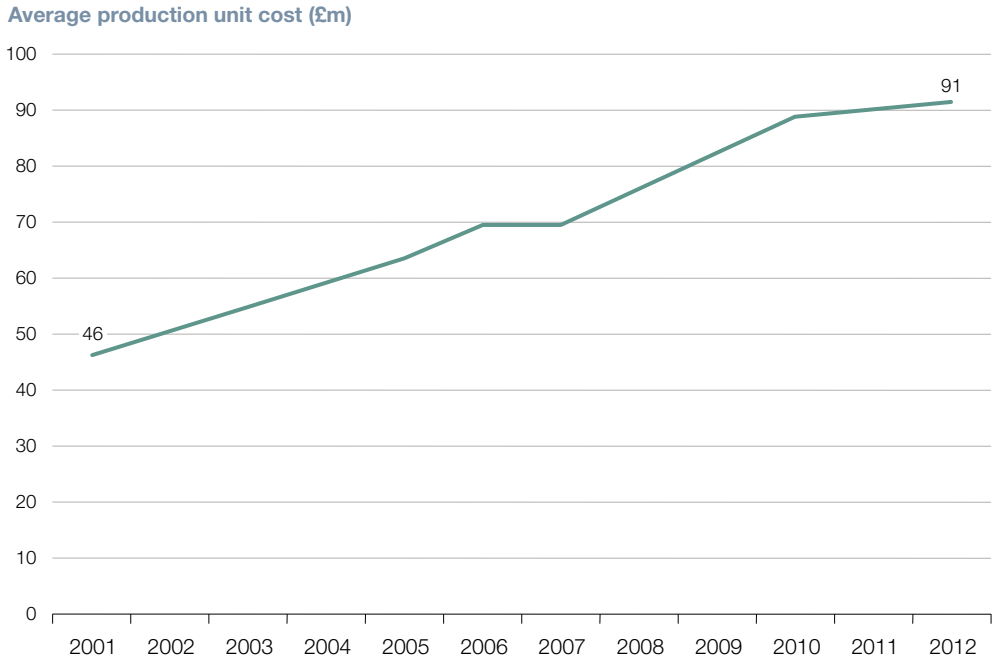
3.10 An important enabler of the UK's STOVL Carrier Strike capability will be the ability to conduct Ship-borne Rolling Vertical Landings (SRVL). This landing technique will be necessary where a conventional vertical landing is less likely to be possible without jettisoning large weapons or fuel load when in hot, humid or low pressure weather conditions.[15] At present the technology is not proven with redesigns required to the carrier deck and aircraft software. The capability will be required for operations by 2020 and the Department included a provision to complete development as part of the cost of reverting to STOVL. The Department is confident it will develop the technique within the required timescale.

15 Beyond the operational implications there is the cost factor of jettisoning weapons to be borne in mind. Modern missiles are expensive, for example, the unit cost of Meteor missile is £2.1 million – Comptroller and Auditor General, *The Major Projects Report 2011*, Session 2010–2012, HC 1520, Volume II, page 11, National Audit Office, November 2011.

3.11 The UK's contribution to the development of the Joint Strike Fighter is capped at $2 billion (roughly £1.3 million converted at an exchange rate of $1.5:£1). However, the production cost of the aircraft is not yet finalised. As **Figure 9** shows, forecast unit production costs have doubled since the start of development in 2001. The Department is confident that, as the programme is maturing and given the intensive efforts being made by the US Department of Defense to produce realistic cost estimates, its current estimates are realistic. There remains a risk, however, of further cost increases which the Department can do little to control. For example, if other partner nations change the numbers of aircraft they buy and the timing of their orders.[16] In addition the Department is yet to finalise the cost of integrating UK specific weapons such as ASRAAM and Paveway IV. The Department hopes to conclude its price negotiations in autumn 2013.

Figure 9

The cost of the Joint Strike Fighter doubled between 2001 and 2012



NOTES

1 The unit cost data stated is the Average Production Unit Cost. This is the average unit production cost (i.e. the total production cost divided by the number of aircraft) across all three variants of the JSF plus support equipment, initial spares, training and various other costs that are required before the jets are ready to fly in operations. It excludes development costs.

