



National Audit Office

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## **Report**

by the Comptroller  
and Auditor General

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## **Ministry of Defence**

# Delivering Carrier Strike

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Ministry of Defence

# Delivering Carrier Strike

Report by the Comptroller and Auditor General

Ordered by the House of Commons  
to be printed on 14 March 2017

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

Sir Amyas Morse KCB  
Comptroller and Auditor General  
National Audit Office

10 March 2017

This volume has been published alongside a second  
volume comprising Ministry of Defence: Delivering Carrier  
Strike: Appendices Three to Five HC 1057-II

This report examines how the Ministry of Defence is managing its programme to deliver an initial Carrier Strike operating capability by December 2020 and how it is handling the technical, cost and schedule risks since we last reported in 2013.

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## Key facts

**£6.2bn**

approved cost of two new Queen Elizabeth Class aircraft carriers



Queen Elizabeth class aircraft carrier

**£5.8bn**

forecast cost of Lightning II procurement up to March 2021



Lightning II fast-jet

**£0.3bn**

cost of developing and buying the airborne radar system to protect the carriers (Crowsnest)



Merlin Mk2 helicopters (for hosting Crowsnest)

**December 2020** when the Ministry of Defence (the Department) expects to have an initial capability to operate the carriers, Lightning II and Crowsnest together (Carrier Strike)

**April 2026** when the Department expects to have a fully flexible carrier capability, allowing a range of roles (Carrier Enabled Power Projection)

# Summary

**1** In 1998, the Ministry of Defence (the Department) decided to replace its Invincible Class aircraft carriers with two larger, more versatile carriers and to replace its Harrier jets with a new generation of fast-jets. Deploying a carrier and jets, with a new radar system, is referred to as 'Carrier Strike'. This is the first step towards 'Carrier Enabled Power Projection' (CEPP), which the government considers will allow it greater flexibility in responding to conflicts, engaging with allies and supporting humanitarian relief efforts. CEPP will allow the UK to deploy military capabilities from anywhere in the world. By making a long-term commitment to projecting power in this way, the government has signalled that it intends the carriers to form a significant part of its response to changes in global security.

**2** The two new Queen Elizabeth Class carriers are the largest warships ever built for the Navy, and will be an important defence capability for the next 50 years. Deploying the carriers will involve much of the Navy's existing fleet to protect and supply them. The Department has committed to buying 48 F-35B Lightning II aircraft to fly from the carriers. This is the first tranche of the 138 Lightning II aircraft that the UK has committed to purchasing over the life of the programme. These sophisticated jets will employ stealth technology, allowing them to fly in contested airspace, a significant military advantage. As well as flying from the carriers, the Lightning II jets will be used for land-based operations. The US-led F-35 programme is the largest defence programme in history.

**3** The Department plans to use the Carrier Strike role from 2021. This will involve flying a squadron of up to 12 Lightning II jets from a carrier, supported by a new airborne radar system called Crowsnest to detect threats beyond the horizon. Between 2021 and 2026, the Department will introduce the second carrier and a second squadron of Lightning II jets. It will complete trials and training to allow the carriers to perform a range of roles, including acting as helicopter carriers or transporting military forces. This represents the full CEPP capability.

**4** The Department is now close to moving from the build to the operational phase of the programme (**Figure 1**). The first carrier (HMS Queen Elizabeth) is nearing completion and the build of the second (HMS Prince of Wales) is progressing well. Systems testing is being carried out before the Navy formally accepts the first carrier from the supplier by the end of 2017. The UK has a growing fleet of Lightning II jets, and is training pilots in the US. The first squadron is expected in the UK in August 2018. The Department signed a contract for Crowsnest in November 2016.

**5** The next phase between 2017 and 2020 will be critical to establishing the capability. The Department must bring together the carriers, Lightning II jets, and Crowsnest with trained crews and supporting infrastructure, logistics, communications and surveillance. It needs to test and operate all these elements together in preparation for deploying Carrier Strike in 2021.

### **Scope of this report**

**6** We have reported three times on the Department's progress, focusing on the decisions about the type of carrier and jets it would buy.<sup>1</sup> Our last report in 2013 also noted that the highest-risk phases of constructing and integrating the carriers were still to come. The risks relating to integration remain.

**7** This report examines how the Department has managed the programmes and handled the technical, cost and schedule risks since 2013. It also outlines the challenges the Department faces in reaching the first milestone of an initial Carrier Strike operating capability by December 2020. Our report examines:

- the strategic importance of the Carrier Strike capability (Part One);
- programme performance and risks to delivering Carrier Strike (Part Two); and
- the effectiveness of management arrangements (Part Three).

**8** We conclude on how well the Department is managing delivery of Carrier Strike, the programme's progress and how well placed the Department is to achieve value for money in the future.

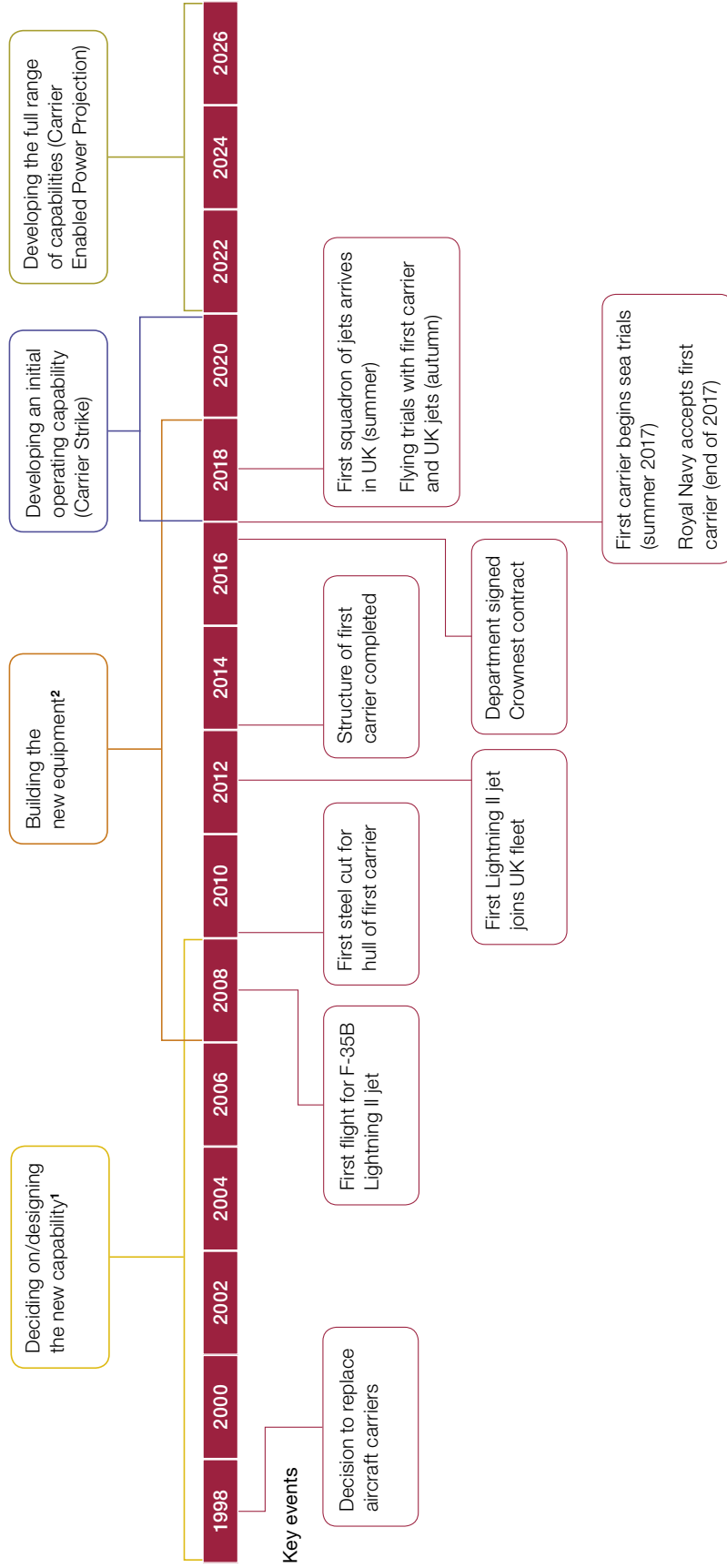
<sup>1</sup> Comptroller and Auditor General, *Carrier Strike*, Session 2010–2012, HC 1092, National Audit Office, July 2011; Comptroller and Auditor General, *Carrier Strike: Supplementary Report*, Session 2010–2012, HC 1657, National Audit Office, November 2011; Comptroller and Auditor General, *Carrier Strike: The 2012 reversion decision*, Session 2013–14, HC 63, National Audit Office, May 2013.



**Figure 1**  
Timeline for delivering the Carrier Enabled Power Projection capability

The Department is near the end of the build phase

Phases



□ Design □ Build □ Develop □ Operate

**Notes**

- 1 The Department decided on design of the jets and carriers, but it was still considering the Crownstest design until 2016.
- 2 The build of the new equipment will continue to take place into the 2020s, as Lightning II jets come off the production line and further Crownstest radar are fitted into Navy helicopters.

Source: National Audit Office analysis of Departmental data

## Key findings

### Current status

**9 The Department has clear plans to achieve an initial Carrier Strike operating capability by December 2020, but these could be delayed by technical issues with the first carrier, which are yet to be resolved.** The inaugural sailing of the first carrier is expected in summer 2017. This was delayed for approximately three months because of technical issues. At the time of our report, the Department was assessing the impact of this delay on the overall schedule. However, it believes that the current target of accepting the carrier from the Aircraft Carrier Alliance by the end of 2017 is achievable. The build phase of the second carrier is progressing well, and the carrier is expected to leave Rosyth dockyard in 2019. The Department has accelerated its purchase of Lightning II jets and Crowsnest so that it will have enough jets and helicopters to fly from the first carrier by December 2020. The senior responsible owners for these three core programmes are reporting that successful delivery of an initial operating capability by December 2020 is feasible, but significant issues remain (paragraphs 2.7, 2.20 to 2.23, 2.26 and 2.30).

**10 Successful operation depends on a mix of equipment, support and infrastructure, but plans for some of these are not yet mature.** Alongside the core equipment programmes (carriers, Lightning II and Crowsnest), the Commands are responsible for ensuring that crucial enabling capabilities are in place.<sup>2</sup> Improvements to Portsmouth Naval Base and RAF Marham to accommodate the carriers and Lightning II jets are progressing well. However, new support arrangements to provide spares and maintain the equipment are less developed. Operating Carrier Strike will rely on logistics, communications and surveillance. While the Department has advised us that it is normal to prioritise investments according to strategic need, the Commands have yet to fund all of these capabilities, which could restrict how Carrier Strike is used (paragraphs 2.31 to 2.37).

**11 The build costs of the core programmes have remained stable since 2014, but forecast costs of supporting and operating Carrier Strike are less certain.** The Commands manage individual programmes within their delegated budgets. These budgets have already been committed to programmes. Therefore, if the cost of the core Carrier Strike programmes increases further, the Commands will have to prioritise their spending, potentially at the expense of other capabilities (paragraphs 2.15 to 2.19, 2.24 and 2.27 to 2.28):

- **Build costs**

The Aircraft Carrier Alliance and the Department are dealing with potential cost growth of between 1% and 2% on the £6.212 billion approved cost of both carriers. The Department has not accepted this increase and is working with the Alliance to minimise any cost growth. The Department has brought forward Lightning II costs originally planned for after 2020, so that two squadrons of jets are available sooner. The total forecast spend of £5.8 billion on Lightning II procurement to March 2021 could change if foreign exchange rates shift and the total number of jets on order globally varies. The Department signed a £269 million contract for Crowsnest in November 2016.

<sup>2</sup> Navy, Army, Air and Joint Forces.

- **Support and operating costs**

Support and maintenance costs to March 2021 are forecast at £1.3 billion. These are less certain because contracts have not been let, and requirements will continue to be refined as the equipment is used. Historically, the Department's estimates of the cost of supporting equipment have been less robust than its estimates of the costs of buying it. The Department has estimated that operational costs up to March 2021 will be £0.6 billion. It has budgeted for a sustainable level of use of Carrier Strike within available resources and is developing its assessment of the additional costs from deploying more equipment or deploying it in different ways, where the costs will arise and how they will be funded.

