National Audit Office

REPORT BY THE
COMPTROLLER AND
AUDITOR GENERAL

HC 1092
SESSION 2010–2012

7 JULY 2011

Ministry of Defence

Carrier Strike

Our vision is to help the nation spend wisely.

We apply the unique perspective of public audit to help Parliament and government drive lasting improvement in public services.

The National Audit Office scrutinises public spending on behalf of Parliament. The Comptroller and Auditor General, Amyas Morse, is an Officer of the House of Commons. He is the head of the NAO, which employs some 880 staff. He and the NAO are totally independent of government. He certifies the accounts of all government departments and a wide range of other public sector bodies; and he has statutory authority to report to Parliament on the economy, efficiency and effectiveness with which departments and other bodies have used their resources. Our work led to savings and other efficiency gains worth more than £1 billion in 2010-11.

The Comptroller and Auditor General explained to the Committee of Public Accounts during his pre-appointment hearing (11 February 2009) that the carrier is the only defence project where his level of engagement as a former official of the Ministry of Defence raised the prospect of a conflict of interest. The C&AG therefore put in place arrangements to enable the review of the carrier to be conducted without his engagement. The review was led by Martin Sinclair, the Assistant Auditor General for Defence, reporting to Michael Whitehouse, the NAO's Chief Operating Officer. Sir Andrew Likierman, the Chairman of the NAO, oversaw the arrangements to ensure they were fully independent.

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Ministry of Defence

Carrier Strike

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HC 1092 Session 2010–2012
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Amyas Morse
Comptroller and
Auditor General

National Audit Office

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Key facts

£6.2bn
to procure one operational carrier and one unable to launch or recover aircraft

9 years
without any United Kingdom Carrier Strike capability 2011-20

£3.4bn*
savings over the next ten years from changes to current and future carrier and associated aircraft projects

	Main investment decision (2007)	Pre-Strategic Defence and Security Review (July 2010)	Post-Strategic Defence and Security Review (October 2010)
Estimated cost of carriers	£3.65 billion	£5.24 billion	£6.24 billion[1]
Operational Queen Elizabeth Class Carriers[2]	2	2	1
Carrier availability	Continuous	Continuous	150-200 days at sea a year, on average
Launching and landing equipment	Ski slope and flat deck	Ski slope and flat deck	Catapults and arrestors
Types of Joint Strike Fighter (JSF)	JSF Short Take-Off and Vertical Landing	JSF Short Take-Off and Vertical Landing	JSF carrier variant
JSF weapons bay capacity	1,000lb class weapon	1,000lb class weapon	2,000lb class weapon
Combat radius of JSF (nautical miles)	480	480	650
Carrier capacity	Max capacity 36 JSF	Max capacity 36 JSF	Max capacity 36 JSF, initially 12 embarked
* Additional benefits of selecting the carrier variant of the Joint Strike Fighter			£1 billion of funding for Deep and Persistent Offensive Capability deleted. Carrier variant able to cover what would otherwise have been a capability gap

1 This includes costs of £1 billion for conversion of one carrier.
2 Queen Elizabeth and Prince of Wales.

Summary

1 The core of Carrier Strike capability[3] comprises aircraft carriers and the aircraft that operate from them. The 1998 Strategic Defence Review committed to the replacement of the three existing Invincible Class aircraft carriers "from around 2012 by two larger, more versatile, carriers capable of carrying a more powerful force, including a future carrier-borne aircraft to replace the Harrier". In 2002, the Ministry of Defence (the Department) selected the Short Take-Off and Vertical Landing (STOVL) version of the United States-led Joint Strike Fighter as the preferred aircraft to replace the Harrier. The policy decisions in the 2010 Strategic Defence and Security Review have significantly affected the delivery of Carrier Strike and the role it will be expected to fulfil over the next 50 years. The Key Facts (opposite page) set out the main differences between Carrier Strike as it was envisaged before the Strategic Defence Security Review and the solution the Department is now progressing.

2 When the main investment decision was taken on the carriers in 2007, the 1998 Strategic Defence Review still set the policy baseline. Assessed against the parameters set out in the 2007 decision, the Department is delivering a lower scale of carrier capability, later than planned, and at significantly higher cost. In the past we have concluded that the effects of previous decisions on the carrier project were not value for money. The Department will not make a final decision on the number of Joint Strike Fighters to be procured until after the next Strategic Defence and Security Review in 2015, but, against its previous budgetary assumptions, it now plans to spend less over the next ten years and deliver more capable aircraft later than planned. The 2010 Review radically changed the Carrier Strike concept to make it relevant to the anticipated future security environment. Our test of value for money in this report is therefore whether the strategic decision to re-focus investment in both the carriers and the linked combat aircraft was well informed, and whether the Department is now well-placed to cost-effectively deliver the Carrier Strike capability now required.

3 Our report is in three Parts:

a the status of Carrier Strike before the Strategic Defence and Security Review began;

b whether the Department undertook sufficient, robust analysis to support strategic level decisions taken as part of the Strategic Defence and Security Review, and what the cost and capability implications of the decisions taken are; and

c changed risks and uncertainties to delivering the carriers and Joint Strike Fighters as a result of the Strategic Defence and Security Review decision.

4 Our methodology is described in Appendix One.

3 The Ministry of Defence (the Department) 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.

The evidence base for our conclusions

5 The 2010 Strategic Defence and Security Review was different to previous reviews which were run largely by the Department and covered only defence-related issues. The Review was cross-departmental. Leadership rested with the newly formed National Security Council, a Cabinet Committee chaired by the Prime Minister. The key Strategic Defence and Security Review policy decisions relating to Carrier Strike were taken by this Committee. The Department's inputs were principally supported through the Defence Strategy Group, chaired by the Secretary of State for Defence.

6 We have seen the Department's submissions to the National Security Secretariat in the Cabinet Office and held a number of meetings with the Department and with National Security Secretariat officials who explained the Strategic Defence and Security Review approach. We were not given access to particular Cabinet Committee papers held by the Cabinet Office. We considered we needed access to these papers to understand the way in which the cost, affordability, military capability and industrial implications of the alternative Carrier Strike options were drawn together to support the Strategic Defence and Security Review decision.

7 The National Audit Act 1983 provides for the Comptroller and Auditor General to have a right of access to all such documents as he may reasonably require for carrying out value for money examinations. By convention the Comptroller and Auditor General does not have an automatic right of access to policy papers (including policy focused Cabinet Committee papers) and historically in cases where the Comptroller and Auditor General has needed to understand the policy intention in order to reach a judgement on value for money, access to policy papers has been discussed on a case by case basis. In this case, the Cabinet Office have told us that the papers which have been withheld were written to inform policy decisions and that they are confident we have seen sufficient information and analysis to inform our audit judgement.

8 Our judgements in this Report are not about the policy decisions taken by the National Security Council, but about the basis on which the Accounting Officer for defence was satisfied that the decisions represented value for money and were affordable.[4] This follows from the Accounting Officer's personal responsibility to gain assurance on the way funds voted to the Department are spent. The Committee of Public Accounts has stated that "our interest is in the financial management and value for money secured from all departmental spending, and we expect Accounting Officers to put in place arrangements to provide us with the assurances we need. Parliament needs to be able to assure the public that value for money is obtained and Government must put in place arrangements to enable Parliament to do its job[5]". On the basis of the evidence we have seen, we cannot conclude on how the Accounting Officer was able to reach a strategic judgement on the value for money of the Carrier Strike decision.

4 Set out in *Managing Public Money*, HM Treasury, Chapter 3, Section 3.3.
5 Committee of Public Accounts, *Accountability for Public Money*, Twenty-eighth Report, Session 2010-11. HC 740. Conclusions and Recommendations, paragraph 2.

Key findings

The status of Carrier Strike before the Strategic Defence and Security Review began

9 The aircraft variant originally selected to fly off the carriers was not evaluated as the most cost- or operationally-effective choice. In 2002, the Department selected the STOVL variant of the Joint Striker Fighter being developed in cooperation with the United States as its preferred aircraft, but did not plan to finally confirm this decision until January 2011. The Department's quantitative analysis consistently showed that the carrier variant of the Joint Striker Fighter was more capable and cheaper to support throughout its operational life. The decision to select STOVL took into account a number of wider political, military and industrial factors. During the Strategic Defence and Security Review, the Department decided to buy the carrier variant of the Joint Striker Fighter.

10 The scale of the carrier project prompted the Department to form an alliance with industrial partners to deliver the carriers. The Alliance comprises BAE Systems, Thales, Babcock Marine, and the Department. The key principles underpinning the Alliance are transparency and incentivising partners to work together to minimise costs.

11 Commitment to the carrier project and the subsequent finalisation of the contract followed the Department's regular practices. The 2007 decision to invest in the two new carriers followed the Department's normal processes with the deal scrutinised by the Investment Approvals Board and Ministers. The project was approved to proceed by the then Prime Minister. The contract was negotiated by the then Defence Commercial Director[6], with the terms of the contract typical of those in other large defence contracts.

12 The Department was aware of a £234 million affordability gap when it signed the contract to build the carriers in July 2008, but considered it could make these savings within its overall equipment programme. Subsequently, the cost of the project increased by some £1.6 billion and delivery was delayed by two years when the Department changed its funding profile to try and manage the mismatch between its overall expenditure plans and the available funding, as reported in our 2010 Major Projects Report.[7]

13 To meet the contracted Final Target Cost of £5.24 billion, the Alliance must deliver a further £219 million in savings. Under the terms of the incentivisation mechanism agreed at Final Target Cost negotiations, the Department and Industry share equally any gains from coming in below Target Cost. 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.

6 Amyas Morse, subsequently appointed as Comptroller and Auditor General in June 2009. The inside front cover of this report sets out the governance of this examination by the National Audit Office.

7 Comptroller and Auditor General, *Ministry of Defence, Major Projects Report 2010* Session 2010-11, HC 489-I, National Audit Office, 15 October 2010.

14 Decisions on the carrier project are closely interlinked with the rationalisation of the United Kingdom warship building industry. The Department agreed a 15-year Terms of Business Agreement (ToBA) with BAE Systems in July 2009. The Agreement is designed so that industry will rationalise, reduce overheads and improve its performance. In order to enable its long-term requirements for complex naval shipbuilding to be met, the Department undertook to sustain certain Key Industrial Capabilities, either by providing a sufficient volume of work, or by making payments to compensate for any lack of work. If the workload was insufficient to sustain these Key Industrial Capabilities, the Department would be liable for payments of up to £230 million per annum for shipbuilding and support. The work provided by the carriers is integral to the delivery of the core workload assumed in this agreement. In its absence, the risk is that the Department would have a funding liability for which it would receive no outputs unless it could substitute alternative work.

