<u>TR020002 – SMAa representation to the Secretary of State for Transport</u>

<u>Response to report by Arup (Part 2)</u>

Re-determination of the Application by RiverOak Strategic Partners Limited ("the Applicant") for an Order granting Development Consent for the reopening and development of Manston Airport in Kent.

Save Manston Airport association (SMAa) has over 3,700 members who are in full support of the Development Consent Order to reopen Manston Airport, many wanting jobs for themselves, their family or other Kentish people. Thus, we wish to make further representations to assist in the re-determination of the DCO.

1.0 Introduction

On the 11th June the Secretary of State (SoS) published a letter asking for representations from interested parties on 4 matters:

Matter 1: The extent to which current national or local policies (including any changes since 9 July 2020 such as, but not limited to, the re-instatement of the ANPS) inform the level of need for the services that the Development would provide and the benefits that would be achieved from the Development;

Matter 2: Whether the quantitative need for the Development has been affected by any changes since 9 July 2019, and if so, a description of any such changes and the impacts on the level of need from those changes (such as, but not limited to, changes in demand for air freight, changes of capacity at other airports, locational requirements for air freight and the effects of Brexit and/or Covid);

Matter 3: The extent to which the Secretary of State should, in his re-determination of the application, have regard to the sixth carbon budget (covering the years between 2033 – 2037) which will include emissions from international aviation; and

Matter 4: Any other matters arising since 9 July 2019 which Interested Parties consider are material for the Secretary of State to take into account in his re-determination of the application.

2.0 The Arup report

In their report, Arup relied heavily, without the appropriate scrutiny, on the evidence produced by Louise Congdon (LC) from York Aviation. The Arup report referenced the work by LC 14 times often using long quotes from her to help Arup reach conclusions, that were as a result often flawed.

It is noteworthy that the LC report did not address Matter 3 relating to the Sixth Carbon budget.

For reasons unknown, the Arup report failed to produce anything on Matter 3 although the first published version of the report clearly indicated they had originally intended to do so.

We hope that there is not a link between these events.

3.0 Matter 3

We find the fact that neither LC nor Arup have bothered to address the Climate Change issue unforgivable. We outlined our position on the implications of the Sixth Carbon Budget for the

Development in our representation for Matter 3[1] sent before the first deadline.

However, we wish to highlight a publication by Arup and how it strengthens the case for the Manston Development.

N.B. To avoid confusion when referring to the Arup report produced for the SoS we will continue to refer to it as the Arup report. When referring to the Arup publication on sustainable airports we will refer to it as the Arup sustainability article.

The Arup sustainability article[2] states:

"*For aviation, there are two clear priorities – the shift to sustainable aviation fuels, a transition that's a work in progress, and second, the need to develop sustainable airports.*"

The Arup sustainability article then went on to list several measures that could or should be adopted to make an airport sustainable:

- Airports will need to comprehensively switch to renewable energy and invest in energy efficiency and energy storage to reduce carbon emissions.
- There are also possibilities to develop on-site energy generation from solar, wind, biomass, and hydrogen sources.
- Prioritising public transport can reduce surface access related emissions.
- Set stringent targets for reductions in waste and embodied carbon, and levels of renewable energy procurement
- Embody a circular economy approach to their built assets, adopting materials passports and other measures to enable the reuse of materials when facilities reach their end of life, lowering lifetime emissions and retaining the value of building products and assemblies as a result.
- Optimisation requires taking a system-wide approach, by reducing waste, improving recycling, using on-site waste-to-energy and anaerobic digestion systems to improve performance, and committing to zero-waste-to-landfill commitments.
- Agreeing mutually acceptable methods of monitoring and enforcement regarding issues like noise, carbon emissions, surface access impacts, air quality and so on – but would also represent a spur to innovation.
- adopting practices like green roofs and expanded planting within their estates in ways that are compatible with aviation safety.
- Instead of simply off-setting by planting forests in other areas or regions, airports could invest in the domestic boiler replacement with heat pumps in the local community, helping to accelerate the decarbonisation of home heating and bolstering their status as socially responsible businesses.
- Policies to encourage the use of electric vehicles within their estates and ground power to aircraft can bring down air pollution, supporting local air quality goals.
- Reductions in light pollution and adoption of indoor air quality monitoring, limiting the use of toxic substances, introduction of biophilic design, as well as measures to reduce the risks of creating heat islands, would also all strengthen an airport's sustainability credentials.
- Taking a fundamentally human-centred design approach to aviation infrastructure, operations, and environments.
- Airports are major employers, but the sustainable airport can play a larger role in the community than merely providing jobs.

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[1] SMAa representation to the Secretary of State - Matter 3

[2] Arup – What Makes a Sustainable Airport?

- A sustainable airport can act as a focus point for a range of technical, engineering and service skills.
- A sustainable airport can become a hub for local skills, offering apprenticeships, and reaching out to communities that lack traditional advantages.
- Airports are typically located in the outer reaches of urban areas, providing a potentially powerful set of connections in areas of often less-wealthy populations.
- There’s clear potential [for sustainable airports] to develop low-emission agriculture on their surrounding land, helping the food industry to reduce ‘food miles’ and advance its own sustainability agenda.

In our submission on Matter 3 we outlined many of the mitigation measures that RSP is committed to implementing through its Carbon Minimisation Action Plan.

This action plan is to be agreed with the Secretary of State, which goes beyond good practice and aims to significantly reduce GHG emissions associated with the design, construction and operation of the scheme.[3]

We feel it is important to highlight some of the mitigation measures planned for Manston Airport, so that the SoS can see that the measures match very closely with the measures outlined by the Arup sustainability article as to what would make it a sustainable airport.

- Fixed electrical ground power.
- Using hybrid/ electric/Hydrogen powered ground vehicles both in the construction and operational phase.
- Low carbon welfare facilities.
- Encouraging construction and operational staff to use public transport.
- Low carbon energy supply and storage such as roof mounted photovoltaic (PV), solar carports, thermal storage, battery storage.
- Decentralised energy system to power buildings.
- Energy efficient buildings to reduce emissions and using natural light.
- Insisting that contractors commit to sustainable procurement and practices.
- Reuse and recycling of materials.
- Prefabrication where possible.
- Effective storage and segregation of waste.
- Using sustainable materials in construction.

The applicant reinforced and added to its mitigation measures in July 2019 with the publication of its “Updated Register of Environmental Actions and Commitments (REAC)”[4]. The mitigation measures included cover 100 pages so are too numerous to mention them all. However, some of the additional measures included from the original list that have a bearing on the environment are:

- Cycle and walking paths to be extended to the terminal.
- Provision of ample cycle bays and provision of additional shower and changing facilities.
- Additional bus service provision.
- Courtesy bus to and from the railway station.
- Airport layout and arrival/departure timetabling to minimise idling, taxiing and holding.
- Bans on older less efficient aircraft.

[3] [APP – 034] – table 16.16
[4] [REP11 – 008]

- A commitment to a Climate Change Adaption Strategy following the granting of the DCO.
- Appendix A of the REAC outlines the methods that will be used to monitor and enforce issues relating to noise, air quality, light pollution etc.

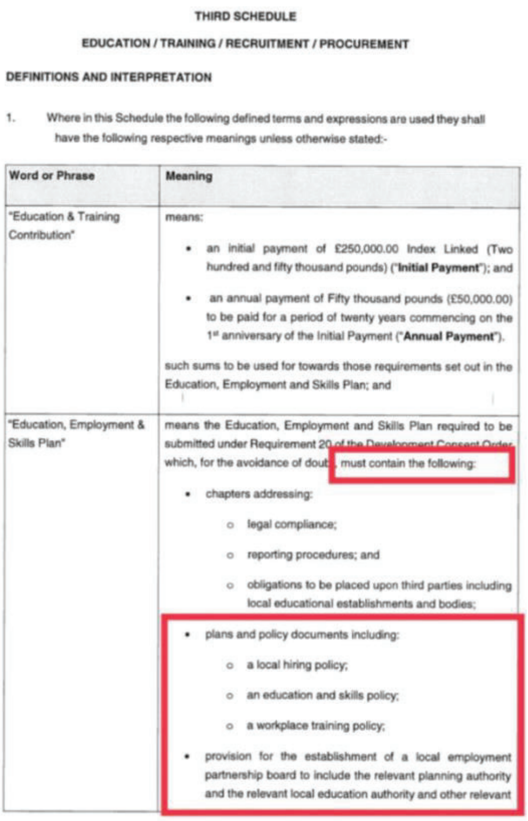
In addition, it is the stated aim of the applicant to employ as many local people as possible. They intend to:

"*Work with local councils and 3rd sector organisations to help promote job opportunities to local people, particularly to the long-term unemployed*."[5]

Schedule 2 Requirement 20 of the DCO states that:

"No part of the authorised development is to commence until an Education, Employment and Skills Plan has been submitted to, and approved in writing by, the relevant planning authority".

It makes clear that this plan must include a Local Hiring Policy.
This has been incorporated into the Third Schedule of the section 106 agreement.[6]



THIRD SCHEDULE

EDUCATION / TRAINING / RECRUITMENT / PROCUREMENT

DEFINITIONS AND INTERPRETATION

1. Where in this Schedule the following defined terms and expressions are used they shall have the following respective meanings unless otherwise stated:-

Word or Phrase	Meaning
"Education & Training Contribution"	means: • an initial payment of £250,000.00 Index Linked (Two hundred and fifty thousand pounds) ("**Initial Payment**"); and • an annual payment of Fifty thousand pounds (£50,000.00) to be paid for a period of twenty years commencing on the 1st anniversary of the Initial Payment ("**Annual Payment**"). such sums to be used for towards those requirements set out in the Education, Employment and Skills Plan; and
"Education, Employment & Skills Plan"	means the Education, Employment and Skills Plan required to be submitted under Requirement 20 of the Development Consent Order which, for the avoidance of doubt, must contain the following: • chapters addressing: ○ legal compliance; ○ reporting procedures; and ○ obligations to be placed upon third parties including local educational establishments and bodies; • plans and policy documents including: ○ a local hiring policy; ○ an education and skills policy; ○ a workplace training policy; • provision for the establishment of a local employment partnership board to include the relevant planning authority and the relevant local education authority and other relevant

The Applicant is committed to providing a Manston Training Facility on site to enable local people to acquire the qualifications and skills including apprenticeships necessary to undertake a range of technical, engineering and service jobs.

To this end RSP has a long established "Manston Skills and Education Board" which meets regularly and has representatives from the Kent and Medway Skills Commission, Kent County Council, Thanet District Council, Dover District Council, Thanet and East Kent Chamber of Commerce, Partnership Manager for

[5] [APP-085] – Volume IV – page 38
[6] [REP 11-010] – page 16

Thanet Jobcentre Plus, Director of Engineering at Canterbury Christ Church University, Shaw Trust, a Secondary Education Advisor, the Enterprise People as well as members from RSP.

RSP have already firm links with the community and has already helped several organisations despite the delays in the DCO process. These include giving financial backing to enable 1200 trees to be planted and maintained in Thanet, giving money to the Monkton Nature Reserve, giving a large sum of money to the RAF History Museum to help with a major refurbishing and the most recent financing a Health, Activity and Food (HAF) programme brilliantly run by Ramsgate Football Club.

By any measure, the Manston Development matches the criteria laid down by Arup on "What makes a Sustainable Airport".

In summary the Arup sustainability article comments:

"*The development of sustainable aviation fuels, including biofuels, hydrogen, and electric-powered aircraft is well underway, but will take time.* ***The sustainable airport is something we can achieve right now.*** *(Our emphasis).*

Airports have a fantastic opportunity to lead the sustainability agenda, pioneer progressive economic measures and practices, and ensure that the industry is seen as an active participant in the shift to a net zero economy.

Ultimately, once the world's airports are more vocal about their sustainability commitments, and making progress on a path to net zero, they will strengthen their social license to operate. This won't just be to the benefit of the industry but will strengthen the cities and communities it serves."

The Manston Development is ready to meet the challenge and all it needs is for the SoS to grant the DCO to enable Manston to "*to lead the sustainability agenda, pioneer progressive economic measures and practices, and ensure that the industry is seen as an active participant in the shift to a net zero economy."*[7] It seems strange that the Arup report did not take the Arup sustainability article into account as it clearly strengthens the case for the Manston Development.

<u>From the SMAa Committee on behalf of the 3,700 members</u>

Dr Beau Webber (Chairman)

[redacted]

[7] Arup – What Makes a Sustainable Airport?

References for SMAa representation to the Secretary of State for Transport
Response to Arup Report – Part 2

TR020002 – SMAa representation to the Secretary of State for Transport – Matter 3

Re-determination of the Application by RiverOak Strategic Partners Limited ("the Applicant") for an Order granting Development Consent for the reopening and development of Manston Airport in Kent.

SMAa has over 3,700 members who are in full support of the Development Consent Order to reopen Manston Airport, many wanting jobs for themselves, their family or other Kentish people. Thus, we wish to make further representations to assist in the re-determination of the DCO.

Statement of Matters

In the Department for Transport's Statement of Matters letter dated 11th June 2021 it invited Interested Parties to make further representations on 4 matters. This representation will look at:

"the extent to which the Secretary of State should, in his re-determination of the application, have regard to the sixth carbon budget (covering the years between 2033 – 2037) which will include emissions from international aviation".

1.0 Background

In 2018 the UK Aviation emissions were 39.3 $MtCO_2$/yr which was 7% of the UK GHG emissions[1]. Using that data gives the Total UK GHG emissions of about 500 $MtCO_2$/yr. The applicant has indicated that, without mitigation, the development will produce 276.9 $ktCO_2$ (0.2769 $MtCO_2$) in year 2 of operation and 808.7 $ktCO_2$ (0.8087 $MtCO_2$) in year 20 of operation[2].

The development represents 0.05% (year 2) and 0.14% (year 20) of the total UK emissions.

Following the granting of the DCO, the applicant is committed to implementing the appropriate mitigation measures by way of a Carbon Minimisation Action Plan.

This action plan is to be agreed with the Secretary of State, which goes beyond good practice and aims to significantly reduce GHG emissions associated with the design, construction and operation of the scheme.[3]

The applicant outlines a number of mitigation measures including fixed electrical ground power, using hybrid/ electric/Hydrogen powered ground vehicles both in the construction and operational phases, low carbon welfare facilities, encouraging construction and operational staff to use public transport, low carbon energy supply and storage such as roof mounted photovoltaic (PV), solar carports, thermal storage, battery storage, decentralised energy system to power buildings, energy efficient buildings to reduce emissions and using natural light, insisting that contractors commit to sustainable procurement and practices, reuse and recycling of materials, prefabrication where possible, effective storage and segregation of waste and using sustainable materials in construction[4].

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[1] Sixth Carbon Budget – Aviation – page 5
[2] [APP – 034] – 16.9.17
[3] [APP – 034] – table 16.16
[4] [APP – 034] – table 16.15

The Carbon Minimisation Action Plan, that will be agreed with the Secretary of State following DCO approval, will ensure that:

***"The Proposed Development's effect on the global climate is not significant"*[5].**

The applicant reinforced and added to its mitigation measures in July 2019 with the publication of its "Updated Register of Environmental Actions and Commitments"[6]. The mitigation measures included cover 100 pages so are too numerous to mention them all. However, some of the additional measures included from the original list that have a bearing on the environment are; cycle and walking paths to be extended to the terminal, provision of ample cycle bays and provision of additional shower and changing facilities, additional bus service provision, courtesy bus to and from the railway station, airport layout and arrival/departure timetabling to minimise idling, taxiing and holding, bans on older less efficient aircraft and the commitment to a Climate Change Adaption Strategy following the granting of the DCO. The register also states that:

"An adequate target for the reduction of the 78.6 ktCO_2 per annum from non-aviation sources and the 808.7 ktCO_2 per annum from all sources will be set within the Carbon Minimisation Plan by the applicant and signed off by the Secretary of State"[7].

2.0 The Sixth Carbon Budget

The sixth Carbon Budget, produced by the Climate Change Committee (CCC), as required under the Climate Change Act, provides ministers with advice on the volume of greenhouse gases the UK can emit during the period 2033-2037.

The applicant has already shown its commitment to being as Carbon neutral as policy with its mitigation measures that will be implemented through its Carbon Minimisation Action Plan. It has already become involved in Carbon Capture by supporting financially an extensive tree planting scheme in Thanet[8]. The applicant has already donated £35,000 towards the scheme with a commitment to contribute far more once the DCO is granted.

However, to satisfy the recommendations of the CCC will require National and International efforts and agreements to achieve Net Zero by 2050.

In a press release[9], the government indicated that it intends to pass The Sixth Carbon Budget by the end of June 2021 but, at the time of writing it has not yet happened. It is, therefore, hard to know how many of the recommendations from the CCC the government will adopt but we do know that they have pledged to cut emissions by 78% by 2035 and that it will include international aviation and shipping within it.

The CCC report indicates that even after contributions from efficiency improvements, low-carbon fuels and demand-side measures, there will still be residual emissions by 2050. It states that:

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[5] [APP – 034] – table 16.16
[6] [REP11 – 008]
[7] [REP11 – 008] – page 91
[8] Ramsgate Community Magazine
[9] Government press release – sixth carbon budget

"*Following the Balanced Net Zero Pathway, the remaining 23 MtCO2e/year of gross aviation emissions in 2050 would require 40% of total UK engineered greenhouse gas removals to be assigned to the aviation sector to achieve Net Zero within aviation*"[10].

However, as stated above, at the time of writing, it is not clear whether this recommendation would be adopted by the Government as policy whereas the recent Stansted Airport Public Inquiry decision makes clear that "Making Best Use of existing runways (MBU) should be accepted as government policy:

"*The in-principle support for making best use of existing runways provided by MBU is a recent expression of policy by the Government. It is given in full knowledge of UK commitments to combat climate change, having been published long after the Climate Change Act 2008 (CCA) and after the international Paris Agreement. It thoroughly tests the potential implications of the policy in climate change terms, specifically carbon emissions. To ensure that Government policy is compatible with the UK's climate change commitments the Department for Transport (DfT) aviation model was used to look at the impact of allowing all MBU airports to make best use of their existing runway capacity. This methodology appears to represent a robust approach to the modelling*"[11].

Since MBU can be considered Government Policy on Aviation and is "*compatible with the UK's climate change commitments"* the following point from MBU is very relevant:

"*Under the carbon-traded scenario, UK aviation emissions could continue to grow provided that compensatory reductions are made elsewhere in the global economy. This could be facilitated by a carbon trading mechanism in which aviation emissions could be traded with other sectors*"[12].

Whether or not the Government adopt the 40% figure recommended by the CCC or some lower figure with the shortfall distributed to other sectors, the aviation sector will have to contribute significantly to greenhouse gas removals.

2.1 CORSIA

Undertaking removal of aviation greenhouse gas emissions globally is a massive undertaking and the International Civil Aviation Organisation (ICAO) are playing a major role in making this a reality. The ICAO is funded and directed by 193 national governments and the ICAO have established the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). As indicated in a press release, the UK government have been:

"*Instrumental in agreeing and the developing a global offsetting scheme – the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) – aimed at meeting the ICAO's medium-term climate change goal of Carbon Neutral Growth from 2020"[13].*

CORSIA has now been put into law by means of an Air Navigation Order (ANO)[14] and it imposes obligations on aeroplane operators which will involve a first phase of monitoring, reporting and verification (MRV)[15] of CO_2 emissions from International flights and a second phase involves offsetting using the first phase data. Aeroplane operators will be set a "CORSIA Eligible Emission

[10] Sixth Carbon Budget – aviation – page 33
[11] Stansted Airport Public Inquiry decision – page 4 section 18
[12] Making Best Use of existing runways – page 6 section 1.15
[13] UK Government – implementing CORSIA
[14] UK Government – CORSIA
[15] CORSIA – FAQs – page 16 section 1.6

Unit" quota by the ICAO Council and these must be cancelled by the buying and selling of Eligible Emission Units on the Carbon Market[16].

The implications for Manston Airport are clear. The applicant will put mitigation measures in place, through its Carbon Minimisation Action Plan, to make the development as Carbon neutral as possible. With aeroplane operators obliged to offset all CO_2 emissions caused by International Flights, the granting of the DCO for Manston is not at odds with the recommendations by the CCC in the sixth carbon budget and the need to reach Net Zero by 2050.

The 40% value for greenhouse gas removal, by the aviation sector, in the sixth carbon budget was dependant on other measures being implemented.

2.2 Demand Management

Without constraints, the CCC predict that there would be a growth in aviation of 65% by 2050 compared with 2018 levels. The sixth carbon budget recommends that this growth in the aviation sector is limited to 25% by 2050 to enable Net Zero by 2050[17].

The Manston Airport development involves a maximum of 17,170 Cargo ATMs and 9,298 Passenger ATMs which gives a total of 26,468 ATMs. According to CAA data there were 2,267,893 ATMs in 2019[18] so the development represents 1.2% of total ATMs which could easily be accommodated in the 25% growth allowed for in the sixth carbon budget.

2.4 Aircraft Fleet Efficiency Improvements

The CCC advice to the Government on setting the sixth carbon budget suggests, amongst other things, that efficiencies can be achieved through airspace modernisation, improvements in aircraft design and engine efficiency improvements, use of hybrid aircraft and other technologies that can reduce the use of fossil fuels[19].

The Government have been very proactive in enabling the appropriate efficiencies to be achieved. In 2017, the Department for DFT set out the Strategic Case for Airspace Modernisation and it stated:

"*important environmental improvements are also expected from the airspace upgrades as aircraft can follow more fuel-efficient routes, climb sooner, descend quieter and navigate more accurately around populated centres*" [20].

In response the CAA produced its Airspace Modernisation Strategy in 2018 and it stated:

"*Unlocking the benefits of modernisation will make journeys faster and more environmentally friendly*"[21].

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[16] CORSIA – FAQs – page 20 section 2.14
[17] The sixth carbon budget – aviation - page 21
[18] CAA ATM data
[19] The sixth carbon budget – aviation - page 9
[20] Strategic rationale for airspace modernisation
[21] CAA Airspace Modernisation Strategy

The Government established the Jet Zero Council which had its first meeting in July 2020.

"*The Jet Zero Council (JZC) is a partnership between industry and government to bring together ministers and chief executive officer-level stakeholders, with the aim of delivering zero-emission transatlantic flight within a generation, driving the ambitious delivery of new technologies and innovative ways to cut aviation emissions*"[22].

This is a very ambitious but achievable target, and the Government has demonstrated, through its vaccination programme, just what can be achieved in a very short timeframe when there is the overwhelming will to do so.

"*The partnership [Government, business and investors] will leverage the UK's world-leading aviation sector, which employs 230,000 people in the UK and contributes £33 billion to the UK economy, to effectively tackle emissions while encouraging growth and green innovation"*[23].

There is clearly much work ahead, but progress has already been made with the world's first hydrogen-electric passenger flight (albeit a 6-seater) at Cranfield being carried out successfully in 2020.

The Manston Airport development is going to be done in phases over a 20-year period. All calculations used to achieve Net Zero at Manston have been based on a worst-case scenario and any advances in aircraft design that reduce or remove aircraft emissions can only be beneficial.

2.5 Sustainable Aviation Fuels (SAF)

"*These are "drop-in" replacements for fossil jet fuel, meeting international fuel specifications (and currently allowed to be blended at up to 50% by volume), and have nil accounting CO_2 emissions on combustion*"[24].

In June 2021, the Government announced that BA had carried out the first ever Net Zero freighter flight powered by waste materials such as cooking oil[25].

Again, there is much work to do by the UK Government on SAF but, according to the CCC, the Government have indicated there is willingness to introduce an SAF blending mandate[26]. It is vital that the Government "*set out a policy package for supporting the near-term deployment of commercial sustainable aviation fuel (SAF) facilities in the UK (with carbon capture and storage (CCS) where applicable)"*[27].

The Manston Airport development involves considerable changes to the existing fuel farm, and this gives the option to diversify the types of fuel, including Hydrogen, that can be stored there.

[22] Jet Zero Council
[23] JZC September press release
[24] The sixth carbon budget – aviation - page 9
[25] JZC – first net zero freighter flight
[26] The sixth carbon budget – aviation - page 36
[27] The sixth carbon budget – aviation - page 36

3.0 Conclusion

It is Government Policy to Make Best Use of existing runways and to reopen Manston would not be at odds with the recommendations of the CCC on the Sixth Carbon Budget which will form the basis of Government emerging Policy. The Government firmly believe they are on track to deliver Net Zero by 2050:

***"The UK over-achieved against its first and second Carbon Budgets and is on track to outperform the third Carbon Budget which ends in 2022. This is due to significant cuts in greenhouse gases across the economy and industry, with the UK bringing emissions down 44% overall between 1990 and 2019, and two-thirds in the power sector"*[28].**

The development, even without mitigation, represents a tiny proportion of the overall UK GHG emissions and a tiny proportion of the total passenger and cargo ATMs in the UK. With mitigation measures implemented, through the Carbon Minimisation Action Plan, the Proposed Development's effect on the global climate is not significant. With aeroplane operators obliged to offset all CO_2 emissions caused by International Flights, the granting of the DCO for Manston is not at odds with the recommendations by the CCC in the sixth carbon budget.

With Government action to push forward airspace change, aircraft innovation and a commitment to SAF there is no reason why the Secretary of State should not grant the DCO for Manston Airport.

From the SMAa Committee on behalf of the 3,700 members

Dr Beau Webber (Chairman)

[redacted]

[28] Government press release – sixth carbon budget

References for SMAa representation to the Secretary of State for Transport - Matter 3

The Sixth Carbon Budget

Aviation

This document contains a summary of content for the aviation sector from the CCC's Sixth Carbon Budget Advice, Methodology and Policy reports.

Introduction

The Committee is advising that the UK set its Sixth Carbon Budget (i.e. the legal limit for UK net emissions of greenhouse gases over the years 2033-37) to require a reduction in UK emissions of 78% by 2035 relative to 1990, a 63% reduction from 2019. This will be a world-leading commitment, placing the UK decisively on the path to Net Zero by 2050 at the latest, with a trajectory that is consistent with the Paris Agreement.

Our advice on the Sixth Carbon Budget, including emissions pathways, details on our analytical approach, and policy recommendations for the aviation sector is presented across three CCC reports, an accompanying dataset, and supporting evidence.

- **An Advice report**: *The Sixth Carbon Budget – The UK's path to Net Zero*, setting out our recommendations on the Sixth Carbon Budget (2033-37) and the UK's Nationally Determined Contribution (NDC) under the Paris Agreement. This report also presents the overall emissions pathways for the UK and the Devolved Administrations and for each sector of emissions, as well as analysis of the costs, benefits and wider impacts of our recommended pathway, and considerations relating to climate science and international progress towards the Paris Agreement. Section 7 of Chapter 3 of that report contains an overview of the emissions pathways for the aviation sector.
- **A Methodology Report:** *The Sixth Carbon Budget – Methodology Report*, setting out the approach and assumptions used to inform our advice. Chapter 8 of that report contains a detailed overview of how we conducted our analysis for the aviation sector.
- **A Policy Report:** *Policies for the Sixth Carbon Budget and Net zero*, setting out the changes to policy that could drive the changes necessary particularly over the 2020s. Chapter 8 of that report contains our policy recommendations for the aviation sector.
- **A dataset** for the Sixth Carbon Budget scenarios, which sets out more details and data on the pathways than can be included in this report.
- **Supporting evidence** including our public Call for Evidence, 10 new research projects, three expert advisory groups, and deep dives into the roles of local authorities and businesses.

All outputs are published on our website (www.theccc.org.uk).

For ease, the relevant sections from the three reports for each sector (covering pathways, method and policy advice) are collated into self-standing documents for each sector. A full dataset including key charts is also available alongside this document. This is the self-standing document for the aviation sector. It is set out in three sections:

1) The approach to the Sixth Carbon Budget analysis for the aviation sector
2) Emissions pathways for the aviation sector
3) Policy recommendations for the aviation sector

Chapter 1

The approach to the Sixth Carbon Budget analysis for the aviation sector

The following sections are taken directly from Chapter 8 of the CCC's Methodology Report for the Sixth Carbon Budget.[1]

Introduction and key messages

This chapter sets out the method for the aviation sector's Sixth Carbon Budget pathways.

The scenario results of our costed pathways are set out in the accompanying *Advice report*. Policy implications are set out in the accompanying *Policy report*.

For ease, these sections covering pathways, method and policy advice for the aviation sector are collated in *The Sixth Carbon Budget – Aviation*. A full dataset including key charts is also available alongside this document.

The key messages from this chapter are:

- **Background**. Aviation emissions accounted for 7% of UK GHG emissions in 2018 and were 88% above 1990 levels. Emissions have been relatively flat from 2008-2018, with increasing international travel being offset by some improvements in efficiencies and by falling military and domestic aviation emissions. 2020 has likely seen a drop in GHG emissions of over 60% from 2019, due to the impact of COVID-19, with a return to pre-pandemic passenger levels not expected until 2024.[2]
- **Options for reducing emissions**. Mitigation options considered include demand management, improvements in aircraft efficiency (including use of hybrid electric aircraft), and use of sustainable aviation fuels (biofuels, biowaste to jet and synthetic jet fuels) to displace fossil jet fuel.
- **Analytical approach**. Our starting point for this analysis has been the 2019 *Net Zero* report, and the underlying DfT demand, efficiency and emissions modelling.
  - We have adapted and updated this analysis to fit to a new set of demand scenarios (consistent with those considered by the Climate Assembly), before introducing significantly higher shares of sustainable aviation fuels than previously considered.
  - This includes new evidence on the costs and emissions savings of sustainable aviation fuels, fitting with our Fuel Supply analysis, and the added capital costs of efficiency improvements.
- **Uncertainty**. We have used the scenario framework to test the impacts of uncertainties, to inform our balanced Net Zero Pathway. The key areas of uncertainty we test relate to sustainable aviation fuel supplies and costs of synthetic jet fuel, the mix of SAF options, the profile for expansion in passenger demand over time (with mid-term or no net expansion of airports), and whether there will be long-term structural change in the sector due to COVID-19. Out of all the CCC's sectors, Aviation has been most impacted by COVID-19, and continues to face the highest uncertainties about the future size of the sector.

We set out our analysis in the following sections:

1. Sector emissions
2. Options for reducing emissions
3. Approach to analysis for the Sixth Carbon Budget

1. Sector emissions

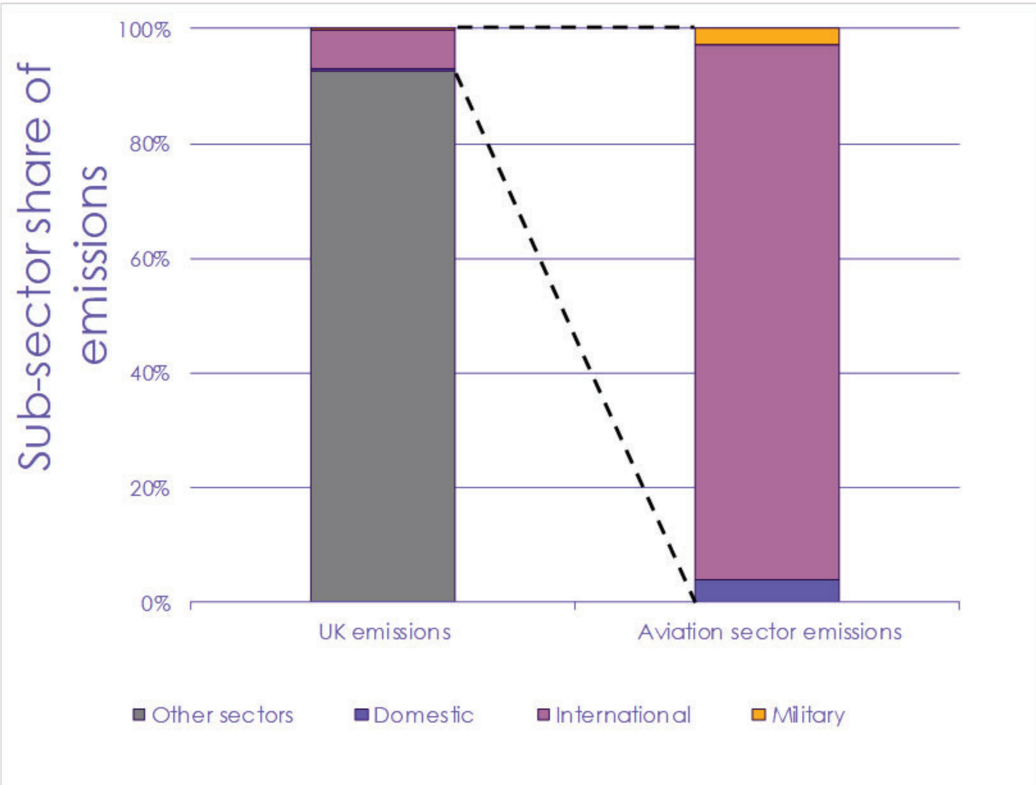
This section outlines the recent trends in aviation emissions and their sources. For more detail, see our 2020 Progress Report to Parliament.[3]

a) Breakdown of current emissions

Based on the most recent official UK emissions data, total UK aviation emissions increased by 0.8% from 2017 levels to 39.3 $MtCO_2e$/year in 2018. Within this, emissions from international flights increased by 1.1% to 36.7 $MtCO_2e$/year, emissions from domestic flights fell by 5.9% to 1.5 $MtCO_2e$/year, and emissions from military aviation fell 0.6% to 1.1 $MtCO_2e$/year. Aviation therefore comprised 7% of UK GHG emissions in 2018, and within this international aviation dominates at 93% of UK aviation emissions (Figure M8.1).

To be consistent with other sectors and the Climate Change Act framework, these GHG emissions do not include non-CO_2 impacts of aviation, which are discussed in Chapter 8, section 4 of the main *Advice Report*.

Figure M8.1 Breakdown of aviation sector emissions (2018)



Source: BEIS (2020) *Final UK greenhouse gas emissions national statistics 2018*.
Notes: Total UK emissions in 2018 were 539 $MtCO_2e$/yr (AR5 basis peatland revisions and IAS included). UK aviation sector emissions in 2018 were 39 3 MtCO2e/yr.

We have also estimated UK aviation emissions for 2019 at 39.6 $MtCO_2e$/year, a 0.9% increase on 2018 levels. This combines 11% falls in domestic and military emissions with a 1.7% increase in international aviation emissions.

However, given the COVID-19 pandemic and its impact on the aviation sector, and the need to reflect this in our analysis in the near-term, we have also estimated a fall in 2020 GHG emissions of over 60% from 2019 levels (and then a recovery to 2024), as detailed below in section 3(e). The emissions estimates from 2019 onwards will revised once official BEIS final GHG emissions data is published.

b) Emissions trends and drivers

The breakdown of aviation emissions since 1990 is shown in Figure M8.2. Overall, emissions from domestic and international aviation in 2018 were 124% above 1990 levels, and military aviation emissions have fallen 71% from 1990 levels.

Figure M8.2 Breakdown of aviation sector emissions (1990-2019)

Source: BEIS (2020) *Final UK greenhouse gas emissions national statistics 2018* BEIS (2020) *Provisional UK greenhouse gas emissions national statistics 2019* BEIS (2020) *Energy Trends* CCC estimates for 2019.

Aviation emissions rose strongly throughout the 1990s and early-to-mid 2000s, due to increasing passenger demand, with only minor falls seen around 1990 and 2000 due to economic down-turns.

Emissions fell significantly during 2007-2010 due to the financial crisis, then stayed relatively flat in the early 2010s, but have been rising again in recent years.

UK aviation emissions in 2018 were therefore the same as in 2008, as falls in domestic and military aviation emissions have been balanced by a rise in UK international aviation emissions. Over the same 2008-2018 period, the total number of UK terminal passengers rose by 24% to reach 292 million in 2018, with a further 2% increase seen in 2019.

The increase in emissions has been more modest than growth in passengers due to increased plane loadings, decreases in average flight distance (due to faster growth in flights to the EU than other international destinations) and some improvements in fleet efficiency.

2. Options for reducing emissions

Several different emissions reduction options have been explored within the Aviation sector. These include:

- **Demand management**. A reduction in the annual number of passengers versus a counterfactual with unlimited passenger demand growth. Demand management policies could take several forms, either reducing passenger demand for flying through carbon pricing, a frequent flyer levy, fuel duty, VAT or reforms to Air Passenger Duty, and/or restricting the availability of flights through management of airport capacity. Our analysis only assumes a demand profile is achieved, and does not model the policies required to achieve these profiles.

- **Aircraft fleet-efficiency improvements**, achieved via a combination of airspace modernisation, operational optimisation, aircraft passenger loadings, aircraft design and new engine efficiency improvements, as well as introduction of hybrid electric aircraft (significant falls in jet use, but adding some use of electricity via on-board batteries and motors). Our analysis uses fleet fuel tCO_2/passenger values from DfT modelling, and does not model individual improvements from the list above.

- **Sustainable aviation fuels (SAF)**. These are "drop-in" replacements for fossil jet fuel, meeting international fuel specifications (and currently allowed to be blended at up to 50% by volume), and have nil accounting CO_2 emissions on combustion. SAF production routes considered include:

  - Biomass to Fischer-Tropsch (FT) biojet, with or without CCS;
  - Biogenic waste fats/oils to Hydroprocessed Esters and Fatty Acids (HEFA) biojet;
  - Biogenic fraction of waste* to Fischer-Tropsch (FT) biojet, with or without CCS; and
  - Synthetic jet fuel produced via Direct Air Capture (DAC) of CO_2 and low-carbon H_2.

  Our analysis uses these four SAF options to displace fossil jet fuel, and each SAF option has its own deployment and cost profile, based on the availability of the feedstocks, efficiencies, input energy, capital and operating costs. Each route is discussed in more detail in the Fuel Supply chapter.

* Note that the non-biogenic fraction of waste converted to FT jet will still have fossil accounting CO_2 emissions on combustion in aviation and so is included within fossil jet fuel figures not as SAF.

a) Summary of scenario choices

As a reminder from Chapter 3, section 7 of the *Advice Report*, the measures discussed in section 2 above are combined into the different scenarios as set out in Table M8.1.

Table M8.1
Aviation scenario composition

	Passenger demand growth by 2050 from 2018 levels	Average efficiency improvement 2018-2050 (%/year)	Use of biomass FT jet (TWh, % of liquid fuel demand in 2050)	Use of HEFA biojet (TWh, % of liquid fuel demand in 2050)	Use of bio-waste FT jet (TWh, % of liquid fuel demand in 2050)	Use of synthetic jet (TWh, % of liquid fuel demand in 2050)	Use of fossil jet (TWh, % of liquid fuel demand in 2050)
Balanced Net Zero Pathway	**+25%, with no net expansion**	**+1.4%**	**14 (11%)**	**8 (6%)**	**-**	**10 (8%)**	**94 (75%)**
Headwinds	+25%, with expansion	+1.4%	14 (11%)	11 (9%)	-	-	101 (80%)
Widespread Engagement	-15%, no expansion	+1.6%	14 (16%)	4 (4%)	5 (5%)	-	61 (74%)
Widespread Innovation	+50%, with expansion	+2.1%	23 (19%)	9 (7%)	-	30 (25%)	58 (49%)
Tailwinds	-15%, no expansion	+2.1%	23 (33%)	12 (18%)	-	30 (44%)	4 (5%)
Baseline	+64%, with expansion	+0.7%	-	-	-	-	205 (100%)

Our baseline is taken direct from DfT modelling, with high demand growth (64% growth in passenger number by 2050, from 2018 levels), low efficiency improvement (0.7%/year), no hybrid electric aircraft and no SAF deployment.

The exploratory scenarios use different mixes of the options set out in section 2 to reduce emissions below baseline emissions:

- **Headwinds** follows the approach in Net Zero 2019, with 25% passenger growth by 2050, 1.4%/year efficiency improvement (in-line with historical averages), and 14 TWh/year of biomass to FT jet. We have also added 11 TWh/year of HEFA biojet, as surface transport shifts to EVs, leaving waste fats/oils resources available to be converted into HEFA biojet instead of biodiesel.
- **Widespread Engagement** assumes a reduction in aviation demand of 15% from 2018 levels, based on the lowest of the Climate Assembly scenarios. This reflects a scenario in which people are willing to embrace greater changes to behaviour. Efficiencies are marginally higher than in Headwinds. Biomass to FT jet remains at the same level, whereas significantly lower livestock numbers and a phasing out of biofuel imports leads to lower HEFA biojet use. However, in this scenario, residual wastes are assumed to be increasingly diverted from energy-from-waste plants, with 70% of the UK's residual waste converted into 5 TWh/year of biojet (plus a similar fossil fraction) by 2050, thereby contributing an additional 5% of aviation fuel demand from waste biojet.

- **Widespread Innovation** assumes demand growth of 50% from 2018 levels, based on the highest demand amongst the preferred Climate Assembly scenarios. Efficiencies are much higher, based on the DfT scenario selected. More biomass is assumed to be diverted to FT biojet, along with HEFA biojet making up ~25% of supply, and the other 25% of the fuel mix is assumed to be made up of synthetic jet fuel. We did not increase the blending of synthetic jet fuel above 25% due to the high costs of synthetic jet fuel, and the high penetration of biomass to hydrogen in the Widespread Innovation scenario (where it would be more efficient to make biojet direct from the biomass, rather than via a hydrogen intermediary). However, the overall choices fit with the overall scenario design philosophy of maximal technical change.

- **Tailwinds** combines the most stretching of the scenarios above – a reduction in demand, high efficiency, and the maximal resource allocations for the biojet and synthetic jet fuel from the other scenarios. Waste to jet has not been included, as the remaining energy-from-waste (EfW) plants in our analysis all retrofit CCS before 2050, ensuring 95% capture of the fossil & biogenic carbon. However, putting the residual waste instead into new jet production plants with CCS would likely lead to a very similar outcome in terms of GHG emissions.*

Our scenario for the Balanced Net Zero Pathway takes elements from each of the above pathways:

- **Demand growth**: Our demand growth by 2050 matches Headwinds at 25%, although the passenger growth profile is more gradual due to an assumption of no net capacity expansion at UK airports in this scenario. This arises as a function of 2050 passenger numbers (365 million passengers) being within current UK airport capacities (at least 370 million passengers), and the need to ensure the UK achieves Net Zero by 2050 with aviation still one of the largest emitting sectors. We therefore do not assume a surge in emissions occurs in the early 2030s, as happens with the airport expansion modelled in the Headwinds and Widespread Innovation scenarios. Airport expansion could still occur under the Balanced Pathway, but would require capacity restrictions elsewhere in the UK (i.e. effectively a reallocation of airport capacity).

Box M8.1
Climate Assembly scenarios

The Climate Assembly debated five aviation scenarios, with changes in demand from 2018 to 2050 of -15%, +20%, +25%, +50% and +65%. Growth of 65% growth was highly unpopular - a majority wanted to see a 25-50% growth in flights, with the higher end of the range acceptable if technology was developed to mitigate the additional emissions. However, the weighted average of scenario Borda votes was +24% growth, and the report also noted that a majority voted for +25% growth or less. This gives added confidence that the required demand management to keep the Balanced Net Zero Pathway to only 25% growth by 2050 would be acceptable to the UK general public.

Source: Climate Assembly UK (2020) CCC analysis.

* This assumes that jet production is maximised and that other co-products (e.g. diesel LPG) also still displace fossil fuels (increasingly difficult to 2050 as other sector counterfactuals decarbonise) and that EfW plants with CCS are displacing grid electricity with zero emissions by 2050 (rather than displacing fossil gas with CCS plants).

- **Efficiency**: The Balanced Net Zero Pathway takes the same efficiency assumptions as in the Headwinds scenario, in line with historical average improvement.

- **SAF**: Use of SAF matches Headwinds and Widespread Engagement for biomass to FT jet, and similar assumptions are taken on HEFA biojet (with slight differences due to waste fats/oils availability). Our Balanced Net Zero Pathway also assumes some synthetic jet fuels might be available in 2040s, at one third of the level deployed in the Widespread Innovation scenario, due to the higher costs of hydrogen and Direct Air Capture in the Balanced Net Zero Pathway compared to the Widespread Innovation scenario. Similar to the Tailwinds scenario, we have not allocated residual waste to jet fuel in this scenario.

The resulting GHG emissions in the Balanced Pathway grow during 2021-2023 with the return in passenger numbers post-COVID, before flat demand, efficiency measures and the start of SAF deployment lead to falls in emissions to the early 2030s. The more back-ended passenger growth in the Balanced Pathway (compared to Headwinds) has passenger numbers starting to grow from the mid-2030s, meaning that emissions continue to decline to 2040, as this later passenger growth is able to be accommodated by further improvements in efficiency and the continued uptake of SAF (compared to emissions increasing in Headwinds in the early 2030s with earlier passenger growth). The Balanced Pathway therefore only sees growth in passenger numbers towards 2050 once SAF is commercially proven and contributing at scale (in this scenario, there is 8% SAF used in 2035, increasing at slightly above 1 percentage point a year). From 2040, DfT modelling then introduces a new generation of aircraft (including the start of hybrid electric aircraft) that lead to further falls in emissions, with continued SAF uptake and passenger numbers continuing to increase to 2050.

Aviation measures reduce sector emissions to 23 $MtCO_2e$/year by 2050 in the Balanced Pathway, and all scenarios have positive emissions. The aviation sector will therefore require significant amounts of GHG removals to be developed to offset an increasing proportion of the sector's (declining) gross emissions to 2050, and aviation is therefore likely to be a key driving force behind the long-term deployment of engineered removals.

b) Sector classifications

Note that with our current sector classifications, some emissions reduction options have been counted outside of the CCC's Aviation sector, even if these emissions reductions are achieved via aviation policy and could count towards a separate Net Zero goal for the sector. For example:

- Sequestering biogenic CO_2 by installing CCS on UK biojet production facilities is counted within the CCC's engineered GHG removals sector, as a form of bioenergy with CCS (BECCS).

- Airlines paying for Direct Air Capture with CCS (DACCS) in the UK, in order to offset their remaining aviation gross emissions, is also counted within CCC's engineered GHG removals sector.

- Airlines paying for tree planting in the UK, in order to offset their remaining aviation gross emissions, is counted within CCC's Land Use, Land Use Change & Forestry (LULUCF) sinks sector.

These do not constitute recommendations on emissions accounting, merely what we have assumed for this analysis. These 'negative emissions' options are discussed in greater detail in the LULUCF and engineered GHG removals chapters.

This CCC sector classification also means that whilst some SAF fuels can be strongly carbon-negative on a lifecycle basis at the point of use (e.g. if there is upstream biogenic CCS involved in their production), our Aviation sector analysis only considers the direct accounting CO_2 emissions from the use of SAF in the sector, i.e. nil and not negative. If an alternative accounting methodology were followed, the negative emissions from upstream biogenic CCS could be counted within the Aviation sector emissions, but then these upstream negative emissions would have to be excluded from the GHG removals or LULUCF sinks sector to avoid double-counting. Overall, these discussions reflect emissions accounting classifications and do not affect aggregate UK emissions.

The residual aviation emissions in the Widespread Innovation scenario are used to calculate the Direct Air Capture with CCS requirement (14.5 $MtCO_2$/year) in both the Widespread Innovation scenario and the Tailwinds scenario. DACCS costs, energy inputs and deployment profiles are discussed in the GHG removals sector.

c) Analytical steps

The aviation analysis for the Sixth Carbon Budget advice consists of the following steps:

- **Coverage.**
  - Aviation is split into three sub-sectors: domestic, international and military.
  - Emissions cover CO_2, N_2O and CH_4.
  - Coverage is for UK, Scotland, Wales and Northern Ireland.
- **Abatement measures** are split into three types: demand, efficiency (including hybrids) and SAF.
  - Domestic and international passenger demand and fuel use trajectories to 2050 are sourced from DfT aviation modelling, thereby incorporating DfT efficiency assumptions.
  - Trajectory start points were adjusted for 2015-2019 actual NAEI[4] and CCA data[5], and estimated COVID-19 impacts in 2020-23 (discussed below), and trajectories then re-scaled to meet passenger growth targets for 2050 (discussed above).
  - The domestic share of DfT fuel use increases from 3.4% today to 3.9% by 2050. Military fuel use is derived separately from NAEI[4] and held fixed to 2050. Freight flights are included within DfT trajectories, so are implicitly assumed to scale with CCC passenger profiles.
  - SAF deployments from the CCC's Fuel Supply sector modelling are used to calculate residual fossil jet demands, with the same SAF % blend assumed to be used in each sub-sector (including in military aviation).
  - Direct accounting CO_2, CH_4 and N_2O emissions are calculated based on fuel use, then split into sub-sectors and DAs (discussed below).

- Energy inflows to the sector (SAF = bioenergy, non-bio waste and hydrogen derived fuels, fossil jet and electricity from hybrid planes) are split into sub-sectors and DAs. It is assumed that 50% of the hybrid aircraft electricity use is in the domestic sub-sector.

- **Costs.**
  - Re-scaled DfT departing seat-km data is used to calculate operating cost savings from efficiency measures and increased annualised aircraft capital costs (which are de-annualised to in-year investments), based on ATA data which assumes a 20 year economic lifetime, 10% residual value and a 4.5% interest rate[6]. No cost data was available for the military aviation sub-sector. Marginal added costs of SAF above fossil jet are also calculated for all sub-sectors.
  - Costs are then split into sub-sectors and DAs to calculate £/tCO_2e abated by each measure, using CCC's 3.5% social discount rate.

Further assumptions used in the analysis include:

- In 2018, 99.91% of fuel used in the UK aviation sector was aviation turbine fuel (avtur or jet), and 0.09% of fuel used was aviation spirit (avgas). CCC have used the term "jet" or "jet fuel" to include all the fuel used in UK aviation. Our analysis uses the 2018 weighted average of avtur and avgas, with constant fuel density, calorific value and carbon content values from Defra.[7]
- NAEI factors are also applied to scale combustion CO_2 to combustion CH_4 (with separate factors for domestic, international and military sub-sectors), and a constant factor to scale combustion CO_2 to combustion N_2O (applied for all sub-sectors).[8] SAF fuels are assumed to continue to have the same combustion CH_4 and N_2O emissions per kWh as fossil jet (only their accounting CO_2 emissions are reduced).
- Jet fuel costs are not part of the BEIS/HMT Green Book Long-run variable costs of energy supply (LRVCs) dataset. However, based off IATA[9], financial market and refining datasets, the jet crack ($/bbl) above crude oil price is historically very similar to the diesel crack ($/bbl). The Green Book diesel LRVCs (p/litre) were therefore used and converted into p/kWh values for fossil jet fuel.

d) Devolved administrations

The 2018 share of emissions from the NAEI is used to apportion UK emissions to emissions at devolved administration (DA) level. Separate splits are used for domestic, international and military aviation:

- Domestic: 32.8% Scotland, 0.80% Wales, 13.1% NI, 53.2% England
- International: 4.3% Scotland, 0.29% Wales, 0.55% NI, 94.9% England
- Military: 7.4% Scotland, 3.4% Wales, 2.2% NI, 86.9% England

These DA splits are held fixed over time in all scenarios, except for in the Baseline, Headwinds and Widespread Innovation scenarios, where expansion in London airports from 2030 to 2033 is assumed (delayed from DfT modelling which assumes this happens from 2026):

- This expansion leads to domestic DA splits reaching 28.7% Scotland, 0.73% Wales, 10.9% NI, 59.7% England by 2033, before a linear return to 2018 DA splits is assumed by 2050.
- International DA splits reach 3.8% Scotland, 0.27% Wales, 0.48% NI, 95.4% England by 2033, before a linear return to 2018 DA splits is assumed by 2050.
- No change assumed in military aviation DA splits.

As show in Figure M8.3, Welsh aviation emissions to not rebound post-COVID as much as other DAs relative to the 2020 base year, due to the outsized influence of military aviation emissions in Wales, where fuel use has been assumed to be held flat from 2019. Scotland and NI have much smaller military sub-sectors relative to their combined domestic and international emissions, and so their emissions profile matches the UK profile with the COVID-19 recovery.

Figure M8.3 Comparison of emission pathways for the UK, Scotland, Wales, Northern Ireland

Source: CCC analysis.
Notes: Aviation sector GHG emissions for the Balanced Net Zero Pathway split into DAs and re-based from 2020 levels (which is at the bottom of the COVID-19 dip hence strong growth in the following years).

e) Uncertainties

Given aviation will be one of the largest-emitting sectors in 2050 (23 $MtCO_2e$/year in the Balanced Pathway), the following uncertainties could change UK emissions in 2050 by many $MtCO_2e$/year and impact Net Zero:

- **COVID-19**. Out of all the sectors, aviation has been most impacted by COVID-19, and continues to be severely impacted. There remain major uncertainties as to the size of the aviation industry that will emerge post-COVID, particularly as the pandemic continues to spread globally and many countries return to forms of stricter lockdowns in late 2020. CCC have estimated a drop in UK flights and emissions during 2020-2023 as shown in Table M8.2, with a return to previously projected to demand levels from 2024 in most scenarios.
    - Data for 2020 is based on CAA flight data to date, and OAG scheduling trackers showing UK flights in mid-October at ~30% of last year's levels. We have then assumed flat demand over winter 2020/21, before increases from 2021. Values chosen for 2021-23 are estimates, but align with IATA forecasts for a recovery by 2024, i.e. a return to the chosen pathways from 2024 onwards.
    - In the Widespread Engagement and Tailwinds scenarios we assume a structural shift in demand due to behaviour change (e.g. due to video-conferencing) and have estimated this potential impact via halving business travel (which previously comprised 20% of UK passengers) by 2024. These two pathways ultimately end up at a 15% fall in passenger numbers from 2018 levels by 2050, but most of the change in demand is assumed to happen over the next 4 years.
    - The pandemic may result in a near-term marginal improvement in fleet efficiency, due to earlier retirement of older aircraft (e.g. Boeing 747s), although lower passenger loadings could offset this on a tCO_2/passenger basis, and so has not been modelled. Lower demand could also decrease or delay purchases of newer, more efficient aircraft.