### Managing risks to delivery

**12 The Department has made decisions that could limit how its uses Carrier Strike.** The carriers and Lightning II jets rely greatly on technology for military advantage. Technological failures on the carriers might mean that larger crews are needed or place greater pressure on existing personnel. The design and testing of the US-led Lightning II programme is happening concurrently until 2019, increasing the risk that jets already in the UK fleet will need modifications. This could reduce the number available for forming the first squadron in readiness for first carrier-based deployment in 2021. The Department accelerated its purchase of Lightning II jets, which will support pilot training. But the number of pilots will be just sufficient up to 2026, with limited resilience if staff decide to leave the RAF. Additionally, the Department is relying on an unusually high level of simulator-based training for pilots. If this training is not sufficiently realistic, it could limit how well prepared pilots are to operate the jets. The Department decided to fit Crowsnest radar systems to Navy helicopters that are already in demand, rather than buying new aircraft. High demand for helicopters could limit the availability of Crowsnest to protect the carriers (paragraphs 1.9 and 2.9 to 2.14).

**13 The Department is now entering a high-risk phase. It is focusing on managing strategic risks across the programmes over the next three years which could have a significant impact on delivery.** These risks include:

- **A tight schedule with limited contingency**

The Department has set an ambitious master schedule that brings together the interdependent schedules of the three core programmes to achieve the full CEPP capability by 2026. It has taken a number of decisions to address slippage, which has compressed the schedule and increased risk (paragraphs 2.2 to 2.8).

- **Operational unknowns that will only become clear once the equipment has been tested**

The schedule to 2020 includes several 'firsts' where the result is uncertain. For example, the first sailing of HMS Queen Elizabeth will take place in 2017, followed by flying trials from the carrier at sea in 2018. The Department has made good use of external expertise where available, for example UK personnel are training alongside the US military to maintain carrier skills. This means the Department will not need to train personnel from scratch when the carriers enter service (paragraphs 1.13 and 2.3).

- **Increasing pressure on a few highly trained personnel to operate the capability**

The Department has a shortage of military personnel, running at 4% below a target strength of 145,560. Key shortages include engineering roles and war-fighting specialists in the Navy and engineering, intelligence, and some aircrew cadres in the RAF. To minimise the impact of these gaps on Carrier Strike, the Department is prioritising the capability and carrying out targeted recruitment. However, it will rely on a few people in certain roles to build up the skills and experience needed in time. This is creating a risk of overburdening a small number of personnel in the build-up to first operational use from 2021 (paragraphs 1.11, 1.12 and 2.12 to 2.14).

Planning for operational use

**14 Introducing Carrier Strike will fundamentally affect how the Navy works.**

The Department is turning its attention to planning different options for using the capability. Incorporating use of CEPP into the Commands' existing plans will be challenging. It is not possible to satisfy all demands for its use with current levels of equipment, budget and personnel. Iterative planning work is giving the Commands a better understanding of the prioritisation decisions they will need to make to balance the demands of Carrier Strike and other capabilities. This will be particularly important for the Navy, because a significant proportion of its fleet will be needed to support and protect the carriers. The Navy will need to fundamentally change how it operates, moving away from deploying single ships. Building on existing cooperation with the US to reintroduce a carrier capability, the Department is planning early use of Carrier Strike alongside the US and other allies (paragraphs 1.6 to 1.13 and 1.17 to 1.19).

**15 Deploying Carrier Strike depends on a period of trials, training and further work.** Increasing awareness of Carrier Strike as the equipment is completed may lead to demand for it to be deployed earlier than December 2020. The first carrier is expected to sail during 2017 and the first squadron of jets will be flying from the UK in 2018. But before the Department can operate the two together as Carrier Strike, there will be an intensive period of training, trials and further work. This period is crucial to ensure that crews can operate the equipment safely and to give the Department confidence the capability works as intended. While the equipment could be used together before these trials are complete, this could carry safety risks or limit how the equipment could be used. It would also disrupt the Department's planned schedule. The Department has examined the feasibility of deploying Carrier Strike before December 2020 and advised against this in anything other than an operational emergency (paragraphs 1.14 to 1.16 and 2.8).

Arrangements for managing the programme

**16 To oversee CEPP the Department has set up governance arrangements that reflect its strategic importance.** It has appointed a small team to oversee the programmes managed separately by the Commands, creating a CEPP 'portfolio'. This arrangement is new for the Department and reflects the challenge of fostering collaboration between the Commands. Placing the CEPP team in Head Office, and appointing the Deputy Chief of Defence Staff (Military Capability) as the senior responsible owner (SRO) for CEPP affords the programme prominence and strategic importance. The SRO's role in ensuring coherence across defence's many capabilities allows him to balance competing demands and mediate between them. For example, he determined which Command would fund and provide staff for UK-specific software programming for Lightning II when the Commands did not agree (paragraphs 3.2 to 3.5).

**17 Governance arrangements are working well, but will be tested during the crucial period between 2017 and 2020.** The way the Department manages CEPP aligns with good programme management principles. There are clear roles set out in mandates from the SRO for CEPP, regular reporting cycles and consistent management information, visibility of risks and issues, and strong leadership. There is good buy-in from stakeholders across the Department. The period between 2017 and 2020 will be challenging and may require the Department to take difficult decisions to keep to schedule. The CEPP team has no authority to manage the programmes, but provides clear visibility of composite risks across the programmes. Decisions are often made at a senior level, reflecting the strategic and defence-wide nature of this programme (paragraphs 3.6 to 3.10).

**18 Governance arrangements will change as the Department plans for operational use of Carrier Strike.** Current governance arrangements focus on scrutinising the build phase and ensuring coordination between the Commands managing the core Carrier Strike programmes. The CEPP team will disband once the new capability is delivered. The Department is introducing new governance arrangements so that those responsible for making decisions on using the capability are involved in early preparations. These arrangements are emerging and may introduce some duplication in the short term, but they are important for ensuring coordination across many stakeholders within Head Office and the Commands (paragraphs 1.14 and 3.7 to 3.10).

**19 The Department is reliant on complex commercial arrangements that could stretch its capacity.** The Department has formed an alliance with industry to build the carriers, sharing cost increases above a target price. Changes since 2014 have strengthened governance and introduced better joint working between the Department and industry. The Lightning II programme is an international arrangement. The Department had some early influence on the programme, but has limited contractual levers on cost or time. The Crowsnest contract is a more straightforward contract with industry, although negotiations were protracted because of issues with the technical specification of the chosen radar system. The Department's immediate priority is contracting for complex support arrangements. Ensuring there is sufficient commercial capacity to do this will be challenging, as there are long-standing skills gaps in the Department's contract management teams (paragraphs 2.21 and 3.11 to 3.13).

## **Conclusion on value for money**

**20** The Department has made good progress since we last reported on Carrier Strike. The build phase is nearing completion and the Department has clear plans to achieve an initial Carrier Strike operating capability by December 2020. The Department still has a lot to do as it brings together equipment, trained crews, infrastructure and support. Problems in any of these areas could mean that use of the carriers is delayed or reduced. To achieve its plan, the Department needs to coordinate many tasks across the Commands. It will have to make difficult decisions to accommodate the demands that use of the carriers will place on existing equipment and manpower, particularly for the Royal Navy. It has put in place arrangements to support these decisions, but they will only be fully tested as the capability is introduced.

**21** The next three years are critical as the programme moves into a high-risk period of trials, testing and training. The technology is innovative and operational unknowns, which will only become clear during testing, may affect plans and increase costs. For example, at the time of reporting, the Department and Aircraft Carrier Alliance were considering how to fix technical problems with the first carrier which could delay progress. To recover earlier delays, the Department has already compressed the timetable and is running some testing in parallel with other tasks. The closely timed sequence of tasks offers no further room for slippage and there remain significant risks to value for money. We expect to return and review progress later in the programme's timeline.

## Recommendations

22 The Department should:

- a Maintain a realistic view of the aggregate risk and review the master schedule and key milestones regularly.** This will help to mitigate the risk of the schedule driving poor decision-making that does not make operational sense or that leads to greater risks or compromises elsewhere.
- b Guard against over-ambition and robustly resist any pressure to bring operational dates forward.** In assessing any decision to use elements of Carrier Strike before December 2020, the Department should set out the risks of doing so, the impact on achieving the full capability and the wider impact on defence.
- c Make the decisions needed to integrate Carrier Strike into wider defence capability within the Department's next annual planning round.** This will help identify where there are conflicts such as overcommitting equipment or differing views on deployment. Clarity about these issues will be important for ensuring that current programme plans are realistic.
- d Set out arrangements for long-term leadership and oversight of the CEPP capability.** Even after reaching the milestones of Carrier Strike and CEPP, there will still be a need for strategic oversight and a forum for discussing issues across the Commands and wider Department.
- e Build more resilience into its workforce model.** The Department should continue to monitor workload and time away from base, and ensure that personnel have enough support. In the longer term, the Department needs to maintain efforts to recruit and train extra personnel.
- f Promote formal and informal sharing of lessons learned,** and ensure transfer of learning to other complex defence programmes such as the Nuclear Enterprise.

# Part One

## The strategic importance of the Carrier Strike capability

**1.1** This part considers the strategic importance of the Carrier Strike capability to defence. We examine what the Ministry of Defence (the Department) must consider in setting up a sustainable future capability with constrained resources, and in cooperation with allies.

### **Carrier Strike capability**

**1.2** The Department is buying two new aircraft carriers (HMS Queen Elizabeth and HMS Prince of Wales) and new Lightning II fast-jets. These are the largest warships and the most technologically sophisticated jets ever purchased by the UK. It is also buying Crowsnest, a new airborne radar to detect threats beyond the horizon, to be fitted to Navy helicopters flying from the carriers. By December 2020, it aims to have one squadron of Lightning II jets flying from one carrier with its new Crowsnest system, with supporting infrastructure, logistics and communications and surveillance. This is referred to as 'Carrier Strike'.

**1.3** Between 2020 and 2026, the Department plans to introduce the second carrier and a second squadron of jets, and to complete trials and training (**Figure 2**). This will allow the carriers to perform a range of roles, including acting as helicopter carriers or transporting military forces. This represents the full Carrier Enabled Power Projection (CEPP) capability.

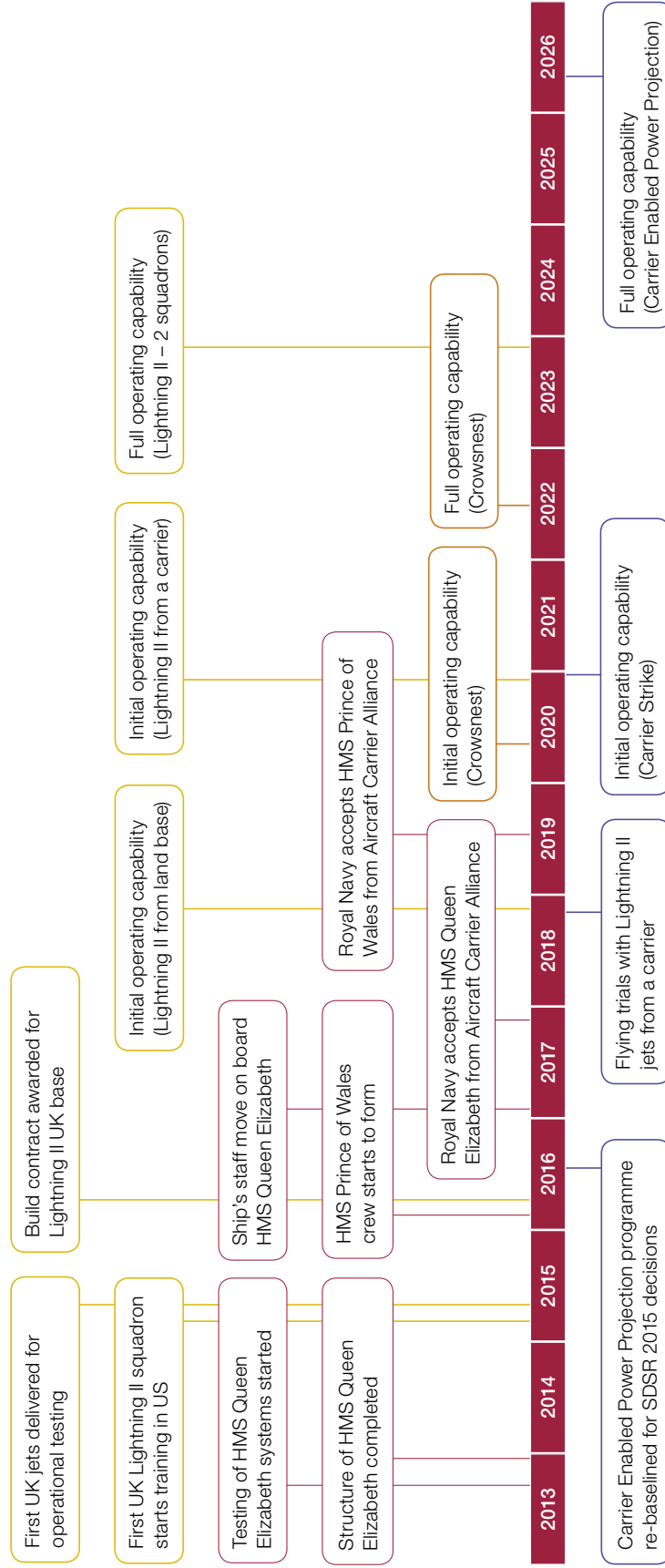
**1.4** The government sees its new aircraft carriers as central to the UK's future defence strategy and symbolic of the country's standing internationally in the coming decades. They will give the UK political flexibility to act without depending on agreement from other countries for use of their bases. Ultimately, the carriers are designed to support direct military action, individual defence tasks (including deterrence and defence engagement), humanitarian aid and diplomatic initiatives.

