HOUSE OF COMMONS

# Defence

## Oral evidence: F-35 Procurement, HC 326

Tuesday 12 September 2017

Ordered by the House of Commons to be published on 12 September 2017.

Watch the meeting

Members present: Rt hon. Dr Julian Lewis (Chair); Leo Docherty; Martin Docherty-Hughes; Rt hon. Mr Mark Francois; Graham Jones; Gavin Robinson; Ruth Smeeth; Rt hon. John Spellar; Phil Wilson.

Questions 1-71

### Witnesses

I: Deborah Haynes, Defence Editor, The Times, and Alexi Mostrous, Head of Investigations, The Times.

II: Justin Bronk, Research Fellow, RUSI.

### Examination of witnesses

Witnesses: Deborah Haynes and Alexi Mostrous gave evidence.

Q1 **Chair:** Good morning, everybody. Welcome to the first oral evidence session of the newly constituted Select Committee on Defence—so newly constituted that it was actually constituted formally last night by a vote on the Floor of House. Here we are, ready to get under way straightaway with a topical subject: the role of the F-35 joint strike fighter and the acquisition process so far, with particular reference to an investigation carried out by *The Times* that raised a number of serious doubts concerning the acquisition and performance of the aircraft. For our first session we have two representatives from *The Times*: Deborah Haynes and Alexi Mostrous. Would you like to say a word or two to introduce yourselves?

***Deborah Haynes:*** Thank you very much for inviting us here. My name is Deborah Haynes and I am the defence editor for *The Times.*

***Alexi Mostrous:*** I am Alexi Mostrous and I am the head of investigations.

Q2 **Chair:** You were the main investigator for this particular report that came out, I believe. Is that right?

***Alexi Mostrous:*** Yes, although it was very much a joint effort.

**Chair:** Very good. We will start with some questions from John Spellar.

Q3 **John Spellar:** What would you say are the main takeaways from your investigation into the F-35 programme?

***Alexi Mostrous:*** We were looking at three main areas. The first was the cost. We tried to work out, as best we could, the actual cost of each F-35 aircraft delivered this year in what is called Lot 9. We did that by trying to analyse some contracts that had been released by the US, and then comparing that analysis with the so-called fly-away costs published by Lockheed Martin and the US Government. That was one area. The second area that we focused on was concerns around the safety, reliability and maintenance of the planes. That evidence primarily came from publicly available sources, including two recent US reports. The third area specifically looked at how Britain was integrating the F-35 into its wider military capabilities. In that third area a number of our sources raised concerns that Britain had not invested sufficiently in the network capabilities that would allow the F-35 to operate to its full capacity.

***Deborah Haynes:*** As well as that, on the cost side of things we had concerns put to us from sources about whether the Government have a genuine understanding of the support costs for the airframe. The National Audit Office raises the maturity of the understanding of the support costs as in issue. If you do not have an affordable support programme, there is no point buying the aircraft in the first place—that is the allegation from the people that we spoke to. Then there is the issue of the foreign exchange rate, which also impacts the programme, according to the people that we spoke to. Since we published our reports, the MOD showed in its major projects report that an additional £80 million was added to the cost of the F-35 spend over the previous financial year because of the change in the sterling rate against the dollar.

I focused on exactly that: the British end of things. I spoke to people who are closely involved with the programme. Obviously a lot of questions have been raised about the joint strike fighter. We all know that the programme has been going on for an awful lot longer than was initially intended, the cost has risen an awful lot and there have been a lot of challenges; however, the actual aircraft itself is said to be game-changing. Taking that on face value—that it is good to have F-35—the sources I spoke to said that we need to make sure that we have a credible force and the question is: are we putting sufficient resource and prioritisation on the networking side? JSF is so much more than just a fighter or a bomber. It is a sensory device that can absorb—suck up or hoover up—information on the battle space. It could 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. We did not really cover this in our investigation, but it is much the same in the land space too.

The sources we spoke to said that, at the moment, the balance between platform and software is perhaps too tilted towards platform. So, you are left with an expensive platform that is unable to reap its full benefits, just for the sake of a relatively small cost on the networking side.

Q4 **John Spellar:** May I just clarify: is your main contention that there are problems with the integrity of the international programme, led by the United States but with a number of partner nations at different tiers? Or is your contention that the real problem is the lack of proper integration of this new aircraft into Britain's defence capability and, in balance of relative expenditure, a relatively small part of the expenditure, compared with the purchasing and ongoing maintenance and upgrade costs of the F-35?

***Deborah Haynes:*** I think it is both of those. If you read the test and evaluation reports that come out of the Pentagon—we are not technical experts, we are just journalists and all we can do is read the experts' reports and speak to the experts. There is no doubting—I am sure you have all read the most recent test and evaluation report, and it does go through in forensic detail—that still, 20 years into the programme, there are significant development issues. They obviously are being worked through and people say that with every new piece of technology there will be development issues, but just because of that, should we just be reassured? Shouldn't we, at least, probe and ask? The question we had was, why is there not the same level—or there doesn't seem to be—the same kind of public scrutiny of the UK buy, given that we are having the F-35B at the moment and the kind of technique we are using to land it on the carrier is different to the way the US Marines are doing it? Where is the public scrutiny to the same level you have in the United States over here?

That is one element. Then, very much on the technology capability side, you all know of the financial pressures facing the MOD at the moment. Sources express dismay that, at a time when everybody is conscious of the need to invest in the technology, the Joint Forces Command, which is the branch that has ownership of that area, is having its budget wedged—sacrificed to pay for ships and planes.

Q5 **John Spellar:** I think that is understandable and I also take the point that there are glitches, particularly in leading-edge projects. Does that, then, lead to justification for the claim I understand was made in your articles that the F-35 programme was "way over budget, unreliable, full of software glitches and potentially unsafe"?

***Alexi Mostrous:*** We can take you through each of those areas, as each one is dealt with, specifically, in this December 2016 report. For example, in terms of unreliability, the United States Government Accountability Office report found that "the F-35 fleet was falling short of reliability and maintainability expectations in 11 of 21 areas." That report found that reliability had stagnated. That report also found that deficiencies were being discovered at about 20 per month. There were 72 deficiencies classified as priority 1 deficiencies, which links to the fact that if you fly with a category 1 deficiency, there are potential issues around the safety of that mission. Specific safety concerns were raised in terms of the green glow of the F-35 helmet. The report said, "gun strafing symbology" in the helmet was "currently operationally unusable and potentially unsafe." So

in terms of all those areas—reliability, maintenance, safety and overruns—there is evidence for all four in this report.

To echo what Deborah said, it isn't really up to us to form some sort of editorial conclusion about whether or not the F-35 is an appropriate plane. It is striking that, in spite of the US report and the conclusions of the Australian Senate inquiry, Britain, despite being a tier 1 partner, has made no comment on any of the issues identified in this report—has interviewed no witnesses, unlike in Australia, which is supposedly a lesser partner.

Australia had a public inquiry into this project and concluded that, at the end of the day, the F-35 was the right thing to be buying, but it said in its published conclusions, "Nonetheless, in light of the serious problems that led to a re-baselining of the F-35 program in 2012, and the ongoing issues identified by the United States Director of Operational Test and Evaluation"—in other words, this report—"the committee retains a healthy scepticism towards assurances by Defence regarding cost, schedule and capability outcomes of the F-35A." It is this sort of healthy scepticism that seems to be lacking within the British political process.

