



House of Commons  
Defence Committee

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# Unclear for take-off? F-35 Procurement

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to the report*

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## The Defence Committee

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## Summary

The procurement of the F-35 Joint Strike Fighter, which is designed and built by a consortium led by Lockheed Martin, is the most expensive international defence procurement programme in history. A ‘fifth-generation’ aircraft, the F-35 comes in three variants, and the UK is, at present, committed to procuring 138 aircraft. However, there is no guarantee that this total will be achieved. The F-35 programme will supply combat aircraft to nine countries, with the principal customer being the United States of America. The UK is the second biggest client and, as the sole ‘Tier One’ partner in the programme, 15% of all F-35 production will take place in this country.

In July 2017, *The Times* published a series of articles on the F-35 programme. These reported a number of serious allegations, including claims that the F-35 “is way over budget, unreliable, full of software glitches and potentially unsafe”.

Our report has examined the allegations made by *The Times* in its investigation into the F-35 programme and has drawn on the work of other studies into the programme, such as the 2016 Annual Report of the US Department of Defense’s Director of Operational Test and Evaluation (DOT&E), and on the oral and written evidence we have gathered over the course of the inquiry, including from both Lockheed Martin and the Ministry of Defence.

Overall, our report concludes that:

- The MoD’s acknowledgement of the potential value of using the Multifunctional Advanced Data Link (MADL) for secure communications between the F-35 and legacy aircraft is welcome. Without such a link and translation node, the UK will be underusing one of the key capabilities of the F-35 and we recommend that the MoD make provision for the procurement of a gateway translation node for MADL-based F-35 to Typhoon communication in the next Equipment Plan.
- The broadband capacity on the Queen Elizabeth carriers will need to be beyond the reported limit of 8 megabits, and, in all likelihood, in excess of the 32 megabits currently available on the USS America, if the potential benefits of the F-35 to the UK’s future carrier strike capabilities are to be realised.
- The assurances from Lockheed Martin and the MoD about the rigorous level of cyber-testing of the ALIS software are welcome, as is the assurance from Lockheed Martin that the UK will have complete and unfettered use of the software for the sovereign operation of our F-35 fleet. However, we ask for greater clarity from Lockheed Martin on the level of protection in place for the technical data gathered by ALIS in relation to the UK’s F-35 fleet, including whether this data falls within the US Government’s ‘unlimited rights license’.
- The MoD’s failure to provide adequate cost estimates for its procurement of the F-35, either on an overall programme basis or on a per-aircraft basis, is wholly unsatisfactory and this unacceptable lack of transparency risks undermining

public confidence in the programme. We recommend that the Department provides us with the 'rough orders of magnitude' it claims to possess for the total costs of the programme beyond 2026/7.

- The F-35 has clearly experienced a number of software and hardware problems during its development phase, as might be expected from a project of this scale and technical complexity. However, *The Times's* investigation has provided cause for concern and these concerns were not alleviated by the disappointing nature of the initial responses from Lockheed Martin and the MoD.

During our inquiry, we received a number of assurances from the Government and Lockheed Martin that the issues with the programme that have been previously identified either have been, or are in the process of being, resolved. For the time being, we are willing to accept these assurances. The F-35 is a major investment in defence capability for the UK and we want it to succeed and become the cornerstone of a new and effective strike capability for this country. However, it is precisely because this project is so important that it must be subjected to the closest possible scrutiny.

We, therefore, recommend that the MoD provide the Committee with six-monthly updates on the programme, detailing the progress made in addressing the issues that have been previously identified, as well as any future problems. We also believe that these updates should include information on the ongoing cost of the programme.

# 1 Introduction

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## The Times investigation into the F-35 programme

1. In July 2017, *The Times* newspaper published a series of articles into the F-35 Joint Strike Fighter project. This project, the most expensive international defence procurement programme in history, will supply combat aircraft for at least nine countries and will form a key component of the UK's future carrier strike capability.

2. In their investigation, Deborah Haynes and Alexi Mostrous (respectively Defence Editor and Head of Investigations at *The Times*) reported claims that the F-35 “is way over budget, unreliable, full of software glitches and potentially unsafe” and argued that the UK was left “particularly exposed because defence officials have skimped on buying critical support technology”.<sup>1</sup> *The Times* further alleged that:

- the ‘stealth’ jet cannot transmit data to British ships or older planes without revealing its position to the enemy;
- broadband on Britain’s principal aircraft carrier is four times weaker than that of an average UK household, severely hampering the jet’s abilities;
- a test pilot had to land in almost total darkness after night vision failed in the plane’s £309,000 helmet;
- the plane’s £12 billion software system is vulnerable to cyber attack and Britain will not be able to test its security independently;
- Joint Forces Command, the part of the MoD in charge of computer networks essential to the plane’s operation, must find savings of £400 million this year; and
- the fall in the value of the pound against the dollar has exposed British taxpayers to more than £1 billion in extra costs.<sup>2</sup>

3. The claims made in *The Times* investigation draw upon a variety of named and unnamed sources, including the 2016 Annual Report of the US Department of Defense’s (DoD) Office of the Director of Operational Test and Evaluation (DOT&E), the body responsible for reviewing the operational testing and evaluation conducted for each major DoD programme.<sup>3</sup> The allegations made by the paper were rejected by the Minister for Defence Procurement, Harriett Baldwin MP, in a letter and accompanying briefing note that was sent to Conservative MPs.

4. According to the Minister, the F-35 programme “remains on time, within costs, and offers the best capability for our Armed Forces”. The briefing noted that the MoD

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1 Alexi Mostrous and Deborah Haynes (17 July 2017), Jets are overbudget, unreliable and vulnerable to cyber attacks, *The Times*, <https://www.thetimes.co.uk/article/jets-are-overbudget-unreliable-and-vulnerable-to-cyberattacks-v3gt8dcb>

2 Alexi Mostrous and Deborah Haynes (17 July 2017), Britain spends billions on flawed F-35s, *The Times*, <https://www.thetimes.co.uk/article/britain-spends-billions-on-flawed-fighter-jets-qrtj95kv>

3 Director, Operational Test and Evaluation, Annual Report, 2016, FY16 DoD Programs: [F-35 Joint Strike Fighter](#),

“simply do not recognise” the figures cited in the article as hidden costs within the F-35 programme, and argued that the programme “remains within its cost approval” as described in the 2016 Equipment Plan.

5. Mrs Baldwin’s letter stated that the newspaper reports were “out of date, lack technical understanding of complex issues, and contain commentary that is ill-informed and inaccurate”. Furthermore, “where concerns are valid they are not new, have been reported in recent years, and are resolved or being addressed as part of the trials”. The Minister’s letter and accompanying briefing are appended to this report.

## Our inquiry

6. On 12 September, the day after our appointment by the House of Commons after the General Election, we launched a short inquiry into the procurement of the F-35 and the allegations made by *The Times*. We took evidence from Deborah Haynes and Alexi Mostrous of *The Times* and Justin Bronk, a research fellow at RUSI.

7. At a second evidence session on 17 October, we heard from representatives of Lockheed Martin, including Mr Jeff Babione, the company’s Executive Vice-President and General Manager of the F-35 programme, the Minister for Defence Procurement, Harriett Baldwin MP, and officials from the Ministry of Defence. A full list of those who gave evidence can be found at the back of this report. We thank all who contributed.

8. This report begins with a short introduction to the F-35 programme, outlining the history and development of the Joint Strike Fighter programme and the UK’s participation in this multi-national project. This chapter will highlight both the purported capabilities that will materialise from the F-35 programme and the controversies and issues that have arisen from it.

9. The second section of the report examines a number of areas relating to the F-35 programme that have been identified as causes for concern, including the communications link between the F-35 and older aircraft (so-called ‘legacy assets’); the broadband capacity on board the Queen Elizabeth class carriers; the Autonomic Logistics Information System (ALIS), the operational and management system for the F-35; the Generation III helmet; the allegation of hidden costs within the F-35 programme; and the weight of the fighter jet.

10. The report concludes with a series of general observations on the F-35 programme, including on the Government and Lockheed Martin’s responses to the allegations made by *The Times*.

## 2 The F-35 Joint Strike Fighter

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### The F-35 Lightning II

11. Designed and manufactured by a consortium led by Lockheed Martin, the F-35 Lightning II Joint Strike Fighter is a ‘fifth generation’<sup>4</sup> combat aircraft that comes in three main variants:

- the F-35A (conventional take-off and landing);
- the F-35B (short take-off and vertical-landing); and
- the F-35C (catapult assisted take-off and arrested recovery).<sup>5</sup>

12. Described as the “most expensive military development and procurement programme in history”, the F-35 programme will supply combat aircraft for at least nine countries, with the principal consumer being the United States. The UK is the second biggest client country and the sole ‘Tier One’ partner (i.e. the one most closely involved, with the USA) in the system design and development (SDD) phase of the programme. This status has resulted in the following advantages to the UK:

- according to Lockheed Martin, the UK has had a “significant input into the design requirements of the F-35 to ensure it meets UK operational requirements”;
- 15% of all F-35 production will take place within the United Kingdom. BAE says it employs 1,800 people in the United Kingdom to work on the F-35 programme.<sup>6</sup> Lockheed Martin claims that UK companies have already received “\$12.9 billion in F-35 related orders” from themselves and Pratt & Whitney, and that the programme will support “more than 500 companies and 20,000 jobs in the UK throughout the 30-year production phase”; and
- the UK taxpayer has been insulated from additional costs that have arisen during SDD.<sup>7</sup>

13. Following some hesitation, the UK Government confirmed in the 2015 Strategic Defence and Security Review (SDSR) that it would buy 138 F-35Bs.<sup>8</sup> The F-35Bs will fly from the Royal Navy’s new Queen Elizabeth class aircraft carriers, and the previous Government decided in the 2015 SDSR to speed up the purchase so that the UK would

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4 The Fifth Generation Fighter is the current standard naming convention for ‘next-generation’ fighter aircraft. However, the precise definition of a ‘fifth-generation fighter’ is contested and ambiguous, with contrasting definitions of the concept being provided by Lockheed Martin and other manufacturers (see: B. Sweetman (24 March 2014), [Is Saab’s new Gripen the future of fighters?](#), Aviation Week and Space Technology). Fourth-generation fighters include the Eurofighter Typhoon, the F-15 and the MiG-31.