**1.5** In 2014, the Prime Minister announced that both carriers ordered from the Aircraft Carrier Alliance would be brought into operational use. This would allow one carrier to be available 100% of the time, either at sea or in port at very high readiness to deploy.



**Figure 2**  
Outline timetable for Carrier Enabled Power Projection

The Department aims to introduce an initial Carrier Strike operating capability in December 2020, before achieving a full Carrier Enabled Power Projection capability in 2026



- Queen Elizabeth Class carriers programme
- Lightning programme
- Crowsnest programme
- Carrier Enabled Power Projection

**Notes**

- 1 Initial operating capability is where the capability can be deployed on operations, but with limitations. This is based on military judgement and varies according to the capability. Further testing, modifications and increased numbers are required before full operating capability is achieved.
- 2 SDSR – Strategic Defence and Security Review.

## **Transformative effect**

**1.6** The UK has been without a Carrier Strike capability since the Strategic Defence and Security Review (SDSR) 2010, when the government decided to retire its existing aircraft carriers. CEPP will address this gap.

**1.7** The Department cannot use the carriers on their own. Depending on what they are being tasked to do, the Department must send other warships, submarines, helicopters and auxiliary ships to protect and resupply them. This group of vessels is a 'carrier task group' (**Figure 3**). The group needs robust logistics and communications to work together, with suitable support and infrastructure at base and while the carriers are deployed. The carriers can also be used alongside allies.

**1.8** While the carriers are expected to offer greater flexibility in how the Department responds to global events, deploying them will require a significant proportion of the Navy's fleet to form the carrier task group. The task group is likely to represent around 27% of the Navy's fleet by tonnage and 20% of the personnel needed to crew the fleet, depending on how the carriers are deployed. Currently, the Navy carries out multiple operations concurrently using single ships. This means the Navy will need to change fundamentally how it operates and make judgements on priorities.

**1.9** Until the Department has refined operational plans on how it will routinely deploy the carriers, the precise availability requirements for the rest of the task group will remain uncertain. For example:

- The Navy has eight Type 23 anti-submarine frigates, several of which are needed in the carrier task group. These are due to be out of service from 2023 onwards, and the programme to replace them is late. It is not clear whether the new Type 26 ships will be ready to replace them.
- The propulsion system on the Type 45 destroyers has developed technical problems and a major refit programme is under way to a taut schedule. The Department expects only a limited number to be ready to support HMS Queen Elizabeth's first deployment, leaving no scope for delays to the repair programme.
- Merlin helicopters currently provide anti-submarine protection and are in high demand. The carrier task group will need Merlin helicopters both for anti-submarine protection and to host Crowsnest. The helicopters cannot carry out both roles at once. Of the fleet of Merlin helicopters, the task group will need a significant number for full capability. These may not be available in time for first deployment.

**Figure 3**  
Illustrative carrier task group

The Department will deploy the carrier alongside other ships and military equipment, collectively referred to as a carrier task group



**Notes**

- 1 The make-up of this group is likely to vary with time and depending on why the group is being deployed.
- 2 Maritime intra-theatre lift is the ability to move people and goods within the task group. The Department is deciding how it will meet this requirement.

Source: National Audit Office analysis of Departmental data

**1.10** Reliance on this method of projecting power over such a long period carries both strategic opportunities and risks. The Department sees the Carrier Strike capability as a long-term investment, with the ships expected to have a 50-year life and the Lightning II jets to remain in service until 2048. Technological advances are likely to allow the UK to project air power in other ways, as the next generation of fast-jets may be unmanned. The Department is confident that it has future-proofed the carriers by building flexibility and space into the design so they can be reconfigured easily to carry future jets.

### **Sustainability of the capability**

**1.11** The Department is introducing the capability at a time of resource constraints and alongside other strategic priorities. The Department also faces challenges in delivering the capability with limited suitably qualified and experienced personnel to operate it (paragraphs 2.12 to 2.14). The long-term nature of Carrier Strike brings future obligations of ownership. There is also a need to take strategic decisions across defence that balance the resource, personnel and equipment demands of Carrier Strike with other defence capabilities.

**1.12** The Department has already reduced existing capability in other areas to prioritise Carrier Strike. The decision to operate both carriers means both ships must be crewed. The Department decided not to extend in service HMS Ocean (the Royal Navy's current flagship and helicopter carrier) beyond 2018 in order to provide crew for the second carrier. HMS Ocean underwent maintenance and refit work between 2012 and 2014 to ensure that it could provide a helicopter carrier capability until at least 2019. But it would require significant capital investment in a major refit to keep it running beyond that. The Department now plans for the carriers to provide some capacity to support battlefield helicopter operations. However, the necessary changes to the carriers to enable this are yet to be fully funded and will add further work to the CEPP schedule. Also, the Navy's capability to undertake certain 'ship to shore amphibious operations' from 2018 onwards will be reduced.

### **Defence cooperation**

**1.13** The UK has not operated aircraft carriers since 2010, and expects a decade-long gap before it reintroduces them. To maintain valuable skills in carrier operations during this gap, the Department has sought opportunities for its personnel to work alongside US teams. In 2012, the US and UK Secretaries of Defence signed a joint statement to strengthen cooperation for carrier operations. As part of this agreement, UK personnel are working alongside the US Navy on board their carriers. Lightning II pilots, maintenance engineers, software programmers, logistics and support staff are also training with their counterparts in the US Marine Corps before the UK sets up its own training unit in 2019.

## Planning for operational use

**1.14** In line with good practice, the Department is now managing the transition from the build phase of CEPP to operational use.<sup>3</sup> Carrier Strike combines new military equipment never before operated together. The Department is putting in place new governance arrangements so that those responsible for using Carrier Strike in the future are involved in early preparations. These arrangements are emerging and the Department will need to manage the overlap with those delivering the capability (paragraph 3.7), and ensure coordination across many stakeholders within Head Office and the Armed Forces (the Commands).

**1.15** During our review the Department was carrying out detailed strategic planning on how it could deploy the carriers and the implications for defence. There are many options and possible configurations. Operational use could be in the form of planned routine deployments, or unplanned uses such as direct military action, humanitarian aid or cooperation with allies. The Department is planning to operate closely with the US, including with US Lightning II jets embarking regularly on the carriers but not routinely. Decisions on some deployments will ultimately rest with ministers. The Department has established three programmes of work to plan for:

- the crucial period between 2017 and 2020;
- the first operational deployment of HMS Queen Elizabeth in 2021; and
- how CEPP could be routinely operated from 2023.

## Planning for 2017 to 2020

**1.16** The Department commissioned work to develop a draft schedule between 2017 and 2020 to help the Commands identify the equipment needed for trials and training of the capability. The aim was to provide direction to the Commands to enable them to plan resources for this period. For most of the enablers (for example, battlefield helicopters and logistics), the Department will need to prioritise its resources to ensure they are available. Most are currently committed to other activities, but without them, the requisite trials and training for Carrier Strike cannot take place.

<sup>3</sup> Our work on the government's management of major programmes indicates that successful programmes have clear plans for transferring to operations and 'business as usual'. Where there is a failure to plan for operations, this can often result in a mismatch between the outcomes of a programme and end-users' expectations.

## **Planning for the first operational deployment in 2021**

**1.17** Planning for first deployment has highlighted a number of necessary decisions and investments. This is helping to focus future work, including:

- reinforcing the need for changes to the way the Navy works and ensuring Navy Command's global infrastructure can accommodate the demands of the carrier task group;
- ensuring flexibility in the schedule to allow battlefield helicopters to be tested and flown from the carriers (paragraph 1.12);
- balancing the use of Lightning II on the carriers with other demands, such as upgrades, training requirements and unplanned military deployments;
- ensuring IT infrastructure is in place to support information sharing across the carrier task group; and
- aligning operational planning with that of the US in preparation for first deployment.

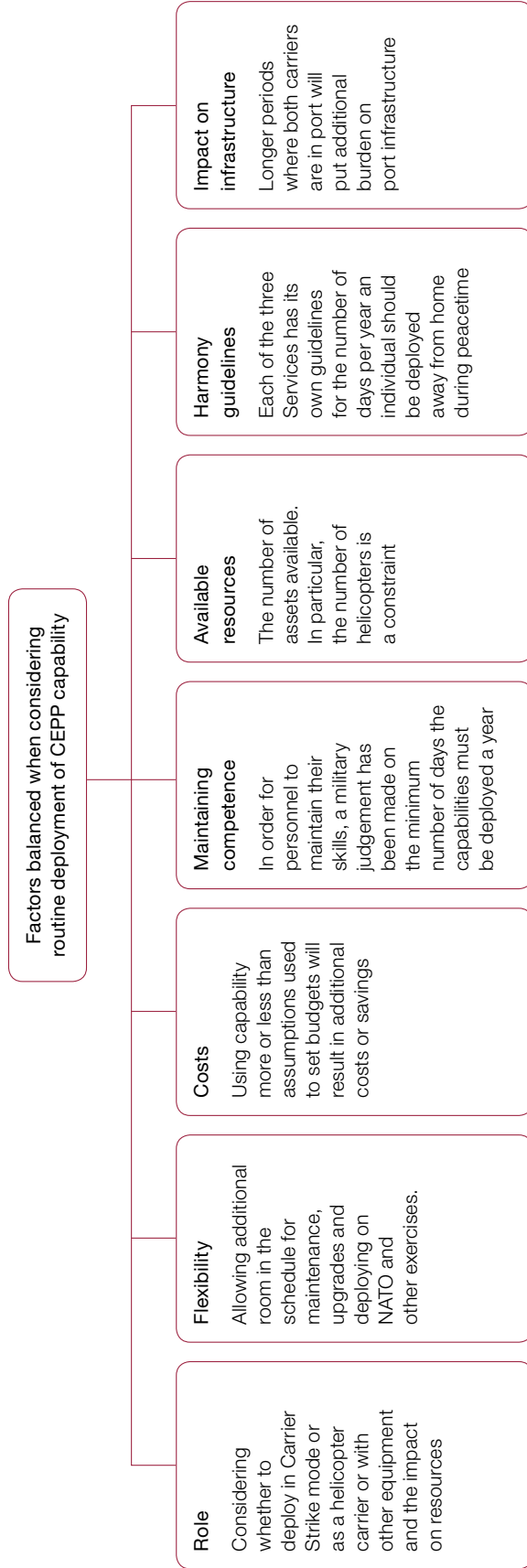
## **Planning for routine operations from 2023**

**1.18** The Department has undertaken detailed work on how it could use the CEPP capability routinely, outside unplanned military operations. While this work models possible deployments from 2023 onwards, the Department needs to decide soon how it plans to use CEPP. This will inform current work looking at support arrangements and requirements for enablers and will also allow the Commands to make plans. As part of these plans, the Department is modelling the marginal cost of varying how often the carriers are deployed, the duration, number and type of embarked aircraft (eg carrying jets or primarily battlefield helicopters).