Table M8.2
Aviation COVID-19 impacts, as a % of expected pathway emissions

	2019	2020	2021	2022	2023	2024+	Notes
Headwinds	100%	39%	70%	85%	95%	100%	Recovers to expected pathway
Widespread Engagement	100%	39%	67%	76%	86%	90%	Half of business customers do not return
Widespread Innovation	100%	39%	70%	85%	95%	100%	Recovers to expected pathway
Balanced Net Zero Pathway	100%	39%	70%	85%	95%	100%	Recovers to expected pathway
Tailwinds	100%	39%	67%	76%	86%	90%	Half of business customers do not return
Baseline	100%	39%	70%	85%	95%	100%	Recovers to expected pathway

- **GDP/economic outlook.** We have not attempted to calculate a long-term reduction in aviation demand due to structural changes to the economy or long-term level of GDP due to COVID-19 (flights have historically correlated to GDP). We have also not considered any reductions in supply via e.g. failures of airports, airlines or engine manufacturers. Lower long-term fossil jet fuel prices and slowed aircraft sales and development cycles could lead to smaller efficiency gains than previously projected, although this has also not been modelled.
- **Efficiency** measures are expected to be cost saving in all scenarios, and under a range of fossil fuel costs and passenger demands. However, costs have not been modelled by DfT, and the DfT model is not an aircraft stock/sale model.

  We have therefore had to infer added investment costs in each year from representative ATA aircraft Class data, applied to DfT seat-km/year outputs, and de-annualising using annual changes. There are therefore some years with particularly large or small (or even very occasionally negative*) capital costs, due to the limitations of the datasets.
- **Future aircraft**.
  - The uptake of electric hybrid aircraft in the DfT modelling is relatively modest (around 9% of aircraft kilometres by 2050, consuming 6-7% of jet fuel). The DfT model assumes that full electric planes will not be commercialised by 2050, and it does not have a role for hydrogen turbine or hydrogen fuel cell planes by 2050 either. There could be break-throughs in these aircraft options, although the time taken to design, build, test, scale-up, certify and manufacture new aircraft propulsion systems (and the new aircraft bodies to accommodate them and their energy stores on-board) is significant – at least several decades.
  - Even if one of these options were commercialised in the 2040s, it would be challenging to immediately achieve a large % share of aircraft sales, and given the 20-30 year lifetimes of aircraft, this will not lead to a significant fleet penetration by 2050. These full electric or hydrogen options have energy storage limitations, and would be most suited for domestic or short-haul flights and/or smaller airplane classes, which make up a relatively small share of UK aviation emissions.
  - Combined, these range, aircraft class and development timings mean that 2050 penetrations of these options are likely to be limited, or they could occupy small niches by 2050 – although neither is likely to significantly improve the overall UK emissions profile. Long-haul flights dominate UK aviation emissions and are likely to stay using a hydrocarbon fuel until 2050 or beyond, hence the need for SAF.

* A negative capital cost is possible and would indicate a net sale of assets in the year. This only occurs where there is a particularly large divergence in demand from the Baseline scenario at which point the sector may down-size.

- **SAF** is expected to be an added marginal cost, and this marginal cost will depend heavily on the counterfactual fossil jet cost, the cost of feedstocks (especially for synthetic fuels using hydrogen and DAC CO_2), and the future improvement in processing plant costs (including the addition of CCS to FT routes which will significantly increase fuel GHG savings). Our scenarios explore different hydrogen and DAC costs, but hold costs of biomass, waste and waste fats/oils fixed over time (prices may well rise over time, but CCC analysis is only focused on resource costs). Processing costs are assumed to fall over time (as they are largely determined by global progress in SAF scale-up), and do not vary between scenarios. However, the earliest, high-risk projects, or smaller UK projects, or projects further from feedstocks or CO_2 sequestration sites, might be significantly more expensive than modelled. SAF costs are therefore have some level of uncertainty.

- **Impact of demand policies.** Although we have assessed how much efficiency and SAF costs would subtract/add to an indicative trans-Atlantic ticket price, our analysis is only taking the outputs of DfT modelling, and we do not have the ability to feed the specific decarbonisation costs back in to the demand framework to calculate the impact on passenger demand. This limitation also applies to demand management policies – DfT modelling internally assumes a rising carbon price, which reduces demand from an original counterfactual scenario, but CCC again only take the outputs after this internal carbon pricing is applied to demand. The particular policies that might be utilised to manage demand could have different impacts on ticket prices (e.g. carbon pricing, frequent flier levy, VAT, fuel duty, APD reform, airport capacity management). CCC analysis has focused on the outcomes (demand, fuel and emissions), rather than prescribing or modelling the policy method for achieving the demand levels required.

- **Measure interdependencies**. Theoretically, any combination of the mitigation measures discussed in section 2 would be possible, as they separately impact demand, fuel use and fuel accounting emissions. However, scenarios that rely on high amounts of technical change or new expensive fuels will likely either require a profitable sector to fund this RD&D, customers being willing to pay more, and/or more government intervention (regulation or support). Scenarios with negative growth, if repeated globally, are likely to result in a slower uptake of new, more efficient aircraft, and less investment in SAF due to depressed fossil fuel prices. Delivery of the Tailwinds scenario would therefore be particularly challenging – a reduction in demand from 2018 levels, with maximal efficiency and 95% SAF by 2050.

- **Non-CO_2 impacts.** These impacts are discussed in Chapter 8, section 4 of the Advice Report. There remain significant uncertainties in the science and mitigation options, and therefore uncertainties regarding the policy response and any interactions with sector GHG emissions (e.g. re-routing aircraft around super-saturated atmospheric zones to avoid cirrus cloud formation could increase GHG emissions).

Endnotes

[1] CCC(2020) *The Sixth Carbon Budget – Methodology Report*. Available at: www.theccc.org.uk

[2] IATA (2020) *Recovery Delayed as International Travel Remains Locked Down*

[3] CCC (2020) *2020 Progress Report to Parliament*

[4] National Atmospheric Emissions Inventory (2020) *UK Greenhouse Gas Inventory, 1990 to 2018: Annual Report for submission under the Framework Convention on Climate Change*

[5] Civil Aviation Authority (2020) Airport data 2019

[6] ATA & Ellondee (2018) *Understanding the potential and costs for reducing UK aviation emissions*

[7] Defra (2020) *Greenhouse gas reporting: conversion factors 2020*

[8] All the analysis is conducted on an IPCC AR5 basis with carbon feedbacks, using 34 tCO_2e/tCH_4 and 298 tCO_2e/tN_2O.

[9] IATA (2020) *Jet Fuel Price Monitor*

Chapter 2

Emissions pathways for the aviation sector

The following sections are taken directly from Section 7 of Chapter 3 of the CCC's Advice Report for the Sixth Carbon Budget]. [1]

Introduction and key messages

Aviation is one of the sectors in which we expect there to be significant remaining positive emissions by 2050, given the limited set of options for decarbonisation. Remaining residual emissions will need to be offset by greenhouse gas removals (see section 11) for the sector to reach Net Zero.

The evidence base on how to achieve GHG savings in aviation in the UK relies on internal modelling from DfT, Climate Assembly UK demand scenarios and internal CCC analysis of sustainable aviation fuel costs. Further details are provided in the Methodology Report.

We present the scenarios for aviation emissions in three parts:

a) The Balanced Net Zero Pathway for aviation

b) Alternative pathways for aviation emissions

c) Investment requirements and costs

a) The Balanced Net Zero Pathway for aviation

In the Balanced Net Zero Pathway, the aviation sector returns to close to pre-pandemic demand levels by 2024. Thereafter, emissions gradually decline over time (Figure A3.7.a) to reach 23 $MtCO_2e$/year by 2050, despite modest growth in demand.

This gradual reduction in emissions is due to demand management, improvements in efficiency and a modest but increasing share of sustainable aviation fuels:

The Balanced Pathway has 25% growth in demand by 2050 compared to 2018 levels but with no net expansion of UK airport capacity.

- **Demand management.** The Balanced Net Zero Pathway does allow for some limited growth in aviation demand over the period to 2050, but considerably less than a 'business as usual' baseline. We allow for a 25% in growth by 2050 compared to 2018 levels, whereas the baseline reflects unconstrained growth of around 65% over the same period. We assume that, unlike in the baseline, this occurs without any net increase in UK airport capacity, so that any expansion is balanced by reductions in capacity elsewhere in the UK.
- **Efficiency improvements.** The fuel efficiency per passenger of aviation is assumed to improve at 1.4% per annum, compared to 0.7% per annum in the baseline. This includes 9% of total aircraft distance in 2050 being flown by hybrid electric aircraft.

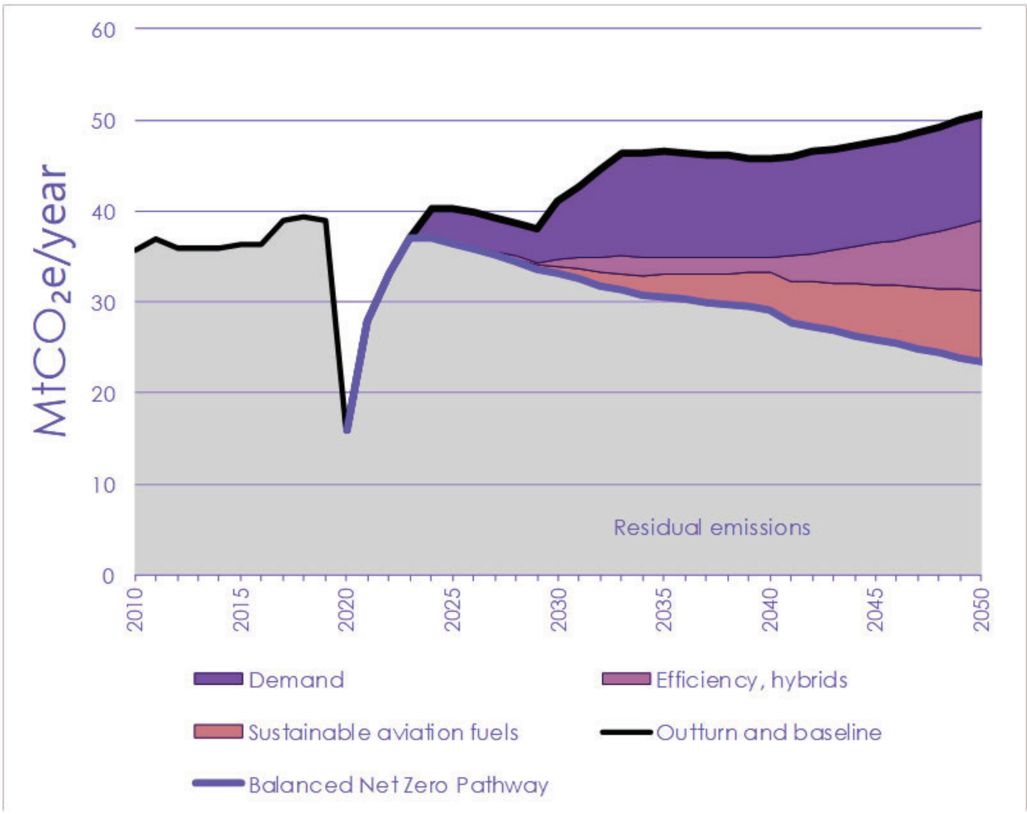
A quarter of jet fuel by 2050 is made from sustainable low-carbon sources.

- **Sustainable aviation fuels (SAF)** contribute 25% of liquid fuel consumed in 2050, with just over two-thirds of this coming from biofuels[1] and the remainder from carbon-neutral synthetic jet fuel (produced via direct air capture of CO_2 combined with low-carbon hydrogen, with 75% of this synthetic jet fuel assumed to be made in the UK and the rest imported).

[1] Biofuels are assumed to be produced with CCS on the production plant – overall carbon-negative but assumed to have zero direct CO_2 emissions in aviation. Removals are accounted for in section 11.

Demand management plays a critical role in ensuring GHG emissions continue to decrease particularly while efficiency benefits and SAF take time to scale up.

Figure A3.7.a Sources of abatement in the Balanced Net Zero Pathway for the aviation sector



Source: BEIS (2020) *Provisional UK greenhouse gas emissions national statistics 2019* CCC analysis.

b) Alternative pathways for aviation emissions

Each of our exploratory scenarios for aviation sees emissions fall from 2018 to 2050 by more than 35% (Figure A3.7.b), though with different contributions from efficiency improvements, sustainable fuels and constraints on demand (Table A3.7):

- **Headwinds** assumes the same 25% growth in demand from 2018 to 2050 as in the Balanced Pathway, although with higher demand in the 2030s due to a net increase in airport capacity. Improvements in efficiency are as in the Balanced Pathway, while biofuels comprise 20% of the fuel mix by 2050. Emissions are 25 $MtCO_2e$ in 2050, 36% below 2018 levels.

Widespread Engagement assumes lower demand in 2050 than in 2018 due mainly to reduced business travel.

- **Widespread Engagement** has lower demand, with an overall reduction of 15% on 2018 levels and therefore around half the 2050 demand as in the baseline. This is in line with the Climate Assembly UK's 'flying less' scenario. It includes a substantial reduction in business aviation due to widespread near-term adoption of videoconferencing. Efficiency improvements are slightly faster than those in the Balanced Pathway at 1.6% per annum, while the share of biofuels in 2050 is slightly lower at 20%, with a further 5% contribution from the biogenic fraction of waste-based fuels.[2] Emissions in 2050 are 15 $MtCO_2e$, 62% below 2018 levels.

Widespread Innovation assumes much higher demand growth is possible due to rapid technology development.

- **Widespread Innovation** has a greater contribution from technological performance, both in terms of improved efficiency (2.1% per annum) and the contribution of sustainable aviation fuels. By 2050, around a quarter of fuel use is biofuel, with a further quarter carbon-neutral synthetic jet fuel. These technical improvements lead to a lower carbon-intensity and lower cost of aviation, although demand in this scenario is considerably higher, reaching 50% above 2018 levels by 2050 (in line with the Climate Assembly UK's 'technological change' scenario). Emissions in 2050 are 15 $MtCO_2e$, 63% below 2018 levels.
- In **Tailwinds**, the reductions in demand under Widespread Engagement are combined with the technology improvements in Widespread Innovation. Demand in 2050 is 15% below 2018 levels and efficiency improves at 2.1% per annum. Very similar volumes of sustainable fuels are used as in Widespread Innovation, but when applied to the lower fuel consumption in Tailwinds these comprise a higher combined share of 95% of fuel use. Emissions in 2050 are 1 $MtCO_2e$, 97% below 2018 levels.

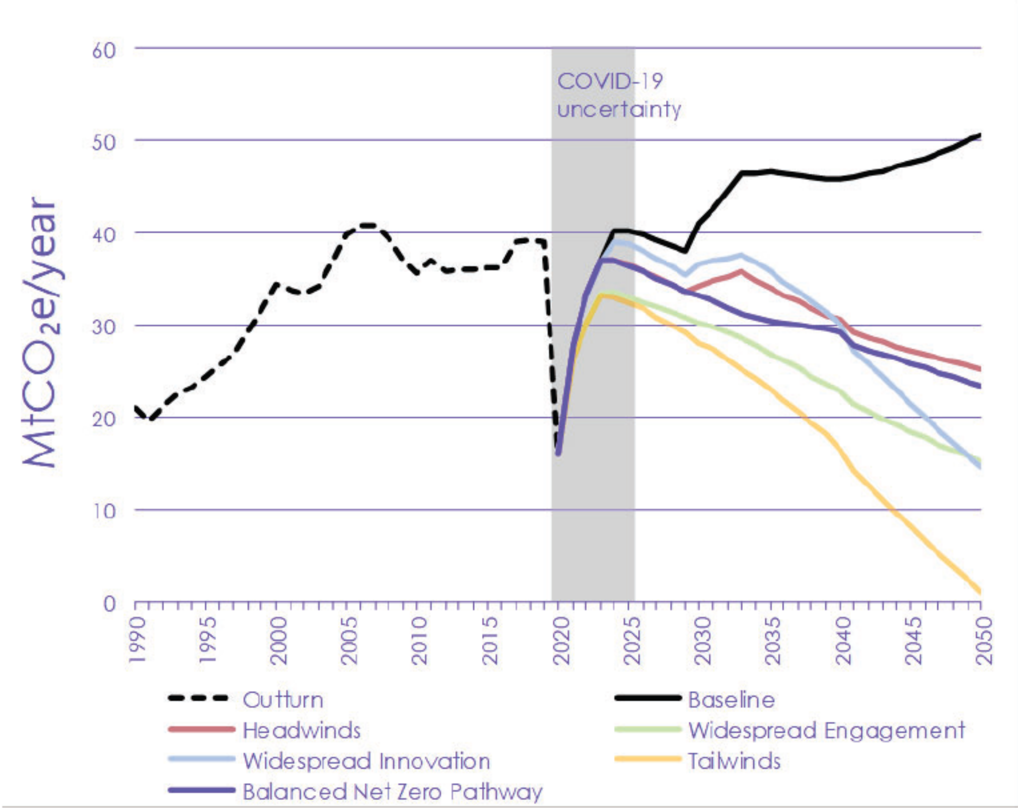
In each case, for the aviation sector to reach Net Zero by 2050, the remaining emissions will need to be offset with greenhouse gas removals (see section 11).

In addition to the GHG emissions presented here, aviation also has non-CO_2 warming impacts due to contrails, NO_x emissions and other factors. While outside of the emissions accounting framework used by UK carbon budgets (see Chapter 10), we estimate the additional warming from these non-CO_2 effects in section 4 of Chapter 8.

[2] Waste-based fuels save less CO_2 than biofuels due to approximately half of the waste carbon content being of fossil origin. Only the biogenic fraction of wastes save CO_2 compared to fossil jet fuel.

COVID-19 has had a dramatic impact and all scenarios remain under 2019 emissions levels. Tailwinds is able to almost completely decarbonise by 2050.

Figure A3.7.b Emissions pathways for the aviation sector



Source: BEIS (2020) *Provisional UK greenhouse gas emissions national statistics 2019* CCC analysis.
Notes: Only direct CO_2 CH_4 and N_2O combustion emissions in aviation are shown. 'Non-CO_2 impacts' are excluded.

Table A3.7
Summary of key differences in the aviation scenarios

	Balanced Pathway	Headwinds	Widespread Engagement	Widespread Innovation	Tailwinds
Demand growth to 2050 (vs. 2018)	**+25%**	+25%	-15%	+50%	-15%
Efficiency improvements (%/year)	**1.4%**	1.4%	1.6%	2.1%	2.1%
Biofuel share in 2050	**17%**	20%	20%	26%	51%
Bio-waste fuel share in 2050	**-**	-	5%	-	-
Synthetic jet fuel share in 2050	**8%**	-	-	25%	44%

c) Investment requirements and costs

In our 2019 *Net Zero* report, we identified aviation as one of the sectors with cost-effective GHG savings, given that efficiency gains could offset the added costs of sustainable aviation fuels. Our updated Sixth Carbon Budget pathways estimate the full costs and savings involved:

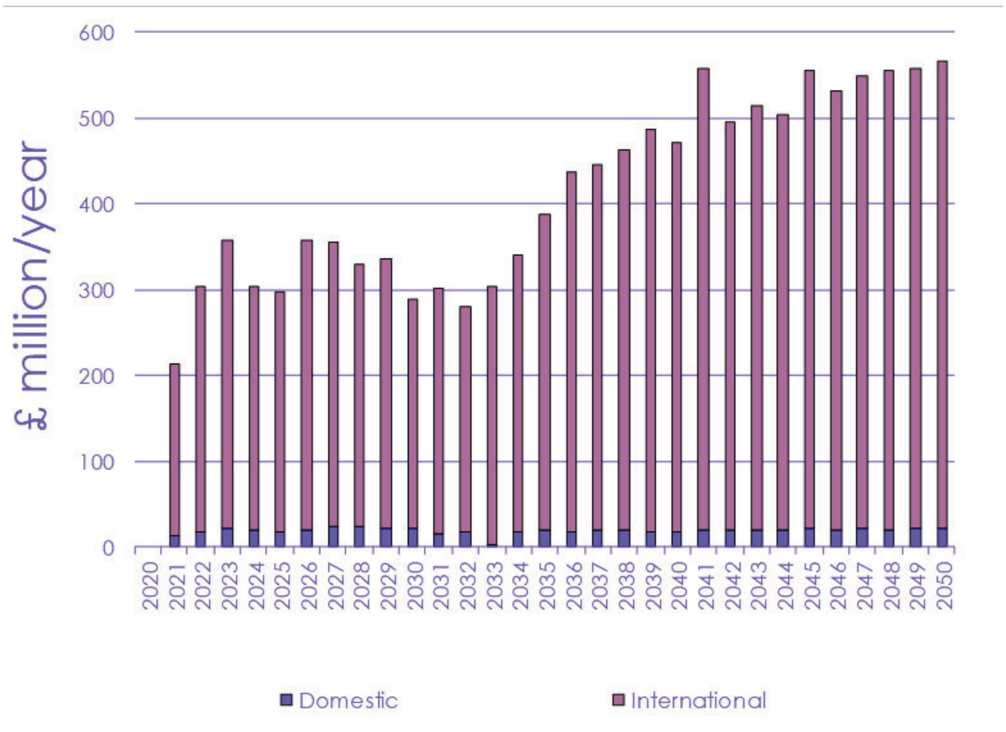
- In the Balanced Net Zero Pathway we estimate total added investment costs above our baseline of around £390 million/year in 2035 and £570 million/year in 2050, for efficiency improvements and hybridisation (Figure A3.7.c).

The capital costs of improved aircraft efficiency are more than offset by fuel savings. Sustainable aviation fuels add significant costs.

- However, these added investment costs are offset by operational cost savings of around £1,230 million/year in 2035 and £2,750 million/year in 2050. There are also added operational costs of using sustainable aviation fuels, given their additional cost above fossil jet fuel, of £470 million/year in 2035, and £1,520 million/year in 2050 (Figure A3.7.d). We have not assigned any costs or savings to reductions in demand in our scenarios.

International aviation dominates UK aviation emissions and investment.

Figure A3.7.c Breakdown of aviation sector additional investment



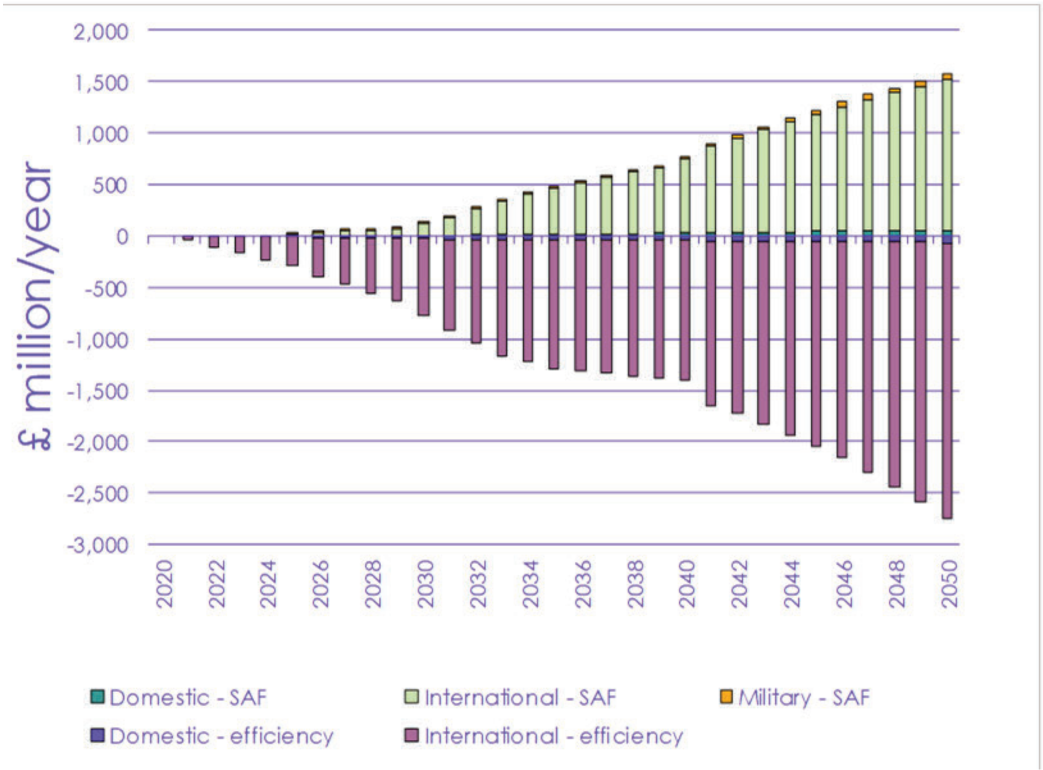
Source: CCC analysis.
Notes: Additional investment in Balanced Net Zero Pathway compared to the baseline due to higher costs of more efficient aircraft. No costs or savings have been assumed for reductions in demand vs. the baseline trajectory. No military aviation cost data available.

- Reducing GHG emissions from UK domestic and international aviation is therefore expected to cost between -£90 and -£40/tCO_2e abated in 2035, and between -£30 and +£20/tCO_2e abated by 2050.* There are increases over time due to higher aircraft costs, and the higher share of GHG savings from biofuels and more expensive synthetic jet fuel. In earlier years, efficiency gains significantly outweigh added fuel costs.

Paying for a fully zero-carbon flight via the use of GHG removal offsets will be affordable by 2050.

- As an example of costs for passengers, sustainable aviation fuels priced with marginal GHG removals might add £35 to a return ticket from London to New York in 2050 in the Balanced Pathway, minus £21 of fuel savings from improved efficiency.[3] If full decarbonisation were paid for using GHG removals to offset residual emissions, this may add a further £41, giving a net added cost of £56.
- The cost of GHG savings in military aviation is based only on the use of biofuels and synthetic jet, and falls to around £110/tCO_2e abated in 2035, staying at around this level to 2050 in the Balanced Pathway.

Figure A3.7.d Breakdown of aviation sector additional costs



Source: CCC analysis.
Notes: Additional operational costs in Balanced Net Zero Pathway compared to the baseline due to higher costs of sustainable aviation fuels and costs savings from improved efficiency. No costs or savings have been assumed for reductions in demand vs. the baseline trajectory. No military aviation cost data for efficiency savings available.

* International aviation is typically at the lower end of this cost range and domestic aviation at the upper end. Efficiency costs are -£280 to -£135/tCO_2e and SAF costs are £110/tCO_2e on average.

[3] Based on ICAO (2020) Carbon Emissions Calculator current value of 671 kgCO_2 per passenger economy return. In 2050 243 kgCO_2 is saved via efficiency 108 kgCO_2 directly via sustainable aviation fuels with 89 kgCO_2 saved upstream from biogenic CO_2 sequestration leaving a further 230 kgCO_2 to be offset via other GHG removals. £180/tCO_2 is assumed for residual offsetting and marginal SAF costs (based on Direct Air Capture with CCS).

Endnote

[1] CCC (2020) *The Sixth Carbon Budget – Methodology Report*. Available at: www.theccc.org.uk

Chapter 3

Policy recommendations for the aviation sector

The following sections are taken directly from Chapter 8 of the CCC's Policy Report for the Sixth Carbon Budget.[1] Chapter 8 covers aviation & shipping policy recommendations together – we have excluded shipping-only content here.

Table P8.1 Summary of policy recommendations in aviation and shipping	
Aviation	• Formally include International Aviation emissions within UK climate targets when setting the Sixth Carbon Budget. • Work with ICAO to set a long-term goal for aviation consistent with the Paris Agreement, strengthen the CORSIA scheme and align CORSIA to this long-term goal. • Commit to a Net Zero goal for UK aviation as part of the forthcoming Aviation Decarbonisation Strategy, with UK international aviation reaching Net Zero emissions by 2050 at the latest, and domestic aviation potentially earlier. Plan for residual emissions, after efficiency, low-carbon fuels and demand-side measures, to be offset by verifiable greenhouse gas removals, on a sector net emissions trajectory to Net Zero. • There should be no net expansion of UK airport capacity unless the sector is on track to sufficiently outperform its net emissions trajectory and can accommodate the additional demand. • Monitor non-CO_2 effects of aviation, set a minimum goal of no further warming after 2050, research mitigation options, and consider how best to tackle non-CO_2 effects alongside UK climate targets without increasing CO_2 emissions. • Longer-term, support for sustainable aviation fuel (SAF) should transition to a more bespoke policy, such as a blending mandate. However, near-term construction of commercial SAF facilities in the UK still needs to be supported. • Continue innovation and demonstration support for SAF technologies, aircraft efficiency measures, hybrid, full electric and hydrogen aircraft development and airspace modernisation.

Progress in decarbonising aviation and shipping has been slow over the past decade, and changes in emissions have primarily been driven by changes in demands along with some improvements in efficiency. Policy to date has been mainly driven by international fora (negotiations at ICAO and the IMO), although neither organisation has both established ambitious 2050 global goals and a set of policies to meet these goals.

The main policy challenges in aviation and shipping are the international nature of these sectors requiring fuel infrastructure coordination, long asset lifetimes and economic competitiveness concerns.

Aviation policy in the UK has previously focused on aerospace developments, although several announcements have been made in 2020, with an Aviation Decarbonisation Strategy now due in 2021. Funding is still mainly directed at innovation and demonstration activities, rather than long-term market deployment support for sustainable aviation fuels and GHG removals.

Our recommendations are based on an assessment of existing policies and announcements, a review of evidence (including the views of the Climate Assembly) and updating our existing findings set out in our 2020 *Progress Report* and 2019 *International aviation & shipping letter*.[2]

This chapter covers:

1. The respective roles for international and domestic policy
2. Existing UK policy, gaps, and planned publications
3. Key policy changes needed

Inclusion of IAS emissions in UK climate targets does not imply taking a unilateral policy approach for them.

Even with their emissions formally included in UK carbon budgets and the Net Zero target, the primary policy approach to reducing emissions from international aviation and shipping (IAS) should be at the international level. These sectors are global in nature and there are some risks that a unilateral UK approach to reducing these emissions could lead to carbon leakage (under certain policy choices) or competitiveness concerns.

The UK has played a key role in progress by both the International Civil Aviation Organisation (ICAO) and International Maritime Organisation (IMO). In the context of international negotiations at the ICAO and the IMO, inclusion of IAS emissions in the Net Zero target should not be interpreted as a rejection of multi-lateral approaches or as prejudicing discussions on burden sharing.

International approaches are unlikely to overcome all barriers to decarbonising the IAS sectors.

However, international approaches are unlikely to overcome all barriers to decarbonising the IAS sectors. Supplementary domestic policies should also be pursued where these can help overcome UK-specific market barriers, and where these do not lead to adverse impacts on competitiveness and/or carbon leakage.

a) International approaches

At the international level, global policies consistent with the ambition in the Paris Agreement are required to provide a level playing field for airlines and shipping operators, and to guard against the risk of competitive distortions. The international trade bodies for both aviation and shipping have begun to develop their approaches but further progress is required:

- **Aviation.** The ICAO's current carbon policy to 2035, the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), aims to ensure that most emissions increases above a baseline year are balanced by offsets.
  - In light of COVID-19, ICAO agreed a baseline year change to 2019 (instead of averaging over 2019-2020). This will reduce offset requirements in the initial years of the scheme as the sector recovers. CORSIA's list of eligible emissions reduction measures has also been finalised.

ICAO needs to set a long-term goal aligned with the Paris Agreement and strengthen CORSIA.

  - A new long-term goal for global international aviation emissions is now required that is consistent with the Paris Agreement. CORSIA then needs to be extended and aligned with this goal, and rules need to be put in place to ensure that CORSIA offsets deliver genuine emission reductions, transitioning to sustainable, well-governed greenhouse gas removals (see Chapter 11).

b) Supplementary domestic policies

Domestic policy can focus on supporting low-carbon fuels managing demand domestic fleet decarbonisation and developing GHG removals.

Supplementary domestic policies that have limited competitiveness or carbon leakage risks should be pursued in parallel to international approaches to decarbonisation. These include support for developing alternative fuels and associated infrastructure, managing demand, decarbonising domestic fleets, and kick-starting a UK market for greenhouse gas removals (see Chapter 11). These domestic policy recommendations are discussed in section 3 below.

By taking these domestic and international policy approaches in parallel to including IAS formally within carbon budgets and the Net Zero target, the UK will be contributing fully to the global effort to tackle aviation and shipping emissions.

a) Aviation

Aerospace development has been a focus in UK policy although the RTFO is yet to bring forward renewable jet fuel.

Existing UK policy in Aviation has been focused on match-funding for aircraft technology development (e.g. the £300million Future of Flight Challenge), and traded certificate price support for aviation biofuels and synthetic jet fuels under the Renewable Transport Fuel Obligation (RTFO)'s 'development fuels' sub-mandate. Recent announcements include:

- The Jet Zero Council has also been established as a forum with the ambition for developing zero-emissions commercial flight.
- £15 million has been invested into FlyZero, with the Aerospace Technology Institute looking at design challenges and the market opportunity for zero-emissions aircraft concepts from 2030.
- £15 million will be invested in a new grant-funding competition for SAF production.
- A SAF clearing house will be set up to enable UK to certify new fuels.
- A planned consultation on a SAF blending mandate has been announced, for a potential start in 2025.
- An aviation Net Zero Consultation and following Strategy were planned for 2020. Plans are to now consult on a combined Aviation Decarbonisation Strategy in 2021.

Government announcements and support to date focuses on innovation and demonstration but long-term deployment policy needs developed.

However, there remain significant gaps within the policy framework for aviation. Government support at present is focused on innovation funding and demonstration activities, but without clear long-term policy mechanisms driving SAF uptake or valuing negative emissions in the UK:

- The RTFO development fuels sub-mandate is unlikely to drive significant development of jet fuels, as it can be met with cheaper fuels.
- There is currently no price signal for GHG removals in the UK.
- There is a lack of larger-scale deployment support and policy frameworks specifically for sustainable aviation fuel and GHG removals.

UK aviation industry has committed to reaching Net Zero by 2050.

Although the UK aviation industry has committed to a Net Zero goal for 2050 (via the Sustainable Aviation coalition),[3] this is not yet a policy goal for Government. Higher-level strategic gaps include the lack of formal inclusion of international emissions in UK carbon budgets and the Net Zero target, and the need for a sector emissions trajectory to inform demand management and airport capacity policies. Further research is also needed on non-CO_2 effects and potential mitigation options.

a) Aviation

International aviation emissions to be included in Carbon Budgets.

The Government should include international aviation emissions within the Sixth Carbon Budget, subsequent carbon budgets and the 2050 Net Zero target.

Government should commit to a 2050 Net Zero goal for UK aviation with use of verifiable GHG removals.

The forthcoming Aviation Decarbonisation Strategy should commit to a 2050 Net Zero goal for UK aviation, with use of verifiable GHG removals (but with limits), and set out demand management policies to ensure a trajectory to 2050 is achieved and that non-CO_2 effects are addressed.

i) Aviation emissions on the way to Net Zero

The Government should commit to UK international aviation reaching net zero GHG emissions by 2050 at the latest, and UK domestic and military aviation potentially earlier.

An emissions trajectory to 2050 will set expectations for use of GHG removals over time.

This will necessarily entail having a plan for how verifiable greenhouse gas removals will offset residual emissions over time (i.e. after contributions from efficiency improvements, low-carbon fuels and demand-side measures). DfT should set a net emissions trajectory for aviation (net of a constrained level of GHG removals), or as a minimum, interim targets on the way to 2050.

- Following the Balanced Net Zero Pathway, the remaining 23 $MtCO_2e$/year of gross aviation emissions in 2050 would require 40% of total UK engineered greenhouse gas removals to be assigned to the aviation sector to achieve Net Zero within aviation.
- With the ramp-up in GHG removals in the UK over time, Figure P8.1 gives an indicative net aviation emissions trajectory that could be followed if 40% of UK GHG removals were assigned to aviation in all years.
- Interim targets for aviation emissions net of greenhouse gas removals could therefore be 31 $MtCO_2e$/year in 2030, 21 $MtCO_2e$/year in 2035 and 14 $MtCO_2e$/year in 2040.

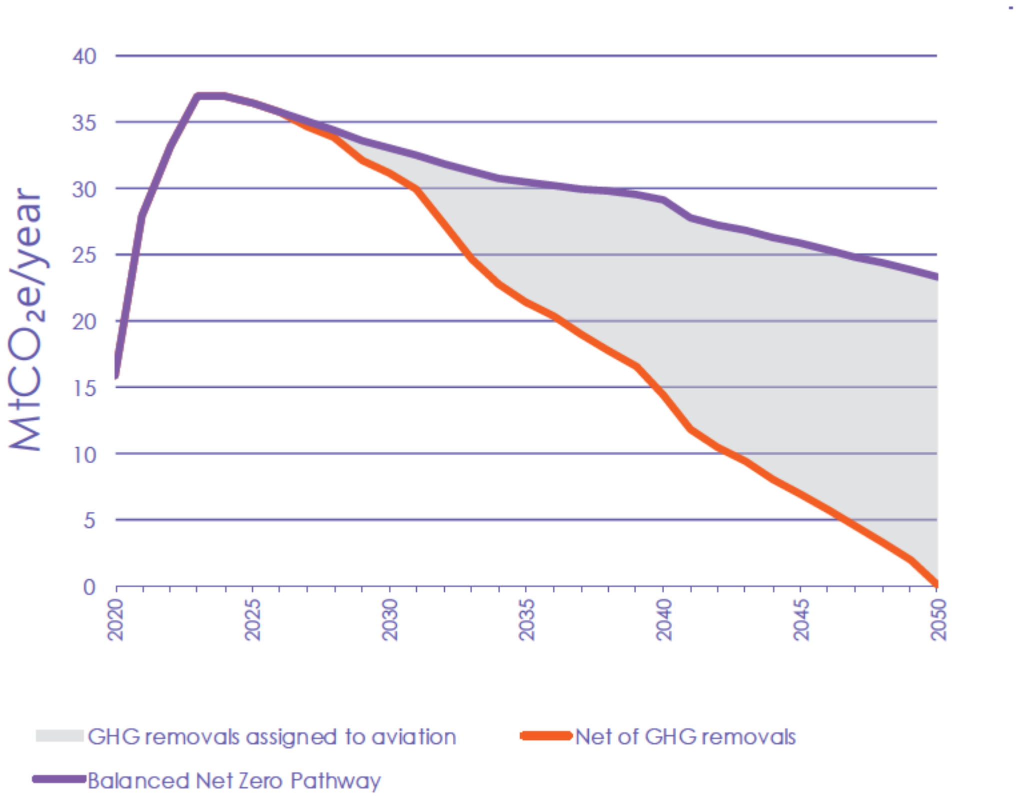
Inclusion of IAS in Carbon Budgets does not diminish the value of a sector target and trajectory.

- Setting an aviation sector net emissions target and trajectory is not obviated by IAS inclusion with carbon budgets. This is more important in aviation than other emitting sectors, given that without policy action aviation emissions could rise significantly (as would non-CO_2 effects) and that, even with appropriate action, residual positive GHG emissions are very likely to remain by 2050 (and need compensating for with greenhouse gas removals). The UK aviation industry has also already committed to a 2050 Net Zero target.

This plan should dovetail with the wider overall strategy for Net Zero, which should set out how this can be achieved with manageable volumes of sustainable greenhouse gas removals.

From the Balanced Net Zero Pathway aviation emissions net of GHG removals fall relatively smoothly from the mid-2020s to 2050 Net Zero.

Figure P8.1 Indicative UK aviation emissions trajectory to achieve Net Zero with GHG removals



Source: CCC analysis.
Note: Net of GHG removals trajectory assumes that 40% of UK engineered GHG removals are assigned to/bought by the aviation sector. COVID-19 recovery assumed from 2020 to 2024.

ii) Demand management

Demand management policy is required as demand growth will need significantly constrained from baseline assumptions and there are non-CO_2 risks.

Demand management policy should be implemented, as given expected developments in efficiency and SAF deployment, demand growth will need to be lower than baseline assumptions, and likely constrained to 25% growth by 2050 from 2018 levels for the sector to contribute to UK Net Zero.

If efficiency or SAF do not develop as expected, further demand management will be required. Conversely, if efficiency and SAF develop quicker, it may be possible for demand growth to rise above 25%, provided that additional non-CO_2 effects are acceptable or can be mitigated.

Demand management needs to act as a back-stop to keep emissions on track to the sector trajectory to Net Zero.

A demand management framework will therefore need to be developed and in place by the mid-2020s to annually assess and, if required, act as a backstop to control sector GHG emissions and non-CO_2 effects.

- There are a number of demand management policies that could be considered, as we outlined in our 2019 *IAS letter*.[2] However, the Climate Assembly has provided valuable evidence that demand management policies will have to be fair and be seen as fair, with a clear preference for any taxes to increase as people fly more and fly further (Box P8.1).

- As part of providing wider information regarding transport choices, Government should also consider the feasibility and benefits of providing flight CO_2 labelling to prospective aviation passengers, building on the work of the Civil Aviation Authority (CAA).

The Government should assess its airport capacity strategy in the context of Net Zero and any lasting impacts on demand from COVID-19. Investments will need to be demonstrated to make economic sense in a Net Zero world and the transition towards it.

- Unless faster than expected progress is made on aircraft technology and SAF deployment, such that the sector is outperforming its trajectory to Net Zero, current planned additional airport capacity would require capacity restrictions placed on other airports.

No net expansion of UK airport capacity unless the sector is on track to sufficiently outperform its trajectory.

- Going forwards, there should be no net expansion of UK airport capacity unless the sector is assessed as being on track to sufficiently outperform a net emissions trajectory that is compatible with achieving Net Zero alongside the rest of the economy, and is able to accommodate the additional demand and still stay on track.

The Climate Assembly stated a clear preference for demand taxes to increase as people fly more and fly further.

Box P8.1
Climate Assembly aviation demand findings

Box 8.1 from the *Methodology Report*, Chapter 8, highlights the Climate Assembly's preferences regarding demand growth. The Assembly recommended 25-50% demand growth by 2050 from 2018, depending on how quickly technology progressed. A weighted average of the scenario votes was a 24% growth.

80% of assembly members 'strongly agreed' or 'agreed' that taxes that increase as people fly more often and as they fly further should be part of how the UK gets to Net Zero. Assembly members saw this as fairer than alternative policy options, such as a carbon tax that would impact all flights.

There were also strong calls for making alternatives to flying cheaper and better, and for the UK to influence the rest of the world in implementing global decarbonisation policies.

Source: Climate Assembly UK (2020).

iii) Wider supporting policies

Alongside the Aviation Decarbonisation Strategy, UK policy should also:

Support is needed for the UK's first commercial SAF plants.

- Set out a policy package for supporting the near-term deployment of commercial sustainable aviation fuel (SAF) facilities in the UK (with carbon capture and storage (CCS) where applicable). This may involve capital or loan guarantee support. In the mid-term, SAF support should transition to a more bespoke policy than the RTFO.
  - The existing RTFO will not be suitable for delivering mass commercial roll-out of SAF, due to decreasing liquid road fuel use. It may also make more sense for long-term SAF deployment to be paid for by the aviation sector rather than road fuel users.

A SAF blending mandate could provide more certainty to SAF plant investors.

  - Government has indicated willingness to consider introducing a SAF blending mandate from 2025,[4] which could ultimately provide more certainty to SAF plant investors than the RTFO. A SAF mandate is likely to be more effective than Contracts for Difference (as the technology maturity of many routes are not high enough and there are variable feedstock costs), inclusion in an Emissions Trading Scheme (likely insufficient and volatile pricing signal) or carbon taxation (would have to be high to incentivise initial SAF deployment, and not perceived as fair by the Climate Assembly).

Many other European countries already have SAF blending mandates so carbon leakage risks are decreasing.

  - Whether the mandate's added SAF costs then fall to the aviation sector or general taxation will depend on the policy design and any concerns regarding UK operator competitiveness or carbon leakage. Several other European countries already have SAF blending mandates and are introducing ambitious blending trajectories, which suggests the risk of leakage is decreasing (e.g. France is targeting 5% by 2030 & 50% by 2050; Finland & Sweden 30% by 2030; Germany 2% by 2030; with an EU-wide proposal for 1-2% by 2030).[4]
  - Ongoing uncertainty until 2025 about a new UK SAF mandate, and withdrawal of SAF from the RTFO, may risk delaying first commercial SAF projects in the UK reaching financial close for several years. Consideration could be given to either RTFO grandfathering, starting the SAF mandate earlier or running it in parallel to the RTFO.
- Continue innovation and demonstration support for newer SAF technologies, ensuring fuels can meet international standards. The newly announced £15m competition focused only on SAF is welcome, although is smaller than previous competitions.
- Continue RD&D support for aircraft efficiency measures, hybrid, full electric & hydrogen aircraft development and airspace modernisation. Continue to use existing delivery bodies, such as ATI, the Future of Flight Challenge, NATS, and guided by the Jet Zero Council.

Strict sustainability standards will need to be enforced any double-counting of removals avoided and SAF plants should be built with CCS.

- Continue to enforce strict sustainability standards, and work to consistently account for fuels produced with biogenic CO_2 capture without allowing double-counting of any GHG removals.

[4] From our analysis potential UK SAF blending levels could be 1.5-3 5% by 2030 4-9% by 2035 and 11-17% by 2040 although the top end of these figures could almost be doubled in a Tailwinds scenario due to faster technology deployment and higher biofuel imports.

- SAF facilities should have to install CCS, or be built CCS ready, in order to maximise GHG savings from any concentrated CO_2 streams or dilute flue gases.* The 2022 Bioenergy Strategy should set a date after which all new build plants must use CCS, and a date after which existing plants should retrofit CCS.

- An accounting choice needs to be made as to whether the consumer of a fuel made with CCS gets to account for the GHG removals (i.e. fuels can be carbon negative, further reducing end-use sector direct emissions),[5] or whether the producer of the fuel gets to account for the GHG removals (and the fuel is carbon neutral).

- Any GHG removals accounted for within a fuel carbon intensity factor or by a producer cannot also be claimed by another actor or sector.

- A clear GHG savings methodology needs to be established for wastes.

• Monitor non-CO_2 effects of aviation, continue to work to reduce scientific uncertainties, and fund research into mitigation options such as SAF benefits and engine design improvements.

  - Once mitigation options are better characterised, consider policy responses as to how best to tackle them alongside UK climate targets without increasing CO_2 emissions.

There should be no additional non-CO_2 warming after 2050.

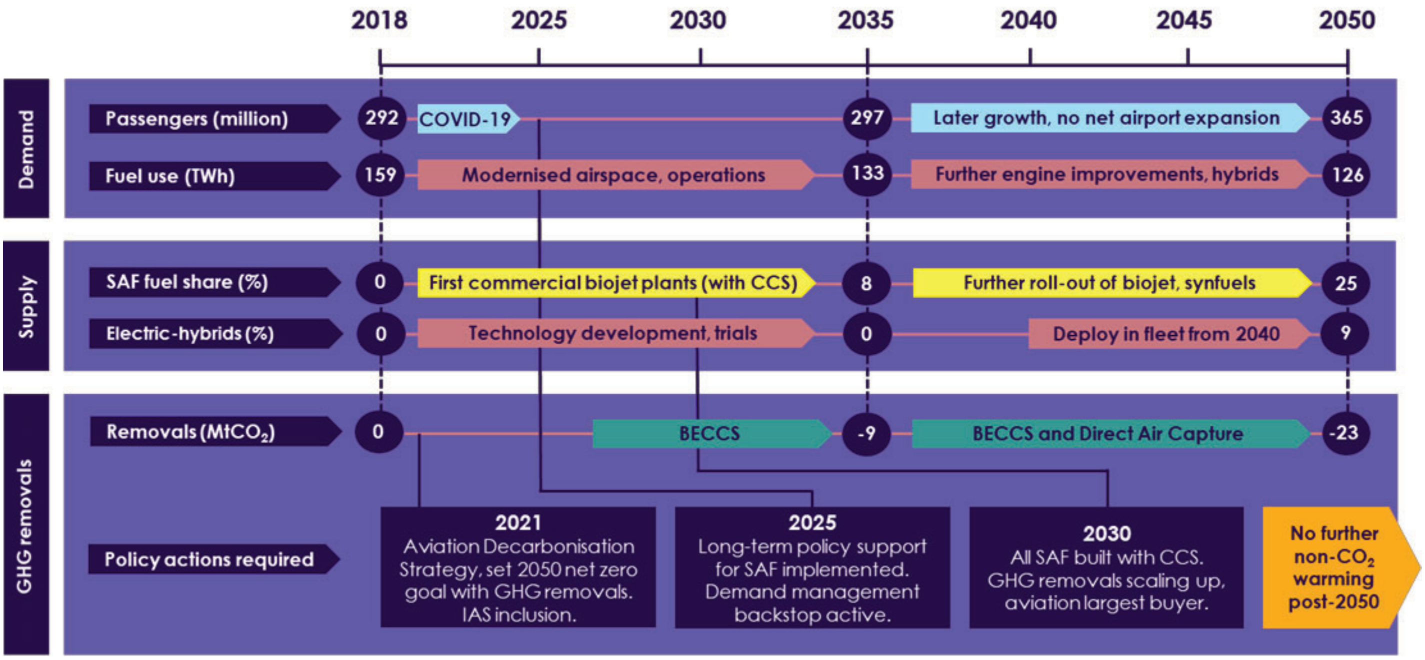
  - As a minimum goal, there should be no additional non-CO_2 warming from aviation after 2050. If mitigation options develop quickly, or new risks are identified, DfT could consider an earlier date, or setting a maximum level of allowable non-CO_2 warming from a base year.

Alongside efforts at ICAO, the Aviation Decarbonisation Strategy and the package of domestic policies, plus parallel progress on a mechanism for deploying GHG removals in the UK (see Chapter 11), should put UK aviation emissions on track to contribute fully to meeting the Sixth Carbon Budget and the Net Zero target. A summary of the required steps in aviation is given in Figure P8.2.

* Some SAF conversion plants do not produce CO_2 and hence these CCS provisions may not apply to them. For example synthetic jet fuel routes use CO_2 as a feedstock and waste fats/oils to biojet wil produce little CO_2. However these plants may still have dilute flue gas streams from which CO_2 should still be captured.

[5] UK biofuels policy currently uses GHG emissions thresholds (gCO2e/MJ of fuel) as one set of eligibility criteria for support. Setting a negative GHG emissions threshold may lead to perverse outcomes where only less efficient plants meet the threshold. Any negative threshold would have to be accompanied by a minimum efficiency and would preclude carbon-neutral fuels. It is likely more appropriate to maintain low positive GHG emissions thresholds for eligibility purposes but allow additional benefits to flow to conversion plants capturing biogenic CO_2 (this may be achieved already by the design of wider GHG removals policies).

Figure P8.2 Timeline of key outcomes and policy requirements under the Balanced Pathway (2020-50)



Source: CCC analysis.
Note: SAF = Sustainable Aviation Fuel. BECCS = Bioenergy with carbon capture and storage

Endnotes

[1] CCC(2020) *Policies for the Sixth Carbon Budget and Net Zero*. Available at: www.theccc.org.uk
[2] CCC (2019) *Net-zero and the approach to international aviation and shipping emissions*
[3] Sustainable Aviation (2020) *UK aviation commits to net zero carbon emissions by 2050*
[4] Argus (2020) *Europe makes legislative push for aviation transition*

Climate Change Committee

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Photo: bust of Edward Welby Pugin by Rebekah Smith

Photo by Luke Evans

Thanet benefits from 1,192 new trees **and many more to come**

Eighteen months ago a local teacher, Luke Evans, had a vision for Thanet: greener open spaces, increased bio-diversity and more trees.

He enlisted the help of Colourful Margate, Thanet Community Forest School, Sunken Garden Society, local Councillors and Thanet District Council and then applied for a Forestry Commission Urban Tree Challenge grant for £500,000, little believing he would get it.

But he did! Luke recruited Peter Hasted and the Isle of Thanet Trees and Woods Initiative (ITTWI), was born on January 11, 2020.

The Urban Tree Challenge Fund (UTCF) awards payments once the work is done and money has already been spent on planting. But ITTWI had a problem. How to buy the trees and all the kit to start with? Thanet Community Forest School could subsidise some of it, but not all.

Grants and donations were needed to bridge the gap as trees don't come cheap! The new owners of Manston Airport, RiverOak Strategic Partners (RSP) kindly agreed to help fund the buying of trees for Thanet.

They initially donated £20,000, with the promise of more money later. The dream was becoming reality.

The first tree was planted in Dane Park with the help of volunteers and then 99 more. The next phase of planting was 286 trees in one day at Dane Valley Green, by Peter and more than 300 volunteers from the community.

Next came a further 362 trees at the Thanet Community Forest School and six trees at the Sunken Garden at Westgate.

Despite Covid, and when safe to do so, the Spring and Summer 2020 saw the Community out and about again watering the trees with the help of Quex Estates, who helped out with a Water Tanker for Dane Valley Green and Dane Park.

The new planting projects for Autumn/Winter of 2020/21 were disrupted and volunteers were no longer allowed to help.

Continued >

However, since then, Peter and a small team including Karen McKenzie, Tree Warden for Broadstairs & St Peters, have managed to plant 363 more; Tivoli & Hartsdown Park in Margate now enjoys 180 new trees, 50 at Westover Gardens and 50 at George V Avenue. In total, by the end of its first year, Thanet is already benefiting (at the time of writing in March) from 1,192 new trees, with the remaining 68 trees in the Urban Tree Challenge Fund to follow next year. While ITTWI continues to negotiate with many organisations to continue 'planting trees for our future'.

A further donation of £15,000 was gratefully received recently from RSP towards the payment for more trees, with the promise of even more in the future. Further grants, sponsors and donations will continue to be vital for the project to continue its life beyond the end of the initial grant from the Forestry Commission. Their aim is to create and stimulate interest from people of all ages and encourage them to become "champions of trees and wildlife" throughout Thanet.

With a new Board who are focused on training, education and employment, it is proposed and hoped that primary and secondary schools will get on board as soon as they can, so that in the future, generations will be keen to appreciate, possibly even own and maintain the trees in their local area and across the whole of Thanet. Planting from seed is one way of getting youngsters to appreciate how things grow and mature. Remember the saying: from tiny acorns the mighty oaks will grow.

If you or your school would be interested in any aspects of the seed growing and/or tree planting projects, or would like to donate, or if you are a local company that can see the benefit of linking to ITTWI, please contact **info@ittwi.org.uk**. You can also find us on Facebook by searching Isle of Thanet Trees & Woods Initiative.