5 Justin Bronk (February 2016), [Maximum Value from the F-35: Harnessing Transformational Fifth-Generation Capabilities for the UK Military](#), RUSI: Whitehall Report 1–16, p.1

6 BAE Systems. F-35, <http://www.baesystems.com/en/product/f-35-lightning-ii>

7 Qq102, 230

8 HM Government (2015), [National Security Strategy and Strategic Defence and Security Review 2015: A Secure and Prosperous United Kingdom](#), p.31

have 24 F-35Bs available on these carriers by 2023.<sup>9</sup> The UK has already started taking delivery of the F-35Bs and should have its first squadron in service in the UK in 2018. Flight trials from HMS Queen Elizabeth are scheduled for later that year.

## The genesis of the Joint Strike Fighter programme

14. The F-35's roots can be found in the Joint Strike Fighter (JSF) project that was launched by the US Department of Defense (DoD) in the early 1990s. At the same time the UK began to examine how to replace the capabilities provided by the Royal Navy Sea Harrier on the Invincible class carriers (this became known as the Future Carrier-Borne Aircraft Programme, renamed as the Future Joint Combat Aircraft following the 1998 Strategic Defence Review).<sup>10</sup>

15. In 1995, the UK became a formal partner in the JSF programme, signing a Memorandum of Understanding (MoU) and agreeing to pay \$200 million, or 10% of the concept demonstration phase.

16. On 17 January 2001, the UK signed a further MoU with the DoD on the engineering manufacturing development phase of the JSF. The MoU committed the UK to an investment of \$2 billion towards the development costs of the aircraft and in return provided it with Tier One partner status during the SDD phase of the programme and an input into the aircraft design and the selection of the prime contractor for the project. Later that year it was announced that Lockheed Martin had been awarded the JSF contract.<sup>11</sup>

17. In 2002, the MoD announced that the Royal Navy and RAF would operate the F-35B variant, with the Government tentatively agreeing to order nearly 150 aircraft.<sup>12</sup> This number has since been revised to 138 F-35Bs.

## Capabilities

18. Lockheed Martin claims that, as a fifth-generation fighter, the F-35 will combine “advanced stealth with fighter speed and agility, fully fused sensor information, network-enabled operations and advanced sustainment”.<sup>13</sup> According to a House of Commons Library briefing paper in 2015, the F-35 should have the following capabilities:

- advanced electronic warfare: to locate and track enemy forces, jam radars and disrupt attacks; immediate data links with commanders at sea, in the air or on the ground;
- air-to-surface: stealth (low observability), active electronically scanned array radar technology; internal weapons bay. Designed to enter the battlespace first;
- air-to-air: integrated sensors, information and weapons systems. Greater ability to detect other aircraft first;

9 BBC News (22 November 2015), Osborne: UK to speed up aircraft carrier jet purchase, <http://www.bbc.co.uk/news/uk-politics-34893614>

10 Louisa Brooke-Holland (6 February 2015), [The UK's F-35 Lightning II Joint Strike Fighter](#), House of Commons Library, Standard Note: SN06278, pp.4–5

11 Louisa Brooke-Holland (6 February 2015), [The UK's F-35 Lightning II Joint Strike Fighter](#), House of Commons Library, Standard Note: SN06278, pp. 6, 21–22

12 BBC News (30 September 2002), UK to buy 150 fighter planes, <http://news.bbc.co.uk/1/hi/business/2288747.stm>

13 Lockheed Martin, F-35, <http://www.lockheedmartin.co.uk/us/products/f35.html>

- intelligence, surveillance and reconnaissance (ISR): pilots have real-time, 360-degree access to battlefield information captured from its advanced sensor suite. Data can be shared securely with commanders at sea, in the air and on the ground, providing a comprehensive view of operations. Electro-Optical Targeting System (EOTS) recommends to the pilot which target to attack;
- stealth: integrated airframe design, advanced materials and other features make the F-35 virtually undetectable to enemy radar;
- interoperability: F-35 shares data with other aircraft to expand situational awareness of aircraft across the entire network of aircraft; and
- helmet mounted display: information is projected on the helmet's visor rather than on a traditional Heads-up Display. Six infrared cameras mounted around the aircraft allow pilots to "look through" the airframe".<sup>14</sup>

### Controversies

19. In his 2016 report, *Maximum Value from the F-35*, Justin Bronk, a Research Fellow in combat air power and technology at RUSI, noted the programme had "attracted a great deal of controversy and speculation since the development contract for the aircraft was signed in 1996". The programme has experienced a number of cost overruns and delays and it is still "not yet clear" how much the F-35 will cost the United Kingdom, with the best publicly available estimate, according to Mr Bronk, being a cost for the "first major buy of 14 aircraft for the UK" of some £2.5 billion in 2014.<sup>15</sup> Similarly, it is not entirely certain whether the Government will stick to the F-35B variant for the remainder of the 138 fighters being bought or will instead opt for the F-35A variant.<sup>16</sup>

20. In January 2017, the US Defense Secretary, General James Mattis, ordered a review into the F-35 Programme to "determine opportunities to significantly reduce the cost" of the fighter jet and to assess whether improvements could be made to the F/A-18E/F (the Super Hornet multirole fighter) "in order to provide a competitive, cost effective, fighter aircraft alternative".<sup>17</sup>

21. In July 2017, *The Times* ran a series of stories into the F-35 programme (see paras 1–5 above). These reports repeated claims that the F-35 "is way over budget, unreliable, full of software glitches and potentially unsafe" and argued that the UK was "particularly exposed because defence officials have skimmed on buying critical support technology".<sup>18</sup>

**22. Our report examines the serious allegations made by *The Times* newspaper in its investigation into the F-35 programme. We draw on the work of other studies into**

14 Louisa Brooke-Holland (6 February 2015), [The UK's F-35 Lightning II Joint Strike Fighter](#), House of Commons Library, Standard Note: SN06278, p.12

15 Justin Bronk (February 2016), [Maximum Value from the F-35: Harnessing Transformational Fifth-Generation Capabilities for the UK Military](#), RUSI: Whitehall Report 1–16, p.1

16 Justin Bronk (February 2016), [Maximum Value from the F-35: Harnessing Transformational Fifth-Generation Capabilities for the UK Military](#), RUSI: Whitehall Report 1–16, p.2

17 Nafessa Syeed, Anthony Capaccio and Rick Clough (27 January 2017), Trump's Pentagon Chief Orders F-35 Jet, Air Force One Review, Bloomberg Business, <https://www.bloomberg.com/news/articles/2017-01-27/trump-s-pentagon-chief-orders-review-of-f-35-jet-air-force-one>

18 Alexi Mostrous and Deborah Haynes (17 July 2017), Jets are overbudget, unreliable and vulnerable to cyber attacks, *The Times*, <https://www.thetimes.co.uk/article/jets-are-overbudget-unreliable-and-vulnerable-to-cyberattacks-v3gt8dcbb>

**the programme, including the most recent Annual Report of the US DOT&E, and the oral evidence we gathered over the course of two evidence sessions, including from both Lockheed Martin and the Ministry of Defence. The next section of this report examines the main areas of concern identified by *The Times* and other reports on a case-by-case basis.**

## 3 Reported communications and software issues

### The Communications Link

23. The F-35's information gathering capabilities are considered to be one of its key assets and the main value of the fighter to the UK's future carrier strike capability. As Justin Bronk puts it, "the most effective use of the aircraft is likely to be as a survivable intelligence, surveillance and reconnaissance (ISR) enabler in defence airspace to enhance the lethality, flexibility and survivability of legacy platforms such as the Typhoon and the Type 45".<sup>19</sup>

24. According to *The Times*, the UK is "particularly exposed" as a result of the MoD failing to buy "critical support technology". For example, *The Times* reports that the MoD has not purchased a Battlefield Airborne Communications Node (BACN) "that allows secure signals from the F-35 to be read by older aircraft".<sup>20</sup> *The Times* argues that, as a result, F-35 pilots wishing to share data with older aircraft will have to use a less secure channel "known as Link 16, potentially giving away their position".

25. In addition, the paper claims that another problem lies in the jet's ability to communicate in stealth mode to HMS Queen Elizabeth:

The Royal Navy's new aircraft carrier is understood to lack a Multifunctional Advanced Data Link (MADL), which enables covert transmissions of data. It means that an F-35 returning to the carrier in stealth mode would be indistinguishable on radar from an enemy missile, one source said.

The source raised the possibility of an accompanying British ship, such as the Type 45 destroyer, shooting down a jet returning to the carrier in error.<sup>21</sup>

26. According to the MoD's briefing for Conservative MPs, the claim that the F-35 is unable to share data "is incorrect", with the F-35 acquitting itself "exceptionally" during a recent data exchange test. Similarly, the MoD's briefing insisted that it was "incorrect" to describe the data link as insecure.

27. In their oral evidence to the Committee, Deborah Haynes and Alexi Mostrous suggested that one of the key questions underpinning their investigation was whether the UK was "putting sufficient resource and prioritisation on the networking side [of the F-35]" as the F-35 had the potential to "be an incredible force multiplier if it can talk to all the legacy equipment, not only the airframes, such as Typhoon, but also the carrier strike group—the ships".<sup>22</sup>

19 Justin Bronk (February 2016), [Maximum Value from the F-35: Harnessing Transformational Fifth-Generation Capabilities for the UK Military](#), RUSI: Whitehall Report 1–16, p.vii

20 Alexi Mostrous and Deborah Haynes (17 July 2017), Jets are overbudget, unreliable and vulnerable to cyber attacks, *The Times*, <https://www.thetimes.co.uk/article/jets-are-overbudget-unreliable-and-vulnerable-to-cyberattacks-v3gt8dcbb>

21 Alexi Mostrous and Deborah Haynes (17 July 2017), Jets are overbudget, unreliable and vulnerable to cyber attacks, *The Times*, <https://www.thetimes.co.uk/article/jets-are-overbudget-unreliable-and-vulnerable-to-cyberattacks-v3gt8dcbb>

22 Q3

28. Indeed, they suggested that it was “surprising [ ... ] that the relevant technology has not been invested in”, particularly as the UK is buying relatively few F-35s, in comparison with the USA, and might therefore need these fighters to be even more integrated with the rest of its military capabilities.<sup>23</sup>

29. Ms Haynes and Mr Mostrous noted that the US had invested in a Battlefield Airborne Communications Node (BACN) and a multi-function advanced data link (MADL) to enable secure transmission of data between the F-35s and legacy aircraft and vessels. By contrast, they claimed that, while similar technology has been trialled in an F-35-Typhoon demonstration, “as things stand today the funding is not there to bring that capability forward”.<sup>24</sup>

30. Justin Bronk’s 2016 report on the F-35 programme emphasised the transformational potential of the F-35’s information gathering abilities and the consequent importance of investing in the technology and processes needed to harvest this potential; “the F-35 has the potential to be a huge capability and flexibility enhancer for legacy platforms [ ... ] because of its abilities in gathering, processing and sharing information”.