**1.19** The Department, by devising this routine operating model, has identified that it is impossible to satisfy all demands for CEPP all the time, based on the current level of equipment, budget and personnel planned. The model provides senior decision-makers with an assessment of how the Department could use the carriers and the possible trade-offs it would have to make when deciding how to deploy them routinely (**Figure 4**).

**Figure 4** Factors influencing the routine operating model for Carrier Enabled Power Projection (CEPP)

There are a range of factors the Department must balance when deciding how it will deploy Carrier Enabled Power Projection on a routine basis



Source: National Audit Office

# Part Two

## Programme performance and risks to delivering Carrier Strike

**2.1** This part provides an overview of the Ministry of Defence's (the Department's) progress in delivering Carrier Enabled Power Projection, the three core equipment programmes, and the other equipment, infrastructure and support needed to achieve an initial Carrier Strike operating capability in December 2020.

### Overall CEPP performance

#### Schedule

**2.2** The Department has set out an ambitious Carrier Enabled Power Projection (CEPP) schedule. This brings together the schedules for the three core programmes to deliver the Department's ambition for CEPP by 2026 (Figure 2). This overall schedule is designed to minimise the length of time the UK does not operate carriers and to reduce costs.<sup>4</sup> In line with normal practice, the Department has set project schedules that it assesses have a 50% probability of being achieved, and there is little contingency for unforeseen events.<sup>5</sup>

**2.3** The Department has plans to deliver an initial Carrier Strike operating capability by December 2020. However, there remains considerable risk that it will not achieve these plans. The period between 2017 and 2020 includes several 'firsts' where the outcome is uncertain. These include HMS Queen Elizabeth leaving Rosyth through a restricted channel, the inaugural sailing of a 'first of class' ship, and sea flying trials for the Lightning II jets.

**2.4** The Department has a good understanding of the critical path between 2017 and 2020 (**Figure 5** on page 24 and 25). Individually, each core programme has a set sequence of events, and timetables are managed by the Commands. There are several 'pinch points' on the critical path to delivering Carrier Strike. In addition, there are complex interdependencies between the programmes which, if not achieved on time, will need Head Office to direct the Commands in the best interests of CEPP.

<sup>4</sup> A decision was taken as part of the 2010 Strategic Defence and Security Review to retire the remaining Invincible Class aircraft carriers before the new Queen Elizabeth Class was introduced.

<sup>5</sup> When setting project schedules the Department models a number of scenarios reflecting risks and uncertainty. It normally selects schedules that it estimates have a 50% probability of being achieved, reflecting that these are as likely to be met as not.



**2.5** Some activities on the critical path for the Lightning II programme are outside the Department's control. The US Government manages the commercial arrangements with Lockheed Martin and Pratt & Whitney on behalf of the UK (see Part Three). This limits the Department's ability to manage the schedule and increases the risk of delays. However, the Department believes that being part of the US-led programme enables the UK to benefit from economies of scale.

**2.6** There has been some schedule slippage in individual programmes, putting pressure on the overall CEPP schedule. The Department has taken decisions to preserve the timetable, although they come with risks. Examples include:

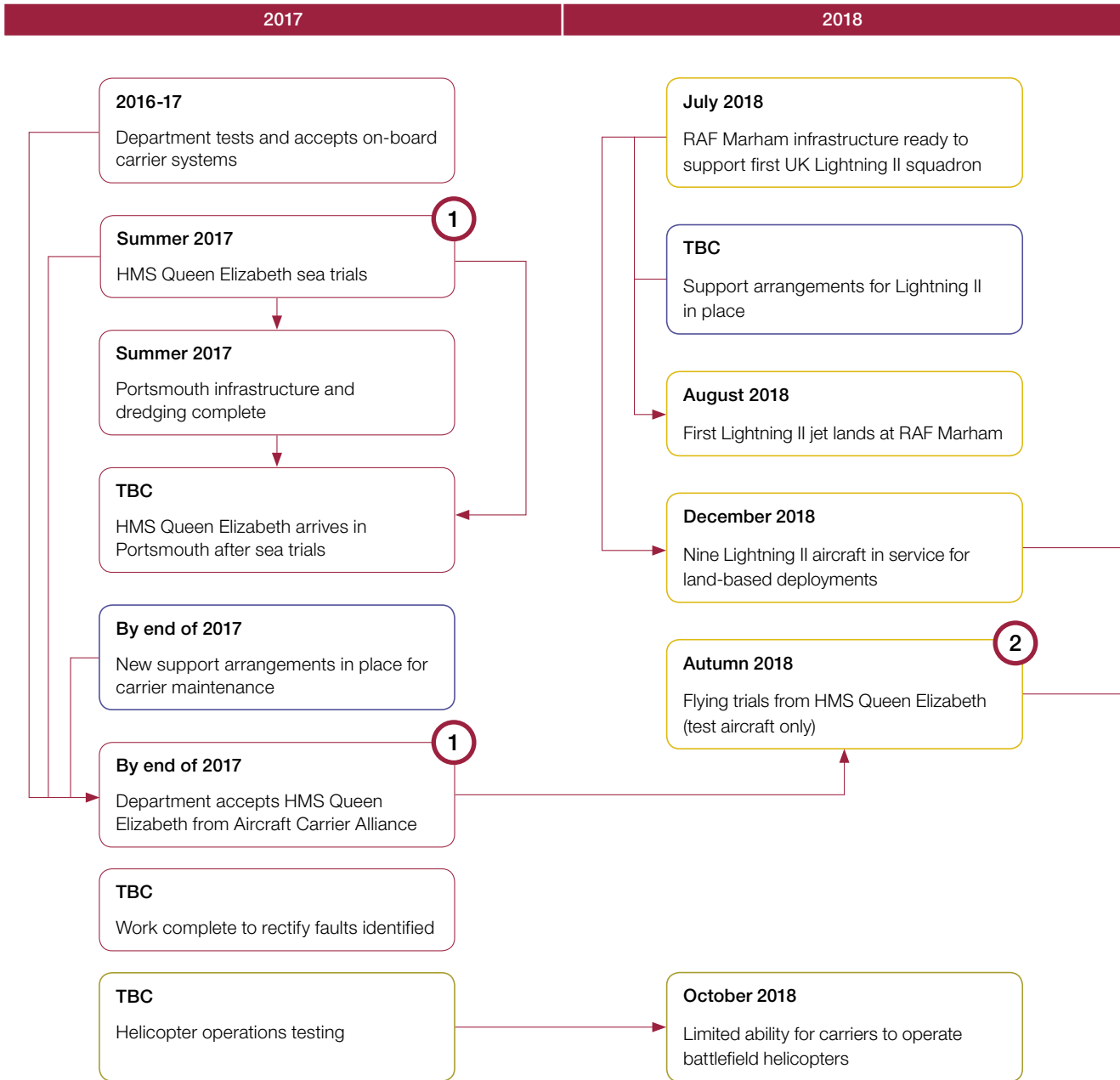
- Dredging Portsmouth harbour was delayed by larger than expected volumes of unexploded ordnance from the Second World War. The Department has focused dredging on a narrow but deep channel to allow HMS Queen Elizabeth to enter port, and will complete wider work later.
- Delays to Lightning II production mean the first UK jets have been delivered later than planned. UK pilots are training alongside the US Marine Corps (USMC) using US jets, which has accelerated pilot training. The UK will pay back these training hours by leaving some UK jets in the US for USMC training in 2018 for a period to be agreed.
- Negotiations between the Department and its contractor to let the Crowsnest contract were delayed. While they were ongoing, the Department commissioned Lockheed Martin to carry out work as planned and to maintain its supply base within the overall budget (paragraph 3.11).

**2.7** In late 2016, the date of the planned first sailing of HMS Queen Elizabeth was delayed by approximately three months to summer 2017 because of technical issues. This has compressed a schedule that already had significant risks that it might not be achieved. At the time of our report, the Department had not yet assessed the impact of this delay on the schedule to 2020. Reviews by the Infrastructure and Projects Authority prior to the delay concluded that the schedule was already taut, but achievable.

**2.8** Between the Department accepting the first carrier and Lightning II jets from the suppliers, and it declaring Carrier Strike ready for operational use, there will be an intensive period of training, trials and further fit-out for additional equipment (**Figure 6** on page 26). This period is crucial for ensuring that crews can safely operate the equipment and for giving the Department confidence the capability works as intended. Any decision to deploy earlier than December 2020 could have safety implications and would delay the schedule. At the request of the Prime Minister, in February 2016, the Department undertook a review into early use of a carrier. This concluded that the schedule was already ambitious and the recommendation not to accelerate the programme was accepted.

**Figure 5**  
Critical path to Carrier Strike (December 2020)

There are a number of 'pinch points' in the schedule, two of which are illustrated below



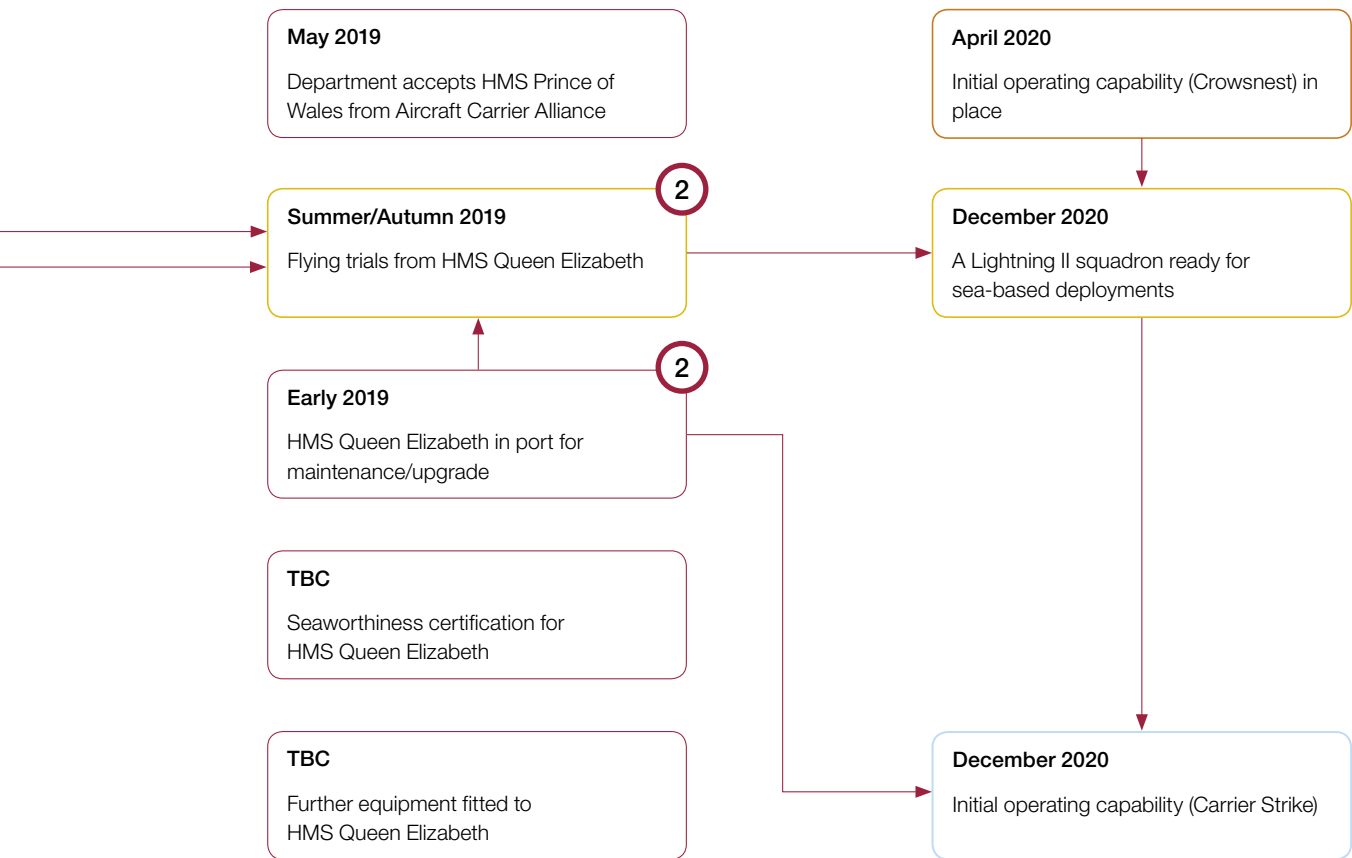
- Queen Elizabeth Class carriers programme
- Lightning II programme
- Crowsnest programme
- Support programmes
- Helicopter carrier capability
- Carrier Enabled Power Projection milestone

Source: National Audit Office analysis of Departmental data

**2019** **2020**

**1** **Pinch point:** Schedule and completion of successful sea trials are critical to the Department accepting HMS Queen Elizabeth from the Aircraft Carrier Alliance by December 2017, as specified in the contract.