The Strategic Defence and Security Review

15 Key decisions in the 2010 Strategic Defence and Security Review were taken against a backdrop of reduced funding. The Review was conducted in parallel with the Spending Review that set the level of defence funding for the next four years. Taken together with the major challenge to address the imbalance in its existing budget, the 7.5 per cent reduction in funding agreed in the 2010 Spending Review required approximately a 20 per cent reduction in expenditure over the four years to March 2015. The level of funding was only agreed at the end of the process, and during the Strategic Defence and Security Review process the Department has considered the implications of funding reductions of between 10 and 30 per cent. All more pessimistic than the final outcome. A primary focus of the Strategic Defence and Security Review was to bring the defence budget in to balance. The Department recognises that the force structures envisaged in the Strategic Defence and Security Review (known as Future Force 2020) will only be achievable with real term increases in the defence budget from 2015 after the current Spending Review period.

16 There was a complex set of interrelated cost, affordability, military and industrial issues which influenced decision-making. In addition to balancing the need to identify savings with delivering military capability to meet the new National Security Strategy, the decisions taken could adversely impact the United Kingdom warship-building industry and there were significant costs associated with cancelling contracts. Choices also had to be made regarding type and numbers of aircraft to be flown from the carriers initially, which in turn could affect the design and cost of the carriers.

17 The Department generated an evidence base against which to make strategic decisions on carriers and associated aircraft. Between June and September 2010, the Department undertook a series of studies to arrive at a view of the military priorities for the next ten years, and various scenarios for delivering these. It presented four cost-assured options, with a recommendation to the National Security Council on 14 September 2010. Subsequently, further options were costed and provided as requested by the National Security Council.

18 The Department balanced its military preferences with its contractual commitments, anticipated affordability constraints and the impact on the warship-building industry. In the face of what, in August 2010, was anticipated to be a significantly reduced budgetary provision, the military view was that the carriers were judged to be of secondary priority to other maritime capabilities. The military view, therefore, would have been to cancel the carriers before eliminating amphibious capabilities or making significant further reductions in destroyers or frigates. Although the Department also considered cancellation, which was feasible and offered significant medium-term savings, it concluded that this would have been unaffordable in the short term.

19 The variant of Joint Strike Fighter aircraft now being procured is more capable than the previous preferred option. The relative cost and capability advantages of the carrier variant of the Joint Strike Fighter have been demonstrated consistently by analysis undertaken by the Department over the last decade. In July 2010, the Department decided to delete the existing budgetary provision of £1 billion for its Deep and Persistent Offensive Capability requirement. The subsequent decision to change to the more capable carrier variant of the Joint Strike Fighter meant that it could also use the aircraft to address what would have been a capability gap for an aircraft to meet its Deep and Persistent Offensive Capability requirement if it had continued to buy the STOVL aircraft.

20 The Carrier Strike solution announced in Strategic Defence and Security Review was judged to offer a better balance of capabilities. The solution was first proposed by the Secretary of State for Defence at the National Security Council meeting taking the final decision on 7 October and had not been cost-assured. The outcome was to build both carriers, convert one to fly the carrier variant of the Joint Striker Fighter and leave the second carrier unconverted and therefore unable to launch or recover the carrier variant aircraft, with a gap in Carrier Strike capability of nine years. The financial impact of these changes over ten years would be a net saving of £3.4 billion against pre-Strategic Defence and Security Review financial projections for the new carriers and aircraft and the existing carriers and Harriers to be taken out of service.

21 A risk-based judgement was taken to go without Carrier Strike capability for almost a decade. The decision reflected the need to rationalise the existing fleets of fast jets to save money and also judgements about strategic context. The choice was between retaining the Harrier or the Tornado. The latter was chosen because it offered key capability advantages, notably for operations in Afghanistan. The decision will increase the challenge facing the Department, as it will have to regenerate a wider range of operating skills before the new carrier enters service.

Implementing the Strategic Defence and Security Review decision

22 The Department will take final investment decisions on Carrier Strike in 18 months. Under its current plans, the Department will be in a position to take final investment decisions on Carrier Strike in late 2012. If at this time it assesses that the approach being pursued is not the optimal balance of cost and capability to achieve value for money, it will revisit its approach to delivering Carrier Strike or decide which other elements of Future Force 2020 to forego.

23 The Alliance approach being used to build the Carriers is sensible and the build project is progressing well. The Alliance model has worked well with the design and build of the carriers progressing despite the significant changes the project has faced because of broader corporate decisions taken by the Department and during the Strategic Defence and Security Review. Evidence suggests that the incentives in the contracts are encouraging the Alliance partners to work together constructively.

24 The Department has been developing its thinking about how it will utilise the operational carrier to best effect to meet a wider range of military needs. Its emerging thinking is called Carrier Enabled Power Projection. To be successfully applied, the concept will require the Department to achieve a level of flexibility not seen elsewhere in the world with comparable carriers. If the Department is able to deliver this outcome, it is confident it would provide a potent combination of air and amphibious forces.

25 The Department has not yet generated quantitative assessments of a variety of uncertainties associated with the Strategic Defence and Security Review decisions. The uncertainties surround a variety of cost, technical, safety and commercial issues. The Department expects to have fully costed the aircraft-based risks and put in place mitigation plans by late 2011. For the carrier, the Department has embarked upon an 18-month Conversion Development Phase to understand the costs and risks associated with the installation of launch and recovery equipment for the new variant of aircraft. This is estimated to cost £76 million and the Department has so far committed £5 million. This will cover the work until the outcome of the Department's three-month exercise to match military assumptions from the Strategic Defence and Security Review with its spending settlement to balance Defence priorities and the budget over the long term. This exercise is due to finish in July 2011.

26 The Department has an incomplete understanding of the costs of the carrier decision. The Department's estimates are still immature but it now considers the cost of converting one carrier ranges from £800 million to £1,200 million. The next Strategic Defence and Security Review in 2015 will make a decision on what to do with the non-operational carrier. As yet the Department does not have a clear view on the costs and significant military risks associated with regenerating Carrier Strike capability.

27 There are risks with carrier conversion which the Department is working to mitigate. The current planning assumption is that the carrier will be fitted with the United States' new Electromagnetic Aircraft Launch System and other equipment. Risks include technical immaturity, safety issues, access to data from the United States and cost risks given lack of competition for the equipment.

28 There are risks associated with the integration of United Kingdom capabilities with the carrier variant of Joint Strike Fighter. The risks cover the interface between the carrier and the aircraft, the need for air-to-air refuelling, integration of United Kingdom specific weapons, absence of defined user requirements, the dependency on the United States for initial training, and the sufficiency of flight test assets to certify United Kingdom specific capabilities. In addition, cost risks remain as there are not yet firm prices for production aircraft.

Conclusion on value for money

29 The Strategic Defence and Security Review was conducted over a period of five months. Relatively early on during the Review, the National Security Strategy provided a policy baseline against which to plan future force structures. The Review was conducted in parallel with the Spending Review and the likely level of funding was only agreed at the end of the process. The Department therefore had to identify, cost and prioritise alternative capability options in an environment of considerable uncertainty. In our view, this is not an ideal situation in which to have to take strategic decisions – including those relating to Carrier Strike.

30 The outcome of the Strategic Defence and Security Review affects Carrier Strike in two ways, both of which could adversely affect the achievement of value for money. First, the Review is unaffordable unless there is a real terms increase in defence funding in the latter half of the decade. We are worried that the continuing difficulties the Department is facing in balancing its budget leaves Carrier Strike vulnerable to further changes in strategic direction as a result of broader corporate decisions taken to address this generic problem.

31 Second, the Review decision radically changed the Carrier Strike concept and introduced a decade long capability gap. We do not question the merits of this policy judgement. As part of the Review, the Department produced quantified analysis of the cost and short-term affordability implications of alternative Carrier Strike options to support strategic decisions. Quantification of military and industrial factors and the completeness of the financial data presented on some options was weaker. The inter-relationship between the various factors involved in the Carrier Strike decision is complex. It is not clear to us from the papers we have seen how, even at a strategic level, they were brought together to enable the Accounting Officer to reach a judgement on value for money.

32 As we look forward, taking these two elements together, we are deeply concerned about the risks to the achievement of value for money on what were previously relatively mature projects with understood risks and funded mitigation plans. 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.

Part One

The status of the Carrier Strike project before the Strategic Defence and Security Review began

1.1 Since HMS Argus entered service in 1918, the United Kingdom has operated aircraft carriers. Together with the aircraft which operate from them, carriers sit at the heart of Carrier Strike capability. In 2008, the Department defined the principal role of Carrier Strike "to provide an expeditionary offensive air capability to contribute to focused intervention, power projection and peace enforcement operations."

1.2 The 1998 Strategic Defence Review committed to the replacement of the three existing Invincible Class aircraft carriers "from around 2012 by two larger, more versatile, carriers capable of carrying a more powerful force, including a future carrier-borne aircraft to replace the Harrier, able to operate fixed-wing aircraft and the full spectrum of defence helicopters." The Department's subsequent approach to delivering Carrier Strike capability in an affordable way, and determining the ways in which it might be used, has been significantly influenced by three interlinked issues:

- the choice of aircraft that will operate from the carriers (paragraphs 1.4-1.7);
- how the carriers would be delivered and their affordability (paragraphs 1.8-1.14); and
- its long-term relationship with the United Kingdom warship-building industry (paragraphs 1.15-1.18).

1.3 This Part of our Report examines each of these issues and sets out the position before the Department entered the 2010 Strategic Defence and Security Review (SDSR).

The choice of aircraft

1.4 The single most important factor in planning the delivery of Carrier Strike is the choice of aircraft[8], as this drives much of the design of the carriers themselves. The two principal options are:

- **Short Take-Off and Vertical Landing (STOVL),** where the aircraft are self-launching and able to land on a flat deck unaided; and

8 The generic requirement to meet both land- and sea-based aircraft is known as the Joint Combat Aircraft.

- the **carrier variant,** which requires the ship to support both take-off, through launch equipment (catapults), and landing with recovery equipment (arrestors), to slow and stop the landing aircraft. The equipment requires additional space in the carrier for power generation.

1.5 Whilst the 1998 Strategic Defence Review did not prescribe which aircraft would be procured, the Department's planning assumption was always that the United States-led development of the new Joint Strike Fighter (JSF) would meet its aircraft requirement for carriers.