Q6 **Chair:** Well, let's hope we can make up for that in the course of today. As you probably know, we have a session immediately following this with Justin Bronk, who is an expert in the area from the Royal United Services Institute, and subsequently, on 17 October, we will be discussing the matter with the Defence Procurement Minister, Harriett Baldwin.

Deborah, I would like focus on what you said earlier about the role of the aircraft, not so much as a strike aircraft itself, but as an enabler for other systems. Justin Bronk, who we are about to see next, has argued previously that the most effective use of the aircraft is likely to be as a "survivable intelligence surveillance and reconnaissance enabler in defended airspace to enhance the lethality, flexibility and survivability of legacy platforms"—in order words, older systems—such as the Typhoon and the Type 45 destroyers. One of your main contentions is that if it is going to fulfil this role, it needs to be able to communicate in certain highly complex ways, but you maintain that it will have to rely on an existing system—a more limited one—called Link 16. Why do you say that relying on Link 16 to share data with other parts of the carrier group would leave the UK particularly exposed? Would you like to explain the implications of that?

We are all going to have to be a little bit shorter with our questions and answers. I have just set a bad example myself. [*Laughter.*] I thought that would get a response, but let's see what we can do.

***Deborah Haynes:*** Absolutely. May I caveat everything I say with the fact that I am not a technology expert? I have spoken to the experts, and I am just relaying what they have said. My understanding is that Link 16 is a legacy means of communication between platforms. It is very resilient: it is the sort of thing that, in Armageddon, it would still kind of work, you would hope. The problem is that, for F-35, one of its key characteristics is its ability to operate in stealth mode—low observability. To do that, it

needs to be able to communicate with legacy platforms, stealthily, and, unfortunately, Link 16 doesn't provide that stealth.

Q7 **Chair:** So it's not secure? You are saying that it's not secure?

***Deborah Haynes:*** It's not that it's not secure; we are just saying that there is a greater potential of the F-35 being discovered if it squeaks on Link 16.

***Alexi Mostrous:*** There's a potential misunderstanding here. By "unsecured" we don't mean that someone could hack into Link 16 to work out what was being said. We mean that the radio frequency might reveal the position of the plane.

***Deborah Haynes:*** And then there's also an issue of capacity. Link 16 doesn't have a big capacity to handle—as far as my sources have said—the huge amount of data that the F-35 hoovers up, and that is an issue that everybody's tackling. I was at an air power conference as part of Defence and Security Equipment International yesterday. One of the senior airmen for the European Air Group was talking about how, come 2027, in terms of the European Air Group, which includes the UK, 18% of fast air was going to be fifth generation and 82% will still be fourth generation. So, they are also grappling with this issue of how to communicate.

Q8 **Chair:** Alexi, are the Americans making the necessary changes so that they can operate their planes stealthily, and are you saying that we are not doing that?

***Alexi Mostrous:*** Yes, exactly. In fact, the Americans are in a better position than us in two respects. There is obviously the caveat of "sources tell us". First, sources have said that because the Americans are buying so many more fifth-generation aircraft it is easier for them to operate on their own.

Whereas, because we are buying relatively few aircraft, it is much more important for us to have those aircraft integrate with our legacy aircraft. It is, therefore, even more surprising perhaps, that the relevant technology has not been invested in. In America's case, we understand that they have something called MADL and something called BACN.

***Deborah Haynes:*** Battlefield airborne communications node.

***Alexi Mostrous:*** There we go. Effectively, these technologies allow a secure transmission of data between fifth-generation aircraft, including the F-22 and the F-35, and legacy aircraft and also ships.

Q9 **Chair:** And we have not been prepared to spend the money to have these systems on ours?

***Deborah Haynes:*** No, actually, people are aware of this; people know this technology. We did trials at the end of last year to prove the capability between the F-35 and Typhoon. As far as I am aware, as things stand today the funding is not there to bring that capability forward.

It is important, not just for talking between F-35 and Typhoon, but also with the carrier group. That is where the MADL—multifunction advanced data link—comes in. Again, it is American IP and so we have to overcome export control issues, potentially. I am told that is hopefully going to be okay but again that is something that we need to iron out.

You would want to have MADL on the carrier in some form, the suggestion is maybe on the crow's nest, because you want to try to get as much of a distance between the F-35 and the carrier to be able to communicate. If you do not have that, it was said to me by one very well placed source who knows what he is talking about—I definitely also have to protect him—that as things stand, without the ability of the F-35 to talk to the carrier group in stealth mode, when it is in a contested space, it will either have to reveal its position, maybe to give important time-sensitive information back to the carrier group or, if it is not able to do that in stealth mode and it stays in stealth mode, it will be hard to distinguish between a fast-approaching enemy missile and an F-35.

We were criticised on Twitter for saying that in our report. Maybe it is not quite as simplistic as that but there is an element that it is a really important thing, and that people understand that the money is not there for it.

Q10 **Chair:** To carry this to its logical conclusion, the suggestion is that the Type 45 destroyer escorting the carrier could inadvertently end up shooting down one of our own aircraft.

***Deborah Haynes:*** That is what the source was saying, yes.

Q11 **Chair:** There is another system called the autonomic logistics information system, or ALIS, and that is one that you think is vulnerable to cyber-attack and you have described it as "the soft underbelly of carrier strike capability". Can you tell me, very summarily, what evidence there is for that concern?

***Alexi Mostrous:*** I think experts agree that there has been no plane before the F-35 that relies more significantly on its software than the F-35 does. ALIS is used, we understand, across the board to determine when the plane is needed to be maintained, to put in mission data, to do all sorts of different things that are very important to the plane's functioning. If ALIS goes down, our sources say it is very difficult to operate the plane or to operate it at fully capacity.

You start by saying that ALIS is very important and then you note in this report, certain threats have been identified in terms of how vulnerable ALIS is to hacking, both—it says here—from an outsider and an insider perspective, in other words, from a rogue person working within the company and an outside threat.

Then you have Christopher Bogdan, who was head of the joint programme, saying, "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", and accepting that software will always be a risk on the programme now, 10 years and 15 years from

now. All we were trying to say there is that this plane relies very much on software. Certain vulnerabilities have been identified in that software, but again, what has Britain said on this? We do not know if Britain is involved in the operational testing of the cyber-security. We do not know if Britain has any concerns about it. So a lot of what we were saying simply fed back into this transparency issue, where we as the British taxpayers do not know what is happening with this plane.

Q12 **Ruth Smeeth:** One area that you touched on was weak broadband for both the Queen Elizabeth and the F-35—I think this is an issue across our fleet, not just on the carrier. Will you give us an overview of what you believe the practical implications are?

***Deborah Haynes:*** We were told by sources we spoke to that the capacity on the carrier was a maximum of 8 megabits. You have to be a bit more understanding because the carrier was conceived 20 years ago and that would have seemed like a massive amount of data then, but obviously, in today's world, it is woefully insufficient. Again, people are aware of it, but the problem is that we do not yet understand how, for example, the ALIS system is going to function on the carrier in terms of the amount of data that it will need. But if you want 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 back to the carrier. I spoke to various people who are experts in the SATCOM link, which provides the bandwidth, and the capacity is there to increase it to about 64 megabits—maybe even more—but that requires funding. It is not a big amount of money, but it needs people to have a proper networking control and proper resources for it. If you do not get that, you will not maximise the potential of what could be incredible kit.

