National Audit Office

Delivering Carrier Strike: Supplementary memorandum

1 This memorandum has been prepared to support the Committee of Public Accounts' consideration of the management by the Ministry of Defence (the Department) of Carrier Strike. It expands upon, and updates information within, our *Delivering Carrier Strike* report, published in March 2017.[1]

Aircraft carriers

2 In late December 2016, the date of the planned first sailing of HMS Queen Elizabeth was delayed from March 2017 to summer 2017 because of technical issues. The build schedule for the carrier was already taut at this point. The Department, and the Aircraft Carrier Alliance (ACA), which is building the carriers, planned to assess the impact of this delay on the overall schedule once sea trials were underway.

3 On 26 June 2017, HMS Queen Elizabeth departed Rosyth dockyard to begin the first stage of sea trials. Fourteen days later, HMS Queen Elizabeth entered the port of Invergordon for re-fuelling and checks on her drive shaft and propeller assembly. She returned to sea on 24 July 2017 for further trials on speed, manoeuvrability, power and propulsion. These were successfully completed and a decision was made to proceed to Portsmouth, rather than the original plan of returning to Rosyth, to maintain schedule momentum. HMS Queen Elizabeth successfully entered Portsmouth Naval Base on 16 August, just over 8 weeks after she left Rosyth. She berthed on the newly refurbished Princess Royal Jetty, which has a new shore power facility. A planned engineering period is now underway and the second period of sea trials is scheduled for later in the autumn. The Department is forecasting taking ownership of HMS Queen Elizabeth from the ACA by the end of 2017 in line with contract.

4 Further specific departmental equipment is planned to be fitted to HMS Queen Elizabeth in 2018 and 2019. This includes sensitive defence systems and some systems that were added to the schedule when the carrier design was changed in 2012. These planned engineering periods are busy and there is a risk of delay if the sequencing of tasks is not managed effectively. Included within the 2019 fit out will be an upgrade to the operating system software used to run computer applications on-board. At present, the carriers are using a number of legacy software systems, which will need updating over time. The Department is managing system integrity by a combination of special software patches and physical security measures. The Department told us that this approach is not unusual for new ships and equipment. Alongside this fit out, a period of intense trials and training of the carrier and Lightning II aircraft is required to ensure that they can be used together to achieve the carrier strike capability.

1 Comptroller and Auditor General, *Delivering Carrier Strike*, Session 2016-17, HC 1057-I, National Audit Office, 16 March 2017.

5 The cost of building both carriers was re-baselined in 2014, with Ministerial and Treasury approval to spend £6.212 billion. The Department has not accepted any further cost growth and is working with the ACA to minimise it. This includes engaging with industry to recover some costs, applying lessons learned from the build of HMS Queen Elizabeth to the build of HMS Prince of Wales, and streamlining some planned steps in testing and trials of HMS Prince of Wales.

Lightning II aircraft

6 The Lightning II programme is a US-led, international partnership consisting of nine countries, each working together under a Memorandum of Understanding with the US government. The UK is the only 'Tier 1' partner and in this capacity in 2001 committed to invest $2 billion towards the $35 billion System Development and Demonstration (SDD) phase of the programme. This secured a 25% stake in the design specification, including ensuring that the jets could carry UK weapons. This arrangement also shielded the UK from SDD phase cost increases, currently estimated at approximately $19 billion.

7 The Lightning II programme is being managed by the Joint Program Office (JPO) in the US. The JPO has 2,590 staff, including 20 UK personnel. The UK is represented on the JPO's Executive Board. UK staff are involved in a variety of different sections of JPO, including engineering, fleet planning, airworthiness. In 2016, a UK staff member was voted into a key position as head of the global support solution for the jets. Once the SDD phase ends in 2019, and full production of aircraft begins, the UK's Tier 1 status will end. However, the UK will retain the largest non-US stake (4.5%) in subsequent phases of the programme.

8 The Department reports that the Lightning II programme remains within approved performance, cost and time boundaries. The Senior Responsible Owner (SRO) for the UK's Lightning II programme revised his programme delivery confidence, reflecting compression in the schedule, from amber (as reported in Figure 8, *Delivering Carrier Strike*) to amber/red in June 2017. This reflected concerns that simulators provided to train UK pilots would not be representative of the UK aircraft standard, that there were delays to providing UK-specific software programming, and that the schedule to deliver the UK weapons programme required further work. The Department told us that the SRO revised his delivery confidence to ensure that all stakeholders, and particularly Lockheed Martin, are clear on the schedule challenge, and that they must focus effort to meet the UK delivery schedule.

9 In *Delivering Carrier Strike*, we note that the carriers and Lightning II aircraft are designed to use technology for military advantage. Increasing reliance on technology can mean system failures restrict how the Department uses the capability. We also note that this risk is particularly relevant for Lightning II, which are being manufactured while design is still underway.