31. The F-35, he suggested, will represent “a significant advance in the situational awareness of pilots and their ability to interpret commanders’ intent” and could “significantly enhance operational flexibility and survivability in heavily defended airspace, which will boost the UK government’s options in certain crisis situations”.<sup>25</sup>

32. For example, he contended that if “the F-35 could securely and covertly transfer target data to Typhoons and, potentially, take over guidance of their AMRAAM/Meteor missiles once launched, the F-35 would greatly enhance the potential survivability of the Typhoon whilst the Typhoon would provide a significant firepower advantage to the F-35”.<sup>26</sup> Similarly, if the F-35 can exchange data in real time with the Type 45, as part of a combat air patrol mission, it could, “greatly increase” the usable range of the Type 45’s anti-aircraft and anti-missile ‘punch’.<sup>27</sup>

33. However, Mr Bronk’s report identified a number of areas where action needs to be taken for the F-35 to be of full value to the UK’s defence. Although stressing the capacity of the F-35 to gather information and the high level of situational awareness it can provide to pilots, he nonetheless asked “to what extent the situational-awareness picture which is generated automatically and presented to the F-35 can be successfully shared and utilised by legacy assets in the air, at sea and on land”.<sup>28</sup>

34. There appear to be two main issues, which are linked: data handling and sharing. At present, “most sensor data gathered by each F-35 are fused, analysed, presented to the

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23 Q8

24 Q9

25 Justin Bronk (February 2016), [Maximum Value from the F-35: Harnessing Transformational Fifth-Generation Capabilities for the UK Military](#), RUSI: Whitehall Report 1–16, pp.vii, 17

26 Justin Bronk (February 2016), [Maximum Value from the F-35: Harnessing Transformational Fifth-Generation Capabilities for the UK Military](#), RUSI: Whitehall Report 1–16, p.9

27 Justin Bronk (February 2016), [Maximum Value from the F-35: Harnessing Transformational Fifth-Generation Capabilities for the UK Military](#), RUSI: Whitehall Report 1–16, p.12

28 Justin Bronk (February 2016), [Maximum Value from the F-35: Harnessing Transformational Fifth-Generation Capabilities for the UK Military](#), RUSI: Whitehall Report 1–16, p.18

pilot and then disappear, unless the aircraft is operating in ‘open transmit’ model using Link 16 [a military tactical data exchange network]”. Crucially, this link, although used by NATO, “may be detectable and, therefore, compromise survivability”.

35. If, however, the pilot has to be relied upon to choose which information to record—and where—for bringing back, Mr Bronk claimed that this was likely to result in “potentially vital data” being lost “and a “huge potential benefit of the F-35 to whole force” being wasted. Furthermore, although the pilot can manually record some of this data, the internal memory is limited.

36. While these internal memory constraints should, Mr Bronk argued, be “significantly alleviated” by the time full operational capability is declared in 2023, the information management system whereby pilots have to choose which information to record for bringing back will remain a more difficult problem to resolve.<sup>29</sup>

37. This is particularly the case as the UK has no capability to convert advanced low-probability-of-intercept waveforms such as the Multifunction Advanced Data Link (MADL) “into Link 16 format for transmission to non-stealthy assets”. The US, by contrast, is using a Battlefield Airborne Communications Node (BACN) to enable sensitive data to be transmitted from MADL into Link 16 format.

38. The UK is, therefore, in a situation where, according to Mr Bronk, the Armed Forces “do not have the equipment or processes in place, nor on order, to make use of the F-35’s data-gathering and data-sharing potential”. Nor does it have the interconnectivity, network bandwidth or operating principles to make use of the data gathered by the F-35. He drew attention, for example, to the Joint Data Network, a programme to provide enhanced networking capability within the RAF for the F-35 and other assets, which was cancelled as a cost-saving initiative in 2011.

39. In his oral evidence, Mr Bronk repeated this emphasis on the importance of investing in a secure communications link for the F-35s and the rest of the carrier group. He believed that if the F-35 is to be able to share data with other UK “assets” without broadcasting on Link 16, and potentially giving away its position while inside defended enemy airspace, then the UK needs “some form of gateway translation node”. This could either be the US BACN, or the Freedom 550, which was the system used during the F-35-Typhoon trials.<sup>30</sup>

40. While Mr Bronk noted that there could be data protection and security issues regarding the use of the MADL, he was nonetheless clear that, unless an advanced data link and translation node were purchased, the UK would be undermining or underusing one of the key capabilities of the F-35: the only secure alternative would be to deploy the F-35s on their own (they can communicate with one another covertly and securely) rather than using them effectively as a force multiplier.<sup>31</sup>

41. Lockheed Martin told us that the US is “exclusively using Link 16” for communication from the F-35 to legacy assets. Steve Over, Lockheed Martin’s Director of International Strategy and Customer Engagement, said that the US Air Force undertook a ‘Red Flag’ (large ‘force-on-force’) exercise in January 2017 in which F-35s and legacy assets, including

29 Justin Bronk (February 2016), [Maximum Value from the F-35: Harnessing Transformational Fifth-Generation Capabilities for the UK Military](#), RUSI: Whitehall Report 1–16, pp.vii-viii, 3–4, 6–7

30 Q46

31 Q47

RAF Typhoons, participated. In this exercise the F-35s reportedly communicated their sensor picture to those legacy assets via Link 16.<sup>32</sup> However, Peter Ruddock, the Chief Executive of Lockheed Martin UK, conceded that using Link 16 did make the jet more detectable. Mr Over also emphasized that “there will be times and places that F-35s go—where only F-35s can go—and they will communicate with each other via MADL”.<sup>33</sup>

42. In their supplementary evidence, Lockheed Martin reasserted the reliability and security of Link 16 as a means of communicating information between the F-35 and fourth generation assets.<sup>34</sup> They also claimed that they were unaware of the US using a BACN as a means of sending MADL encrypted communications between F-35s and other assets. However, they did acknowledge that the US and UK have begun experimenting with fifth to fourth generation gateways, including the UK’s Babel Fish III trial and a US demonstration in which the F-35 was successfully integrated with an Aegis fire control system. According to Lockheed Martin, in the latter demonstration:

... the Aegis system successfully engaged an airborne target drone with an SM-6 missile using only the targeting solution provided by an unmodified F-35B. This F-35 targeting solution was passed to the Aegis via a MADL datalink that had been integrated into the Aegis system.<sup>35</sup>

43. Air Commodore Lincoln Taylor, Assistant Chief of Staff (Capability Delivery, Combat Air), also stressed the usefulness of the Link 16 system, on 17 October, telling us that “it provides incredible situational awareness” to other assets.<sup>36</sup> However, he also told us that the Government had started to look at the benefits of sharing MADL capability with legacy fighters and had conducted a trial called Babel Fish III in 2016 which included F-35s and Typhoons.<sup>37</sup>

44. When asked why legacy assets had not been equipped with a communications node to enable more secure transmission between those assets and the F-35, Lieutenant General Mark Poffley, Deputy Chief of Defence Staff (Military Capability), responded that there was always a lag between new technologies and capabilities and older assets and capabilities.<sup>38</sup> Air Commodore Taylor also argued that it would take time to assess how to share F-35 to F-35 data with other planes and judge the benefits that such a link could yield.<sup>39</sup>

45. However, despite his comments, Lieutenant General Poffley did accept that a link such as MADL would “undoubtedly start to be a very attractive option to move data” and that the UK would “undoubtedly” wish to transfer data from the F-35s to the Typhoons.<sup>40</sup> Indeed, he told the Committee that it was the MoD’s ambition to “have MADL-type capabilities across the portfolio of capabilities”, including the Type 45, Crowsnest and Typhoon.<sup>41</sup>

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32 Q128

33 Q128

34 PRO0001

35 PRO0001

36 Q140

37 Q139

38 Q148

39 Q146

40 Q148

41 Qq149–153

46. We are pleased that the Government acknowledges the potential value of using the Multifunctional Advanced Data Link (MADL) for secure communications between the F-35 and our older aircraft. We note both that it is the MoD's ambition to have MADL-type capabilities across the carrier group and that trials of a gateway communications node have been undertaken involving the F-35 and Typhoon.

47. *We agree with Justin Bronk from RUSI that, without an advanced data link and translation node, the UK will be underusing one of the key capabilities of the F-35—its ability to interact with older aircraft and greatly augment their potency. In the light of the successful Babel Fish III trial, which saw a gateway node used to translate MADL messages to Link 16 format between F-35s and Typhoons, earlier this year, and ahead of the UK receiving its first squadron of F-35 fighters next year, we recommend that the MoD make provision for the procurement of a gateway translation node for MADL-based F-35 to Typhoon communication in the next Equipment Plan.*

### Broadband capacity

48. Another of the claims made by *The Times* is that the broadband on HMS Queen Elizabeth “is four times weaker than that for an average UK household, severely hampering the jet’s capabilities”. This will mean that “the F-35 will not be able to send data on enemy threats back to ground forces while in flight”.<sup>42</sup>

49. In their oral evidence, Ms Haynes and Mr Mostrous warned that if the MoD wanted to use the F-35 to its “full capability, in terms of all the data that it is hoovering up, you will want a significant bandwidth to be able to transmit that all back to the carrier”.<sup>43</sup> Deborah Haynes’s sources had suggested that the capacity existed to increase bandwidth to about 64 megabits, if not more, “but that requires funding”.<sup>44</sup>

50. Both in their written articles and their oral evidence, Ms Haynes and Mr Mostrous drew upon Justin Bronk’s 2016 report on the F-35. He had argued that “the limited bandwidth of 8 megabits available on the QEC [Queen Elizabeth Carriers] is a serious bottleneck”. Indeed, he contrasts the bandwidth available with that of the USS America which, despite its 32-megabit capacity, has still prompted concerns from the US Navy about its ability to cope with the volume of data generated by the F-35.