**2** **Pinch point:** First flying trials for the UK Lightning II squadron depend both on HMS Queen Elizabeth having successfully been maintained and made ready for service and also on the availability of the Lightning II jets and the results of the outcome of initial trials



**Figure 6**

## Developing the capability: trials, training and fit-out 2018 to 2020

**There will be an intensive period of trials, training and fit-out of the carriers and Lightning II jets to ensure that these can be used together to achieve Carrier Strike**

<b>2018</b>	Flying trials for helicopters from HMS Queen Elizabeth	← HMS Queen Elizabeth in-service
	Additional fit-out of carrier systems removed from schedule earlier	
	Sea training for HMS Queen Elizabeth	← First Lightning II arrives in UK
	Flying trials for Lightning II jets (Phase 1: UK test aircraft)	
<b>2019</b>	HMS Queen Elizabeth docks for hull inspection; period of further fit-out	
	Further sea training for HMS Queen Elizabeth	
	Flying trials for Lightning II jets (Phase 2: UK Lightning II squadron)	
	Testing and further training of Lightning II on HMS Queen Elizabeth	← HMS Prince of Wales in-service
<b>2020</b>	Testing and further training of Lightning II on HMS Queen Elizabeth	
	Flying trials from HMS Prince of Wales of Lightning II jets	
	Training with wider task group including fleet escorts and helicopters	

Source: National Audit Office analysis of Departmental data

**Technological risk**

**2.9** The carriers and the Lightning II jets are designed to use the latest technology for military advantage. For example, the Lightning II helmet provides pilots with situational awareness on the visor, allowing them to look through the body of the jet to increase their responsiveness. Advanced technology can be more expensive to buy and support, but may reduce staff requirements. For example, automation of emergency fire systems, ship monitoring and munitions handling on the carriers allows them to be operated by fewer staff than comparable US carriers.<sup>6</sup>

<sup>6</sup> US Ford Class carriers (100,000 tonnes) are operated by around 3,000 personnel; UK Queen Elizabeth Class carriers (66,600 tonnes) are expected to be operated by around 750 personnel.

**2.10** Increasing reliance on technology means system failures can restrict how the Department uses the capability. This risk is particularly relevant for Lightning II jets, which are being manufactured while design testing is still under way. The design phase is expected to last until 2019, after several UK jets are to be delivered. While this approach enables the capability to be ready sooner, any faults or issues identified will require jets already delivered to the UK squadron to be modified. Technological failures on the carriers might mean larger crews are needed or place greater pressure on existing personnel.

**2.11** The Department is relying on an unusually high level of simulator training for Lightning II pilots. Simulator training is an important part of pilot training, enabling pilots to train for scenarios that cannot be replicated easily in a live environment. For cost reasons the Department is using 50% simulator training, the highest proportion it has used for combat aircraft and higher than in other countries.<sup>7</sup> There have been delays providing software that captures data from real scenarios for use in simulators, which has limited how realistic the training is.

### Sufficiently qualified and experienced personnel

**2.12** The Department has a shortage of military personnel, 6,213 (4%) below a target strength of 145,560. Particular roles are affected, having a measurable, detrimental effect on operations and creating a risk that sufficiently qualified and experienced staff will not be in place in time for trials and development of the capability before 2020. The Navy has gaps in engineering and war-fighting roles.<sup>8</sup> The RAF has gaps in engineering, intelligence and some aircrew cadres.

**2.13** The Department is attempting to offset personnel risk by prioritising personnel for the capability (paragraph 1.12) and carrying out targeted recruitment. However, there will be a lag between personnel being recruited and becoming sufficiently qualified and experienced for their new roles. New joiners to the Navy can take five to six years to become technicians. Training pilots to fly the Lightning II jets requires eight to nine months of specialist training, in addition to four years of general fast-jet pilot training.<sup>9</sup> The SDSR 2015 decision to buy jets sooner has enabled more flying hours, supporting the planned pipeline of training to deliver the required capability. However, the number of trained pilots is expected to be just sufficient up to 2026. More generally, the Department will rely on a few people in certain roles to build up the skills and experience needed in time to operate the Carrier Strike capability, with limited resilience if staff decide to leave the services.

**2.14** Until the Department has determined the maintenance and operational requirements of the new equipment, it will not know the total number of sufficiently qualified and experienced staff it needs to operate Carrier Strike. Meanwhile, the Department has developed staffing assumptions, but it cannot confirm these until trials and training are finished.

<sup>7</sup> The Department originally planned a ratio of 70% live and 30% synthetic training.

<sup>8</sup> War-fighting personnel use communications, weapons and defensive systems to analyse, plan and execute global operations.

<sup>9</sup> Comptroller and Auditor General, *Military Flying Training*, Session 2015-16, HC 81, National Audit Office, June 2015.

## Cost

**2.15** Under the Department's delegated organisational model, the Commands manage equipment programmes within their own budgets. The core equipment programmes are managed by the Commands as part of their wider portfolio, rather than as a collection of Carrier Strike programmes.<sup>10</sup> The Department uses its normal financial management processes to scrutinise the costs of the programmes. These include annual budgeting cycles, quarterly reviews of costs and scrutiny of new investments. Any cost increases or decreases in programmes are offset within each Command's budget. The CEPP team, based in Head Office, oversees delivery of the capability. It has visibility of individual programme costs, but has no role in scrutinising them. Reflecting the delegated model, costs are reported by individual programmes, not for Carrier Strike as whole.

**2.16** We have collated the costs already incurred and forecast future costs of the core Carrier Strike equipment, support and infrastructure identifiable from Commands' programme returns to the Cabinet Office. These total £14.3 billion to March 2021, approximately the point at which the capability will first be used.<sup>11</sup> In addition, the Department estimates that the personnel and basic operational costs from now until 2021 will be around £0.6 billion, but will increase depending on how Carrier Strike is used. The full cost to the Department of establishing the capability is likely to be higher, as this figure does not reflect other elements needed for Carrier Strike that are already in use for other tasks (for example helicopters, communications and surveillance) (Figure 3).

**2.17** Reflecting the Department's delegation of the programmes to the Commands, there is no point at which a single baseline of costs for Carrier Strike has been set.<sup>12</sup> We have used the forecast costs as at 2014-15 as a proxy for a baseline date to consider how costs have changed. The Department is now expecting the core elements of Carrier Strike to cost £14.3 billion against an expectation in 2014-15 of £13.8 billion (**Figure 7**). Most of this increase relates to the Department bringing forward Lightning II costs originally planned for after 2020, so that two squadrons are available earlier.

**2.18** The Department is more confident about some forecast costs than others. The carriers, Lightning II and Crowsnest equipment programmes are on contract, reducing the risk that costs will change. The Department's Cost Assurance and Analysis Service (CAAS) has reviewed cost forecasts and has medium to high confidence that they are reasonable. Support arrangements are less mature, as contracts have not yet been signed (paragraph 3.12). The Department is forecasting support for the carriers and Lightning II will cost £1.3 billion to March 2021. CAAS has low to medium confidence in these forecasts because of the limited data currently available. Historically, the Department's estimates of the cost of supporting equipment are less robust than the cost of buying it.

<sup>10</sup> Navy Command is responsible for managing the carriers and Crowsnest programmes, and Air Command the Lightning II programme.

<sup>11</sup> The Department is planning for first deployment in 2021. March 2021 is the end of the 2020-21 financial year.

<sup>12</sup> The baseline for the carrier programme was reset in 2014. The Department is following an incremental approach to approving the purchase of jets; therefore, there is no point at which the full expected cost of the programme was set. The Crowsnest contract was signed in November 2016.

## Figure 7 Estimated cost of Carrier Strike to 2020-21

Carrier Strike costs have increased, primarily because of the Department accelerating the purchase of Lightning II jets

	Baseline (Q2 2014-15) (£bn)		Current estimate (Q2 2016-17) (£bn)		Notes
	Spend to date	Forecast spend to 2020-21	Spend to date	Forecast spend to 2020-21	
<b>QEC Carriers</b>					
Build	4.7	1.5	5.8	0.4	The carrier build costs were re-baselined in 2014, with approved spend set at £6.212 billion. The Aircraft Carrier Alliance is forecasting possible cost growth of between 1% and 2% against the £6.212 billion. However, the Department has not accepted this increase and is working with the Aircraft Carrier Alliance to eliminate it.
Support	0.0	0.5	0.0	0.5	
Other costs <sup>5</sup>	0.1	0.2	0.2	0.1	Other costs include infrastructure costs at Portsmouth and costs related to the Department's decision to change the type of jet to fly from the carriers.
<b>Total</b>		<b>7.0</b>		<b>7.0</b>	
<b>Lightning II</b>					
Build <sup>5</sup>	2.1	3.2	3.6	2.3	Expected cost of the programme has increased as a result of SDRS 2015 decision to bring forward the purchase of jets. Includes support for the jets and infrastructure at RAF Marham.
Support	0.0	1.0	0.2	0.6	Includes certain infrastructure costs at RAF Marham not included within the support costs.
Other costs	0.0	0.2	0.1	0.2	
<b>Total</b>		<b>6.5</b>		<b>7.0</b>	
<b>Crowsnest</b>					
Build	0.0	0.3	0.1	0.2	Approval to proceed with Crowsnest was granted in April 2016 and a contract was signed in November 2016 for £269 million.
Support	0.0	0.0	0.0	0.0	Specific support costs for Crowsnest are minimal as support will be included within the current overarching support contract for the Merlin helicopters.
<b>Total</b>		<b>0.3</b>		<b>0.3</b>	
<b>Total</b>		<b>13.8</b>		<b>14.3</b>	

### Notes

- Forecast costs are to March 2021, the end of the 2020-21 financial year. An initial Carrier Strike operating capability is planned for the end of the 2020 calendar year, with first deployment in 2021.
- Forecast costs includes future planned spending that may not yet be approved.
- Support arrangements for the carriers and Lightning II are still in development (paragraph 3.12). These are forecast at £1.3 billion to March 2021. Support for Crowsnest will fall under existing arrangements to support Merlin helicopters and are not included.
- Crowsnest forecast spend is the total of development costs and the value of the Crowsnest contract.
- Numbers may not sum due to rounding; numbers have been rounded to the nearest £100 million.

Source: National Audit Office analysis of Departmental data

**2.19** As well as the cost of buying and supporting the equipment, the Department has also modelled the operating costs of various alternatives for using the capability above the assumed level of use already reflected within budgets.<sup>13</sup> The Department believes that current budgets reflect a sustainable level of use based on available resources and equipment. This modelling allows senior decision-makers to understand how changes to this assumed use would affect costs. Costs above the assumed level of use are not included in the Commands' budgets, as the Department is refining the detailed operational plans on how it will use the carriers, where the costs will arise and how they will be funded.

### Performance of core CEPP programmes

**2.20** In the rest of this part we examine progress and risks in each of the three core programmes (carriers, Lightning II and Crowsnest) and elements supporting these. The Department is currently reporting that successful delivery is feasible but that significant issues remain for each of the core programmes (**Figure 8**).

### Carriers

**2.21** Overall, since we last reported in May 2013, performance on the carrier programme has improved. In November 2013, the Department and the Aircraft Carrier Alliance (ACA) agreed on a new baseline for the programme, which altered the build schedule for the carriers and shared cost increases to better align their interests. Appointing a non-executive chair has strengthened the ACA's governance. The Department and industry are working together more effectively. The ACA is applying learning from the build of the first carrier to the second, resulting in good progress against its schedule. Background information on the carriers is available, see online Appendix Three.

**2.22** Schedule slippage in 2014-15 on the build of the first carrier, HMS Queen Elizabeth, against the new schedule was subsequently recovered by increasing resources to accelerate the fitting out of the carrier. Some work to rectify issues identified through testing is now planned to take place during a shortened period of initial sea trials. This has increased risk because the schedule has become compressed and tasks that were planned to happen sequentially will now take place in parallel. Some work is also now planned to take place after the Department has accepted HMS Queen Elizabeth from the supplier. The scope of this work is to be agreed by the Department and industry in advance of vessel acceptance. While the Department does not have a warranty from the ACA for the vessels, it does have warranties for subsystems and equipment on board the carriers.