The aircraft variant selected in 2002 was not the most operationally or cost-effective option

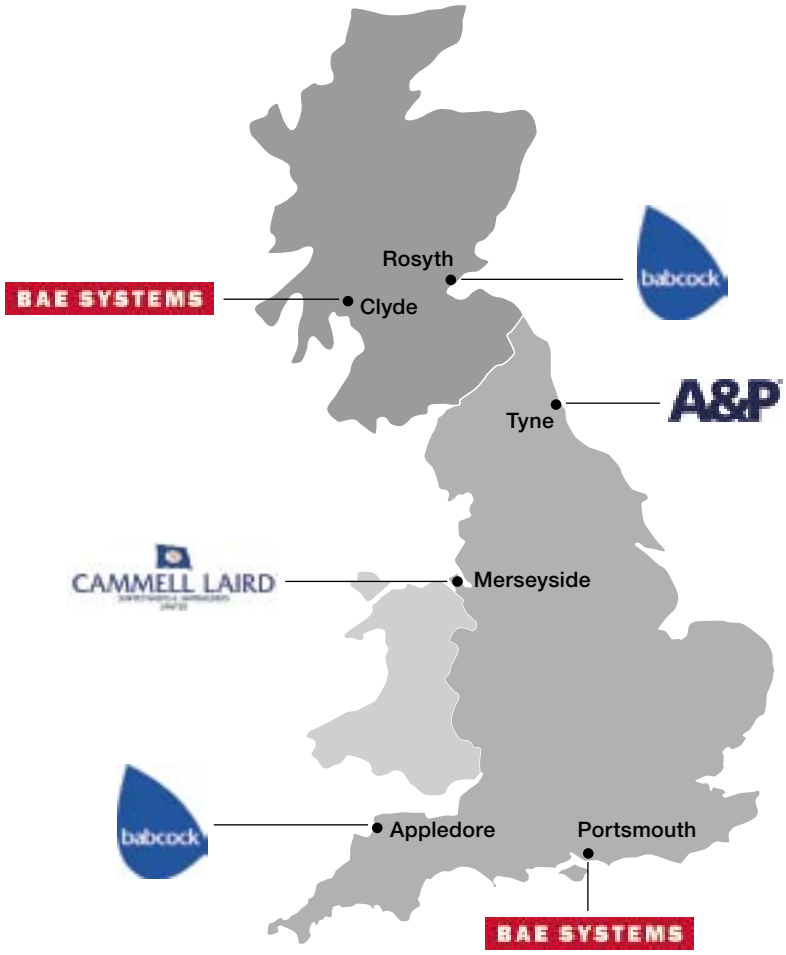
1.6 The JSF offers advanced capability over the Department's existing combat aircraft. The aircraft are multi-role fighters which can perform ground attack, reconnaissance, and air defence missions with stealth capability. It is expected to be the premier strike aircraft until 2040. The aircraft is being designed in three variants, two of which (STOVL and carrier variant) would be suitable for operations from carriers. The STOVL variant of the aircraft is the closest successor to the Harrier aircraft which the Department had flown from its carriers since 1980. The Department had consistently selected the STOVL variant as its favoured option since 2002, and the carrier design was optimised for STOVL operations. The final decision on variant choice was due in January 2011. As such, the Department chose a carrier design which was 'adaptable' and could be fitted with alternative launch and recovery equipment should the choice of aircraft change.

1.7 Beyond its role in Carrier Strike, JSF is central to the Department's Combat Air capability plans. Making choices between the JSF variants requires the Department to make difficult judgements about the relative operational and cost merits of alternatives in a range of scenarios. To inform such decisions the Department has developed a structured quantitative method of analysis known as Combined Operational Effectiveness Investment Appraisal. This analysis has consistently shown that the carrier variant is more capable and cheaper to buy and support throughout its operational life compared to the STOVL variant. The decision to select the STOVL variant had taken into account a number of wider political, military and industrial factors. The SDSR changed the JSF to the carrier variant in 2010.

How the carriers are being delivered and their affordability

1.8 The new Queen Elizabeth Class carriers will be the largest warships ever built in the United Kingdom. Their design and construction is a significant engineering challenge. As **Figure 1** illustrates, the ships are being constructed in blocks at six shipyards around the United Kingdom with final assembly at Rosyth. The scale of the activities is vast; the ships will be 65,000 tonnes at full displacement – over three times the size of the current Invincible Class carriers – and 80,000 tonnes of steel is on order for the two ships, three times that used in Wembley Stadium.

Figure 1
Location of work around the UK



Source: Aircraft Carrier Alliance

1.9 The scale of the design and construction task, and the risks for the Department and any single contractor taking on the project, led the Department and industry to form an Aircraft Carrier Alliance to build the carriers. The Alliance comprises the main industrial participants – BAE Systems, Thales, Babcock Marine, and the Department.

1.10 The decision to invest in the carriers followed the Department's regular processes with the deal scrutinised by the Investment Approvals Board and Ministers. The project was approved to proceed by the then Prime Minister in July 2007 on the basis that the Final Target Cost of £3.65 billion would be affordable. This was some £234 million more than was within the budget and the contract was designed to incentivise the Alliance partners to close the cost gap.

1.11 The carrier contract, negotiated by the then Defence Commercial Director[9], was structured to provide incentives for all of the Alliance members to work together to progress the project and minimise costs. The arrangements are underpinned by open book accounting and a single management information dataset. The terms of the contract, for example on termination, are typical of those in other large defence contracts.

1.12 The manufacturing contract for the carriers was signed in July 2008. The Department undertook an Equipment Examination within six months to address short-term affordability issues in the equipment budget. Although short-term costs were reduced by £450 million by extending construction by two years, the full additional costs of the rescheduling was £1.56 billion.[10] This decision was poor value for money and the Committee of Public Accounts considered this "a new benchmark in poor corporate decision-making[11]". One effect of the Department's decision was that the original cost reduction incentives placed on the Alliance became unworkable.

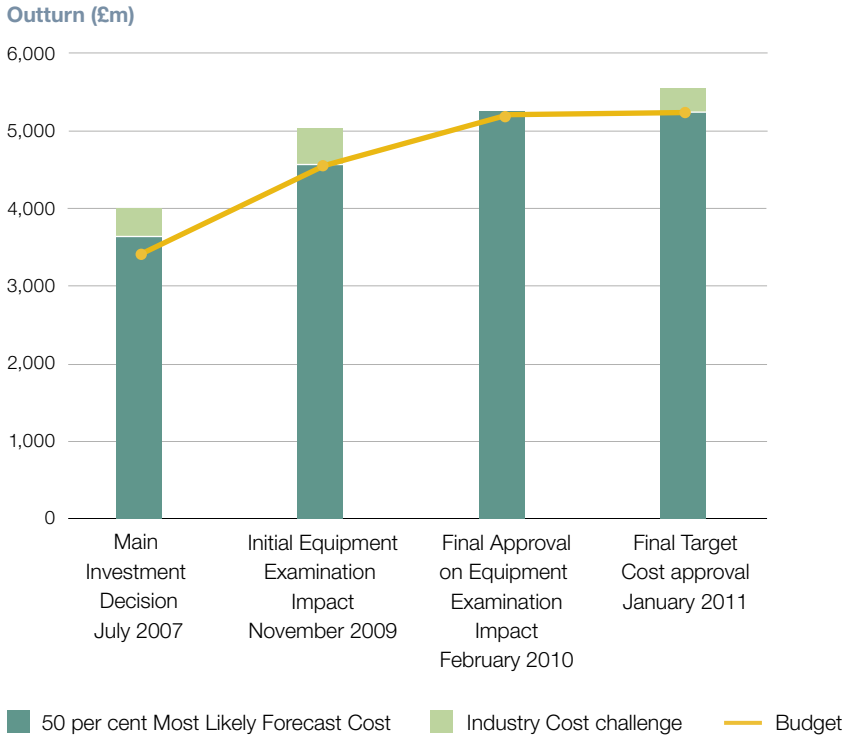
1.13 Following the Equipment Examination a Final Target Cost of £5.24 billion was negotiated with the Alliance partners in July 2010 (but not signed until January 2011, after the SDSR). The payment arrangements are based on the Department reimbursing all allowable costs with Alliance partners incentivised to achieve a Target Cost. The Department and Alliance partners share equally any gains from coming in below Target Cost. The Target Cost would have to be exceeded by £2.5 billion before Alliance profits were foregone. After this point the Department would meet all remaining costs.

9 Amyas Morse, subsequently appointed as Comptroller and Auditor General in June 2009. The inside front cover sets out the governance of this examination by the National Audit Office.
10 Comptroller and Auditor General, *Ministry of Defence*, *Major Projects Report 2010* Session 2010-11, HC 489-I, National Audit Office, 15 October 2010.
11 HC Committee of Public Accounts, *The Major Projects Report 2010*, Twenty-third Report of Session 2010-11, February 2011.

1.14 As **Figure 2** shows, the estimated cost of the carrier project has consistently exceeded the Department's budgetary provision. To help address the budgetary shortfall against the Final Target Cost estimate of £5.24 billion, the Alliance has agreed a £312 million 'cost challenge'. These are savings contractors need to find to meet the Final Target Cost. If the savings are not achieved, there is a risk of cost growth.

Figure 2

How estimated project costs and budgetary provision changed over time



NOTE

1 The cost estimates represent the figures for which the Department estimates that there is a 50 per cent likelihood that the outturn costs will not exceed this figure. The Department also establishes 10 per cent and 70 per cent figures on the same basis.

Source: National Audit Office analysis of Departmental documentation

The long-term relationship between the Department and the United Kingdom warship-building industry

1.15 The 2005 Defence Industrial Strategy[12] confirmed the policy requirement to sustain an industrial capability to build as well as integrate complex ships in the United Kingdom, with the main issue being the scale of the capacity required to do this work. It also highlighted the need to rationalise the capacity of the industry as the Department's long-term demand for new warships was likely to reduce. The Department's chosen solution to deliver the Defence Industrial Strategy was to agree a 15-year Terms of Business Agreement (ToBA) with its main provider of warship-building capacity – BAE Systems.[13] The carrier contract was the single biggest warship-building deal the Department had ever agreed and was the catalyst for the negotiation of the ToBA, with the initial negotiations led by the then Defence Commercial Director.[14]

1.16 The Department assessed that the ToBA was likely to deliver benefits of between £350 million and £900 million over 15 years through allowing the industry the workload and time to rationalise. An important consideration was that under HM Treasury-approved Yellow Book framework, as the major customer of BAE Systems warship-building business, the cost of future industrial under-utilisation would fall on the Department as would a proportion of the rationalisation costs. The liabilities are not created by the ToBA, and at its expiration the Department would no longer be liable for any rationalisation costs.[15]