Q13 **Ruth Smeeth:** The new satellite link is also up for re-tender, so have you been looking into how the future contract might apply to the carrier?

***Deborah Haynes:*** Not specifically in terms of the carrier—

Q14 **Ruth Smeeth:** Because that has been delayed, and I think that is one of the knock-on consequences of this.

***Deborah Haynes:*** It is obviously going to be part of the discussion because people are alive to the fact that 8 megabits looks a bit small.

**Ruth Smeeth:** My phone works better than that.

***Alexi Mostrous:*** There was a good line in Justin Bronk's report, which you can ask him about after this. He highlighted an example of a US Navy ship that has 32 megabits, and the commander of that ship said that he was worried that the volume of data generated by the F-35 and ALIS risks "driving the ship to its knees". That was 32 megabits—as a point of comparison.

***Deborah Haynes:*** I thought it was interesting that yesterday, when I was at a conference, people were really alive to this problem of networking. It is the thing that we need to sort out to be able to capture the capability of F-35. Air Marshal Greg Bagwell, who recently retired from the Air Force, is

very much an authority on this. He was asked—I asked him afterwards whether I could use this, because it was Chatham House rules at the time, and he said I could—whether air, land, maritime in the UK are thinking about the potential of fifth generation in the joint space. He said that everyone is thinking about it and has a vision of the utopia, but to get the utopia, you have to resource it. He said, "I do think that if we are not careful, as we continue to wrestle force structure against force capability, capability always tends to lose in these cutbacks." He was really giving that warning of the ongoing struggle right now—because we know that these capability reviews are going on—about the need to make sure that this whole networking thing is resourced. That is kind of what we were trying to bring up.

Q15 **Ruth Smeeth:** I think we all know the answer to this question, but for the record, what do you think of the MOD's suggestion that the planned bandwidth of the QE class "will be sufficient to carry out the scope of carrier strike operations, over the life of the programme"?

***Deborah Haynes:*** It's a clever non-answer, really, because it's their right to specify what the operating capacity needs to be. Unfortunately, that may mean it won't be at its full potential early on—we will have to wait a while to get there. That is what I read from that.

**Ruth Smeeth:** From that MOD-speak.

Q16 **Leo Docherty:** Can you tell us in grander terms how you arrived at £130 million and £155 million as the cost of an average F-35 delivered this year, once retrofits and upgrades are taken into account?

***Alexi Mostrous:*** Sure. You have the costs published by Lockheed and the US Government—what are known as the "fly-away costs". They differ depending which tranche of F-35s you are talking about. We analysed lot 9—the aircrafts 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.

As I hope we made clear in the story, all of this is a real estimate, because the US Government does not release full details of all these contracts. We don't know whether other contracts also apply to lot 9 aircraft, or are somehow mixed up with them in another way. What we were trying to do

was say that 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, for instance. Given that we also know that these aircraft require a lot of software upgrades, we were trying to determine the rough overall cost of these extras. That is how we came up with that figure.

I would distinguish the figure we came up with from an even larger figure: the total cost of maintaining the aircraft over 10 years. We were not including the estimated cost of fuelling or maintaining the plane, for instance—just the contracts given between 2014 and 2017 in respect of lot 9 aircraft, plus a little bit extra for the overall retrofits.

Q17 **Leo Docherty:** Turning to the delivery for the MOD, what is your response to the MOD's contention that it represents delivery on budget?

***Alexi Mostrous:*** It has always been very unclear, from the MOD's perspective, what they actually mean by "on budget". There are specific lines in the NAO's report that disclose that the MOD has committed a certain amount to acquiring a certain number of aircraft, but at no point have they said, "We are spending *x* on this aircraft and *y* on retrofitting it."

Q18 **Leo Docherty:** So it is not your understanding that there is a cost overrun of some nature?

***Alexi Mostrous:*** It is almost as if, for there to be a cost overrun, there would have to have been a publicised cost in the first place from the MOD, and an ability to measure how much it has overrun by. I think all we were saying was that there appears to be a significant cost implication of the US, Britain and the other partner countries acquiring extras on this aircraft that are not included in the fly-away price.

Q19 **Leo Docherty:** It is not necessarily the case that the MOD is not anticipating that?

***Alexi Mostrous:*** It may have anticipated it internally but, for the public, the only information on the F-35 costs comes from the publicised headline fly-away costs that Lockheed Martin and the US Government put out. The British Government implicitly adopt those costs by not telling the public anything else. Before this investigation, the only way to tell what the "cost" of the F-35 was was to look at a US Government press release, which contained the fly-away cost. We were trying to say that maybe there is an additional cost that no one is talking about.

***Deborah Haynes:*** And also, the NAO, in its report that looked into carrier strike, raised questions about the Department's ability to have high confidence in the costs of its support arrangements, which the report says are less mature. That feeds into the sense that people do not have a clear idea of the cost.

Q20 **Leo Docherty:** That refers to the American DOD?

***Deborah Haynes:*** No, that refers to the UK MOD's cost assurance and analysis service. I also thought it was very telling when I spoke to Sir Nick Harvey, who was the Armed Forces Minister from 2010 to 2012, about the programme. Obviously, he was in government when it was being discussed at a key time around the strategic defence and security review in 2010. About the lack of transparency over Britain's planned purchase of F-35, he said, "We had absolutely no idea what the unit cost would be of the F-35. We would all smile sweetly and sustain this idea that 138 would be the size of the order, but the honest truth is that nobody had the slightest idea how many we would end up with or how many we would be able to afford."

I think it is very interesting that now, as part of the capability review that is taking place inside the MOD and the ABC 17 and ABC 18 funding rounds, one of the considerations is a potential slowdown in the F-35 purchase over the next 10 years. We are supposed to have 48 by 2025 but you can see, at a time of very severe budget constraints, that it is a rather easy win to just push a few to the side and free up a few hundreds of millions. But where is the coherence in that? Where does that leave the credibility of our assets—of this weapon that we have invested so much in? How does that marry with the claim from the Minister that everything is costed?

Q21 **Mr Francois:** Alexi, you have obviously done a forensic analysis on lot 9. As a rule of thumb with a programme like this, if you move from low-rate initial production to high-rate production, the cost generally falls. So having done a very detailed analysis of lot 9, do you think that later aircraft will be more expensive, less expensive, or about the same?

***Alexi Mostrous:*** It makes sense that as production ramps up, costs will come down. In a way, we were working with what we had; we could not analyse anything but lot 9 because those were the only contracts we had available. It may be that costs come down in future, but I come back to the transparency issue: we just do not know. We do not have any visibility on it.

We do know from, I think, the Norwegians, that they had budgeted quite a significant amount of money in the 2020s to upgrade aircraft that they had received. That is a little bit of visibility about the amount that it would cost to bring up already-delivered aircraft to the standard that you would want. To answer your question very generally, yes I would expect costs to come down as production goes up.

Q22 **Ruth Smeeth:** I just want to bring Deborah back to something she said right at the beginning about currency and the fact that the MOD has been very vague about whether it has hedged any of these contracts—the P-8 as well as the F-35. When you talked about £80 million, were you talking specifically about the F-35 programme? That would also be the P-8 programme too.