<sup>13</sup> Including assumptions on the cost of fuel, staffing, infrastructure and utilities.






**Figure 8**






## Delivery confidence assessment for core programmes (as at November 2016)

**The Department is reporting that successful delivery of the carriers, Lightning II and Crowsnest programmes appears feasible but significant issues exist**

Delivery confidence is an assessment of whether a programme will achieve its objectives within the agreed timescale, budget and quality requirements.

Programme	Progress so far	Senior responsible owner's latest assessment of delivery confidence	Areas of concern	Direction of travel
Queen Elizabeth Class carriers	HMS Queen Elizabeth almost complete, testing under way before first sailing summer 2017  HMS Prince of Wales progressing well	 (November 2016)	Manning for carriers not at 100% and manning requirement may increase  Project team under-resourced, delaying contracts for spares  Cost savings measures may result in delays to the capability	Stable
Lightning II	Eight UK aircraft delivered by January 2017 (three are test aircraft)  Eight further jets are expected before August 2018	 (November 2016)	Project team under-resourced  Dependent on US to manage contract, train UK squadron	Stable
Crowsnest	First Crowsnest system fitted to helicopter expected in 2019	 (November 2016)	Delays to contract negotiations (contract subsequently signed)	Reduced confidence (previous assessment was that successful delivery appeared probable)

**An assessment is made using the following definitions:**

-  Successful delivery of the project to time, cost and quality appears highly likely and there are no major outstanding issues that at this stage appear to threaten delivery significantly.
-  Successful delivery appears probable; however, constant attention will be needed to ensure risks do not materialise into major issues threatening delivery.
-  Successful delivery appears feasible but significant issues already exist, requiring management attention. These appear resolvable at this stage and if addressed promptly, should not present a cost or schedule overrun.
-  Successful delivery of the project is in doubt, with major risks or issues apparent in a number of key areas. Urgent action is needed to ensure these are addressed, and whether resolution is feasible.
-  Successful delivery of the project appears to be unachievable. There are major issues on project definition, schedule, budget, quality and/or benefits delivery, which at this stage do not appear to be manageable or resolvable. The project may need re-scoping or its overall viability reassessed.

**Note**

1 Senior responsible owners report quarterly on the progress of their programmes, including their assessment of delivery confidence.

Source: National Audit Office analysis of Departmental data

**2.23** In late 2016, the ACA decided to revise the planned first sailing of HMS Queen Elizabeth by approximately three months to summer 2017. It is managing a number of technical issues, related to the commissioning of the ship's systems. At the time of our report, the Department had not yet assessed the impact of this delay on the schedule to 2020. The Department believes that the current target of accepting the carrier from the ACA by the end of 2017 is achievable.

**2.24** Forecast costs for the carrier build have remained close to the approved re-baselined cost of £6.212 billion, reflecting a greater focus on costs by the Department than when we last reported. This figure includes a target price for both carriers, Departmental costs and some costs resulting from its 2012 decision on the variant of the Lightning II jet to fly from the carriers before the contract was re-baselined.<sup>14</sup> The Department is dealing with potential cost pressure of some 1% to 2% on the approved cost. This pressure arises from:

- the ACA forecasting the cost of the build will exceed the target price agreed in the re-baselined contract. The Department has not accepted this increase and is working with the Alliance to achieve the target contract cost and thus minimise any cost increase;
- higher than expected costs associated with the application of thermal metal coating on the landing areas of the carriers to protect them from the intense heat of the Lightning II engines; and
- the financial impact of risks that the Department must manage, which are not included within the provision for risk in the target price.

## Lightning II

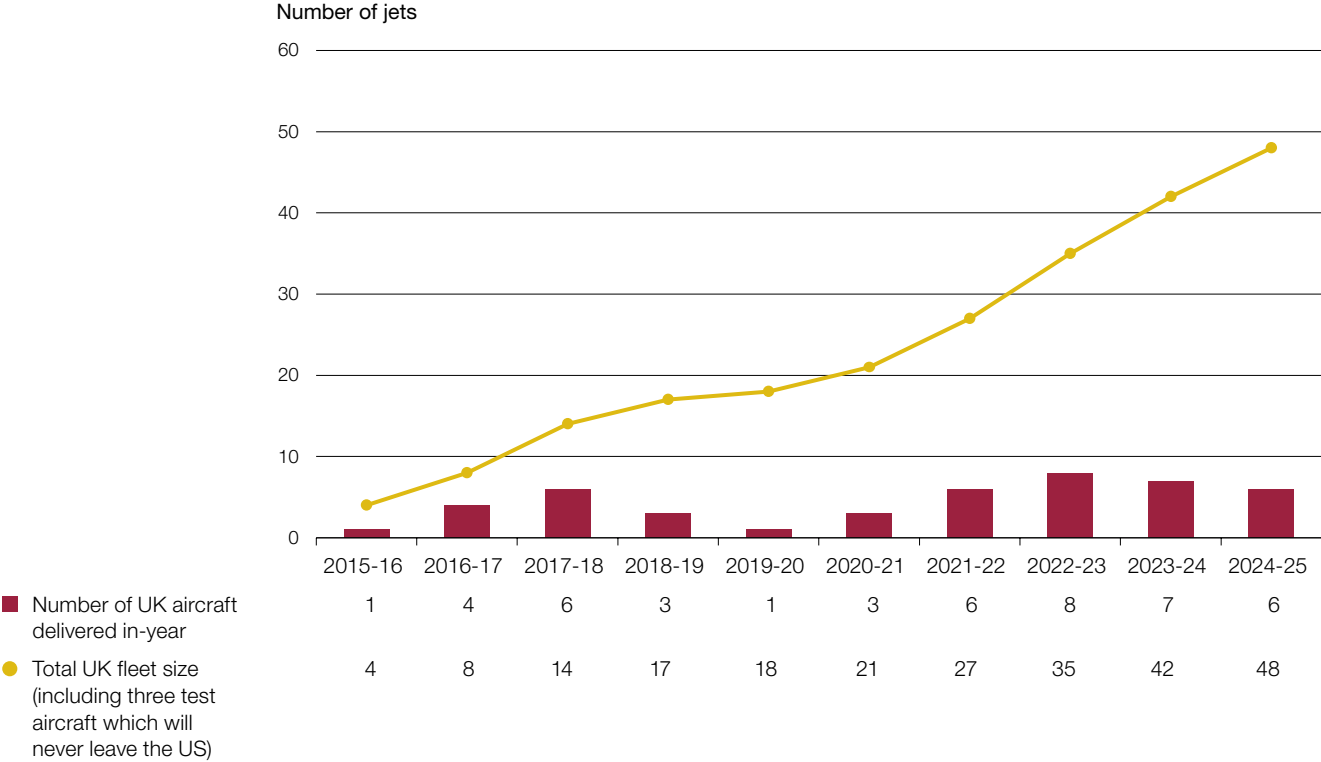
**2.25** The Lightning II, or F-35, is a sophisticated stealth aircraft produced by Lockheed Martin in the US. The Department is purchasing the jets under a memorandum of understanding with the US Government (online Appendix Four). The first jets are expected to land in the UK in August 2018. By January 2017, the UK had accepted delivery of eight aircraft, which are currently in the US. The Department expects delivery of a further eight before August 2018. As well as flying from the carriers, the Lightning II jets will be used for land-based operations.

<sup>14</sup> Comptroller and Auditor General, *Carrier Strike: The reversion decision*, Session 2013-14, HC 63, National Audit Office, May 2013.

**2.26** Bringing forward the purchase of jets to increase Carrier Strike capability adds technical risks. The Department decided as part of SDSR 2015 to bring forward the expected buy profile of a further 30 jets so that two front-line squadrons will be available from 2023 (**Figure 9**). This has increased capability by allowing two squadrons of the jets to be deployed at the same time. However, design and testing are happening concurrently until 2019, which means the early production jets already delivered require modification when design issues are identified in testing.

**Figure 9**  
Expected number of Lightning II jets in the UK fleet

The Department plans to have two squadrons consisting of 12 front-line aircraft each by 2023



**Note**  
1 Alongside the 24 front-line jets, aircraft will be used for testing and evaluation, training front-line pilots, and replacement aircraft for these activities.

Source: National Audit Office analysis of Departmental data

**2.27** The Department has so far approved spending of £9.1 billion on the Lightning programme.<sup>15</sup> This includes the UK's contribution to early development costs; infrastructure, purchase and initial support of 48 aircraft; and administration costs. The Department is purchasing the aircraft in stages. The latest approval to purchase 30 jets, initial support and administration was in January 2017 for around £3 billion.

**2.28** Costs of the jets could increase, either because of changes in the global numbers of jets ordered (paragraph 3.11) or because of foreign exchange rate fluctuations. Programme costs are in US dollars meaning they are sensitive to such variations. The Department mitigated exchange rate volatility until 2017-18 by using forward purchase contracts with the Bank of England, as well as provision set aside within the expected programme costs. From 2018, there is a greater risk to affordability of the programme because of foreign exchange fluctuations. The Department is considering how to mitigate this risk as it monitors movement in the exchange rate.

### Crowsnest

**2.29** The Crowsnest programme was set up in 2011 to equip 10 of the 30-strong Merlin helicopter fleet to provide airborne surveillance (online Appendix Five). The programme is comparatively small in value (approximately £0.3 billion), but critical for providing the carrier task group with intelligence on threats beyond the horizon. Crowsnest will work alongside the air defence capabilities provided by the Type 45 destroyers. Since the number of destroyers in the Royal Navy has now reduced from a planned 12 to just six, the need for Crowsnest capability is even more important. The availability of Crowsnest is one of the main factors the Department is considering when deciding how to deploy Carrier Strike (Figure 4).

**2.30** Crowsnest is now at a critical point, and the schedule does not allow any further delays. Since we last reported,<sup>16</sup> the Department has reversed its 2012 decision to delay Crowsnest. This means Crowsnest will now be ready in time for first deployment in 2021. However, the current schedule leaves limited time for integration training and work-up, which could mean that sufficient numbers of Crowsnest-fitted helicopters and trained crews are not ready to protect the carrier group when needed.

<sup>15</sup> Approved spend will also include future costs beyond the initial operating capability of Carrier Strike in December 2020.

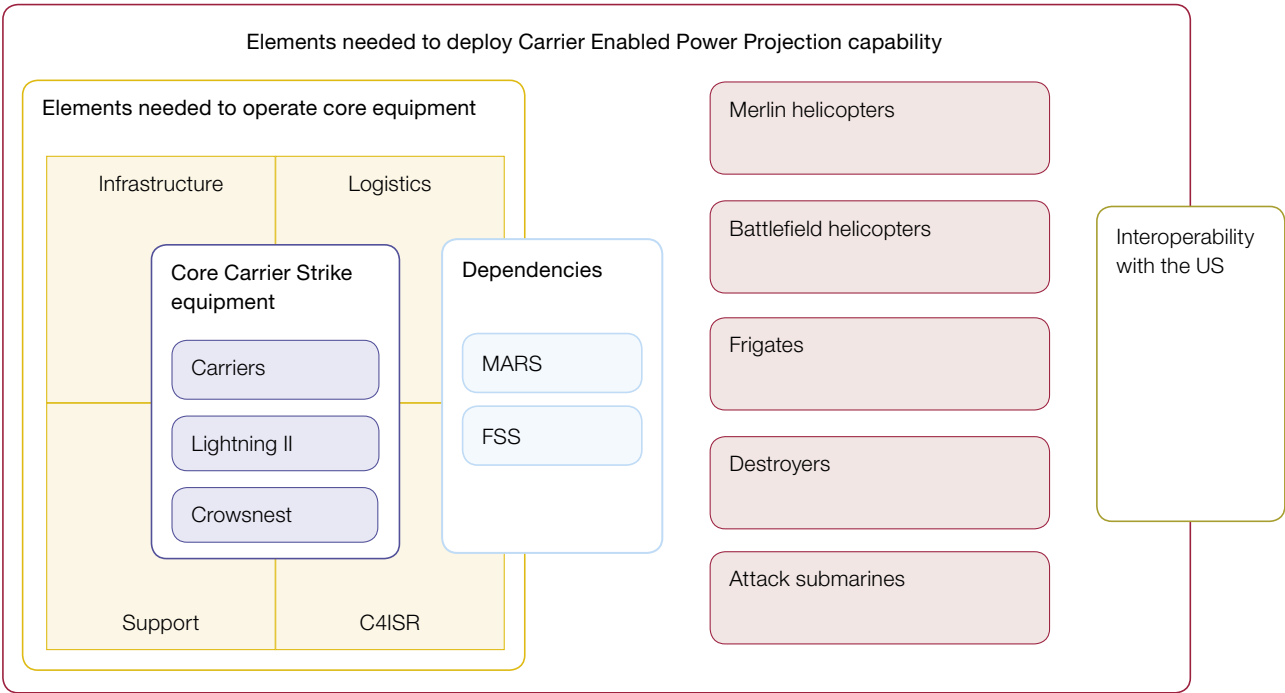
<sup>16</sup> See footnote 14.