51. The F-35’s Autonomic Logistics Information System (ALIS) puts particular pressure on the bandwidth of aircraft carriers. According to Mr Bronk, “the bandwidth available on the ship is nowhere near sufficient to make full use of the F-35B’s potential capabilities”.<sup>45</sup>

52. When we asked him about the claim, made by the MoD, that the broadband capacity was sufficient to carry out the scope of carrier strike operations over the lifetime of the programme, he suggested that “for that statement to be true, the scope of carrier strike operations across the lifetime of the platform would have to be pretty mundane compared with what they could be”.<sup>46</sup>

42 Alexi Mostrous and Deborah Haynes (17 July 2017), Britain spends billions on flawed F-35s, *The Times*, <https://www.thetimes.co.uk/article/britain-spends-billions-on-flawed-fighter-jets-qrtj95kvh>

43 Q12

44 Q12

45 Justin Bronk (February 2016), [Maximum Value from the F-35: Harnessing Transformational Fifth-Generation Capabilities for the UK Military](#), RUSI: Whitehall Report 1–16, p.13

46 Q49

53. Indeed, returning to the reference in his report to the 32 megabits on the USS America, Mr Bronk suggested that the Americans were already “urgently upgrading” their bandwidth to a “target” of 100 megabits (he described this level of capacity as “the American gold standard at the moment”).

54. Furthermore, he stated, if the US Marine Corps, which tend to operate a smaller air group than the Queen Elizabeth class carriers are designed to operate, views 32 megabits as “inadequate”, then “it would be strange if we would not at least benefit from significantly over 32 megabits”. Not least as the UK “will be relying on the F-35s for more of the total carrier strike group capabilities than the US Marine Corps”.<sup>47</sup>

55. While refusing to confirm the broadband capacity of HMS Queen Elizabeth, Mr Over nonetheless noted that Lockheed Martin and the US Navy had undertaken testing that had “proven demonstrably” that, “with disciplined communication”, an 8-megabit bandwidth was “satisfactory for operation of F-35s on board the ship”.<sup>48</sup> In their supplementary evidence, Lockheed Martin provided further details of this demonstration, explaining that it included eight F-35s.<sup>49</sup>

56. The Minister also refused to confirm the broadband capacity on the Queen Elizabeth, telling us that she did not “recognise” the figure mentioned in *The Times*’s investigation and insisting that the bandwidth was “exactly sufficient” for what the UK “currently” needs.<sup>50</sup> However, both Mrs Baldwin and Lieutenant General Poffley confirmed that there was scope for the carriers’ bandwidth to be improved in the future, as required.<sup>51</sup>

**57. If the potential benefits of the F-35 to the UK’s future carrier strike capabilities are to be realised then the Queen Elizabeth carriers will require a broadband capacity beyond 8 megabits. While we note that the MoD claims that there is scope for the current bandwidth to be enlarged, it is seems highly likely that a capacity in excess of the 32 megabits currently available on the USS America will be required for an effective carrier strike capability.**

## Autonomic Logistics System (ALIS)

58. One of the main concerns outlined by *The Times* relates to ALIS—the operational and management system for the F-35. As the House of Commons Library briefing paper explained, ALIS “will serve both the pilots, in terms of mission data and track pilot training, and the aircraft, by tracking maintenance data”.<sup>52</sup> According to *The Times*, experts fear that this £12 billion software system “is filled with bugs and potentially vulnerable to hacking”.

59. *The Times* cited a report for the DoD which noted that ALIS exhibited several vulnerabilities “both from ‘insiders’- referring to employees or contractors who may want

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47 Q50

48 Qq121–122

49 PRO0001

50 Qq165, 167

51 Q170

52 Louisa Brooke-Holland (6 February 2015), [The UK’s F-35 Lightning II Joint Strike Fighter](#), House of Commons Library, Standard Note: SN06278, p.12

to hack the system—and ‘outsider’ threats, which would include rogue states”. According to one source cited in *The Times*’s investigation, ALIS represents the “soft underbelly” of the F-35 carrier strike capability.<sup>53</sup>

60. *The Times* also raised concerns about ownership of the intellectual property rights for the system, reporting fears that Lockheed Martin “could exploit” the ALIS system “to drive up fees for purchasing countries including Britain”. According to one source cited by *The Times* in their investigation, “Lockheed could ultimately decide how, when and if the F-35 flies, and it alone will decide how much it charges F-35 customers for the privilege”.<sup>54</sup>

61. When asked to elaborate on the claims made about the vulnerability of the ALIS system, during the oral evidence session on 13 September, Alexi Mostrous appeared to downplay them, arguing that “all we were trying to say [ ... ] is that this plane relies very much on software [and that] certain vulnerabilities have been identified with the software”.<sup>55</sup>

62. In his 2016 report on the F-35, Justin Bronk acknowledged that there were bugs within ALIS and that the system “is still some way from final maturity”. However, he went on to argue that software upgrades should significantly reduce maintenance and operating costs when mature.

63. Furthermore, version 2.0.2 of the ALIS software is, according to him, “expected to solve many outstanding issues”, while as ALIS is a programme priority for the US Air Force and Lockheed Martin, “it is reasonable to expect that by the time the UK declares IOC [initial operating capability] in 2018, the system will be significantly more mature”.<sup>56</sup>

64. During his appearance before the Committee, Mr Bronk noted that, in theory, ALIS could be the soft underbelly of the F-35. However, he stressed that, in light of the “extremely strategic nature of ALIS software security and its extreme complexity”, it was “impossible for us to know how vulnerable ALIS is”.<sup>57</sup>

65. We asked Lockheed Martin to respond to the concerns about ALIS. Steve Over stressed that “there has been rigorous cyber-testing of the ALIS system and we are unaware of any successful efforts to penetrate the system”.<sup>58</sup>

66. Christopher Bogdan, the former head of the Joint Programme Office (JPO), had commented that “we have a lot of work to do on ALIS [ ... ] it is not nearly as good as it can be, and [ ... ] frankly it’s late”, Mr Over noted that since then a “very big ALIS upgrade” was being pushed forward and he suggested that by the end of the year there would have been “one more significant capability upgrade to ALIS”.<sup>59</sup> Overall, Mr Over

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53 Alexi Mostrous and Deborah Haynes (17 July 2017), Jets are overbudget, unreliable and vulnerable to cyberattacks, *The Times*, <https://www.thetimes.co.uk/article/jets-are-overbudget-unreliable-and-vulnerable-to-cyberattacks-v3gt8dcbb>

54 Alexi Mostrous and Deborah Haynes (17 July 2017), Jets are overbudget, unreliable and vulnerable to cyberattacks, *The Times*, <https://www.thetimes.co.uk/article/jets-are-overbudget-unreliable-and-vulnerable-to-cyberattacks-v3gt8dcbb>

55 Q11

56 Justin Bronk (February 2016), [Maximum Value from the F-35: Harnessing Transformational Fifth-Generation Capabilities for the UK Military](#), RUSI: Whitehall Report 1–16, p.16

57 Q52

58 Q88

59 Q89

expressed confidence that Lockheed Martin was on track to deliver the full performance of ALIS before the conclusion of the SDD (system design and development) phase of the programme “either late this year or very early in 2018”.<sup>60</sup>

67. On the question of intellectual property rights, Peter Ruddock told the Committee that the UK had “sovereign ownership” of the ALIS software deployed on the UK’s F-35Bs and carriers and “can modify and use it without support from the US for a period, if they so wish”.<sup>61</sup> Jeff Babione said that he was “not aware of any constraints” the UK as a consumer would have in stress-testing and modifying the system.<sup>62</sup> However, Mr Ruddock suggested that the UK “would not want” to make changes unilaterally to the software:

... One of the benefits of having a common system is that it is common. If you start to step outside and make it different, you are making problems for yourself [ ... ] if you wished you could go and do something else, but it is not something that the user would find attractive.<sup>63</sup>

68. However, in their supplementary evidence to the Committee, Lockheed Martin note that they, as the developer of the software, will continue to own the intellectual property. Furthermore, while the UK will have “complete and unfettered use of ALIS and its technical data for the sovereign operation of their aircraft”, the US Government has an “unlimited rights license” which provides them with the ability “to use such data for any purpose whatsoever, including providing it to foreign partners and industry competitors”.<sup>64</sup>

69. Unsurprisingly, during their appearance before the Committee the MoD sought to downplay the potential vulnerabilities of ALIS. Indeed, Harriett Baldwin suggested that *The Times’s* reporting had been focused on getting headlines.<sup>65</sup> Air Commodore Taylor, however, conceded that “like any IT system, it [ALIS] can be vulnerable to cyber-attack”. Nonetheless, he emphasized the work which had been undertaken to make the system “cyber-resilient” and which had left him “assured that we are as resilient as we possibly can be at the moment”.<sup>66</sup>

70. With regard to bugs within the ALIS software, Air Commodore Taylor suggested that those issues had “mostly” been remedied. He also took pains to stress that bugs were a normal part of software development and argued that it “is good that we find them” so that they could be fixed.<sup>67</sup>

**71. The F-35 probably relies more on software than any other defence programme in history and ALIS is of particular importance. This software plays a key role in the day-to-day operation and management of the F-35 and it is unsurprising, then, that concerns have been raised about potential vulnerability to hacking. We were, therefore, glad to hear from Lockheed Martin and the MoD that there has been rigorous cyber-testing of ALIS and that software bugs have mostly been rectified.**

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60 Q89  
 61 Q81  
 62 Qq82–83  
 63 Q86  
 64 PRO0001  
 65 Q173  
 66 Q172  
 67 Q172

72. We are aware that concerns were raised about the intellectual property rights of ALIS and the potential implications for the MoD's long-term management of the UK's F-35 fleet. While we were pleased that Lockheed Martin confirmed in oral evidence that the UK will have complete and unfettered use of ALIS and its technical data for the sovereign operation of our fleet, we note that Lockheed Martin's supplementary evidence weakened this guarantee by claiming that the US Government had an 'unlimited rights license' for this software, including the right to distribute technical data to other nations and to industry competitors. *We ask that Lockheed Martin provide clarity on the level of protection in place for the technical data gathered by ALIS software concerning UK F-35s—including whether this data falls within the US Government's 'unlimited rights license'.*

## 4 Hidden costs?

73. *The Times* also claimed that the F-35 would entail “substantial” hidden costs to the taxpayer, “spares, software upgrades and retrofits are understood not have been covered in sums quoted by the US government and Lockheed Martin, the primary contractor”.