Written by: Angela Stevens

Photo of Peter Hasted, Director of ITTWI, by Jamie Horton

Press release

UK enshrines new target in law to slash emissions by 78% by 2035

Related content

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Notes to editors

Appeal Decision

Inquiry held over 30 days between 12 January 2021 and 12 March 2021
Site visits made on 17 December 2020 and 10 March 2021

by Michael Boniface MSc MRTPI, G D Jones BSc(Hons) DipTP MRTPI and Nick Palmer BA (Hons) BPl MRTPI

Panel of Inspectors appointed by the Secretary of State

Decision date: 26 May 2021

Appeal Ref: APP/C1570/W/20/3256619
London Stansted Airport, Essex

- The appeal is made under section 78 of the Town and Country Planning Act 1990 against a refusal to grant planning permission.
- The appeal is made by Stansted Airport Limited against the decision of Uttlesford District Council.
- The application Ref UTT/18/0460/FUL, dated 22 February 2018, was refused by notice dated 29 January 2020.
- The development proposed is airfield works comprising two new taxiway links to the existing runway (a Rapid Access Taxiway and a Rapid Exit Taxiway), six additional remote aircraft stands (adjacent Yankee taxiway); and three additional aircraft stands (extension of the Echo Apron) to enable combined airfield operations of 274,000 aircraft movements (of which not more than 16,000 movements would be Cargo Air Transport Movements) and a throughput of 43 million terminal passengers, in a 12-month calendar period.

Decision

1. The appeal is allowed and planning permission is granted for airfield works comprising two new taxiway links to the existing runway (a Rapid Access Taxiway and a Rapid Exit Taxiway), six additional remote aircraft stands (adjacent Yankee taxiway); and three additional aircraft stands (extension of the Echo Apron) to enable combined airfield operations of 274,000 aircraft movements (of which not more than 16,000 movements would be Cargo Air Transport Movements) and a throughput of 43 million terminal passengers, in a 12-month calendar period at London Stansted Airport, Essex in accordance with the terms of the application, Ref UTT/18/0460/FUL, dated 22 February 2018, subject to the conditions contained in the attached Schedule.

Application for Costs

2. At the Inquiry an application for costs was made by Stansted Airport Limited against Uttlesford District Council. This application is the subject of a separate Decision.

Preliminary Matters

3. The Inquiry was held as a wholly virtual event (using videoconferencing) in light of the ongoing pandemic. The Panel undertook an accompanied site visit to the airport on 10 March 2021 and an unaccompanied visit around the

surrounding area on the same day. An unaccompanied visit to the publicly accessible parts of the airport and surrounding area also took place on 17 December 2020.

4. On 18 May 2018, during the course of the planning application, the Council agreed to a request from the appellant to change the description of development to include a restriction on cargo air transport movements. This is the basis upon which the Council subsequently determined the application. The appeal has been considered on the same basis.

5. The Council resolved to grant planning permission for the development on 14 November 2018 but subsequently reconsidered its position before formally refusing planning permission. In light of the Council's reasons for refusal, its subsequent statement of case in this appeal and given the length of time that had passed since the application was made, an Environmental Statement Addendum (October 2020) (ESA) was produced to update the original Environmental Statement (February 2018) (ES). The Council consulted on the ESA so that all parties had an opportunity to consider its content. As such, the Panel is satisfied that no party is prejudiced by its submission at the appeal stage.

6. The ES and ESA were prepared in accordance with the Town and Country Planning (Environmental Impact Assessment) Regulations 2017 (EIA Regulations), including technical appendices and a non-technical summary. They cover a range of relevant topics, informed at the ES stage by a Scoping Opinion from the Council. The Panel is satisfied that the totality of the information provided is sufficient to meet the requirements of Schedule 4 of the EIA Regulations and this information has been taken into account in reaching a decision. Accordingly, while some of the evidence is critical of the ES and ESA, including in respect to their conclusions regarding carbon emissions, there is no significant contradictory evidence that causes the ES or the ESA to be called into question.

7. A local campaign group known as Stop Stansted Expansion (SSE) was granted Rule 6 status and participated as a main party to the Inquiry. However, shortly before the Inquiry opened it elected to rely on its written evidence for several topics so that a witness was not made available for cross-examination on those topics[1]. As such, this evidence was untested and has been considered by the Panel on this basis.

8. Rule 6 status was also granted jointly to Highways England and Essex County Council (the Highway Authorities) who initially opposed the proposal on highway grounds. However, these issues were resolved before the exchange of evidence and the Highway Authorities subsequently withdrew from the appeal proceedings, subject to appropriate planning obligations being secured.

9. The Council's fourth reason for refusing planning permission referred to the adequacy of infrastructure and mitigation measures needed to address the impacts of the development. This reason was partly addressed following agreement with the Highway Authorities about the scope of highways mitigation required, including at Junction 8 of the M11. The adequacy and need for other forms of mitigation are addressed in the body of this decision in

[1] Historical Background, Noise, Health and Well-Being, Air Quality, Surface Access (Rail)

relation to relevant topics and/or in relation to the discussion on conditions and planning obligations, such that this is not a main issue in the appeal.

10. Upon exchange of evidence between the parties, it became clear that the Council accepted that planning permission should be granted for the development, subject to conditions and obligations. However, there remained significant divergence between the parties as to the form and extent of any conditions and much time was spent discussing this matter over the course of the Inquiry.

11. On 20 April 2021, the Government announced that it would set a new climate change target to cut emissions by 78% by 2035 compared to 1990 levels and that the sixth Carbon Budget will incorporate the UK's share of international aviation and shipping emissions. The parties were invited to make comment and their responses have been taken into account in reaching a decision[2].

Main Issues

12. The main issues are the effect of the development on aircraft noise, air quality and carbon/climate change.

13. However, it is first necessary to consider national aviation policy and some introductory matters.

Reasons

National Aviation Policy and Introductory Matters

14. The Aviation Policy Framework (March 2013) (APF) sets out the Government's high-level objectives and policy for aviation. It recognises the benefits of aviation, particularly in economic terms, and seeks to ensure that the UK's air links continue to make it one of the best-connected countries in the world. A key priority is to make better use of existing runway capacity at all UK airports. Beyond 2020, it identifies that there will be a capacity challenge at all of the biggest airports in the South East of England.

15. There is also, however, an emphasis on the need to manage the environmental impacts associated with aviation and a recognition that the development of airports can have negative as well as positive local impacts. Climate change is identified as a global issue that requires action at a global level, and this is said to be the Government's focus for tackling international aviation emissions, albeit that national initiatives will also be pursued where necessary.

16. More recently, the Government published the ANPS[3] and MBU[4], on the same day, as early components of the forthcoming Aviation Strategy. The ANPS is primarily concerned with providing a policy basis for a third runway at Heathrow and is relevant in considering other development consent applications in the South East of England. It is of limited relevance to the current appeal as it is not a Nationally Significant Infrastructure Project (NSIP). Although the ANPS does refer to applications for planning permission, it notes the findings of the Airports Commission on the need for more intensive use of

[2] Having heard a significant amount of evidence on carbon and climate change during the Inquiry, the matters raised by the announcement did not necessitate reopening the Inquiry. Nor was it necessary for the ES to be further updated, as the announcement does not have a significant bearing on the likely effects of the development

[3] Airports National Policy Statement: new runway capacity and infrastructure at airports in the South East of England (June 2018)

[4] Beyond the horizon, The future of UK aviation, Making best use of existing runways (June 2018)

existing infrastructure and accepts that it may well be possible for existing airports to demonstrate sufficient need for their proposals, additional to (or different from) the need which is met by the provision of a Northwest Runway at Heathrow.

17. MBU builds upon the APF, again referencing work undertaken by the Airports Commission which recognised the need for an additional runway in the South East by 2030 but also noted that there would be a need for other airports to make more intensive use of their existing infrastructure. On this basis, MBU states that the Government is supportive of airports beyond Heathrow making best use of their existing runways[5]. There is no requirement flowing from national aviation policy for individual planning applications for development at MBU airports, such as Stansted, to demonstrate need[6] for their proposed development or for associated additional flights and passenger movements. This was not disputed by the Council and whilst SSE took a contrary view, even its witness accepted that there was a need for additional capacity within the London airport network, beyond any new runway at Heathrow[7].

18. The in-principle support for making best use of existing runways provided by MBU is a recent expression of policy by the Government. It is given in full knowledge of UK commitments to combat climate change, having been published long after the Climate Change Act 2008 (CCA) and after the international Paris Agreement. It thoroughly tests the potential implications of the policy in climate change terms, specifically carbon emissions. To ensure that Government policy is compatible with the UK's climate change commitments the Department for Transport (DfT) aviation model was used to look at the impact of allowing all MBU airports to make best use of their existing runway capacity[8]. This methodology appears to represent a robust approach to the modelling.

19. International aviation emissions are not currently included within UK carbon budgets and are instead accounted for through 'headroom' in the budgets, with a planning assumption for aviation emissions of 37.5Mt of CO_2. Whilst the Government has recently announced that international aviation will expressly form part of the sixth Carbon Budget, its budget value has not yet been defined.

20. Of course, the headroom approach of taking account of emissions from international aviation which has been used to date means that accounting for such carbon emissions as part of the Carbon Budget process is nothing new. What is set to change, however, is the process by which it is taken into account. As of yet, there has been no change to the headroom planning assumption. Nor has there been any indication from the Government that there will be a need to restrict airport growth to meet the forthcoming budget for international aviation, even if it differs from the current planning assumption. The specific carbon/climate change implications of this appeal are considered in more detail below.

[5] There is nothing in MBU which suggests that making best use proposals cannot involve operational development of the type proposed in this case
[6] Notwithstanding conclusions in relation to Manston Airport, which is not comparable to the current proposal (being a Development Consent Order scheme, involved an unused airfield and was a cargo-led proposal rather than passenger)
[7] Brian Ross in response to questions from the Inspector
[8] Emissions from UK airports not included in the model are unlikely to be significant as they are small and offer only short-range services

21. MBU sets out a range of scenarios for ensuring the existing planning assumption can be met, again primarily through international agreement and cooperation, considering carbon traded or carbon capped scenarios. It concludes that the MBU policy, even in the maximum uptake scenario tested, would not compromise the planning assumption.

22. Notwithstanding that conclusion, no examples of MBU-type airport development having gained approval since the publication of MBU were brought to the attention of the Inquiry[9] and whilst numerous other airports have plans to expand, none of those identified appear to have a prospect of receiving approval before this scheme. As such, it can be readily and reasonably concluded that this development would not put the planning assumption at risk.

23. Consistent with the APF, MBU differentiates between the role of local planning and the role of national policy, making it clear that the majority of environmental concerns, such as noise and air quality, are to be taken into account as part of existing local planning application processes. Nonetheless, it adds that some important environmental elements should be considered at a national level, such as carbon emissions, which is specifically considered by MBU. The Council apparently understood this distinction in resolving to grant planning permission in 2018. However, it subsequently changed its position, deciding that carbon is a concern for it as local planning authority despite MBU, and this led, at least in part, to the refusal of planning permission, as well as to its subsequent case as put at the Inquiry.

24. Since publication of MBU, UK statutory obligations under the CCA have been amended to bring all greenhouse gas emissions to net zero by 2050, compared to the previous target of at least 80% reduction from 1990 levels. In addition, the Government has indicated a new climate change target to cut emissions by 78% by 2035 compared to 1990 levels, effectively an interim target on the journey to net zero. Notwithstanding these changes, MBU has remained Government policy. There are any number of mechanisms that the Government might use to ensure that these new obligations are achieved which may or may not involve the planning system and may potentially extend to altering Government policy on aviation matters.

25. These are clearly issues for the Government to consider and address, having regard to all relevant matters (not restricted to aviation). The latest advice from the Committee on Climate Change (CCC) will be one such consideration for the Government but it cannot currently be fully known to what extent any recommendations will be adopted. The Government is clearly alive to such issues and will be well aware of UK obligations[10].

26. The ES and ESA contain detailed air traffic forecasts which seek to demonstrate the difference between a 'do minimum' scenario, where the airport makes use of its existing planning permission within its relevant restrictions, and the 'development case' scenario where the appeal development were to proceed. The forecasts are prepared in accordance with industry guidance and practise

[9] With the potential exception of the Southampton Airport scheme, which involved a runway extension to accommodate larger aircraft. No detailed evidence in relation to this scheme was provided by the parties, but it would not alter the Panel's conclusions on MBU support even if an increase in capacity resulted from the scheme
[10] Not least from the recent Supreme Court Judgement in respect of the ANPS - R (on the application of Friends of the Earth Ltd and others) v Heathrow Airport Ltd [2020] UKSC 52

by a professional in this field working as a Director in the aviation department for a global consulting service.

27. The Council, whilst highlighting the inherent uncertainty in forecasts and projections into the future, did not dispute the appellant's position on forecasting, concluding that the predictions were reasonable and sensible[11]. SSE made a series of criticisms of the inputs and assumptions used by the appellant, but these were largely based on assertion and often lacked a clear evidential basis. Different opinions about the likely number of passengers per air transport movement, fleet replacement projections, dominance of / reliance on a single airline at Stansted and cargo expectations were all rebutted by the appellant with justification for the inputs and assumptions used. The Panel was not persuaded that the conclusions in the ES and ESA were incorrect or unreliable. Indeed, they are to be preferred over the evidence of SSE on this matter, which was not prepared by a person qualified or experienced in air traffic forecasting. Accordingly, the forecasts contained within the ES and ESA are sufficiently robust and the best available in this case.

28. The appellant's forecasts do not align with those prepared by the Government in 2017 (DfT forecasts) which are used as the basis for conclusions in MBU, as referred to above. However, there is no reason why they should. The DfT makes clear that its forecasts are a long-term strategic look at UK aviation, primarily to inform longer term strategic policy. They do not provide detailed forecasts for each individual airport in the short-term and the DfT acknowledge that they may differ from local airport forecasts, which are prepared for different purposes and may be informed by specific commercial and local information not taken into account by the DfT. As such, the DfT states that its forecasts should not be viewed as a cap on the development of individual airports.

29. On this basis, the Panel does not accept that a divergence between the appellant's and the DfT's forecasts indicate any unreliability in the data contained in the ES and ESA. Nor is there any justification for applying a reduction to the appellant's forecasts[12]. Furthermore, SSE's forecasting witness recently challenged the validity and reliability of the DfT forecasts in the High Court while acting for SSE, thereby further calling into question the credibility of their now contradictory evidence to this Inquiry.

30. It remained unclear throughout the Inquiry, despite extensive evidence, why the speed of growth should matter in considering the appeal. If it ultimately takes the airport longer than expected to reach anticipated levels of growth, then the corresponding environmental effects would also take longer to materialise or may reduce due to advances in technology that might occur in the meantime. The likely worst-case scenario assessed in the ES and ESA, and upon which the appeal is being considered, remains just that. Conversely, securing planning permission now would bring benefits associated with providing airline operators, as well as to other prospective investors, with significantly greater certainty regarding their ability to grow at Stansted, secure long-term growth deals and expand route networks, potentially including long haul routes.

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[11] Proof of Hugh Scanlon, UDC/4/1

[12] This is notwithstanding examples of previous air traffic forecasts for Stansted and other airports that have not be borne out for whatever reason. Any reduction to account for perceived optimism bias would be arbitrary and unlikely to assist the accuracy of the forecasts

31. SSE argued that the 'do minimum' case had been artificially inflated to minimise the difference from the 'development case'. However, there is no apparent good reason why the airport would not seek to operate to the maximum extent of its current planning restrictions if the appeal were to fail. Indeed, as a commercial operator, there is good reason to believe that it would. The fact that it does not operate in this way already does not mean it cannot or will not in future. In fact, the airport has seen significant growth in passenger numbers in recent years, since Manchester Airports Group took ownership, albeit that these have latterly been affected by the pandemic.

32. As such, there is no good reason to conclude that the air traffic forecasts contained within the ES and ESA are in any way inaccurate or unreliable. Of course, there is a level of uncertainty in any forecasting exercise but those provided are an entirely reasonable basis on which to assess the impacts of the proposed development. The Panel does not accept that there has been any failure to meet the requirements of the EIA Regulations, as concluded above.

Aircraft Noise

33. The overarching requirements of national policy, as set out in the National Planning Policy Framework (the Framework) and the Noise Policy Statement for England (NPSE), are that adverse impacts from noise from new development should be mitigated and reduced to a minimum and that significant adverse impacts on health and quality of life should be avoided. It is a requirement of the NPSE that, where possible, health and quality of life are improved through effective management and control of noise.

34. The APF states that the overall policy is to limit and, where possible, reduce the number of people significantly affected by aircraft noise. The APF expects the aviation industry to continue to reduce and mitigate noise as airport capacity grows and that as noise levels fall with technology improvements the benefits are shared between the industry and local communities.

35. While the APF states that the 57 dB LAeq 16 hour contour should be treated as the average level of daytime aircraft noise marking the approximate onset of significant community annoyance, the 2014 Survey of Noise Attitudes (SoNA) indicates that significant community annoyance is likely to occur at 54 dB $L_{Aeq\ 16\ hour}$. The latter metric has been used by the Civil Aviation Authority in its *Aviation Strategy: Noise Forecast and Analysis – CAP 1731.* It has also been used in the Government's consultation *Aviation 2050, The future of UK aviation.* The Council and the appellant agree that the 54 dB $L_{Aeq\ 16\ hour}$ contour should be the basis for future daytime noise restrictions in this case.

36. The NPSE describes the concepts of Lowest Observed Adverse Effect Level (LOAEL) and Significant Observed Adverse Effect Level (SOAEL). The LOAEL is set at 51 dB $L_{Aeq\ 16\ hour}$ in the DfT's Air Navigation Guidance and is the level above which adverse effects on health and quality of life can be detected. These levels apply to daytime hours. The corresponding levels at night are a LOAEL of 45 dB $L_{Aeq\ 8\ hour}$ and onset of significant annoyance at 48dB $L_{Aeq\ 8\ hour}$.

37. The World Health Organisation's (WHO) Environmental Noise Guidelines 2018 (ENG) recommend lower noise levels than those used in response to SoNA. The Government has stated in *Aviation 2050* that it agrees with the ambition to reduce noise and to minimise adverse health effects, but it wants

policy to be underpinned by the most robust evidence on these effects, including the total cost of action and recent UK specific evidence which the WHO did not assess. These factors limit the weight that can be given to the lower noise levels recommended in the ENG.

38. Aircraft modernisation is reducing aircraft noise over time. It has been demonstrated that the daytime 57 dB and 54 dB noise contours will decrease in extent over the period to 2032, both with and without the development, albeit that the 54 dB contour would be slightly larger in the development case (DC) compared to the do minimum (DM) scenario. The 51 dB LOAEL contour is however predicted to increase slightly in extent compared to the 2019 baseline.

39. The night-time 48 dB contour is also predicted to decrease in extent and this reduction would be greater in the DC than in the DM scenario. This is based upon there being a greater amount of fleet modernisation, including fewer of the noisier cargo flights.

40. The ESA compares the DC with the DM scenario at 2032, which is when the maximum passenger throughput is predicted to be reached, and at 2027 which is identified as the transition year. In 2032 there would be an increase in air noise levels during the daytime of between 0.4 and 0.6 dB which is assessed as a negligible effect. There would be a beneficial reduction in night-time noise of between 0.3 and 0.8 dB in the DC compared to DM, but this is also assessed as negligible.

41. Saved Policy ENV11 of the Uttlesford Local Plan 2005 (ULP) resists noise generating development if this would be liable to adversely affect the reasonable occupation of existing or proposed noise sensitive development nearby. The ESA demonstrates that this would not be the case.

42. It is necessary to ensure that the benefits in terms of the reduction in noise contours over time arising from fleet modernisation, and the reduction in night noise are secured in order that these are shared with the community in accordance with national policy in the APF. The Council's position is that the development is acceptable in terms of aircraft noise, subject to suitable mitigation measures. Condition 7 defines the maximum areas to be enclosed by 54 dB $L_{Aeq\ 16hour}$, and 48 dB $L_{Aeq\ 8\ hour}$ noise contours and requires that the area enclosed by each of those contours is reduced as passenger throughput is increased, in accordance with the findings of the ESA.

43. There is no control of the night-time noise contour under the existing permission. This is instead subject to control under the Government's night flight restrictions which impose a Quota Count. It is noted that the Secretaries of State in granting the last planning permission considered that there was no need for such a condition because of the existing controls.

44. However, the night flight restrictions do not cover the full 8 hour period used in the L_{Aeq} assessment. Consequently, if only the night flight restrictions were to be relied upon, there would be no control of aircraft noise between 23:00 and 23:30 hours and between 06:00 and 07:00 hours. The ESA has demonstrated that the reductions in night noise would be beneficial to health. For these reasons, inclusion of the $L_{Aeq\ 8hour}$ restriction in condition 7 would be necessary. In coming to this view, the Panel has taken into account the dual restrictions that would apply. However, the night noise contour requirement in condition 7

would be necessary to secure the benefit and it has not been demonstrated that the night noise restrictions would be sufficient in this respect.

45. The Panel has considered SSE's submissions concerning the methodology used in the ES and ESA. The use of L_{Aeq} levels in the assessment is in accordance with Government policy and reflects the conclusions of SoNA, but the ES and ESA also include assessments of the number of flights exceeding 60 and 65 dB(A) and maximum single event noise levels. The assessments of aircraft noise are comprehensive, and the methodology used is justified and widely accepted as best practice, including by the Government and industry. The Council considers that the methodology used is robust. The Panel has also considered the evidence on air traffic forecasts and, for the reasons given elsewhere in this decision, is satisfied that the assumptions regarding fleet replacements are robust.

46. SSE has referred to the number of complaints about noise increasing in recent years. However, it is also relevant to consider the number of complainants which has significantly decreased. These factors have been taken into account in the ES and ESA.

47. The existing sound insulation grant scheme (SIGS) provides for financial assistance to homeowners and other noise-sensitive occupiers, to be used to fund sound insulation measures. This uses a contour which is based on 63 dB $L_{Aeq\ 16\ hour}$ for daytime and the aggregate 90 dBA SEL footprint of the noisiest aircraft operating at night.

48. The submitted Unilateral Undertaking (UU) provides for an enhanced SIGS whereby a 57 dB daytime contour is used, thereby increasing its extent and the number of properties covered. This is consistent with the evolving perceptions of the level of significant adverse effects and exceeds the levels recommended for such measures as stated in the APF. The use of this contour together with the 90 dBA SEL footprint as qualifying criteria would provide mitigation against both daytime and night-time noise. The latter criterion recognises that sleep disturbance is more likely to arise from single events than average noise levels over the night-time period.

49. The UU also applies to specific identified noise-sensitive properties including schools, community and health facilities and places of worship. An assessment of these properties has been undertaken using the daytime 57 dB contour used for residential properties, the number of flights above 65 dB and the maximum sound levels of aircraft flying over properties. Inclusion of properties in the list in Schedule 2 Part 1 of the UU means that bespoke measures may be discussed between the property owner and the airport operator and that further noise surveys may be undertaken. Thaxted Primary School does not qualify for inclusion in the list under the criteria used. However, submissions were made to the Inquiry that the school should be included. It has provisionally been included in the list subject to the Panel's decision.

50. Thaxted Primary School is outside, but adjacent to the boundary identified for the SIGS. This is represented by the 57 dB $L_{Aeq\ 16\ hour}$ and 200 daily flights above 65 dB (N65 200). The school is well outside the 63 and 60 dB contours, the former being the level that Government policy recognises, in the APF, as requiring acoustic insulation to noise-sensitive buildings and the latter the level to which this may potentially be reduced.

51. Departing aircraft predominantly take off towards the south-west, away from the school. Those that do take off towards the north-east turn onto standard routes away from the school before reaching it. The school is, however exposed to noise from arriving aircraft.

52. Standards for internal noise levels in schools are set out in *Building Bulletin 93 – Acoustic design of schools: performance standards* (BB93). These use $L_{Aeq\ 30mins}$ as a metric because school pupils experience noise over limited periods and not over the full daytime period. No assessment has been undertaken using this metric. It is, however, possible to determine the effect of the proposal having regard to the maximum sound levels of aircraft flying over the property in question.

53. It has been demonstrated that the school would not be exposed to L_{Amax} flyover levels of 72 dB or more. The Council agrees that this maximum level would ensure that internal noise levels would not exceed 60 dB, with windows open. This provides a good degree of certainty that noise levels would be in accordance with BB93 which states that indoor ambient noise levels should not exceed 60 dB $L_{A1,\ 30\ mins}$.

54. No representations have been made either by the school or the education authority with regard to inclusion of Thaxted Primary School in the list. It has not been demonstrated that the school should be included in the list in terms of any specific need for mitigation. For these reasons the inclusion of Thaxted Primary School in the list of properties in Schedule 2 Part 1 of the UU would not be necessary and on this basis this provision would not meet the tests in the Community Infrastructure Levy Regulations 2010 (the CIL Regulations).

55. The noise assessments in the ES and ESA take into account ground noise from aircraft. The Council's reason for refusal concerns only aircraft noise and not noise from ground plant and equipment or surface access. The Panel has considered the evidence provided by SSE in respect of the latter, but these do not alter its conclusions on this main issue.

56. It has been demonstrated beyond doubt that the development would not result in unacceptable adverse aircraft noise and that, overall, the effect on noise would be beneficial. Subject to the mitigation provided by the UU and the restrictions imposed by condition 7, the development would accord with Policy ENV11 of the ULP and with the Framework.

Air Quality

57. Although air pollution levels around the airport are for the most part well within adopted air quality standards, an area around the Hockerill junction in Bishop's Stortford has nitrogen dioxide levels that are above those standards. This is designated an Air Quality Management Area (AQMA). The development would increase emissions from aircraft, other airport sources and from road vehicles, but this would be against a trend of reduction in air pollution as a result, amongst other things, of increasing control of vehicle emissions.

58. The pollutants which are assessed are oxides of nitrogen (NOx), particulate matter (PM_{10}) and fine particulate matter ($PM_{2.5}$). Ultrafine particulates (UFP) are recognised as forming a subset of $PM_{2.5}$ and they are likely to affect health. However, there is no recognised methodology for assessing UFP and the most that can be done is a qualitative, rather than quantitative assessment.

59. Policy ENV13 of the ULP resists development that would involve users being exposed on an extended long-term basis to poor air quality outdoors near ground level. The Policy identifies zones on either side of the M11 and the A120 as particular areas to which the Policy applies.

60. Paragraph 170 of the Framework states that development should, wherever possible, help to improve local environmental conditions such as air quality. Paragraph 181 states that planning decisions should sustain and contribute towards compliance with relevant limit values or national objectives for pollutants, taking into account the presence of AQMAs and the cumulative impacts from individual sites in local areas. Opportunities to improve air quality or mitigate impacts should be identified.

61. Emissions of NOx, PM_{10} and $PM_{2.5}$ would increase slightly in the DC compared to the DM scenario. They would also increase in comparison to the 2019 baseline. However, pollutant levels resulting from other sources, notably road traffic, are forecast to decline. The ES and ESA demonstrate that there would be no exceedance of air quality standards at human receptors and that air quality impacts would be negligible. The overall effect of the development in terms of air quality would be in accordance with the Framework and with the Clean Air Strategy, which refers to the need to achieve relevant air quality limit values. While the Framework seeks to improve air quality where possible, it recognises that it will not be possible for all development to improve air quality.

62. While the proposed development would not improve air quality, the UU secures a number of measures to encourage the use of public transport and to reduce private car use, including single occupancy car trips. The airport has a Sustainable Development Plan which, whilst not binding, commits to reducing air pollution. It has already achieved significant increases in use of public transport, thereby limiting emissions and these initiatives would be continued. The measures would have other objectives such as reducing carbon emissions, which would not necessarily benefit air quality but nonetheless the provisions of the UU would overall be likely to secure improvements in air quality.

63. Although it has raised a number of issues concerning the methodology used and the robustness of the assessments during the appeal process, the Council made no request for further information under the EIA Regulations.

64. SSE has commented on a number of aspects of the air quality assessments, including the transport data used, the receptors assessed and modelling. The appellant has provided clarification of the aspects that have been queried by SSE and has justified the approach taken and the assumptions made. The appellant’s responses provide sufficient reassurance that the assessments are soundly based and that they are conservative.

65. The air quality assessment depends on the assessment of road traffic in terms of vehicle emissions. Surface access is dealt with elsewhere in this decision, but the transport modelling forms a robust assessment which has been accepted by the Highway Authorities. Consequently, this forms a sound basis for the air quality assessment.

66. The Clean Air Strategy includes a commitment to significantly tighten the current air quality objective for fine particulates, but no numerical standard has yet been set. The current objective for $PM_{2.5}$ is $25\mu g/m^3$. The 2008 WHO guidelines recommend an ultimate goal for annual mean concentrations of

$PM_{2.5}$ of 10µg/m^3. The Clean Air Strategy commits to examine the action that would be necessary to meet this limit but no timescale for this has been set.

67. The ESA assesses the largest concentration of $PM_{2.5}$ in 2032 to be 11.6µg/m^3 in the DC. This is well below the current objective but slightly above the more ambitious WHO guideline. The great majority of the modelled concentrations would be below that guideline value. The assessment also shows that the effect of the development by comparison to the DM scenario would be negligible. The proposal would not unacceptably compromise the Clean Air Strategy in reducing concentrations of $PM_{2.5}$ and accords with the current objective.

68. The Bishop's Stortford AQMA is within East Hertfordshire District Council's (EHDC) administrative area. Policy EQ4 of the East Hertfordshire Local Plan 2018 requires minimisation of impacts on local air quality. That Policy also requires, as part of the assessment, a calculation of damage costs to determine mitigation measures. The ES and ESA demonstrate that there would be negligible effects for which the UU secures mitigation measures. EHDC has consequently raised no objection to the proposal.

69. The AQMA is centred around a traffic signal-controlled road junction which is enclosed by buildings on all sides. The A1250 is at a gradient on both sides of the junction. It is likely that the high monitored levels of pollutants here result from emissions from queuing traffic and the enclosing effect of the buildings. Nitrogen dioxide (NO_2) levels have been declining here in recent years, with a reduction in levels between 2012 and 2019. However, NO_2 levels remain above the air quality standard for 3 of the 4 locations monitored and significantly above the standard for 2 of those locations.

70. An adjustment factor has been used to compensate for the difference between modelled and measured concentrations of NO_2 in the AQMA. Uttlesford District Council is concerned that this factor is unusually high, but it has been undertaken in accordance with Defra's Local Air Quality Management Technical Guidance TG16 and on this basis, is not considered unreasonable. This guidance was used together with the Emission Factor Toolkit and Defra's background pollutant concentrations maps in predicting future improvements in air quality. Sensitivity tests using less optimistic assumptions regarding future improvements in air quality were incorporated in the ES and ESA. While there is acknowledged uncertainty in predicting future levels, a rigorous approach has been used in the assessment.

71. It is not disputed that airport activities contribute less than 1% to NOx concentrations in Bishop's Stortford. The appellant's transport modelling demonstrates that any increase in traffic along the A1250 and through the Hockerill junction would, at worst be 1.3% of current traffic flow in the DC compared to DM. This extra traffic would not necessarily be evenly distributed throughout the day. Queuing traffic would tend to increase emissions and the adjacent buildings would have an enclosing effect. Nonetheless, this level of additional traffic would be unlikely to appreciably affect pollution levels in the AQMA.

72. It is common ground that UFPs result from combustion sources including burning of aviation fuel, which contains higher levels of sulphur than fuel used for road vehicles. It is also agreed that there is no reliable methodology for assessing the quantity of UFPs that would result from the development. It is

the quantity of these particulates, rather than their mass, that is particularly relevant in terms of implications for human health.

73. Although the development would result in increases in $PM_{2.5}$, the ES and ESA demonstrate that those increases would be negligible compared to the DM scenario. It is also the case that ambient levels of $PM_{2.5}$ are predicted to reduce over time. The assessment considers the mass of $PM_{2.5}$. While assumptions can be made about the mass of UFPs as a subset of $PM_{2.5}$ reducing over time, it is not possible to conclude on the number of UFPs in the absence of any recognised assessment methodology. That said, the Health Impact Assessment considered epidemiological research, which includes the existing health effects of $PM_{2.5}$ and thus UFPs as a subset. This concluded that there would be no measurable adverse health outcomes per annum.

74. The Aviation 2050 Green Paper proposes improving the monitoring of air pollution, including UFP. While the significance of UFP as a contributor to the toxicity of airborne particulate matter is recognised, footnote 83 of the Green Paper notes that the magnitude of their contribution is currently unclear.

75. The Council, while raising concern over UFPs, is nonetheless content that permission could be granted subject to conditions requiring monitoring of air quality. The UU secures such monitoring, and condition 10 requires implementation of an air quality strategy, which is to be approved by the Council.

76. The nearby sites of Hatfield Forest and Elsenham Woods are Sites of Special Scientific Interest (SSSI). Policy ENV7 of the ULP seeks to protect designated habitats.

77. The ES and ESA assessments were undertaken in accordance with Environment Agency[13] and Institute of Air Quality Management (IAQM)[14] guidance. The ESA demonstrates that the development would result in long-term critical loads for NOx concentrations at the designated sites being increased by less than 1%.

78. Previous monitoring has shown that 24-hour mean NOx concentrations can greatly exceed annual mean concentrations. Condition 10 requires a strategy to minimise emissions from airport operations and surface access. A condition has also been suggested which would require assessment of 24-hour mean NOx concentrations at the designated sites and provision of any necessary mitigation. The IAQM guidance states that the annual mean concentration of NOx is most relevant for its impacts on vegetation as effects are additive. The 24-hour mean concentration is only relevant where there are elevated concentrations of sulphur dioxide and ozone which is not the case in this country. Natural England has accepted the assessment and has not requested use of the 24-hour mean concentration.

79. The UU includes obligations to monitor air quality, and to discuss with the Council the need for any measures to compensate for any adverse effect on vegetation within the designated sites. Because monitoring of air quality and necessary mitigation in respect of the SSSIs would be secured by the UU, the suggested condition to assess 24-hour mean NOx concentrations would not be necessary.

[13] Environment Agency H1 guidance
[14] Institute of Air Quality Management: Land-Use Planning & Development Control: Planning for Air Quality (2017)

80. The ES concluded that there would be no significant effect at ecological receptors. The Council considers that the development would be acceptable in air quality terms subject to imposition of suitable conditions to limit the air quality effects and to secure mitigation measures.

81. For the reasons given, it has been demonstrated that the development would not have an unacceptable effect on air quality and that it accords with Policies ENV7 and ENV13 of the ULP.

Carbon and Climate Change

82. There is broad agreement between the parties regarding the extremely serious risks associated with climate change. These risks are acknowledged and reflected in Government policy. Indeed, in this regard, the Framework states, amongst other things, that the environmental objective of sustainable development embraces *mitigating and adapting to climate change, including moving to a low carbon economy*. It adds that *the planning system should support the transition to a low carbon future in a changing climate* … and … *should help to shape places in ways that contribute to radical reductions in greenhouse gas emissions*.

83. Nonetheless, in spite of that general accord there remains much disagreement between the main parties to the Inquiry over how the effects of the development on climate change should be assessed, quantified, monitored and managed, including into the future.

84. The Government has recently made it clear that it will target a reduction in carbon emissions by 78% by 2035 compared to 1990 levels and that the sixth Carbon Budget, scheduled to be introduced before the end of June 2021, will directly incorporate international aviation emissions rather than by using the headroom / planning assumption approach of the previous budgets. The first of these measures will introduce a target for reducing emissions prior to the net zero target of 2050, acting as an intermediate target, and is set to be enshrined in law.

85. The latter measure will alter the way in which such emissions are accounted for. The Government intends to set the sixth Carbon Budget at the 965 MtCO2e level recommended by the CCC. As outlined above, carbon emissions from international aviation have always been accounted for in past carbon budgeting. There is no good reason to assume that the coming change in how they are accounted for will significantly alter Government policy in this regard or that the Government intends to move away from its MBU policy.

86. Indeed, the Government's press release expressly states, amongst other things, that *following the CCC's recommended budget level does not mean we are following their policy recommendations*. Moreover, it also says that *the Government will 'look to meet' this reduction through investing and capitalising on new green technologies and innovation, whilst maintaining people's freedom of choice, including on their diet. For that reason, the 6CB will be based on its own analysis, and 'does not follow each of the Climate Change Committee's specific policy recommendations.'*

87. As outlined in the *National Aviation Policy and Introductory Matters* subsection, there is in-principle Government policy support for making best use of existing runways at airports such as Stansted, and MBU thoroughly tests the potential

implications of the policy in terms of carbon emissions. International aviation carbon emissions are not currently included within UK carbon budgets, but rather are accounted for via an annual 'planning assumption' of 37.5MtCO_2. MBU policy establishes that, even in the maximum uptake scenario tested, this carbon emissions planning assumption figure would not be compromised.

88. The contents of the ES and ESA, which - unlike MBU - specifically assess the potential impacts of the appeal development, support the conclusions of MBU in this regard. Indeed, they indicate that the proposed development would take up only an extremely small proportion of the current 'planning assumption'. For instance, the ESA shows in 2050 that the additional annual carbon emissions from all flights resulting from the development are likely to be in the region of 0.09MtCO_2, which would equate to only 0.24% of the 37.5MtCO_2 planning assumption[15].

89. This assessment assumes that the airport would not seek to use its permitted total of 274,000 ATMs in the event that the appeal were to be dismissed. Yet, in practice, it seems more likely that it would, as a commercial operator, seek to maximise flights. Consequently, the relative increase in carbon emissions resulting from the development would be likely to be less than as predicted in the ESA compared to what might happen if the proposed development were not to proceed.

90. In light of the CCC's recommendations and the Government's 20 April 2021 announcement, the 37.5MtCO_2 planning assumption, as a component of the planned total 965 MtCO_2e budget, may well change. Even if it were to be reduced as low as 23MtCO_2, as is suggested might happen by the Council's carbon/climate change witness with reference to the advice of the CCC on the sixth Carbon Budget, an increase in emissions of 0.09MtCO_2 resulting from the appeal development in 2050 would be only some 0.39% of this potential, reduced figure.

91. Unsurprisingly, the carbon emission figures in the ESA vary across the years modelled to 2050 and over the three scenarios employed from 2032 ('Pessimistic', 'Central' and 'Best practice'). For instance, the predicted additional annual carbon emissions from flights increases steadily from the base-year of 2019 over the years to 2032 leading to a predicted increase of some 0.14MtCO_2 in 2032[16], which equates to 0.38% of the planning assumption. Notwithstanding these variations, in each case the annual values for all years and scenarios would, nonetheless, remain only a very small proportion of both the Government's established planning assumption and a potentially reduced assumption of 23MtCO_2.

92. Of course, these are annual emissions figures and, as such, they need to be summed in order to give the full, cumulative amount of predicted additional carbon emissions resulting from flights associated with the appeal development for any year on year period, such as the 2019 to 2050 period used in the ESA. Consequently, the cumulative additional emissions predicted in the ESA for the entire 2019-2050 period or for the 2032-2050 period are far greater than the 0.09MtCO_2 forecast for the year 2050. However, the Government's planning

[15] 0.09MtCO_2 is the difference between the 'Annual Development Case Central' and the 'Annual Do Minimal Central' scenarios of the ESA
[16] 0.14MtCO_2 is the difference between the 'Development Case Pessimistic' and the 'Do Minimum Pessimistic' scenarios of the ESA

assumption of 37.5MtCO_2 is also an annual figure, as is the figure of 23MtCO_2, such that the relative cumulative amounts of carbon emissions would remain proportionately small.

93. Notwithstanding reference to a range of planned airport development as part of the appeal process, the fact that no examples of MBU-type development having been approved since the publication of MBU were brought to the attention of the Inquiry lends further support to the conclusion that this development alone would not put the planning assumption at risk[17].

94. Although UK statutory obligations under the CCA have been amended since the publication of MBU to bring all greenhouse gas emissions to net zero by 2050, with an additional target of a 78% reduction in carbon emissions by 2035 set to be introduced, MBU remains Government policy. Given all of the foregoing and bearing in mind that there are a range of wider options that the Government might employ to meet these new obligations and that aviation is just one sector contributing to greenhouse gas emissions to be considered, there is also good reason to conclude that the proposed development would not jeopardise UK obligations to reach net zero by 2050 or to achieve the planned 2035 intermediate target. On this basis, given the very small additional emissions forecast in relative terms, there is also no reason to expect that the Council's climate emergency resolution should be significantly undermined.

95. The aviation emissions assessments of the ES and ESA are reported as CO_2 only rather than in the wider terms of carbon dioxide equivalent emissions (CO_2e), which also includes nitrous oxide (N_2O) and methane (CH_4), and which the Government has adopted for its sixth Carbon Budget. While it may have been beneficial to have used CO_2e in preference to CO_2 in the ES and ESA, this was not a matter raised by the Council during scoping, nor at any other stage prior to the exchange of evidence. The approach of the ES and ESA, in this regard, is also consistent with the DfT's 2017 Forecasts and with the MBU policy. Consequently, the approach adopted in the ES and ESA is not flawed or incorrect as such. In any event, the evidence indicates that were N_2O and CH_4 to have been included in the ES and ESA assessments, the results would not change significantly on the basis that N_2O and CH_4 account for in the region of only 0.8 to 1.0% of total international aviation CO_2e emissions.

96. In addition to carbon and carbon dioxide equivalent emissions, other non-carbon sources have the potential to effect climate change. Nonetheless, they are not yet fully understood, with significant uncertainties remaining over their effects and how they should be accounted for and mitigated. There is currently no specific Government policy regarding how they should be dealt with and uncertainty remains over what any future policy response might be. Moreover, no evidence was put to the Inquiry which clearly and reliably establishes the extent of any such effects.

97. The nature of non-carbon effects resulting from aviation has parallels with carbon effects in that they are complex and challenging, perhaps even more so than carbon effects given the associated greater uncertainties, and that they largely transcend national boundaries. Consequently, in the context of MBU development, it is reasonable to conclude that they are matters for national Government, rather than for individual local planning authorities, to address.

[17] Subject to footnote 9 above

It is also noteworthy that the current advice on this matter from the CCC to the Government appears largely unchanged compared to its previous advice.

98. In this context, therefore, the potential effects on climate change from non-carbon sources are not a reasonable basis to resist the proposed development, particularly bearing in mind the Government's established policy objective of making the best use of MBU airports. Moreover, if a precautionary approach were to be taken on this matter, it would be likely to have the effect of placing an embargo on all airport capacity-changing development, including at MBU airports, which seems far removed from the Government's intention.

99. The reason for refusal relating to carbon emissions and climate change refers only to the proposed development's effects resulting from additional emissions of international flights. Nonetheless, the evidence put forward as part of the appeal process also refers to wider potential effects on climate change, including carbon emissions from sources other than international flights.

100. Discussion and testing of the evidence during the Inquiry process revealed no good reasons to conclude that any such effects would have any significant bearing on climate change. Indeed, the Statement of Common Ground on Carbon between the appellant and Council states that *the emissions from all construction and ground operation effects (i.e. all sources of carbon other than flight emissions) are not significant.* It adds that *Stansted Airport has achieved Level 3+ (carbon neutrality) Airport Carbon Accreditation awarded by the Airport Council International*.

101. Given the conclusions outlined above regarding the potential effects of the appeal development arising from international flights, the evidence does not suggest that the combined climate change effects of the development would be contrary to planning policy on such matters, including the Framework, or that it would significantly affect the Government's statutory responsibilities in this regard. Furthermore, no breach of the development plan associated with carbon/climate change is cited in the relevant reason for refusal and none has been established as part of the appeal process.

102. Accordingly, for all of the foregoing reasons, having due regard to current national aviation policy and wider planning policy, including the development plan and the Framework, the proposed development would not have a significant or unacceptable effect on carbon/climate change.

Other Matters

103. Other topic areas considered during the Inquiry that are not expressly assessed above included Local Context, Health & Well Being, Ecology, Socio-Economic Impacts, and Surface Access (Road & Rail). Before assessing the planning balance, these are considered in turn, followed by any remaining matters raised by interested parties during both the planning application stage and the appeal process.

Local Context

104. The airport is located in a pleasant rural context. Hamlets, villages and small towns, many of which have conservation areas and listed buildings, are dispersed amongst countryside. Nonetheless, the operational development proposed in this case would all be well contained within the airport boundaries.

105. The only material effect apparent in the wider area would be from increased passenger flights over time. Other types of flight are not expected to increase to their current caps as a result, given that the overall limit on annual air transport movements would not change. The main consequences of this for local people are discussed above. Given the Panel's conclusions on these matters, it is not expected that the proposed development would alter the airport's rural context or affect nearby heritage assets in any way bearing in mind the current permitted use of the airport and its likely future use were the appeal to be dismissed.

Health & Well Being

106. The Health Impact Assessment (HIA) considers health impacts arising from noise and air quality both from airport operations and from surface access, and socio-economic factors. The ES and ESA conclude that health effects in terms of air quality would be negligible and that there would be a minor beneficial effect from a reduction in the number of people exposed to night-time air noise. The ES and ESA further conclude that the development would have a major beneficial effect on public health and wellbeing through generation of employment and training opportunities and provision for leisure travel.

107. Research underpinning the WHO ENG guidelines was considered as part of the HIA, and the ES and ESA have taken a more precautionary approach than those guidelines. Whilst criticisms are made by other parties, no alternative detailed assessment has been put forward that would cast doubt on the findings of the ES and ESA or indicate that the likely effects would differ from those assessed. The conclusions of the ES and ESA are considered reliable.

Ecology

108. Given the conclusions of the Air Quality sub-section, in light of the wider evidence, including the findings of the ES and ESA, and subject to the identified suite of mitigation to be secured via the UU and conditions, there is no good reason to believe that the appeal development would have any effects on biodiversity and ecology that would warrant the refusal of planning permission.

Socio-Economic Impacts

109. The ES and ESA demonstrate that the proposal would be of social and economic benefit by enabling increased business and leisure travel. Leisure travellers would benefit from increased accessibility to foreign destinations. Businesses would benefit through increased inward investment. The economy would benefit through increased levels of employment and expenditure. Associated with employment growth, training facilities would be supported. Representatives of business, including local and regional business organisations, transport operators, and the Stansted Airport College expressed their support for the proposal at the Inquiry. The social and economic benefits of the proposal are not disputed by the Council.

110. SSE and interested parties have questioned several of the assumptions made in the ES and ESA, including those regarding the level of job creation, the suitability of those jobs for local people and the effect of the proposal on the trade balance. The appellant has demonstrated, however, that the assumptions made in the ES and ESA are appropriate and robust. The evidence base that has been used and the modelling undertaken are also

questioned but these are sufficient to demonstrate the benefits. Furthermore, even if some of the assumptions made by SSE and interested parties proved to be correct, such as a lower level of job creation than expected, a considerable number of beneficial jobs would still be created.

111. It is likely that increased economic prosperity in the south-east and east of England would not be at the expense of growth elsewhere in the country but would rather assist the growth of the UK economy as a whole. There is no reason to believe that the development would divert investment from other parts of the country that need investment or prejudice the Government's 'levelling-up' agenda, particularly as the development seeks to meet an established need for airport expansion in the south-east of England.

Surface Access

112. As outlined above, both Highways England and Essex County Council withdrew from the appeal proceedings following the identification of a mechanism to secure the delivery of a suite of highways related mitigation. No objections have been made to the appeal scheme by Network Rail or by the rail operators that serve Stansted. Indeed, there is broad support from those quarters. There are, nonetheless, remaining concerns expressed by other parties, including SSE, regarding surface access.

113. Notwithstanding that criticism is made of the methodology, assumptions and evidence that has led the statutory highway authorities and rail operators to their respective current positions, they appear to be well founded, based on a good understanding of the operation of the airport and the surrounding surface access infrastructure, both rail and highway, including capacity and modal share. This includes in respect to dealing with two-way car trips and the likely effects of the development on the highway network through Stansted Mountfitchet and Takeley, which were the subject of considerable discussion at the Inquiry. No alternative traffic counts, surveys, modelling or comprehensive assessment of the potential effects of the development in respect to surface access have been put to the Panel.

114. The Framework states that development should only be prevented or refused on highway grounds if there would be an unacceptable impact on highway safety, or the residual cumulative impacts on the road network would be severe. The evidence put to the Inquiry falls far short of demonstrating that this would be the case.

115. Subject to securing and delivering the range of proposed mitigation, which includes improvements to Junction 8 of the M11 and the Prior Wood Junction, as well as to the local road network and to public transport, the development would have no significant effects in terms of surface access. Moreover, Stansted Airport is and would continue to be well served by the strategic highway network and wide ranging public transport services, including its integrated rail, bus and coach stations.

Other Considerations

116. There was much discussion during the Inquiry and in written evidence about previous expansion at the airport and the conclusions of decision makers at that time. The last planning permission to increase the capacity of the airport was granted in 2008. Putting aside that previous applications did not involve

the form of development sought here, planning policy and other considerations have changed significantly since that time and it is not possible to draw any meaningful parallels with the consideration of this appeal.

117. Public engagement occurred in advance of the planning application, as set out in the Statement of Community Involvement (February 2018), the results of which informed the development now under consideration. Further extensive consultation took place at both the planning application and appeal stages and a significant number of responses have been received, both supporting and opposing the scheme, covering a range of topics. The Panel is satisfied that all statutory requirements have been met in these regards and that interested parties have had good opportunity to comment and engage with the planning application and appeal processes.

118. The planning application and appeal have progressed in accordance with normal process and procedure and there is no evidence before the Inquiry that suggests otherwise. It was necessary to hold the Inquiry using a virtual format in accordance with the Planning Inspectorate's Interim Operating Model and in light of restrictions in place as a result of the pandemic. This allowed the appeal to progress in an efficient and expedient way, whilst upholding the opportunity for interested parties to engage with the process. Indeed, many local people and organisations spoke at the Inquiry over several days. It would not have been appropriate to unnecessarily delay the appeal pending potential changes in Government or local policy. Appeals must be determined in accordance with the circumstances at the time of the decision.

119. The respective Secretaries of State were asked several times to recover the appeal for their own determination but declined to do so, determining that the issues involved are of no more than local significance. There is no requirement for appeals to be recovered and the Panel has properly considered the proposals on behalf of the Secretary of State, having had regard to all the evidence, including the case made by the Council and comments from local people. There is a statutory right to appeal planning decisions which is vital to the operation of the planning system and the public costs involved are not a material consideration.

120. In addition to the foregoing matters, concern has been expressed by a range of interested parties, including by Parish Councils. These cover a range of topics, including: local infrastructure, services and facilities, and their potential cost to the public sector; vibration; malodour; rat-running; public safety and risk; water resources, sewerage and flooding; wider pollution issues, including littering and from light; effects on agriculture; parking, including 'fly parking' and the cost of drop-off at the airport; demand for more housing, including affordable housing; the combined effects of planned airport development elsewhere; the 'monopoly' held by the appellant at the airport; the local economy being said to be over-reliant on the airport; current and potential future flight paths; the effects of stacking aircraft; the physical works proposed are said not to be needed to support the proposed changes to flight and passenger numbers; the existing quality of the airport, including security, management and size; a new airport should be developed in the Thames Estuary instead of the appeal scheme; damage to the highway network, including erosion, and to property; stress for residents and businesses associated with uncertainty over development and activity at the airport; and alleged aviation fuel dumping.

121. These matters are largely identified and considered within the Council officer's reports on the appeal development. They were also before the Council when it prepared its evidence and when it submitted its case at the Inquiry and are largely addressed in its evidence and in the various statements of common ground. The Council did not conclude that they would amount to reasons to justify withholding planning permission. The Panel has been provided with no substantiated evidence which would prompt us to disagree with the Council's conclusions in these respects subject to the UU and the imposition of planning conditions.

122. Some of the submissions from interested parties refer to potential interference with human rights. Given the foregoing conclusions, particularly in terms of the appeal process and the main issues, any interference with human rights that might result from the appeal being allowed would not be sufficient to give rise to a violation of rights under Article 1 of the First Protocol to the Convention, as incorporated by the Human Rights Act 1998.

123. Interested parties have also referred to a number of matters which are either not planning matters or not relevant to the appeal. These include property values, compensation claims, and the conduct and motives of the appellant and of Council members and officers. Any potential future development or further increase in capacity at the airport would require a further planning application which would be subject to the Council's consideration. The lawfulness or otherwise of past development at the airport is a matter for the Council, as local planning authority.

Planning Obligations

124. Planning obligations made under S106 of the Town and Country Planning Act 1990 as a Unilateral Undertaking, dated 26 March 2021 (the UU), were completed after the Inquiry closed in line with an agreed timetable. In the event that planning permission were to be granted and implemented it would be subject to the obligations of the UU, which would include the securing of:

- Noise Mitigation - a new enhanced sound insulation grant scheme for a defined area in the vicinity of the airport to replace existing measures. This would include a greater number of properties than the existing scheme through use of a lower noise contour;
- Transport
    - Mechanisms and funding to secure improvements to Junction 8 of the M11 and to the Priory Wood Junction, local road network improvements and monitoring, and local bus service improvements;
    - The airport operator shall join the Smarter Travel for Essex Network;
    - Expanded Sustainable Transport Levy (to replace the existing Public Transport Levy) to be used to promote the use of sustainable transport by passengers and airport staff;
    - Enhanced rail users discount scheme, with higher rate of discount and revised eligibility;
    - Revised targets for mode share (applying 'reasonable endeavours' to achieve those targets) – non-transfer passenger mode share of 50% by public transport, of 20% (by 39mppa) and 12% (by 43mppa) by 'kiss and fly', and 55% (by 39mppa) of staff access by single occupancy private car; updated working arrangements for the airport's Transport Forum,

Airport Surface Access Strategy and Travel Plan; and a study of and pursuant improvements to the on-site bus and coach station;

- Skills, education and employment – continuance of the Stansted Airport Employment Forum and Combined Local Benefits, including the on-site education centre for local children and schools, the on-site airport Employment Academy, Stansted Airport College, and local supply chain support;
- Community - a new, replacement Community Trust Fund to help mitigate any adverse health and / or quality of life effects arising from the development as a result of increased noise levels and a reduction in the amenity of local green spaces;
- Air Quality and Ecology – protection and enhancement of environmentally sensitive sites, including air quality and ecological monitoring at the airport, Eastend Wood and Hatfield Forest, and pursuant compensation;
- Water quality – retention of the requirement to monitor local watercourses; and
- Monitoring – payments to support the Council's costs associated with monitoring the UU's planning obligations.