### Enablers and dependencies supporting CEPP

**2.31** Successfully deploying Carrier Strike from December 2020 and CEPP in 2026 depends on other defence equipment and capabilities being available (**Figure 10**). There are specific requirements for logistics, communications and surveillance, collectively known as ‘enablers’. Deploying the carriers also depends on support ships. While the CEPP team has primarily focused on the three core programmes so far, greater attention is now being given to the wider programmes as first use approaches.

**Figure 10**  
Carrier Enabled Power Projection

Deploying a CEPP capability requires many other elements to be in place



**Notes**

- 1 C4ISR – Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance; MARS – Military Afloat Reach and Sustainability; and FSS – Future Solid Support shipping.
- 2 Dependencies are separate projects needed to allow the carriers to operate as well as the rest of the Naval fleet.

Source: National Audit Office analysis

## Enablers

**2.32** Carrier Strike creates requirements for extra logistics, communications and surveillance. Under the Department’s delegated organisational model, the Commands are responsible for delivering these within their existing budgets. CEPP’s senior responsible owner (Part Three) holds each Command to account for identifying and delivering the requirements, and the CEPP governance boards check progress. Plans for some of the enablers are at an early stage and will develop as the Department decides how Carrier Strike will be deployed.

**2.33** Because of the Commands’ tight financial position, they have not prioritised funding for some enablers or have delayed funding them until the last possible opportunity. Some enablers remain unfunded and further analysis is ongoing to decide on the requirements and expected cost (**Figure 11**). The Department advised us that this is normal business and that, while some of the CEPP-related demands may be met in the current financial planning cycle, others may be delayed until later where they are not critical. This presents a risk to achieving Carrier Strike successfully or may increase dependence on allies. The central CEPP team does not have budget to assign to unfunded projects and needs the Commands to escalate risks that enablers will not be in place because of funding.

**Figure 11**  
Unfunded enablers

**Enablers important to support Carrier Enabled Power Projection (CEPP) that are unfunded**

Enabler	Requirement	Estimate of cost (£ million)
US/UK interoperability	Additional equipment and training to enable US Lightning II jets to fly from UK carriers and vice versa	To be determined once the Department’s analysis is complete
Weapons stockpile	Sufficient weapons for Lightning II and helicopters	To be determined once the Department’s analysis is complete
Maritime intra-theatre lift	Ability to move people and goods, including Lightning II parts within the carrier task group	To be determined once the Department has decided on a potential solution
Tactical datalinks	IT software and hardware that allows exchange of command and control and tactical data between allies and within the task group	Commercially sensitive prior to the Department’s invitation to tender process
Integrated mission data	Further development of Lightning II computer system	To be determined once the Department’s analysis is complete

Source: National Audit Office analysis

## Dependencies

**2.34** Deploying Carrier Strike as part of a carrier task group depends on two projects to replace current support ships:

- tankers supplying oil and water;<sup>17</sup> and
- solid support ships, carrying food, ammunition and general stores.

**2.35** In 2013, we reported that the Department had delayed funding for the solid cargo ships, only going ahead with procurement of four tankers.<sup>18</sup> Subsequently, as part of SDSR 2015, the Department decided on a new fleet of three solid support ships, to enter service from 2026. Existing support ships are being retired from service and between 2024 and 2026 the Navy will have limited solid support shipping capability. The Department will need to closely manage availability of these ships over this period to ensure that it can support the carriers as well as the rest of the Navy's fleet.

## Infrastructure

**2.36** Successfully delivering Carrier Strike depends on new infrastructure, mainly upgrading Portsmouth Naval Base to accommodate the carriers, dredging Portsmouth harbour and upgrading RAF Marham. Timely delivery of these projects is critical to support the equipment and the overall CEPP schedule:

- The work at RAF Marham is running with three weeks' contingency before the first squadron of jets arrives in August 2018. This is because the Department was late in deciding where the jets would be based, delaying contracting for this work.
- The Department had intended to close Portsmouth Naval Base, so had not invested in infrastructure there for many years. It subsequently decided to base its new carriers there. This means the base needs significant upgrades. The Department has prioritised infrastructure work to ensure the base can accommodate the first carrier, but work will be ongoing even after HMS Queen Elizabeth arrives. The Portsmouth harbour dredge has been delayed (paragraph 2.6).

## Support

**2.37** The Department is developing new arrangements to support the carriers and Lightning II once they are in service.<sup>19</sup> These include maintenance, engineering and repair and provision of spares. These rely on the Department successfully implementing complex contractual arrangements (paragraph 3.12). The exact support requirements will remain uncertain until the Department has experience of using the equipment. It does not yet know, for example, how frequently the equipment will need spares or the systems will need maintenance. Given the unique nature and longevity of the capability, the Department expects to develop and refine support arrangements over its life.

<sup>17</sup> Military Afloat Reach Sustainability project.

<sup>18</sup> See footnote 14.

<sup>19</sup> Crowsnest will be supported as part of the existing arrangements to support Merlin helicopters.

# Part Three

## The effectiveness of management arrangements

**3.1** This part examines the effectiveness of the Ministry of Defence's (the Department's) governance and commercial arrangements to ensure the coherent delivery of the equipment, personnel and support needed to achieve Carrier Enabled Power Projection (CEPP).

### **Central oversight within a delegated model**

**3.2** The Department delegates responsibility for managing defence capabilities and budgets to the military Commands (Navy, Army, Air and Joint Forces), including those needed for CEPP. The Commands are held to account through existing governance structures.

**3.3** Within this delegated model, the Department established extra arrangements to ensure coordination across the Commands of the various elements needed for CEPP (**Figure 12**). A small CEPP team has been established in Head Office to oversee the programmes as a portfolio. This arrangement is new for the Department and helps to identify interdependencies between programmes.

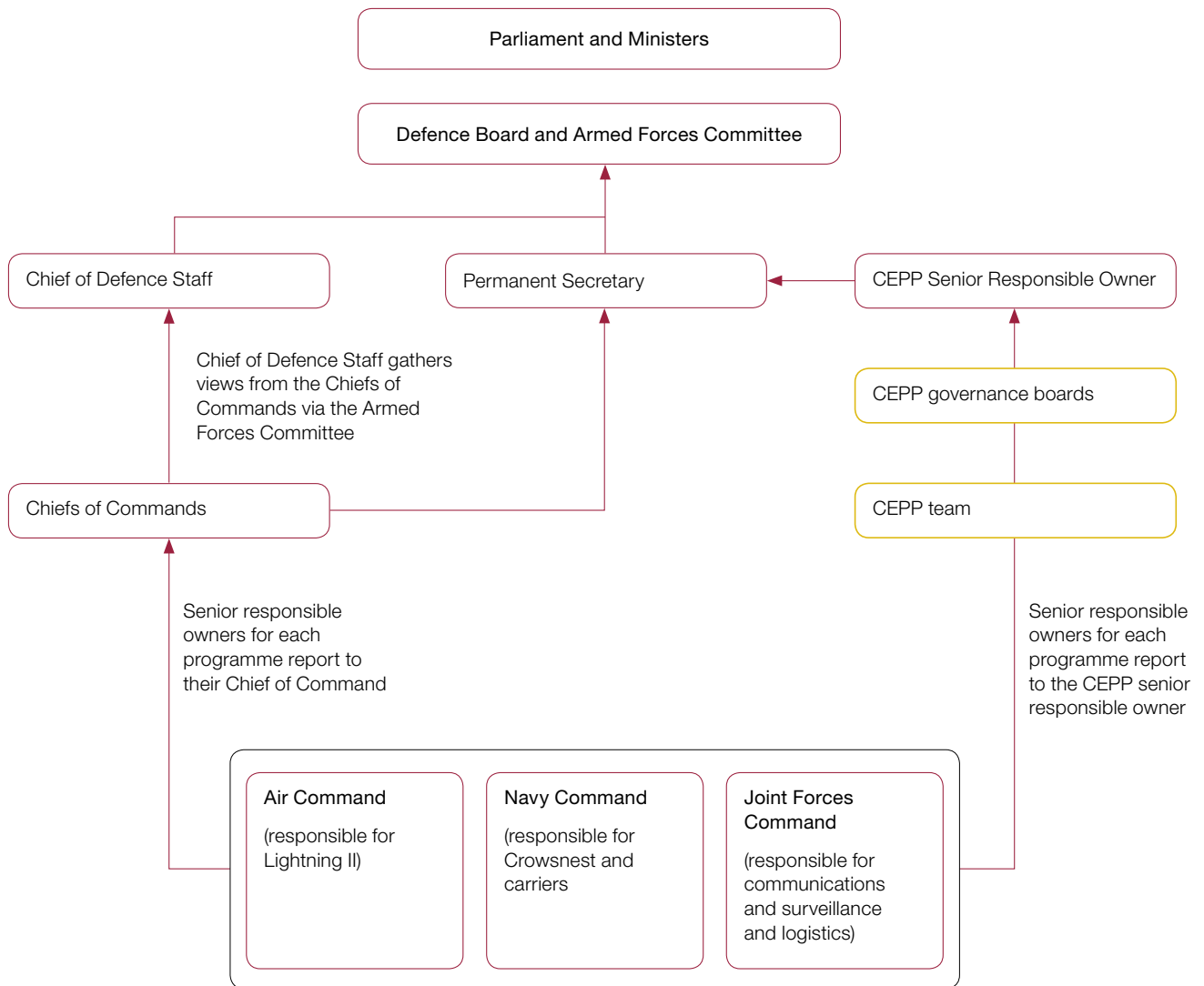
**3.4** The Department appointed the Deputy Chief of Defence Staff for Military Capability as senior responsible owner (SRO) for the CEPP programme, reflecting its significance. He is personally accountable to the Permanent Secretary for delivering CEPP. In his wider role, he is responsible for planning future military capability, ensuring coherency between Commands and making strategic investment decisions for an affordable defence portfolio. For example, he determined which Command would fund and provide staff for UK-specific software programming for Lightning II when the Commands did not agree. By choosing him as SRO, and placing the CEPP team in Head Office, the Department has ensured CEPP is prioritised and that it will be a defence-wide capability.

**3.5** For the three core programmes (carriers, Lightning II and Crowsnest) and enablers (communications, surveillance and logistics), the CEPP SRO has issued mandates to ensure the Commands take account of CEPP requirements when delivering their programmes. The CEPP team has no formal authority for managing the programmes, but supports the CEPP SRO holding the Commands to account against these CEPP mandates. To ensure the other defence capabilities needed to deploy CEPP are in place (such as sufficient numbers of helicopters, escorts and support ships), the Department is shaping its long-term plans around the carriers. These other capabilities are already assigned to other tasks.



**Figure 12**  
Governance of Carrier Enabled Power Projection (CEPP)

Each of the programmes reports through both their respective Command hierarchy and CEPP arrangements



- Relevant parts of Departmental governance
- CEPP-specific governance

Source: National Audit Office

## Governance

**3.6** Introducing a complex new capability within the context of constrained resources and existing capabilities requires strong governance. This supports oversight of progress, aligns stakeholders' plans and, where necessary, directs actions to balance competing demands on resources.