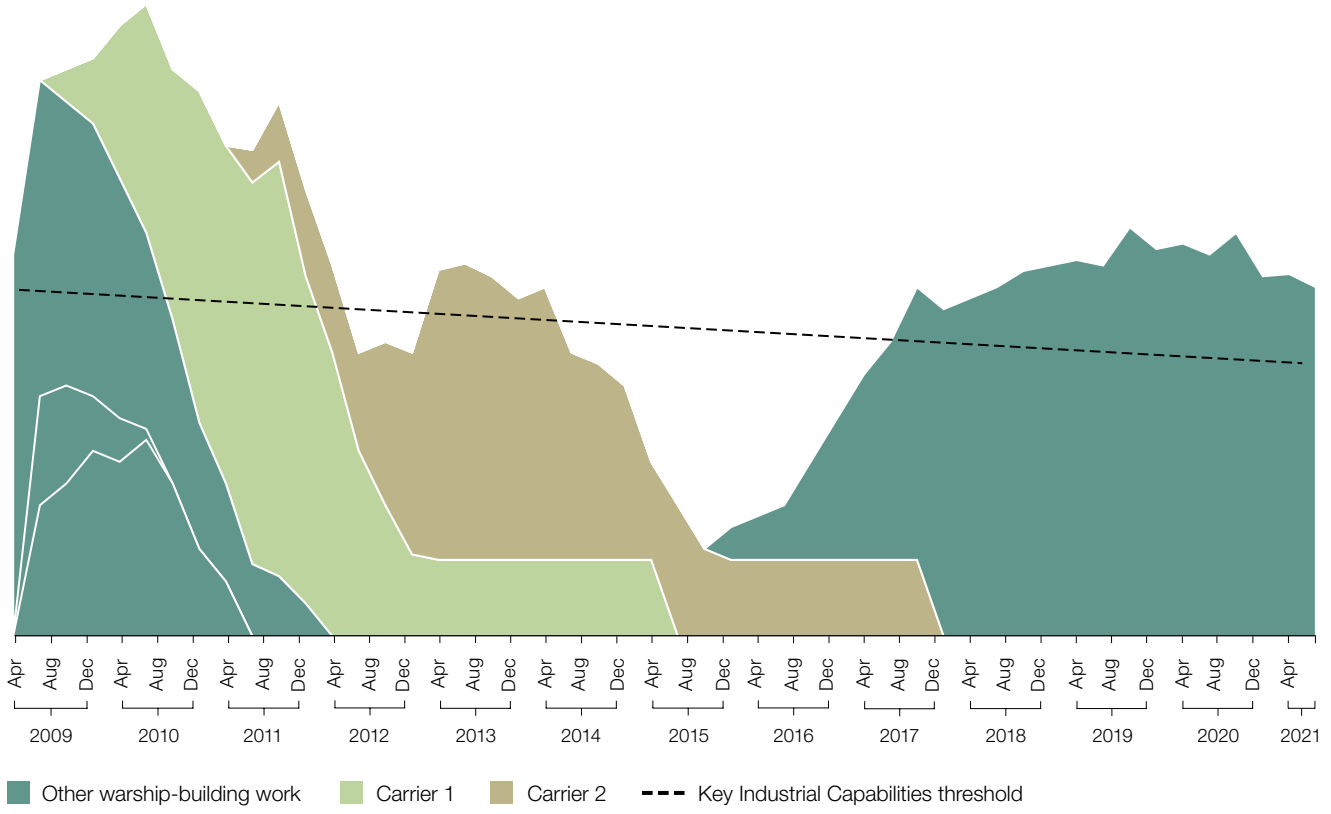
1.17 The ToBA was signed in July 2009. The carrier contract of July 2008 was signed on the basis of a Heads of Terms agreement for the ToBA. The ToBA commits BAE Systems shipbuilding to reach world class standards of value for money in shipbuilding as determined by third party benchmarking by 2018 and provides guarantees to BAE Systems of a minimum level of warship building and support activity of around £230 million a year. In return, BAE Systems agreed to sustain a set of quantified Key Industrial Capabilities. In years where the workload falls below the required levels, the Department is liable for funding the shortfall to maintain the Key Industrial Capabilities.

1.18 **Figure 3** overleaf shows the projected warship-building workload for BAE Systems under the ToBA, as at September 2010, and highlights the fact that the carrier is integral to the deliverability of the core workload guaranteed by the Department. The risk of the deal for the Department is that when there is insufficient workload to maintain the required capabilities to meet future Defence needs, it will have funding liabilities to protect industrial capabilities to meet future Defence needs for which it will receive little immediate benefit to either defence procurement or support to ongoing operations.

12 Ministry of Defence, *Defence Industrial Strategy* (Defence White Paper) Cm 6697, December 2005.
13 The Department made it a precondition of signing the carrier contract that the two main remaining warship builders – BAE Systems and VT – agreed to merge their surface shipbuilding businesses. The companies did so and formed a joint undertaking called BVT in July 2008. BAE Systems subsequently purchased the VT share in the undertaking on 30 October 2009 and renamed the business BAE Systems Surface Ships.
14 Amyas Morse, now Comptroller and Auditor General. See Footnote 6.
15 The 'Yellow Book' is the regulations, dating from 1968, used by the Department when pricing work to be procured under single-source conditions without reference to competition. The existing framework is described by the Government Profit Formula and Associated Arrangements of which the Department is the sole user.

Figure 3

Key warship-building workload profile for BAE Systems under the ToBA



NOTE

1 Workload position as at September 2010.

Source: National Audit Office analysis of Departmental data

Part Two

The Strategic Defence and Security Review

2.1 The SDSR made changes to the way in which the Department will use and deliver Carrier Strike capability. In announcing the results of the Review the Prime Minister explained that: "We will build both carriers, but hold one in extended readiness.[16] We will fit the 'cats and traps' – the catapults and arrestor gear to the operational carrier. This will allow our allies to operate from our operational carrier and allow us to buy the carrier version of the Joint Strike Fighter which is more capable, less expensive, has a longer range and carries more weapons. We will also aim to bring the planes and carriers in at the same time".

2.2 This Part of our Report:

- explains how the SDSR decisions were made (paragraphs 2.3-2.4);
- examines how the Department generated information to support SDSR decision-makers (paragraphs 2.5-2.12);
- presents the key factors influencing the choice of options (paragraphs 2.13-2.25); and
- sets out the capability and cost implications of the SDSR for Carrier Strike capability (paragraphs 2.26-2.32).

How SDSR decisions were made

2.3 The decision to undertake the SDSR was announced in May 2010, with the outcomes presented to Parliament by the Prime Minister on 19 October 2010 and published the same day. In contrast to previous Strategic Defence Reviews, which were run largely by the Department and only covered defence-related issues, the SDSR was cross-departmental. The key objectives of the SDSR were to "set a clear target for the national security capabilities the UK will need by 2020, and chart a course for getting there[17]".

16 There is no definition of 'extended readiness' but at best it means the capability cannot be regenerated at less than a year's notice, although it may take longer.
17 *Securing Britain in an Age of Uncertainty: The Strategic Defence and Security Review*, HM Government, 2010, page 9.

2.4 Leadership of SDSR rested with the newly formed National Security Council, a Cabinet Committee chaired by the Prime Minister. It was attended by the Secretary of State for Defence, the Departmental Accounting Officer and the Chief of the Defence Staff.[18] Its terms of reference are "to consider matters relating to National Security, Foreign Policy, Defence, International Relations and Development, Resilience, Energy and Resource Security in the round[19]". The SDSR decisions relating to the carriers were taken by this Committee with support from:

- the National Security Adviser, assisted by an SDSR team in the National Security Secretariat, was responsible for advising the National Security Council; and
- the Defence Strategy Group, established by the Secretary of State for Defence and attended by the National Security Adviser, which acted as the Department's advisory body to the Secretary of State for Defence and considered analysis and cost estimates for a range of military options.

The Defence Strategy Group was offered advice from the Chief of Defence Staff and other Service Chiefs. In addition, a Senior Judgement Panel, chaired by the Vice Chief of the Defence Staff, provided high-level military comments on the robustness of force structure options and offered views on the military priorities.

How the Department supported National Security Council decision-makers

2.5 This section of our report examines how the Department undertook its analysis, the key factors considered, and the options prepared for the National Security Secretariat.

The Department analysed a range of options to support strategic decisions

2.6 The Department undertook its analysis in three main waves of activity over a period of five months. Some of the work was iterative, but where costings for different options were requested there was progressively less time for the Department to prepare and assure the information as the SDSR moved towards its conclusion. The following paragraphs explain the process.

2.7 **The creation of a long list of options.** During June and July 2010, a series of reports were produced which, drawing on previous work, presented a range of options for delivering three levels of savings and explaining the implications of each for the Armed Forces. Production of each report was led by an individual from within the Department without direct responsibility for the topic area. We have reviewed the two reports relevant to Carrier Strike (Maritime Environment and Air Environment) and consider that they were well put together given the time constraints and that the Department chose to produce them (due to the sensitivity) without discussion with industry. Overall, the reports provided a sound evidence base against which to begin to make strategic decisions.

18 The permanent membership of the National Security Council is the Prime Minister, the Deputy Prime Minister, the Chancellor of the Exchequer, the Secretary of State for Foreign and Commonwealth Affairs, the Home Secretary, the Secretary of State for Defence, the Secretary of State for International Development and the Security Minister, the Chief Secretary to the Treasury, the Secretary of State for Energy and Security and the Minister for Government Policy. The Business Secretary also attended the meetings on defence issues. Officials attended as required.

19 *Securing Britain in an Age of Uncertainty: The Strategic Defence and Security Review*, HM Government, 2010, page 9.

2.8 The identification and short-listing of options. Towards the end of July 2010, the National Security Council endorsed the 'Adaptable Britain' posture which was later enshrined in the National Security Strategy. The military Senior Judgement Panel drew on this framework to offer advice on the relative utility of different combinations of platforms and capabilities in a range of potential future scenarios. The Defence Strategy Group used this work to shortlist areas for ongoing option development, including the need for none, one or two carriers. This work was also to consider how to maximise other capabilities such as amphibious operations alongside Carrier Strike, and implications of which JSF aircraft to use.

2.9 In mid-September 2010, four costed options were prepared for the Defence Strategy Group (see options A to D in **Figure 4** overleaf).[20] It is not clear how these four options were selected or why they did not include any discussion of the aircraft type and associated modifications to the carriers. In our opinion the costings were put together on a reasonable basis given the time constraints and the very limited consultation with industry (BAE Systems did offer comments on option B). The Department sought external assurance from three independent consultants on option B and assurance from its own costing experts on the costs of cancelling the second carrier. The Defence Strategy Group meeting on 14 September 2010, agreed to recommend Option A – the purchase of both carriers, with one being used in Carrier Strike with the JSF STOVL variant and the other going into extended readiness – to the National Security Council meeting on 28 September 2010. The Defence Strategy Group considered that this represented the least-cost option to the Department in the short term and that "any option that increased spending would result in capability cuts elsewhere".