125. The Council has submitted detailed statements (the CIL Statements), which address the application of statutory requirements to the planning obligations within the UU and also set out the relevant planning policy support / justification. Having considered the UU in light of Regulation 122 of the CIL Regulations and Government policy and guidance on the use of planning obligations, we are satisfied that most of the obligations therein would be required by and accord with the policies set out in the CIL Statements.

126. The exception to this is the inclusion of Thaxted Primary School within the SIGS in Schedule 2 Part 1 of the UU, for the reasons outlined in the *Noise* section above. For those reasons, its inclusion is not necessary and as such does not accord with the CIL Regulations. Subject to this exception, the SIGS is necessary to ensure the development accords with national and local policy requirements to minimise and mitigate adverse noise impact and to avoid significant adverse impact.

127. Subject to the above noted exception, the Panel is satisfied that the remainder of the obligations are directly related to the proposed development, fairly and reasonably related to it and necessary to make it acceptable in planning terms. Furthermore, the UU and its terminology are sufficiently precise and enforceable.

Conditions

128. Conditions were suggested by all three main parties to the appeal in the event that planning permission were to be granted, and these have been taken into account in formulating the conditions imposed.

129. A five year period for the commencement of development has been imposed rather than the standard three year period promoted by the Council, to allow greater flexibility in light of the anticipated impact of the pandemic on the airport and wider aviation industry. Although not suggested by any party, it is

also considered necessary in the interests of certainty to specify the plans approved and with which the development must accord.

130. A scheme of water resource efficiency measures is secured to minimise water consumption in accordance with Policy GEN2 of the ULP. It is also considered necessary to secure a surface water drainage scheme in order to avoid flooding as a result of the development.

131. A Construction Environmental Management Plan is needed to minimise the impact of the works on neighbouring occupants and to ensure that acceptable living conditions are maintained in accordance with Policy GEN4 of the ULP.

132. A Biodiversity Management Strategy is necessary in light of findings contained within the submitted ecological surveys. There is a need to conserve and enhance protected and priority species in accordance with statutory obligations and Policy GEN7 of the ULP.

133. For the same reason, the mitigation and enhancement measures and/or works identified in the Preliminary Ecological Appraisal (Feb 2018), Preliminary Ecological Appraisal Update (October 2020) and Ecology Mitigation Strategy (February 2018), are necessary. The Preliminary Ecological Appraisal Update is referenced as the most up to date appraisal, which includes measures beyond those contained in the Ecological Mitigation Strategy, in particular, provisions for the protection of ground nesting birds. A licence will also be required from Natural England, who do not object to the appeal proposal, for the translocation of protected species.

134. Condition 7 restricts noise emanating from aircraft in line with that permissible under the extant planning permission up to 35 million passengers per annum. After that, a progressive improvement in noise conditions is secured over time in line with the ES/ESA predictions to protect the living conditions of neighbouring occupants in accordance with Policy ENV11 of the ULP, and consistent with the APF's objective to share the benefit of improvements to technology with local communities.

135. There are currently no noise restrictions imposed by planning condition for night flights and Stansted, as a designated airport, is controlled by separate night flight operating restrictions imposed by the DfT. These operate on a Quota Count system over a 6.5 hour night-time period, meaning that there is a 1.5 hour period that remains uncontrolled, beyond the 16 hour daytime period imposed by condition 7. In order to ensure certainty that the noise impacts of the development will be as anticipated in the ES/ESA, and to avoid harm to the living conditions of local residents, it is considered necessary to impose a night-time restriction by condition in this case, alongside the daytime restrictions and notwithstanding some existing DfT control.

136. In order to clarify the terms of the planning permission and to ensure that the development and associated effects do not exceed those assessed, conditions are attached which restrict the total number of aircraft movements, the number of cargo air transport movements and passenger throughput during any 12 month period.

137. There is dispute between the parties regarding whether and to what extent it is necessary to control the effects of noise, air quality and carbon arising from the development.

138. Condition 7, discussed above, satisfactorily secures a betterment in noise conditions over time so as to make the development acceptable, such that there is no need or justification for imposing further measures in respect to noise.

139. The effect of the development on local air quality is expected to be very small and would not put nationally prescribed air quality standards or limits at risk in the area. Nevertheless, the appellant proposes a condition to secure an Airport Air Quality Strategy that would be updated over time in a continued effort to minimise emissions and contribute to compliance with relevant limit values or national objectives for pollutants. The provision of electric vehicle charging points can also be secured by separate condition as a measure necessary to minimise air pollution associated with the development. This is considered sufficient to make the development acceptable in planning terms, in accordance with Policy ENV13 of the ULP and the objectives of the Framework.

140. International aviation emissions are not currently directly included in UK carbon budgets and Government policy is clear that there is sufficient headroom for MBU development at all airports, including Stansted. Carbon emissions associated with the development from sources other than international aviation are expected to be relatively small and would not themselves materially impact upon carbon budgets, including the planned sixth Carbon Budget which will directly include international aviation emissions, or otherwise conflict with the objectives of the Framework. As such, a condition limiting carbon is not necessary.

141. The appeal proposal accords with current policy and guidance and there is no evidence that it would compromise the ability of future generations to meet their own needs. The conditions discussed above are sufficient to make the development acceptable in planning terms.

142. The Council proposes alternative conditions to deal with noise, air quality and carbon. Its primary case involves a condition, referred to during the Inquiry as 'condition 15', which would impose restrictions based upon the impacts assessed in the ES/ESA, along with future more stringent restrictions (using some interpolated data from the ES/ESA) and a process that would require the Council's reassessment and approval periodically as the airport grows under the planning permission, allowing for a reconsideration against new, as yet unknown, policy and guidance. In light of the Panel's conclusions on these matters, there is no policy basis for seeking to reassess noise, air quality or carbon emissions in light of any potential change of policy that might occur in the future. Furthermore, it would be likely to seriously undermine the certainty that a planning permission should provide that the development could be fully implemented. This appeal must be determined now on the basis of current circumstances and the proposed 'condition 15' is not necessary or reasonable.

143. As an alternative to 'condition 15', two other conditions (dealing with air quality and carbon) are suggested by the Council. These would also impose future restrictions defined by the Council. Again, it follows from our conclusions on the main issues that these are not necessary to make the development acceptable in planning terms, so these have not been imposed.

144. It is also unnecessary to require an assessment of impacts of the full proposed airport expansion on 24-hour mean NOx concentrations at Elsenham

Woods SSSI and Hatfield Forest SSSI given that this has not been requested by Natural England and the ES/ESA indicates that the development would not be significant in ecology terms.

145. SSE suggested a separate set of conditions, though many were broadly in line with those agreed between the Council and the appellant as considered above. No additional trigger for the commencement of development is needed as this permission must necessarily have been implemented for passenger numbers to exceed 35 million in any 12-month period. Noise restrictions beyond that imposed by condition 7 are suggested by SSE but these seek arbitrary limits with no certainty that they would be achievable. They are not necessary or reasonable in light of the Panel's findings as outlined above. Similarly, no evidence was put to the Inquiry which would justify imposing specific restrictions on helicopter movements. Publication of passenger throughput figures on the airport's website is not necessary to make the development acceptable, as conceded by SSE during the Inquiry.

146. SSE also sought a requirement for the provision of a taxi holding area close to the terminal to minimise unnecessary empty running, whereby taxis drop off at the airport but do not pick-up a return fare. A taxi company is already based at the airport and the appellant explained that it has recently provided a holding area within the mid-stay car park that might assist with such concerns. Regardless, extensive sustainable transport measures are secured by planning obligations so that a specific requirement of this type is unnecessary.

147. Additional air quality and carbon requirements to those sought by the Council were suggested by SSE but given the Panel's conclusions on these matters, these are not reasonable or necessary. Finally, SSE sought restrictions on future applications for development at the airport in terms of passenger numbers or a second runway, though recognised the difficulties of complying with the tests for conditions. Such restrictions are not relevant to the development being sought and would not be necessary or reasonable.

148. The wording of conditions has been amended as necessary to improve their precision and otherwise ensure compliance with the tests for conditions contained in the Framework. So far as the conditions require the submission of information prior to the commencement of development, the appellant has provided written confirmation that they are content with the wording and reasons for being pre-commencement requirements.

Planning Balance

149. The development plan, so far as it is relevant to this appeal, is the ULP. Although dated, it contains a number of policies[18] relevant to this proposal which are not materially inconsistent with the objectives of the Framework and continue to provide a reasonable basis upon which to determine the appeal, alongside other material considerations.

150. Policy S4 of the ULP provides for development directly related to or associated with Stansted Airport to be located within the boundaries of the airport.

151. Policy ENV11 of the ULP seeks to avoid harm to noise sensitive uses. The evidence indicates that the overall effect of the proposal on aircraft noise would

[18] Relevant ULP policies were reviewed by the Council and the appellant for the purposes of the appeal

be beneficial. Even at their peak, noise levels would not exceed that permissible under the existing planning permission. After that, it is expected that noise would reduce as a result of factors such as fleet mix and advances in technology. This improvement in noise conditions over time can be secured by condition in line with Government policy to share the benefits of airport expansion with local communities. As such, there would be no conflict with Policy ENV11 or the similar objectives of the Framework to protect living conditions.

152. Not all development can have the effect of improving air quality and by its very nature, there would inevitably be some additional air pollution from the proposed development which must weigh against the proposal. However, the ES/ESA assesses the impacts as being negligible at all human receptors and no exceedances of the air quality standards are predicted for any of the pollutants at human receptors in the study area. NOx concentrations at all ecological receptors are predicted to be below the critical level/air quality standard of 30µg/m^3 for all scenarios tested. The predicted changes in nitrogen deposition at the Hatfield Forest SSSI and NNR and Elsenham Woods SSSI remain less than 1% of the sites' lower critical loads. Ongoing monitoring of air quality within the SSSIs is provided for within the submitted Unilateral Undertaking. Overall, there would be no material change in air quality as a result of the development. As such, there would be no conflict with Policy ENV13 of the ULP, which seeks to avoid people being exposed on an extended long-term basis to poor air quality; or the similar objectives of the Framework.

153. Carbon emissions are predominantly a matter for national Government and the effects of airport expansion have been considered, tested and found to be acceptable in MBU. It is clear that UK climate change obligations would not be put at risk by the development, including in light of the Government's 20 April 2021 announcement. Carbon emissions from other sources associated with the development, such as the operation of airport infrastructure, on site ground based vehicles and from people travelling to and from the site are relatively small and would be subject to extensive sustainable transport measures secured by conditions and obligations that would minimise impacts as far as possible. Therefore, this matter weighs against the proposal only to a limited extent and could not be said to compromise the ability of future generations to meet their needs, or otherwise conflict with the objectives of the Framework taken as a whole.

154. The Highway Authorities are satisfied that the development would not unacceptably affect highway safety or capacity and the Panel agrees. All infrastructure and mitigation measures required to make the development acceptable in planning terms can be secured by conditions or planning obligations. On this basis, there would be no conflict with ULP Policies GEN1, GEN6, GEN7, ENV7, ENV11 or ENV13 so far as they require infrastructure delivery or mitigation.

155. The Council and the appellant agree that the proposed development accords with the development plan, taken as a whole. It is further agreed that the Framework's presumption in favour of sustainable development should apply as a result of the proposals' accordance with an up-to-date development plan[19].

[19] Framework paragraph 11(c)

In these circumstances the Framework states that development should be approved without delay.

156. In addition, the scheme receives very strong support from national aviation policy. Taken together, these factors weigh very strongly in favour of the grant of planning permission. Furthermore, the development would deliver significant additional employment and economic benefits, as well as some improvement in overall noise and health conditions.

157. The Council has recently withdrawn its emerging Local Plan such that it has no prospect of becoming part of the development plan and attracts no weight in the determination of this appeal. There are a number of made Neighbourhood Plans in the local area, but none contain policies that have a bearing on the outcome of the appeal.

158. Overall, the balance falls overwhelmingly in favour of the grant of planning permission. Whilst there would be a limited degree of harm arising in respect of air quality and carbon emissions, these matters are far outweighed by the benefits of the proposal and do not come close to indicating a decision other than in accordance with the development plan. No other material considerations have been identified that would materially alter this balance.

Conclusion

159. In light of the above, the appeal is allowed.

Michael Boniface	*G D Jones*	*Nick Palmer*
INSPECTOR	INSPECTOR	INSPECTOR

APPEARANCES

FOR THE LOCAL PLANNING AUTHORITY:

Philip Coppel, of Queens Counsel and Asitha Ranatunga, of Counsel	Instructed by Elizabeth Smith, Interim Legal services Manager, Uttlesford District Council
They called	
James Trow BSc(Hons) MIOA MIEnvSc	Managing Director, Noise Consultants Ltd
Dr Mark Broomfield BA DPhil	Associate Director, Ricardo Energy and Environment Ltd
Dr Mark Hinnells BA(Hons) MA MSc PhD	Senior Consultant, Ricardo Energy and Environment Ltd
Hugh Scanlon BA(Hons) MPhil MRTPI	Senior Director, Lichfields

FOR THE APPELLANT:

Thomas Hill, of Queens Counsel and Philippa Jackson, of Counsel	Instructed by Alistair Andrew, Head of Planning Services, Manchester Airport Group (MAG)
They called	
Tim Hawkins BSc MSc	Chief of Staff, MAG
Dan Galpin BSc(Hons)	Director, ICF
David Thomson BSc MSc	Senior Director, RPS
Vernon Cole BSc(Hons) MSME MBA CEng MIOA FIMechE IIAV	Acoustic Consultant, Cole Jarman Ltd
Dr Michael Bull BSc PhD CEng CSci CEnv IAQM MIEnvSc IChemE	Director, Ove Arup & Partners Ltd
Dr Andrew Buroni BSc(Hons) MSc PhD RSM RSPH	Director, RPS
Mike Barker BSc(Hons) MSc CIEEM	Director of Ecology, RPS
Neil Robinson BSc MSc MBA	CSR & Future Airspace Director, MAG
George Vergoulas BSc(Hons) MSc CEnv MIEnvSc MIEMA	Associate, Ove Arup & Partners Ltd
Philip Rust CEng MICE CIHT	Director, Steer Group
Edith McDowall BA(Hons) MPhil	Director, Optimal Economics
Louise Congdon BA(SocSci) MA	Managing Partner, York Aviation

Alistair Andrew BA(Hons) DipTP (UC) MRTPI	Head of Planning Services, MAG

FOR STOP STANSTED EXPANSION:

Paul Stinchcombe and Richard Wald, both of Queens Counsel	Instructed by Brian Ross, Deputy Chairman of Stop Stansted Expansion (SSE)
They called[20]	
Ken McDonald FCA	Founder, Secretary and Trustee of The Hundred Parishes Society and SSE Executive Committee Member
Brian Ross[21] BCom(Hons) MBA FRSA MSPE	Deputy Chairman of SSE
Peter Lockley MA	Barrister
Michael Young BA(Hons) FCA	SSE Executive Committee Member
Bruce Bamber BSc MA MSc MCIHT	Director of Railton TPC Ltd

INTERESTED PERSONS:

Derek Connell	The Three Horseshoes Public House, Duton Hill
Vere Isham	Broxted Parish Council
Dr Graham Mott	Elsenham Parish Council
Cllr Jenny Jewell	Great Canfield Parish Council
Neville Nicholson	Helions Bumpstead Parish Council
Dr Zoe Rutterford	Henham Parish Council & Chickney Parish Meeting
Cllr Neil Reeve	High Easter Parish Council
Julia Milovanovic	Moreton Bobbingworth & The Lavers Parish Council
Peter Jones	Stansted Mountfitchet Parish Council
Cllr Barrett	Stebbing Parish Council
Cllr Geoff Bagnell	Takeley Parish Council
Cllr Duncan McDonald	Much Hadham Parish Council
Richard Haynes JLL	Thaxted Parish Council
John Devoti	Howe Green and Great Hallingbury Residents Chairman of East Hertfordshire Green Party
Alex Daar	The Aviation Environment Federation
Tim Johnson	New Economics Foundation
Alex Chapman	Local Resident
Jonathan Fox	Local Resident
Michael Belcher	Local Resident

[20] Although other proofs of evidence were submitted in support of SSE's case, including those of Peter Sanders CBE MA DPhil, Prof Jangu Banatvala CBE MA MD(Cantab) FRCP FRCPath FMedSci DPH, Martin Peachey MA(Cantab), John Rhodes MA(Oxon), Dr Claire Holman and Colin Arnott BA MPhil MRTPI, only the five witnesses listed were called to give evidence at the Inquiry

[21] Mr Ross gave evidence in respect to the Inquiry topics of 'air traffic forecasting and predictions', 'socio-economic impacts' and 'planning matters'. For the latter of these topics he adopted the proof of evidence of Mr Arnott

Maggie Sutton	Local Resident
Simon Havers	Local Resident
Irene Jones	Local Resident
Mark Johnson	Uttlesford Green Party
Edward Gildea	Local Resident
Raymond Woodcock	Local Resident
Cliff Evans	Local Resident
George Marriage	Local Resident
Quintus Benziger	Local Resident
Jonathan Richards	Local Resident
Vincent Thompson	Local Resident
Peter Franklin	Local Resident
Roger Clark	Local Resident
Martin Berkeley	Local Resident
Suzanne Walker	Director of Policy, Essex Chamber of
David Burch	Commerce
	Director of Policy, Suffolk Chamber of
Andy Walker	Commerce
	CBI East
Freddie Hopkinson	Chair, Cambridge Ahead
Harriet Fear MBE	Executive Director, Visit East of England
Pete Waters	UK VP Strategy, AstraZeneca
Dr Andy Williams	UK Director, World Duty Free
Martyn Scarf	Managing Director, National Express
Chris Hardy	Director of Corporate Affairs, Greater Anglia
Jonathan Denby	Principal, Stansted Airport College
Karen Spencer MBE	The Easter and Rodings Action Group
Robert Beer	

SCHEDULE OF CONDITIONS FOR APPEAL REF APP/C1570/W/20/3256619:

1. The development hereby permitted shall be begun before the expiration of 5 years from the date of this decision.

2. Prior to reaching 35mppa, a scheme for the provision and implementation of water resource efficiency measures during the operational phases of the development shall be submitted to and approved in writing by the local planning authority. The scheme shall include the identification of locations for sufficient additional water meters to inform and identify specific measures in the strategy. The locations shall reflect the passenger, commercial and operational patterns of water use across the airport. The scheme shall also include a clear timetable for the implementation of the measures in relation to the operation of the development. The approved scheme shall be implemented, and the measures provided and made available for use in accordance with the approved timetable.

3. Prior to the commencement of construction works, a Construction Environmental Management Plan (CEMP) shall be submitted to and approved in writing by the local planning authority. The construction works shall subsequently be carried out strictly in accordance with the approved CEMP, unless otherwise approved in writing by the local planning authority.

   The CEMP shall incorporate the findings and recommendations of the Environmental Statement and shall incorporate the following plans and programmes:

   (a) External Communications Plan
      (i) External communications programme
      (ii) External complaints procedure

   (b) Pollution Incident Prevention and Control Plan
      (i) Identification of potential pollution source, pathway and receptors
      (ii) Control measures to prevent pollution release to water, ground and air (including details of the surface/ground water management plan)
      (iii) Control measures for encountering contaminated land
      (iv) Monitoring regime
      (v) Emergency environmental incident response plan
      (vi) Incident investigation and reporting
      (vii) Review/change management and stakeholder consultation

   (c) Site Waste Management Plan
      (i) Management of excavated materials and other waste arising
      (ii) Waste minimisation
      (iii) Material re-use

   (d) Nuisance Management Plan (Noise, Dust, Air Pollution, Lighting)
      (i) Roles and responsibilities
      (ii) Specific risk assessment – identification of sensitive receptors and predicted impacts
      (iii) Standards and codes of practice
      (iv) Specific control and mitigation measures
      (v) Monitoring regime for noise

(e) Management of Construction Vehicles
   (i) Parking of vehicles of site operatives
   (ii) Routes for construction traffic

The CEMP shall include as a minimum all measures identified as "Highly Recommended" or "Desirable" in IAQM "Guidance on the assessment of dust from demolition and construction," Version 1.1 2014 commensurate with the level of risk evaluated in accordance with the IAQM guidance, for construction activities which are within the relevant distance criteria from sensitive locations set out in Box 1 and Tables 2, 3 and 4 of the IAQM guidance.

The CEMP shall provide for all heavy goods vehicles used in the construction programme to be compliant with EURO VI emissions standards, and for all Non Road Mobile Machinery to be compliant with Stage V emissions controls as specified in EU Regulation 2016/1628, where such heavy goods vehicles and Non Road Mobile Machinery are reasonably available. Where such vehicles or machinery are not available, the highest available standard of alternative vehicles and machinery shall be used.

4. Prior to commencement of the development, a detailed surface water drainage scheme for the airfield works hereby approved based on the calculated required attenuation volume of $256m^3$, shall be submitted to and approved in writing by the local planning authority. The approved scheme shall be fully implemented before any of the aircraft stands and taxiway links hereby approved are brought into use. The scheme shall be implemented in accordance with the approved details as part of the development, and shall include but not be limited to:

- Detailed engineering drawings of the new or altered components of the drainage scheme;
- A final drainage plan, which details exceedance and conveyance routes, and the location and sizing of any drainage features; and
- A written report summarising the scheme as built and highlighting any minor changes to the approved strategy.

5. A Biodiversity Management Strategy (BMS) in respect of the translocation site at Monks Farm shall be submitted to, and approved in writing by, the local planning authority prior to the commencement of construction works. The BMS shall include:

- Description and evaluation of features to be managed;
- Ecological trends and constraints on site that might influence management;
- Aims and objectives of management;
- Appropriate management options for achieving aims and objectives;
- Prescriptions for management actions;
- Preparation of a work schedule (including an annual work plan capable of being rolled forward over a five year period);
- Details of the body or organisation responsible for implementation of the Strategy; and
- Ongoing monitoring and remedial measures.

The Strategy shall also set out (where the results from monitoring show that conservation aims and objectives of the BMS are not being met) how contingencies and/or remedial action shall be identified, approved by the local planning authority and implemented so that the development still delivers the fully functioning biodiversity objectives of the originally approved scheme. The BMS shall be implemented in accordance with the approved details.

6. All ecological mitigation and enhancement measures and/or works shall be carried out in accordance with the details contained in the Stansted – Ecology Mitigation Strategy (RPS, February 2018) forming part of Appendix 16.1 and 16.2 of the Environmental Statement and in the Conclusions and Recommendations of the Preliminary Ecological Appraisal Update (RPS, 5 October 2020), Appendix 16.A of the Environmental Statement Addendum.

7. The area enclosed by the 57dB(a) Leq, 16h (0700-2300) contour shall not exceed 33.9 sq km for daytime noise.

By the end of the first calendar year that annual passenger throughput exceeds 35million, the area enclosed by the following contours shall not exceed the limits in Table 1:

Table 1

54 dB $L_{Aeq,\ 16hr}$	57.4 km^2
48 dB $L_{Aeq,\ 8hr}$	74.0 km^2

By the end of 2032 or by the end of the first calendar year that annual passenger throughput reaches 43million (whichever is sooner), Stansted Airport Limited, or any successor or airport operator, shall reduce the areas enclosed by the noise contours as set out in Table 2. Thereafter the areas enclosed by the contours as set out in Table 2, shall not be exceeded.

Table 2

54 dB $L_{Aeq,\ 16hr}$	51.9 km^2
48 dB $L_{Aeq,\ 8hr}$	73.6 km^2

For the purposes of this condition, the noise contour shall be calculated by the Civil Aviation Authority's Environmental Research and Consultancy Department (ERCD) Aircraft Noise Contour model (current version 2.4), (or as may be updated or amended) or, following approval by the local planning authority, any other noise calculation tool such as the Federal Aviation Administration Aviation Environmental Design Tool (current version 3.0c) providing that the calculations comply with European Civil Aviation Conference Doc 29 4th Edition (or as may be updated or amended) and that the modelling is undertaken in line with the requirements of CAA publication CAP2091 (CAA Policy on Minimum Standards for Noise Modelling). All noise contours shall be produced using the standardised average mode.

To allow for the monitoring of aircraft noise, the airport operator shall make noise contour mapping available to the local planning authority annually as part of demonstrating compliance with this condition. Contours should be provided in 3dB increments from 51 dB $L_{Aeq,16hr}$ and 45 dB $L_{Aeq,\ 8hr}$.

8. The passenger throughput at Stansted Airport shall not exceed 43 million passengers in any 12 calendar month period. From the date of this permission, the airport operator shall report the monthly and moving annual total numbers of passengers in writing to the local planning authority no later than 28 days after the end of the calendar month to which the data relate.

9. There shall be a limit on the number of occasions on which aircraft may take-off or land at the site of 274,000 Aircraft Movements during any 12 calendar month period, of which no more than 16,000 shall be Cargo Air Transport Movements (CATMs). From the date of the granting of planning permission, the developer shall report the monthly and moving annual total numbers of Aircraft Movements, Passenger Air Transport Movements and CATMs in writing to the local planning authority no later than 28 days after the end of the calendar month to which the data relate.

   The limit shall not apply to aircraft taking off or landing in any of the following circumstances:

   a) The aircraft is required to land at the airport because of an emergency, a divert or any other circumstance beyond the control of the operator and commander of the aircraft; or

   b) The aircraft is engaged on the Head of State's flight, or on a flight operated primarily for the purposes of the transport of Government Ministers or visiting Heads of State or dignitaries from abroad.

10. Prior to the airport first handling 35mppa, an Airport Air Quality Strategy (AAQS) shall be submitted to and approved in writing by the local planning authority. The AAQS shall set out how the airport operator shall take proportionate action to contribute to compliance with relevant limit values or national objectives for pollutants through:

    a) Measures to minimise emissions to air from its own operational sources;

    b) Measures to influence actions to be undertaken to improve air quality from third party operational sources; and

    c) Measures that reduce emissions through the Airport Surface Access Strategy (ASAS), the Sustainable Transport Levy and the Local Bus Network Development Fund.

    Thereafter, the AAQS shall be reviewed at the same time as the ASAS reviews (at least every 5 years or when a new or revised air quality standard is placed into legislation) and submitted to and be approved in writing by the local planning authority. At all times the AAQS shall be implemented as approved, unless otherwise approved in writing by the local planning authority.

11. Within 6 months of the date of this planning permission a scheme for the installation of rapid electric vehicle charging points at the airport shall be submitted to and approved in writing by the local planning authority. The scheme shall indicate the number and locations of the charging points and timetable for their installation. The approved scheme shall be fully implemented in accordance with the approved timetable and retained thereafter.

12. The development hereby permitted shall be carried out in accordance with the following approved plans: Location Plan: NK017817 – SK309;
    Site Plan: 001-001 Rev 01; Mike Romeo RET: 001-002 Rev 01;
    Yankee Remote Stands: 001-003 Rev 01; Runway Tango: 001-004 Rev 01 and Echo Stands: 001-005 Rev 01.

HM Government

Beyond the horizon
The future of UK aviation

Making best use of existing runways

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1. Making best use of existing runways

1.1 The government's 2013 Aviation Policy Framework provided policy support for airports outside the South East of England to make best use of their existing airport capacity. Airports within the South East were to be considered by the newly established Airports Commission.

1.2 The Airports Commission's Final Report recognised the need for an additional runway in the South East by 2030 but also noted that there would be a need for other airports to make more intensive use of their existing infrastructure.

1.3 The government has since set out its preferred option for a new Northwest runway at Heathrow by 2030 through drafts of the Airports National Policy Statement (NPS), but has not yet responded on the recommendation for other airports to make more intensive utilisation of their existing infrastructure.

1.4 On 24th October 2017 the Department for Transport (DfT) released its latest aviation forecasts. These are the first DfT forecasts since 2013[1]. The updated forecasts reflect the accelerated growth experienced in recent years and that demand was 9% higher in London[2] in 2016 than the Airports Commission forecast[3]. This has put pressure on existing infrastructure, despite significant financial investments by airports over the past decade, and highlights that government has a clear issue to address.

1.5 The Aviation Strategy call for evidence set out that government agrees with the Airports Commission's recommendation and was minded to be supportive of all airports who wish to make best use of their existing runways, including those in the South East, subject to environmental issues being addressed. The position is different for Heathrow, where the government's proposed policy on expansion is set out in the proposed Airports NPS.

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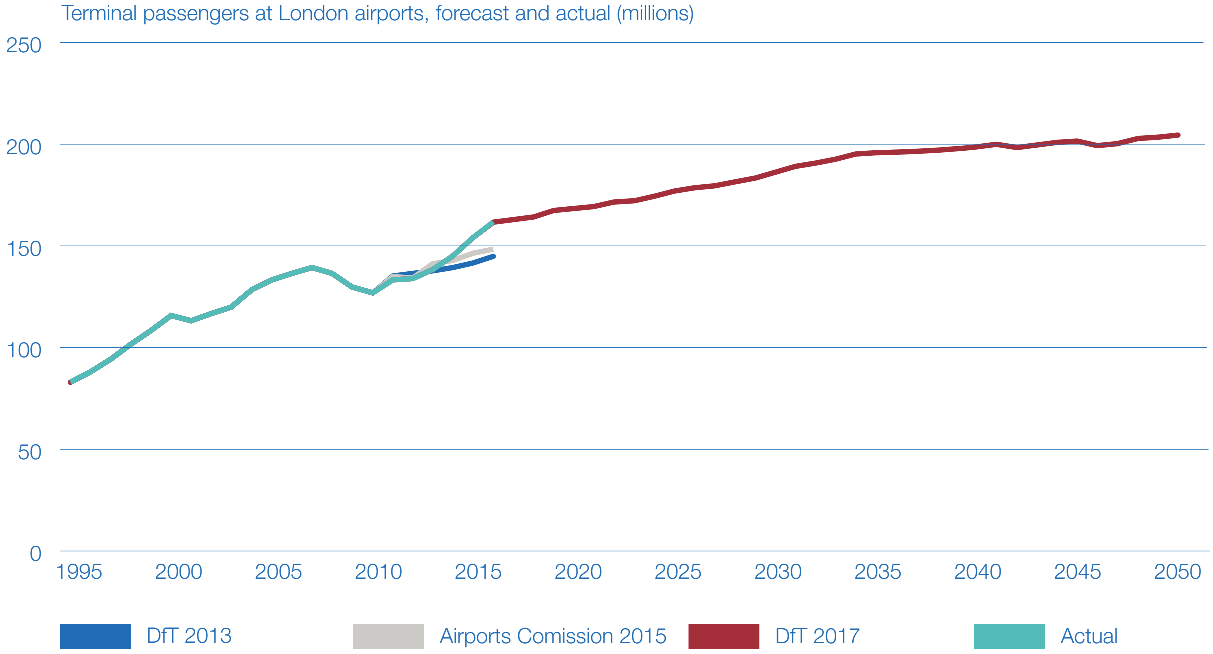
1 Additional aviation forecasts were published by the Airports Commission in 2015 to support their recommendations for an additional runway in the south east.

2 Heathrow, Gatwick, Stansted, Luton and London City

3 The difference is explained largely be the fact that oil prices were lower than expected



Call for evidence response summary

1.6 The Aviation Strategy call for evidence document asked specifically for views on the government's proposal to support airports throughout the UK making best use of their existing runways, subject to environmental issues being addressed.

1.7 We received 346 consultation responses. Excluding those who either did not respond or responded on a different topic, 60% were in favour, 17% against and 23% supportive provided certain issues were addressed.

1.8 The main issues raised included the need for environmental issues such as noise, air quality, and carbon to be fully addressed as part of any airport proposal; the need for improved surface access and airspace modernisation to handle the increased road / rail and air traffic; and clarification on the planning process through which airport expansion decisions will be made.

Role of local planning

1.9 Most of the concerns raised can be addressed through our existing policies as set out in the 2013 Aviation Policy Framework, or through more recent policy updates such as the new UK Airspace Policy or National Air Quality Plan. For the majority of environmental concerns, the government expects these to be taken into account as part of existing local planning application processes. It is right that decisions on the elements which impact local individuals such as noise and air quality should be considered through the appropriate planning process and CAA airspace change process.

1.10 Further, local authorities have a duty to consult before granting any permission, approval, or consent. This ensures that local stakeholders are given appropriate opportunity to input into potential changes which affect their local environment and have their say on airport applications.

Role of national policy

1.11 There are, however, some important environmental elements which should be considered at a national level. The government recognises that airports making the best use of their existing runways could lead to increased air traffic which could increase carbon emissions.

1.12 We shall be using the Aviation Strategy to progress our wider policy towards tackling aviation carbon. However, to ensure that our policy is compatible with the UK's climate change commitments we have used the DfT aviation model[4] to look at the impact of allowing all airports to make best use of their existing runway capacity[5]. We have tested this scenario against our published no expansion scenario and the Heathrow Airport North West Runway scheme (LHR NWR) option, under the central demand case.

1.13 The forecasts are performed using the DfT UK aviation model which has been extensively quality assured and peer reviewed and is considered fit for purpose and robust for producing forecasts of this nature. Tables 1-3 show the expected figures in passenger numbers, air traffic movements, and carbon at a national level for 2016, 2030, 2040, and 2050.

	Baseline	Baseline + best use	LHR NWR base	LHR NWR + best use
2016	266.6	266.6	266.6	266.6
2030	313.4	314.8	342.5	341.9
2040	359.8	365.9	387.4	388.8
2050	409.5	421.3	435.3	444.2

Table 1: Terminal Passengers at UK airports, million passengers per annum

	Baseline	Baseline + best use	LHR NWR base	LHR NWR + best use
2016	2,119	2,119	2,119	2,119
2030	2,330	2,358	2,459	2,460
2040	2,584	2,602	2,697	2,700
2050	2,901	2,958	3,013	3,043

Table 2: Air Transport Movements (ATMs) at UK airports, 000s

	Baseline	Baseline best use	LHR NWR base	LHR NWR best use
2016	37.3	37.3	37.3	37.3
2030	38.6	38.8	43.5	43.4
2040	38.1	38.7	42.3	42.4
2050	37.0	37.9	39.9	40.8

Table 3: CO_2 from flights departing UK airports, million tonnes

4 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/674749/uk-aviation-forecasts-2017.pdf

5 Modelled the impact of airports increasing their planning cap whenever they have become 95% full.

Implications for the UK's carbon commitments

1.14 As explained in Chapter 6 of the Aviation Strategy Next Steps document[6], we have made significant steps in developing international measures for addressing aviation carbon dioxide (CO_2) emissions, including reaching agreement at the International Civil Aviation Organisation (ICAO) in October 2016 on a global offsetting scheme for international aviation, known as the Carbon Offsetting and Reduction Scheme for International Aviation, or CORSIA. However, there remains uncertainty over future climate change policy and international arrangements to reduce CO2 and other greenhouse gases. The Airports Commission devised two scenarios which continue to be appropriate to reflect this uncertainty: carbon traded and carbon capped[7]. In this assessment the DfT has followed the same approach.

Carbon traded scenario

1.15 Under the carbon-traded scenario, UK aviation emissions could continue to grow provided that compensatory reductions are made elsewhere in the global economy. This could be facilitated by a carbon trading mechanism in which aviation emissions could be traded with other sectors. In this case, provided a global trading scheme is place, higher UK aviation activity would have no impact on global emissions as any increase in emissions would be offset elsewhere and therefore there is nothing to indicate that this policy would prevent the UK meeting its carbon obligations.

Carbon capped scenario

1.16 The carbon-capped scenario was developed to explore the case for expansion even in a future where aviation emissions were limited to the Committee on Climate Change's (CCC) planning assumption of 37.5Mt of CO_2 in 2050. Under DfT's carbon-capped scenario the cap is met using a combination of carbon pricing and specific measures. For the central demand case we determined that the most appropriate specific measures to use, based on cost effectiveness and practicality of implementation, were more efficient aircraft ground movements (using single engine taxiing) and higher uptake of renewable fuels[8].

6 https://www.gov.uk/government/consultations/a-new-aviation-strategy-for-the-uk-call-for-evidence

7 For background to the Carbon Policy scenarios used by DfT both in this document and in its airport expansion analysis see pages 9 and 33-38 of: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/653879/updated-appraisal-report-airport-capacity-in-the-south-east.pdf

8 These would be implemented alongside the carbon price.

1.17 The more efficient ground movement policy involves government action to incentivise the use of single-engine taxiing at UK airports. It is assumed that the policy would lead to a 95% take-up rate by 2030 and beyond and it is estimated that this measure would reduce fuel consumption by around 1% per flight on average[9].

1.18 The renewable fuels policy involves government regulations to mandate specific renewable fuel percentages in aviation fuel supply. Any measures deployed would be designed to ensure that the renewable feedstock is sustainable and delivers substantial lifecycle CO_2 savings, such as municipal waste, which on this basis could deliver savings of over 70%. Such a scheme would be consistent with the future aims of the Renewable Transport Fuel Obligation to include aviation and focus on advanced fuels, as set out in the government's response to its recent consultation[10]. The levels of carbon reduction delivered by the policy measures are presented in Table 4.

	No expansion base	No expansion + best use	LHR NWR base	LHR NWR + best use
Carbon reduction required, $MtCO_2$	-0.5	0.4	2.4	3.3
Abatement from single engine taxiing, $MtCO_2$*	0	0.3	0.3	0.3
Renewable fuel uptake required	0	0**	12%	16%

*Figure does not vary due to rounding
**Zero due to rounding

Table 4: Policies to meet CCC cap (37.5 $MtCO_2$), levels in 2050

1.19 The level of renewable fuels required is higher under the making best use sensitivity but these are still at the conservative end of the range of forecast future biofuel supply[11].

1.20 There is significant uncertainty over the likely future cost of these measures and their impact on carbon so this policy mix is presented to illustrate the type of abatement action that could be taken. It should not be interpreted as a statement of future carbon policy which will be considered through the development of the Aviation Strategy. Other measures are likely to be available and may turn out to be more cost effective or have greater abatement potential.

1.21 On balance, therefore, it is likely that these or other measures would be available to meet the planning assumption under this policy.

9 Ricardo Energy & Environment, 2017. *Carbon Abatement in UK Aviation* https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/653776/carbon-abatement-in-uk-aviation.pdf

10 DfT, 2017. *Renewable transport fuel obligations order: government response.* https://www.gov.uk/government/publications/renewable-transport-fuel-obligations-order-government-response

11 See Increased use of biofuels chapter in Carbon Abatement in UK Aviation Report prepared by Ricardo Energy & Environment for discussion https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/653776/carbon-abatement-in-uk-aviation.pdf

Local environmental impacts

1.22 The government recognises the impact on communities living near airports and understands their concerns over local environmental issues, particularly noise, air quality and surface access. As airports look to make the best use of their existing runways, it is important that communities surrounding those airports share in the economic benefits of this, and that adverse impacts such as noise are mitigated where possible.

1.23 For the majority of local environmental concerns, the government expects these to be taken into account as part of existing local planning application processes.

1.24 As part their planning applications airports will need to demonstrate how they will mitigate local environmental issues, which can then be presented to, and considered by, communities as part of the planning consultation process. This ensures that local stakeholders are given appropriate opportunity to input into potential changes which affect their environment and have their say on airport applications.

Policy statement

1.25 As a result of the consultation and further analysis to ensure future carbon emissions can be managed, government believes there is a case for airports making best of their existing runways across the whole of the UK. The position is different for Heathrow Airport where the government's policy on increasing capacity is set out in the proposed Airports NPS.

1.26 Airports that wish to increase either the passenger or air traffic movement caps to allow them to make best use of their existing runways will need to submit applications to the relevant planning authority. We expect that applications to increase existing planning caps by fewer than 10 million passengers per annum (mppa) can be taken forward through local planning authorities under the Town and Country Planning Act 1990. As part of any planning application airports will need to demonstrate how they will mitigate against local environmental issues, taking account of relevant national policies, including any new environmental policies emerging from the Aviation Strategy. This policy statement does not prejudge the decision of those authorities who will be required to give proper consideration to such applications. It instead leaves it up to local, rather than national government, to consider each case on its merits.

1.27 Applications to increase caps by 10mppa or more or deemed nationally significant would be considered as Nationally Significant Infrastructure Projects (NSIPs) under the Planning Act 2008 and as such would be considered on a case by case basis by the Secretary of State.

1.28 Given the likely increase in ATMs that could be achieved through making best use of existing runways is relatively small (2% increase in ATMs "without Heathrow expansion" scenario; 1% "with Heathrow"), we do not expect that the policy will have significant implications for our overall airspace capacity. However it is important to note that any flightpath changes required as a result of a development at an airport will need to follow the CAA's airspace change process. This includes full assessment of the likely environmental impacts, consideration of options to mitigate these impacts, and the need to consult with stakeholders who may be affected. Approval for the proposed airspace change will only be granted once the CAA has been satisfied that all aspects, including safety, have been addressed. In addition, government has committed to establish an Independent Commission on Civil Aviation Noise (ICCAN) to help ensure that the noise impacts of airspace changes are properly considered and give communities a greater stake in noise management.

1.29 **Therefore the government is supportive of airports beyond Heathrow making best use of their existing runways. However, we recognise that the development of airports can have negative as well as positive local impacts, including on noise levels. We therefore consider that any proposals should be judged by the relevant planning authority, taking careful account of all relevant considerations, particularly economic and environmental impacts and proposed mitigations. This policy statement does not prejudge the decision of those authorities who will be required to give proper consideration to such applications. It instead leaves it up to local, rather than national government, to consider each case on its merits.**

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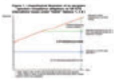
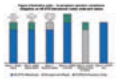
Implementing the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)

How to respond

Introduction

CORSIA Monitoring Reporting and Verification (MRV)





The Air Navigation (Carbon Offsetting and Reduction Scheme for International Aviation) Order 2021

Status: This is the original version (as it was originally made). This item of legislation is currently only available in its original format.

Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)

— Frequently Asked Questions (FAQs) —

(updated as of 31 December 2020)

Note:

The information included in the responses to the selected "Frequently Asked Questions" makes reference to the following documents:

- *Assembly Resolution A40-19:* Consolidated statement of continuing ICAO policies and practices related to environmental protection - Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)[1], adopted *by the 40th Session of the ICAO Assembly (24 September – 4 October 2019);*
- *First edition of Annex 16 —* Environmental Protection, Volume IV – Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)*, adopted by the ICAO Council at its 214th Session (11 - 29 June 2018)[2];*
- *Second edition of the* Environmental Technical Manual *(Doc 9501), Volume IV, —* Procedures for demonstrating compliance with the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)[3]; and
- *The five ICAO CORSIA Implementation Elements as reflected in 14 ICAO documents approved by the ICAO Council for publication[4]. These ICAO documents are directly referenced in Annex 16, Volume IV and are essential for the implementation of the CORSIA.*

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[1] https://www.icao.int/environmental-protection/Documents/Assembly/Resolution_A40-19_CORSIA.pdf
[2] https://www.icao.int/environmental-protection/CORSIA/Pages/SARPs-Annex-16-Volume-IV.aspx
[3] https://www.icao.int/environmental-protection/CORSIA/Pages/ETM-V-IV.aspx
[4] https://www.icao.int/environmental-protection/CORSIA/Pages/implementation-elements.aspx

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Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)

Frequently Asked Questions (FAQs)

1.	**General questions about a market-based measure (MBM) and CORSIA**
1.1	What is a market-based measure (MBM)?
	A market-based measure (MBM) is a policy tool that is designed to achieve environmental goals at a lower cost and in a more flexible manner than traditional regulatory measures. Examples of MBMs include levies, emissions trading systems, and carbon offsetting.
1.2	What is the contribution of aviation to global greenhouse gas emissions?
	According to the Intergovernmental Panel on Climate Change IPCC (AR4 Climate Change 2007: Mitigation of Climate Change, pp 49; also see the IPCC Special Report on Aviation and the Global Atmosphere, pp 6), aviation (domestic and international) accounts for approximately 2 per cent of global CO_2 emissions produced by human activity. In 2015, approximately 65 per cent of global aviation fuel consumption was from international aviation (see ICAO 2019 Environmental Report); applying this share to CO_2 emissions, international aviation is responsible for approximately 1.3 per cent of global CO_2 emissions.
1.3	Why does the Paris Agreement not include international aviation emissions?
	The Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC) is an international treaty that was agreed in December 2015 and entered into force in November 2016 to enhance the implementation of the UNFCCC. Its aim is "to strengthen the global response to the threat of climate change" by establishing specific goals for "holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C". The Paris Agreement, adopted under the UNFCCC, addresses sectors and related greenhouse gas emissions following an approach similar to that of its overarching Convention. While all domestic GHG emissions are dealt with under the UNFCCC, GHG emissions associated with international aviation and maritime transport are to be dealt with under ICAO and International Maritime Organization (IMO), respectively. This approach is consistent with similar UNFCCC decisions that also apply to the Kyoto Protocol. In this regard, GHG emissions from domestic aviation, as per other domestic sources, are calculated as part of the UNFCCC national GHG inventories and are included in national totals (part of the Nationally Determined Contributions (NDCs) of the Paris Agreement), while GHG emissions from international aviation are reported separately and are not included in NDCs. ICAO, as a specialized UN agency to address all matters related to international civil aviation, including environmental protection, has been diligently addressing GHG emissions from international aviation. The ICAO agreement on carbon neutral growth and CORSIA complements the ambition of the Paris Agreement and constitutes the most significant international climate-related agreement since its adoption.
1.4	Why did ICAO decide to develop a global MBM scheme for international aviation?
	The ICAO Assembly has resolved that ICAO and its Member States, with relevant organizations, would work together to strive to achieve a collective medium term global aspirational goal of keeping the global net CO_2 emissions from international aviation from 2020 at the same level (so-called "carbon neutral growth from 2020").

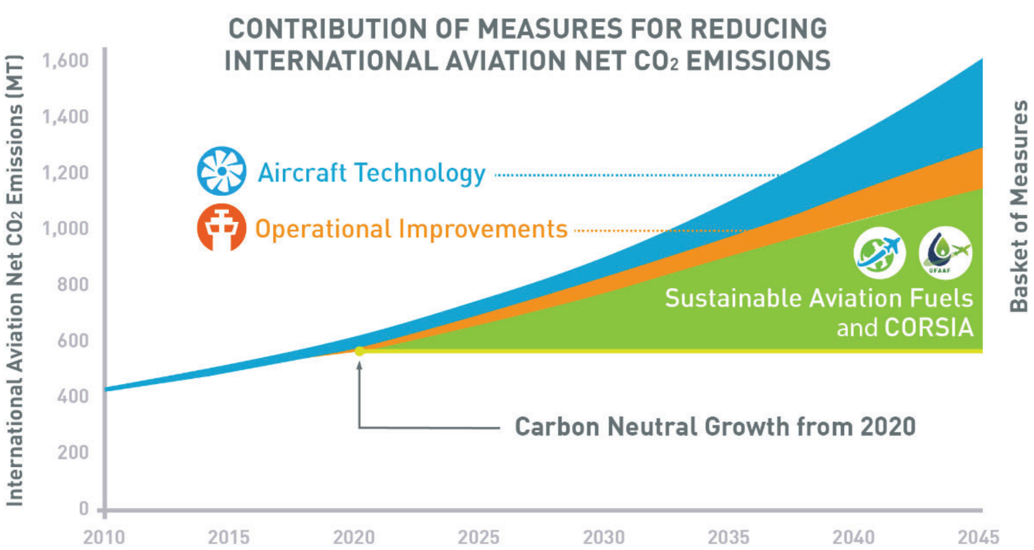
The Assembly also defined a basket of measures designed to help achieve the ICAO's global aspirational goal. This basket includes aircraft technologies such as lighter airframes, higher engine performance and new certification standards, operational improvements (e.g., improved ground operations and air traffic management), sustainable aviation fuels, and market-based measures (MBMs).

Based on the environmental trend assessment by the ICAO Council's Committee on Aviation Environmental Protection (CAEP), international aviation fuel consumption is estimated to grow somewhere between 2.2 to 3.1 times by 2045 compared to the 2015 levels (for further details on the CAEP assessment, please refer to Assembly Working Paper A40-WP/54 presented to the 40th Session of the ICAO Assembly). The impact of COVID-19 on international aviation fuel consumption is being evaluated and will be reported to the 41st ICAO Assembly in 2022.

The aggregate environmental benefits achieved by non-MBMs measures will not be sufficient for the international aviation sector to reach its aspirational goal. According to the CAEP analysis, international aviation emissions are forecasted to grow in the coming decades, as the projected annual improvements in aircraft fuel efficiency of around 1 to 2 per cent (as result of technological and operational measures), and the reductions from the use of sustainable aviation fuels in the short- to medium-term are expected to be largely surpassed by the forecasted traffic growth of around 5 per cent per year.

A global MBM scheme can help fill the emissions reductions gap, while further advancements in key technologies (e.g., engines, fuels) may result in further CO_2 emissions reductions in the future. The global MBM scheme is the preferred approach compared to having a patchwork of regional and local measures.

The Figure below illustrates the contribution of different measures for reducing international aviation CO_2 emissions.



1.5 What ICAO process was followed to develop CORSIA?

Discussions on the application of MBMs as a means to limit or reduce CO_2 emissions from international civil aviation had taken place prior to the 37th Session of the Assembly in 2010, which adopted Assembly Resolution A37-19: *Consolidated*

	statement of continuing ICAO policies and practices related to environmental protection — Climate change. Assembly Resolution A37-19 requested the Council, with the support of Member States and international organizations, to continue to explore the feasibility of a global MBM scheme by undertaking further studies on the technical aspects, environmental benefits, economic impacts and the modalities of such a scheme, taking into account the outcome of the negotiations under the United Nations Framework Convention on Climate Change (UNFCCC) and other international developments, as appropriate, and report the progress for consideration by the 38th Session of the ICAO Assembly in 2013. The 37th Session of the Assembly also adopted global aspirational goals for the international aviation sector of annual average fuel efficiency improvement of 2 per cent, and keeping the global net carbon emissions from 2020 at the same level (also referred to as carbon neutral growth from 2020). The work requested by Resolution A37-19 focused on the qualitative and quantitative assessments of potential options for a global MBM scheme for international aviation. Building on this work, the 38th Session of the ICAO Assembly in 2013, through Resolution A38-18: *Consolidated statement of continuing ICAO policies and practices related to environmental protection — Climate change*, decided to develop a global MBM scheme for international aviation, and requested the Council, with the support of Member States, to finalize the work on the technical aspects, environmental and economic impacts and modalities of the possible options for a global MBM scheme, including on its feasibility and practicability, taking into account the need for development of international aviation, the proposal of the aviation industry and other international developments, as appropriate, and without prejudice to the negotiations under the UNFCCC. Assembly Resolution A38-18 further requested the Council to identify the major issues and problems, including those for Member States, and make a recommendation on a global MBM scheme that appropriately addresses them and key design elements, including a means to take into account special circumstances and respective capabilities of ICAO Member States. The Council was also requested to identify the mechanisms for the implementation of the scheme from 2020 as part of a basket of measures that also include technologies, operational improvements and sustainable aviation fuels to achieve ICAO's global aspirational goals. Following the 38th Session of the Assembly, the 200th Session of the Council in November 2013 supported that the Committee on Aviation Environmental Protection (CAEP) would continue to undertake technical tasks related to the development of a global MBM scheme, as requested by Resolution A38-18. The Council also decided upon the establishment of an Environment Advisory Group of the Council (EAG), which was mandated to oversee all the work related to the development of a global MBM scheme and make recommendations to the Council. The EAG focused its work on a mandatory carbon offsetting approach as the basis for a global MBM scheme for international aviation. The EAG/15 meeting in January 2016 considered a draft Assembly Resolution text on a global MBM scheme, which was further refined throughout 2016 by two meetings of a High-level Group on a Global MBM Scheme in February and April 2016, a High-level Meeting on a Global MBM Scheme in May 2016 and a Friends of the President Informal Meeting in August 2016.

The Assembly, by adopting Resolution A39-3, agreed to implement a global MBM scheme in the form of CORSIA. It also requested the Council, with the technical contribution of CAEP, to develop the SARPs and related guidance material for the implementation of the Monitoring, Reporting and Verification (MRV) system under the CORSIA.

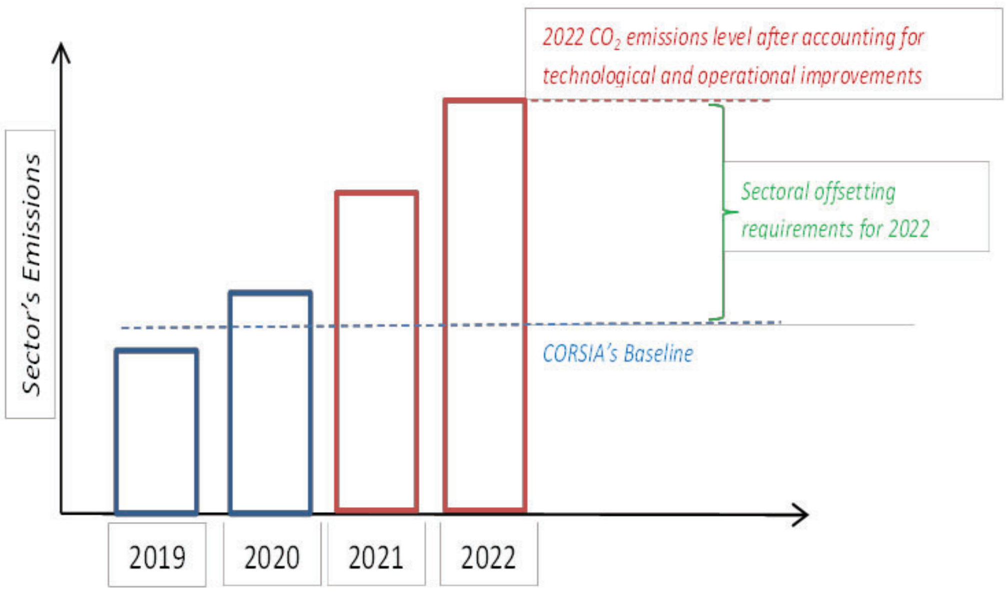
The CAEP developed SARPs for the CORSIA and, after amendment following the consultation with the Member States, Annex 16, Volume IV was adopted by the Council at its 214th Session (11 – 29 June 2018), and is applicable from 1 January 2019.

The 40th Session of the ICAO Assembly (25 September – 4 November 2019) adopted resolution A40-19 (Consolidated statement of continuing ICAO policies and practices related to environmental protection - Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)), which supersedes the previous Assembly Resolution A39-3.