***Deborah Haynes:*** Yes. It was the major projects report that came out a couple of months ago—

**Ruth Smeeth:** There was the election.

***Deborah Haynes:*** I think it was after the election. It was the day that the Queen Elizabeth came into Portsmouth—no, it wasn't then; that was the day I wrote the story. I remember it, because I was a bit frantic. They had a nice Excel spreadsheet, and they went through all the big projects in defence, including the joint strike fighter. Tucked away in there was this little nugget about the forex. It was very clearly stated. That was the first time I had seen that stated. Obviously, everybody was aware that the fall in the pound against the dollar and the euro would have an effect, but as yet we have not actually seen the reality of it, other than what experts have prophesied. It was interesting to see that that was the effect.

Q23 **Martin Docherty-Hughes:** Would you like to put an accurate cost on the retrofits and upgrades, maybe even including the 10-year fuelling period as well? It seems that much of the evidence we have had to date—most of it from the United States, not the Ministry of Defence, and especially from the director of testing and evaluation—says that many issues remain. For example, to quote from their own 2015 annual report: "Each new version of software, while adding some new capability, failed to resolve all the deficiencies identified in earlier releases." Do you think that the Ministry of the Defence has factored that in, in terms of the cost and effectiveness of the retrofit?

***Alexi Mostrous:*** It is impossible to know. This is part of the problem.

***Deborah Haynes:*** It is interesting. The one number that is in the public domain is from the National Audit Office, which says that the UK Lightning II programme to March 2021 is forecast to be £5.8 billion. I asked the MOD what that meant, because by that time we will have bought 21 planes. Obviously, you do not just divide £5.8 billion by 21, but I asked what part of that is the aircraft, given that the aircraft are supposed to cost £100 million each. I got a non-answer, which I am happy to share with you; I won't boringly read it out. It is weird. I would love to see a breakdown of what that £5.8 billion actually buys. I think that would not be too unreasonable to ask for.

Q24 **Martin Docherty-Hughes:** It might be that we have to ask the Department of Defence in the United States, because they clearly share more information than the Ministry of Defence here. Even though they might internally anticipate cost, they are certainly not sharing that with this Committee or with Members of the House. Do you think there is any better comparison between how the Ministry of Defence shares its information, in terms of the F-35B, and how the Department of Defence shares it with members of the joint House in the United States?

***Alexi Mostrous:*** There is quite a lot of information that comes from the US about how much different departments within the US Government are asking for in terms of budget to buy the planes. We know, for instance, that the Pentagon comptroller report in 2018 suggested that the total cost of acquiring each F-35—or the amount of money they wanted to acquire each F-35—was $154 million, falling from last year's figures of $166

million. In June 2017, the Marine Corps specifically asked Congress for $617 million for four F-35Bs, which translates to about $154 million each. Again, these were above the Joint Programme Office fly-away figures. If you scrape together different parts of the US reporting structure, you get some interesting points of comparison, but nothing equivalent exists in this country.

Q25 **Phil Wilson:** You mentioned the *Times* report that the F-35B is too heavy to take off or land safely. I would have thought it was a prerequisite for a fighter jet to at least get off the ground. All the other issues that we have raised seem to fall into insignificance if it can't even do that.

***Alexi Mostrous:*** Well, it is fair to say that the fear that the F-35B is too heavy to land vertically only applies to very early models. In our report, we said that the concerns apply to planes produced in lots 2 to 4 inclusive, and that Britain was understood to have bought four aircraft within those lots.

Q26 **Mr Francois:** Sorry, you said too heavy to land vertically?

***Alexi Mostrous:*** Yes, that's right, with some unexpended weaponry. This comes from this report. There is a section on weight. It said: "The weight management of the F-35 will be as critical to meeting its key performance parameters. The KPP"—as it is known—"requires the F-35 to be able to safely conduct a vertical landing with some unexpended weapons", as you would expect.

Then it said: "Fourteen aircraft produced within lots 2 and 4 required modifications which were expected to add an additional 350 lbs to their weight, pushing their weight above the objective not to exceed weight".

It also said that: "Further improvements to get it up to what is known as lot 4 capability were expected to add an additional 250 lbs, pushing the aircraft over its structural limit".

So these weight concerns applied to lots 2 to 4 aircraft, of which we understand Britain to have bought four. The MOD may say that these planes are used for training and will not be used to land on ships or that they have somehow strengthened their carriers to enable such landings to take place. In this respect, we were reflecting what was in here.

Q27 **Phil Wilson:** But the latest tier of F-35 planes can take off safely and land safely, can it? Have you thought about what we have to focus on going forward?

***Alexi Mostrous:*** Yes, I think we were saying that the four aircraft that Britain had bought were potentially too heavy to land.

***Deborah Haynes:*** We never contended otherwise.

Q28 **Mr Francois:** Sorry, but this is important. Too heavy to land vertically?

***Alexi Mostrous:*** Yes, too heavy to land vertically.

Q29 **Mr Francois:** Yes, but not too heavy to land and take off conventionally?

***Alexi Mostrous:*** Yes, that is true—exactly.

Q30 **Mr Francois:** That is a very important distinction.

***Alexi Mostrous:*** Yes, except that on the carriers they are required to land vertically, as I understand it.

Q31 **Mr Francois:** No, not necessarily.

***Deborah Haynes:*** It's shipborne vertical landing, isn't it?

Q32 **Mr Francois:** I think whereas the old Harriers on the Invincible class would sometimes land vertically, because of the length of the carrier deck on the QE you don't have to land vertically; you can land conventionally.

***Deborah Haynes:*** That's true, but our reporting was based on the Office of Test and Evaluation report, which specifically talks in very careful and clear detail about weight issues to do with vertical landing.

Q33 **Mr Francois:** But it is important to make the distinction, if you weren't normally vertically landing.

***Deborah Haynes:*** May I just finish my point? In the Minister's response, when she dismissed that claim as "nonsense"—bearing in mind we are talking about the ability of early aircraft to land—she said: "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". She then said: "Shipborne rolling vertical landing will be tested". That implies that it has not actually been tested and categorically verified that it will work. We are basing our analysis on what has been made publicly available by the US. Unfortunately, as yet, that kind of analysis has not been made available by the UK and it surely should be, given the amount of money we are spending on it.

Q34 **Mr Francois:** All I am saying is that I think there is an important distinction and for the sake of accuracy it is important to be clear that the allegation you were making about being too heavy to land related to a vertical landing and not a conventional landing.

***Alexi Mostrous:*** Yes.

Q35 **Martin Docherty-Hughes:** Given that you have both already highlighted what seemed a lack of transparency on the part of the MOD, we may go on to the initial testing of the UK's unique carrier capability. I believe this only began in June at the naval air station—forgive my pronunciation—Patuxent River in the United States.

Should we have any particular concerns around, for example, the shipborne rolling vertical landing of the F-35 carriers—the premise is that if we are paying for it, we want it to work—given that there won't have been tests on them until at least 2018?

***Deborah Haynes:*** I haven't looked into that. It wasn't really part of our investigation. There is not very much publicly available—we were saying this yesterday—about the UK side of the testing. All the test and

evaluation information comes from the US side. It is something that I would be really interested to hear some information on.

**Martin Docherty-Hughes:** I think everyone would, Chair.

Q36 **Leo Docherty:** I would say that clearly the MOD's analysis will come as a consequence of the sea trials that will take place over the next two years, so perhaps you have more data on America because they have had it for longer. I think the next two years will be critical for the emerging MOD analysis of the F-35.