74. For example, while Lockheed Martin recently said that the price of the plane had fallen below £77 million per unit, *The Times* claimed that “the real price [including the upgrades and retrofits mentioned above] of an “average” F-35 delivered this year is going to be much higher—between £130 million and £155 million each”.<sup>68</sup> According to *The Times*, these figures have been “buried in US defense contracts and have not been included in the published figures”.<sup>69</sup>

75. In its briefing, the MoD rejected the claim that there were hidden costs in the programme, said that they did not “recognise” the figures provided in the article and argued that the programme “remains within its cost approval” as detailed within the 2016 Equipment Plan.

76. When asked how *The Times* had arrived at their figure of around £130–155 million per F-35B fighter produced this year, once modifications and retrofits have been taken into account, Alexi Mostrous explained their methodology:

We analysed lot 9—the aircraft delivered this year—because we could not compare the lot 10 contracts, which had not been released yet.

We started off by looking at the fly-away costs, which are public, but the US Government also releases a whole series of details about the individual contracts given to companies like Lockheed to build the particular planes. These contracts will often specify that they are for lot 9 aircraft: “£140 million in March 2014, granted to Lockheed to provide long-term parts for lot 9 aircraft.” Given that we also know how many and which variants of aircraft are being built in lot 9, you can make a broad estimate of the total cost by adding up all the contracts—the retrofits, the helmets, the spares, everything that has lot 9 within the description—and dividing by the total number of aircraft. That gives an average F-35 aircraft cost. Given that we also know that the F-35B and F-35C command a roughly 30% premium on the F-35A, we can then factor that in to determine the average cost of a B variant.<sup>70</sup>

77. Mr Mostrous stressed that this was, by its very nature, an estimate. It was an attempt to say “we already know that the fly-away costs do not represent the full costs of the aircraft, because Lockheed Martin and the US Government accept that they do not include retrofit costs”, and therefore to “determine the rough overall cost” of those extras.<sup>71</sup>

68 Alexi Mostrous (17 July 2017), Upgrades and extras push up flyaway costs, *The Times*, <https://www.thetimes.co.uk/article/upgrades-and-extras-push-up-flyaway-costs-t2jhslw6d>

69 Alexi Mostrous and Deborah Haynes (17 July 2017), Britain spends billions on flawed F-35s, *The Times*, <https://www.thetimes.co.uk/article/britain-spends-billions-on-flawed-fighter-jets-qrtj95kvh>

70 Q16

71 Q16

78. Asked about the MoD’s claim that the project remained on budget, he replied that it was, and “has always been”, very unclear what the MoD actually means by “on budget [ ... ] at no point have they said, “we are spending x on this aircraft and y on retrofitting it.”<sup>72</sup> At the heart of this question of costs is a fundamental problem, according to Alexi Mostrous—that of transparency: “we just don’t know [about the costs and the potential overrun]”.<sup>73</sup>

79. When he was asked about *The Times*’s estimates of the cost of an average F-35 produced this year, once retrofits and upgrades are included, Mr Bronk said £130–155 million was “probably a fair figure in terms of what you would end up parting with, to get a representative squadron, per aircraft of F-35s produced this year, counting the necessary spares, consumables, infrastructure, set-up costs and so on”.<sup>74</sup>

80. However, he warned that it was “very difficult to know” how many of the costs identified in the earlier production lots are “one-off set-up costs, or at least early set-up costs, and how many are integral to the jet and what you require to buy it”.<sup>75</sup>

### Calculating the cost of the F-35

81. Both Lockheed Martin and the MoD insisted that the programme was within budget. However, neither could provide firm costings, pointing instead to the unit recurring flyaway (URF) costs of the jets (this is the basic cost of the aircraft, not including any country specific requirements, retrofits, software updates, spares or logistical support). For example, Jeff Babione highlighted that this cost has been “going down year over year” and, for an F-35B purchased in Lot 9 (the latest production lot), was \$131 million—a reduction of 25% from the first lot from which UK bought planes (Lot 3).<sup>76</sup> According to Mr Babione the unit recurring flyaway costs of the programme to date, for the UK, are:

Unit flyaway costs for lots where UK has purchased, or is due to purchase, F-35s

Production lot	Unit recurring flyaway cost	Number of UK aircraft
Lot 3	\$161 million	2
Lot 4	\$139 million	1
Lot 7	\$137 million	1
Lot 8	\$134 million	4
Lot 9	\$131 million	6
Lot 10 (the next Lot to enter production)	\$122.3 million	3
Lot 11	TBC	1
Lot 12	TBC	3
Lot 13	TBC	6
Lot 14	TBC	8

Source: Q95; PRO0001

The figures, however, do not include the cost of retrofits, add-ons or software upgrades.

72 Q17

73 Q17–21

74 Q62

75 Q62

76 Qq73, 91

### *The aircraft procurement cycle: a process of lot-by-lot negotiation*

82. One of the difficulties in costing—or even producing a firm estimate for—the F-35 programme is the way in which the procurement cycles operate for the aircraft and for spares and logistics. Mr Babione explained that Lockheed Martin aggregates the purchase of aircraft into lots “to afford economies of scale”, as the lots grow bigger, with production increasing, this should “bring the unit cost down for all of the airplanes, including the B model”.<sup>77</sup> Rather than there being one overall negotiation for the entire purchase of the 138 jets, each of the lots is negotiated independently between the manufacturers and the Joint Programme Office. This means that there is neither a fixed ceiling, nor a floor for the price of the jet, but the cost is determined on a lot-by-lot process of negotiation.<sup>78</sup>

83. This does not mean that there are no price targets for the programme. As mentioned in the last paragraph, the grouping of purchases into lots is designed to achieve economies of scale that should, as production increases, see costs per unit decline. Mr Babione told us that, at the request of the JPO, Lockheed Martin will be aggregating Lots 12, 13 and 14 into what they called a “block buy and an economic order quantity opportunity” of approximately 445 airplanes. He also explained that Lockheed Martin’s cost target was for the price of the B model to be \$105 million by the end of that block buy (\$80 million for the A model).<sup>79</sup>

84. Tony Douglas, the Chief Executive of Defence Equipment and Support (DE&S), told us that, ahead of the block buy opportunity, the Government’s target cost per aircraft was around \$105 million.<sup>80</sup> When asked what would happen if that target could not be met, Mr Douglas claimed that they would “not sign the contract unless we can back it off against that price”.<sup>81</sup>

### *Procurement of spares and logistics*

85. As Mr Babione explained to the Committee, procurement of spares and logistics, including those supplied by Lockheed Martin, is conducted separately from the production of the aircraft. He stated that these contracts are “aggregated over a longer period of time” which makes it more difficult to generate a cost per unit.<sup>82</sup> When pressed on this, Mr Babione conceded that if Lockheed Martin were asked “specifically on a given scenario—a certain number of spares for a certain number of airplanes—we would be able to generate an estimate”. However, he repeated that this was “not the way that the customers procure from us [ ... ] they buy these spares in aggregate [ ... ] over about a three-year period”. As a result, each contract differed and would increase as the size of the fleet rose.<sup>83</sup>

86. Steve Over added that the types of equipment supplied by Lockheed Martin, in terms of facilities and infrastructure, were “probably more site specific” and thus not easily split on a per-aircraft basis. For example, “you will buy a pool of spares, a number of training devices and an ALIS system as you stand up each specific site of F-35s”. For that reason,

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77 Q91  
 78 Q100  
 79 Q96  
 80 Q210  
 81 Q211  
 82 Q105  
 83 Q107

and because other sustainment costs such as personnel and fuel were borne by the client nations, Mr Over suggested that the MoD “would probably be in a better position” to help the Committee understand the costs of the programme.<sup>84</sup>

87. Since then, Lockheed Martin has provided more details to the Committee in a supplementary evidence submission.<sup>85</sup> This document outlines three elements to the cost of the F-35 programme: 1) unit recurring flyaway (URF) costs; 2) aircraft modification costs; and 3) sustainment costs. The costs for the first category are outlined in paragraph 89 above. As for the second aspect, Lockheed Martin’s supplementary evidence suggested that the UK is spending at least 3% of the original URF costs on aircraft modification (they could not provide figures on engine and weapons system modification). With regard to sustainment, Lockheed Martin told the Committee that these break down into three categories:

- i) “Infrastructure such as logistics facilities, training environments, and maintenance, repair and overhaul facilities”. Lockheed Martin is contracted with the MoD to supply a package of facilities at RAF Marham, “including the construction and fit out of a logistics operations centre, integrated training centre and maintenance and final finishes building”. According to Lockheed Martin, the value of these contracts with the MoD totals £142 million;
- ii) “A global pool of spare parts that are unique to F-35, support equipment to operate the aircraft, equipment to train pilots and maintainers, and Information Technology systems that enable aircraft operation and sustainment.” Customers deal directly with the JPO for these items, the cost of which is based on a cost-sharing formula that pools resources at the JPO level and then a negotiation between the JPO and Lockheed Martin and other providers, e.g. Pratt and Whitney for the propulsion system; and
- iii) “Other generic costs outside the scope of the Programme, such as personnel and fuel costs”.

Lockheed Martin also informed the Committee that following the completion of the SDD phase, the partner nations in the programme “are committed to developing enhancements to in-service aircraft through ‘Continuous Capability Development and Delivery (C2/D2)”. According to Lockheed Martin, they expect the UK to “pay approximately 4.5% of the total cost to develop and integrate new capabilities into the F-35”.<sup>86</sup>

### ***The MoD and the cost of the F-35 programme***

88. We asked the Minister for Defence Procurement and her MoD colleagues several times about the cost to the UK taxpayer of the F-35 programme. Pressed on the total cost per aircraft, once support and spares are included, Mrs Baldwin and her colleagues did not answer directly, pointing instead to a recent NAO report which put the total cost of the programme through to 2026, at £9.1 billion, a sum that includes the first 48 aircraft, spares, support, training and the investment in infrastructure at RAF Marham and elsewhere.<sup>87</sup>

84 Q107

85 PRO0001

86 PRO0001

87 Qq183, 194

89. When asked how the £9.1 billion figure equated to a cost per-aircraft, particularly in light of the MoD's criticism of *The Times's* estimate of £130–155 million per aircraft, MoD Permanent Secretary Stephen Lovegrove attacked that estimate as an “extraordinarily crude and misleading calculation” which, he suggested, was arrived at by taking £7.3 billion from the £9.1 billion (this £7.3 billion figure covers the production, sustainment and follow-on phase of the programme to 2026) and dividing it by 48.<sup>88</sup> It should be noted that this is not the calculation process outlined by Alexi Mostrous during his appearance before the Committee (see paras 76–77 of this report).