2 Costs are inclusive of inflation as are stated at outturn prices.

3 The unit cost has been converted from US dollars at a conversion rate of $1.5 to £1.

Source: Government Accountability Office, Joint Strike Fighter, Department of Defense Actions Needed to Further Enhance Restructuring and Address Affordability Risks, June 2012

16 The JSF partners are Australia, Canada, Denmark, Italy, Netherlands, Norway, Turkey and the United Kingdom. However, in December 2012, Canada reopened competition for the replacement of its current F-18 fleet and may no longer buy any Joint Strike Fighters.

Risks to the delivery and affordability of the Queen Elizabeth Class carrier programme

3.12 The Queen Elizabeth Class carriers will be the largest warships the Royal Navy has ever operated: at 65,000 tonnes they will be three times larger than the Invincible Class carriers they are replacing. Early in 2012, the Department commissioned Retired Admiral Sir Robert Walmsley and a team of independent industry experts to determine whether the project controls and governance were fit for purpose and whether the programme and its risks were under control. The Review Team report was completed in April 2012 and concluded that assembly was progressing well. All the hull sections of the HMS Queen Elizabeth have been completed with half delivered to Rosyth for assembly. However, the report warned that the highest risk phases of construction and integration were yet to come. For example, installing 2.5 million metres of electric cable through the ship and the integration of the many different systems such as the air traffic control system, long range radar and the air conditioning control system will be challenging in the next phase.

3.13 Bearing in mind the outstanding construction risk, the report was also critical of the incentive mechanisms in carrier contract. As our 2011 report highlighted,[17] under the terms of the contract, the Department and Industry share equally any gains from coming in below the Target Cost of £5.24 billion. However, the Target Cost would have to be exceeded by £2.5 billion before industry profits were foregone. After this point the Department would meet all remaining costs. If it is to adequately control costs on the project in future, a key element of the ongoing negotiations will be to increase the Department's ability to monitor and incentivise improved performance by industry. We expect the cost of the two carriers will increase from the £5.46 billion reported in the *Major Projects Report 2012*. This figure itself represented an increase of 55 per cent from the main investment decision in 2005, in large part reflecting the effect of corporate decisions taken by the Department. We expect further cost escalation will be announced once the renegotiation with industry is complete.

17 Comptroller and Auditor General reports, *Carrier Strike*, Session 2010–2012, HC 1092, National Audit Office, July 2011 and *Carrier Strike: Supplementary Report*, Session 2010–2012, HC 1657, National Audit Office, November 2011, page 15.

Project and programme governance

3.14 As the Carrier Strike capability draws upon both air and navy forces, there is a risk of divergent views on delivering its benefits. There have also been a wide range of views as to what constituted the wider capability known as Carrier Enabled Power Projection[18] while the Senior Responsible Owner has lacked budgetary power and authority to bring coherence to its elements which draw upon the different forces.

3.15 As a result, and to address concerns raised by the Committee of Public Accounts,[19] in response to our Carrier Strike[20] report, the Department made the Programme Director of Carrier Strike a full-time, two-star role and gave the role of Senior Responsible Owner for Carrier Enabled Power Projection to a three-star officer responsible for capability decisions across the Department. This move has effectively strengthened the budgetary authority of the role and in April 2013 their mandate was also clarified. The Senior Responsible Owner chairs an Executive Programme Board which is attended by those responsible for the delivery of all of the key elements of the capability. These changes are a welcome clarification of previously inadequate governance arrangements; however, the Senior Responsible Owner will continue to face difficult challenges in successfully delivering the Carrier Strike capability and overcoming the historic, cultural differences between the forces.

18 In addition to the Carrier Strike capability, Carrier Enabled Power Projection includes the ability to carry out non-combatant evacuation operations or combat search and rescue and hostage rescue, and the ability to conduct amphibious operations.

19 HC Committee of Public Accounts, *Providing the UK's Carrier Strike Capability*, Fifty-sixth Report of Session 2010–2012, HC 1427, November 2011.

20 Comptroller and Auditor General reports, *Carrier Strike*, Session 2010–2012, HC 1092, National Audit Office, July 2011 and *Carrier Strike: Supplementary Report*, Session 2010–2012, HC 1657, National Audit Office, November 2011.