Q37 **Gavin Robinson:** Weight issues, it seems, are not confined to the aircraft itself, but potentially the Generation III helmet as well. Could you outline the issues that have arisen? I think you referred earlier to the gun-strafing symbols that have been problematic with Generation III.

***Alexi Mostrous:*** The helmet has undergone quite a genesis, because in its first iteration, according to earlier DOT&E reports, it was heavy enough to jeopardise the safety of lighter pilots who eject. Then it was made lighter, but the lighter iteration, according to this report, did not have the ability to switch visors automatically, so that a pilot would have to take off his day visor and replace it with a night visor. Then, in a kind of comedy of errors, there wasn't enough space to put the visor in the cockpit, and the report noted that that meant that the cockpit, in a certain sense, had to be redesigned. In a way, these are minor issues when offset against the problems highlighted in the report, in terms of the green glow emissions coming into the helmet, and the problems with gun-strafing symbology, which I already touched on.

Quite close to our publication, a video was released of a US training exercise, where a pilot wearing a Generation III helmet attempted to land on a carrier in darkness. Through a malfunction in the helmet he couldn't see anything. You could see what he saw and he couldn't see anything. It was scary for him, because at the end when he landed safely he said to his commander, "You're going to have to give me a compelling reason to make me do that again." These issues could be ironed out. Indeed, I think that Harriett Baldwin admits that there are issues with the helmet and that she is holding the supplier to account in respect of those issues. But again—not to sound like a broken record—all of this information is coming from the US, even though British pilots will be wearing this exact helmet.

Q38 **Gavin Robinson:** Following the publication of your story in 2016, have you detected a change in approach from those inside the MOD as to how they deal with these issues, or are you still getting the same refusal to engage and relying solely on US sources? Once you have published and put this into the public domain, have you noticed a marked change in the way the MOD have engaged in these issues?

***Alexi Mostrous:*** We published a couple of months ago now. What would you say—any change?

***Deborah Haynes:*** No.

Q39 **Gavin Robinson:** Your claims have been described as out of date and

lacking technical understanding of complex issues, and it has been said that certain commentary has been both ill-informed and inaccurate. That is the Minister's portrayal of your story. You have been careful enough this morning to protect your sources, and I don't ask you to do anything but that, but of your sources, would you describe them as informed and able to assess accurately the issues that you are raising? Are they people the Minister herself may rely on to get briefings on these issues?

***Deborah Haynes:*** For a start, a lot of the evidence came from the test and evaluation document, which is a US Government document, so you don't get more solid than that. While it was published in December of last year, there was a GAO report—kind of the American equivalent of the NAO—that came out only a couple of months ago, which again touched on issues to do with development. In terms of the actual human intelligence—people who are close to the programme, who understand the concerns—it was very much more on the technical side. The UK-specific stuff that I've talked about was very much reliant on those people and they're definitely well informed and know what they are talking about.

Q40 **Chair:** Would either of you like to make a final comment?

***Alexi Mostrous:*** In respect of the rolling landing versus vertical landing, could I do a little bit more research into it and maybe write to you? I think we had evidence that suggested that the planes would be used vertically, but I cannot remember now, so I would like to write to you.

Q41 **Chair:** I think, inherently, investing a great deal of money in a plane that can land vertically and then not landing it vertically would seem to be an unwise policy to follow, but it is certainly worth exploring that. Feel free to write to us later. Deborah, have you a final comment?

***Deborah Haynes:*** As soon as I walk out the door I will have an amazing epiphany of what I should have said. Thank you ever so much for listening and for being interested. It is so important that you guys are looking at it, especially in the context of the wider equipment programme: we know that it is overheated; what are Government going to do about it? It is so important; the public do not seem to appreciate just how important a credible defence is, so I am so pleased that you are looking at it.

**Chair:** I do not think anyone will dissent from that. Thank you both very much.

## Examination of witness

Witness: Justin Bronk gave evidence.

Q42 **Chair:** Justin, welcome to this session. We have had quite a full account from the two reporters from *The Times* who first publicised this story. We know you are an expert in this field, but will you identify yourself and your expertise for the record?

***Justin Bronk:*** Sure. My name is Justin Bronk. I run the air power programme as a research fellow at RUSI. As a caveat to everything I say today, I do not hold a security clearance; I operate in the open source and

most of my research is conducted through interviews with aircrew, capability managers, visits to bases, as well as desk research and reading POGO and NAO sources—that sort of thing. So on anything to do with electronic warfare, for example, or radar performance, I may have to say that I simply do not have access to that information.

**Chair:** Thank you. To give you a rough idea, we intend to end after about 45 minutes. I must say, by way of apology, that after about half an hour I have to leave, but John Spellar will take over as Chair at that point. Mark Francois will start off our questions now.

Q43 **Mr Francois:** Mr Bronk, what are the main challenges and opportunities that arise from the F-35? How concerned should we be by the allegations made by *The Times* in its investigation into the aircraft system?

***Justin Bronk:*** May I clarify whether you mean specifically for the UK or NATO-wide?

Q44 **Mr Francois:** I think we will look NATO-wide, but the UK is obviously our primary interest.

***Justin Bronk:*** Okay. NATO-wide, I would say the main opportunity is to reinstate or at least maintain the ability of the US, primarily, but NATO as a whole if needed, to go into heavily defended airspace and conduct offensive or defensive operations. Of course, defended airspace in the future might well include allied territory which is either under attack or under area denial, in aerial terms, by long-range systems mounted outside their territory. At the moment the only systems capable of doing that reside, operationally at least, in the US. For NATO as a whole the F-35 represents a great opportunity. For the UK, in many ways there is a similar picture. Looking simply at the F-35, there is the ability to go into heavily defended airspace, which we currently do not have—at least not without extreme risk to pilots and machines.

On the other hand, the main risks are an opportunity cost that is too high if the UK does not get the most out of a relatively small number of planes, at least initially, as was described, because so much of their combat power is potentially tied in with giving Typhoon, as well as other assets such as the Type 45, greater combat relevance and survivability in future. That challenge for the UK is very much around whether we can integrate in network terms—in technical terms—as well as adjust our tactics and command structures in order to best make use of those capabilities. Challenges for the US are very much more around software and glitches as well as retrofit requirements for the aircraft, which often conflict with the weight restrictions, particularly on the B variant. That has already been touched on.

Q45 **Mr Francois:** What do you make of the *Times* allegations?

***Justin Bronk:*** I think that, like most stories, it was designed to create an impact and it clearly did so. In certain cases, I think that some of the issues may well have been or be in the process of being fixed, but a lot of the stuff in the GAO and previous POGO reports, for example, indicate that

there are quite a lot of developmental problems with the aircraft that are quite serious, particularly around vibration and around engine reliability and icing issues. The helmet is clearly a problem as well. It is essentially a software-driven aircraft, so there are a lot of bugs to be ironed out. A given version of software may have solved particular bugs highlighted by previous reports, but then may have either created new ones or left certain other ones extant. It is difficult to know more than the GAO analysts do there. At the same time, structurally the aircraft has always been a major compromise for the B variant across all of them, so issues around vibration and flight regimes are likely to be quite long-term.

Q46 **Mr Francois:** You have said that—in your words—the UK 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". What equipment processes do you think we need that we are not currently allocated to procure?