90. According to Mr Lovegrove, it is not possible accurately to divide the £9.1 billion cost on a unit-by-unit basis due to the inclusion, within that figure, of training and infrastructure costs and additional costs “associated with the design and total concept of the aircraft”.<sup>89</sup> Instead, he suggested that one would have to “do a very complicated sum at the end of the life of the programme [the mid-2030s] and divide it by 138. Then you might be able to do it”.<sup>90</sup>

91. The Department was also unable to provide details of the total cost of the F-35 procurement programme, again pointing to the published costs for the programme up to 2026.<sup>91</sup> The Minister told us that the MoD “have not gone” beyond those costings. Mr Lovegrove, however, suggested that the MoD had “rough orders of magnitude” for the possible costs beyond 2026/7, but which are not published for two principal reasons:

One is that they are rough orders of magnitude, and who knows exactly what the world will look like in 10 years' time? In fact, there are no private enterprises that estimate their costs 10 years out with the accuracy that we do, or to the level of fidelity that we do. Secondly, even the last 17 or 19 F-35s within the first 48 are still under negotiation. To reveal publicly how much we think we might be prepared to pay for those would obviously be compromising our negotiating position and compromising taxpayers' money, so we will not be doing that.<sup>92</sup>

**92. The Committee views the MoD's failure to provide adequate cost estimates, either on an overall programme basis or on a per-aircraft basis, as wholly unsatisfactory. It amounts to an open-ended financial commitment which can be quantified only in retrospect.**

**93. We understand that the Lot-by-Lot procurement process for the aircraft, allied with the separate processes for procuring parts and spares and logistical support, make it difficult to calculate the total cost whether on a per-aircraft or on a programme-as-a-whole basis. However, it is simply not acceptable for the Ministry of Defence to refuse to disclose to Parliament and the public its estimates for the total cost of the programme, and to suggest instead that we must wait until the mid-2030s (when all 138 F-35 have been procured) to be able to work out a full unit cost for each aircraft, once spares and upgrades are included.**

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88 Q195

89 Qq195–197

90 Q196

91 Q190

92 Q194

94. *The lack of transparency over the costs of the F-35 is unacceptable and risks undermining public confidence in the programme. The Department should provide us with the 'rough orders of magnitude' it claims to possess for the total costs of the F-35 programme beyond 2026/7.*

## 5 Other reported issues with the F-35

### The Generation III Helmet

95. According to *The Times*, the Generation III helmet's night vision capability malfunctioned during an exercise, putting a pilot in danger as he tried to land on an aircraft carrier at night.

96. Other helmet-related issues, reported by *The Times*, are:

- Weight: until recently the F-35's helmet was "so heavy that lighter pilots were banned from wearing it in case they broke their necks on ejection". This resulted in a 'lite' version being designed that in turn "required the cockpit to be redesigned to have somewhere to put a spare visor";
- "Gun strafing symbols, which line up targets for the pilot, were 'currently operationally unusable and potentially unsafe'";
- "The night-vision technology was less accurate than in older aircraft, making identification of targets 'more difficult if not impossible'";
- According to a 2015 report, during a dogfight test between an F-35 and an older F-15 aircraft, "the pilot's helmet kept smacking into the canopy when he tried to turn around. "The helmet was too large ... to adequately see behind the aircraft," the report said.

97. While *The Times*'s reporting acknowledged that the helmet is still in development "and many bugs will be ironed out", it nonetheless highlighted the fact that many countries, including the UK, are purchasing the F-35 today, "meaning that they could face higher bills to upgrade the helmet as solutions are discovered".<sup>93</sup>

98. Among the sources cited by *The Times* in its investigation was the Office of the Director of Operational Test and Evaluation (DOT&E) 2016 annual report. This identified issues with the Generation III helmet, particularly in relation its night vision capability. Even with improvements to the helmet, "limitations with night vision capability remain".

99. According to DOT&E, "pilots using the Gen III helmet for night operations report that visual acuity is still less than that of the night vision goggles used in legacy aircraft". As a result, the identification of targets and detecting markers is made "more difficult, if not impossible". While steps have been taken to reduce the 'green glow', whereby light leaks around the edge of the display during low-light conditions, this is still a concern.<sup>94</sup>

93 Alexi Mostrous (17 July 2017), Malfunctioning £309,000 F-35 helmet left pilot floundering in darkness, *The Times*, <https://www.thetimes.co.uk/article/malfunctioning-309-000-helmet-left-pilot-floundering-in-darkness-gzqvxtdrm>

94 Director, Operational Test and Evaluation, Annual Report, 2016, FY16 DoD Programs: [F-35 Joint Strike Fighter](#), p.70

100. Justin Bronk told us that the helmet, in its current software configuration, was “clearly not fit for combat use” and was “still causing potentially dangerous problems in testing”.<sup>95</sup> Overall, his assessment was that the “Gen III helmet is not currently suitable for combat operations but it will have to be, so the US will eventually fix it, but the question is when”.<sup>96</sup>

101. Harriett Baldwin admitted to us that there had been issues with the Generation III helmet, but added that “the supplier has been able to correct those to the satisfaction of the senior responsible owner” [SRO].<sup>97</sup> Air Commodore Taylor, the SRO, confirmed to the Committee that the previously identified issues of “the green glow, the jitter, the gun sight aiming [ ... ] have now been resolved to the satisfaction of the user” and that he was now satisfied with the helmet.<sup>98</sup> On the question of whether any additional costs had arisen to UK taxpayer as a result of rectifying the issues with the helmets, both Mrs Baldwin and Air Commodore Taylor said that any such costs would be borne by the company and the JPO instead.<sup>99</sup>

## Weight

102. *The Times* also suggested that the US documents have revealed that the initial F-35Bs purchased by the UK are too heavy to perform the vertical take-off and landing function safely.<sup>100</sup>

... when early versions were upgraded, they would be over the weight permitted for a safe landing. Britain bought four of the 14 aircraft affected, records suggest. The report estimates further upgrades, to bring the aircraft up to its full potential, would push it over an even stricter “structural limit”. Without the upgrade the aircraft will miss out on future software and hardware updates.<sup>101</sup>

103. The DOT&E report cited by *The Times* states that modifications to the 14 Lot 2 F35-Bs, required to bring those aircraft to the Block 3F configuration, “are expected to bring those aircraft to potentially an additional 350 pounds [in weight]”. This would push those aircraft “above the objective not-to-exceed weight” to meet the vertical landing bring-back (VLBB) key performance parameters.

104. According to the DOT&E report, estimates for the additional weight accrued from follow-on-modernisation (FoM) to the Lot 2 F-35Bs include an extra 250lbs “which will exceed the vertical landing structural limit not-to-exceed weight of 33,029 pounds for the Lot 2 through Lot 4 aircraft”. As mentioned in *The Times*, the report suggested that “this additional weight may prevent these aircraft from being upgraded to the Block 4 configuration”.<sup>102</sup>

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95 Q55

96 Q55

97 Q227

98 Qq229, 232

99 Qq230–231

100 Alexi Mostrous and Deborah Haynes (17 July 2017), Britain spends billions on flawed F-35s, *The Times*, <https://www.thetimes.co.uk/article/britain-spends-billions-on-flawed-fighter-jets-qrtj95kvh>

101 Alexi Mostrous (17 July 2017), Malfunctioning £309,000 F-35 helmet left pilot floundering in darkness, *The Times*, <https://www.thetimes.co.uk/article/malfunctioning-309-000-helmet-left-pilot-floundering-in-darkness-gzqvxtdrm>

102 Director, Operational Test and Evaluation, Annual Report, 2016, FY16 DoD Programs: [F-35 Joint Strike Fighter](#), p.63

105. In response to *The Times's* investigation, the MoD dismissed their claims as “nonsense”, arguing that a specific technique had been developed “to ensure that a heavy aircraft can land on the deck”. This technique (Ship-borne Rolling Vertical Landing) “will be tested on the Flight Trials of HMS Queen Elizabeth over the next couple of years”.

106. We asked Alexi Mostrous and Deborah Haynes about their claims that the F-35 was too heavy. Mr Mostrous made clear that these claims were specifically confined to the F-35s purchased by the UK from the Lot 2 and Lot 4 production rounds, rather than those built more recently.<sup>103</sup> Both witnesses repeated the claim that those earlier aircraft were “potentially” too heavy to land vertically.

107. Ms Haynes also questioned the shipborne rolling vertical landing (SRVL) technique that the MoD will employ for the F-35Bs, noting that the language used in the MoD’s response implied that the technique “has not actually been tested and categorically verified that it will work”.<sup>104</sup>

108. Justin Bronk suggested to us that the weight issue with the F-35s was “very significant in terms of upgrade or retrofit growth potential, as well as bring-back of weapons” and also, potentially, in relation to resolving vibration issues with the aircraft. According to Mr Bronk, where vibration issues have emerged in the past the usual solution would be to investigate and locate the source and to then add cross-braces. As the F-35 B was “already very close to its weight target, for a lot of the vibration issues the traditional solution is likely to be weight sensitive”.<sup>105</sup>

109. We also asked Mr Bronk about the SRVL technique. He took the view that the question was not whether the F-35 was capable of performing such a manoeuvre, but rather “when the software will be developed to conduct such a landing”.<sup>106</sup> He explained that the SRVL technique would be a largely automatic process and, as such, the development of the software required to perform this landing would take “some time”.<sup>107</sup>

110. Lockheed Martin’s Peter Ruddock conceded to us that three F-35Bs procured by the UK were above the specified weight. However, he insisted that this did not mean that those aircraft were too heavy to land on the aircraft carriers and noted that they “can land and have landed vertically”.<sup>108</sup> Indeed, he suggested that while these aircraft were unlikely to be deployed, “they would be able to land and to bring back the entire weapon load internally” in the event that they had to be used in operations.<sup>109</sup>

111. On the general weight of the aircraft, Mr Ruddock told us that, aside from the first two lots of aircraft procured by the UK, the rest of the aircraft “are actually within weight” and went on to suggest that “remarkably, on the B model, there has been no weight growth whatever in the past seven years”.<sup>110</sup> Insisting that he had “no concerns about the weight” of the F-35, Mr Ruddock pointed both to the SRVL technique being pioneered by the UK, which, he suggested, would enable F-35Bs to land with an additional 2,000 pounds of