Appendix One

Our audit approach

1 This study examined the Department's decision to revert to the procurement of the Short Take-Off Vertical Landing variant of the Joint Strike Fighter aircraft. We reviewed:

- how the Department matured its understanding of the implications of the Strategic Defence and Security Review decision to procure the carrier variant of the Joint Strike Fighter – the Conversion Development Phase;
- the key factors affecting value for money and how they were analysed and synthesised to enable decision-makers to take an informed decision; and
- the challenges the Department now faces in delivering the agreed outcome.

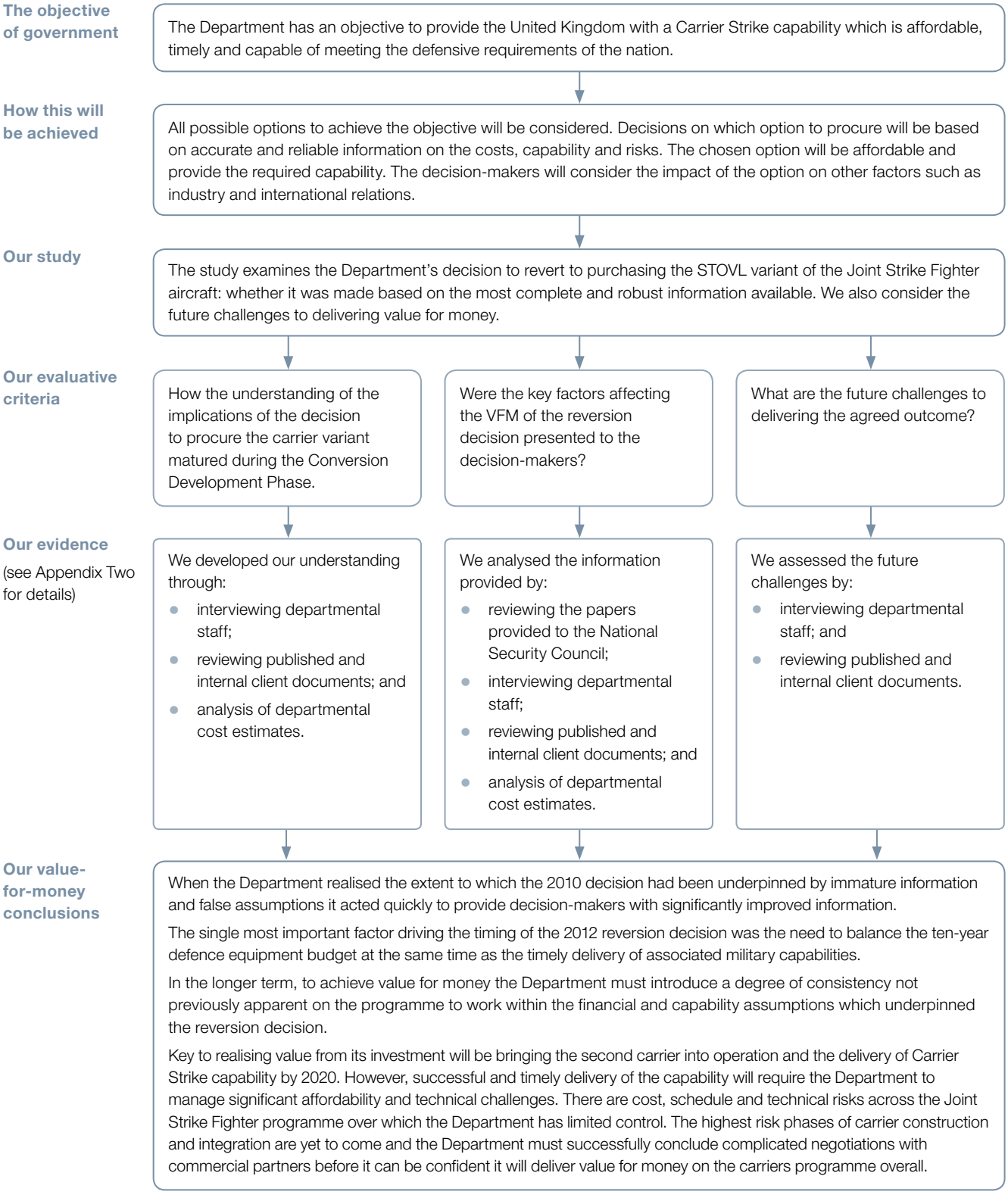
2 We applied an analytical framework with evaluative criteria, which considered what would have been the optimal evidence basis and process for making the decision. Optimal conditions would have meant that the decision-makers were provided with all available options for the decision; each of the options would have full and robust cost estimates, with risks and uncertainties clearly defined, and having undergone appropriate scrutiny. The effect on military capability of each option would have been fully understood, as well as the effect on other external factors such as international relations and industry. The cost of the chosen option would also be fully affordable within the Department's budget.