***Justin Bronk:*** First, as Deborah touched on, the ability for the F-35 to offboard data to other assets without broadcasting on Link 16 or other data legacy links that could give away its position is clearly a major issue for the UK if we plan to operate inside defended airspace, which is the only argument that I can see for purchasing the F-35 itself. We would therefore need some form of gateway translation node, be that the US BACN or the latest version of Freedom 550 which, I believe, is what was used for the trials recently between Typhoon and F-35 in the US. Those gateways were developed for operations in Afghanistan, particularly relaying between special forces teams and other assets in mountainous terrain. They tend to be mounted on a variety of platforms from business jets to Global Hawks—the usual—but could potentially be mounted in most large aircraft. The problem with it—again, as Deborah said—comes down to USIP. So MADL, which was originally intended to be fitted to the B-2 for example, and at one point the F-22, was restricted to the F-35 for data protection reasons, among others, by the US. The F-35 comes with a lot of tamper protection technology so that overseas users that are not allowed to—which may or may not include us, depending on the capability—cannot get into the code and read into how it works, or at least cannot do so easily. The requirement to put MADL on, let's say, the carrier would be potentially problematic depending on the US stance on technology transfer, and it would also require the operation to be partitioned on the carrier for people with direct and specific clearance on MADL, because of what it would potentially show. It does not just show what the F-35 is seeing; it also gives you an idea of what it can see, which is highly classified. You could, for example, have a scenario whereby if Apache operators from the British army were operating on the carrier at the same time as the F-35, you would have to have a separate flight operations room or section for the Apache operators who do not have the same clearance as that required by the fast jet operators for MADL. This is the case if you go down that route. In other words, having a translation relay capability in place is quite important, aside from the fact that Typhoon is at present unable to accommodate MADL.

Q47 **Mr Francois:** Is it true to say that, in simple terms, if you don't invest in an advanced data link—be it MADL or something equivalent—then you are effectively undermining the stealth capability of the aircraft that you have paid rather a lot of money for in the first place?

***Justin Bronk:*** Yes, with the caveat that that is so unless you want it to operate on its own. The F-35s can talk to each other without exposing themselves. That is why MADL has been developed. The F-22 uses something similar, I think called Chameleon; but the issue is that, if you want it to talk to Typhoon or anything else within defended airspace without a relay, yes you would be comprising survivability, potentially.

Q48 **Phil Wilson:** How serious do you believe the bottleneck is that is created by the carrier's bandwidth capacity, and what are its implications for the F35 and the UK's carrier strike capability?

***Justin Bronk:*** As has been outlined, given the comments made around the USS America's bandwidth and the US Marine Corps Amphib— around 32 megabits—and that the captain was very worried about the data volumes being generated by ALIS and F35 operations, and also given the centrality of ALIS to maintaining the F-35 on operations at full capability, which is not just to do with maintenance, although that's the main function; it also includes, for example, updates to theatre software packages for, among other things, automatic recognition of threat radars. For example, if an enemy or a potentially hostile surface-to-air missile radar, like an HQ-9, which is software-dependent, so it is frequency-agile at changes and it can be updated rapidly. If an F-35, say in the US fleet, has detected new emissions or a dedicated radar-detecting aircraft has detected a new type of emission, those are brought back in through and then integrated into the F-35 core software package. One of the benefits for the UK is that ALIS could then enable all F-35 operators in the region to receive the code, so that the aircraft can recognise and react accordingly to that new signal. If bandwidth is a serious issue, therefore, it is not just that we might struggle to get the connectivity to maintain spares and maintenance at optimal efficiency, but we also might struggle to get important combat-related software updates. Of course, F-35 will not be the only consumer of data bandwidth on what is, in effect, the flagship of the task group. In effect, given that the USS America is being urgently updated with additional bandwidth from 32, 8 megabits for our flagship does seem a bit restrictive.

Q49 **Phil Wilson:** What do you think of the MOD's claim that the Queen Elizabeth carrier's broadband capacity—this is what they said—would be sufficient to carry out the scope of carrier strike operations over the lifetime of the programme? Would you agree?

***Justin Bronk:*** 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, especially if you are talking about using F-35 as the eyes and ears of the fleet in defensive terms, given that, because we have gone for a ski jump, rather than a cats and

traps approach, we cannot mount a dedicated AWACS aircraft compared to the E-2D or C that the US Navy operates.

Q50 **Phil Wilson:** What do you think would be the sufficient level of broadband? The Americans said 32 megabits.

***Justin Bronk:*** They are urgently updating from 32 towards, I think, a target of 100—that was the last I heard. Again, it is worth pointing out at this stage that traditionally in a high-threat environment a carrier task group will be operating on strict emissions control protocols, so emissions will be kept to a minimum where they can be. It does depend slightly on the scenario. Certainly, given that the US MC clearly views 32 megabits as inadequate—and they tend to operate a smaller air group than the Queen Elizabeths at least are designed to operate—and we will be relying on the F-35 for more of the total carrier strike group capabilities than the US MC, which can count on a lot more enablers, particularly from the US Navy, it would be strange if we would not at least benefit greatly from significantly over 32 megabits.

Q51 **Phil Wilson:** So 100 megabits, which is what the Americans were talking about—would that be sufficient?

***Justin Bronk:*** The American gold standard at the moment seems to be 100 megabits.

Q52 **Martin Docherty-Hughes:** Do you agree that ALIS is the soft underbelly of the carrier strike capability?

***Justin Bronk:*** I agree that in theory it could be, but given the extremely strategic nature of ALIS software security and its extreme complexity, and given the fact that this programme—with more money than God pumped into it—is still struggling after 20 years to sort ALIS out and make it work as it is supposed to, it is impossible for us to know how vulnerable ALIS is.

What I would say is that the US military is more switched on to the threat of cyber-intrusion into its military systems and platforms than the British military. It is certainly prioritising testing and allocation of funds towards ensuring that the defences around the ALIS system are as secure as they can be.

Q53 **Martin Docherty-Hughes:** Briefly, the way in which the testing has been undertaken for the system means that many bugs are not dealt with before the next block of testing. Do you share the concern of the director of testing and evaluation that it will have a negative cumulative effect on the programme? As a tier 1 partner, whatever tier 1 actually means, we in the United Kingdom should know more about the negative cumulative effect on the programme.

***Justin Bronk:*** I think that the RAF and specifically the F-35 project teams within the RAF probably do know quite a lot about the cumulative effect on the programme, but I would also guess that it is not just a matter of MOD policy that we are very tight lipped about this nationally. I imagine it is a stipulated requirement of programme membership for non-US members. From what I gather, the RAF feels that it has very good visibility on the

progress of ALIS upgrades and testing within the US Air Force and the US marine corps, but that it is not at liberty to talk about them. So, I don't know is the straight answer.

Q54 **Graham Jones:** You mentioned that there was a weight issue with the F-35B. How significant is that weight issue, particularly reflecting on the two carriers?

***Justin Bronk:*** It is very significant in terms of upgrade or retrofit growth potential, as well as bring-back of weapons. The general operating concept as I currently understand it is that vertical landing will be the normal mode of recovery for the carriers, unless there is significant weapons payload and bring-back required, in which case the shipborne rolling recovery technique is being developed to try to allow for that greater bring-back weight. It is not a new issue, in the sense that the Harrier fleet, like all Harrier operators, commonly had to jettison unused weaponry before recovering on-board, simply because the weight and fuel implications of a vertical landing are such that any V/STOL aircraft will always be very close to its operating limits within that phase of flight.