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103 Q26

104 Q33

105 Q54

106 Q54

107 Q54

108 Q111

109 Q115

110 Qq111, 115

ordnance, and also to the level of capability already built-in to the F-35.<sup>111</sup> According to Mr Ruddock, this level of built-in capability “future-proofs” the aircraft and meant that “the risk of weight growth to the programme is much less than on legacy programmes”.<sup>112</sup>

112. In supplementary evidence to the Committee, Lockheed Martin clarified these remarks, suggesting that “since October 2010, there has been zero weight growth in the F-35B that was not driven by the addition of customer requirements”. According to Lockheed Martin, there has been an additional weight growth of 300 pounds in the weight of the aircraft over this period “to accommodate additional requirements and new capabilities requested by customers”.<sup>113</sup>

113. Mr Ruddock’s confidence in the weight capacity of both the three over-specification F-35s and the rest of the fleet was echoed by Harriett Baldwin and Air Commodore Taylor.<sup>114</sup> The latter explained that the three aircraft procured from Lots 3 and 4 which were overweight were test aeroplanes based at Edwards Air Force Base. He said that while “they are slightly heavier than baselines weight” they would still be able to land vertically on the Queen Elizabeth carriers if required.<sup>115</sup> He insisted that this would be the case even “with estimated weights of follow-on modernisation”, although they might not be able to have “the standard loadout” of weapons and fuel.<sup>116</sup> He added that UK aircraft carried only 500 pound bombs, as opposed to the 2,000 pound bombs mentioned in the weight specification, thus providing additional weight capacity for the UK’s fleet.<sup>117</sup>

114. Overall, Air Commodore Taylor was enthusiastic about the “simply exceptional” performance of the F-35:

We are bringing back and vertically landing on to the carrier full stores loadout, with enough fuel to land or, if you cannot land the first time, to go round and have another go and still land vertically with the aeroplane.<sup>118</sup>

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111 Qq115–116

112 Q116

113 PRO0001

114 Qq174–175

115 Q175

116 Q176

117 Q179

118 Q177

## 6 General observations

115. In July 2017, *The Times* conducted an investigation into the F-35 programme. This investigation resulted in a number of serious allegations being levelled at the most expensive international defence programme in history—the linch-pin of our future carrier strike capability. Our short inquiry has sought to weigh the claims made by *The Times* against expert commentary, technical reports and the evidence of Lockheed Martin and the Ministry of Defence.

116. The F-35 has clearly experienced a number of software and hardware problems during its development phase, and it is important to acknowledge that it would have been unusual for a project of the size, scale and technological complexity of the F-35 not to encounter any during its design and development process. Nevertheless, *The Times's* investigation has provided cause for concern.

117. Such concern has not been alleviated by the Department's and Lockheed Martin's initial response to the issues raised by *The Times*. The F-35 is set to be one of the biggest defence investments ever made by a UK Government and a programme that supports thousands of British manufacturing jobs. The newspaper's investigation provided the Government and Lockheed Martin with an opportunity to reassure the public and build support for a vital defence project. It is disappointing that neither invested in a serious media and public relations effort to refute the claims made by *The Times*, relying instead on a letter to the editor of the paper (in the case of Lockheed Martin) and a rather dismissive letter and briefing circulated by the Government to Conservative MPs.

118. We were surprised, given the cross-party nature of defence issues, that the letter from Harriett Baldwin and accompanying briefing document were sent by the Government only to Members on its own side. *In future, where the Government is responding to claims made in public about defence projects, it should ensure that both sides of the House, rather than just Members on its own side, are kept informed. In this instance, the Government, as a matter of course, should have sent the letter and briefing to the Defence Committee and deposited the documents in the Library of the House of Commons.*

119. We have received a number of assurances from the Government and Lockheed Martin that problems identified in *The Times's* investigation and the report of the DOT&E have been, or are in the process of being, tackled. For the time being, we are willing to accept the assurances that have been given by Lockheed Martin and the MoD. Nevertheless, we will continue to pay close attention to the delivery of this programme and will hold both Lockheed Martin and the Government to each of the assurances made during the course of our inquiry.

120. The F-35 could be a transformative capability for the UK and our allies. It is the duty of Lockheed Martin, the MoD and the Joint Programme Office to ensure this potential is realised. *The MoD should, therefore, agree to provide this Committee with six-monthly updates on the F-35 programme. These updates must detail the progress made in addressing each of the issues identified in this report and any additional problems. These updates should also include details of the ongoing cost of the programme, including on sustainment, spares and logistics, software upgrades and the unit recurring*

*flyaway costs. Furthermore, following any future trials of communications between F-35s and older aircraft, via MADL systems, such as Babel Fish III, the MoD should produce a memorandum informing the Committee of the progress made.*

121. The F-35 is a major investment in defence capability for the UK. We want it to succeed and to become the cornerstone of a new and effective carrier strike capability for this country. However, it is precisely because of the significance of this project that it must be subjected to the closest possible scrutiny, so that the public can have confidence in its affordability and deliverability. We thank *The Times* for its investigation and for focusing attention upon the procurement of this vital military capability.

## Conclusions and recommendations

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### Reported communications and software issues

1. We are pleased that the Government acknowledges the potential value of using the Multifunctional Advanced Data Link (MADL) for secure communications between the F-35 and our older aircraft. We note both that it is the MoD's ambition to have MADL-type capabilities across the carrier group and that trials of a gateway communications node have been undertaken involving the F-35 and Typhoon. (Paragraph 46)
2. *We agree with Justin Bronk from RUSI that, without an advanced data link and translation node, the UK will be underusing one of the key capabilities of the F-35—its ability to interact with older aircraft and greatly augment their potency. In the light of the successful Babel Fish III trial, which saw a gateway node used to translate MADL messages to Link 16 format between F-35s and Typhoons, earlier this year, and ahead of the UK receiving its first squadron of F-35 fighters next year, we recommend that the MoD make provision for the procurement of a gateway translation node for MADL-based F-35 to Typhoon communication in the next Equipment Plan.* (Paragraph 47)
3. If the potential benefits of the F-35 to the UK's future carrier strike capabilities are to be realised then the Queen Elizabeth carriers will require a broadband capacity beyond 8 megabits. While we note that the MoD claims that there is scope for the current bandwidth to be enlarged, it seems highly likely that a capacity in excess of the 32 megabits currently available on the USS America will be required for an effective carrier strike capability. (Paragraph 57)
4. The F-35 probably relies more on software than any other defence programme in history and ALIS is of particular importance. This software plays a key role in the day-to-day operation and management of the F-35 and it is unsurprising, then, that concerns have been raised about potential vulnerability to hacking. We were, therefore, glad to hear from Lockheed Martin and the MoD that there has been rigorous cyber-testing of ALIS and that software bugs have mostly been rectified. (Paragraph 71)
5. We are aware that concerns were raised about the intellectual property rights of ALIS and the potential implications for the MoD's long-term management of the UK's F-35 fleet. While we were pleased that Lockheed Martin confirmed in oral evidence that the UK will have complete and unfettered use of ALIS and its technical data for the sovereign operation of our fleet, we note that Lockheed Martin's supplementary evidence weakened this guarantee by claiming that the US Government had an 'unlimited rights license' for this software, including the right to distribute technical data to other nations and to industry competitors. *We ask that Lockheed Martin provide clarity on the level of protection in place for the technical data gathered by ALIS software concerning UK F-35s—including whether this data falls within the US Government's 'unlimited rights license'.* (Paragraph 72)

### Hidden costs?

6. The Committee views the MoD's failure to provide adequate cost estimates, either on an overall programme basis or on a per-aircraft basis, as wholly unsatisfactory. It amounts to an open-ended financial commitment which can be quantified only in retrospect. (Paragraph 92)
7. We understand that the Lot-by-Lot procurement process for the aircraft, allied with the separate processes for procuring parts and spares and logistical support, make it difficult to calculate the total cost whether on a per-aircraft or on a programme-as-a-whole basis. However, it is simply not acceptable for the Ministry of Defence to refuse to disclose to Parliament and the public its estimates for the total cost of the programme, and to suggest instead that we must wait until the mid-2030s (when all 138 F-35 have been procured) to be able to work out a full unit cost for each aircraft, once spares and upgrades are included. (Paragraph 93)
8. *The lack of transparency over the costs of the F-35 is unacceptable and risks undermining public confidence in the programme. The Department should provide us with the 'rough orders of magnitude' it claims to possess for the total costs of the F-35 programme beyond 2026/7.* (Paragraph 94)

### General observations

9. In July 2017, *The Times* conducted an investigation into the F-35 programme. This investigation resulted in a number of serious allegations being levelled at the most expensive international defence programme in history—the linch-pin of our future carrier strike capability. Our short inquiry has sought to weigh the claims made by *The Times* against expert commentary, technical reports and the evidence of Lockheed Martin and the Ministry of Defence. (Paragraph 115)
10. The F-35 has clearly experienced a number of software and hardware problems during its development phase, and it is important to acknowledge that it would have been unusual for a project of the size, scale and technological complexity of the F-35 not to encounter any during its design and development process. Nevertheless, *The Times's* investigation has provided cause for concern. (Paragraph 116)
11. Such concern has not been alleviated by the Department's and Lockheed Martin's initial response to the issues raised by *The Times*. The F-35 is set to be one of the biggest defence investments ever made by a UK Government and a programme that supports thousands of British manufacturing jobs. The newspaper's investigation provided the Government and Lockheed Martin with an opportunity to reassure the public and build support for a vital defence project. It is disappointing that neither invested in a serious media and public relations effort to refute the claims made by *The Times*, relying instead on a letter to the editor of the paper (in the case of Lockheed Martin) and a rather dismissive letter and briefing circulated by the Government to Conservative MPs. (Paragraph 117)
12. We were surprised, given the cross-party nature of defence issues, that the letter from Harriett Baldwin and accompanying briefing document were sent by the Government only to Members on its own side. *In future, where the Government is*

*responding to claims made in public about defence projects, it should ensure that both sides of the House, rather than just Members on its own side, are kept informed. In this instance, the Government, as a matter of course, should have sent the letter and briefing to the Defence Committee and deposited the documents in the Library of the House of Commons. (Paragraph 118)*