3 The intention of the Conversion Development Phase was to achieve greater understanding of the costs and risks of the decision to procure the carrier variant. As it did not progress to completion it was not possible to achieve the optimum conditions stated above. We take this into account in our study and consider how the Department's understanding of the carrier variant procurement developed during the Conversion Development Phase and the process followed for making the decision to cancel it and revert to the Short Take-Off Vertical Landing variant.

4 Given the early termination of the Conversion Development Phase, we evaluate whether the information provided to the decision-makers was based on the most complete understanding possible at the time.

5 Our audit approach is summarised in **Figure 10**. Our evidence base is described in Appendix Two.

Figure 10
Our audit approach



Appendix Two

Our evidence base

1 Our independent conclusion on the basis for the reversion decision was made following our analysis of evidence collected between December 2012 and March 2013.

2 As stated and outlined in Appendix One, we applied an analytical framework with evaluative criteria, which considered the optimal conditions for the decision.

3 We conducted **semi-structured interviews** with a range of Department staff including members of the Joint Strike Fighter and Carrier Project teams, the Cost Assurance and Analysis Service (CAAS) teams and senior staff responsible for the delivery of Carrier Strike and Carrier Enabled Power Projection. The interviews enabled us to collect the views of those working in the area, identify the delivery risks associated with the two options and understand the basis for the cost numbers supplied to the decision-makers.

4 We carried out **document reviews** on a range of published and internal Departmental documents including Investment Approval Committee papers, internal project documents, Department commissioned project reviews, CAAS reports, reports by UK industry and reports by the US Government Accountability Office. The reviews enabled us to identify key issues, gain an understanding of the capability requirements, agree the cost information and identify the delivery risks.

5 We **analysed Departmental data** on the costs of the two options and the different elements of Carrier Strike. We used the findings from the semi-structured interviews and document reviews to develop an understanding of the basis for the figures, the assumptions made and the uncertainties involved.

6 We were allowed access to the information provided to the National Security Council and used as the basis for the reversion decision. We were able to take this information and using the semi-structured interviews, document reviews and analysis of Departmental data, described above, consider whether they had been provided with suitably detailed and accurate information on the costs, affordability, capability and impacts on international relations and industry.

7 To support our findings we also drew on **previous National Audit Office reports** including the previous Carrier Strike report, the Major Projects Report 2012 and the Equipment Plan 2012 to 2022.

Appendix Three

Reversion decision information access

Figure 11
Access to information was limited to a small group of people

Departmental Officials

Secretary of State for Defence (plus two extra officials)

Minister for Department for Equipment & Support Technology

Permanent Under Secretary

Chief of Defence Materiel

Director General of Finance

Chief of the Defence Staff

Deputy Chief of the Defence Staff (Capability)

Vice Chief of the Defence Staff

Director General (Security and Policy)

Commander of Materiel (Fleet)

Director Equipment Resources

Director General Transformation

Director Transformation

National Security Council Permanent Members

Prime Minister (Chair)

Deputy Prime Minister

Chancellor of the Exchequer

Secretary of State for Foreign & Commonwealth Affairs

Home Secretary

Secretary of State for Defence

Secretary of State for International Development and the Security Minister

Chief Secretary to the Treasury

Secretary of State for Energy and Security

Minister for Government policy

Business Secretary also attends the meetings on defence issues

NOTE
1 See paragraph 1.11.