With regards specifically to the shipborne rolling recovery technique, as I believe it is called, I do not think the question is whether the aircraft is capable of it; the question is when the software will be developed to conduct a landing. One of the major advantages of the F-35B over the Harrier is that vertical landing has traditionally been the most dangerous and accident-prone part of fast jet operations in UK history, and certainly for all other Harrier operators. I think Harrier fleet attrition is 30% or higher in peacetime operations over the lifetime of the fleet, because of the landing difficulties in particular. By contrast, the F-35 will maintain speed and course with the ship automatically. Instead of having to switch around and, as one Harrier pilot put it to me, balance on the top of two stilts in a storm at night, he can literally use the same joystick as he flies with to move the aircraft around. In other words, it does it all automatically. Obviously developing new software for a UK-specific recovery, as with anything dealing with F-35 software, is going to take time, and that is why there is still a question over that rolling recovery, but we do need it for the bring-back.

The one other thing that I would add about the weight implications is that a lot of flight testing problems are around vibration, particularly in certain regimes of flight. Normally when aircraft are being tested and vibration is identified, they go through the aircraft and work out which part of it is vibrating at that harmonic frequency and tamp it off basically by putting cross-braces on. That of course adds weight. For the F-35 B, which is already very close to its weight target, for a lot of the vibration issues the traditional solution is likely to be too weight-intensive.

Q55 **Chair:** What about the helmet? Is the Generation III helmet fit for purpose? What are the alternatives to Generation III? Could they be adopted without adding further delays to F-35 production?

***Justin Bronk:*** The Gen III helmet in its current software configuration is clearly not fit for combat use, as it is still causing potentially dangerous problems in testing, as we have heard. Also, in the mentioned 9 carrier landing, basically, overlaid imagery is glitching all around the pilot's visor and seriously impairing the safety of the aircraft.

I think at one point there was a proposal to incorporate Typhoon's new Striker II helmet as an alternative to the Gen III F-35 helmet. I think that is now too far in the past to adopt, certainly without significant cost overruns and delays. From a US point of view, particularly with the America first—if you'll pardon the fascist expression—focus of the current Administration, I think it is very unlikely that, politically, any UK alternative would or could be adopted, Striker II being the obvious example. I think 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.

Q56 **Chair:** One other question is how much extra will it cost? Is it not true to say that in a highly complex piece of equipment such as this—especially one involving software—sooner or later, pretty much all the problems will be sorted out? Am I being over-optimistic about that? Assuming that I am correct and that they are sorted out, are we talking about a serious increase in cost for us as a result of the helmet having exhibited so many deficiencies at the outset?

***Justin Bronk:*** At the moment, I believe that a current generation Striker helmet for Typhoon costs in the region of £400,000. As a benchmark figure, I would imagine that the Gen III is already substantially more expensive than that. Clearly, they are very expensive pieces of kit. The heart of the answer to your question will be determined by whether Lockheed Martin can be convinced to take the hit, as it were, for the extra development work required to iron out the bugs in the helmet, and how much of that extra cost—undoubtedly there will be extra costs involved in fixing the deficiencies in the helmet—is passed on to the eventual purchase price of each helmet.

Q57 **Chair:** Will that depend to some extent on the nature of the contract originally signed? Presumably when we see Harriett Baldwin on 17 October, we should explore that particular question of whether they were covered for possible extra costs of this sort.

***Justin Bronk:*** Yes, although because the F-35 has been sold to so many international partners, I would guess that the spares and additional equipment costs are probably relatively standardised. But you would have to go through the—

**Chair:** I am just talking about the helmet.

***Justin Bronk:*** Yes, I would imagine that the helmet would come under spares and additional equipment required. I would imagine that those are fairly standardised across partner nations, but I do not know that.

Q58 **Chair:** You would anticipate that, because so many of these helmets will

be bought by so many countries, the additional cost to each should not be excessive?

***Justin Bronk:*** Not necessarily, although I would suggest that because they are likely to be standardised across many partner nations, the UK will not have much of a say on what price an F-35 helmet might be sold for, because we all need them to operate the aircraft and we are buying the aircraft.

Q59 **Chair:** Unless the contract was drawn up in such a way as to safeguard us from this eventuality?

***Justin Bronk:*** At least for the aircraft we have currently negotiated to buy by 2025—although as I understand, payment has not gone through on that—there may already be a fixed allocation cost for the helmets. Certainly, helmets get broken through life, accidents and things, so I imagine that they will become another part of the acquisition of spares. I would also suggest—flippant though it sounds—that the helmet cost, even if it is somewhere in the region of half a million dollars, is not an overriding cost in terms of fast jet spares and consumables. You spend more than that when you fire off a single Storm Shadow missile or have to drop one into the sea because you cannot bring it back. So yes, there probably will be extra costs, but—

**Chair:** Thank you very much. I am now going to hand over to John Spellar to take the questioning forward and to chair the remainder of the meeting.

*[In the absence of the Chair, John Spellar was called to the Chair.]*

Q60 **John Spellar in the Chair:** There have been suggestions that the Government should increase the purchase of F-35As as part of the fleet. What is your response to that?

***Justin Bronk:*** There is a very strong argument in capability and cost terms for the A variant over the B, except of course for the fact that they cannot operate off the carriers. If the F-35 for the UK is being viewed primarily as the weapon system for the Queen Elizabeth-class carriers, then of course a diversion of part or most of the remainder after the first 48 to A variants would be seen—by many, at least—as representing a denuding of UK carrier strike capability.

On the other hand—this slightly strays into the QEs rather than the F-35—given the ability of the Royal Navy on projected strength to protect the carrier within usable flying range of an opponent who requires a fifth-generation jet, as opposed to a legacy jet, in order to fight, I would suggest that, were high-end war-fighting to occur and were Britain to be part of it, it is most likely that the F-35 would, at least at first, be flying from land bases and dependent on land-based tankers rather than being brought up to the coastline on a carrier. So, from the RAF's standpoint, it would be much better to have a dedicated land-based A fleet that possessed lower cost, higher reliability, greater range and greater payload than the B. That would also give them greater commonality with the US Air Force, although it would impose refuelling issues—we would basically

have to put booms on our Voyager tankers or rely on the US Air Force entirely for refuelling.

Q61 **John Spellar in the Chair:** But would that not raise a question mark about the capability, and in fact even the utility, of the carriers?

***Justin Bronk:*** Yes.

Q62 **John Spellar in the Chair:** *The Times*'s estimate of the cost of an average F-35 produced this year, once retrofits and upgrades are included, is somewhere between £130 million and £155 million. Do you have any thoughts on that?

***Justin Bronk:*** That is 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. What is very difficult to know in these initial lots, even from looking at US budget submissions data, is how many of those costs 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. It is certainly true that accurately estimating the cost of acquisition of any fast jet in a meaningful sense is extremely difficult to do. Regardless of where you put the figure, people will disagree with you on either side.

That also goes for the two thirds of an aircraft's lifetime costs that are in running rather than acquisition. Look, for example, at the Typhoon as a point of comparison. I have seen figures in *Hansard* of between £8,000 and £12,000 an hour to fly a Typhoon; a Deloitte comparative study put it at about £18,000 an hour; and if you take the entire Typhoon force and its associated infrastructure support costs—everything—and divide it by the number of hours we fly them, you end up with somewhere around £100,000 an hour. It is really impossible to put a single figure on these things that everyone will agree on.