2.10 Preparation of a further two costed options. Following the 28 September meeting of the National Security Council, the Department was asked by the National Security Secretariat to prepare two further costed options (see options 2 and 3 in Figure 4 overleaf). We understand that the Department continued to work closely with the Cabinet Office in the development of its paper ahead of the National Security Council meeting on 7 October. The options were not cost-assured but, as with the 28 September options, were reviewed by HM Treasury.

2.11 Preparation of a further option. Drawing on its earlier work, the Department prepared a further option for the Secretary of State to be judged against an alternative option prepared by the Department for the National Security Council (see Figure 4). The Secretary of State's option was taken directly to the 7 October National Security Council meeting by the Secretary of State. This option suggested changes to the emerging force structure, including increasing the assets available to meet the highest maritime military priorities, emphasising the greater military utility of Tornado for operations in Afghanistan and to provide contingent capability for other operations, and suggested deleting Harrier and recreating Carrier Strike capability around 2020.

20 A further costed option was prepared but dismissed before Defence Strategy Group consideration.

Figure 4
Overview of options prepared for Carrier Strike by the Department

		Impacts	Savings years 1-4 (£m)	Savings years 1 to 10 (£m)
September 2010 (for Defence Strategy Group consideration)				
A	Complete two carriers Operate one and hold one at extended readiness[1] Reduce and delay STOVL JSF	Operational (negative) Industrial (neutral) Interoperability with allies (negative)	710	1,190
B	Complete one carrier Reduce and delay STOVL JSF Replace second carrier with Frigates	Operational (negative) Industrial (negative) Limited value of alternative frigates (negative)	-90	210
C	Complete one carrier Cancel second Accept the demise of shipbuilding industry	Operational (negative) Industrial (negative)	-797	440
D	Cancel both carriers Accept demise of shipbuilding industry Maintain Tornado until 2025 then replace with JSF	Operational (negative) Industrial (negative) Cost (negative) Affordability (negative)	470	6,300
October 2010 (prepared by Department for National Security Secretariat)				
1	Same as option A	As above for A	710	1,190
2	Build one carrier Replace second carrier with two Type 45 Destroyers Change to JSF carrier variant Fit carrier with launch and recovery equipment	Operational (negative for carriers but improved for JSF) Industrial (neutral) Interoperability with allies (positive)	-465	-910
3	Build one carrier, placed into extended readiness Replace second carrier with two Type 45 Destroyers	Operational (negative) Industrial (neutral) Interoperability with allies (negative) No immediate JSF	255	3,500
National Security Council option (prepared by Department for the Council)				
	Same as option A and in addition delete Tornado	Operational (negative) Industrial (neutral) Interoperability with allies (negative)	1,172	4,504
Option presented by Secretary of State to the National Security Council 7 October (prepared by Departmental officials)				
	Build both carriers, one to extended readiness, one converted to fly carrier variant JSF Delete Harriers Delay carrier variant JSF	Operational (negative over next decade then negative for carrier, positive for JSF) enhanced amphibious and naval constabulary capability Industrial (neutral) Interoperability with allies (positive)	1,079	2,564

NOTE

1 There is no definition of 'extended readiness' but at best it means the capability cannot be regenerated at less than a year's notice, although it may take longer. The 'readiness' of the 7 October option is materially different from the readiness in Option A and the National Security Council option which involved the STOVL JSF and a carrier ready to fly the planes being in readiness. The chosen option has no 'ready' carrier as it would require conversion and the fitting of catapults and arrestor gear to launch and recover aircraft.

Source: National Audit Office analysis of Departmental papers

2.12 Compared to the 7 October National Security Council option (Figure 4), taking forward the Secretary of State's option would be almost £2 billion more expensive over the next ten years but with virtually all of the additional funding required after the four-year Spending Review period. The cost and affordability analysis supporting the Secretary of State's option was of similar quality to the three options provided to the National Security Secretariat on 1 October. There was no evidence of cost-assurance of the figures, and the Treasury did not review them. We have not seen evidence which sets out with a similar level of clarity how the Department understood the capability implications of operating for a decade without a Carrier Strike capability or what capabilities it would forego to provide the additional £2 billion of funding required when compared to the National Security Council option. It is not clear how any of these options was assessed against a capability baseline to establish the relative value for money levels provided by each option.

The key factors influencing the choice of options

2.13 Effective strategic decisions are predicated on having a clear understanding of the outcomes desired and the level of funding available together with authoritative data on the relative utility, costs and broader implications of different delivery options. In the absence of any of these factors it will be more difficult to reach decisions which make optimal value of the resources available. Decisions around Carrier Strike required the relative merits of a complex set of interrelated aspects to be considered. Amongst these were affordability, the costs of cancelling any contracts, military priorities, the variant of JSF and industrial impacts.

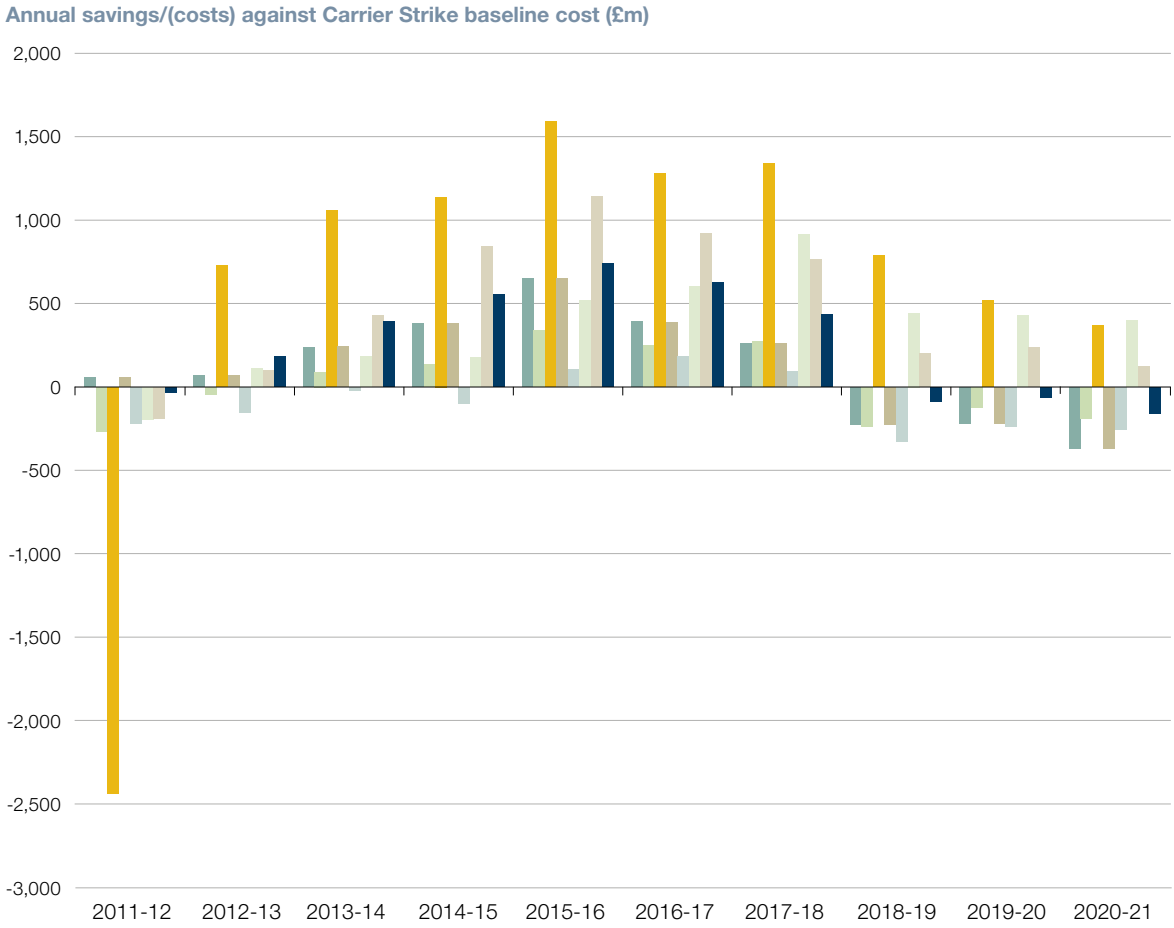
2.14 Affordability. The SDSR was conducted in parallel with the Spending Review covering the four years from 2011-12 to 2014-15. Whilst there was always an expectation that, as with other departments, defence funding would reduce as a result of the Spending Review, the scale of the reduction was unclear for much of the SDSR period. The analysis undertaken to support the options the Department put forward therefore focused significantly on affordability issues, particularly those affecting the next four years. For example, the Air and Maritime Environment studies considered the implications of funding reductions of between 10-30 per cent. **Figure 5** overleaf presents the short- and long-term impact on expenditure of the Carrier Strike options. Option D to cancel Carrier Strike presents the highest level of savings over a ten-year period at £6.3 billion, but at a significant cost in the first year of £2.4 billion due to contractual liabilities. The Department considered that this option would collapse the United Kingdom's warship-building industry.

2.15 The final Spending Review settlement was a reduction of 7.5 per cent in funding over the four-year period. The likely level of funding only became apparent very late in the decision-making process. The Department therefore had to identify, cost and prioritise alternative capability options in an environment of considerable uncertainty – in our view, clearly not an ideal situation in which to have to take strategic decisions. For the Department the funding uncertainty was exacerbated by the major challenge it faced to address the shortfall between its planned programme and likely future budget of between £36 and £38 billion[21] over the next decade.

21 *The Major Projects Report 2009*, Committee of Public Accounts, Twenty-third Report of Session 2009-10, March 2010, p22.

Figure 5

Annual savings of options against baseline for years 1 to 10 of the spending review



Option										Total
A	50	60	230	370	640	380	250	-220	-210	-360	1,190
B	-260	-40	80	130	325	240	265	-230	-115	-185	210
D	-2,430	720	1,050	1,130	1,580	1,270	1,330	780	510	360	6,300
1	50	60	230	370	640	380	250	-220	-210	-360	1,190
2	-210	-145	-15	-95	95	175	85	-320	-230	-250	-910
3	-190	105	175	165	505	590	905	435	420	390	3,500
National Security Council	-181	101	417	835	1,133	909	757	193	227	113	4,504
Secretary of State	-26	174	382	549	732	620	426	-80	-58	-155	2,564

NOTE

1 Option C was discarded before discussion.

Source: National Audit Office analysis of Departmental documentation

2.16 A primary focus of the SDSR was to bring the defence budget in to balance over the Spending Review period. The Department recognises that the force structures envisaged in the SDSR (known as Future Force 2020) will only be achievable with real term increases in the defence budget after the current Spending Review period. In publishing the SDSR in October 2010 the Prime Minister stated:

> "The White Paper we have published today sets out a clear vision for the future structure of our armed forces. The precise budgets beyond 2015 will be agreed in future spending reviews. My own strong view is that this structure will require year-on-year real-term growth in the defence budget in the years beyond 2015. Between now and then the Government are committed to the vision of 2020 set out in the review and we will make decisions accordingly."