Source: National Audit Office analysis of departmental data

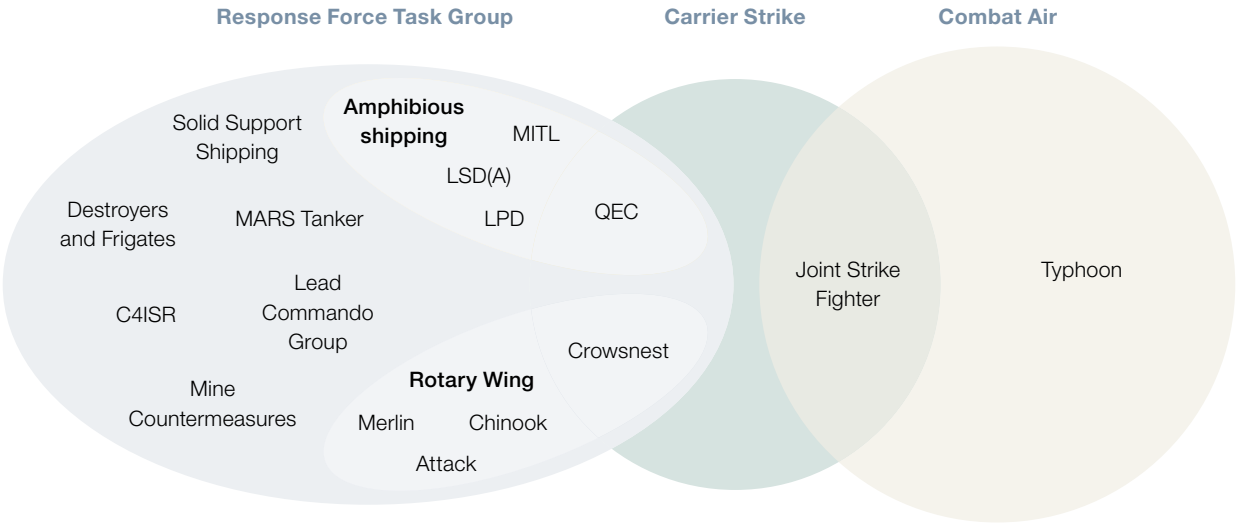
Appendix Four

Carrier Strike and Carrier Enabled Power Projection

1 The 2010 Strategic Defence and Security Review placed Carrier Enabled Power Projection at the heart of UK defence policy. This concept requires the exploitation of the Queen Elizabeth Class (QEC) carriers as multi-role assets. The core of this is Carrier Strike which consists of the QEC, Joint Strike Fighter and the Crowsnest airborne early warning system. In 2020, the Department plans to introduce the Initial Operating Capability of Carrier Strike; and by 2026 it plans to deliver the Full Operating Capability for all remaining elements of Carrier Enabled Power Projection as follows: an amphibious capability as well as the ability to conduct non-combatant evacuations, Special Forces raids, and humanitarian aid and disaster relief.

2 **Figure 12** outlines the dependencies for Carrier Strike and the responsibilities of the Response Force Task Group and Combat Air which are managed by the Navy and Air Force respectively. Most of the assets within the outer circles have utility beyond Carrier Enabled Power Projection and will only be used part of the time for that purpose. The Response Force Task Group is in operation currently using existing assets including HMS Ocean and HMS Illustrious but without a Carrier Strike – fast jet – capability. The Department expects that every component of the Task Group will need to be replaced over the life of the QEC. Investment in these capabilities will need to include the sustainment of their personnel, training, infrastructure and support. Major investment in these wider capabilities will be determined by the five-yearly Strategic Defence and Security Reviews; with more minor adjustments made in the Department's annual budget cycle.

Figure 12
Carrier Strike and its interdependencies



NOTE

1 Acronyms are as follows: Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR); Landing Platform Dock (LPD); Landing Ship Dock (Auxiliary) (LSD(A)); Military Afloat Reach and Sustainability (MARS); Maritime Intra Theatre Lift (MITL); and Queen Elizabeth Class carrier (QEC).

Source: National Audit Office analysis of departmental data

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NAO Communications
DP Ref: 10149-001

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ISBN 978-0-10-298141-4

9 780102 981414