Q63 **Martin Docherty-Hughes:** How concerned should we be about the issues identified by the director of testing and evaluation at the Pentagon?

***Justin Bronk:*** We should take them very seriously as an indication of the current problems with the aircraft. In the longer term, however, the UK expects to declare meaningful combat capability with the F-35s in the early 2020s—in other words, when we might start using them on pointed operations in anything other than an existential threat case. We will be well into Block 4 software and, due to the driving US imperative to make sure that it works, most of the problems will have been ironed out. To put it in flippant but I think accurate terms, the US has absolutely no alternative but to make this plane work. They will throw whatever money it takes at it to make the software work.

In terms of flight regime limitations—around, for example, heating and vibration in bomb bays—the problem of flutter in certain high-g areas of flight is normally fixed by putting wing fences or dog legs on the wings, such as on the Super Hornet, but you cannot do that for a low-observable

aircraft. The F-35 may end up being limited in certain flight regimes compared with older legacy aircraft but at the same time, given its low observability and sensor suite, I do not think that we should be too concerned about that in terms of combat capabilities.

Q64 **Martin Docherty-Hughes:** Briefly, in terms of the various bodies in the Department of Defence, there seems to be quite an open and transparent way of sharing information, and most of the evidence that has come before us today has come from the other side of the pond—we have had to find out about issues with the programme from the Pentagon and not from Main Building. Finally, Justin, how co-operative would you say that the Ministry of Defence has been in comparison with the various bodies of the Department of Defence?

***Justin Bronk:*** Just to clarify, do you mean for me personally, or in general with public inquiries and questions around the F-35?

Q65 **Martin Docherty-Hughes:** From your personal, objective position.

***Justin Bronk:*** From my personal position, I have found the MOD to have been fair but tight-lipped. Generally speaking, they will answer questions, depending on whether information is intended for publication or not, with more or less frankness, but there is always a very strong awareness of the security issues around the programme and that, as the non-lead nation in the programme, they are very limited in what they can say contractually and legally.

Q66 **Martin Docherty-Hughes:** How does that compare with the Department of Defence in the United States?

***Justin Bronk:*** I find the US system to be very closed on F-35, but I think that is because I am a UK national and not a US one—unless you talk to pilots, in which case they are more open.

Q67 **Leo Docherty:** To clarify, Justin, you mentioned Super Hornets in passing. How likely is it that the US Government might switch some of its F-35 order over to Super Hornets?

***Justin Bronk:*** Certainly the F-35C is the most vulnerable, most delayed and most problematic of the variants. The US Navy's total intended order of 240—compared I think with around 750 for the marine corps and around 1,700 for the Air Force—is an indication that the US Navy has never been fully on board with the F-35 programme in the same way as the other two services.The Navy operates a fighter fleet of around 1,500, so the F-35 was always intended to be a tip of the sword luxury or gold-plated capability to enable them to enhance and to act as eyes and ears—basically, shooter cues—for the bulk of Super Hornets and, in the Navy's case, Aegis-equipped ships using SM-6 and, potentially, SM-3 for ballistic missiles. I can see the US Navy potentially doing some sort of grand bargain if the US Administration is determined to make a statement around F-35, or take a heavy bargaining position to force concessions from Lockheed Martin. The US Navy might be tempted by some sort of bargain for an increase in Growlers and upgraded Super Hornets, and then a commitment to develop the MQ-25, their upcoming stealth tanker and

ISTAR UCAV, into a sixth generation carrier strike and, potentially, air-dominance weapon going forward—i.e. basically take a gap on the fifth generation.

On the other hand, given how advanced the F-35C is now, and the fact that there are now training squadrons set up and that they are fully into ship trials, the Navy would be taking a big hit in kickability potential for the next 10 to 15 years if it did that. There is no way to make a Super Hornet anything like comparable to an F-35, so I do not think it is very likely, but in terms of potential losses to the F-35 programme, it is certainly the most vulnerable part.

Q68 **Leo Docherty:** Going back to the review that was mentioned, in your judgment how closely has the MOD worked with the DOD in sharing the American lessons from the F-35 programme?

***Justin Bronk:*** I think that the MOD, RAF and Royal Navy in particular work incredibly closely with the US on the programme. We have had embedded test pilots and engineers from the get-go. A lot of the technology in the F-35 is British developed or co-British developed, and I think it is actually one of the few remaining holy realms of US-UK special relationship military co-operation, alongside the nuclear deterrent and special intelligence, so I think actually the F-35 programme integration stateside is excellent.

Q69 **Leo Docherty:** What you are saying is that over the lifetime of this programme there is likely to be institutionalised co-operation because of the fact that we share the F-35?

***Justin Bronk:*** Yes. For example, we have had seedcorn Navy pilots, and some RAF, flying on US Navy carriers, flying F-18s I think for a decade now, specifically to keep a cadre of Navy pilots going for when the F-35 comes into service. That is in addition to the dedicated F-35 testing and the set-up of 617 Squadron in the US, so we are very integrated there.

Q70 **Leo Docherty:** Does any other country have anything like this in terms of capability?

***Justin Bronk:*** In terms of upcoming or do you mean seedcorn integration?

Q71 **Leo Docherty:** In terms of current fifth-generation fighters. Of our nearest competitors globally, which other countries have anything even nearly similar?

***Justin Bronk:*** There are two programmes of note. There is the Russian T-50, or Pak Fa, programme, recently potentially classified Su-57. I would suggest that this is a classic example of the rule that it is very easy to build something that looks like a fifth-generation fighter and it is extremely difficult to build one that works like a fifth-generation fighter.

The current buy for the Russian Air Force is between six and 12 for the programme, and India is furiously trying to get back the billions that it has sunk into co-development, given also that they are having to continually

work to say when they might integrate a new engine that is critical to the aircraft. By the way, engine integration is one of the most difficult bits of building any aircraft. At some point in the 2020s, they are putting metal patches on the wings of the test aircraft because they are cracking under strain. If you know anything about stealth coatings and low-observability standards, that really does not indicate a stealth aircraft. I would not worry too much about the Russian programme. It is basically for show and an illustration of how difficult it is.

The Chinese, on the other hand, with the J-20 are very much moving towards an operational capability now. They have moved into low-rate initial production and it has entered service—at least officially—with the PLAAF. I think it represents a long-range, relatively hard-to-detect interceptor and strike aircraft. It is not optimised for ultra-low radar cross-section in the same way that the F-22 and F-35 are. Canards on the front, for example, are a concession to RCS, for added manoeuvrability, but it does have a large internal weapons bay, it will be able to carry much bigger missiles and bombs, and more of them, than an F-35 or even an F-22, and it will have very impressive arrangements on internal fuel because of its size. Within the noise and background clutter of any clash with Chinese forces, with thousands of aircraft and missiles, and everything going everywhere, I think the J-20 will be very difficult to find and locate and capable of striking both ships and bases a long way out, as well as critical enablers such as tankers and AWACS.

I think the J-20 is to be concerned about, but given it is not up for export yet and does not seem to be, at least for now, it will remain a Chinese capability. Their J-31, which is the export version—again I refer you to the rule—looks like a fifth-generation, but does not necessarily work like one.

**John Spellar in the Chair:** Thank you very much for a very interesting and instructive session, which will very helpfully inform our report.