1.6 What is CORSIA and how does it work, in general?

The CORSIA has been adopted as complementary to the broader package of measures to help ICAO achieve its aspirational goal of carbon-neutral growth from 2020 onwards. CORSIA relies on the use of emissions units from the carbon market to offset the amount of CO_2 emissions that cannot be reduced through the use of technological and operational improvements, and sustainable aviation fuels.

The approach for CORSIA is based on comparing the total CO_2 emissions for a year (from 2021 onwards) against a baseline level of CO_2 emissions, which is defined as the average of CO_2 emissions from international aviation covered by the CORSIA for the years 2019 and 2020 (see question 2.17 for more details on CORSIA's baseline). In the following years, any international aviation CO_2 emissions covered by the CORSIA that exceed the baseline level represent the sector's offsetting requirements for that year (see graph below for an illustrative example for year 2022).



The sectoral offsetting requirements are shared among aeroplane operators participating in the CORSIA based on the sectoral growth factor and the individual

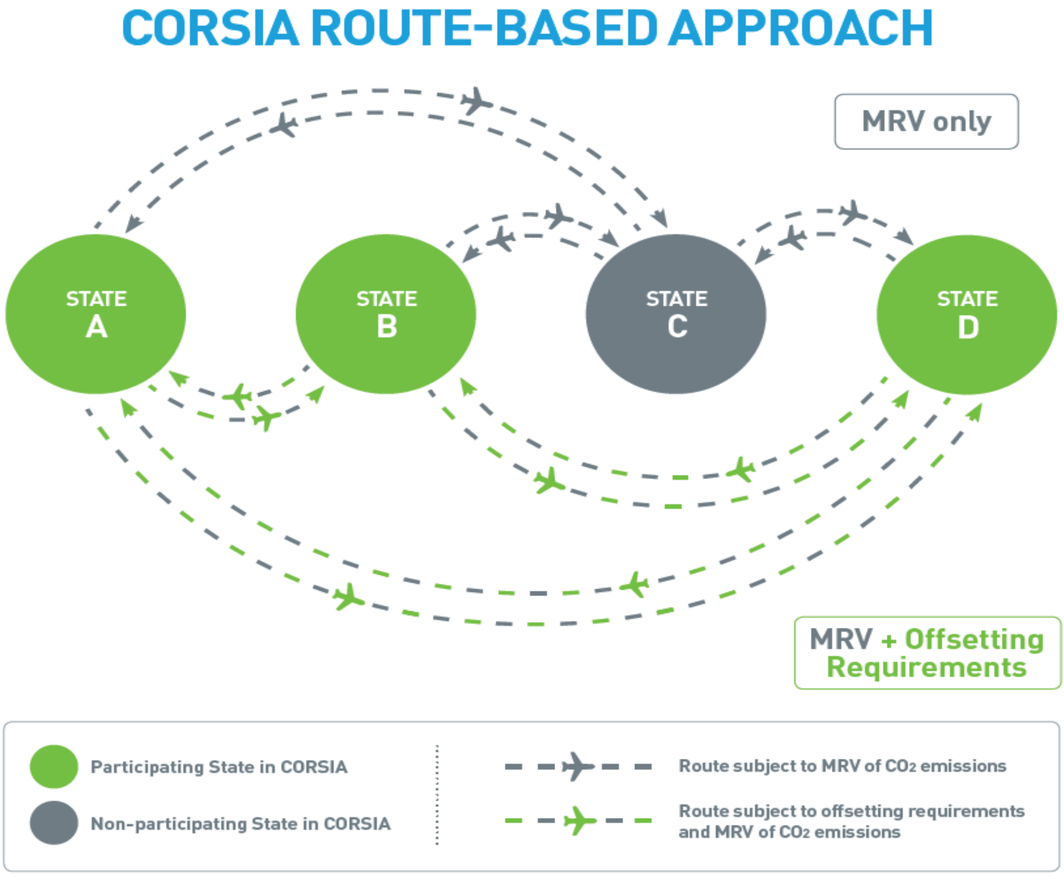
	CO_2 emissions of the operators. For more details on calculating offsetting requirements, please see question 2.15. The CORSIA will be implemented in three phases, starting with participation of States in the CORSIA offsetting on a voluntary basis (pilot phase and first phase), followed by participation of all States except the States exempted from offsetting requirements, as follows: • Pilot phase: from 2021 to 2023; • First phase: from 2024 to 2026; and • Second phase: from 2027 to 2035. See questions 2.1 – 2.6 for more information regarding the phased implementation of CORSIA, as well as on how to determine States' participation in different phases. It is important to note that all States whose aeroplane operator undertakes international flights need to develop a monitoring, reporting and verification (MRV) system for CO_2 emissions from international flights starting from 1 January 2019. The requirement to monitor, report and verify CO_2 emissions from international aviation is independent from the offsetting requirements, and the data reported by States will be used for the calculation of the CORSIA's baseline, as well as for the basis of calculating aeroplane operators offsetting requirements, where applicable. See section 3 of these FAQs for more information on CORSIA MRV system.
2.	**Questions about CORSIA's key design elements**
	Key design element 1: Phased implementation of CORSIA
2.1	What is the rationale for the phased implementation of CORSIA?
	Paragraph 9 of the Assembly Resolution A40-19 determines the phased implementation of the CORSIA, and the participation of States in the CORSIA offsetting. According to this paragraph, phased implementation of CORSIA intends to accommodate "the special circumstances and respective capabilities of States, in particular developing States, while minimizing market distortion."
2.2	What are the different phases?
	The CORSIA has three phases: a pilot phase (2021 – 2023); a first phase (2024 – 2026); and a second phase (2027 – 2035). The difference between the phases is that the participation of States in the CORSIA offsetting in the pilot phase and in the first phase is voluntary, whereas the second phase applies to all ICAO Member States (See also questions 2.3 and 2.4 for details). States that voluntarily decide to participate in CORSIA offsetting may join the scheme from the beginning of a given year, and should notify ICAO of their decision to join by June 30 of the preceding year. The figure below illustrates the different phases of CORSIA.

	 • Participation of States in the pilot phase (2021 to 2023) and first phase (2024 to 2026) is voluntary. • For the second phase from 2027, all States with an individual share of international aviation activity in year 2018 above 0.5% of total activity or whose cumulative share reaches 90% of total activity, are included. Least Developed Countries, Small Island Developing States and Landlocked Developing Countries are exempt unless they volunteer to participate.
2.3	What is the difference between the pilot phase (from 2021 through 2023) and the first phase (from 2024 through 2026)?

	The requirements for the two phases are identical except for how the aeroplane operator's offsetting requirements are determined by the State. Specifically:
	
	• For the pilot phase, States have two options to determine the basis of an aeroplane operator's offsetting requirements:
	    o Option 1: Use the aeroplane operator's emissions covered by CORSIA in a given year (i.e. 2021, 2022 and 2023)
	    o Option 2: Use the aeroplane operator's emissions for the year 2020[1].
	• For the first phase, the calculation to determine an aeroplane operator's offsetting requirements is based on the emissions in a given year (i.e. 2024, 2025 and 2026).
	
	For more details on calculating offsetting requirements, please see question 2.15.
	
	[1] In order to safeguard against inappropriate economic burden on aeroplane operators due to the COVID-19 pandemic, the Council, at its 220th Session (June 2020), decided that during the pilot phase, 2019 emissions shall be used for 2020 emissions and published in all relevant ICAO documents referenced in Annex 16, Volume IV. There was no change for the provisions of Annex 16, Volume IV or Assembly Resolution A40-19 text.

2.4	Which criteria determine the participation or exemption of States from CORSIA offsetting in its second phase from 2027 to 2035?
	Unlike the voluntary participation of States in the CORSIA offsetting in the pilot and first phases from 2021 to 2026, the second phase of the CORSIA from 2027 to 2035 applies to all Member States. There are, however, two categories of exemptions based on aviation-related and socio-economic criteria. These criteria for the exemption of States from the CORSIA offsetting requirements in the second phase are defined in A40-19 paragraph 9 e). For aviation-related criteria, there are two thresholds: • States whose individual share of international aviation activities in Revenue Tonne Kilometers (RTKs) in year 2018 is below 0.5 per cent of total RTKs; and • States that are not part of the list of States that account for 90 per cent of total RTKs when sorted from the highest to the lowest amount of individual RTKs.

	For socio-economic criteria, States that are defined as Least Developed Countries (LDCs); Small Island Developing States (SIDS); and Landlocked Developing Countries (LLDCs), regardless of their level of international aviation RTK share, are exempted from offsetting requirements in the second phase of CORSIA. Nevertheless, these States can voluntarily participate in the second phase of the CORSIA.
2.5	What is a "RTK"?
	Revenue Tonne Kilometers or RTKs is the utilised (or sold) capacity for passengers and cargo expressed in metric tonnes, multiplied by the distance flown. In other words the RTK levels correspond to the volume of air transport activity. As an aeroplane operator carries more passengers and cargo over a longer distance, the RTK levels of the operator increase. A State's RTK represents the total RTK levels of all aeroplane operators registered to that State. Annual RTK data is being reported from Member States to ICAO as part of the ICAO Statistics Programme, and published in the Annual Report of the ICAO Council. RTK data for the year 2018 will be used for the purposes of determining the participation of States in the second phase of the CORSIA (see question 2.4).
2.6	How are RTK shares calculated?
	A State's individual RTK share is calculated by dividing the State's RTKs by the total RTKs of all States. **The cumulative RTK share** is calculated by sorting the individual RTK shares from the highest to lowest, then successively increasing the value by summing the RTK shares from highest to lowest until the value reaches 90%. The values of all States are considered for this calculation, regardless of whether a State is exempted or not from offsetting requirements under the CORSIA.
	Key design element 2: Route-based approach of CORSIA
2.7	What is the route-based approach of CORSIA?
	Paragraph 10 of the Assembly Resolution A40-19 defines the coverage of the CORSIA offsetting on the basis of routes between States, with a view to minimizing market distortions between aeroplane operators on the same routes. For this purpose, the approach is to provide equal treatment of all aeroplane operators on a given route. Specifically: • A route is covered by the CORSIA offsetting if both States connecting the route participate in the scheme. • A route is not covered by the CORSIA offsetting if one or both States connecting the route do not participate in the scheme. When an aeroplane operator calculates its CO_2 emissions covered by the CORSIA offsetting in a given year, it needs to take into consideration emissions from its operations on all the routes covered by the scheme, as outlined in paragraph 10 of the Assembly Resolution. It should be noted that the applicability of CORSIA offsetting requirements and the applicability of CORSIA monitoring, reporting and verification (MRV) requirements are not the same. Even if an international flight is not covered by the offsetting requirements, it is still covered by the MRV requirements. See question 3.19 for more information on the applicability of CORSIA MRV requirements.

	The figure below illustrates CORSIA's route-based approach, and the applicability of MRV and offsetting requirements. 
2.8	What does "participation of States to CORSIA offsetting" mean for the route-based approach?
	The term "participation of States to CORSIA offsetting" means that if a State participates in CORSIA offsetting, then all routes between this State and all other States participating in CORSIA offsetting are covered by offsetting requirements. Please see questions 2.2 and 2.4 for details on how the participation to CORSIA offsetting is being determined in different phases.
2.9	Can the characterisation of a route as "covered" or "not covered" by the CORSIA offsetting change over time?
	Paragraph 10 of the Assembly Resolution A40-19 determines the characterisation of a route as "covered" or "not covered" by the CORSIA offsetting requirements, on the basis of whether the States connecting the route participate in CORSIA offsetting. The voluntary participation of States in different phases of the CORSIA will determine the overall coverage of the scheme. To give certainty on the routes to be covered by the CORSIA offsetting requirements every year, the Assembly Resolution A40-19 sets a deadline by 30 June of the preceding year for States to notify ICAO of their intention to voluntarily participate in the scheme, or discontinue their participation, from 1 January of the following year.
2.10	Do States and aeroplane operators that do not participate in the CORSIA offsetting have any requirements under the CORSIA?
	According to paragraph 10 of the Assembly Resolution A40-19, all international flights on the routes between States, both of which are not included in the CORSIA

	offsetting, are exempted from the offsetting requirements of the CORSIA, while retaining simplified reporting requirements. The requirement to monitor, report and verify CO_2 emissions from international aviation is thus independent from the offsetting requirement. The data reported by States will be used for the calculation of the CORSIA baseline (see question 2.17 for more details on CORSIA's baseline) as well as for the calculation of the aeroplane operators' offsetting requirements, where applicable.
2.11	Can an aeroplane operator have offsetting requirements, even if its State of registration does not participate in CORSIA offsetting?
	Yes. Because of the CORSIA's route-based approach, an operator operating on routes between participating States would be subject to the offsetting requirements under the CORSIA, no matter whether its State of registration participates in CORSIA offsetting or not.
2.12	What would happen to the CORSIA emissions coverage if an operator of a non-participating State flies on the routes between participating States (e.g. fifth-freedom traffic right)?
	Because of the CORSIA's route-based approach, these routes between participating States would be subject to the coverage of emissions offsetting requirements under the CORSIA. Thus, an operator of a non-participating State would be subject to offsetting requirements if it had a flight between two participating States, and emissions from such flights would be added to the coverage of CORSIA's offsetting requirements.
2.13	What would happen to the CORSIA emissions coverage if a State without an operator undertaking international flights decides to participate in the CORSIA offsetting?
	States without an operator flying international flights are encouraged to participate in all phases of the CORSIA. If such a State decides to participate, international flights to and from that State to other participating States are additionally included for the CORSIA's offsetting requirements, due to the route-based approach. The total international emissions covered by CORSIA offsetting would ultimately increase.
	Key design element 3: CORSIA offsetting requirements and eligible emissions units
2.14	What is offsetting and how does it work, in general?
	In general, offsetting is done through the purchase and cancellation of emissions units (see question 4.20), arising from different sources of emissions reductions achieved through mechanisms, programmes or projects. The buying and selling of eligible emissions units happens through the carbon market. The price of the emissions units in the carbon market is influenced by the law of supply (availability of emissions units) and demand (level of offsetting requirements). "Cancelling" means the permanent removal and single use of an emissions unit so that the same emissions unit cannot be used more than once. This is done after an aeroplane operator has purchased emissions units from the carbon market. For CORSIA, an aeroplane operator is required to meet its offsetting requirements by cancelling CORSIA Eligible Emissions Units in a quantity equal to its total final offsetting requirements for a given compliance period. CORSIA Eligible Emissions Units are to be determined by the ICAO Council, and up-to-date information on eligible units is made available on the ICAO CORSIA website (see question 4.21).
2.15	How are an aeroplane operator's offsetting requirements calculated?
	Paragraph 11 of the Assembly Resolution A40-19 addresses the distribution of the total amount of CO_2 emissions to be offset in a given year among individual aeroplane operators. This is accomplished by introducing a dynamic approach for the distribution

of offsetting requirements, which takes into account:

- The Sector's Growth Factor: represents the international aviation sector's global average growth of emissions in a given year. It will be applied as a common factor for all individual operators participating in the scheme for the calculation of their offsetting requirements. ICAO will calculate the Sector's Growth Factor every year based on the reported CO_2 emissions data from States to ICAO; and
- The Individual Growth Factor: represents an individual operator's growth factor of emissions in a given year. This variable will start to be used from 2030 together with the Sector's Growth Factor. It will increase gradually to represent more of an operator's offsetting requirement.

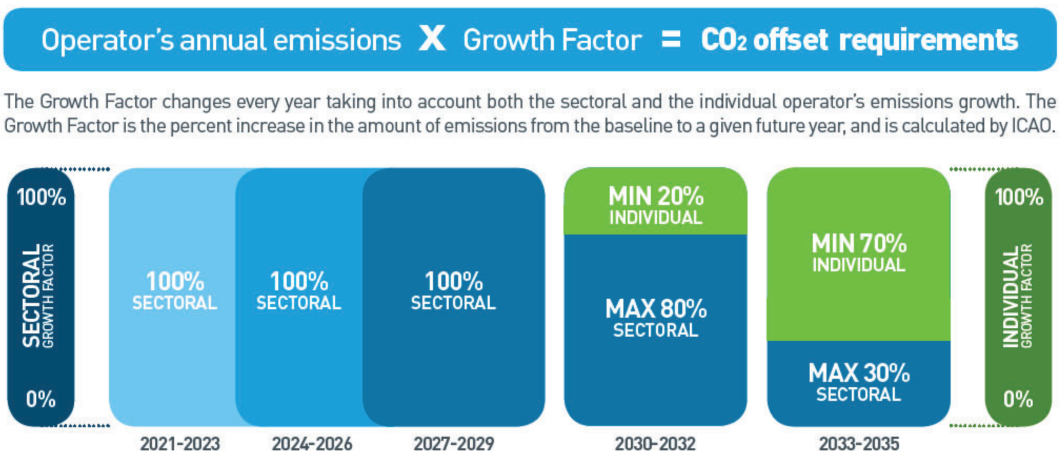
Offsetting requirements will be calculated as follows:

a) From 2021 through 2029 a 100 per cent sectoral approach (and 0 per cent individual approach) will be applied. This applies to the pilot phase, the first phase, and the first compliance period of the second phase.
b) During the second compliance period of the second phase (2030 through 2032) at least 20 per cent of offsetting requirements would be calculated according to the "individual approach". From 2033 to 2035, at least 70 per cent of offsetting requirements would be calculated according to the "individual approach". In 2028, the Council will recommend to the Assembly whether and to what extent to adjust the individual percentage.

The sectoral/individual approach is applied from 2030, rather than from the start of the second implementation phase (2027), to provide for the equal treatment of the calculation of offsetting requirements between aeroplane operators participating in the first and second phase of the CORSIA.

Once the sector's (and individual operator's, if applicable) growth factor for a given year is being made available by ICAO, the State will calculate an operator's CO_2 offsetting requirements by multiplying the operator's annual emissions covered by CORSIA offsetting in the given year by the growth factor. Result of this calculation is the operator's offsetting requirements for a given year. For each compliance period (see question 2.16), the State will sum up the offsetting requirements for each year within that compliance period, and the result will be the operator's total offsetting requirement for that compliance period.

The figure below describes the calculation of an aeroplane operator's offsetting requirements.



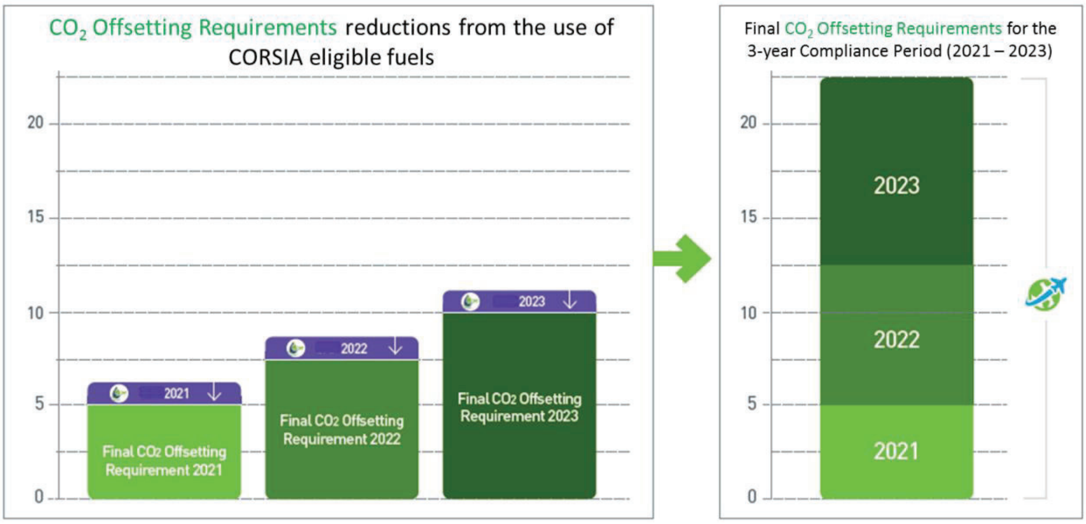
2.16	What are CORSIA's compliance periods?
	Paragraph 15 of the Assembly Resolution A40-19 determines that CORSIA has three-years compliance cycles (also referred to as a compliance period), for which the operators need to reconcile their offsetting requirements. The compliance periods are: • Compliance period 1: years 2021 – 2023; • Compliance period 2: years 2024 – 2026; • Compliance period 3: years 2027 – 2029; • Compliance period 4: years 2030 – 2032; • Compliance period 5: years 2033 – 2035. It should be noted that an operator will report its CO_2 emissions on an annual basis, corresponding to calendar years. See question 3.68 for more information on the relationship between CORSIA's compliance periods and reporting periods.
2.17	What are CORSIA's baseline emissions?
	For the purposes of CORSIA, the sectoral baseline is defined as the average of total CO_2 emissions for the years 2019 and 2020 on the routes covered by CORSIA offsetting in a given year from 2021 onwards. The Council, at its 220th Session (June 2020), made a series of decisions in order to safeguard against inappropriate economic burden on aeroplane operators due to the COVID-19 pandemic. Council's decisions regarding the CORSIA baseline can be summarized as follows: • During the pilot phase, 2019 emissions shall be used for 2020 emissions and published in all relevant ICAO documents referenced in Annex 16, Volume IV. There was no change for the provisions of Annex 16, Volume IV or Assembly Resolution A40-19 text. • For future phases of CORSIA implementation beyond the pilot phase, the Council will examine the impact of COVID-19 on the CORSIA baseline, among various issues, when undertaking the 2022 CORSIA periodic review. Paragraph 11(g) of the Assembly Resolution A40-19 notes that the sectoral baseline will be re-calculated when the routes included in the CORSIA change. This can happen, for example, when new States volunteer to participate or States decide to withdraw their voluntary participation. The recalculation of the baseline will be done by ICAO at the start of each year.
2.18	What is the difference between the Sector's Growth Factor used by the formula under the CORSIA and the generally-used term "emission growth rate"?
	In general, the term "emissions growth rate" refers to the percentage increase in the amount of emissions from the baseline to a given year from 2021, compared to the baseline emissions. For the purposes of CORSIA, the Sector's Growth Factor is defined as the percentage increase in the amount of emissions from the baseline to a given year from 2021, compared to the emissions in that given year.
2.19	How are CORSIA Eligible Fuels accounted for in the calculation of offsetting requirements?
	From 2021 onwards, operators can reduce their CORSIA offsetting requirements by claiming emissions reductions from CORSIA Eligible Fuels. In order to do this, the operator will:

- Use the amounts of CORSIA Eligible Fuels purchased, based on purchase records;
- Use the life-cycle emissions values to determine emissions reduction factors for each CORSIA Eligible Fuel;
- Obtain valid sustainability certification document; and
- Report and claim verified reductions of its emissions from the use of CORSIA Eligible Fuels to the State.

The State will calculate the operator's total final offsetting requirements at the end of each compliance period by subtracting the emissions reductions from the use of CORSIA Eligible Fuels from the operator's offsetting requirements during the compliance period.

The CORSIA Implementation Element "CORSIA Eligible Fuels" provides the necessary methodologies to determine the emissions reductions from the use of CORSIA Eligible Fuels (see questions 4.11 to 4.19 of these FAQs).

The figure below provides an illustration of accounting the benefits from CORSIA Eligible Fuels.



2.20 Can an aeroplane operator's CO_2 offsetting requirements be negative?

Compliance periods for offsetting requirements are every 3 years, with the first period starting on 1 January 2021 and ending on 31 December 2023 (see also question 2.16).

If, as a result of the calculation described in questions 2.15 and 2.19, an aeroplane operator's total final offsetting requirements during a compliance period are negative (e.g., the verified emissions reductions claimed by an operator from the use of CORSIA Eligible Fuels are more than its offsetting requirements), the operator has no offsetting requirements for the compliance period.

Negative offsetting requirements will not be carried forward to a subsequent three-year compliance period. However, if an operator's offsetting requirements in a given year within a compliance period are negative, the operator reduces its total final offsetting requirement for the three-year compliance period.

2.21	Will an aeroplane operator, which reduces its emissions compared to the baseline, have any offsetting requirements?
	If an operator's emissions do not increase or decrease compared to the baseline emissions, there will still be offsetting requirements for the operator, as long as the global emissions covered by CORSIA increase above the global baseline emissions (i.e. the Sector's Growth Factor is positive). Potential efforts of such an operator to renew its fleet and improve its operational efficiency will not be ignored, as the calculation of CORSIA offsetting requirements for the operator will be done by multiplying the Sector's Growth Factor with the operator's emissions covered by CORSIA offsetting requirements in a given year. Such efforts are reflected in the operator's level of emissions, and offsetting requirements would be smaller than using the operator's emissions without fleet renewal or operational improvements in the calculation. Therefore, the CORSIA maintains incentives for individual operators to make efforts to improve their fuel efficiency. The incentive for individual aeroplane operators to reduce their emissions is further strengthened starting from 2030, when an individual aeroplane operator's Growth Factor will be added to the offsetting requirements calculation formula. The individual Growth Factor represents an individual operator's Growth Factor of emissions in a given year, and the weight of this factor in the formula of calculating the offsetting requirements will increase gradually to represent more of an operator's offsetting requirement. Please see question 2.15 for more information.
	Key design element 4: Exemptions and new entrants
2.22	Does the CORSIA include provisions to exempt very low international aviation activities?
	Paragraph 13 of the Assembly Resolution A40-19 provides the following exemptions from the CORSIA offsetting requirements for the purposes of avoiding an administrative burden from the application of CORSIA due to low levels of international aviation activities: 1. Aeroplane operators with a low level of annual emissions from their international aviation operations (less than 10 000 metric tonnes of CO_2 emissions per year); 2. Aircraft with less than 5 700 kg of Maximum Take-Off Mass (MTOM); 3. Humanitarian, medical and firefighting operations. In addition to being exempted from CORSIA offsetting requirements, these activities are also exempted from CORSIA MRV requirements (see question 3.19 for more information on the applicability of MRV requirements).
2.23	How will the CORSIA apply to operators that will initiate activities after the entry into force of the scheme (a so-called "new entrant")?
	Paragraph 12 of the Assembly Resolution A40-19 refers to "new entrants" as aeroplane operators that commence an aviation activity falling within the scope of the CORSIA. This paragraph outlines criteria to determine when "new entrants" should start participating in the CORSIA offsetting, with the exemption period being the earliest out of the following two: • Three years from commencing aviation activities within the scope of CORSIA; or • The year in which new entrant's annual emissions exceed 0.1 per cent of total emissions in 2020[1].

In other words, a new entrant is exempted from the application of the CORSIA offsetting requirements for the first 3 years, or until its annual emissions exceed 0.1% of total 2020 emissions[1] from the international aviation sector. The condition that applies earlier will determine when a new entrant's emissions are subject to the offsetting requirements.

It is important to note that the CO_2 emissions of a new entrant are still to be reported from the year after the new entrant falls under the applicability of CORSIA MRV requirements (also see question 3.19), regardless of the exemptions from the CORSIA offsetting requirements.

In the example below, operators A and B start operations in year 2022 as shown in the table. According to the Assembly Resolution A40-19, operator A will have offsetting requirements starting in 2025, and operator B in 2024. However, both operators will need to comply with the MRV requirements from 2023 onwards, assuming that they are within the CORSIA MRV applicability.

Operator	Emissions (% of total emissions in 2020)[1]			
	2022	2023	2024	2025
A	0.02	0.04	0.06	0.08
B	0.06	0.11	0.16	0.21

[1] In order to safeguard against inappropriate economic burden on aeroplane operators due to the COVID-19 pandemic, the Council, at its 220th Session (June 2020), decided that during the pilot phase, 2019 emissions shall be used for 2020 emissions and published in all relevant ICAO documents referenced in Annex 16, Volume IV. There was no change for the provisions of Annex 16, Volume IV or Assembly Resolution A40-19 text.

2.24 Will a new entrant operator affect the CORSIA baseline?

Under CORSIA, only CO_2 emissions corresponding to years 2019 and 2020 are relevant for the purpose of defining CORSIA's baseline (see question 2.17 for more details on CORSIA's baseline).

The CO_2 emissions of a new entrant are to be reported from the year after the CORSIA MRV system begins to apply to the operator (see question 2.23):

- If a new entrant commences aviation activities and falls within the applicability of CORSIA MRV requirements in year 2019, the first year when the new entrant would be subject to the CORSIA MRV requirements would be 2020:
  - The 2020 CO_2 emissions of this new entrant will not affect the CORSIA baseline during the pilot phase, in line with the Council's decision, at its 220th Session (June 2020), that during the pilot phase 2019 emissions shall be used for 2020 emissions.
  - For future phases of CORSIA implementation beyond the pilot phase, the Council will examine the impact of COVID-19 on the CORSIA baseline, among various issues, when undertaking the 2022 CORSIA periodic

	review. Whether or not the 2020 CO_2 emissions of this new entrant will affect the CORSIA baseline beyond the pilot phase will depend on a future Council decision on whether or not to consider 2020 CO_2 emissions in this regard. • If a new entrant commences aviation activities and falls within the applicability of CORSIA MRV requirements in a given year after 2019, such new entrant will in no case affect the CORSIA baseline, as the new entrant's CO_2 emissions in years 2019 and 2020 would not be monitored and reported under CORSIA. CAEP work is ongoing to produce recommendations for how to determine individual baseline emissions for new entrant aeroplane operators.
2.25	If an aeroplane operator, which (in the past) had domestic operations only, establishes international routes, will it be considered a new entrant?
	According to the guidance provided in the Environmental Technical Manual, Volume IV, an aeroplane operator will be considered as a new entrant under CORSIA if the following conditions are met in such year: a) The aeroplane operator has not been within the scope of applicability of Annex 16, Volume IV, Part II, Chapter 2 in each year from 2019 until the year preceding the entry year; or b) None of the activities performed by the aeroplane operator is determined to be the continuation of activities previously performed by another aeroplane operator. This could be interpreted in a way that an aeroplane operator does not actually need to be a newly created entity. Indeed, the entity can exist since many years without having operated any or a sufficient (in terms of CO_2 emissions on international routes) number of international flights. This would be the case for instance of a well-established aeroplane operator flying only domestic routes and then starting to operate on international routes.
	Key design element 5: Review process
2.26	Does the CORSIA include provisions to review its implementation and to make adjustments if needed?
	Paragraph 9 g) of the Assembly Resolution A40-19 includes a provision that the ICAO Council will conduct a review of the implementation of the CORSIA every three years, starting in 2022. This review will include an assessment of the impact of the CORSIA on the growth of international aviation. The results of this assessment will serve as an important basis for the Council to consider adjustments and make recommendations to the Assembly for decisions about the next implementation phase or compliance period, as appropriate. In addition - as elaborated in paragraph 17 of the Assembly Resolution A40-19 - the purpose of the periodic review is to contribute to the sustainable development of the international aviation sector and to the effectiveness of the scheme. The review will assess, inter alia: the progress towards achieving ICAO's global aspirational goal, the scheme's market and cost impact on States and aeroplane operators and on international aviation, and the functioning of the scheme's design elements. The review will also involve consideration of the scheme's improvements that would support the purpose of the Paris Agreement or simply result in better design. A special review will be performed by the end of 2032 regarding the termination of the

scheme, its extension or any other post-2035 improvements.

The sequence of the phases of the CORSIA, compliance periods, periodic reviews, special review and ICAO Assemblies is summarised in the figure below.

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Phases	Pilot Phase (voluntary, 3 years)			First Phase (voluntary, 3 years)			Second Phase (all non-exempted States, 9 years)								
Compliance cycles	Cycle 1 (3 years)			Cycle 2 (3 years)			Cycle 3 (3 years)			Cycle 4 (3 years)			Cycle 5 (3 years)		
Periodic reviews		Review 1			Review 2			Review 3			Review 4	Special		Review 5	
Assemblies		A41			A42			A43			A44			A45	

2.27 What are the methodologies and procedures for periodic reviews of CORSIA?

The Council, at its 220th Session (June 2020) highlighted the importance of undertaking the 2022 periodic review, with technical contribution of the Committee on Aviation Environmental Protection (CAEP), which will offer an opportunity to examine the impact of COVID-19 on CORSIA on various issues, including the impact on the baseline beyond the pilot phase. The Council will consider a structure, process and methodology of the 2022 periodic review, including the work programme of CAEP, at its 222nd Session in March 2021.

3. Questions about Annex 16, Volume IV – CORSIA

General questions related to Annex 16, Volume IV

3.1 What are the differences between: Annex 16, Volume IV; Environment Technical Manual, Volume IV; and CORSIA Implementation Elements?

Annex 16, Volume IV and Environmental Technical Manual (ETM), Volume IV follow a similar structure to that of the Annex 16, Volumes I, II and III. This is the traditional ICAO Standards and Recommended Practices (SARPs) approach, where the implementation of the SARPs is supported by guidance material.

The SARPs of Annex 16, Volume IV provide the necessary actions by States or operators (the "what" and "when") to implement CORSIA, whereas the Environmental Technical Manual (ETM), Volume IV provides the guidance on the process (the "how") to implement CORSIA.

Due to CORSIA's specific characteristics, CORSIA Implementation Elements have been developed. The Implementation Elements are reflected in 14 ICAO documents, which are directly referenced in the SARPs and contain essential information for the implementation of CORSIA. These ICAO documents are made available on the ICAO CORSIA website, once approved by the ICAO Council, and may only be amended by the ICAO Council.

The table below provides information on the linkages each of the ICAO CORSIA Implementation Elements and the corresponding ICAO documents. Please refer to section 4 of these FAQs for more information on CORSIA Implementation Elements and corresponding ICAO documents.

ICAO CORSIA Implementation Elements	ICAO documents
CORSIA States for Chapter 3 State Pairs (see questions 4.1 to 4.3)	1. CORSIA States for Chapter 3 State Pairs
ICAO CORSIA CO_2 Estimation and Reporting Tool (CERT) (see questions 4.4 to 4.10)	2. ICAO CORSIA CO_2 Estimation and Reporting Tool
CORSIA Eligible Fuels (see questions 4.11 to 4.19)	3. CORSIA Eligibility Framework and Requirements for Sustainability Certification Schemes 4. CORSIA Approved Sustainability Certification Schemes 5. CORSIA Sustainability Criteria for CORSIA Eligible Fuels 6. CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels 7. CORSIA Methodology for Calculating Actual Life Cycle Emissions Values
CORSIA Eligible Emissions Units (see questions 4.20 to 4.31)	8. CORSIA Eligible Emissions Units 9. CORSIA Emissions Unit Eligibility Criteria
CORSIA Central Registry (CCR) (see questions 4.32 to 4.41)	10. CORSIA Central Registry: Information and Data for the Implementation of CORSIA 11. CORSIA Aeroplane Operator to State Attributions 12. CORSIA 2020 Emissions 13. CORSIA Annual Sector's Growth Factor (SGF) 14. CORSIA Central Registry (CCR): Information and Data for Transparency

3.2	What ICAO process was followed to develop Annex 16, Volume IV?
	Following the adoption of Assembly Resolution A39-3, the ICAO Council in November 2016 endorsed the overall plan of CORSIA preparatory activities on the development of CORSIA-related SARPs and guidance. The Council also established an Advisory Group on CORSIA (AGC) to serve as an advisory body to the Council. CAEP was tasked to develop recommendations for CORSIA-related SARPs and guidance. Following CAEP's recommendation, preliminary reviews by the AGC and ICAO's Air Navigation Commission (ANC), consultation with Member States, and the final reviews by AGC and ANC, the CORSIA-related SARPs were adopted by the Council on 27 June 2018 in the form of Annex 16 — *Environmental Protection* to the

	Convention on International Civil Aviation, Volume IV — *Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)*.
	Administrative aspects
3.3	What is the definition of international flight for CORSIA purposes?
	Reference in Annex 16, Volume IV: Part II, Chapter 1, 1.1.2. For the purposes of CORSIA, an international flight is defined as the operation of an aircraft from take-off at an aerodrome of a State or its territories, and landing at an aerodrome of another State or its territories.
3.4	What guidance should be followed to determine whether a flight is international or domestic?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.1.2. For the purposes of CORSIA, an international flight is defined as the operation of an aircraft from take-off at an aerodrome of a State or its territories, and landing at an aerodrome of another State or its territories (see also question 3.3). When considering whether a flight is international or domestic for the purposes of CORSIA, an aeroplane operator and a State should use Doc 7910 — *Location Indicators*, which contains a list of aerodromes and the State they are attributed to.
3.5	Does CORSIA apply to international flights to/from non-ICAO States?
	Reference: Environmental Technical Manual, Volume IV, Chapter 2, 2.1.1 CORSIA is implemented through Annex 16, Volume IV to the Convention on International Civil Aviation (Chicago Convention), which applies to Contracting States of the Convention. Flights taking off from or landing at an aerodrome of a State, or one of its territories, which is not an ICAO Member State are not considered to fall within the applicability scope of Annex 16, Volume IV.
3.6	What is the definition of an "aeroplane" in CORSIA? How does this definition differ from the definition of an “aircraft”?
	Reference in Annex 16, Volume IV: Part I, Chapter 1, Definitions. The following definition of “an aeroplane” is included in the Annex 16, Volume IV: **Aeroplane**. A power-driven heavier-than-air aircraft, deriving its lift in flight chiefly from aerodynamic reactions on surfaces which remain fixed under given conditions of flight. Regarding the difference between the definitions of an aircraft and an aeroplane, Annex 2 to the Convention on International Civil Aviation offers the following definition for “an aircraft”: **Aircraft**. Any machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the earth’s surface. Under CORSIA, only aeroplane operators will have compliance requirements (see also question 3.26).
3.7	What is the definition of “an aerodrome” in CORSIA?
	Reference in Annex 16, Volume IV: Part I, Chapter 1, Definitions. Annex 16, Volume IV offers the following definition for “an aerodrome”: **Aerodrome.** A defined area on land or water (including any buildings, installations and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft.

3.8	How are diverted flights handled in CORSIA?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.1. Diversion of flights can lead to any of the following scenarios: a) A flight originally subject to MRV requirements, which continues to be subject to such requirements as a result of the diversion; b) A flight originally not subject to MRV requirements, which continues not to be subject to such requirements as a result of the diversion; c) A flight originally subject to MRV requirements, which is no longer subject to such requirements as a result of the diversion; or d) A flight originally not subject to MRV requirements, which becomes subject to such requirements as a result of the diversion. Under CORSIA, in any of the scenarios listed above, the actual aerodromes of departure and arrival for a flight, rather than the scheduled ones, will be taken as a reference to determine whether or not that flight is subject to MRV requirements. See also question 3.31.
3.9	What does a "State pair" mean? Is it uni- or bidirectional?
	Reference in Annex 16, Volume IV: Part I, Chapter 1, Definitions. In CORSIA, State pair is being defined as a group of two States composed of a departing State or its territories and an arrival State or its territories. For example, when reporting CO_2 emissions from international flights between States A and B, an aeroplane operator will report both directions as separate State pairs (A-B and B-A).
3.10	Who will ensure that aeroplane operators comply with the requirements of Annex 16, Volume IV?
	Reference in Annex 16, Volume IV: Part II, Chapter 1, 1.3.1. According to Assembly Resolution A40-19, paragraph 19 f), ICAO Member States will take necessary action to ensure that the national policies and regulatory framework be established for the compliance and enforcement of CORSIA. As per Annex 16, Volume IV, an aeroplane operator will be attributed to a State for administering CORSIA based on the rules for attribution (see question 3.12). The State is primarily responsible for ensuring that the aeroplane operator complies with the CORSIA requirements.
3.11	How is an international flight being attributed to a single aeroplane operator?
	Reference in Annex 16, Volume IV: Part II, Chapter 1, 1.1.3. It is important to identify all applicable international flights so that the CO_2 emissions from these flights are monitored and reported. Also, each international flight should be allocated to a single aeroplane operator without duplication. In order to achieve this, the following information will be used for attributing international flights to an aeroplane operator: • **ICAO Designator:** When Item 7 (aircraft identification) of the flight plan contains the ICAO Designator, that flight shall be attributed to the aeroplane operator that has been assigned this Designator; • **Registration marks:** When Item 7 (aircraft identification) of the flight plan contains the nationality or common mark, and registration mark of an aeroplane that is explicitly listed in an air operator certificate (AOC) (or equivalent) issued by a State, that flight shall be attributed to the aeroplane operator that holds the AOC (or equivalent); or

	• **Other**: When the aeroplane operator of a flight has not been identified via previous points, that flight shall be attributed to the aeroplane owner who shall then be considered the aeroplane operator.
3.12	How is an aeroplane operator being attributed to a single State?
	Reference in Annex 16, Volume IV: Part II, Chapter 1, 1.2. Under CORSIA, each aeroplane operator will report its CO_2 emissions to a single State. The rules for attributing an aeroplane operator to a State are based on: • **ICAO Designator:** Where the aeroplane operator has an ICAO Designator, the State to which the aeroplane operator fulfils its requirements under CORSIA shall be the Notifying State of the Designator; • **Air operator certificate:** Where the aeroplane operator does not possess an ICAO Designator, but has a valid air operator certificate (or equivalent), the State to which the aeroplane operator fulfils its requirements under CORSIA shall be the State that issued the air operator certificate (or equivalent); or • **Place of juridical registration**: Where the aeroplane operator does not possess an ICAO Designator or air operator certificate, the State where the aeroplane operator is registered as juridical person shall be the State to which the aeroplane operator fulfils its requirements under CORSIA. Where the aeroplane operator is a natural person, the State of residence and registration of this person shall be the State to which the aeroplane operator fulfils its requirements under CORSIA. The State is required to ensure the correct attribution of an aeroplane operator to it. In order to determine which aeroplane operators fall under its administration, the State should take the following steps: review operators' possible communications indicating that are likely to be administered by the State, review the contents of Doc 8585 — *Designators for Aircraft Operating Agencies, Aeronautical Authorities and Services*, and identify those operators that are notified by the State, review AOCs issued by that State, and review of registered entities within that particular State (e.g., from the State's company register). It should be noted that the "place of juridical registration" refers to the State in which the entity (company or person) is legally registered. The purpose is to have jurisdictional clarity in cases of enforcement, such as international court measures. The place of juridical registration may differ from the principal place of business. Regarding the use of the expression "AOC (or equivalent)", the wording "or equivalent" is used because in some States the AOC is named differently. The "AOC" refers to an official document issued by a State that gives an aeroplane operator license to operate and that contains the identification of the aircraft operator and may also contain aircraft registration marks. The use of general aviation operating certificates and other certificates permitting non-commercial air transport could thus be appropriate as long as these certificates are issued/approved by a State. After identifying the aeroplane operators under its administration, the State is required to submit to ICAO information of those aeroplane operators that are attributed to it, and ICAO will publish a list of aeroplane operators and the States attributions on the ICAO CORSIA website, as a part of the ICAO document entitled "CORSIA Central Registry (CCR): Information and Data for Transparency".
3.13	Can an aeroplane operator delegate its administrative requirements?
	Reference in Annex 16, Volume IV: Part II, Chapter 1, 1.1.5.

	Yes, an aeroplane operator can delegate its CORSIA administrative requirements to a third party. However, this third party cannot be the same entity as the verification body. Also, liability for compliance with the CORSIA requirements will remain with the aeroplane operator.
3.14	Can an aeroplane operator report together with one or more of its subsidiaries?
	Reference in Annex 16, Volume IV: Part II, Chapter 1, 1.2.6. An aeroplane operator can report together with a subsidiary aeroplane operator, if the subsidiary is: • Wholly owned by the parent company; and • Legally registered in the same State as the parent company. If both conditions are met, an aeroplane operator with a subsidiary aeroplane operator can be treated as a single consolidated aeroplane operator liable for compliance with CORSIA requirements. Such an arrangement is subject to the approval of the State, and evidence shall be provided in the aeroplane operator's Emissions Monitoring Plan to demonstrate that the subsidiary aeroplane operator is wholly owned. If two aeroplane operators are treated as a single consolidated aeroplane operator, the two operators will be administered as a single entity, and their emissions aggregated. Therefore, the applicability of the requirements of Annex 16, Volume IV will be based on their aggregated emissions.
3.15	Who is responsible for reporting emissions from flights operated with leased aeroplanes?
	Reference in Annex 16, Volume IV: Part II, Chapter 1, 1.1.2. According to Annex 16, Volume IV, the attribution of international flights to an operator is based on the Flight Plan, Item 7, which means that the operating entity (i.e. in a case of wet-lease arrangement, the lessee) is responsible for the international flights (under the lessee's ICAO Designator) and therefore responsible for compliance of the international flights attributed to the lessee. In addition, the State of the lessee is responsible for administrative tasks related to lessee, for example approval of the lessee's Emissions Monitoring Plan and Emissions Report.
3.16	Can a State delegate its administration processes under the CORSIA to another State?
	Reference in Annex 16, Volume IV: Part II, Chapter 1, 1.3.2. Yes, a State may delegate administration processes of CORSIA to another State through an administrative partnership based on a bilateral agreement between the respective States. Nevertheless, the State shall not delegate enforcement of CORSIA requirements, or its administrative tasks towards ICAO, to another State. If such an arrangement is agreed upon, the State receiving capacity support must ensure that aeroplane operators attributed to that State are advised of the administrative arrangements.

3.17	How long does a State and an aeroplane operator need to keep CORSIA-related records? What is included in those records?
	Reference in Annex 16, Volume IV: Part II, Chapter 1, 1.4, and Appendix 4. An aeroplane operator is required to keep records relevant to demonstrating compliance with the requirements of Chapters 2, 3, and 4 of Annex 16, Volume IV, Part II, for a period of 10 years. It is also recommended that an aeroplane operator keep records relevant to its CO_2 emissions per State pair during the 2019-2020 period in order to allow the operator to cross-check its offsetting requirements calculated by the State during the 2030-2035 compliance periods, when the operator's Individual Growth Factor will be applied in calculating the offsetting requirements. An operator is required to include a documentation and record keeping plan in its Emissions Monitoring Plan for the approval by the State. This plan will specify how (e.g., by using an IT system), and where the operator will store CORSIA-relevant information. The State shall keep records relevant to the aeroplane operator's CO_2 emissions per State pair during the period of 2019-2020 in order to calculate the aeroplane operator's offsetting requirements during the 2030-2035 compliance periods.
	Monitoring, reporting and verification (MRV) in general
3.18	What are the components of the CORSIA MRV system?
	Reference in Annex 16, Volume IV: Part II, Chapter 2. CORSIA's MRV (Monitoring, Reporting and Verification) system consists of three components: • Monitoring of CO_2 emissions is either based on a Fuel Use Monitoring Method, or the on use of the ICAO CORSIA CERT (see question 3.41). For the former, each operator has to collect accurate information on the fuel use per each flight and calculate CO_2 emissions by multiplying the amount of fuel used with a conversion factor representing the amount of tonnes of CO_2 produced from using one tonne of fuel. An aeroplane operator is required to describe its approach to CO_2 emissions monitoring in an Emissions Monitoring Plan (see question 3.32), which the operator will submit for approval by the State. • After monitoring and calculating CO_2 emissions, the necessary information will be reported from aeroplane operators to their State Authority, and from States to ICAO, by using harmonised templates and procedures. ICAO consolidates the CO_2 emissions data, calculates the annual Sectoral Growth Factor, and communicates the Growth Factor to States. • Verification of CO_2 emissions information is to ensure that the data is accurate and free of errors. A very basic idea of verification is that a third party checks that everything has been done correctly. This is similar to the accounting practices that are performed in the financial world.
3.19	What is the applicability of the CORSIA MRV requirements? Are there any exemptions?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.1. All aeroplane operators conducting international flights are required to monitor, report and verify CO_2 emissions from these flights from 1 January 2019 until 31 December 2035. It should be noted that the requirement for the MRV of CO_2 emissions is independent from participation in CORSIA offsetting.

	As per Annex 16, Volume IV, the MRV requirements do not apply to: • An aeroplane operator that produces annual CO_2 emissions from international flights less than or equal to 10 000 tonnes; • Aeroplane(s) with a maximum certificated take-off mass less than or equal to 5 700 kg; • Humanitarian, medical and firefighting flights, as well as flights preceding or following a humanitarian, medical or firefighting flight, provided that such flights were conducted with the same aeroplane, and were required to accomplish the related humanitarian, medical or firefighting activities or to reposition thereafter the aeroplane for its next activity.
3.20	In view of the decisions made by the ICAO Council in order to safeguard against inappropriate economic burden on aeroplane operators due to the COVID-19 pandemic, do aeroplane operators have to undertake the monitoring, reporting and verification of CO_2 emissions from international flights operated in 2020?
	The decisions made by the Council at its 220th Session do not bring a change to the provisions of Annex 16, Volume IV or Assembly Resolution A40-19. Consequently, the monitoring, reporting and verification of CO_2 emissions from international flights operated in 2020 has to be undertaken as per the requirements in Annex 16, Volume IV.
3.21	Can an aeroplane operator with emissions of less than 10 000 tonnes of CO_2 per year be included in CORSIA?
	Reference in Annex 16, Volume IV: Part II, Chapter 1, 1.2.6, Chapter 2, 2.1. An aeroplane operator that produces annual CO_2 emissions from international flights less than or equal to 10 000 tonnes is not subject to the requirements of Annex 16, Volume IV (see also question 3.19). However, if an aeroplane operator below the threshold of 10 000 tonnes of CO_2 is wholly-owned by and legally registered in the same State as another aeroplane operator, the two aeroplane operators can request to be treated as a single operator (see question 3.14). In this case the combined emissions of both aeroplane operators could exceed this threshold and become subject to the applicability of the MRV requirements of CORSIA.
3.22	What are the actions for an aeroplane operator, who has been covered by CORSIA, but now drops below the 10 000 tonnes of CO_2 threshold?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.1. If an aeroplane operator falls below the 10 000 tonnes threshold in a given year, then it falls outside the scope of applicability of Annex 16, Volume IV and would not have any requirements in that year. In such an instance, it is suggested the aeroplane operator contact its State of attribution to inform them that they are below the threshold. The State may choose to engage with the operator to confirm that the aeroplane operator is out of the scope of applicability.
3.23	How to address aeroplane operators with annual CO_2 emissions close to the 10 000 tonnes threshold?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.1. If an aeroplane operator is close to the 10 000 tonnes threshold of annual CO_2 emissions, it should consider engaging with the State for guidance. Likewise, the State should carry out oversight of the aeroplane operators attributed to it, and engage with any that it considers may be close to or above the threshold. The aeroplane operator

	with annual CO_2 emissions below the threshold may also choose to voluntarily engage with the State to which it is attributed (e.g. to declare that the operator's emissions are below the threshold).
3.24	Are aeroplane manufacturers or airports subject to any requirements under Annex 16, Volume IV?
	No, aeroplane manufacturers and airports do not have requirements under Annex 16, Volume IV, unless those entities operate international flights themselves, and thus become aeroplane operators as defined in Annex 16, Volume IV.
3.25	Is a re-positioning flight before or after an exempted humanitarian, medical or firefighting flight exempt?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.1. Yes. Flights preceding or following humanitarian, medical or firefighting flights are also exempt if they were required to accomplish the humanitarian, medical or firefighting activities or to reposition the aeroplane thereafter. The operator will have to be able to provide evidence of the nature of the flight. See also question 3.19.
3.26	Are helicopter operations covered by the CORSIA MRV system?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.1. No. The applicability of the CORSIA MRV requirements covers aeroplanes, and helicopter operations are outside of the scope of applicability of CORSIA. See also question 3.6.
3.27	Are international flights by police, military, customs or State aircraft within the scope of applicability of the CORSIA MRV system?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.1. No, Annex 16, Volume IV only applies to international civil aviation; international flights from police, military, customs and State aircraft are excluded from the Chicago Convention as per Article 3, and thus are excluded from the scope of CORSIA.
3.28	How can humanitarian, medical, firefighting, police, military, customs and State aircraft flights be identified?
	Reference: Environmental Technical Manual, Volume IV, Chapter 2, 2.1.4. An aeroplane operator should provide evidence to the State to which it has been attributed to prove that an operation was a humanitarian, medical, firefighting, military or State aeroplane flight. Information included in Item 8 (flight rules and type of flight) of the flight plan can be used to demonstrate the nature of a flight, and the ETM, Volume IV provides examples of specific marks that can be included in the Flight Plan in this regard, as per Doc 4444 — *Procedures for Air Navigation Services — Air Traffic Management*. It should be noted that a State might have in place specific procedures and practices to demonstrate humanitarian, medical, firefighting, police, military, customs and State aircraft flights. The decision to interpret whether a flight is under the applicability of Annex 16, Volume IV is on the State Authority. Procedures for identifying international flights that are exempted from CORSIA's applicability should be provided within the Emissions Monitoring Plan approved by the State Authority.
3.29	Are Search and Rescue (SAR) flights exempted from CORSIA?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.1. As per Annex 16, Volume IV, the MRV requirements do not apply to: • An aeroplane operator that produces annual CO_2 emissions from international

	flights less than or equal to 10 000 tonnes; • Aeroplane(s) with a maximum certificated take-off mass less than or equal to 5 700 kg; • Humanitarian, medical and firefighting flights, as well as flights preceding or following a humanitarian, medical or firefighting flight, provided that such flights were conducted with the same aeroplane, and were required to accomplish the related humanitarian, medical or firefighting activities or to reposition thereafter the aeroplane for its next activity. Annex 16, Volume IV does not specifically exclude international Search and Rescue flights from the applicability of CORSIA, unless such flights are categorised under one of the above mentioned categories.
3.30	Are repatriation flights operated in response to the ongoing COVID-19 pandemic identified as humanitarian flights in the context of CORSIA implementation?
	The Standards and Recommended Practices in Annex 16, Volume IV do not address the question of *defining* humanitarian, medical and firefighting flights, but rather the *treatment* to which these types of flights are subject under CORSIA, as reflected in Annex 16, Volume IV, Part II, Chapter 2, 2.1.1 and 2.1.3. On the matter of identifying humanitarian, medical and firefighting flights, the following has to be noted: • Aeroplane operators' Emissions Monitoring Plans have to include "Procedures for identifying domestic flights and/or humanitarian, medical or firefighting international flights, as defined in Part II, Chapter 1, 1.1.2, that would not be subject to Part II, Chapter 2 requirements", as per Annex 16, Volume IV, Appendix 4, 2.2.8. • The guidance included in the *Environmental Technical Manual* (Doc 9501), Volume IV — *Procedures for demonstrating compliance with the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)*, section 2.2.5 points out that "The aeroplane operator should provide evidence to the State to prove that a flight was a humanitarian, medical or firefighting flight", and goes on to detail how Item 18 of the flight plan is to be filled for these types of flights: a) "STS/HUM", then it should be considered a humanitarian flight according to Doc 4444; b) "STS/HOSP", then it should be considered a medical flight declared by medical authorities according to Doc 4444; c) "STS/MEDEVAC", then it should be considered a life critical medical emergency evacuation flight according to Doc 4444; or d) "STS/FFR", then it should be considered a firefighting flight according to Doc 4444. Therefore, it corresponds to the aeroplane operator to identify a given flight as humanitarian, medical or firefighting, and to provide evidence to the State to prove that such qualification is correct, in line with the established provisions relating to flight plans. If the State considers that such qualification is correct, then the provisions of Annex 16, Volume IV related to humanitarian, medical and firefighting flights will apply.