If funding is not increased the Department will have to take difficult judgements about which capabilities it will need to scale back or forego completely.

2.17 The cost of cancelling the carriers. Compared to the procurement costs of continuing with the existing project and building two carriers, building one carrier would save just £200 million (0.4 per cent) and cancelling both carriers would save £1.2 billion (23 per cent). As **Figure 6** shows, the relatively low level of savings reflects the costs to the Department of either cancelling or significantly amending the carrier contract, when the project was already well advanced, and the payments it would continue to be liable for under the ToBA for the protection of industrial capability to meet future defence needs.

Figure 6
Summary of where cancelling one or two carriers would make savings

Cost category	Cancel one carrier Cost/(Saving) (£m)	Cancel both carriers Cost/(Saving) (£m)
Remaining non-recurring costs e.g. infrastructure and design, and remaining costs of the first carrier, Queen Elizabeth	0	(2,200)
Remaining costs of the second carrier, Prince of Wales	(1,000)	(1,000)
Removed need for risk allowance	0	(400)
Liabilities through ToBA (Key Industrial Capability payments) and other contractual liabilities	800	2,400
Total saving	**(200)**	**(1,200)**

Source: Ministry of Defence, Queen Elizabeth Class Value for Money, Discussion Paper, 22 June 2010

2.18 The Department was mindful of the opportunity costs of continuing to invest in the carriers. It did look at alternative ways to fill the gap in workload left by cancelling a carrier. For example, it examined whether it would be feasible or militarily desirable to build additional frigates or corvettes. The Department concluded that alternative projects would cost significantly more than cancelling the second carrier would save. As paragraphs 1.15-1.18 explained, the ToBA is structured around sustaining Key Industrial Capabilities by providing a workload sufficient to maintain the required skills or paying agreed support in the absence of such a workload. If the Department chose to cancel the carriers and was unable to substitute suitable alternative work it would remain liable to make payments to BAE Systems[22], as estimated on workload assumptions in September 2010. **Figure 7** shows how cancelling the second carrier would increase the Key Industrial Capabilities gap.[23]

2.19 The variant of JSF to be procured. The SDSR process looked at rationalising the Combat Air fleet to two main aircraft types. Within this context, the relative cost and capability advantages of the carrier variant, demonstrated consistently by analysis undertaken by the Department over the last decade, took on greater significance.

2.20 In July 2010, the Department decided to delete the existing budgetary provision for its Deep and Persistent Offensive Capability requirement. The decision saved £1 billion over the ten-year planning period. The October 2010 decision to change to the carrier variant of the JSF meant that the Department could use the aircraft to cover what would otherwise have been a capability gap for Deep and Persistent Offensive Capability. The STOVL variant of JSF, which formed the baseline for the four Carrier Strike options which the Department prepared in September, could not meet the Deep and Persistent Offensive Capability requirement.

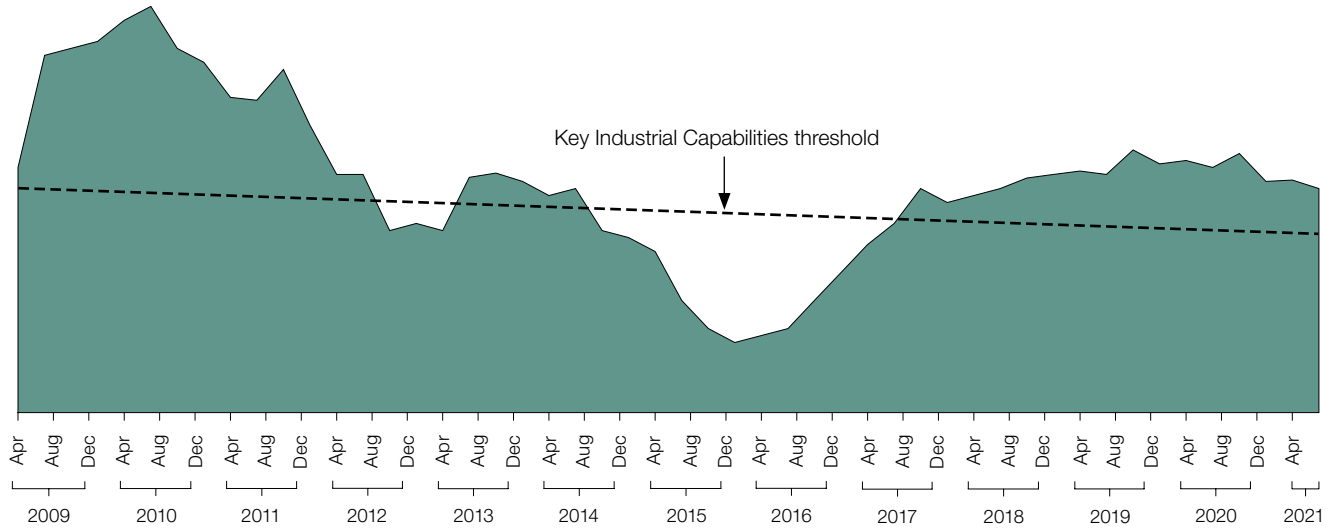
2.21 The Department recognised that there would be costs associated with converting the carriers to operate the carrier variant instead of the STOVL variant. On 12 August the Department wrote to the Secretary of State advising that conversion of one carrier with launch and recovery equipment would cost around £500 million (powered by steam) to £800 million (powered by an Electromagnetic Aircraft Launch System) (see paragraph 3.8 for latest estimates). The estimates were based on July 2010 data from the Aircraft Carrier Alliance. The numbers were subject to a high degree of uncertainty, with estimates varying by up to 50 per cent depending on the technology used and whether the equipment was fitted during build or whilst in refit.

2.22 The Department recognised the attractiveness of the carrier variant but on the basis of the additional costs and its anticipated Spending Review settlement, the Department considered the conversion unaffordable as the emphasis was on not adding costs to the project in the short term. There is no documentary trail showing that the Department's position on this changed from mid-August to late-September when the Department was asked by the National Security Council to provide the National Security Secretariat with costs for a carrier variant option.

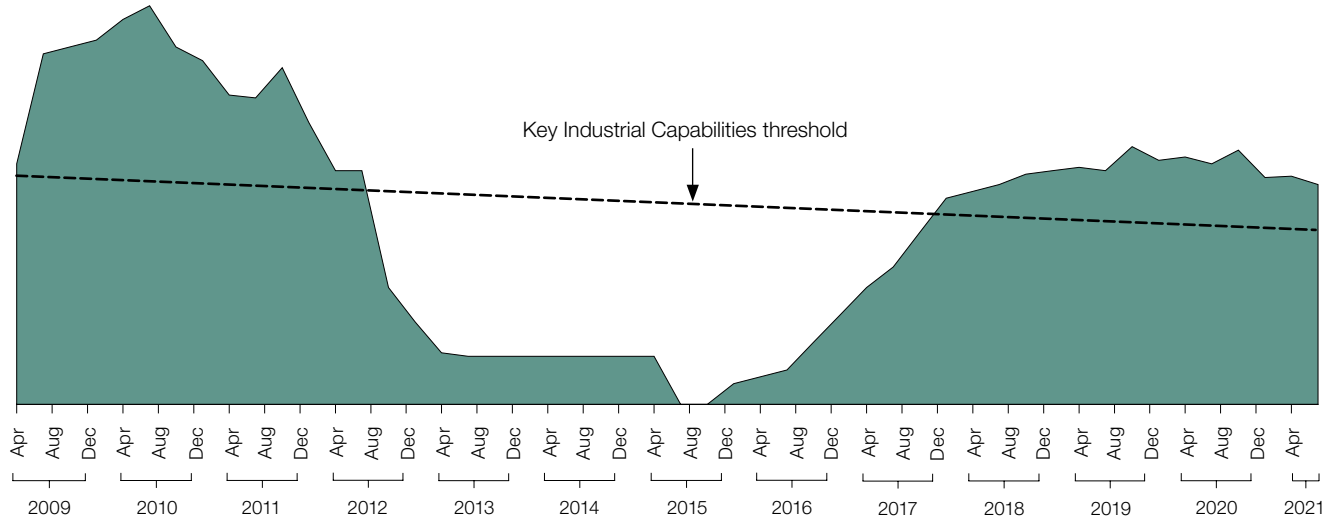
22 The scale of potential payments is commercially sensitive.
23 The payment of Key Industrial Capabilities charges does not enable industry to maintain design or construction skills indefinitely in the absence of suitable work, thus jeopardising the existence of the industry.

Figure 7
Key Industrial Loading funding profile

Workload with two carriers



Workload with one carrier



NOTE

1 Workload estimates are as at September 2010.

Source: National Audit Office analysis of Departmental data

2.23 The relative military utility of carriers. The Senior Judgement Panel had concluded that Carrier Strike supported the Adaptable Britain posture; however, in the event of a serious cut in funding it would be prioritised below other capabilities such as amphibious operations and naval constabulary. This was based on its view of the United Kingdom's requirements over the next decade for Future Force 2020. In September 2010, the Department's assumption was that the likely reduction in its funding would be twice as great as the 7.5 per cent reduction financially agreed. Working within this funding contraint, the Defence Strategy Group agreed, that cancelling both carriers was the preferred military option rather than eliminating amphibious capabilities or making significant further reductions in destroyers or frigates and asked that the National Security Council be notified of this position. The Group acknowledged that this might be unacceptable to the National Security Council as cancelling both carriers would give rise to considerable costs in the early years and would result in the collapse of the United Kingdom warship-building industry. It therefore recommended the construction of both carriers with one being operational and one in extended readiness.

2.24 Industrial factors. We have seen no analysis undertaken to examine whether, in the envisaged current and future security environment, the rationale underpinning the industrial policy set out in the 2005 Defence Industrial Strategy remains extant. For example, it would have been useful to have an understanding of whether sustaining the full range of industrial capabilities could be justified in terms of military benefit or risk, the cost premiums (if any) being paid and the broader economic benefits of sustaining United Kingdom warship-building. At its meeting on 2 September 2010, the Defence Strategy Group noted that a priority action was to confirm the Government's position on maintaining a sovereign warship-building capability. From the papers we have seen, we are not aware whether this policy was reviewed by the Government during the SDSR.

2.25 The SDSR committed to publishing a Green Paper by the end of 2010, setting out its intended approach to industrial policy and to the closely related issue of technology policy, with a view to a White Paper that formalises Defence Industrial and Technology policy for the five years until the next strategic review.