**3.7** The Department has set up two CEPP programme governance boards, with representatives from across the Commands, to examine progress and identify issues that need escalation to senior decision-makers in the Department. These boards allow open and robust discussion to highlight the risks and issues that need attention. A working-level board provides a forum for discussing issues on individual programmes, escalating contentious or important issues to an executive board. This is chaired by the SRO for CEPP, who can resolve any issues, such as a lack of alignment between programme schedules, by directing a particular course of action. Where issues are complex, these are escalated to the Armed Forces Committee and the Defence Board.<sup>20</sup>

**3.8** Detailed programme management information is available to board members, allowing a shared understanding of progress. Programme teams within the individual Commands rank risks so that board members can quickly determine trends and relative importance. The information also includes a map of key dependencies for each programme, with individual milestones and an overall timeline.

**3.9** The Department acts on external advice to help deliver the programme. CEPP is within the government's Major Projects Portfolio and subject to annual reviews by the Infrastructure and Projects Authority (IPA), who also attend the executive governance board. IPA's latest review of the carrier programme was carried out by a team which included a retired US Navy admiral, who drew on personal experience of delivering US carriers into service.

**3.10** The Department has a structured approach to understanding how risks within individual programmes could impact on CEPP overall. The CEPP team provides governance board members with an aggregate view of risk, focusing senior attention on key issues. Each of the three core programmes and enablers (logistics, communications and surveillance) is managing significant risks that could hinder successful delivery to agreed timescales, costs and performance levels. Decisions to mitigate these risks are normally made through existing Command structures (or centrally at the Armed Forces Committee), rather than in CEPP-specific governance forums.

<sup>20</sup> The Defence Board and Armed Forces Committee are responsible for the strategic direction and oversight of the Department.

## Commercial arrangements

**3.11** Delivering Carrier Strike also relies on successful commercial arrangements, which are complex and at varying levels of maturity. Arrangements for building equipment and infrastructure are well developed, but the Department has different levels of leverage over each:

- The carriers are being built by the Aircraft Carrier Alliance (ACA), an alliance between industry and the Department. The Department is represented on its main governance boards, giving it a formal role in decision-making within the Alliance. In 2013 and 2014, the Department renegotiated the contract with ACA to share cost increases above a target price to better align their interests. The build of the first carrier is almost complete, subject to resolving technical issues, and the second is progressing well.
- The Department is participating in the US-led F-35 programme (Lightning II) through a memorandum of understanding with eight other countries. The US Government manages the contract with industry on behalf of partner nations. The Department has limited contractual levers over the commercial arrangements. Costs are determined by the proportion of the total number of jets purchased by the UK and vary if other nations change their orders. Should the US reduce its order, costs would increase significantly for the UK. The Department has sought to influence the programme in a number of ways. Unlike other partner nations, the UK decided to work with the US more closely, contributing \$2 billion to early development costs. The aim was to shape the design of the jet to UK requirements, including UK weapons. It also provided staff for the US-based Joint Program Office managing the programme. The Department has committed to a three-year contract with other partner nations, which gives industry greater certainty over the number of jets ordered during that period, reducing costs.
- Crowsnest is being procured through a direct contract with industry. Lockheed Martin is the Department's prime contractor and manages a supply chain of companies. Contract negotiations were delayed because of technical specification issues, the cost of the chosen system, and additional work to fully interpret and apply the single source contracting regulations, leading to a risk that Crowsnest might not be ready in time to protect the carriers for first deployment. To mitigate this risk, the Department paid the contractor an initial £41.9 million, contained within the overall contract value of £269 million, to start technical development work until the contract was signed in November 2016.
- The Department has let contracts to build infrastructure at RAF Marham (main operating base for UK's Lightning II fleet) and Portsmouth (home port for the carriers) (paragraph 2.36). It has also agreed to fund some of the extra costs associated with dredging Portsmouth harbour to reflect a higher than expected volume of unexploded ordnance from the Second World War.

**3.12** Long-term support arrangements for carriers and jets are still in development, and must be in place before the inaugural sailing of the first carrier and before the first squadron of jets arrives in the UK. In particular:

- The Department is changing how it supports complex warships, setting up common support arrangements between different ships. Under the new model, one support contract might cover propulsion maintenance, rather than all maintenance for a single class of ship. It expects to achieve efficiencies and improve quality, but the contracts must be ready before HMS Queen Elizabeth is formally accepted from the ACA by the end of 2017. Defence Equipment and Support faces challenges in aligning multiple new and existing contracts by then (paragraph 3.13). Delays in securing budget approval for the changes have compressed the schedule.
- Support for all Lightning II jets will be organised globally via regional hubs. The nations taking part in the US-led F-35 programme (Lightning II) are competing for contracts to maintain and repair the jets. The Department will use this global support arrangement for UK Lightning II jets, but is also investing in support facilities at RAF Marham to reduce its reliance on other nations. Support arrangements must be firmed up before the first squadron arrives in the UK (August 2018), although the Department expects to introduce these incrementally over a number of years.

### Commercial capacity

**3.13** The Department has assessed that its contract management teams are under-staffed and is prioritising higher-risk commercial areas. Defence Equipment and Support has long-standing skills gaps, as highlighted in our 2015 report.<sup>21</sup> It has failed to recruit and retain enough skilled staff and is undergoing a new change programme to re-prioritise its commercial skills. With such complex commercial arrangements to negotiate for supporting Carrier Strike, there is a risk that not all contracts will be in place on time. A lack of commercial staff has delayed the purchase of spares for HMS Queen Elizabeth before its first sailing. The Department now aims to have the full complement of spares for the first carrier in time for flying trials in 2018, increasing operational risks when it first sails in summer 2017. Any attempt to take parts from the second carrier instead would delay the build programme.

<sup>21</sup> Comptroller and Auditor General, *Reforming defence acquisition*, Session 2014-15, HC 946, National Audit Office, February 2015.

# Appendix One

## Our audit approach

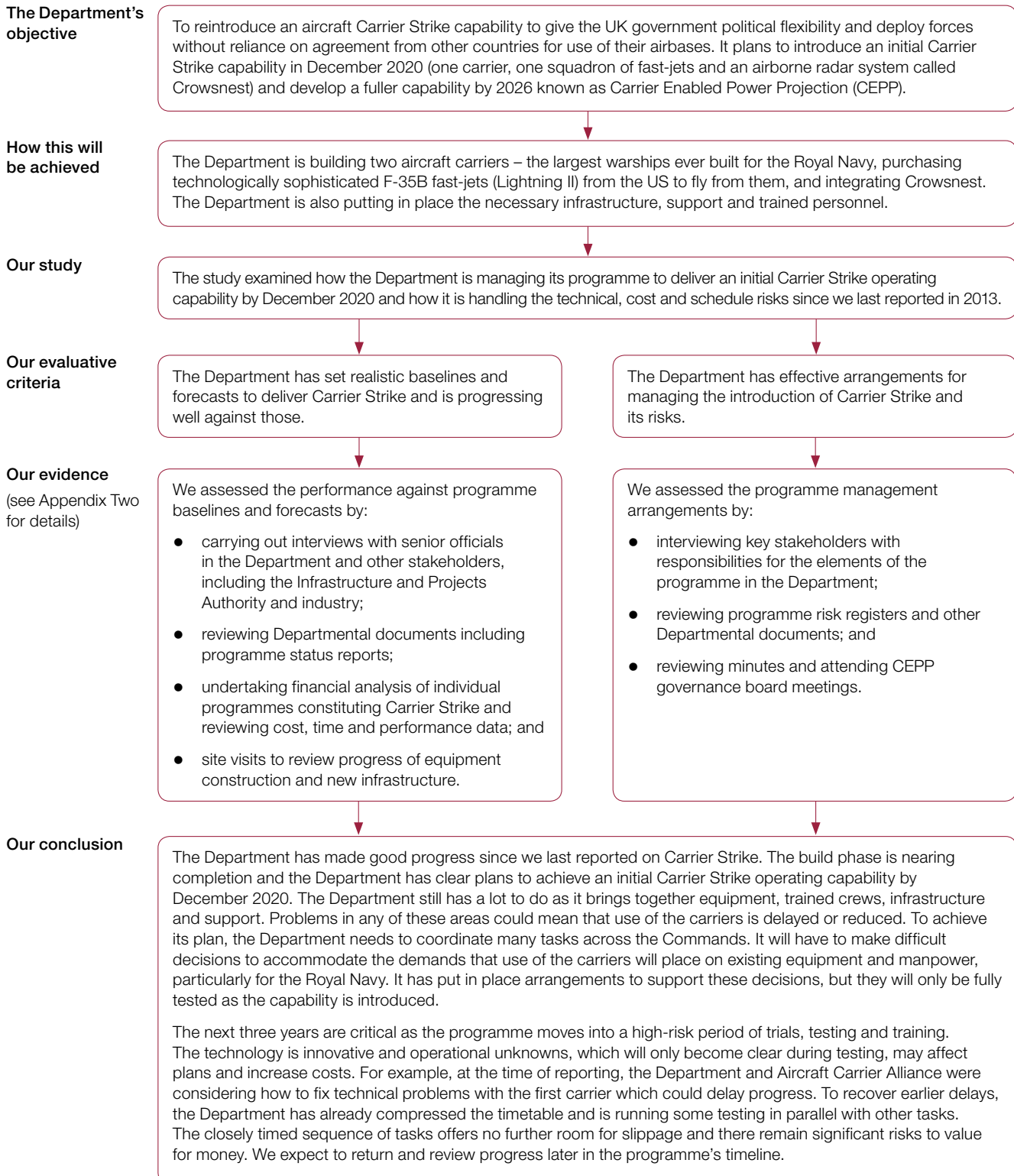
**1** This study assessed the Ministry of Defence's (the Department's) progress managing the equipment programmes, and other equipment, infrastructure and support needed to achieve an initial Carrier Strike operating capability in December 2020. We assess how it is handling the technical, cost and schedule risks since we last reported in 2013. We also consider the Department's preparations establishing a full Carrier Enabled Power Projection capability in 2026. We reviewed:

- the strategic importance of Carrier Strike;
- programme performance and risks to delivering Carrier Strike; and
- the effectiveness of management arrangements.

**2** Our audit approach is summarised in **Figure 13** overleaf. Our evidence base is described in Appendix Two.

**Figure 13**

## Our audit approach



# Appendix Two

## Our evidence base

**1** Our conclusions on how the Ministry of Defence (the Department) is managing the technical, cost and schedule risks to deliver an initial Carrier Strike operating capability (carriers, Lightning II jets and airborne radar system) in December 2020, follows our analysis of evidence collected between September 2016 and January 2017.

**2** Our audit approach is outlined in Appendix One.

**3 We examined the Department's progress against programme baselines and forecasts:**

- We undertook **semi-structured interviews with senior stakeholders within the Department responsible for delivery of the programmes**, including Navy, Air and Joint Forces Commands, as well as officials from the Department's procurement and support arm (Defence Equipment and Support). We also met with representatives from the Infrastructure and Projects Authority, which has undertaken regular reviews of the Lightning II and carrier programmes. We also met with senior representatives from industry, including the Aircraft Carrier Alliance and Lockheed Martin. This was to understand current progress and the risks to delivery.
- We **reviewed the strategic documents concerning the Department's oversight of progress of the programmes**, including programme documentation, programme board papers and minutes, and reviews by the Infrastructure and Projects Authority.
- We **undertook financial analysis and reviewed cost, time and performance data**. This allowed us to understand and analyse the status of the programmes and how the Department is managing the risks we have reported on previously. We also discussed the costs of the programme with the Department's Cost Assurance and Analysis Service, and examined the Department's cost modelling work.
- We **undertook site visits** to Rosyth (where the carriers are being built), as well as RAF Marham (where the Lightning II will be based) and the Royal Naval Base at Portsmouth. These enabled us to see the aircraft carriers at first hand and to receive a briefing on the progress and challenges for the ships, as well as see progress with developing the necessary infrastructure to support the jets and the ships in the future.

**4 We examined whether the Department has effective arrangements for managing the programme and its risks:**

- We undertook **semi-structured interviews with stakeholders**, including a number of senior responsible owners for the programmes. This was to examine the effectiveness of governance arrangements and to gain their views on the quality of management information.
- We **reviewed documentary evidence**, including programme board minutes and papers. This was to understand whether senior officials were presented with complete and consistent information from which to make decisions.
- **We observed meetings of CEPP governance boards in September 2016, October 2016 and February 2017.** The purpose was to see at first hand the working of these boards and how risks are escalated to the Defence Board and Armed Forces Committee.



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National Audit Office

Design and Production by NAO External Relations  
DP Ref: 11450-001

£10.00

ISBN 978-1-78604-110-4



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