3.31	How are diversions handled in CORSIA?
	Reference in Annex 16, Volume IV: Part II, Chapter 1, 1.1.2; Chapter 2, 2.1;, Chapter 2, 2.2.1.3.3. A flight should be considered to be diverted when it makes an unplanned landing at an aerodrome different from the destination aerodrome indicated by the aeroplane operator in the last approved flight plan filed prior to the flight departure. A diverted flight and the subsequent flight are to be treated as two consecutive and separate flights operating, respectively, to and from the aerodrome the diverted flight actually landed at, rather than that which was originally planned. A diversion is by its nature unplanned. However, according to the rules of CORSIA, whether a flight is international, or subject to offsetting requirements, is based on where it actually went, not where it meant to go. If in a given year an aeroplane operator is subject to the CORSIA offsetting requirements only because of diverted or subsequent flights (all other flights being operated on routes not subject to offsetting), the aeroplane operator will still be required to offset the emissions of those flights. Should an aeroplane operator that is approved to use the ICAO CORSIA CERT exceed in a given year the threshold of 50 000 tonnes of CO_2 on the routes subject to offsetting requirements due to diverted or subsequent flights, then the operator will still be permitted to use the ICAO CORSIA CERT in that year and the following year (year y+1). However, if the operator also exceeds the 50 000 tonnes threshold in that following year (year y+1), then it would be required to submit a new Emissions Monitoring Plan by 30th September in (Year y+2) and begin using a Fuel Use Monitoring Method from 1st January in Year y+3.
	Emissions Monitoring Plan
3.32	What is an Emissions Monitoring Plan and why is it needed?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.2.2 and Appendix 4. An aeroplane operator falling under the applicability of CORSIA MRV requirements is required to submit an Emissions Monitoring Plan to the State Authority for approval. An Emissions Monitoring Plan is a collaborative tool between the State and the aeroplane operator that identifies the most appropriate means and methods for CO_2 emissions monitoring on an operator-specific basis, and also facilitates the reporting of required information to the State. During the development and approval process of the Emissions Monitoring Plan, the State Authority and aeroplane operator should maintain clear and open communication. Working collaboratively for CORSIA preparation and implementation reduces potential errors and increases effectiveness of the CO_2 emissions monitoring.
3.33	What are the contents of an Emissions Monitoring Plan?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.2.2 and Appendix 4. An Emissions Monitoring Plan has four main components: • Aeroplane operator identification; • Fleet and operations data; • Methods and means of calculating emissions from international flights; and • Data management, data flow and control.

	Full contents of an Emissions Monitoring Plan are included in Annex 16, Volume IV, Appendix 4.
3.34	Is there a standardised template for an Emissions Monitoring Plan?
	A template for an Emissions Monitoring Plan is provided in the *Environmental Technical Manual* (Doc 9501), Volume IV – *Procedures for demonstrating compliance with the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)*. The template is also available on the ICAO CORSIA webpage.
3.35	When should an aeroplane operator submit an Emissions Monitoring Plan to the State?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.2.2 and Appendix 1. In line with the provisions in Annex 16, Volume IV, aeroplane operators that fell within the scope of applicability of MRV requirements at the time when these became applicable (i.e. 1 January 2019) were required to submit their Emissions Monitoring Plan to their State for approval by 28 February 2019. A new entrant aeroplane operator shall submit an Emissions Monitoring Plan to the State to which it is attributed within three months of falling within the scope of applicability of MRV requirements.
3.36	When will the Emissions Monitoring Plan be approved by the State?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.2.2 and Appendix 1. After receiving the Emissions Monitoring Plan from the aeroplane operator, the State Authority will review the plan. If the plan meets the requirements of Annex 16, Volume IV, then the State Authority will approve the Emissions Monitoring Plan. Guidance for the review and approval of an Emissions Monitoring Plan is included in the *Environmental Technical Manual* (Doc 9501), Volume IV – *Procedures for demonstrating compliance with the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)*. For aeroplane operators that fell within the scope of applicability of MRV requirements at the time when these became applicable (i.e. 1 January 2019), the deadline for State approval was by 30 April 2019 (if the aeroplane operator had submitted the Plan by 28 February 2019).
3.37	Does the third-party verification body need to review the Emission Monitoring Plan prior to its review and approval by the State?
	Reference in Annex 16, Volume IV: Part I, Chapter 1,1.1.5. No. An Emissions Monitoring Plan is a tool to facilitate CORSIA-related communication between an aeroplane operator and a State Authority, and it does not need to be verified by a third-party verification body. A verification body is required to conduct the verification of an Emissions Report that the aeroplane operator develops in accordance with the approved Emissions Monitoring Plan.
3.38	Does the Emissions Monitoring Plan have to be submitted annually?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.2.2. No. The Emissions Monitoring Plan has to be submitted only once unless there are material changes to the operator's procedures in which case the operator will have to

	re-submit the Emissions Monitoring Plan to the State Authority for approval.
3.39	What happens if there are changes to the information contained in an Emissions Monitoring Plan?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.2.2. In general, an Emissions Monitoring Plan should reflect the current status of an aeroplane operator's operations. An operator is required to resubmit the Plan for review and approval by the State if a "material change" is made to the information contained within the Plan. Examples of a material change include: • A change to the information presented in the Plan that would affect the status or eligibility of an aeroplane operator for an option under the emissions monitoring requirements; • A change that would otherwise affect the decision by the State with regards to whether the aeroplane operator's approach to monitoring conforms with the requirements; or • A change in the identifying information for attributing the aeroplane operator to a State, or a change in the means for having international flights attributed to the operator. The aeroplane operator is also required to inform the State of changes that would affect the State's oversight. This applies even if the changes do not fall within the definition of a material change. Examples of such changes include a change in corporate name or address, or a change in the contact information for a person responsible for the operator's Emissions Monitoring Plan. Guidance on identifying material changes to an Emissions Monitoring Plan is provided in the *Environmental Technical Manual* (Doc 9501), Volume IV – *Procedures for demonstrating compliance with the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)*.
3.40	How should non-material changes to an Emissions Monitoring Plan be communicated to the State?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.2.2. An aeroplane operator is required to inform the State of changes that would affect the State's oversight, including changes that do not fall within the definition of a material change (see question 3.39). As per Annex 16, Volume IV, the operator shall include as a part of its Emissions Monitoring Plan the procedures for providing notice in the Emissions Report of non-material changes that require the attention of the State. Guidance on identifying material and non-material changes to an Emissions Monitoring Plan is provided in the *Environmental Technical Manual* (Doc 9501), Volume IV – *Procedures for demonstrating compliance with the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)*.
	Monitoring
3.41	How does an aeroplane operator monitor its fuel use and CO_2 emissions?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.2.2. Appendix 2, and Appendix 3. Under CORSIA, there are two possible ways of monitoring the CO_2 emissions: either by tracking the fuel use by applying one of the five Fuel Use Monitoring Methods and then calculating CO_2 emissions from the fuel use, or by using the ICAO CORSIA CO_2 Estimation and Reporting Tool (CERT). Aeroplane operator's level of activity (see

	below for the activity thresholds) will determine whether the operator is eligible to use the ICAO CORSIA CERT, or it is required to apply a Fuel Use Monitoring Method. An aeroplane operator will select an appropriate method and include the selection in its Emissions Monitoring Plan, for submission to the State for approval. An aeroplane operator with annual CO_2 emissions from international flights of less than 500 000 tonnes during the period of 2019-2020 can use the ICAO CORSIA CERT for estimating and reporting its CO_2 emissions under CORSIA (see question 3.43 for more information about the ICAO CORSIA CERT). An aeroplane operator with annual CO_2 emissions from international flights of more than or equal to 500 000 tonnes during the period of 2019-2020 is required to choose one of the five eligible "Fuel Use Monitoring Methods". The five Eligible Fuel Use Methods are described more in details in Annex 16, Volume IV, Appendix 2 (see also question 3.46). For the period of 2021-2035, the eligibility threshold for the use of the ICAO CORSIA CERT changes. For this period, an aeroplane operator can use ICAO CORSIA CERT to estimate and report its annual CO_2 emissions, if the operator's emissions from international flights subject to offsetting requirements are less than 50 000 tonnes. Also, an operator can still use the ICAO CORSIA CERT to estimate and report those CO_2 emissions from international flights not covered by offsetting requirements.
3.42	Who approves the monitoring method for an aeroplane operator?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.2.1. An aeroplane operator shall monitor and record its fuel use from international flights in accordance with an eligible monitoring method, and as approved by the State to which it is attributed. It is the responsibility of the State to approve an appropriate monitoring method for an operator, as a part of the approval of the operator's Emissions Monitoring Plan.
3.43	Who are eligible to use the ICAO CORSIA CO_2 Estimation and Reporting Tool (CERT)?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.2.2, and Appendix 3. Assembly Resolution A39-3 requested the development of simplified MRV procedures as a part of the CORSIA MRV system. ICAO CORSIA CERT is a simplified tool that is designed to help aeroplane operators to estimate and report their international aviation emissions. All aeroplane operators can use the ICAO CORSIA CERT for a preliminary CO_2 assessment to support the determination of an appropriate eligible method for the monitoring of the CO_2 emissions. Eligible aeroplane operators can use ICAO CORSIA CERT for estimating and reporting of their annual CO_2 emissions (see question 3.41 for the eligibility criteria for using the ICAO CORSIA CERT).
3.44	Where can one access the ICAO CORSIA CERT?
	ICAO CORSIA CERT is available free of charge on the ICAO CORSIA webpage.
3.45	Where can one find more information about ICAO CORSIA CERT?
	The ICAO CORSIA webpage contains detailed information on the ICAO CORSIA CERT, namely: a document containing technical details on the development and use of the ICAO CORSIA CERT; a Frequently Asked Questions document; and a tutorial.

	Please also refer to section 4 of these FAQs for more information on ICAO CORSIA CERT.
3.46	What are the five Eligible Fuel Use Monitoring Methods? Are they different from ICAO CORSIA CERT?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.2.2, and Appendix 2. Not all aeroplane operators are eligible to use the ICAO CORSIA CERT for estimating and reporting their annual CO_2 emissions (see question 3.41). Operators which are ineligible to use the ICAO CORSIA CERT shall select and use one of the five Eligible Fuel Use Monitoring Methods. The five methods are entitled as “Method A”; “Method B”; “Block-off / Block-on”; “Fuel Uplift”; and “Fuel Allocation with Block Hour”, and are described in details in Annex 16, Volume IV, Appendix 2, as well as in the *Environmental Technical Manual* (Doc 9501), Volume IV – *Procedures for demonstrating compliance with the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)*. These five methods represent the most accurate established practices, and are equivalent; there is no hierarchy for selecting one method. Providing five methods is to allow flexibility for the operator to choose a method that best fits its existing fuel use tracking procedures. The differences in results between the five Fuel Use Monitoring Methods are not significant, in particular over a full reporting period. A comparison of the methods performed by CAEP experts demonstrated that there are no major differences between the results of the methods for the purpose of CORSIA. An aeroplane operator can use a different Fuel Use Monitoring Method for different aeroplane types included in its fleet. The aeroplane operator is required to specify in its Emissions Monitoring Plan which method it will apply to which aeroplane type. Aeroplane types are included in Doc 8643 — *Aircraft Type Designators* (https://www.icao.int/publications/DOC8643/Pages/Search.aspx). It should be noted that if the aeroplane operator wants to change its monitoring method, this change must be reflected in the Emissions Monitoring Plan, and approved by the State Authority before the operator can start applying the new monitoring method (also see question 3.39). Difference between a Fuel Use Monitoring Method and ICAO CORSIA CERT is that, a Fuel Use Monitoring Method tracks the quantity of fuel for each flight. ICAO CORSIA CERT is an emissions estimation tool to calculate CO_2 emissions based on the aeroplane type and aerodromes of origin and destination.
3.47	Is it necessary to describe all five Fuel Use Monitoring Methods in the Emissions Monitoring Plan, even if not all are used?
	No, an operator needs to describe only those methods that it will use for the fuel use monitoring; there’s no need to describe all five methods in the Emissions Monitoring Plan (also see question 3.46).
3.48	Is it possible to use a Fuel Use Monitoring Method for reporting that is different to the method(s) described in the approved Emissions Monitoring Plan?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.2.2. An Emissions Monitoring Plan should reflect the current status of an aeroplane

	operator's operations, including the current monitoring method. If there is a change to the monitoring method, this would constitute a "material change" to the Emissions Monitoring Plan, and the operator would be required to resubmit the Plan for review and approval by the State (also see question 3.46).
3.49	Can an aeroplane operator change its Fuel Use Monitoring Method?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.2.1.1. and 2.2.1.2. Yes. An aeroplane operator can change its fuel monitoring method. However, an operator must use the same eligible monitoring method for the entire compliance period. In addition, an operator is recommended to use the same monitoring method for the 2019 – 2020 period that it expects to use during the 2021 – 2023 period. If an operator changes a monitoring method, this constitutes a material change to the Emissions Monitoring Plan, and the operator will need to submit a revised Emissions Monitoring Plan to the State for approval (also see question 3.46).
3.50	Can an aeroplane operator use several different Fuel Use Monitoring Methods?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.2.1.3, and Appendix 4. An aeroplane operator can use different Fuel Use Monitoring Methods for different aeroplane types included in the operator's fleet. If different methods are to be used for different aeroplane types, then the operator shall specify in its Emissions Monitoring Plan which method applies to which aeroplane type. Approving appropriate monitoring method(s) for an operator is the responsibility of the State, as a part of the approval of the operator's Emissions Monitoring Plan. Also, during the period of 2021 – 2035, an aeroplane operator is entitled to use either a Fuel Use Monitoring Method or the ICAO CORSIA CERT for international flights not subject to offsetting requirements. This might lead into a situation where the operator is using a Fuel Use Monitoring Method for international flights subject to offsetting requirements, and ICAO CORSIA CERT for international flights not subject to offsetting requirements (also see questions 3.41 and 3.46).
3.51	How is "Block-off" and "Block-on" defined in Fuel Use Monitoring Method "Block-off / Block-on"?
	Reference in Annex 16, Volume IV: Appendix 2, 2.4. ***Block-off:*** any time between last door closed and first engine on. Any deviation to this definition should be in accordance with the aeroplane operator's existing operational practices as defined in the Emissions Monitoring Plan. The aeroplane operator shall state in its Emissions Monitoring Plan the points at which block-off measurements will be taken, with a reference to the relevant aeroplane operator documentation, to be approved by the State Authority. ***Block-on:*** any time between last engine out and first door open. Any deviation to this definition should be in accordance with the aeroplane operator's existing operational practices as defined in the Emissions Monitoring Plan. The aeroplane operator shall state in its Emissions Monitoring Plan the points at which block-on measurements will be taken, with a reference to the relevant aeroplane operator documentation, to be approved by the State Authority.

3.52	What are the data requirements for the Fuel Use Monitoring Method “Fuel Allocation with Block Hour”?
	Reference in Annex 16, Volume IV: Appendix 2, 2.6. Fuel Use Monitoring Method “Fuel Allocation with Block Hour” requires data from all flights of each aeroplane type for the reporting year. This method requires data on block hour of the flight under consideration (BH) and data from other flights of the same aircraft type (ICAO aircraft type designator level) in the same year. There are two ways to implement the method: (1) When the aeroplane operator can clearly distinguish between fuel uplifts for domestic and international flights, it uses actual fuel use (determined using the fuel uplift methodology) and block hour per flight for all international flights of the aeroplane type in the reporting year; (2) When the aeroplane operator cannot clearly distinguish between fuel uplifts for domestic and international flights, it uses fuel uplift and block hour of all flights of the aeroplane type in the reporting year. The average fuel burn ratios (AFBR) are computed for each aeroplane operator and aeroplane type used. The computation of average fuel burn ratios is done using the formula in Annex 16, Volume IV, Appendix 2, 2.6.1; the computation of fuel use for individual flights is defined in Annex 16, Volume IV, Appendix 2, 2.6.1 and 2.6.2. An illustrative calculation is provided in the *Environmental Technical Manual* (Doc 9501), Volume IV – *Procedures for demonstrating compliance with the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)*, Table 3-7 for the Fuel Allocation with Block Hour Method. The assumed average fuel burn (AFBR) in the illustration is 7 270 tonnes/h.
3.53	How should missing data under the Fuel Use Monitoring Method “Fuel Allocation with Block Hour” be handled?
	Reference in Annex 16, Volume IV: Part II, 2.5.1; Appendix 2, 2.6. The fuel allocation with block hour method requires the collection of block time and fuel uplift data to calculate the average fuel burn ratio in a given year for a given aeroplane type. In the case where no primary and secondary data sources are available to determine the block time and/or fuel uplift for one or more flights (i.e. there are data gaps), the aeroplane operator will use the ICAO CORSIA CERT to estimate and report CO_2 emissions for each flight with data gaps. For all remaining flights (i.e., excluding flights with data gaps), the aeroplane operator will apply the fuel allocation with block hour for the respective aeroplane(s) in accordance with Annex 16, Volume IV, Appendix 2, section 2.6. The average fuel burn ratio should be computed without consideration of the flights for which a data gap occurred. The average fuel burn ratio is not to be applied on flights with data gaps.

3.54	What will happen if an aeroplane operator exceeds the eligibility threshold to use ICAO CORSIA CERT during a given year?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.2.1.3. If the emissions of an aeroplane operator increase above the 500 000 tonnes threshold during the 2019 – 2020 period, the State may authorise it to continue using the ICAO CORSIA CERT. From 2021 onwards, if an operator's annual CO_2 emissions from international flights increase above the 50 000 tonnes threshold in a given year (y) and stay above the threshold in the following year (y+1), the operator will have to submit a revised Emissions Monitoring Plan by 30 September of the subsequent year (y + 2) and start monitoring actual fuel use thereafter (from 1 January of year y+3).
3.55	How is fuel use treated while performing non-commercial activities (e.g., APU fuel use during maintenance)?
	Reference in Annex 16, Volume IV: Appendix 2. Sometimes an aeroplane does not perform a flight previous or subsequent to the flight for which fuel consumption is being monitored; this could happen, e.g., if the flight under consideration follows a major revision or maintenance. As a result of this, some of the fuel measurement points needed for the application of a certain Fuel Use Monitoring Method might not be available. In such cases the aeroplane operator may substitute the missing fuel measurement point with an alternative fuel measurement point for the flight under consideration, e.g., as recorded in the technical logs.
3.56	How are CO_2 emissions calculated from the fuel used?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.2.3. After an aeroplane has monitored its fuel use, the operator is required to determine the CO_2 emissions by using the following equation: *CO_2 Emissions = Mass of fuel × Fuel Conversion Factor of given fuel type* Fuel conversion factors are: • 3.16 kg CO_2/kg of fuel for Jet-A and Jet-A1 fuel; and • 3.10 kg CO_2/kg fuel for AvGas or Jet-B fuel. After conducting an analysis on the matter, these fuel conversion factors were agreed by the CAEP as the appropriate factor to be used at a global level. The analysis took into consideration the work of the IPCC, information from petroleum quality surveys, information from national GHG inventories, other emissions trading schemes, worldwide and regional values for the CO_2 fuel conversion factor, as well as methods that are based on measuring hydrogen and sulphur contents to calculate carbon content. If an aeroplane operator is using the ICAO CORSIA CERT for CO_2 emissions monitoring, the tool automatically estimates the CO_2 emissions, and no separate calculation of emissions is needed.
3.57	Why do we need to know total CO_2 emissions from international aviation?
	Knowing the total emissions from international aviation is important for several reasons: 1) To assess the overall emissions coverage of CORSIA and track progress in achieving the global aspirational goal of carbon neutral growth from 2020.

	2) As States voluntarily participate in CORSIA and the route-based approach affects the emissions coverage of CORSIA, the CORSIA baseline emissions will change to reflect the route-based coverage by CORSIA (also refer to question 2.17 on the calculation of CORSIA baseline). 3) The total emissions from international aviation in 2020 is also a reference value that will be used to inform exemptions for new entrants whose annual emissions do not exceed 0.1% of the total 2020 emissions[1]. [1] In order to safeguard against inappropriate economic burden on aeroplane operators due to the COVID-19 pandemic, the Council, at its 220th Session (June 2020), decided that <u>during the pilot phase</u>, 2019 emissions shall be used for 2020 emissions and published in all relevant ICAO documents referenced in Annex 16, Volume IV. There was no change for the provisions of Annex 16, Volume IV or Assembly Resolution A40-19 text.
3.58	What are the requirements for fuel density?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.2.3. If fuel quantities are measured in units of volume instead of units of mass, then an aeroplane operator is required to convert the fuel volume into fuel mass by applying a fuel density value that is used for operational and safety reasons. For CORSIA purposes, the operator shall either use an actual density value, or a standard density value (0.8 kg/litre). The operator shall detail the procedure for using actual or standard density in its Emissions Monitoring Plan.
3.59	What is the standard fuel density?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.2.3. A standard density value of 0.8 kg per litre is being used under CORSIA.
3.60	How to account for the use of CORSIA Eligible Fuels in the CORSIA MRV system?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.2.4. Claims of emissions reductions from the use of CORSIA Eligible Fuels by an aeroplane operator are based on mass of CORSIA Eligible Fuels according to purchasing and blending records. For the purposes of the CORSIA MRV system, an aeroplane operator, that intends to claim for emissions reductions from the use of CORSIA Eligible Fuels, shall use a CORSIA Eligible Fuel that meets the CORSIA Sustainability Criteria. Also, only CORSIA Eligible Fuels from fuel producers that are certified by an approved Sustainability Certification Scheme are allowed under CORSIA. Such certification schemes need to meet specific requirements developed by ICAO. The emissions reductions from the use of a CORSIA Eligible Fuel are calculated in the context of reducing the operator's CO_2 offsetting requirements (see also question 2.19). These calculations use the approved life cycle emissions values for the CORSIA Eligible Fuels. All the relevant documentation on CORSIA Eligible Fuels is available on the ICAO CORSIA website (also see questions 4.11 to 4.19).
	Reporting
3.61	What is the timeline for reporting of CO_2 emissions, and who will report to whom?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.3. and Appendix 1. **<u>An aeroplane operator</u>** is required to submit **<u>to the State</u>** a verified Emissions Report

	on an annual basis. The Emissions Report will include information on the previous calendar year's CO_2 emissions, and it shall be accompanied by a Verification Report that will be developed by a third-party verifier. The operator and the verification body shall both independently submit the verified Emissions Report and associated Verification Report to the State Authority (see also question 3.82 for more information on verification). According to the timeline included in Annex 16, Volume IV, Appendix 1, CO_2 emissions from the calendar year of 2020 shall be reported by aeroplane operators to their respective State by 31 May 2021. Regarding the CO_2 emissions for the period of 2021-2035, the deadline for the reporting of the previous calendar year's CO_2 emissions from aeroplane operators to their respective State is 30 April. After the State has received the Emissions Reports from all attributed aeroplane operators, **the State** shall submit required information regarding the CO_2 emissions **to ICAO**: • For 2019 emissions, this should have taken place by 31 August 2020, according to the timeline included in Annex 16, Volume IV, Appendix 1. The Council, at its 220th Session (June 2020), encouraged States to make all the efforts to meet this deadline. At the same time, the Council, cognizant of the challenges posed by the COVID-19 pandemic, invited those States that have difficulty in meeting this deadline to inform the Secretariat. The Council also requested the Secretariat to work flexibly to accommodate late submissions by States, as appropriate. • According to the timeline included in Annex 16, Volume IV, Appendix 1, for 2020 emissions, the State shall submit this information by 31 August 2021. • Regarding CO_2 emissions from 2021-2035, the annual reporting deadline from States to ICAO is 31 July following the calendar year for which the CO_2 emissions are being reported.
3.62	Do all international routes have to be included in the Emissions Report, or only the international routes with the States that participate in the CORSIA offsetting?
	Reference in Annex 16, Volume IV: Part II, Appendix 5. All international routes need to be included for reporting. Appendix 5 of Annex 16, Volume IV includes the content of an Emissions Report from aeroplane operator to State. From 2021, information to be reported includes the total CO_2 emissions from flights subject to offsetting requirements, **and** the total CO_2 emissions from international flights, that are not subject to offsetting requirements.
3.63	Who decides on the selection of aggregation level for the CO_2 emissions data (State pair or aerodrome pair)?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.3.1. According to the Annex 16, Volume IV, the State shall decide on the level of aggregation (i.e., State pair or aerodrome pair) for which an aeroplane operator attributed to it shall report the number of international flights and CO_2 emissions. The State shall inform the operator whether the operator's annual Emissions Report shall include State pair or aerodrome pair level information during the approval process of the Emissions Monitoring Plan.

3.64	What is the level of aggregation of the CO_2 emissions information that will be reported to States, and to ICAO?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.3. and Appendix 5. The State shall decide on the level of aggregation (i.e., State pair or aerodrome pair) for which an aeroplane operator is required to report the number of international flights and CO_2 emissions (also see question 3.63). The annual Emissions Report from an aeroplane operator to the State includes CO_2 emissions from all international flights per aerodrome pair or State pair (as per State's decision), no matter whether these flights are subject to CORSIA offsetting requirements or not. A "State pair" in this context means a group of two States composed of a departing State or its territories and an arrival State or its territories (e.g., flights between two States, State A and State B, will be reported as separate State pairs: A-B, and B-A). In turn, the information to be reported from State to ICAO includes: • Total annual CO_2 emissions for each State pair aggregated for all aeroplane operators from 2019; • Total annual CO_2 emissions for each aeroplane operator from 2021; • Total aggregated annual CO_2 emissions for all State pairs subject to offsetting requirements for each aeroplane operator from 2021; and • Total aggregated annual CO_2 emissions for all State pairs not subject to offsetting requirements for each aeroplane operator from 2021. Complete information to be reported from aeroplane operators to States and from States to ICAO is included in Annex 16, Volume IV Appendix 5.
3.65	What is the ICAO tool to facilitate reporting of the necessary information from States to ICAO?
	The CORSIA Central Registry (CCR), developed by ICAO, provides a tool for States to submit data and information to ICAO.
3.66	Where can one find more information about the CORSIA Central Registry CCR?
	Please refer to section 4 of these FAQs for more information about the CCR.
3.67	Are there any provisions regarding the confidentiality of data if a route is only operated by one operator?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.3. When an aeroplane operator operates a very limited number of State pairs that are subject to offsetting requirements, and/or a very limited number of State pairs that are not subject to offsetting requirements, it may request to the State that such data not be published at the aeroplane operator level. The same applies when aggregated State pair data may be attributed to an identified aeroplane operator as a result of a very limited number of aeroplane operators conducting flights between that State pair. Based on the request, the State shall determine whether this data is confidential. All data recognised as confidential by States will be aggregated and published by ICAO without attribution to a specific aeroplane operator, or to a specific State pair. There will be a distinction between State pairs subject to offsetting requirements, and those not subject to offsetting requirements (see also question 4.40).

3.68	Are the reporting periods and compliance periods the same for all operators?
	Reference in Annex 16, Volume IV: Appendix 1. Yes. All aeroplane operators are subject to the same reporting and compliance periods. Reporting periods are annual and correspond to calendar years. Compliance periods for offsetting requirements are 3-year periods, with the first period starting on 1 January 2021 and ending on 31 December 2023.
3.69	Is there an established template for reporting annual CO_2 emissions from an aeroplane operator to the State, and from the State to ICAO?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.3. It is recommended that an aeroplane operator uses the standardised Emissions Report template provided in the *Environmental Technical Manual* (Doc 9501), Volume IV – *Procedures for demonstrating compliance with the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)*. The template is also available on the ICAO CORSIA webpage. Regarding the reporting from a State to ICAO, the CCR provides a standardised format and means to submit the CORSIA specific data from a State to ICAO, and also allows ICAO to consolidate and develop the necessary reports for CORSIA.
3.70	What if there are gaps identified in the reported data?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.5.1. Data gaps may occur as a result of an aeroplane operator missing data that are needed for the determination of its fuel use on one or more international flights. In a case of a data gap, an aeroplane operator is required to correct issues identified with the data and information management system in a timely manner to mitigate ongoing data gaps and system weaknesses. As a part of its Emissions Monitoring Plan, an aeroplane operator has to identify secondary data sources to prevent data gaps. For example, if an aeroplane operator normally uses ACARS data and, due to a problem, is missing this data for a flight, it may still be able to source actual fuel data from fuel invoices or technical logs as the secondary sources.
3.71	What constitutes a data gap? How can such data gaps be addressed?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.5. Data gaps occur when an aeroplane operator is missing data relevant for the determination of its fuel use for one or more international flights. Gaps in emissions-related data can occur due to various reasons, including irregular operations, data feed issues or system failures. For example, a missing Block-off value, a missing fuel invoice, or a missing fuel density measurement, and no secondary source is available. It may, on occasion, include information about the actual flight itself, such as aerodrome of departure or aerodrome of destination incorrectly recorded, or unavailable from, on board system. When data from a primary source is missing but an agreed secondary source can be used instead, as detailed and approved in the aeroplane operator's Emissions Monitoring Plan, this is sufficient to provide the information and it is not considered a data gap. The primary data source refers to the electronic or paper process and documentation which are used by default by the operator to record fuel data measurements. A secondary data source is any other process and documentation which

	can be used by the operator to record fuel data measurements required for the application of the approved fuel monitoring method. The secondary data source must provide a fuel data measurement and cannot be estimated or statistically reconstructed. The measurement must be equivalent to the measurement which would have been obtained through the primary source, and it should not be measured at a materially different point in time. Such secondary sources may include, for example, the technical log or a fuel invoice. Using a data source from an equivalent point in time as the missing measurement allows the approved monitoring method to be completed so as to achieve the measurement of fuel for the flight in question according to the requirements of that monitoring method. To use a simple example, the secondary data source for block-off / block-on provides a recorded measurement of block-off fuel at an equivalent time to when the regular block-off measurement would be taken and/or it provides a recorded measurement of block-on fuel at an equivalent time to when the regular block-on measurement would be taken. If such a data source is not available, it is not permitted, for example, to use the fuel uplift method instead for that flight but the CO_2 emissions for the flight in question should be estimated with the ICAO CORSIA CERT. A data gap occurs when approved primary and secondary data are not available (i.e., the data is incomplete to calculate the emissions for the flight) and, as a result, the approved Fuel Use Monitoring Method cannot be applied to determine fuel use. In this case, the emissions for the flight in questions will be estimated using the ICAO CORSIA CERT.
3.72	What is the threshold for using ICAO CORSIA CERT to fill data gaps?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.5.1. If the data gap does not exceed 5 per cent of international flights for the 2019-2020 period, or 5 per cent of international flights subject to offsetting requirements for the 2021-2035 period, an aeroplane operator using a Fuel Use Monitoring Method is required to fill data gaps by using the ICAO CORSIA CERT. If there are data gaps that exceed a **5 per cent** threshold of total international flights, the operator is responsible for stating the percentage of data gaps, and for engaging with the State in order to address the issue.
3.73	Is the 5 per cent data gap threshold based on CO_2 emissions or number of flights?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.5.1. The 5 per cent threshold refers to the number of international flights (and **not** to the amount of CO_2 emissions). Please also refer to question 3.72 for precise definitions of the data gap thresholds.
3.74	Is an alternative estimation approach (instead of using the ICAO CORSIA CERT) possible for addressing data gaps?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.5.1. If an aeroplane operator has data gaps and system weaknesses that exceed the 5 per cent threshold, the operator shall engage with the State to address the issue. The operator shall also state the percentage of international flights that had data gaps, and provide an explanation to the State in the Emissions Report. The operator is required to fill all data gaps and correct systematic errors and misstatements prior to the submission of the Emissions Report. Alternative data

	sources, such as air traffic control (ATC) records, flight logs, flight plans, etc., are also possible for addressing data gaps and for estimating CO_2 emissions in such cases, however, Annex 16, Volume IV is clear in that an aeroplane operator using a Fuel Use Monitoring Method, shall fill data gaps using the ICAO CORSIA CERT, provided that the data gaps during a compliance period do not exceed the data gap thresholds (see also question 3.72).
3.75	Will CORSIA's baseline emissions be affected due to an error correction to the Emissions Report?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.6. Once a State has reported to ICAO, through the CORSIA Central Registry (CCR), information on the annual CO_2 emissions from international flights performed by aeroplane operators attributed to the State, it is possible that the State identifies an error in the reported CO_2 emissions data. Such an error can be identified by the State itself, or be reported to the State by either the relevant aeroplane operator or by the verification body that has undertaken the verification of the operator's Emissions Report. In such a situation, the State needs to correct the annual CO_2 emissions data affected by the identified error, and update the information reported to ICAO through the CCR. It is important that the State undertakes these actions as soon as practicable once the error has been identified, as the affected CO_2 emissions data will be used for the calculation of CORSIA's baseline emissions and, from 2021, for the calculation of the annual Sector's Growth Factor (SGF). If, despite all efforts made by a State to correct an identified error in a timely manner, such correction (and related reporting to ICAO through the CCR) took place after publication of the relevant ICAO documents containing information on the total sectoral CO_2 emissions or the Sector's Growth Factor calculated on the basis of the corrected data (i.e. ICAO documents "CORSIA 2020 emissions" and "CORSIA Annual Sector's Growth Factor (SGF)"), no adjustment would be made to the values published in these ICAO documents.
3.76	What happens in case of late reporting or no reporting by an aeroplane operator or a State?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.5.2. If an aeroplane operator does not provide its annual Emissions Report in accordance with the reporting timeline, the State is required to take action and to engage with the aeroplane operator to clarify the situation. If this proves unsuccessful, then the State shall estimate the aeroplane operator's annual emissions using the best available information and tools, such as the ICAO CORSIA CERT. In a case where the State does not provide its annual Emissions Report to ICAO in accordance with the reporting timeline, then the data provided by ICAO shall be used to fill the missing information and to make relevant calculations. The State is required to take necessary action to ensure that the necessary national policies and regulatory framework be established for the compliance and enforcement of CORSIA (see also question 3.10). For the reporting of 2019 emissions, the Council, at its 220th Session (June 2020), made a series of decisions in this regard, cognizant of the challenges posed by the

	COVID-19 pandemic. While the Council encouraged States to make all the efforts to meet the reporting deadline of 31 August 2020, the Council also invited those States that have difficulty in meeting this deadline to inform the Secretariat. The Council also requested the Secretariat to work flexibly to accommodate late submissions by States, as appropriate.
3.77	Who reports emissions from an aeroplane operator that has gone bankrupt during a reporting year?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.5.2. If an aeroplane operator's CO_2 emissions exceed 10 000 tonnes CO_2 for the year when the bankruptcy takes place, the operator falls within the applicability of CORSIA MRV requirements, and is required to submit an Emissions Report to the State Authority. If the operator fails to submit an Emissions Report in such a situation, and the State is not able to obtain necessary information from the operator, then the State shall estimate the operator's annual emissions by using the best available information and tools, such as the ICAO CORSIA CERT.
3.78	Why does a State need to provide State pair data to ICAO, even if this data has been identified as confidential?
	Reference in Annex 16, Volume IV: Appendix 5. State-pair level data will define the CORSIA baseline emissions for each State pair, which will be compared against the annual emissions from 2021 onwards from those State pairs that are subject to offsetting requirements, in order for ICAO to calculate the Sector's Growth Factor (see question 2.15). Any disaggregated data that has been determined as confidential by the State and informed to ICAO accordingly, will not be disclosed to the public by ICAO (also see question 3.67).
3.79	How does an aeroplane operator report the use of CORSIA Eligible Fuels?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.3 and Appendix 5. An aeroplane operator shall report the use of CORSIA Eligible Fuels as a part of its annual Emissions Report. In addition, in order to claim emissions reductions from the use of such fuels, the operator will provide supplementary information to the Emissions Report, which includes the details of the CORSIA Eligible Fuels and associated emissions reductions. A template of a CORSIA Eligible Fuels supplementary information to the Emissions Report is provided in the *Environmental Technical Manual* (Doc 9501), Volume IV – *Procedures for demonstrating compliance with the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)*, and is also available on the ICAO CORSIA website. All the relevant documentation on CORSIA Eligible Fuels is available on the ICAO CORSIA website (also see questions 4.11 to 4.19).
3.80	Why should an aeroplane operator report CORSIA Eligible Fuels every year while the compliance cycle is three years?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.3.3. Annex 16, Volume IV includes a recommendation for an aeroplane operator to make CORSIA Eligible Fuel claims on an annual basis, in order to ensure all documentation is dealt with in a timely manner. However, the aeroplane operator also has the option to make a CORSIA Eligible Fuel

	claim by the end of a given compliance period for all CORSIA Eligible Fuel received by a blender within that compliance period (also see question 2.19).
3.81	What will be the process of reporting of emissions unit cancellations?
	Reference in Annex 16, Volume IV: Part II, Chapter 4, 4.3. An aeroplane operator is required to report to the State the cancellation of CORSIA Eligible Emissions Units to meet its total final offsetting requirements for a given compliance period. The operator will do this by submitting to the State a copy of the verified Emissions Unit Cancellation Report and a copy of the associated Verification Report. The first deadline for reporting of emissions unit cancellations will be on 30 April 2025. By that time an aeroplane operator and the verification body are required to submit to the State Authority the verified Emissions Unit Cancellation Report and associated Verification Report for the 2021-2023 compliance period (also see question 3.90). The State shall report to ICAO aggregated information on the cancellations of emissions units by the operators attributed to the State. This report shall contain the information as defined in Annex 16, Volume IV, Appendix 5, Table A5-8 (see also question 4.41). A template for an Emissions Units Cancellation Report from aeroplane operators to States will be made available in the next revision of the *Environmental Technical Manual* (Doc 9501), Volume IV – *Procedures for demonstrating compliance with the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)*, and will also be available on the ICAO CORSIA website.
	Verification
3.82	How does the verification of CO_2 emissions work in CORSIA? Who will do the verification?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.4. and Appendix 6. Verification on emissions data intends to ensure the consistency of information, and to identify any potential errors in the aeroplane operator's annual Emissions Report. CORSIA foresees a three-step verification pathway: • At Step 1, a voluntary internal pre-verification **by an aeroplane operator** is recommended. This means that the aeroplane operator conducts a verification of its data before submitting it to a third-party verification body. The internal pre-verification is likely to increase the quality of the Emissions Report, but it does not replace the requirement for third-party verification. • At Step 2, a third-party verification is performed **by an independent third-party verification body**, before the operator reports to the State Authority. The requirements for the third-party verification will be based on existing Standards from the International Organization for Standardization (ISO), as well as on CORSIA-specific requirements from Annex 16, Volume IV. A third-party verification body is contracted by an aeroplane operator. • At Step 3, **the State Authority** conducts an order of magnitude review. This is the check performed by a State to verify the data against different sources of information that the State has access to.

3.83	Is third-party verification a requirement under Annex 16, Volume IV?
	Yes, the third-party verification is a requirement under Annex 16, Volume IV. Annex 16, Volume IV, Part II, Chapter 2, 2.4.1.1 states: *The aeroplane operator shall engage a verification body for the verification of its annual Emissions Report.*
3.84	Is there any exception to third-party verification requirements in CORSIA due to the current situation regarding COVID-19?
	There is no exception to third-party verification requirements in CORSIA due to the current situation regarding COVID-19. The ICAO Council, at its 220th Session (June 2020), encouraged States to make all the efforts to meet the deadline of 31 August 2020 to report on their respective CO_2 emissions data corresponding to year 2019, as per the timeline reflected in Annex 16, Volume IV, Appendix 1. At the same time, the Council, cognizant of the challenges posed by the current situation, invited those States that have difficulty in meeting this deadline of 31 August 2020 to inform the Secretariat (for example, by communicating through email, sending a letter, or filing a difference to the relevant provisions in Annex 16, Volume IV under Article 38 of the Convention on International Civil Aviation). The Council also requested the Secretariat to work flexibly to accommodate late submissions by States, as appropriate. In doing so, the Council reiterated the importance of the third-party verification requirements in Annex 16, Volume IV, and advocated for more flexibility in the reporting timeline and related deadlines (i.e. Appendix 1 of Annex 16, Volume IV) rather than for more flexibility regarding the verification requirements as such (i.e. Annex 16, Volume IV, Part II, Chapter 2, 2.4 and related Appendix 6).
3.85	Is it necessary for an aeroplane operator to perform an internal pre-verification of its Emissions Report, prior to the third-party verification?
	Reference in Annex 16, Volume IV: Part II, Chapter 4, 2.4.1.2. Voluntary pre-verification is a recommended practice for an aeroplane operator. Pre-verification will provide the operator with an opportunity to identify potential irregularities and take corrective actions prior to third-party verification, thereby having a potential to save time and resources later on in the process. The *Environmental Technical Manual* (Doc 9501), Volume IV – *Procedures for demonstrating compliance with the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)* provides a recommended checklist approach for the internal pre-verification.
3.86	Does the voluntary pre-verification by an aeroplane operator substitute the third-party verification?
	Reference in Annex 16, Volume IV: Part II, Chapter 4, 2.4.1.2. No. The voluntary pre-verification does not substitute the third-party verification. Voluntary pre-verification is not a requirement, although aeroplane operators are recommended to conduct a pre-verification as a preparatory activity for the third-party verification process (see also question 3.85).

3.87	Is a third-party verification needed when an aeroplane operator uses the ICAO CORSIA CERT?
	Reference in Annex 16, Volume IV: Part II, Chapter 4, 2.4.1. Yes, an aeroplane operator shall engage a third-party verification body for the verification of its annual Emissions Report also when the ICAO CORSIA CERT has been used for generating an Emissions Report (see also question 3.43).
3.88	What are the requirements to be accredited as a verification body to conduct the third-party verification?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.4. and Appendix 6. In order to be eligible to verify the Emissions Report of the aeroplane operator under CORSIA, a verification body must be accredited to ISO standard 14065:2013 (*Greenhouse gases – Requirements for greenhouse gas validation and verification bodies for use in accreditation or other forms of recognition*), and to the relevant requirements described in Annex 16, Volume IV, Appendix 6. Once accredited, the verification body is required to conduct the verification according to ISO standard 14064-3:2006 (*Greenhouse gases – Part 3: Specification with guidance for the validation and verification of greenhouse gas assertions*), and to the relevant requirements in Annex 16, Volume IV, Appendix 6.
3.89	Are the references to ISO standards included in Annex 16, Volume IV linked to specific versions of the standards, or will the latest version of these ISO standards automatically apply?
	The ISO standards referred to in Annex 16, Volume IV are: • ISO standard 14064-3:2006 (Greenhouse gases – Part 3: Specification with guidance for the validation and verification of greenhouse gas assertions) • ISO standard 14065:2013 (Greenhouse gases – Requirements for greenhouse gas validation and verification bodies for use in accreditation or other forms of recognition) • ISO/IEC 17011:2004 (Conformity assessment – General requirements for accreditation bodies accrediting conformity assessment bodies) Reference is always made to a specific version of an ISO standard. Should there be changes or revisions to the respective ISO standard, these changes will be analysed during the process of maintaining Annex 16, Volume IV, and the references to the ISO standards in the Annex 16, Volume IV will be updated accordingly, if deemed appropriate.
3.90	What are the requirements for the verification of an Emissions Unit Cancellation Report?
	Reference in Annex 16, Volume IV: Part II, Chapter 4, 4.4. Verification of an Emissions Unit Cancellation Report follows very similar process and requirements as the verification of an annual Emissions Report (see question 3.82). In order to be eligible to verify the Emissions Unit Cancellation Report of the aeroplane operator under CORSIA, a verification body must be accredited to ISO standard 14065:2013 (Greenhouse gases – Requirements for greenhouse gas validation and verification bodies for use in accreditation or other forms of recognition), and to the relevant requirements described in Annex 16, Volume IV, Appendix 6. Accreditations are granted by national accreditation bodies. National accreditation bodies are required to work in accordance with ISO/IEC 17011 (Conformity assessment – General requirements for accreditation bodies accrediting conformity

	assessment bodies). Once accredited, the verification body is required to conduct the verification according to ISO standard 14064-3:2006 (Greenhouse gases – Part 3: Specification with guidance for the validation and verification of greenhouse gas assertions), and in accordance with the relevant requirements in Annex 16, Volume IV, Appendix 6. It should be noted that an aeroplane operator may choose to use the same verification body for the verification of an Emissions Units Cancellation Report as it has engaged for the verification of the Emissions Report, although the operator is not obligated to do so. Guidance on the verification of the Emissions Units Cancellation Report is included in the *Environmental Technical Manual* (Doc 9501), Volume IV – *Procedures for demonstrating compliance with the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)*.
3.91	How much time is normally required for the third-party verification process?
	The time required for the verification process will vary on a case by case basis. The time required relates to, e.g., the size of the operator and whether simplified procedures, such as the ICAO CORSIA CERT, have been used.
3.92	Who pays for the third-party verification and what will be the price? Is a price list included in the list of verification bodies to be compiled by ICAO?
	An aeroplane operator will be responsible for covering the cost of the third-party verification of its Emissions Reports and Emissions Unit Cancellation Reports. Details of the verification (including the price of the verification service) will be agreed and included in the contract between an aeroplane operator and a verification body.
3.93	Who accredits the verification body?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.4 Accreditations are granted by national accreditation bodies. National accreditation bodies are required to work in accordance with ISO/IEC 17011 (Conformity assessment – General requirements for accreditation bodies accrediting conformity assessment bodies).
3.94	Is there any requirement for a verification body to be accredited by the National Accreditation Body (NAB) of the State it is registered in?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.4.2.1; and Part II, Chapter 4, 4.4.2. According to Annex 16, Volume IV, Part II, Chapter 4, 4.4.2, a verification body shall be accredited to ISO 14065:2013 and the relevant requirements in Appendix 6, Section 2 by a national accreditation body. Additional requirements or conditions for NABs to accredit verification bodies, including the accreditation of a foreign verification bodies, are within the purview of the NABs of each State. According to Annex 16, Volume IV, Part II, Chapter 2, 2.4.2.1, note, an aeroplane operator may engage a verification body accredited in another State, subject to rules and regulations affecting the provision of verification services in the State to which the aeroplane operator is attributed.

3.95	Can a verification body be accredited by several National Accreditation Bodies (NABs)?
	Yes, a verification body can seek accreditation by NABs in more than one State.
3.96	Can a Civil Aviation Authority accredit verification bodies?
	No; according to Annex 16, Volume IV, Part II, Chapter 2, 2.4.2, accreditation is granted by the National Accreditation Body (NAB), in accordance with ISO/IEC 17011 (Conformity assessment – General requirements for accreditation bodies accrediting conformity assessment bodies). In case there is no NAB, a State may notify aeroplane operators to engage verification bodies accredited in another State. The list of accredited verification bodies accredited in States for CORSIA is included in the ICAO document "CORSIA Central Registry (CCR): Information and Data for Transparency", available on the ICAO CORSIA website.
3.97	Can an aeroplane operator become a verification body?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.4. and Appendix 6. No. The verification body is required to be accredited to ISO 14065, but not the aeroplane operator. The verification body must be independent from the aeroplane operator, so even if an operator were to be certified to ISO 14065, it could not undertake the verification of its own Emissions Report.
3.98	How can an aeroplane operator identify an accredited verification body?
	Reference in Annex 16, Volume IV: Part II, Chapter 1, 1.3.7. The State is required to submit to ICAO a list of nationally-accredited verification bodies. ICAO will compile this information, and make available a list of verification bodies accredited in each State as a part of the ICAO document entitled "CORSIA Central Registry (CCR): Information and Data for Transparency", in order to facilitate the identification of an accredited verification body by an aeroplane operator (also see question 4.37). This ICAO document is regularly updated, on the basis of the information submitted by States. Once approved by the ICAO Council, the latest version of this ICAO document is available for download on the ICAO CORSIA webpage. An aeroplane operator may consult this list in order to identify and contract a verification body for the verification of the Emissions Report. See question 3.99 for further guidance on the recommended steps to be taken by an aeroplane operator in order to identify an eligible verification body.
3.99	What are the recommended steps to be taken by an aeroplane operator in order to identify an eligible verification body?
	As a first step in identifying an eligible verification body for the verification of an Emissions Report and/or Emissions Unit Cancellation Report, the aeroplane operator should familiarize itself with any rules and regulations affecting the provision of verification services in the State to which the operator is attributed[1]. For example, some States may specify in domestic regulation that, for the purposes of CORSIA, an aeroplane operator must use a verification body (VB) accredited by the State national accreditation body (NAB). Where there is not a NAB in the State, other rules may be specified. For example, the State could require that VBs are accredited by other specified NABs, or regional accreditation body. Where there is no State requirement in

	this regard, then the aeroplane operator is not restricted in its choice of eligible CORSIA accredited VB. For further detail on this step, the aeroplane operator should contact its national administering authority for CORSIA. Once all State-specific requirements are understood, the next step is to consult the ICAO document *CORSIA Central Registry (CCR): Information and Data for Transparency*[2]. This ICAO document provides a starting point to identify an eligible VB. Another important resource are the NABs themselves, which usually publish a list of verification bodies that they have accredited. NABs in many States publish such lists either online or in hard copy, and include information about the scope of the accreditation, accreditation status, and contact details for the accredited verification body. Although it is expected that an accredited VB would be listed by both the relevant NAB and on the ICAO document, a delay in publication on either the relevant NAB or ICAO could cause the accredited VB to appear on only one of the published lists until it is updated. Due to such possible delay for publication, the published lists may not be exhaustive at any given point in time, therefore, primary evidence should be sought in accordance with the checklist below. As a final step before selecting an eligible VB, it is recommended that the aeroplane operator request a copy of the accreditation certificate of the prospective VB and perform a simple check of the information provided using the checklist provided below. Generally, the accreditation certificate can also be downloaded from the website of the NAB. In the event that any of the checklist items cannot be confirmed through the review of the accreditation certificate itself, further follow up with the accrediting NAB may be required. The aeroplane operator should confirm the following: • The name of the prospective verification body matches the name on the accreditation certificate. • The scope of the accreditation is applicable to the specific office location of the prospective VB. • The scope of the accreditation is applicable to the intended purpose (i.e., applicable to verification of the CORSIA Emissions Report, the CORSIA Emissions Unit Cancellation Report, or both; the aeroplane operator should also ensure that the scope refers to Annex 16, Volume IV – Carbon Offsetting and Reduction Scheme for International Aviation – Standards and Recommended Practices (SARPs)[3]). • The accreditation is within the specified accreditation period and has not expired (usually 4-5 years). • The accreditation status is valid, and that the accreditation is not in the application phase, otherwise under review by the NAB or withdrawn. • The accreditation is granted by a NAB that satisfies the rules and regulations affecting the provision of verification services in the State to which the operator is attributed (if applicable). [1] See Annex 16, Volume IV, Part II, 2.4.2.1 [2] Available at https://www.icao.int/environmental-protection/CORSIA/Documents/CCR%20Information%20and%20Data%20for%20Transparency_Dec2019_v20200106.pdf [3] This can include reference to applicable national regulations that accommodate Annex 16, Volume IV requirements.