The outcome of SDSR for Carrier Strike

2.26 The principal SDSR decisions affecting Carrier Strike were to: build both carriers but with one kept at extended readiness; changing the variant of JSF to the carrier version; and, fitting launch and recovery equipment to the operational carrier (the Secretary of State's option in Figure 4). The following paragraphs outline the key capability and cost changes arising from the SDSR decisions. We examine how the Department is planning to understand the risks and uncertainties around the changes in Part Three.

Capability

2.27 The decision to buy the carrier variant of the JSF will deliver an aircraft with greater range, payload and the ability to stay over a target area for longer when compared to the STOVL variant. The number of aircraft to be routinely embarked on the carrier for operations has initially reduced to 12, but the carrier will retain the capacity to deploy up to the 36 fast jets originally envisaged. The Department had stated a requirement for the Carrier Strike capability to be able to generate daily sortie rates of 72 with 36 fast jets embarked. As a result of the SDSR decision, the sortie rate will reduce to 20 – a level which the Department considers sufficient to meet the immediate requirements of the National Security Strategy. We have seen no quantitative analysis to explain how this judgement was reached. We note that the carrier still has the capability to deploy 36 aircraft should this be necessary in the future, and the Department decides to buy sufficient aircraft.

2.28 Having only one carrier restricts the at-sea capability to five years in seven. The original two-carrier solution would have allowed approximately 435 days at sea a year between the two carriers, giving a continuous at-sea presence. The post-SDSR outcome will give approximately 150-200 days at sea each year on average. The Department considers that the lower level of at-sea days is all that is required to support air combat training levels for the reduced number of jets initially embarked.

2.29 To mitigate the risks of operating a single carrier, the Department is planning greater cooperation with allies, principally the United States, who operate the same aircraft, to fill any gaps in capability. There is also the possibility of interoperability with France and a commitment to increased cooperation was a feature of the November 2010 Anglo-French treaty on defence and security. However, the feasibility of flying the JSF carrier variant from the French carrier and the French aircraft (the Rafale) from the United Kingdom carrier is as yet unclear.

2.30 Prior to the SDSR the carriers were due to be in service by 2016 and 2018, respectively. The Department anticipates that the conversion will delay the in-service date by two years, so Carrier Strike will not be operational until late 2020. This will lead to a gap in Carrier Strike capability for the next nine years. The Department had intended to continue the existing Invincible Class Carriers and Harrier aircraft until the new carriers were available. Following the SDSR, HMS Ark Royal and Harrier aircraft have both been withdrawn from service. HMS Illustrious remains in service as a helicopter carrier. The rationale for this decision was the need to rationalise the existing fleets of fast jets to save money and a judgement that the United Kingdom could call on allies for the next decade. The choice was between retaining Harrier or Tornado. The latter was chosen, because it offered key capability advantages, continued support to Afghanistan, and the ability to support concurrent operations.

Costs

2.31 The key consideration for the Department was assuring affordability over the four years covered by the Spending Review. Overall, the changes to Carrier Strike capability as a result of the SDSR have reduced the level of funding required over three of the next four years. Within this overall picture, over the four years the cost of the carriers has increased by £350 million on one carrier conversion. The costs of the aircraft have fallen by £624 million as a result of changes in the timing of the procurement. There are also savings of £999 million over the four-year period as a result of the decision to take the existing Carrier Strike capability out of service.

2.32 Over the next ten years the aggregate savings will be more significant as previously planned expenditure on projects including the Deep and Persistent Offensive Capability (see paragraph 2.20 above) will not be required. Overall, the scale of the reduced expenditure is forecast to be £3.4 billion with a further £1 billion for the removal of the Deep and Persistent Offensive Capability aircraft.

Part Three

Implementing the Strategic Defence and Security Review decision

3.1 Implementing the SDSR decision affecting Carrier Strike will require the Department to manage major change. It is unsurprising that it will take the Department some time to fully understand the implications of the decision. This part of our report sets the current position on the main uncertainties and risks which the Department must now understand so that it can put the carrier and JSF projects on a firm footing to deliver the required military capabilities cost-effectively. The Department is aware of these risks and the fact that it will take some time to develop its plans and mitigation strategies.

3.2 Under its current plans, the Department will be in a position to take final investment decisions on Carrier Strike in late 2012. If at this time it assesses that the approach being pursued is not the optimal balance of cost and capability to achieve value for money, it will revisit its commitment.

Construction of the carriers is progressing well but risks remain

3.3 The design and build of the carriers is progressing well despite the changes in schedule and strategic direction introduced by the Equipment Examination and the SDSR. For example, so far 98 per cent of the work originally planned to be completed to date has been finished and the project achieved 48 of the 53 target milestones in 2010-11 on time. However, construction is only part way through and risks remain. For example, the project is a complex endeavour with multiple dependencies on timely delivery and transfer of work between dockyards. In cost terms, the project is currently forecast by the Alliance to cost £5.461 billion, £219 million higher than the contracted Target Cost, with a planning trajectory to meet the Target Cost. There are also short-term cashflow pressures with projected Alliance costs in 2011-12 running some £58 million (11 per cent) above the cost profile for the year.

The carrier contract has incentivised Alliance members to work together

3.4 There is evidence to suggest that the incentives in the contracts are working. Elements of construction have been moved between shipyards owned by different companies to maintain progress. For example, construction was moved from Barrow to Govan to optimise use of facilities when it became clear that Barrow would be fully occupied with Astute submarine production. Also, employees from all the partner companies are working at each other's sites on a 'best worker for the job' basis. This has been particularly useful in terms of supervisory staff and also for design resource, where the Alliance partners have shown flexibility to maintain progress.

The Department is still developing its thinking on how to use the carrier in light of the SDSR decision

3.5 Following the SDSR decision the Department has been developing its thinking about how it will utilise the operational carrier and the aircraft to best effect. Its emerging thinking, building on some pre-SDSR work is called Carrier Enabled Power Projection (CEPP).

3.6 As part of CEPP, the role of Carrier Strike was expanded from predominantly focusing on fast jets to "support a broad range of operations including landing a Royal Marines Commando group, or Special Forces squadron, assisting with humanitarian crises or the evacuation of UK Nationals". However, the design of the carriers is not optimised to embark the full range of capabilities or the manpower needed to carry out commando group scale amphibious operations and the carrier would have to be supplemented by additional ships for this work. We note that no other country uses its carriers in the way that the United Kingdom is planning to do. The closest analogy is the United States Marine Corps, which operates STOVL aircraft making concurrent fast jet and helicopter operations easier.

3.7 Compared to what was already a difficult challenge for Carrier Strike, coordinating the delivery of all the components which will make up the CEPP capability will be highly complex. The Department is designing a governance structure which reflects this challenge and earlier concerns expressed by the Committee of Public Accounts.[24] It is proposing to introduce a single Senior Responsible Owner for CEPP who will be supported by a Coordination Group and chair a Programme Board, made up of the owners of each of the elements contributing to CEPP capability.

24 Committee of Public Accounts, *The Major Projects Report 2010*, Twenty-third Report of Session 2010–11, 15 February 2011, Committee of Public Accounts, *Management of the Typhoon Project*, Thirtieth Report of Session 2010-12, 4 April 2011.

Converting the carriers

The Department has an incomplete understanding of the costs of the carrier conversion

3.8 Working with the Alliance, the Department has begun to develop its understanding of the costs of converting a carrier. The estimates are still immature but, based on a planning assumption of converting the second carrier during build (which offers the best balance of cost, risk, time and performance), the Department estimates costs will be between £800 million and £1,200 million. Converting the second carrier (Prince of Wales) could allow the Department to use the first carrier (Queen Elizabeth) to mitigate risks by testing the major platform systems (which are common to both ships) and familiarising the crew with the operation of the warship.

3.9 The Department has embarked upon an 18-month Conversion Development Phase to understand the costs and risks associated with conversion. This is estimated to cost £76 million and the Department has so far committed £5 million which will cover the work until the outcome of the Department's in-year spending review in July 2011 is known. Without timely decisions there is a risk that options would be constrained and potentially there would be a delay to conversion and consequential cost increases.

3.10 It is not only the costs of conversion where there are uncertainties. The Department is undertaking a Develop Preferred Option Phase costing £5.3 million to work with industry to develop costed solutions for the berthing requirements for one carrier at Portsmouth. The Business Case states that there is a £109 million provision for the berthing, but recognises that "there remain affordability and programme challenges… for the deliverability of this requirement". The Department will address the need for a second berth once there is more certainty about the future of the second carrier after the 2015 SDSR.

There are risks with conversion that the Department is working to understand

3.11 The Department has chosen to investigate the Electromagnetic Aircraft Launch System (EMALS) system instead of the legacy steam catapult system as its preferred initial option for an aircraft launch system. Steam-catapult technology is well established, is considered reliable, and the risks are well understood. But it could become obsolete during the life of the carriers and steam is not a natural by-product of the engines being fitted on the carriers (in contrast to the nuclear-powered United States and French carriers).

3.12 EMALS potentially provides a much more controllable launch mechanism, capable of adapting to a very wide range of aircraft. There are 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. There are still unknowns concerning EMALS technology that the Department is working to understand alongside the United States military, which is committed to operating the system at sea by 2016. **Figure 8** summarises the key risks and uncertainties associated with carrier conversion which the Conversion Development Phase, assuming the Department proceeds with it, is designed to address. The Department plans to take a final investment decision in the latter half of 2012 on the choice of system.

Figure 8
Risks with the conversion of the carrier using EMALS

Risk area	Description
The Electromagnetic Aircraft Launch System (EMALS)	The EMALS system is not yet in operational service anywhere. The United States is investing heavily in the system in order to de-risk its introduction to service on the USS Gerald R Ford in 2016. The trials programme has been extensive, but risk remains in terms of its integration into an operational platform at sea and compatibility testing with JSF has yet to take place. Should the United Kingdom proceed with the acquisition of EMALS, our system would be the third produced (after the trials set and the installation on USS Gerald R Ford). The United Kingdom system will differ (it is a 2-rail system whilst the Americans will operate a 4-rail system) which means that while the technology will have been tested, it will not have been tested in the form that the United Kingdom will be using it. There will be some variation given the different design and operating parameters of the United Kingdom carriers and risks that the electromagnetic environment generated by EMALS could cause interference with existing ship systems. The very high voltages required for the EMALS system may represent a risk to personnel and equipment. Key safety risks and hazards need to be identified, mitigated and a safety case developed.
Access to United States data	Given that the majority of the new equipments expected to be fitted to the carriers will be sourced from the United States, early access will be required to large quantities of data from the United States Department of Defense and United States industry. Early access will require a number of agreements to be concluded successfully. The Department has already negotiated a Foreign Military Sales agreement with the United States to explore the EMALS system. These agreements are multi-faceted and the sensitive nature of the equipment means that they will attract a high profile within the United States approvals system.
Lack of competition	The sole-source supply of EMALS from General Atomic reduces ability to negotiate on price.