10 Since we reported, the Government Accountability Office (GAO) – the national audit office of the United States – published its latest review of the F-35 Joint Strike Fighter [Lightning II] programme. The report noted that "cascading F-35 testing delays" could increase US costs by over £1 billion and lead to the programme being delayed by between 5 months and 1 year, extending the design phase beyond 2019. The delays relate to testing of the software and systems that provide warfighting capabilities, known as 'mission systems', largely because the software was delivered late to be tested and once delivered it has not worked as expected.[2] The JPO does not accept that delays will extend beyond five months, and plans to re-allocate programme funding to address any further delay. The Department accepts the JPO position, recognising that the schedule is taut.

11 The GAO report also stated that the "F-35 [Lightning II] program continues to address technical risks. The programme has incorporated design changes that appear to have mitigated several of the technical risks that we have highlighted in prior reports … however, over the past year the program continued to address risks with":

a Helmet Mounted Display: a new helmet was developed to address some shortfalls in the night vision capability.

b Autonomic Logistics Information System[3] (ALIS): this system continues to lack required capabilities.

c Engine seal: a design change has been made to address the identified technical problem and the majority of engines have been retrofitted.

d Ejection seat: a design change has been developed to address the risk that pilots weighing less than 135 pounds could possibly suffer neck injuries during ejection. This design change is expected to be incorporated into future production aircraft.

e Insulation on coolant tubes: the wrong type of insulation being used led to US Air Force's initial operating capability being grounded.[4] This has now been replaced. US officials are considering removing insulation from tubes on the rest of the aircraft going forward.[5]

12 The Department told us that all issues raised are under active management by the JPO and the Department and that practical progress on the technical issues was being seen. It continues to closely monitor the Lightning II programme and hold the suppliers to account for resolving issues identified.[6]

2 GAO, F-35 *Joint Strike Fighter, DOD Needs to complete developmental testing before making significant new investments*, April 2017.
3 A complex IT system supporting operations, mission planning, supply chain management, maintenance, and other processes.
4 The US Air Force has bought a different variant of the Lightning II than the one the UK has on order.
5 See footnote 2.
6 JPO Statement – April 2017 GAO Report 'DoD needs to complete development testing before making significant new investments'.

Infrastructure and enablers

13 In March 2017, works were completed to upgrade the Princess Royal Jetty in Portsmouth Naval Base to accommodate the carriers. Dredging of the approach channel and inner Portsmouth harbour were completed in August 2017 to enable the carriers to enter the Naval Base.

14 RAF Marham will become the main operating base for the UK's two operational squadrons of Lightning II jets. The first squadron is expected to land in the UK in August 2018. Significant infrastructure upgrades at the base are needed to accommodate the jets. In June 2017, the Department signed a £135 million contract to deliver an aircraft hangar capable of housing 12 of the new jets. The contract will also improve existing facilities, including re-surfacing two existing runways and laying three vertical landing pads for the jets. This is the last of seven contracts to build infrastructure to support the first squadron. The Department has assessed that the works schedule is taut and completing the infrastructure in advance of the jets arrival in August 2018 will be challenging. The Department has agreed incentive payments within the contract for early delivery of crucial elements of the infrastructure. Separate arrangements are in place with Lockheed Martin, manufacturing the Lightning II, to build facilities at the Base to support maintenance of the stealth capabilities of the jets.

15 Carrier Strike creates a requirement for extra logistics, communications and other 'enabling' equipment. Also, the planned close cooperation with allies, notably the US, creates the need to fund additional equipment and training to enable this. Figure 11 of *Delivering Carrier Strike* identifies that not all required enablers are funded due to the Department's tight financial position and because the support arrangements for US operations on the carriers have not been fully established. Since we last reported, the Department has funded Tactical datalinks. This provides IT software and hardware to support the exchange of command and control and tactical data between allies and within the task group. Other crucial enablers remain unfunded, although some interim solutions have been identified, for example an interim maritime intra-theatre lift capability has been agreed.[7] The Department expects to consider funding these as part of the exercise to set budgets for the 2018-19 financial year. However, it also expects that alternative approaches to meet demands on enablers may be needed, or that it may need to prioritise the needs of Carrier Strike over other capabilities.

Naval task group

16 In July 2017 the Department announced the signing of a contract worth £3.7 billion with BAE Systems to build the first three of eight Type 26 frigates for the Royal Navy. The Type 26 will replace the current Type 23 Frigates and will support deployment of the Carriers in an anti-submarine warfare role. The first Type 26 is expected to enter service in 2027.

7 Maritime intra-theatre lift is the ability to move people and goods within a Carrier task group.

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