3.100	Should an aeroplane operator submit a copy of the accreditation certificate of the verification body to States along with the Emissions Report?
	No; according to the Annex 16, Volume IV, there is no such requirement for aeroplane operators to submit a copy of accreditation certificate to the States.
3.101	What can States do to check the accreditation status of verification bodies referred in the Emissions Report?
	According to the *Environmental Technical Manual* (Doc 9501), Volume IV – *Procedures for demonstrating compliance with the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)*, Chapter 3, 3.3.4.3, Table 3-9 (State order of magnitude checklist for Emissions Report), the State is encouraged to compare the verification body with the information in the ICAO document "CORSIA Central Registry (CCR): Information and Data for Transparency", available on the ICAO CORSIA website. If the verification body referred in the Emissions Report is not included in the list, the Emissions Report does not meet the requirements of Annex 16, Volume IV.
3.102	Does the verification body have to be from the administrating State of an aeroplane operator?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.4.2. An aeroplane operator may engage a verification body accredited in another State, as long as the State in which the aeroplane operator has been attributed to recognises this accreditation.
3.103	What if there is no accredited verification body in a State?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.4. An aeroplane operator may engage a verification body accredited in another State, subject to rules and regulations affecting the provision of verification services in the State to which the aeroplane operator is attributed.
3.104	What can a State do if it has limited accreditation structure in place to support the verification process?
	Reference in Annex 16, Volume IV: Appendix 6 Detailed guidance on this matter can be found in section 3.3.2.3 of the *Environmental Technical Manual* (Doc 9501), Volume IV – *Procedures for demonstrating compliance with the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA).*
3.105	Must a State ensure to have accredited verification bodies through its national accreditation body?
	Reference in Annex 16, Volume IV: Part II, Chapter 1, 1.3.7; and Appendix 1, No. States are asked to submit a list of verification bodies accredited in the State to ICAO, if any, at least once a year. The first time this was requested was by 30 April 2019. In addition, a State may submit updates to this list on a more frequent basis as needed through the CCR.
3.106	What may a witness audit involve during the accreditation process of a verification body?
	Reference in Annex 16, Volume IV: Appendix 6, 2.12. Detailed guidance on this matter can be found in section 3.3.2.4 of the *Environmental Technical Manual* (Doc 9501), Volume IV – *Procedures for demonstrating compliance with the Carbon Offsetting and Reduction Scheme for International*

	Aviation (CORSIA).
3.107	How does a verification team meet the knowledge requirements?
	Reference in Annex 16, Volume IV: Appendix 6, 2.5. *Note: The information contained in the answer to this question is of primary interest to verification bodies.* Detailed guidance on this matter can be found in section 3.3.2.2 of the *Environmental Technical Manual* (Doc 9501), Volume IV – *Procedures for demonstrating compliance with the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)* (section "Personnel and team competency", subsection "a) Knowledge requirements for verification teams (Annex 16, Volume IV, Appendix 6, 2.5)".
3.108	How does a verification team meet the technical expertise requirements?
	Reference in Annex 16, Volume IV: Appendix 6, 2.6. *Note: The information contained in the answer to this question is of primary interest to verification bodies.* Detailed guidance on this matter can be found in section 3.3.2.2 of the *Environmental Technical Manual* (Doc 9501), Volume IV – *Procedures for demonstrating compliance with the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)* (section "Personnel and team competency", subsection "b) Technical expertise requirements for verification teams (Annex 16, Volume IV, Appendix 6, 2.6)".
3.109	How does an independent reviewer meet the knowledge and technical expertise requirements?
	Reference in Annex 16, Volume IV: Appendix 6, 2.5 and 2.6. *Note: The information contained in the answer to this question is of primary interest to verification bodies.* Detailed guidance on this matter can be found in section 3.3.2.2 of the *Environmental Technical Manual* (Doc 9501), Volume IV – *Procedures for demonstrating compliance with the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)* (section "Personnel and team competency", subsection "c) Knowledge requirements and the technical expertise requirements for independent reviewers (Annex 16, Volume IV, Appendix 6, 2.5 and 2.6)".
3.110	Can the independent review be outsourced to another verification body?
	Reference in Annex 16, Volume IV: Appendix 6, 2.9. No. Outsourcing within the Annex 16, Volume IV refers to contracted external verifiers who are part of the verification body and therefore covered by the accreditation.
3.111	To avoid conflicts of interest, the leader of the verification team cannot undertake more than six verifications without a three consecutive year break. What if the leader performs three verifications, stops for one year, and then performs another three verifications?
	Reference in Annex 16, Volume IV: Appendix 6, 2.2. The requirement to take a three consecutive year break also applies in cases where the six annual verifications are not consecutive. Therefore, a three consecutive year break

	will still be required if the leader performs three verifications, stops for one year, and then performs another three verifications.
3.112	What are the contents of a Verification Report?
	Reference in Annex 16, Volume IV: Appendix 6, 3.10. According to Annex 16, Volume IV, a verification body shall submit a copy of a Verification Report to the aeroplane operator. Upon authorisation by the operator, the verification body shall forward a copy of the Verification Report together with the Emissions Report, the Emissions Unit Cancellation Report, or both, to the State. Contents of a Verification Report are outlined in Appendix 6 of Annex 16, Volume IV.
3.113	Is there a template for a Verification Report?
	A Verification Report template is provided in the *Environmental Technical Manual* (Doc 9501), Volume IV – *Procedures for demonstrating compliance with the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)*. The template is also available on the ICAO CORSIA webpage.
3.114	What does "materiality" mean in connection to the verification of CO_2 emissions?
	Reference in Annex 16, Volume IV: Appendix 6, 3.4. Materiality refers to the concept that individual misstatements and non-conformities, or the aggregation of them, could affect the correct amount of CO_2 emissions stated in the Emissions Report. A specific piece of information is considered to be material if, by its inclusion or exclusion, it can influence the emissions calculation or actions or decisions taken based on it. Materiality is linked to the quality of the Emissions Report and therefore its acceptance. Regarding the accepted level of materiality in CORSIA, Annex 16, Volume IV prescribes the following two materiality levels: • For aeroplane operators with annual CO_2 emissions from international flights, above 500 000 tonnes the materiality threshold is 2 per cent. • For aeroplane operators with annual CO_2 emissions from international flights equal or less than 500 000 tonnes the materiality threshold is 5 per cent. These are the largest acceptable percentage discrepancies between the declared amount of emissions in the aeroplane operator's Emissions Report and the verification body's estimation of the total amount of emissions. In the context of verification of an Emissions Report under CORSIA, the over and understatements contained in the sample of flights being verified are allowed to balance out each other.
3.115	Does the verification body need to include non-material misstatements and non-conformities as a part of the Verification Report?
	Reference in Annex 16, Volume IV: Appendix 6, 3.10. Yes. A verification body is required to include non-conformities and misstatements identified during the verification into the Verification Report, including a description of how these have been resolved (also see question 3.114).

3.116	Is a non-conformity acceptable if it does not lead to a material discrepancy?
	Reference in Annex 16, Volume IV: Appendix 6, 3.10. Yes. If the Emissions Report includes non-material misstatement and/or non-material non-conformities, the verification body will verify the Emissions Report as 'verified as satisfactory with comments', specifying the misstatements and non-conformities. The verification body must exercise professional judgment when evaluating the significance of issues with regards to misstatements, non-conformities and their impact on materiality. Also note that an aeroplane operator is required to fill all data gaps and correct systematic errors and misstatements prior to the submission of the Emissions Report.
3.117	Is a site visit a requirement under Annex 16, Volume IV for the verification process in CORSIA?
	No, site visits are not a requirement under Annex 16, Volume IV on CORSIA. The *Environmental Technical Manual* (Doc 9501), Volume IV – *Procedures for demonstrating compliance with the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)*, Chapter 3, 3.3.4 recommends site visits to take place as an essential means for the verification team to collect sufficient and appropriate evidence to confirm whether the aeroplane operator's Emissions Report is free from material misstatements and non-conformities. Whether site visits take place is dependent on the result of the risk analysis prior to the verification activities. ETM, Volume IV provides flexibility to replace a site visit with an equivalent approach when the verification risk is determined to be low, and also recommends to clearly mention in the Verification Report whether a site visit has been replaced and the reasoning for the decision. The verification body should coordinate with the State of the aeroplane operator before replacing the site visit with an alternative approach.
3.118	How can verification bodies conduct site visits given the existing COVID-19 travel restrictions in many States?
	Given the restrictions and measures imposed in several States due to the ongoing COVID-19 pandemic, National Accreditation Bodies (NABs), in close coordination with the Civil Aviation Authorities, may guide their verification bodies whether a general remote assessment would be accepted as a measure to address the current situation. Some States have taken such an approach and have provided their accredited verification bodies with guidance on this matter (see questions 3.119 and 3.120 for guidance to States on remote verification under the CORSIA MRV system).
3.119	What can be the specific role of remote verification techniques when an extraordinary event or circumstance prevents site visits?
	Guidance on this matter has been developed as part of ICAO's response to the concerns from States and aeroplane operators in terms of their capacity to meet the 2020 CORSIA reporting requirements and timelines in light of the COVID-19 pandemic. This guidance is available on the ICAO CORSIA website.
3.120	What should a State generally consider when coordinating with a verification body on a remote verification approach for Emissions Reports?
	Guidance on this matter has been developed as part of ICAO's response to the concerns from States and aeroplane operators in terms of their capacity to meet the 2020 CORSIA reporting requirements and timelines in light of the COVID-19 pandemic. This guidance is available on the ICAO CORSIA website.

3.121	What is the CORSIA-specific guidance available for verification bodies in order for them to undertake the remote verification of CORSIA Emissions Reports?
	Guidance on this matter has been developed as part of ICAO's response to the concerns from States and aeroplane operators in terms of their capacity to meet the 2020 CORSIA reporting requirements and timelines in light of the COVID-19 pandemic. This guidance is available on the ICAO CORSIA website.
3.122	Does the order of magnitude check by States require specific training, or is it enough to follow the checklist included in the ETM, Volume IV?
	The order of magnitude check by States does not require special training. The *Environmental Technical Manual* (Doc 9501), Volume IV – *Procedures for demonstrating compliance with the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)*, Chapter 3, 3.3.4.3, contains a checklist for the State's order of magnitude check of the Emissions Report (Table 3-9), which provides a guide for States to conduct the order of magnitude check. The 2019 ICAO CORSIA Regional Workshops included materials on this topic, which can be found on the ICAO CORSIA website.
3.123	What are the available sources of information for a State when conducting the order of magnitude check?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.4.1.5. According to Annex 16, Volume IV, a State will perform an order of magnitude check of the Emissions Report of the aeroplane operator (also see question 3.82). Guidance for the State to conduct the order of magnitude check is included in the form of a checklist in the *Environmental Technical Manual* (Doc 9501), Volume IV – *Procedures for demonstrating compliance with the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA*), in Table 3-9.
3.124	Why do both the aeroplane operator and verification body submit Emission Report and Verification Report to the State?
	Reference in Annex 16, Volume IV: Part II, Chapter 2, 2.4.1.4. Following the verification of the Emissions Report by the verification body, the aeroplane operator and the verification body shall both independently submit, upon authorisation by the aeroplane operator, a copy of the Emissions Report and associated Verification Report to the State (also see question 3.112). Receiving both reports independently from the operator and verification body provides assurances to the State that the information contained in the reports has been agreed by both stakeholders. The State will then perform an order of magnitude check on the basis of these two reports submitted to the State.
3.125	Does ICAO provide training on CORSIA verification requirements?
	Yes. In 2019, ICAO launched a CORSIA Verification Course aimed to provide training on how to verify CO_2 Emissions Reports that have been prepared by aeroplane operators, in accordance with the provisions of the CORSIA SARPs. More information about the course, as well as upcoming deliveries can be found from the course webpage. Mindful of the concerns from States and aeroplane operators in terms of their capacity to meet the 2020 CORSIA reporting requirements and timelines in light of the COVID-19 pandemic, ICAO took a series of actions, including on the matter of verification under CORSIA, namely:

	• Launching of an online version (virtual classroom) of the CORSIA Verification Course. The online modality, available since 8 May 2020, allows for the continuous provision of training on CORSIA-specific matters to verification bodies. • Organization of an online Webinar on CORSIA Verification, held on 14 May 2020. The objective of the webinar was to provide clarification on CORSIA's verification requirements to States' CORSIA Focal Points. Detailed information on this webinar, including the webinar's recording, can be found on the ICAO CORSIA website.
4.	**Questions about CORSIA Implementation Elements**
	CORSIA States for Chapter 3 State Pairs
4.1	What are "Chapter 3 State Pairs"?
	All routes between States participating in CORSIA offsetting in a given year (starting in 2021) are termed "Chapter 3 State Pairs", as these routes will be subject to offsetting requirements as per the provisions in Annex 16, Volume IV, Part II, Chapter 3 (see also questions 2.7 and 2.8).
4.2	What is the ICAO document "CORSIA States for Chapter 3 State Pairs"?
	For a given year (starting in 2021), the States included in the ICAO document entitled "CORSIA States for Chapter 3 State Pairs" define the State pairs subject to CO_2 offsetting requirements in CORSIA in that year (see question 3.1). This ICAO document is directly referenced in Annex 16, Volume IV, Part II, Chapter 3. The first edition of this ICAO document, approved by the ICAO Council, contains the list of States that will participate in CORSIA offsetting from 1 January 2021, and defines the State pairs with CO_2 offsetting requirements in CORSIA in 2021. This list was compiled on the basis of States' notifications of their voluntary participation to CORSIA offsetting; States made these notifications by 30 June 2020, in line with the timelines established in Annex 16, Volume IV, Appendix 1. This ICAO document will be annually updated in order to define the State pairs with CO_2 offsetting requirements under CORSIA in subsequent years after 2021.
4.3	Where can the ICAO document "CORSIA States for Chapter 3 State Pairs" be found?
	This ICAO document is available on the ICAO CORSIA webpage.
	ICAO CORSIA CO_2 Estimation and Reporting Tool (CERT)
4.4	What is ICAO CORSIA CERT?
	The ICAO CORSIA CERT is a simplified tool, which is developed for aeroplane operators to support the monitoring and reporting of their CO_2 emissions under CORSIA (please also see questions 3.41 and 3.43). The ICAO CORSIA CERT is one of the five ICAO CORSIA Implementation Elements, and is reflected in the ICAO document entitled "ICAO CORSIA CO_2 Estimation and Reporting Tool", referenced in Annex 16, Volume IV (see question 3.1).

4.5	What are the different versions of the ICAO CORSIA CERT?
	The ICAO CORSIA CERT will have different versions over time. The 2018 version of the ICAO CORSIA CERT allowed operators to estimate their CO_2 emissions from international flights and assess their eligibility or not of using the ICAO CORSIA CERT as a simplified monitoring method (see question 3.41). The 2019 and 2020 versions of the ICAO CORSIA CERT include a functionality to not only estimate CO_2 emissions, but also to generate aeroplane operator's annual Emissions Report. Regarding the estimation of the CO_2 emissions, the 2019 and 2020 versions of the tool allow either estimating CO_2 emissions based on either Great Circle Distance, or on Block Time input. From 2021 onwards, the ICAO CORSIA CERT will be updated by including a list of States Pairs subject to CORSIA offsetting requirement for each year.
4.6	What is new in the 2020 version of the ICAO CORSIA CERT?
	The 2020 version of the ICAO CORSIA CERT includes the same functionalities as the 2019 version of the tool, but the underlying data supporting the tool has been updated on the basis of the latest available information. The 2020 version of the ICAO CORSIA CERT is the latest version of the tool, to be used by an aeroplane operator to support the monitoring and reporting of their 2020 CO_2 emissions, in accordance with the requirements from ICAO Annex 16, Volume IV, Part II, Chapter 2, 2.2 and Appendix 3.
4.7	Can an Emissions Report that was generated by the ICAO CORSIA CERT be submitted from an aeroplane operator to the State?
	The CORSIA Emissions Report template has been embedded into the ICAO CORSIA CERT, and the report generated by the tool can be submitted to the State Authority after third party verification.
4.8	Can the ICAO CORSIA CERT be used for an aeroplane operator's internal pre-verification?
	In order to prepare for third-party verification, aeroplane operators are recommended to conduct a voluntary internal pre-verification in order to ensure that there will be no large data issues during the verification (also see question 3.82). ICAO CORSIA CERT can support an operator to cross-check CO_2 emissions information during an internal pre-verification.
4.9	Will the third-party verification of an Emissions Report be cheaper when an aeroplane operator has used the ICAO CORSIA CERT for monitoring?
	External third-party verification is still required, also when an aeroplane operator has used ICAO CORSIA CERT for estimating its CO_2 emissions. Details of the verification (including the price of the verification service) will be agreed and included in the contract between an aeroplane operator and a verification body (see also questions 3.87 and 3.92).
4.10	Where can one find more information about the ICAO CORSIA CERT?
	The ICAO CORSIA CERT, technical details on the design, development and validation of the tool, CORSIA CO_2 Estimation Models, template for importing data into the ICAO CORSIA CERT, as well as a tutorial and separate FAQs and on the tool, can be found on ICAO CORSIA webpage.

	CORSIA Eligible Fuels
4.11	What is the definition of "CORSIA Eligible Fuels"?
	The ICAO CORSIA Implementation Element "CORSIA Eligible Fuels" is reflected in five ICAO documents referenced in Annex 16, Volume IV (see question 3.1). Annex 16, Volume IV provides the following definitions in this respect: • **CORSIA Eligible Fuel**: "A CORSIA sustainable aviation fuel or a CORSIA lower carbon aviation fuel, which an operator may use to reduce their offsetting requirements." • **CORSIA sustainable aviation fuel**: "A renewable or waste-derived aviation fuel that meets the CORSIA Sustainability Criteria under this Volume." • **CORSIA lower carbon aviation fuel**: "A fossil-based aviation fuel that meets the CORSIA Sustainability Criteria under this Volume."
4.12	Which sustainability criteria shall be met by CORSIA Eligible Fuels?
	For an aeroplane operator to claim emissions reductions from the use of CORSIA Eligible Fuels, such fuel shall meet the CORSIA Sustainability Criteria defined within the ICAO document entitled "CORSIA Sustainability Criteria for CORSIA Eligible Fuels". The criteria applicable during the CORSIA Pilot Phase (years 2021 - 2023) are available on the ICAO CORSIA website.
4.13	Which life cycle emissions values will be used for calculating the emissions reductions from CORSIA Eligible Fuels?
	The emissions reductions from the use of CORSIA Eligible Fuels in a given year are based on their life cycle emission values, which depend on the feedstock, conversion process, and region where the fuel was produced. There are two possibilities to obtain the life cycle emission value of a given CORSIA Eligible Fuel: An aeroplane operator can use a "default life cycle emissions value" from the ICAO Document entitled "CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels", which is available on the ICAO CORSIA website; or An operator can use an "actual life cycle emissions value", based on the methodologies defined in the ICAO document entitled "CORSIA Methodology for Calculating Actual Life Cycle Emissions Values", which is available on the ICAO CORSIA website. In this case, an approved Sustainability Certification Scheme shall ensure that the methodology has been applied correctly.
4.14	What constitutes the life cycle emission value of a CORSIA Eligible Fuel?
	The life-cycle emissions values of a CORSIA Eligible Fuel is composed of two main elements: 1) Core Life Cycle Assessment (LCA) emissions, which include the emissions associated with: feedstock cultivation, feedstock harvesting, collection and recovery, feedstock processing and extraction, feedstock transportation to processing and fuel production facilities, feedstock to fuel conversion processes, fuel transportation and distribution, and fuel combustion in an aircraft engine, and 2) Induced land-use change (ILUC) emissions – CORSIA Eligible Fuel production may require some additional land to be used, and generate land use change GHG emissions. These could occur where the new CORSIA Eligible Fuel production is

	taking place (direct land use change) but also in other locations due to the displacement of crops (or animals) for which the land was previously used (indirect land use change). ILUC emissions assessment accounts for these different effects, by evaluating greenhouse gas released from conversion of natural vegetation (forest, other natural land), soil organic carbon, oxidation of peatlands, and sequestered biomass. The total life cycle emission value (LSf) value for a given CORSIA Eligible Fuel is the sum of core LCA emission and the ILUC emission.
4.15	Who certifies CORSIA Eligible Fuel in order to be used in CORSIA?
	An aeroplane operator that intends to claim for emissions reductions from the use of CORSIA Eligible Fuels shall only use CORSIA Eligible Fuels from fuel producers that are certified by an approved Sustainability Certification Scheme.
4.16	What are the requirements for Sustainability Certification Schemes?
	Sustainability Certification Schemes must meet the requirements included in the ICAO document entitled "CORSIA Eligibility Framework and Requirements for Sustainability Certification Schemes", which is available on the ICAO CORSIA website.
4.17	Where can one find a list of approved Sustainability Certification Schemes?
	Approved Sustainability Certification Schemes are included in the ICAO document entitled "CORSIA Approved Sustainability Certification Schemes", which is available on the ICAO CORSIA website.
4.18	Can an aeroplane operator claim all the CORSIA Eligible Fuel it has purchased?
	No. An aeroplane operator cannot claim the amount of CORSIA Eligible Fuels that have been sold to a third party or claimed under another greenhouse gas emissions scheme. The aeroplane operator is required to provide a declaration of all other Greenhouse Gas schemes it participates in where the emissions reductions from the use of CORSIA Eligible Fuels may be claimed, and a declaration that it has not made claims for the same batches of CORSIA Eligible Fuel under these other schemes.
4.19	Which date is relevant in order to claim a batch of CORSIA Eligible Fuel?
	The blending date of the CORSIA Eligible Fuel is relevant. An aeroplane operator can only claim a reduction to its offsetting requirements from the use of such fuel if it was blended during the associated compliance period. An aeroplane operator may therefore purchase a batch of CORSIA Eligible Fuel at an earlier date and make the claim in a later compliance period during which the blending occurs.
	CORSIA Eligible Emissions Units
4.20	What are emissions units, in general?
	CORSIA calls for international aviation to offset part of its CO_2 emissions through the reduction of emissions elsewhere (outside of the international aviation sector), involving the concept of "emissions units". One emissions unit represents one tonne of CO_2 emissions reduced. Emissions units are generated when emissions from a specific project or programme are reduced, compared to a baseline (or business-as-usual), through the implementation of emission reductions techniques/technologies. These projects or programmes can be implemented in various sectors, such as electricity generation, industrial processes, agriculture, forestry, waste management etc. Emissions units are sometimes also referred to as carbon credits.
4.21	What are the eligible emissions units to be used under CORSIA?
	The ICAO CORSIA Implementation Element "CORSIA Eligible Emissions Units" is reflected in two ICAO documents referenced in Annex 16, Volume IV (see question

	3.1). The CORSIA Eligible Emissions Units are only those units described in the ICAO document entitled "CORSIA Eligible Emissions Units", which meet the CORSIA Emissions Unit Eligibility Criteria contained in the ICAO document entitled "CORSIA Emissions Unit Eligibility Criteria" (see question 4.22). These ICAO documents are available on the ICAO CORSIA website.
4.22	What are the eligibility criteria for CORSIA Eligible Emissions Units?
	The eligibility criteria for CORSIA Eligible Emissions Units have been approved by the ICAO Council, and are included in the ICAO document entitled "CORSIA Emissions Unit Eligibility Criteria", available on the ICAO CORSIA website.
4.23	Can an aeroplane operator already start purchasing CORSIA Eligible Emissions Units?
	An aeroplane operator can purchase emissions units at any time. However, aeroplane operators should be aware that they can use only eligible emissions units for the purpose of meeting their offsetting requirements under CORSIA. Paragraph 19 c) of the Assembly Resolution A40-19 requests the ICAO Council to develop and update the ICAO CORSIA document referenced in Annex 16, Volume IV related to the eligible emissions units for use by the CORSIA, considering the recommendations of the Technical Advisory Body (TAB) (see also question 4.27). In this regard, it is important to note that it is not the individual aeroplane operator or individual State who will determine which programmes and emission units are eligible in CORSIA, but the ICAO Council. Once determined by the Council, the CORSIA Eligible Emissions Units are included in the ICAO document entitled "CORSIA Eligible Emissions Units".
4.24	Can an aeroplane operator implement a project that generates CORSIA Eligible Emissions Units?
	Yes – an aeroplane operator can implement emissions reduction project that generates emissions units. Equally to any other emissions unit, the emissions units generated from such a project need to meet the CORSIA Emissions Unit Eligibility Criteria, if the operator wishes to use the units to fulfil its offsetting requirements under CORSIA. It should be noted, however, that projects that reduce emissions from international flights would not be eligible to be used under CORSIA as this would result in double counting of emissions reductions.
4.25	Can an aeroplane operator cancel CORSIA eligible emissions units prior to having received the total final offsetting requirements from the State at the end of a compliance cycle?
	Yes. An aeroplane operator can purchase and cancel CORSIA eligible emissions units at any time, and does not need to wait until the operator has been notified of its total final offsetting requirements at the end of the compliance period.
4.26	What happens if an operator does not cancel enough CORSIA Eligible Emissions Units to meet its offsetting requirements?
	The State is required to take necessary action to ensure that the necessary national policies and regulatory framework be established for the compliance and enforcement of CORSIA (see also question 3.10).
4.27	What is the "Technical Advisory Body" (TAB)?
	Assembly Resolution A39-3 requested the ICAO Council, with the technical contribution of the ICAO Committee on Aviation Environmental Protection (CAEP), to establish a Technical Advisory Body (TAB) which will make recommendations to the Council on eligible emissions units for use by the CORSIA.

	The Council, at its 215th Session in November 2018, agreed to initiate a process to establish the TAB. Following this agreement by the Council, a State letter was issued to ICAO's Member States, inviting them to nominate experts to the TAB. At the 216th session in March 2019, the Council reviewed the nominated candidates to the TAB, and approved the TAB membership. At the same session, the Council also approved the TAB Terms of Reference (TOR).
4.28	What are the tasks of the TAB? Who are the TAB members?
	In line with the Assembly Resolution A39-3 request, the mandate of the TAB is to make recommendations to the Council on the eligible emissions units for use by the CORSIA. TAB Terms of Reference (TOR), as well as a list of TAB members, is available on ICAO CORSIA webpage.
4.29	What is the timeline for the work of the TAB?
	TAB Work Programme and Timeline are available on the ICAO CORSIA webpage.
4.30	How will the TAB adjust to changing contexts, such as decisions at the UNFCCC?
	The iterative nature of the TAB process means that new information can be considered during a subsequent TAB assessment. The first two TAB assessments took place during 2019-2020. Further TAB assessments are anticipated. Thus, the TAB's work will continue to consider new information, new programmes, and new decisions which may affect the eligibility of emissions units for use under the CORSIA.
4.31	Where can one find more information about the TAB?
	More information on TAB can be found from the ICAO CORSIA webpage.
	CORSIA Central Registry (CCR)
4.32	What is the CORSIA Central Registry (CCR)?
	The CCR is one of the five implementation elements of CORSIA (see question 3.1). It is an information management system that allows States to submit CORSIA-related data and information to ICAO in a standardised format. Using the CCR, the ICAO Secretariat will store the submitted information, perform calculations, develop the necessary reports for CORSIA, and make available the required information for transparency (see question 4.39 for the information to be made publically available through the CCR).
4.33	Who has access to the CCR?
	Only authorized users have access to a State's CCR account. The CCR requires the official nomination of one CORSIA Focal Point (CFP) per State. A CFP can upload and change State-specific data, and has the responsibility of approving and submitting the information and data to ICAO. If needed, a CFP can nominate one or more State Users (STU), who will help the CFP with uploading and editing data in the CCR. A STU cannot submit data to ICAO.
4.34	If an aeroplane operator is in a parent-subsidiary relationship, does the State need to list the subsidiary operator on the CCR?
	Information submitted by States will be used to facilitate the compilation and publication of the ICAO document "CORSIA Aeroplane Operator to State Attributions", which aims to avoid duplications and gaps in attributing aeroplane operators to States, and to promote the highest level of completeness in terms of the aeroplane operators participating in CORSIA. For the purposes of reporting aeroplane operators to ICAO, a State should include both the subsidiary and the parent aeroplane operator into the list, and report information (attribution method, identifier, contact information) separately for each operator.

	For other purposes of CORSIA (e.g., for reporting of CO_2 emissions and emissions unit cancellations), and assuming that the State has approved it, the two operators can be treated as a single consolidated aeroplane operator (see also question 3.14).
4.35	Should the list of aeroplane operators include operators which do not have any requirements under CORSIA?
	If an aeroplane operator does not have CORSIA requirements, there is no need for the administering State of that operator to include it in the list of operators for the purposes of CORSIA. However, if the operator is close to the threshold of annual CO_2 emissions (10 000 tonnes of CO_2), it should engage with the State to which it is attributed for further guidance. Likewise, the State should maintain oversight of the operators attributed to it, and engage with any of them that may be close to or above the threshold (see also question 3.23). A State can include an operator, which is close to the annual threshold for CO_2 emissions, or which is likely to exceed the threshold in the future, into the list of operators, if the State so decides (see question 4.34 for the purpose of the list of operators).
4.36	How can a State validate information contained in the list of verification bodies accredited in the State?
	As set out in Appendix 1 of Annex 16, Volume IV, States are required on an annual basis (by 30 November) to submit updates to ICAO on the list of verification bodies accredited in the State, in accordance with Annex 16, Volume IV, Part II, Chapter 1, 1.3.7. The State may also submit updates to this list to ICAO on a more frequent basis. What is an update? Updating the State list of verification bodies in the CORSIA Central Registry (CCR) can include adding newly accredited verification bodies, and changing the status of verification bodies already in the list. For example, a verification body could choose to voluntarily withdraw from the CORSIA accreditation, or it could have its accreditation withdrawn by the national accreditation body (NAB). In this case, the State would mark the status of the verification body in the CCR as "inactive". Indicative information about verification bodies that are in the process of accreditation should not be included in the State list of verification bodies in the CCR. Only verification bodies that have an "active" status in a State list in the CCR will be included in the submission to ICAO. Identifying updates to the list of verification bodies accredited in the State Different States will have a different level of interaction with their national accreditation body (ies). States that are working closely with their NABs may have the option to ask them to provide regular updates on the status of the accreditation of their verification bodies. For States without this option, it is recommended that compilation of the list begins at least two months in advance of the ICAO submission deadline. As a first step in compiling the list of verification bodies accredited within the State, the State should search the website of those NAB(s) that offer a CORSIA verification body accreditation programme for an online list of verification bodies that have been accredited. NABs in many States publish such lists either online or in hard copy, and include information about the scope of the accreditation, accreditation status, and contact details for the accredited verification body. Using the published list, the State

should determine if there have been any new accreditations since the last ICAO list update, and if the status of any verification bodies already in the State list has changed (if applicable). If such a published list of accredited verification bodies is not readily available, the State should reach out directly to the NAB(s) for information about any new accreditations since the last update, and if the status of any verification bodies already in the State list has changed.

Validating updated information

If there are any updates, the State should seek supporting information about each affected verification body from the NAB. Types of information that should be sought, including directly from the NAB where the information is not publicly available, are set out in Table 1 below. Once compiled, the State should conduct a review of the information for accuracy. Recommended items that should be checked by the State are also included in Table 1.

After the State and the NAB confirm the status of each verification body in question, the State should encourage the NAB to update any of its own public lists of CORSIA verification bodies (e.g. website).

Even where all required information is available publically, it is recommended that the State confirm the information with the NAB before submitting to ICAO.

Table 1: Types of information to be requested by a State from the national accreditation body

	Information to request from NAB	What to check	Rationale/Other comments
1	Name of verification body	• Confirm that the name of the verification body matches the name on the accreditation certificate or other official documentation	
2	Specific verification body locations that are accredited (if applicable)	• Confirm that the specific verification body locations provided match the locations specified on the certificate or other official documentation	Some verification bodies have multiple offices, including international operations. The scope of the accreditation may not be applicable to all locations.
3	The title of the specific CORSIA accreditation and scope of accreditation	• Confirm that the accreditation listed is specific to CORSIA, including accreditation to ISO 14065:2013 and the CORSIA requirements set out in Annex 16, Volume IV • Confirm the accreditation scope matches the official documentation (e.g. for Emissions Reports and/or Emissions Unit Cancellation Reports)	Verification bodies that do not meet the full set of requirements for either verifying the Emissions Report and/or the Emissions Unit Cancellation Report according to Annex 16, Volume IV cannot be considered CORSIA verification bodies and should therefore not be included in the ICAO list.
4	The date that the verification body received its accreditation, and/or the date its	• Confirm that the date provided matches the official documentation	

	accreditation changed	• Confirm that this date is not in the future	
5	The date when the accreditation expires, or until when the status change is valid	• Confirm that the date provided matches the official documentation • For verification bodies already on the list, confirm that the accreditation has not already expired	
6	The status of the accreditation: pending, conditional, accredited, withdrawn, suspended etc.	• For new verification bodies to be added to the list, confirm that the status is CORSIA accreditation, and that the accreditation is not pending or conditional in any way • Confirm the accreditation status of verification bodies already on the list	NABs globally may use different terms and offer differing types of accreditation status. It is important for the State to understand what each of the different status are.
7	A copy of the accreditation certificate of each accredited verification body: this could include a link to the online certificate, if available	• Use this to confirm the information about each accredited verification body provided by the NAB	
8	Any other documentation that the State needs to understand the accreditation status of each verification body	• Use this to confirm the information about each accredited verification body provided by the NAB	

4.37 What is the information that a State submits to ICAO in relation to accredited verification bodies?

Once the necessary elements are confirmed, the State should compile the complete list of verification bodies accredited in the State at the time of submission to ICAO.
As per Annex 16, Volume IV, Appendix 5, Table A5-3 this compilation must include the following:

- State; and
- Name of verification body.

The State should not include in its list to ICAO those verification bodies that are in the process of accreditation, or are not accredited to CORSIA requirements, as specified in Annex 16, Volume IV. In addition, those verification bodies that have lost their accreditation should be marked as "inactive".

For newly accredited verification bodies, States are also encouraged to submit the following information to ICAO:

- The accreditation certificate (or online web link to the certificate).

The State list of accredited verification bodies that have an "active" status should then be submitted to ICAO through the CCR by the submission deadline.

4.38 Will the lists of aeroplane operators and accredited verification bodies be updated on a regular basis?

States are required to provide ICAO with updates to the lists of aeroplane operators and accredited verification bodies annually by 30 November. A State may also submit updates to this information to ICAO on a more frequent basis. ICAO updates the ICAO documents "CORSIA Aeroplane Operator to State Attributions", and "CORSIA Central Registry (CCR): Information and Data for Transparency" as needed, and once new information has been reported by States.

<table>
<tr><td>4.39</td><td>What information from the CCR will be made publicly available?</td></tr>
<tr><td></td><td>Information and data relating to CORSIA that has been reported by States to ICAO through the CORSIA Central Registry (CCR) will be published on the ICAO website as five ICAO CORSIA documents. All ICAO CORSIA documents will be published following their approval by the ICAO Council.

The ICAO document “CORSIA Central Registry (CCR): Information and Data for the Implementation of CORSIA” is an umbrella document that provides information to support implementation of CORSIA. It includes the following ICAO documents:

“CORSIA Aeroplane Operator to State Attributions”
“CORSIA 2020 Emissions”
“CORSIA Annual Sector’s Growth Factor (SGF)”

The following information will be made available in the ICAO document “CORSIA Central Registry (CCR): Information and Data for Transparency”:

List of verification bodies accredited in each State;
Total average CO_2 emissions for 2019 and 2020 aggregated for all aeroplane operators on each State pair;
Total annual CO_2 emissions aggregated for all aeroplane operators on each State pair, with identification of State pairs subject to offsetting requirements;
For each aeroplane operator:

Aeroplane operator name;
State in which aeroplane operator is attributed;
Reporting year;
Total annual CO_2 emissions;
Total annual CO_2 emissions for State pairs subject to offsetting requirements;
Total annual CO_2 emissions for State pairs not subject to offsetting requirements;

For CORSIA Eligible Fuels claimed:

Production year;
Producer of the fuel;
Type of fuel, feedstock and conversion process used;
Batch number(s);
Total mass of each batch;
State reporting the information;

Information at a State and global aggregate level for a specific compliance period:

Total final offsetting requirements over the compliance period;
Total quantity of emissions units cancelled over the compliance period to reconcile the total final offsetting requirements;
Consolidated identifying information for cancelled emissions units, including:

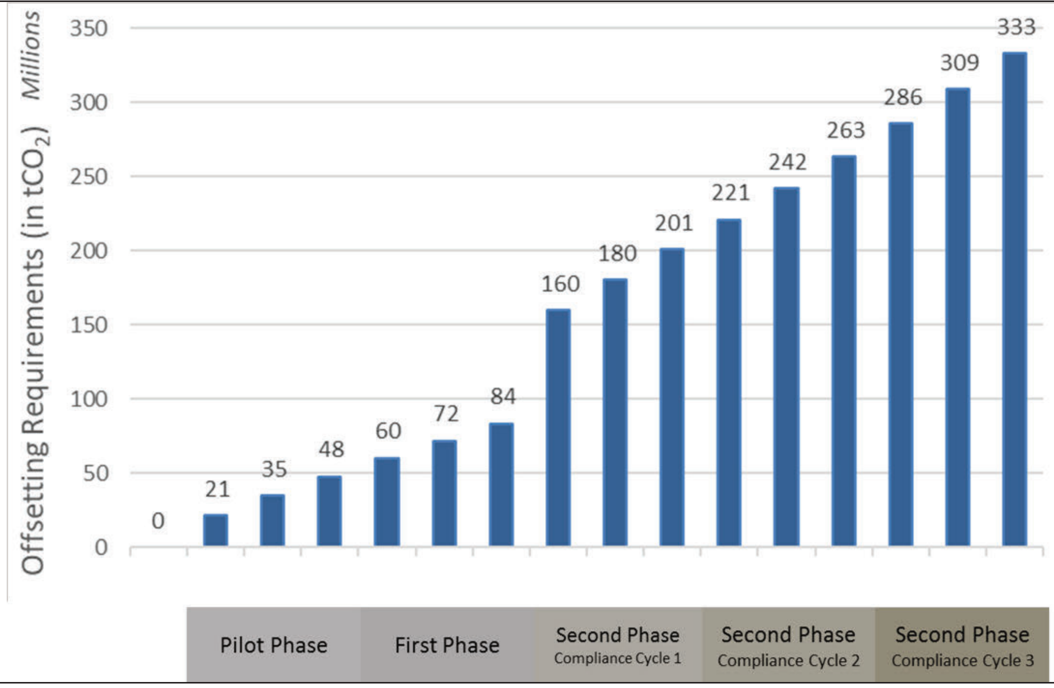
Quantity of emissions units cancelled;
Start and end of serial numbers, and date of cancellation;
Eligible emissions unit program;
Unit type, Host country, Methodology;
Demonstration of unit date eligibility;
Program-designated registry name.

</td></tr>
<tr><td>4.40</td><td>What happens to data flagged as confidential by a State when ICAO receives it?</td></tr>
<tr><td></td><td>Data that are flagged as confidential by States will be treated as such by ICAO. This</td></tr>
</table>

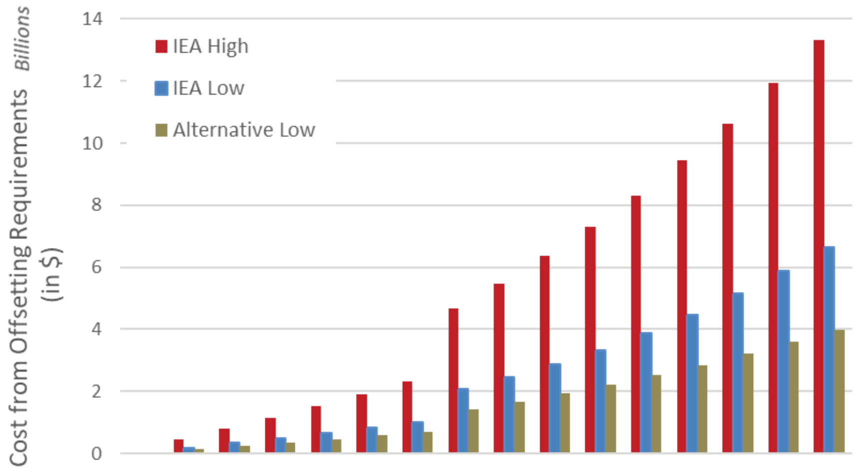
	information will be used for calculations (for example, to determine the Sector's Growth Factor) but will not be published individually in any ICAO CORSIA document (see question 4.39). Instead, all confidential data will be aggregated and published by ICAO without attribution to a specific aeroplane operator or specific State pair.
4.41	How will the reporting of emissions units cancellations from States to ICAO work?

	Similar to the reporting of CO_2 emissions, States will report aggregated information to ICAO through the CCR. This information will include:
	• Aeroplane operators attributed to the State;
	• Compliance period years reported;
	• Total final offsetting requirements;
	• Total quantity of emissions units cancelled; and
	• Consolidated identifying information for cancelled emissions units, including:
	  ○ Quantity of emissions units cancelled;
	  ○ Start and end of serial numbers, and date of cancellation;
	  ○ Eligible emissions unit program;
	  ○ Unit type, host country, methodology;
	  ○ Demonstration of unit date eligibility;
	  ○ Program-designated registry name.
	
	The complete list of information to be reported from aeroplane operators to States, and from States to ICAO is included in Annex 16, Volume IV Appendix 5. Also, see question 4.39 for information that will be made available to the public from the CCR.

5.	**Questions about the cost impact of CORSIA**
5.1	What is the estimated quantity to be offset under the CORSIA?
	Note: The information contained in the answer to this question is based on analyses undertaken by the ICAO Council's Committee on Aviation Environmental Protection (CAEP) prior to the start of the COVID-19 pandemic. Up-to-date information on various impacts of the ongoing COVID-19 pandemic on CORSIA implementation, as well as the remedial measures and decisions being taken by ICAO, can be found on the ICAO CORSIA webpage. Since the 38th ICAO Assembly, CAEP provided a significant amount of technical analyses regarding the impacts of different approaches for a global MBM scheme' design, as requested by the Council. The analyses included quantification of the total quantities of CO_2 emissions from international aviation based on the CAEP CO_2 trends assessment, and estimation of the total quantities of offsets. Based on the CAEP analyses presented to the CAEP/11 meeting in February 2019, the total offsetting requirements resulting from CORSIA are estimated to be approximately 2.5 billion tonnes of CO_2 from 2021 to 2035. The figure below illustrates the estimated total annual offsetting requirements.



5.2	What is the estimated compliance cost for the CORSIA offsetting requirements by aeroplane operators?
	Note: The information contained in the answer to this question is based on analyses undertaken by the ICAO Council's Committee on Aviation Environmental Protection (CAEP) and by the International Air Transport Association (IATA) prior to the start of the COVID-19 pandemic. Up-to-date information on various impacts of the ongoing COVID-19 pandemic on CORSIA implementation, as well as the remedial measures and decisions being taken by ICAO, can be found on the ICAO CORSIA webpage. CAEP also analysed possible costs of CORSIA by multiplying the estimated quantities of offsets with the assumed emissions unit prices. It should be noted that the emissions unit prices drive difference in total cost impacts of offsetting CO_2 emissions from international aviation. Considering carbon prices ranging from the low assumption of 6 to 12 \$/ton CO_2-eq to the high assumption of 20 to 40 \$/ton CO_2-eq, the estimated costs from CORSIA offsetting are presented in the table below.



Carbon Price Assumptions:

IEA High	**20** $/ton	**33** $/ton	**40** $/ton
IEA Low	**8** $/ton	**15** $/ton	**20** $/ton
Alternative Low*	**6** $/ton	**10** $/ton	**12** $/ton

Putting the costs into a business perspective, the analysis also shows that the cost of carbon offsetting for operators could range from approximately 0.4% to 1.4% of total ICAO forecast revenues from international aviation in 2035 (source: A39-WP/153).

According to a cost analysis conducted by IATA, the offsetting costs related to the implementation of a global MBM scheme are expected to have a much lower impact on international aviation than that caused by fuel price volatility. The estimated offsetting cost in 2030 is equivalent to that of a 2.6 US$ rise in jet fuel price per barrel. This means that an extra 10 US$ per barrel on the price of jet fuel would cost the industry about four times the estimated cost of offsets in 2030. To give a reference on magnitude, over the past decade the standard deviation of the jet fuel price annually has been almost 40 US$ per barrel, meaning that airlines have managed to cope with oil price volatility (mostly upwards) of more than 15 times the size of the estimated offsetting cost in 2030.

5.3 What is the estimated administrative cost for the CORSIA implementation by States, aeroplane operators and ICAO?

Note: The information contained in the answer to this question is based on analyses undertaken by the ICAO Council's Committee on Aviation Environmental Protection (CAEP) prior to the start of the COVID-19 pandemic. Up-to-date information on various impacts of the ongoing COVID-19 pandemic on CORSIA implementation, as well as the remedial measures and decisions being taken by ICAO, can be found on the ICAO CORSIA webpage.

According to the CAEP analysis, the vast majority (i.e., 98%) of the total cost resulting from the CORSIA is comprised of costs from offsetting requirements (see question 5.2 for the estimated cost of CORSIA offsetting requirements). These costs represent a small fraction of total operating costs or revenue from international aviation.

According to CAEP's analysis, the cost for the implementation of the MRV system and Registry are borne by aeroplane operators, ICAO Member States and ICAO, and represent approximately 1.4%; 0.5%; and 0.02% of total cost from the CORSIA respectively.

6.	**Questions about capacity building and assistance for CORSIA implementation**
6.1	What is ICAO "ACT-CORSIA"?
	The ICAO **A**ssistance, **C**apacity building and **T**raining programme on CORSIA (ACT-CORSIA) is aimed at supporting Member States to implement CORSIA requirements as per Annex 16, Volume IV. ACT-CORSIA, which was officially launched during the ICAO Seminar on CORSIA (Montréal, Canada, 2-3 July 2018), responds to ICAO Council's endorsement of the Secretariat plan for the CORSIA-related outreach and capacity building activities under ICAO coordinated approach. It is designed to harmonize and bring together all relevant actions, promoting coherence to CORSIA capacity building efforts, and includes a number of activities and products, namely: CORSIA buddy partnerships; model regulations; frequently asked questions (FAQs); brochures and leaflets; videos; seminars and related materials; online tutorials; and other background information. All information on ACT-CORSIA is accessible through the ICAO CORSIA website.
6.2	What are the activities covered under the ICAO ACT-CORSIA?
	ICAO ACT-CORSIA includes a number of activities and products, namely: CORSIA buddy partnerships; example regulatory framework; frequently asked questions (FAQs); brochures and leaflets; videos; seminars and related materials; online tutorials; and other background information.
6.3	What are CORSIA Buddy Partnerships?
	CORSIA Buddy Partnerships are a cornerstone of ICAO's plan to support States to prepare for CORSIA implementation. Under the partnerships, technical experts provided by supporting States are working together with the CORSIA Focal Points of requesting States to provide on-site training on various aspects of CORSIA implementation, in close coordination with the ICAO Secretariat.
6.4	How many CORSIA Buddy Partnerships have been established under the ICAO ACT-CORSIA programme?
	As of December 2020, a total of 16 States are providing support to 115 requesting States under the ACT-CORSIA Buddy Partnerships. The most up-to-date information on established partnerships is available on the ICAO CORSIA webpage.
6.5	What is ICAO's plan for continued capacity building for CORSIA implementation?
	Recognising the need for continuous capacity-building in implementing CORSIA, the ACT-CORSIA Buddy Partnerships have been structured in phases whose contents relate to the successive steps of CORSIA implementation: • The first phase of the ACT-CORSIA Buddy Partnerships (2018) focused on the development and approval of the Emissions Monitoring Plans, as well as on the development of the national/regional regulatory frameworks. • The second phase in 2019 focused on preparatory work for the reporting and verification of CO_2 emissions in CORSIA. • The ongoing third phase (2020-2021) is focused on familiarizing CORSIA Focal Points from recipient States with the CCR, with the purpose of facilitating States' submission to ICAO of their aggregated Emissions Reports for the 2019 CO_2 emissions.

	Future phases of the ACT-CORSIA Buddy Partnerships will focus on elements of CORSIA implementation such as aspects related to CORSIA Eligible Emissions Units and CORSIA Eligible Fuels.
6.6	How can my State contribute to ICAO ACT-CORSIA?
	All ICAO States are encouraged to inform the ICAO Secretariat of their assistance needs, as well as of their offers to support other States. States in a position to do so are encouraged to contribute additional resources through voluntary funding and/or other in-kind contributions to ICAO ACT-CORSIA.
6.7	Which capacity building and assistance activities has ICAO undertaken thus far to support States in CORSIA implementation under the COVID-19 pandemic?
	Mindful of the concerns from States and aeroplane operators in terms of their capacity to meet the 2020 CORSIA reporting requirements and timelines in light of the COVID-19 pandemic, ICAO adjusted the planned CORSIA capacity building activities, including the deployment of additional activities, to allow for a continuous support to States. Thus far, the following activities have been undertaken: • Five online training sessions on the CORSIA Central Registry (CCR) for all ICAO regions, held in April 2020. The sessions, targeted to States' CORSIA Focal Points, provided training on the main CCR functionalities, including on how to report CO_2 emissions. • Launching of an online version (virtual classroom) of the CORSIA Verification Course organized by ICAO's Global Aviation Training Programme (GAT). The online modality, available since 8 May 2020, allows for the continuous provision of training on CORSIA-specific matters to verification bodies. • Online webinar on CORSIA verification activities, held on 14 May 2020. The objective of the webinar was to provide clarification on CORSIA's verification requirements to States' CORSIA Focal Points. • Launching of the third phase of the ICAO ACT-CORSIA programme, involving 16 donor States and 115 recipient States. • In addition, two sets of guidance on remote verification in the context of CORSIA's verification activities have been developed, namely: – Guidance for States on remote verification under the CORSIA MRV system; and – Guidance for verification bodies on remote verification of CORSIA Emissions Reports.

— END —

Air Transport Movements 2019
Comparison with Previous Year (a)

Table 6

	<----------------2019---------------->			<----------------2018---------------->			<---------- Percentage Change ---------->		
	Total	Passenger Aircraft	Cargo Aircraft	Total	Passenger Aircraft	Cargo Aircraft	Total	Passenger Aircraft	Cargo Aircraft
London Area Airports									
GATWICK	282,896	282,848	48	283,186	283,186	-	-	-	..
HEATHROW	479,811	477,083	2,728	480,339	477,367	2,972	-	-	-8
LONDON CITY	80,931	80,931	-	78,037	78,037	-	4	4	..
LUTON	112,745	110,628	2,117	106,666	105,081	1,585	6	5	34
SOUTHEND	19,162	19,162	-	17,088	17,088	-	12	12	..
STANSTED	183,147	172,939	10,208	185,077	175,599	9,478	-1	-2	8
Total London Area Airports	1,158,692	1,143,591	15,101	1,150,393	1,136,358	14,035	1	1	8
Other UK Airports									
ABERDEEN	78,209	76,549	1,660	81,552	79,943	1,609	-4	-4	3
BARRA	1,366	1,365	1	1,390	1,389	1	-2	-2	-
BELFAST CITY (GEORGE BEST)	34,625	34,625	-	35,845	35,845	-	-3	-3	..
BELFAST INTERNATIONAL	47,230	42,984	4,246	46,115	42,747	3,368	2	1	26
BENBECULA	1,974	1,917	57	1,960	1,960	-	1	-2	..
BIGGIN HILL	325	325	-	202	202	-	61	61	..
BIRMINGHAM	102,515	100,288	2,227	104,553	101,829	2,724	-2	-2	-18
BLACKPOOL	4,014	4,014	-	4,724	4,724	-	-15	-15	..
BOURNEMOUTH	4,973	4,973	-	4,096	4,096	-	21	21	..
BRISTOL	62,556	62,556	-	66,147	66,147	-	-5	-5	..
CAMPBELTOWN	1,064	1,063	1	1,069	1,069	-	-	-1	..
CARDIFF WALES	16,688	16,687	1	17,009	17,008	1	-2	-2	-
CITY OF DERRY (EGLINTON)	3,063	3,063	-	2,324	2,324	-	32	32	..
DONCASTER SHEFFIELD	9,520	9,270	250	8,797	8,650	147	8	7	70
DUNDEE	1,212	1,212	-	1,215	1,215	-	-	-	..
EAST MIDLANDS INTERNATIONAL	56,053	32,851	23,202	56,947	34,728	22,219	-2	-5	4
EDINBURGH	127,335	122,219	5,116	125,426	120,395	5,031	2	2	2
EXETER	14,528	14,032	496	13,512	13,020	492	8	8	1
GLASGOW	79,276	78,607	669	85,877	85,191	686	-8	-8	-2
HUMBERSIDE	7,340	7,215	125	7,618	7,481	137	-4	-4	-9
INVERNESS	12,733	12,473	260	12,007	11,896	111	6	5	134
ISLAY	2,021	2,021	-	1,832	1,831	1	10	10	..
ISLES OF SCILLY (ST.MARYS)	10,692	9,782	910	10,587	9,771	816	1	-	12
KIRKWALL	11,256	11,212	44	11,840	11,782	58	-5	-5	-24

	<-----------------2019----------------->			<-----------------2018----------------->			<---------- Percentage Change ---------->		
	Total	Passenger Aircraft	Cargo Aircraft	Total	Passenger Aircraft	Cargo Aircraft	Total	Passenger Aircraft	Cargo Aircraft
Other UK Airports									
LANDS END (ST JUST)	8,310	7,389	921	8,587	7,704	883	-3	-4	4
LEEDS BRADFORD	29,746	29,746	-	31,525	31,525	-	-6	-6	..
LERWICK (TINGWALL)	904	904	-	955	955	-	-5	-5	..
LIVERPOOL (JOHN LENNON)	34,976	34,732	244	35,914	35,886	28	-3	-3	771
LYDD	13	13	-	58	58	-	-78	-78	..
MANCHESTER	195,926	195,230	696	194,131	193,451	680	1	1	2
NEWCASTLE	40,169	39,751	418	42,412	42,083	329	-5	-6	27
NEWQUAY	8,206	8,206	-	7,631	7,631	-	8	8	..
NORWICH	19,729	19,729	-	20,575	20,575	-	-4	-4	..
OXFORD (KIDLINGTON)	-	-	-	3	2	1	..	..	..
PRESTWICK	4,542	3,778	764	4,760	4,085	675	-5	-8	13
SCATSTA	4,820	4,820	-	8,081	8,081	-	-40	-40	..
SOUTHAMPTON	32,529	32,508	21	35,750	35,731	19	-9	-9	11
STORNOWAY	5,858	5,761	97	6,903	6,903	-	-15	-17	..
SUMBURGH	12,600	12,595	5	10,474	10,474	-	20	20	..
TEESSIDE INTERNATIONAL AIRPORT	3,630	3,630	-	3,802	3,799	3	-5	-4	..
TIREE	1,600	1,597	3	1,769	1,762	7	-10	-9	-57
WICK JOHN O GROATS	1,397	1,397	-	1,526	1,526	-	-8	-8	..
Total Other UK Airports	1,095,523	1,053,089	42,434	1,117,500	1,077,474	40,026	-2	-2	6
Total All Reporting UK Airports	2,254,215	2,196,680	57,535	2,267,893	2,213,832	54,061	-1	-1	6
Non UK Reporting Airports									
ALDERNEY	4,702	4,683	19	4,955	4,934	21	-5	-5	-10
GUERNSEY	23,030	21,219	1,811	20,930	19,160	1,770	10	11	2
ISLE OF MAN	13,530	12,997	533	14,097	13,566	531	-4	-4	-
JERSEY	24,972	24,034	938	23,804	22,546	1,258	5	7	-25
Total Non UK Reporting Airports	66,234	62,933	3,301	63,786	60,206	3,580	4	5	-8

Notes

(a) Excludes Air Taxi operations.
(b) Coventry resumed Commercial activity October 2011.
(c) Plymouth Airport closed December 2011
(d) Penzance Heliport closed October 2012

Please note that figures may change overtime as each new version is produced. Information relating to an airport that has ceased to handle regular traffic/closed will be excluded from this table completely. For data concerning historical years it is recommended that you use earlier produced versions of this table.

Department for Transport

Upgrading UK Airspace

Strategic Rationale

Moving Britain Ahead

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Contents

Executive Summary

Introduction

As an island nation, the UK relies greatly on the speed and global reach of air transport to keep us connected and provide the international access that we need for trade, business and tourism.

Aviation in the UK has grown significantly in the last 40 years driven by globalisation, the growth in real incomes and a greater desire from the public to travel abroad. The aviation sector now adds around £20bn a year to the economy and enables tourists arriving to the UK by air to add a further £21bn. Aviation supports 220,000 UK jobs and is a key driver for future economic growth, especially through global trade – an increasingly important area following our decision to leave the European Union.