Source: National Audit Office examination of Departmental documentation

There are loss of skills risks

3.13 The SDSR decision to take the existing Invincible Class carriers out of service almost a decade before the new carriers enter service was a risk-based judgement that the Armed Services could operate without Carrier Strike. This decision will increase the challenge facing the Department to regenerate a wider range of operating skills among the ships' crew before the new carrier enters service.

3.14 Skills retention and regeneration is the Department's most significant risk on this project as it means it will have to learn how to operate carriers with carrier variant aircraft, all its previous experience having been with STOVL. The First Sea Lord has said that the Navy is absolutely reliant upon the relationship with the United States and France to provide this capability. The Department is seeking to mitigate this risk by working closely with the United States Navy and seconding both pilots and a variety of ships crew to work on United States carriers. Whilst no formal arrangements are in place yet, the Department has established a posting in the Pentagon to enable this closer working.

Procuring the carrier variant of JSF

3.15 The decision to change to procuring the carrier variant of JSF has resulted in a number of cost, integration and programming risks, although the Department considers these are more than offset by the enhanced capability it offers.

JSF costs uncertain

3.16 The JSF is still in development. While the United Kingdom contribution to this phase is capped at $2 billion, the unit production cost and delivery date are still to be fully determined. Whilst performance on the project is improving, the development and flight test programmes are behind schedule and there is a risk of further delays and cost growth. Of note, the STOVL variant has had technical problems and the United States Department of Defense has directed a two-year period to re-evaluate and engineer STOVL solutions.[25] Progress with the carrier variant remains stable.

There are additional programming and integration risks which the Department is working to understand

3.17 The Department had identified a number of United Kingdom specific programming risks related to the STOVL variant of JSF. Some of these risks do not apply to the carrier variant, however many are common. The Department has costed the risks, developed mitigation plans and put funding provision in place to cover them. The change to the carrier variant has introduced six new areas of risk associated with the integration of United Kingdom capabilities and programming. The Department has not yet generated quantitative assessments of the risk impacts and, consequently, has not fully costed them or put funded mitigation plans in place. It expects to complete these activities by late 2011. The risk areas are summarised in **Figure 9** overleaf.

25 Government Accountability Office *Joint Strike Fighter* May 19, 2011.

Figure 9

New risks associated with the procurement of the carrier variant of JSF

Risk area	Description
Ship/Aircraft interface	The United Kingdom has not operated aircraft with catapults and arrestor gear for over 30 years, and has a limited understanding of the risks. Features of the carrier variant design such as recovery speeds, fatigue strength and airframe life have been optimised for the United States Nimitz Class Carrier. The Department needs to understand the implications of differences between the United Kingdom and United States carriers and the effect they could have on, for example, safety. The electromagnetic compatibility of whatever launch and recovery equipment is selected and other equipments such as landing aids with the aircraft and United Kingdom weapons will also need to be explored.
Air-to-Air refuelling capability	Unlike the STOVL variant, the carrier variant cannot land if the carrier deck is not fully clear. To ensure aircraft can loiter and subsequently be safely recovered to the carrier if there is no suitable diversionary airfield available, an air-to-air refuelling capability is necessary. The Department needs to understand the most cost-effective way of providing this capability which could be to use another JSF (some initial design work has been done) or an alternative aircraft (the United States will use F-18 aircraft for example).
United Kingdom weapons integration	The Department planned to integrate two main United Kingdom weapons on to the STOVL JSF – the ASRAAM missile and Paveway 4 bomb – and the design was evolved with this in mind. The Department continues to better understand the technical feasibility and costs of integrating these weapons on to the carrier variant which is optimised for United States Navy use.
User Requirement definition	There is not yet a defined United Kingdom User Requirement for the carrier variant of JSF. Without this document the Department cannot fully quantify the level of technical risk associated with the integration of the carrier variant.
Dependency on United States Services for initial training	Following initial deliveries of the aircraft, the United Kingdom will be highly dependent on the United States to provide flying instructors and shared access to training facilities. Before the variant change, the Department had a pooling arrangement with the United States Marine Corps (which also plans to operate the STOVL variant) which shared aircraft, pilots, maintainers and support for training. It is not yet fully clear how this arrangement will develop with both the Marine Corps and United States Navy following the variant change.
Sufficiency of flight test assets to certify United Kingdom capabilities	In January 2009, the Department agreed to buy three STOVL JSF aircraft at a cost of £517 million to use for operational testing and evaluation. Following the SDSR decision to buy the carrier variant of JSF the Department is still planning to undertake test and evaluation activities using the STOVL aircraft (there is sufficient commonality to enable this) and is negotiating to change the third aircraft on order to the new variant. This arrangement could increase risks as it may require the Department to certify both variants as safe for flight and may mean the Department needs more flight test assets.

Source: National Audit Office examination of JSF project documentation

Appendix One

Methodology

1 This appendix sets out the key methodologies we employed during our fieldwork.

Selected method	Purpose
Semi-structured interviews. We, and consultants engaged to support us, spoke to a range of staff in the Ministry of Defence, other involved government departments and the industrial participants in the Aircraft Carrier Alliance.	To collect the views of those working in the area to identify the key issues, the basis for decisions and the key lessons that can be learnt.
Document Review. We reviewed a range of key Departmental documents including Defence Strategy Group minutes, investment cases and project reviews and documentation.	To identify key issues, determine the Department's Carrier Strike requirements and priorities and forward plans.
Analysis of the Department's financial performance data. We commissioned consultancy advice to analyse the Department's financial planning data for Carrier Strike.	To identify forecast costs for the development of Carrier Strike capability.

Appendix Two

Data reconciliation

1 In this report we have presented the capital investment costs for acquiring equipment (Capital Department Expenditure Limits), as approved by the Department's Investment Approvals Board. This has allowed us to show the cost of the carrier consistently along with the estimated costs for converting it with launch and recovery equipment, in-line with the Treasury's Clear Line of Sight project to simplify reporting to Parliament.

2 The reported costs for the carrier shown in this report are different to those previously reported in the Major Projects Report 2010. Figures presented in previous Major Project Reports included the capital investment costs, plus an allowance for non-cash expenditure, such as the cost of capital. The Major Project Report figures also netted off the sunk costs incurred during the project's Assessment Phase. These are stripped out to give the comparisons used in the current report.

3 The reconciliation of acquisition costs in this report with our previous reporting on carriers is set out opposite.

Estimated costs at main investment decision July 2007		**Reference**
Capital Department Expenditure Limits	**£3.65 bn**	Key facts on page 4 of this Report Paragraph 1.10 Figure 2
Add: non-cash expenditure	£0.54 bn	
Less: Assessment Phase costs	£0.11 bn	
MPR 2010 Figure	**£4.09 bn**	Major Projects Report 2010 Figure 3 page 10 Page 156 in project summary sheets B2

Final Target Cost agreed July 2010		**Reference**
Capital Department Expenditure Limits	**£5.24 bn**	Key facts page 4 of this Report Paragraphs 1.13, 1.14 Figure 2
Add: non-cash expenditure	£0.77 bn	
Less: Assessment Phase costs	£0.11 bn	
MPR 2010 Figure	**£5.9 bn**[1]	Major Projects Report 2010 page 41 Page 156 of project summary sheets B3

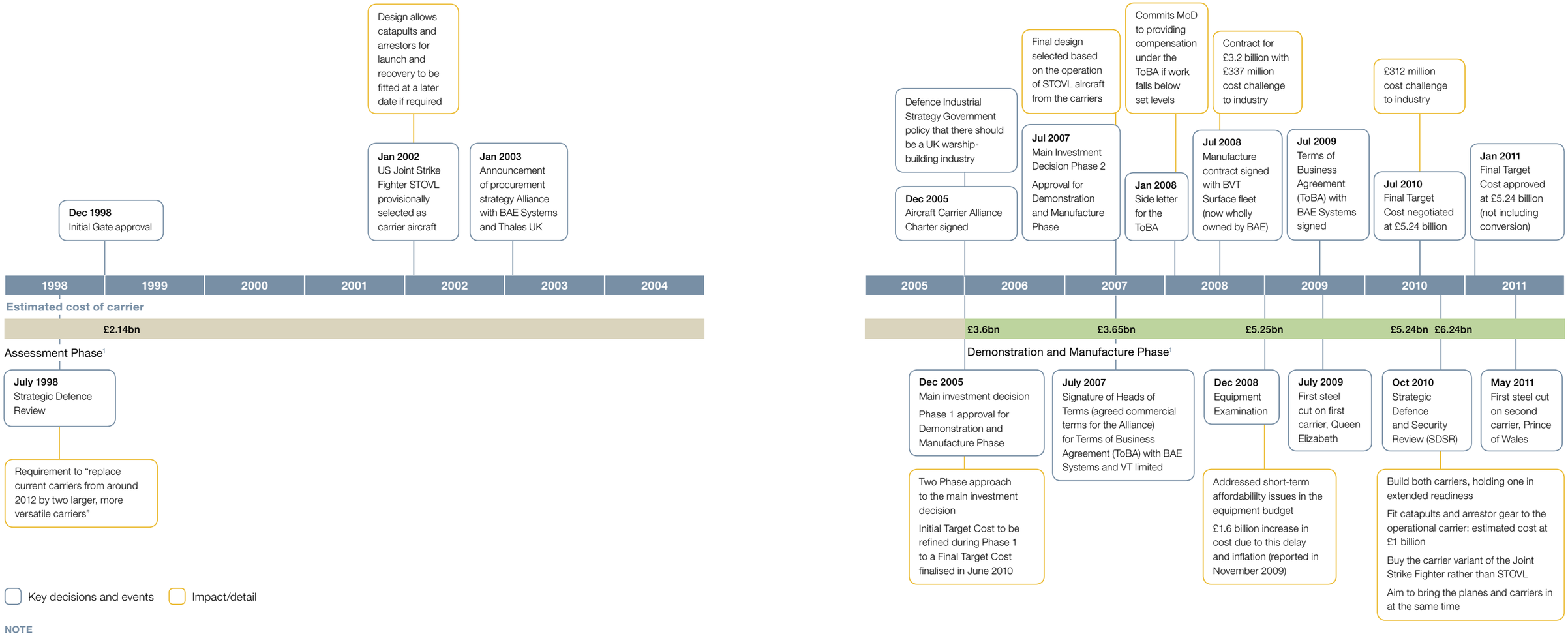
NOTE

1 This Capital Department Expenditure Limits figure used in MPR 2010 was prior to the Final Target Cost agreement, and is based on an estimated cost of £5.254bn.

Appendix Three

Carrier Strike timeline

Queen Elizabeth Class Aircraft carriers



NOTE

1 Cost figures shown are at 50 per cent confidence unless otherwise indicated.

Source: National Audit Office analysis of departmental papers

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