13. We have received a number of assurances from the Government and Lockheed Martin that problems identified in *The Times's* investigation and the report of the DOT&E have been, or are in the process of being, tackled. For the time being, we are willing to accept the assurances that have been given by Lockheed Martin and the MoD. Nevertheless, we will continue to pay close attention to the delivery of this programme and will hold both Lockheed Martin and the Government to each of the assurances made during the course of our inquiry. (Paragraph 119)
14. The F-35 could be a transformative capability for the UK and our allies. It is the duty of Lockheed Martin, the MoD and the Joint Programme Office to ensure this potential is realised. *The MoD should, therefore, agree to provide this Committee with six-monthly updates on the F-35 programme. These updates must detail the progress made in addressing each of the issues identified in this report and any additional problems. These updates should also include details of the ongoing cost of the programme, including on sustainment, spares and logistics, software upgrades and the unit recurring flyaway costs. Furthermore, following any future trials of communications between F-35s and older aircraft, via MADL systems, such as Babel Fish III, the MoD should produce a memorandum informing the Committee of the progress made. (Paragraph 120)*
15. The F-35 is a major investment in defence capability for the UK. We want it to succeed and to become the cornerstone of a new and effective carrier strike capability for this country. However, it is precisely because of the significance of this project that it must be subjected to the closest possible scrutiny, so that the public can have confidence in its affordability and deliverability. We thank *The Times* for its investigation and for focusing attention upon the procurement of this vital military capability. (Paragraph 121)

# Appendix 1: F-35 letter and briefing from MoD

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## Letter from Harriett Baldwin MP to Conservative MPs

Dear Colleague,

### F35 Capability and Queen Elizabeth Aircraft Carrier

You may have seen recent coverage in *The Times* making claims about the F-35 Joint Strike Fighter and the Queen Elizabeth aircraft carrier. Given the importance of this programme to our Armed Forces and our industrial base, I want to reassure you that F-35 programme remains on time, within costs, and offers the best capability for our Armed Forces.

The articles are out-of-date, lack technical understanding of complex issues, and contain commentary that is ill-informed and inaccurate. Where concerns are valid they are not new, have been reported in recent years, and are resolved or being addressed as part of the trials.

The F-35B Lightning II aircraft is the world's most advanced fighter jet and is needed to combat the future threats we will face. The RAF and the Royal Navy will fly F-35s from Queen Elizabeth Class aircraft carriers and from Operating Bases such as RAF Marham.

The programme is on track. Today there are over 100 British pilots and aircrew training in the US on our 10 F-35s before they arrive in the UK next year. Those best placed to comment on the F35 capability are those who have flown them as part of 95,000 hours of test flights. Wing Commander Jim Beck, one of the UK's most experienced F-35 pilots, said:

“The F-35 is the best aircraft I've ever flown. It is the most advanced multi-role fighter jet out there and the aircraft most suited to the UK's needs. With huge flexibility and cutting-edge innovation, this supersonic, stealth aircraft will bring about a generation change in the way we fight in the Combat Air arena for many decades to come.”

By the end of this year we will have 14 F-35 aircraft and in 2018 we will begin initial flight trials for F-35 jets from HMS Queen Elizabeth, building towards delivering a UK carrier strike capability from 2020. HMS Queen Elizabeth is now undergoing sea trials before being accepted into the Royal Navy by the end of the year.

As well as providing first rate military capability, UK-based companies benefit from 15% of the value of the manufacture of every F-35 on what is the largest global defence programme ever. Furthermore, last year the UK was chosen to be a global repair hub for hundreds of European-based F35s, supporting thousands of high skilled jobs.

These programmes form an important part of our £178bn equipment plan.

I attach a briefing on the claims. Wing Commander Beck's article is available at <https://ukcarrierpower.tumblr.com/post/163087799726/the-f35-is-the-best-fighter-jet-out-there> .

Yours,

Harriett Baldwin

Minister for Defence Procurement

## Accompanying briefing from MoD to Conservative MPs

### *F35–Claims and Reality*

*Claim: The F-35 is unable to share data.*

This is incorrect. Data exchange was examined during a recent Red Flag exercise with the US where the F-35 acquitted itself exceptionally well. To describe the data link as insecure is incorrect. MOD, alongside our NATO partners, has allocated funding to continue the upgrade of secure communications via this data link.

*Claim: There are hidden costs within the F-35 programme.*

We simply do not recognise the costs quoted in the article. The UK's F-35 programme remains within its cost approval, details of which are in the Defence Equipment Plan 2016, published on 27 January 2017. MOD is working hard with the suppliers to ensure delivery to budget and programme cost effectiveness.

Defence expert Howard Wheeldon has described *The Times*' figures as 'back of a fag packet' cost guestimates that also fail to mention cost reductions that will come from a low rate initial production (LRIP)

As recently announced, the Department has invested in RAF Marham to ensure availability and support to the UK F-35. This investment ensures that cutting edge maintenance facilities are available to the aircraft on arrival in the UK next year.

*Claim: The broadband capacity of Queen Elizabeth is insufficient to support F-35.*

This is incorrect. The planned bandwidth of the Queen Elizabeth Class aircraft carriers will be sufficient to carry out the scope of carrier strike operations, over the life of the programme.

As with all programmes, requirements and opportunities are kept under constant review and will be developed through the life of the programme. The aircraft, the carrier and our communication networks are all designed with the capacity to grow, and are not constrained by design or bandwidth limitations.

*Claim: The Autonomic Logistics Information System (ALIS) software system is [a] vulnerability in the F-35 system*

This is incorrect. ALIS is part of the ground based information system and is not fitted on board the F-35B Lightning II fighter aircraft.

We don't comment on the specifics of Cyber operations, but we take encryption and protection of our information very seriously and these measures remain classified. All classified data transmissions to and from the F-35B Lightning II fighter aircraft are fully encrypted.

*Claim: The F-35 has a number of on-going technical issues:*

All issues raised have been reported in the past and are under active management by the Joint Strike Fighter Joint Programme Office and the MOD. The F-35 Programme is still within the Development Test phase. As issues are found, solutions are developed; the UK is part of that testing.

*Claim: The F-35 is too heavy to land on the aircraft carrier.*

This is nonsense. We have specifically developed a UK technique for recovering the aircraft to the carriers to ensure that a heavy aircraft can land on the deck. Ship-borne Rolling Vertical Landing (SRVL) will be tested during Flight Trials of HMS Queen Elizabeth over the next couple of years.

*Claim: Helmet not fit for purpose.*

We are holding the supplier to account to deliver a helmet that delivers the full operational requirement and we are confident that issue will be resolved satisfactorily.

*Claim: The F-35 has less memory than the average iPhone.*

The figure of 10 GB is not recognised by the MoD and comparison of F-35 memory with an iPhone is neither credible, nor sensible. The F-35 software architecture is partitioned with memory distributed around the aircraft to achieve specific functions in a rigorous security architecture, and the memory is of many, many orders of magnitude higher than 10GB.

*Claim: The F-35 programme is not subject to proper public scrutiny.*

This is incorrect. The F-35 programme is publicly held to account by:

- In March 2017, the NAO report 'Delivering Carrier Strike', for example, analysed the carrier programme and conducted a deep dive in the F-35.
- The annual Project Performance Summary Table (formerly the Major Projects Report), which forms part of the Equipment Plan, scrutinised by both the HCDC and PAC.
- The Major Projects Authority, which provides independent assurance as part of its Government Major Projects Portfolio.
- The Director of Operational Test & Evaluation report, as part of the global F-35 programme.

All of these reviews can be found online.

The programme is also held to account internally by:

- The Defence Portfolio Approvals Secretariat
- Integrated Assurance Reviews

# Formal Minutes

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**Tuesday 12 December 2017**

Members present:

Rt Hon Dr Julian Lewis, in the Chair

Leo Docherty

Ruth Smeeth

Rt Hon Mr Mark Francois

Rt Hon John Spellar

Graham P. Jones

Phil Wilson

Gavin Robinson

Draft Report (*Unclear for take-off? F-35 Procurement*), proposed by the Chair, brought up and read.

*Ordered*, That the draft Report be read a second time, paragraph by paragraph.

Paragraphs 1 to 121 read and agreed to.

Appendix agreed to.

Summary agreed to.

*Resolved*, That the Report be the Second Report of the Committee to the House.

*Ordered*, That the Chair make the Report to the House.

*Ordered*, That embargoed copies of the Report be made available, in accordance with the provisions of Standing Order No. 134.

[Adjourned till Thursday 19 December at 10.45 am

## Witnesses

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The following witnesses gave evidence. Transcripts can be viewed on the [inquiry publications page](#) of the Committee's website.

### Tuesday 12 September 2017

Question number

**Deborah Haynes**, Defence Editor, *The Times*, and **Alexi Mostrous**, Head of Investigations, *The Times*

[Q1–41](#)

**Justin Bronk**, Research Fellow, RUSI

[Q42–71](#)

### Tuesday 17 October 2017

**Mr Peter Ruddock**, Chief Executive, Lockheed Martin UK, **Mr Jeff Babione**, Executive Vice President and General Manager, F-35 Programme, and **Mr Steve Over**, Director, F-35 International Strategy and Customer Engagement

[Q72–134](#)

**Harriett Baldwin MP**, Minister for Defence Procurement, **Stephen Lovegrove**, Permanent Secretary, Ministry of Defence, **Lt General Mark Poffley**, Deputy Chief of Defence Staff (Military Capability), Ministry of Defence, **Tony Douglas**, Chief Executive Officer for Defence Equipment and Support, Ministry of Defence, and **Air Commodore Lincoln Taylor**, Assistant Chief of Staff, Capability Delivery Combat Air, RAF

[Q73–254](#)

## Published written evidence

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The following written evidence was received and can be viewed on the [inquiry publications page](#) of the Committee's website.

PRO numbers are generated by the evidence processing system and so may not be complete.

- 1 Lockheed Martin ([PRO0001](#))
- 2 Ministry of Defence ([PRO0002](#))

## List of Reports from the Committee during the current Parliament

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All publications from the Committee are available on the [publications page](#) of the Committee's website.

The reference number of the Government's response to each Report is printed in brackets after the HC printing number.

### Session 2017–19

First Report	Gambling on 'Efficiency': Defence Acquisition and Procurement	HC 431
First Special Report	SDSR 2015 and the Army	HC 311
Second Special Report	Armed Forces Covenant Annual Report 2016	HC 310
Third Special Report	Investigations into fatalities in Northern Ireland involving British military personnel: Government Response	HC 549