Airspace is a key component of our aviation sector with most flights in the UK's airspace being commercial air transport – that is aircraft carrying passengers and freight. The Military also uses the airspace to secure our nation's borders and train their forces. In addition, the UK also has a thriving General Aviation sector, including private pilots in light aircraft, gliders, microlights and a wide range of other operators. As such, the airspace has become a key part of our national transport infrastructure and a scarce, but largely invisible resource.

The UK's aviation industry has expanded enormously since the 1950s and 1960s when much of our airspace structure was first designed. Since then airspace has been added to and adapted in response to growing traffic levels, but many departure routes, for example, at our major airports have been little changed for many years, even several decades. This piecemeal approach to the development of our airspace structure has created several issues with today's airspace that limit the ability to add capacity without making some more fundamental changes.

Today's upper airspace is structured around a fixed network of way points that are based on the position of ground navigation beacons and create bottlenecks. The busy terminal airspace that serves multiple airports, often closely located, has become a complex web of intersecting flight paths that requires a wholesale redesign to increase capacity and allow aircraft to climb and descend continuously. Airspace at lower altitudes around individual airports is also constrained by the reliance on ground navigation. Airports' standard arrival and departure routes need to be upgraded using satellite navigation to add capacity and introduce the flexibility to better manage noise impacts.

Summary of analysis

Aviation traffic forecasts from NATS suggest that commercial air transport will grow by around 2% a year in the UK, from 2.25m flights in 2015 to 3.25m flights in 2030. These forecasts do not include the additional flights that might be generated by a third runway at Heathrow Airport that is planned to go live around 2025.

If the airspace structure is not upgraded, passenger delays are forecast to increase sharply as traffic levels increase. Analysis conducted by NATS on behalf of the Department for Transport (DfT) estimates the impact of future traffic growth on delays if additional airspace capacity is not introduced – specifically, how many flights will be delayed on the ground at UK airports each year because of bottlenecks in the airspace.

In 2015, a lack of airspace capacity resulted in 78,000 minutes[1] of flight delays (equivalent to 54 days of total delay and an average of 9 minutes per delayed flight). These delays, whilst not substantial, are however forecast to grow to 1 million minutes by 2020 if airspace upgrades are not delivered as a matter of urgency (equivalent to 694 days and an average of 15 minutes per delayed flight). At this level, approximately 1 in 10 flights from UK airports would be delayed by more than half an hour with delay 13 times more than that experienced in 2015, an increase of 1200%.

Looking forward to 2030, the NATS analysis predicts that air traffic delays will increase to 5.6 million minutes a year (3,889 days or an average of 26.5 minutes per delayed flight), as traffic grows to an expected 3.25 million flights. If delays reach this level, more than 1 in 3 flights from all UK airports are expected to depart over half an hour late and the average delay would be 72 times more than in 2015, an increase of 7100%. These delays will leave passengers spending a great deal more time at the airport that could have been used more productively or enjoyably elsewhere. The most severe disruptions will leave travellers stranded on aircraft which are waiting on the runway or forced to wait for long periods of time in the departure lounges. The delays will also have significant environmental consequences, for example increased emissions as aircraft are required to spend time taxiing or in holding awaiting clearance to proceed. In addition, these delays would reduce the overall level of resilience of the air transport network, the performance of which can be affected by other factors such as the weather and industrial action.

Commercial air transport is based on reliability – providing passengers with the punctual and consistent service they expect and have purchased with their ticket. If demand grows and delays increase because of a lack of airspace capacity, many scheduled flights may be forced to cancel, causing passengers' significant frustration, inconvenience and the cost of wasted journeys.

Over a period of time, high numbers of cancellations are expected to transfer into a permanent reduction in the supply of flights to some destinations because carriers are forced to withdraw some services to the reliability of their operation. Delays are already forcing some airlines to build buffers into their flight schedules limiting the number of round trips that can be completed in a day.

[1] Delays are minutes per flight. These delays are air traffic control-related and do not include delays caused by the weather, airline or airport technical problems, or other forms of disruption such as industrial action.

The NATS analysis forecasts that without additional airspace capacity, cancellations are expected to consistently exceed 8,000 flights per year by 2030. The cumulative effects of several years of rising delays and cancellations is forecast to lead to c16,000 flights that would have been scheduled not being possible, and this figure would continue to grow after 2030. The analysis suggests that these cancellations will reduce the amount of delays, but even taking them into consideration the delay figure could be as high as 4.4 million minutes, 50 times more than in 2015. The anticipated cost of these delays could be a cumulative £1bn (at 2016 values) between 2016 and 2030 with an annual cost of £260million by 2030.

Summary of possible consequences if airspace modernisation does not occur:

- Air traffic delays in 2020, 13 times higher than those in 2015;
- Air traffic delays in 2030, 50 times higher than those in 2015;
- A lost opportunity to fly an additional 25,000 flights between 2015 and 2030 with at least 8,000 short notice cancellations a year by 2030;
- 1 in 3 flights delayed by more than half an hour by 2030 which would be a significant disruption to passengers, airports and the airline industry;
- Total cumulative cost of delay and cancellation from 2016 to 2030 could be c£1bn in 2016 values;
- Cost of delay and cancellation could be running at c£260million a year by 2030; and
- Delays and cancellations would get progressively worse after 2030 as demand for aviation grows.

The UK's plan to modernise airspace

The investment required to upgrade the UK's airspace structure, introduce additional capacity and avoid these delays, cancellations and lost supply is almost entirely funded by the aviation industry. A range of organisations from across the aviation industry are working together on a joint programme to tackle the issues with today's airspace. The programme is known as the Future Airspace Strategy (FAS) Deployment Plan and aims to:

- Save passengers time and avoid delays and cancellations growing into lost supply;
- Cut aviation emissions per flight and save fuel;
- Reduce the noise impacts from aircraft overflying population centres; and
- Further enhance aviation safety.

For passengers**,** the benefits of the FAS Plan are clear. Fewer flight delays and service disruptions at short-notice are expected to save time and improve the passenger experience. Also the capacity to add routes and accommodate new flights will lead to better value, more choice and enhanced global connections that can help drive the UK economy forward.

To achieve this the FAS Plan sets out a range of upgrades to the airspace structure and air traffic control systems that increase capacity and allow aircraft to climb, cruise and descend more efficiently; including:

- Removing the fixed structures in the en-route upper airspace;
- Completely redesigning the busy terminal airspace;
- Deploying Queue Management tools to reduce congestion;
- Introducing more precise and flexible satellite-based arrival and departure routes; and
- Sharing accurate airspace information between airports and air traffic controllers.

Several of the FAS Plan projects are scheduled for deployment before 2019 and are expected to significantly increase the airspace capacity in response to growing traffic levels. Some projects extend out to 2024 and will need to align closely with the introduction of a new runway in the south east that is expected to be entering its final stages of development in a similar timeframe.

Some parts of the FAS Plan have already been implemented successfully. For example, a new route structure based on satellite navigation was implemented in the airspace that serves London City and Stansted airports in 2015. The upgrade adds airspace capacity and will minimise future delays. Birmingham, Bristol, Gatwick and Luton airports have also recently implemented satellite-based routes.

There will be environmental impacts associated with the airspace upgrades that are deployed to accommodate growing traffic levels, but important environmental improvements are also expected as aircraft can follow more fuel-efficient routes, climb sooner, descend quieter and navigate more accurately around populated areas.

One of the most significant environmental impacts associated with aviation is the effects of aircraft noise. Overall the airspace upgrades set out in the FAS Plan are expected to see a reduction in the average noise levels per flight, but the redistribution of noise impacts between different areas will often lead to some disruption for communities living under flight paths. The effects of new, more frequent or concentrated noise may increase the risks of causing general annoyance, sleep disturbance, lower levels of productivity and health impacts.

Aviation noise performance has improved significantly in recent decades driven by the introduction of quieter aircraft. However, some residents experience significantly more noise events due to traffic growth. The Government’s policy on aviation noise is to limit and, where possible, reduce the number of people significantly affected by aircraft noise. This policy was established in an era of less accurate navigation. The introduction of satellite navigation routes can bring more intense levels of aircraft concentration and therefore noise.

But satellite-based routes also offer the opportunity to deploy innovative new operational techniques that can improve the management of aircraft noise, for example by introducing multiple flight paths for noise relief. The Government believes that these techniques should be considered wherever feasible, taking into account local circumstances and preferences in determining whether and which options should be explored.

Some of the techniques involve trade-offs with other airspace objectives such as increasing airspace capacity and saving emissions and fuel burn, which will need to be factored into the decision-making process that is guided by the Government's Airspace Policy and the CAA's Airspace Change Process.

Updates to Airspace Policy and Change Process will be issued in the course of this year following consultations. These consultations will gather the views of aviation stakeholders and the Public and help to ensure that both the policy and process are fit for purpose to support the implementation of the FAS Plan and to manage the costs and benefits of upgrading our airspace in a balanced and sustainable way.

1. Introduction

Purpose and structure of the report

1.1 This report describes the strategic national importance of an industry led investment programme to upgrade the UK's airspace structure. The report was produced by the DfT with the support of the CAA, the UK's specialist aviation regulator, and technical input from NATS, the UK's main provider of air traffic control services. The purpose of the report is to describe in general terms why the UK's airspace is being upgraded and how, and also give an indication of what might happen if the modernisation does not happen. It is aimed at those who have an interest in aviation, including those communities which may be impacted by the industry.

1.2 An efficient and effective airspace structure is important to all who fly; whether for developing business opportunities that benefit the UK or for leisure time with family and friends. Both activities are time sensitive and passengers need confidence that they will get to their destination at the time they expect.

1.3 The UK's airspace structure includes the routes that aircraft fly and the procedures and systems used by air traffic controllers to manage traffic flows. Aviation relies on an efficient and effective airspace structure to fully utilise the capabilities of modern aircraft. The aviation industry has started a major investment programme to upgrade the UK's airspace structure because it is outdated, inefficient, and reaching its capacity. The Government believes that airspace upgrades are essential to provide the aviation capacity our country needs to better meet present and future demands.

1.4 Like other modes of transport, aviation is looking at ways to keep pace with growing traffic levels and to adopt new technologies that benefit passengers and improve environmental performance. If the airspace structure is not upgraded, the lack of capacity is expected to lead to a sharp increase in air traffic delays, which create real costs and disruption for passengers and businesses. In addition, today's quieter and cleaner modern aircraft will continue to use flightpaths that can be inefficient, lower than they need to be, and not optimised to reduce their noise impact or offer relief to communities.

1.5 This report is presented in three parts:

The Introduction provides an overview of the UK aviation sector and airspace structure and describes the background to the FAS.

Part A outlines the main issues with today's airspace structure and examines how passenger delays and flight cancellations may increase sharply between now and 2030 if the industry does not introduce additional airspace capacity. Part A also considers the relationship between airspace upgrades and aviation noise.

Part B describes the main features of the industry led FAS Plan that is intended to tackle the issues with today's UK airspace. The second part of the report also considers the treatment of negative impacts that may arise from the airspace upgrades, especially those affecting local communities that may experience changes to where aircraft are usually seen and heard.

Overview of the UK aviation sector

1.6 Our daily lives are shaped by the speed and global reach of aviation. As an island nation, the UK relies greatly on air transport. From large cities to small communities, aviation keeps us connected with one another and provides the international access that we need for trade, business and tourism purposes. In 2014, the aviation sector directly contributed around £20bn to the UK economy and supported 220,000 British jobs.[2] Spending by tourists that flew to the UK generated £21bn gross value added.[3]

1.7 It is therefore noteworthy that the aviation industry's success has been built on an airspace structure which was established over 40 years ago. Since then, the demand for aviation has increased significantly, driven by globalisation, the growth in real incomes and a greater desire from the public to travel abroad. The aviation industry has expanded accordingly, offering flights to a growing list of destinations across the globe and much greater choice for passengers. This growth has also been further enabled by the emergence of low cost airlines that have dramatically expanded the short haul European aviation market.

1.8 In June 2016, the UK voted to leave the European Union. Although the impact of leaving the EU on the aviation industry is uncertain, the decision focusses attention on the infrastructure required to support trade with the wider global economy. Airspace upgrades that create the capacity to increase the range and frequency of global connections are an important enabler for future GDP growth as passenger numbers continue to increase and the UK re-defines the terms of our relationship with the EU.

1.9 Chart 1 sets out the growth in terminal passenger numbers, i.e. those arriving and departing, at UK airports from 1995 to 2015.[4] Passenger numbers hit a record high in 2015, passing the previous peak immediately prior to the 2008 recession.

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[2] Office of National Statistics, National Accounts, 2014.
[3] Office of National Statistics, International Passenger Survey, 2015.
[4] CAA Aviation Data, 2015 (http://www.caa.co.uk/data-and-analysis/)

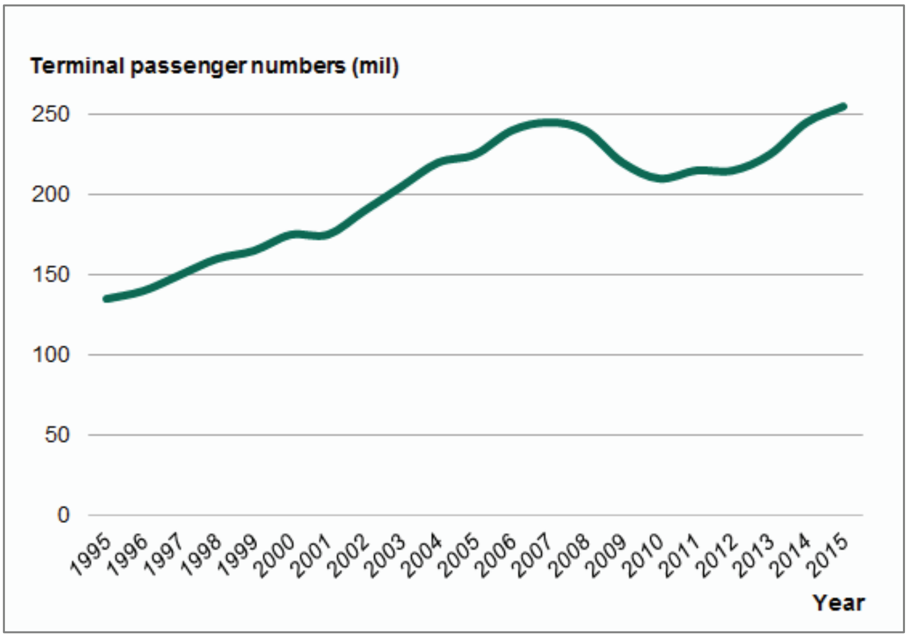

Chart 1: Growth in terminal passenger numbers at UK airports, 1995 – 2015

1.10 Growth in terminal passenger numbers will result in growth in the number of flights through UK airspace although this may not be at the same rate as airlines will absorb the passenger growth in any available seat capacity they have before adding additional flights.

1.11 Flights in UK airspace can be categorised into three types: Commercial Air Transport carrying fare paying passengers and cargo, General Aviation (GA) and Military. There were 2.1m commercial air transport flights in 2015, travelling to and from 49 licensed UK airports.[5] Of these:

- 50% were passenger flights to and from London airports;
- 47% were passenger flights to and from regional airports outside the London area; and
- 3% were air freighters carrying cargo (freight is also carried by passenger flights).

[5] CAA Aviation Data, 2015 (http://www.caa.co.uk/data-and-analysis/)

1.12 Chart 2 sets out the growth in commercial flights at UK airports from 1995 to 2015.[6]

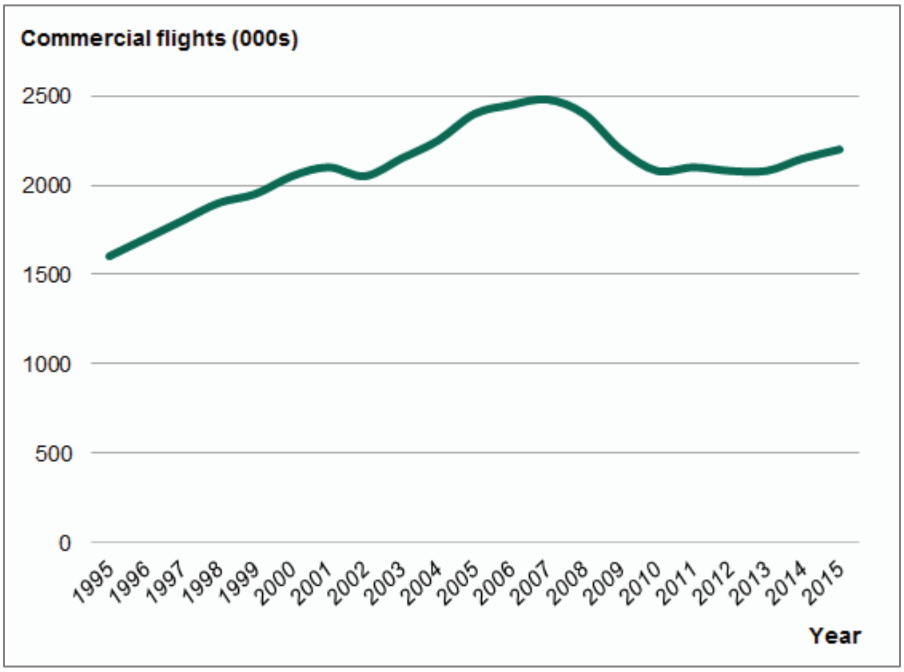

Chart 2: Growth in commercial flights at UK airports from 1995 to 2015

1.13 Despite record airport terminal passenger numbers in 2015, the number of commercial flights has not increased in proportion. This is partly because more passengers have been accommodated on a per flight basis in recent years, due to the use of larger aircraft. For example, Gatwick Airport managed 42m annual passengers in the 12 months to August 2016, a 6.4% increase on the previous year, while annual flights for the same period only increased by 4.5%.[7]

1.14 Air freight is an important part of the commercial aviation sector for consumers and businesses that rely on imports or exports. £101bn of goods travelled via Heathrow in 2014, more than the UK's two biggest shipping ports – Felixstowe and Southampton – combined. 2015 saw 2.5m tonnes of cargo pass through UK airports[8] with Heathrow airport handling around 1.5m tonnes. East Midlands, Stansted, Manchester, Edinburgh and Belfast International airports also handle significant amounts of cargo.

1.15 The UK also has a thriving GA sector that includes traditional fixed wing light aircraft, rotorcraft and gliders, business jets, flight training and surveyors, air sports, balloonists and microlights. This sector requires access to a significant amount of airspace in order for the diverse range of its activities to operate.

1.16 The Military relies on access to the airspace to secure our nation's borders and requires dedicated areas to be reserved for hazardous activities like training fast jet pilots and testing munitions. The military's specific requirements for airspace also change over time.

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[6] CAA Aviation Data, 2015 (www.caa.co.uk/data-and-analysis)
[7] Gatwick Airport Limited, 2016 (http://www.gatwickairport.com)
[8] CAA Airport Data, 2015 (www.caa.co.uk/data-and-analysis)

UK airspace is under pressure

1.17 The UK's airspace structure is an essential, but largely invisible, part of our national transport infrastructure, and it is also some of the most complex in the world. However, our airspace is already struggling to keep pace with the growing demand for aviation. More and more traffic is being squeezed into the same congested areas of airspace, causing inefficient flight paths, passenger delays and poor resilience to disruption, such as that which can occur from bad weather or technical difficulties. The skies over the UK will continue to get busier as the aviation industry expands and incorporates new types of operation like unmanned aircraft and space tourism.

1.18 Forecasts from NATS that are based on the long-term relationship between economic growth and the demand for aviation suggest that commercial air transport flights will increase by around 2% a year from 2.25m in 2015 to 3.25m in 2030. These forecasts incorporate the impact of existing capacity constraints and do not include the expected additional growth associated with proposals to build a third runway at Heathrow Airport.[9]

1.19 Much of the debate about the need for additional capacity has been focussed on airports and runways, especially the proposals for a new runway in the south east of England. In October 2016, the Government announced support for a new runway at Heathrow in the next decade which could add up to 260,000 additional flights a year into what is already highly-congested airspace.[10] However, upgrades to the airspace structure are essential, with or without new runways, as many other UK airports are planning to expand to fill their existing spare capacity in the coming years.

The Future Airspace Strategy

1.20 Aviation in the UK is largely privately owned and managed. The Government believes that a competitive aviation market is the most effective way to meet the interests of passengers and other users. The investment required to upgrade our airspace is almost entirely funded by the aviation industry, unlike other parts of the national transport infrastructure, where there is significant Government funding.

1.21 A wide range of organisations from across the aviation industry are working together on the investment programme to upgrade the airspace. The programme is known as the FAS Deployment Plan and is supported by airports, aircraft operators, air traffic control organisations, the Military and the Regulator (the CAA).[11]

[9] NATS forecasts, 2016.
[10] http://www.heathrow.com/
[11] http://www.caa.co.uk/Commercial-Industry/Airspace/Future-airspace-strategy/Future-airspace-strategy/

1.22 The FAS Plan looks to coordinate the industry's investment in a set of upgrades to the way the UK's airspace is structured, the routes that aircraft fly, and the systems used by air traffic controllers to manage traffic flows. The Plan reaches out to 2030 and aims to:

- Save passenger time and avoid delays through the introduction of extra airspace capacity when and where it is needed;
- Cut aviation emissions per flight and save fuel through more direct routings and improved flight efficiencies;
- Reduce noise from fewer aircraft overflying population centres and holding at lower altitudes; and
- Further enhance aviation safety by reducing airspace complexity and introducing new technologies that help to manage the residual risks.

1.23 The FAS Plan has many components, but is based around five key upgrades, to:

- Remove the fixed structures in the en-route airspace, adding capacity and enabling more direct and free routes;
- Completely redesign the route network in busy terminal airspace to take account of advances in new technology, especially satellite navigation;
- Stream traffic through speed controls in the en-route phase of flight to improve arrival management and reduce the reliance on stack holding in the terminal airspace;
- Redesign airport arrival and departure routes at lower altitudes to allow flights to climb and descend continuously, and better manage the impacts of aircraft noise; and
- Connect airports into the network to provide and receive accurate information about traffic flows which will better manage ground delays and pinch points across the airspace.

1.24 The scope, timing and expected benefits of the FAS Plan airspace upgrades are described in more detail in Part B. Chart 4 illustrates how the upgrades aim to improve the performance of the airspace across each phase of flight.

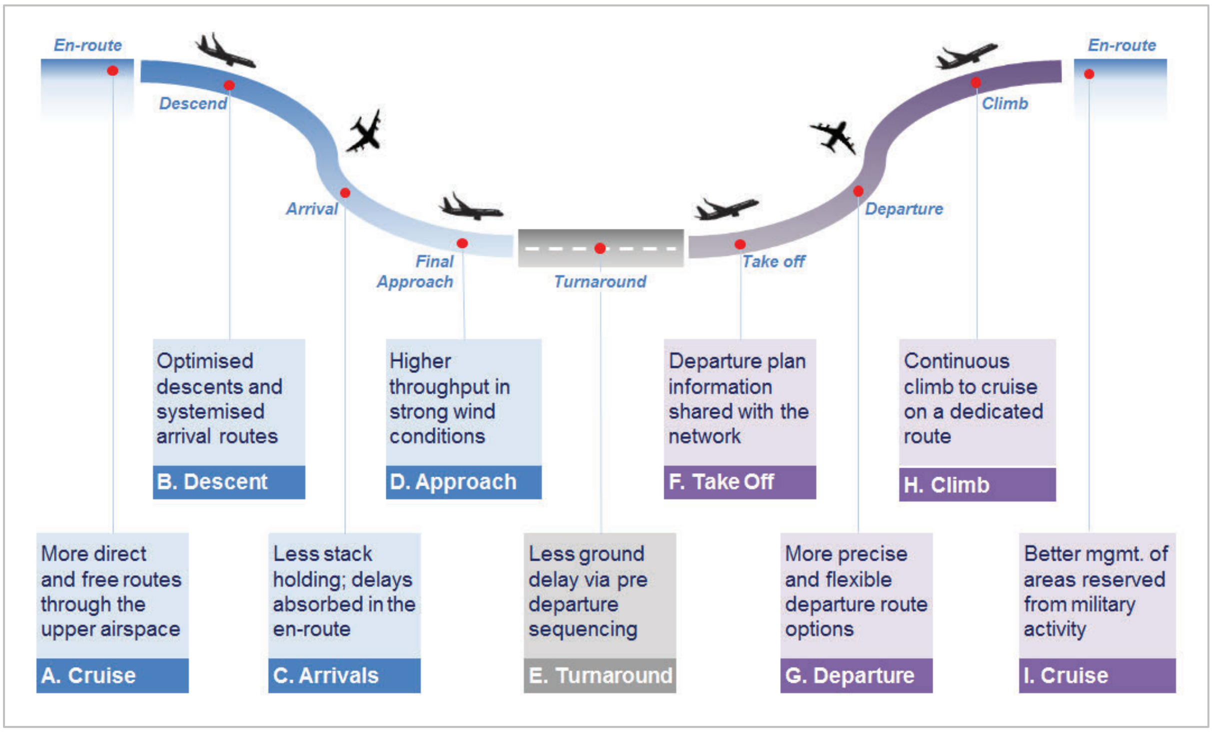

Chart 4: FAS Plan airspace upgrades by phase of flight

Benefits and costs of airspace upgrades

1.25 Airspace upgrades can bring large benefits, especially for passengers and business, but are rarely delivered without some external costs.

- **For passengers,** the benefits of the FAS Plan are clear. Fewer flight delays and service disruptions at short-notice are expected to save time and improve the passenger experience. A more efficient airspace will increase capacity allowing connections to more destinations.

- **For aircraft operators**, the airspace structure is a key determinant of costs, punctuality and environmental performance. More direct and efficient flight paths will mean lower costs for operators because they will save on fuel and be able to enhance the utilisation of their aircraft.

- **For airports,** the sharing of digital information about the inbound and outbound traffic flows using our airspace is expected to improve runway throughput and resilience.

- **For the economy and consumers,** the capacity to add routes and accommodate new flights will lead to better value, more choice and enhanced global connections that can help drive the UK economy forward.

1.26 Although there will be environmental impacts associated with the forecast growth in traffic levels, important environmental improvements are also expected from the airspace upgrades as aircraft can follow more fuel-efficient routes, climb sooner, descend quieter and navigate more accurately around populated centres.

1.27 One of the most significant environmental impacts associated with the airspace upgrades at lower altitudes concerns the effects of aircraft noise. Overall the airspace upgrades are expected to see a reduction in the average noise levels per flight, but the redistribution of noise impacts between different areas will often lead to some disruption for communities living under flight paths. The effects of new, more frequent or concentrated noise may increase the risks of causing general annoyance, sleep disturbance, lower levels of productivity and health impacts.

1.28 The Government has recognised the importance of these issues and is at present looking to update its airspace and noise policies. A key objective of this work is how to balance the benefits of aviation with its local impacts. Within this framework, the aviation industry is being asked to consider ways to better manage the noise impact of their operations. Some of the methods under consideration are described in Part B of this report.

1.29 As the UK's specialist aviation regulator, the CAA is a key stakeholder in the FAS Plan. The CAA sets the initial direction for the FAS. The strategy has now moved into its deployment phase, but the Regulator still plays an important role, producing the processes, standards and guidance needed to ensure that airspace upgrades are deployed safely and in a joined-up manner.

1.30 The Government has directed the CAA to ensure that there is an appropriate balance between environmental and operational factors in any proposed changes to the airspace structure.[12] The environmental impact of proposed changes should be considered at the earliest possible stage. The CAA must also ensure that any airspace change proposals which may have a significant impact on the distribution of aircraft noise near an airport are the subject of an effective consultation exercise with all those concerned.

1.31 The regulatory guidance to industry on how airspace change proposals should be developed and consulted on is currently being strengthened by the CAA to ensure that the options, impacts and decisions associated with each proposal are made transparent and that local communities are sufficiently engaged.

International Developments

1.32 The FAS Plan is closely linked to a wider multi-State programme, known as Single European Sky (SES). The SES initiative was launched by the European Commission in 1999 and now provides the overarching framework to upgrade the airspace and air transport network across Europe. The SES ATM Research (SESAR) Programme is a major public-private initiative to develop new technologies that will improve the way Europe's airspace is managed as part of the broader SES initiative. Many UK organisations have been involved in testing and validating the new technologies.

1.33 Like the FAS Plan the SESAR Programme has now moved into its deployment phase and the European Commission has made over €2.5bn available to support implementation projects. For example, work carried out in a SESAR work package (in which NATS was involved) helped to develop the concept of Time-Based Separation (TBS), whereby aircraft, can be separated by time instead of distance when arriving at an airport. This significantly improves resilience in strong headwind conditions.

[12] Sections 70(2) and 70(3) of the Transport Act 2000 and in other directions and guidance which it has issued to the CAA.

1.34 NATS has built on that initial R&D and, in partnership with Lockheed Martin, developed a TBS solution which has been deployed at Heathrow, helping to maintain landing rates in strong headwind conditions. TBS at Heathrow is expected to save 80,000 minutes of delay per year.[13]

1.35 Globally, airspace structures have seen significant levels of investment in recent years, mainly driven by airport expansions in the Middle East, Far East and China. In North America, a programme known as NextGen is delivering new technologies and airspace changes to tackle similar aviation capacity and efficiency challenges. The International Civil Aviation Organisation (ICAO) is harmonising global developments through a programme of Aviation System Block Upgrades (ASBUs).[14] As a result, the UK aviation industry is increasing its spending on airspace to keep pace with international developments and maintain our country's air links and status as a global hub for aviation.

[13] Calculated by assessing the numbers of flights impacted multiplied by the time delay per flight. Source: NATS, 2015.
[14] http://www.icao.int/Meetings/anconf12/Pages/Aviation-System-Block-Upgrades.aspx

Progress to date

1.36 Some parts of the FAS Plan have already been implemented successfully. Chart 5 summarises some of the main airspace upgrades delivered between 2014 and 2016.

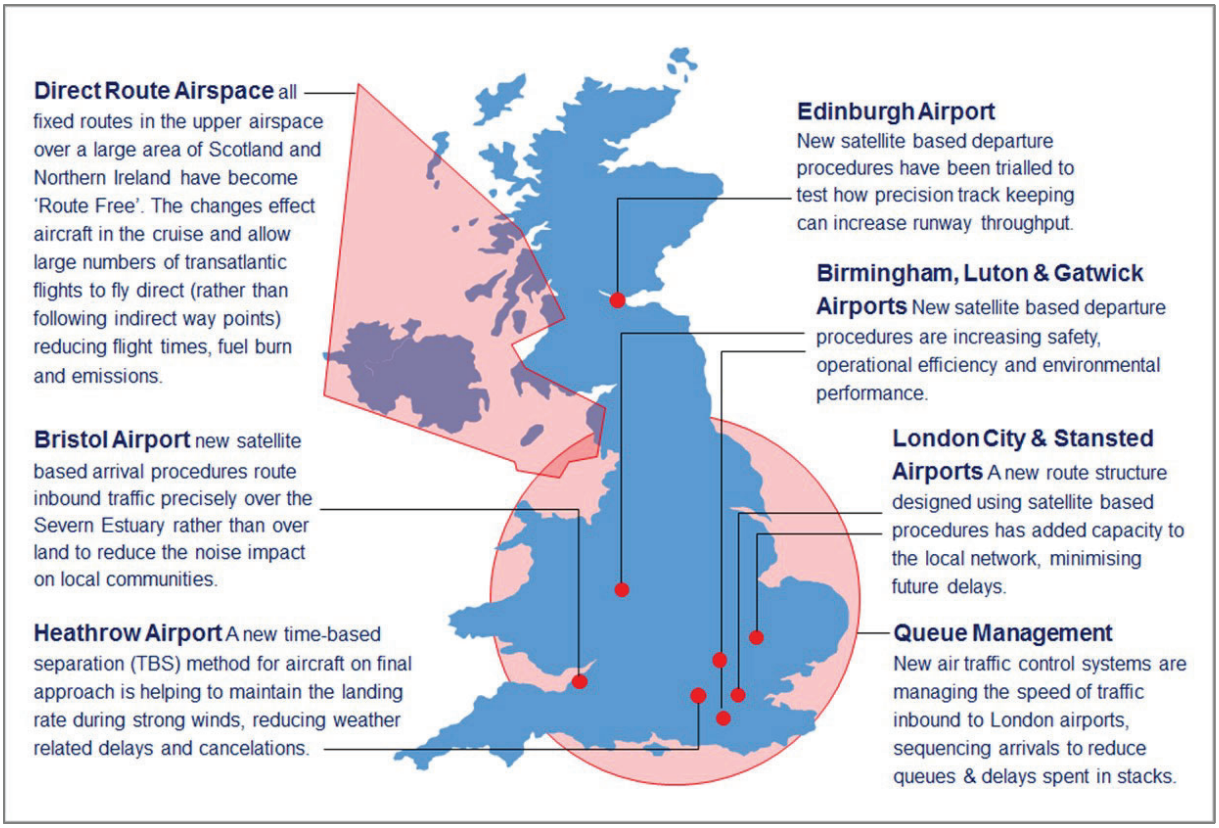

Chart 5: Summary of airspace upgrades delivered between 2014 and 2016.

PART A

The first part of this report outlines the main issues with today's airspace structure and examines how passenger delays and flight cancellations may increase sharply in the next decade or so if the industry does not introduce additional airspace capacity. Part A also considers the relationship between airspace upgrades and aviation noise.

2. Today's airspace

Overview of today's airspace

2.1 The UK's airspace can be divided into two main categories – controlled and uncontrolled. Controlled airspace is created where it is necessary for air traffic control to proactively manage the traffic flying in that airspace. Aircraft flying in controlled airspace do so under the direction of air traffic controllers, and pilots are required to file a flight plan for each journey, providing details such as destination, route, timing and altitude.

2.2 **Controlled airspace** is highly structured and contains a sophisticated framework of features that are mandatory for aircraft operators and air traffic controllers. These features prescribe the capability of aircraft that may operate in an area of airspace, the navigational systems they must use, the location of airways and holding points and the default routes that should be taken between them. The vast majority of commercial flights operate in Controlled Airspace.

2.3 Controlled airspace is subdivided into a variety of areas and zones, including some segregated areas where there are restrictions on flying activities, for example military danger areas used for flight training and testing munitions.

2.4 The guiding principle of air traffic control is that safety is paramount. Controllers keep aircraft safely separated by set distances; for example, aircraft flying in controlled airspace under radar surveillance are normally kept three to five nautical miles apart horizontally or 1,000ft vertically.

2.5 **Uncontrolled airspace** typically incorporates all areas at lower altitudes where there is no operational safety reason for aircraft to be identified and managed by air traffic control (although air traffic controllers sometimes provide an advisory service). Uncontrolled airspace has set boundaries, but in contrast to controlled airspace, is governed only by general rules and principles of operation. The main method of aircraft separation is through pilots visually identifying other aircraft. The GA community operates largely in uncontrolled airspace alongside the Military and a small number of commercial flights.

2.6 Air traffic control is managed by Air Navigation Service Providers (ANSPs). NATS is the UK's main provider, handling all air traffic control in the en-route airspace and the busy terminal airspace over London, Northern England and Scotland. The provision of air navigation services at airports is open to competition in the UK. Some airports choose to manage it themselves, and some let a contract to NATS or another ANSP. In addition, some services in the UK are provided by the Ministry of Defence (MoD). Military controllers work closely with their civilian colleagues to provide a joint and integrated service to all users including those outside controlled airspace.

2.7 The CAA has a general policy of keeping the volume of controlled airspace to the minimum necessary for the effective protection of the air transport network. The creation of additional controlled airspace to maintain safety or to increase the capacity of the air transport network can impinge on the availability of uncontrolled airspace for other users. An appropriate balance is needed therefore that satisfies the economic, security and social requirements of the various types of operation as much as possible.

Issues with today's airspace

2.8 Over the past few decades, the airspace has been added to and adapted in response to growing demand. This piecemeal approach has created inefficiencies that limit the ability to add capacity without making some more fundamental changes. The issues with today's airspace can be grouped into four key areas:

- **The en-route airspace** above around 25,000ft.
- **The busy terminal airspace** from around 25,000ft to 7,000ft that links individual airports with the en-route airspace;
- **The airspace at low altitudes around airports** where dedicated arrival and departure routes link the terminal airspace with runway ends; and
- **The arrangements for managing traffic flows** across the airspace.

2.9 These areas and the related issues are described in the sections below.

Issues in the en-route airspace

2.10 En-route airspace is typically considered to be the airspace above 25,000ft where aircraft are in the cruise phase of flight. Aircraft often fly further than necessary in en-route airspace on flight paths that are determined by the available sequence of way points, rather than the shortest, most direct route to their destination. A range of factors determine the sequence of way points that aircraft plan to follow, including weather conditions (most notably the position of high level winds to be exploited or avoided) and the location of segregated areas reserved for military activity.

2.11 The capacity of en-route airspace is determined by the ability of air traffic controllers to safely manage the flow of traffic through each sector. Traffic flow restrictions are applied to sectors when the volume of traffic exceeds a level that the controllers can manage safely. The restrictions create bottlenecks which cause aircraft to be delayed on the ground pre-departure because of a lack of airspace capacity. Flights that are already airborne when flow restrictions are applied are often directed to fly longer routes at less efficient altitudes and speeds to avoid the bottlenecks.

2.12 The FAS Plan, described in Part B, aims to replace the fixed structure of en-route sectors and way points with Free Route Airspace that removes the bottlenecks and allows aircraft to fly the quickest, most fuel-efficient flight paths.

2.13 Chart 6 uses *Google Maps* to illustrate the main features of the UK's airspace structure, along with the position of airports and the location of segregated areas (in red).

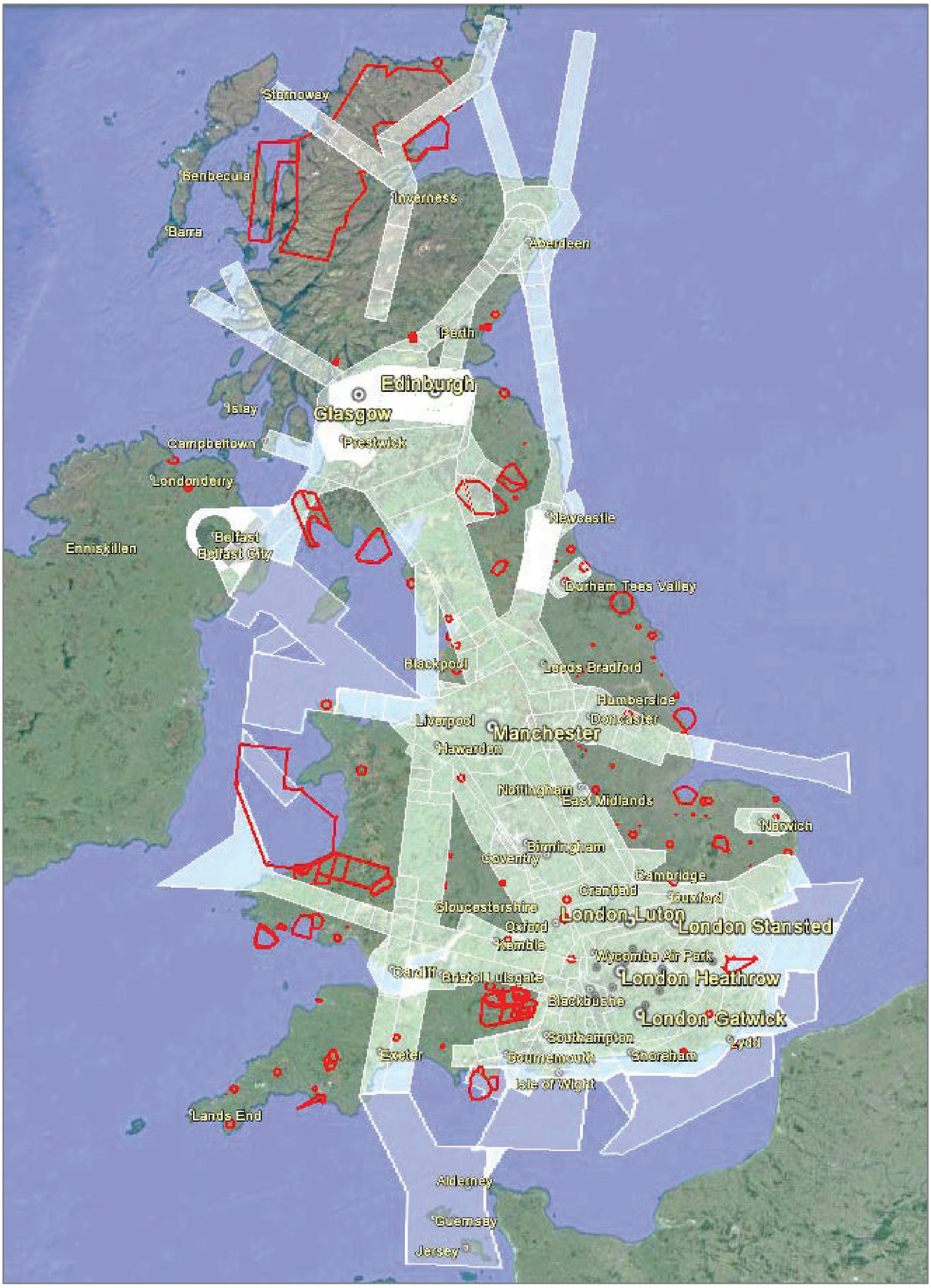

Chart 6: Main features of the UK's airspace

Issues in the terminal airspace

2.14 The terminal airspace from around 25,000ft to 7,000ft is designed to manage high volumes of traffic climbing and descending between individual airports and the en-route. The result is a complex web of intersecting flight paths to and from airports that are in close proximity. For example, Manchester, Liverpool, Leeds Bradford, Birmingham and East Midlands airports collectively manage over 370,000 flights a year[15] and operate in a radius of less than 100 miles. The five largest London airports manage over 1 million flights a year across an area with a radius of less than 60 miles. Chart 7 illustrates the main flows of traffic inbound and outbound to the five London airports on a typical day.

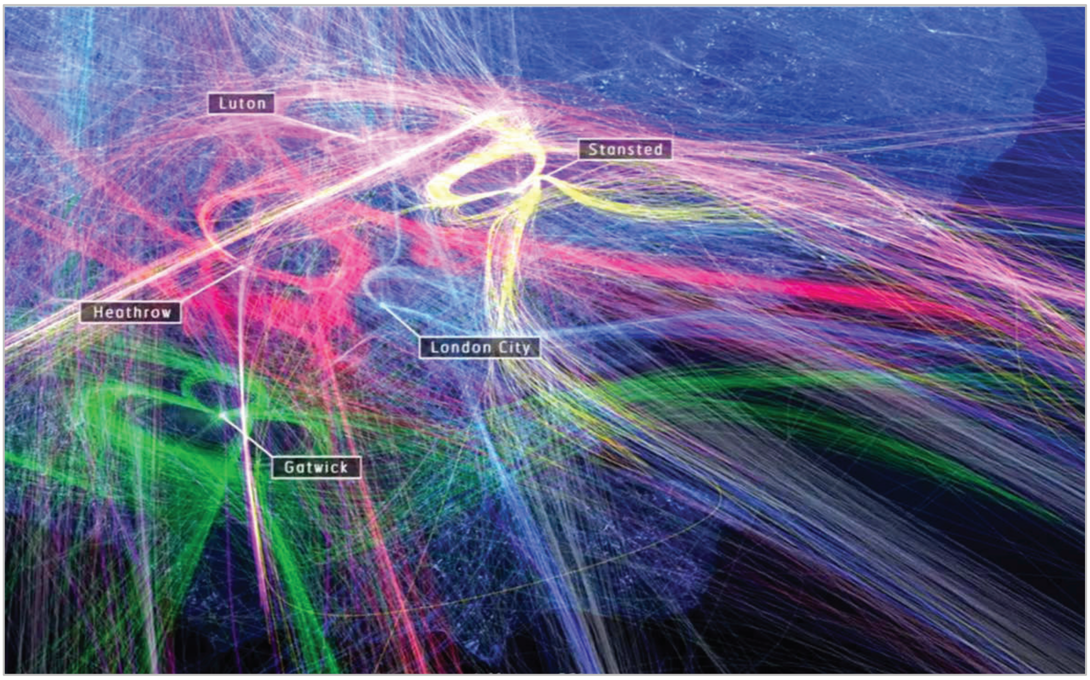

Chart 7: Traffic flows to the five London airports on a typical day

2.15 Chart 7 illustrates the volume and complexity of the interactions between traffic flows in the London terminal airspace. Ideally, departures would climb quickly and continuously through the terminal airspace, and arrivals would descend continuously to the runway with little direction from air traffic controllers. However, in practice, controllers intervene regularly to manage the interactions between departing and arriving traffic, making sure aircraft stay safely separated. Continuous climbs and descends are interrupted by the need for aircraft to return to level flight to avoid crossing traffic. The introduction of these 'steps' of level flight increases aircraft fuel burn, emissions and in some cases noise. The high workload placed on controllers to manage crossing traffic limits the capacity of the terminal airspace, causing delays in a similar way to the en-route bottlenecks.

2.16 Arrival traffic in the terminal airspace is routinely directed into airborne holding stacks, where aircraft fly in a circuit pattern waiting for clearance to land. Airborne holding is used to absorb delays and ensure a steady stream of traffic is presented for landing, maximising airport runway capacity. However, the use of holding stacks creates a 'blockage' in the terminal airspace structure. Departures are kept at lower altitudes to avoid the stacks and in doing so fly longer and potentially noisier routes.

[15] 2015 Air Transport Movements, CAA Airport Data, 2015 https://www.caa.co.uk/Data-and-analysis/

2.17 Departing traffic is managed in different ways, some airports must coordinate their departures with the air traffic control centre this can take time and in periods of high workload this will result in delays for those flights.

2.18 The complexity of the terminal airspace and the lack of spare capacity has weakened its resilience to bad weather and disruption (e.g. technical problems or strike action). Unplanned events often lead to significant delays. Normal service is typically resumed on the next day of operation when airports, air traffic controllers and aircraft operators have used the less busy, but more noise sensitive night period to reset their operations.

2.19 The FAS Plan aims to systemise the terminal airspace, introducing a greater number of dedicated routes to and from individual airports and significantly reducing the number of traffic interactions that controllers need to manage. The FAS Plan also proposes to replace airborne holding stacks with better queue management techniques that absorb delays by slowing aircraft down while they cruise, freeing up the terminal airspace capacity and enabling aircraft to climb more quickly.

Issues in the airspace at low altitudes around airports

2.20 The airspace at lower altitudes around airports – from around 7,000ft to the ground – is reserved for dedicated arrival and departure routes that link the terminal airspace with the end of the runway. The impact of aircraft noise on those living under flight paths is the most important factor, other than safety and feasibility, under consideration when designing arrival and departure routes at lower altitudes.

2.21 Most airport arrival and departure routes in the UK are designed around the position of ground navigation beacons. Although well-known and highly structured, the fixed locations of these beacons often create inflexible and inefficient flight paths. The limited number of beacons mean many flights from different airports often plan to converge on the same pinch points, limiting the flow of traffic, see Chart 8.

2.22 Air traffic controllers intervene tactically to take aircraft off their planned flight paths and avoid pinch points. This is done via a process known as 'vectoring' where controllers instruct pilots to fly a specific compass bearing rather than routeing directly to the beacon. Through vectoring, air traffic controllers are in effect, making up their own endless and variable supply of flight paths to allow multiple aircraft to share the same planned routes and create the airspace capacity needed to meet traffic demand. Chart 8 illustrates the how tactical vectoring is used to add capacity to the airspace and relieve pinch points at low altitudes.

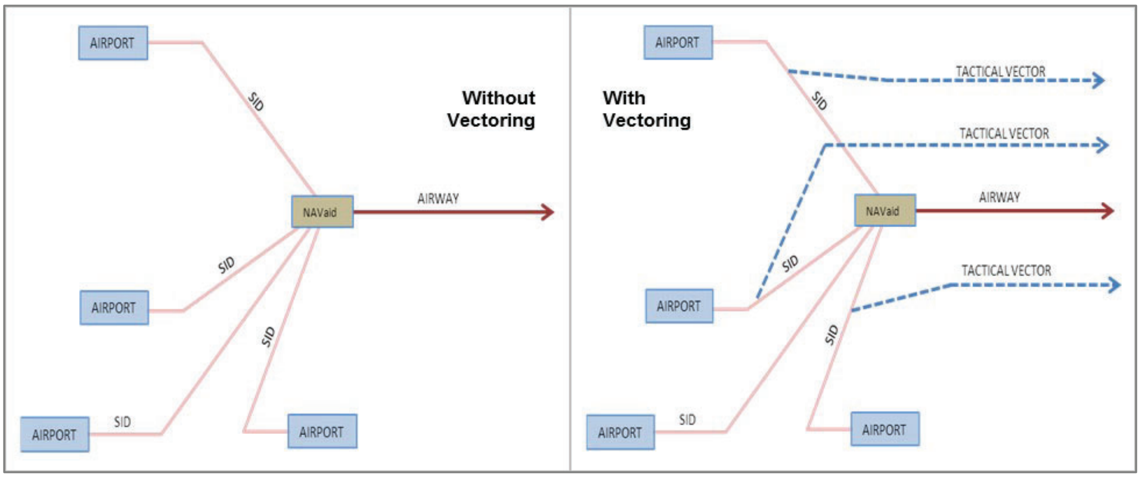

Chart 8: Accommodating traffic demand through tactical vectoring

2.23 The capability of air traffic controllers to operate in this manner has evolved over time to safely and efficiently accommodate growing traffic levels. However, the volume of flights that controllers can safely manage through tactical vectoring is reaching capacity because the physical size of the available airspace sectors through which to vector traffic safely is limited.

2.24 The FAS Plan proposes that airport arrival and departure routes are upgraded to a more precise and flexible satellite-based navigation standard. The introduction of satellite navigation removes the need to rely on ground beacons, offering significantly more flexibility in the way that routes can be designed. Improvements in aircraft navigational performance mean that capacity can be added by implementing more closely spaced arrival and departure routes into the same volumes of airspace and removing the reliance on vectoring.

2.25 The precision and flexibility offered by routes based on satellite navigation also creates opportunities to better manage noise impacts, for example by designing flight paths that avoid population centres and deploying multiple route options to be used at different times there by enabling some dispersion of traffic flows. These opportunities must be balanced against the challenges created by more precise routes that concentrate aircraft noise into narrower contours, which often have a more intense impact on those areas that are affected.

Issues with the management of traffic flows

2.26 Many of the decisions made about managing the flow of traffic through the airspace in line with available capacity are not based on accurate information. There is often little consistent up to the minute information about when flights plan to arrive at airports, turnaround (reload, refuel etc.), and then depart. Airports, airlines, air traffic controllers and other operational organisations like the European Network Management Operations Centre (NMOC) and Ground Handling Agents all use different information, managed by different systems, and updated at different times.

2.27 In the absence of up to the minute information most decisions are based on either the airlines' published schedules that are developed months prior to the day of operation, or their flight plans, submitted at least three hours prior to departure. Neither of these sources are regularly updated to reflect the dynamic nature of the airspace.

2.28 The gaps in information, and the time and effort needed to close them, reduces the effective capacity of the airspace. For example, the lack of accurate information about inbound, turnaround and outbound traffic flows impacts punctuality at airports. Poor punctuality often has significant knock on effects throughout the day in the form of rotational delays. Airlines are strongly incentivised to maintain a high level of punctuality. This creates pressure for airlines to add buffers to their schedules, including a degree of holding on the ground and in the air to their flight plans in the expectation that they will experience some delay.

2.29 The FAS Plan proposes that all airports in the UK are electronically connected with air traffic controllers and NMOC, providing and receiving up to date information about inbound, turnaround and outbound traffic flows to maximise the effective capacity of the airspace.

3. Forecast traffic growth and delays

Introduction

3.1 If the issues that create capacity constraints in today's airspace are not tackled, passenger delays and flight cancellations are forecast to increase sharply as traffic continues to grow. Airspace capacity will ultimately become the constraining factor on growth in the aviation sector and the supply of flights to some destinations may be lost. Analysis conducted by NATS on behalf of the Department estimates the amount of delay and flight cancellations likely to be incurred if traffic grows at the rate anticipated in Chart 3 but no major upgrades to the airspace are introduced, see Annex A.

3.2 The NATS analysis isolates the estimated extent of operational delays and cancellations specifically attributable to a lack of airspace capacity. This analysis includes **only delays due to capacity in en-route airspace and airport departure routes** – so called Air Traffic Flow Management (ATFM) delays. It does <u>not</u> cover weather-induced delays or those caused by technical failures or staffing issues which could add significantly to the amount of delay experienced by passengers and the level of disruption caused.

Expected delays and cancellations if we do not modernise our airspace

3.3 In the NATS analysis, flights in UK airspace, which includes overflights, are forecast to grow from 2.25 million per year in 2015 to 3.25 million in 2030 (an increase of 44%). Without additional capacity, more and more flights will be delayed on the ground at UK airports each year because of the bottlenecks in en-route, terminal and low altitude airspace.

3.4 The relationship between demand, capacity and delay is non-linear. As specific sectors of airspace reach capacity, small further increases in demand can cause significant increases in delay that have knock-on effects across the network.

Expected delays

3.5 In 2015, airspace capacity constraints caused a total of 78,000 minutes (54 days of total delay or an average delay per delayed flight of 9 minutes in UK airspace) of ATFM delay across the 2.25 million flights. Without additional airspace capacity, these delays are forecast to increase to 1 million minutes (694 days and an average of 15 minutes per delayed flight) by 2020, as traffic grows to an expected 2.6 million flights. This is 13 times the number of delays experienced in 2015, an increase of 1200%. By 2020, the NATS analysis predicts that 1 in 10 departures from UK airports would be delayed by more than half an hour.

3.6 Looking forward to 2030, the NATS analysis predicts that delays will increase to 5.6 million minutes a year affecting many more flights than in 2015 (the equivalent of 3,889 days and an average of 26 and a half minutes of delay per delayed flight), as traffic grows to an expected 3.25 million flights. This is over 70 times (7,100%) the delays experienced in 2015. If delays reach this level, one in three flights from the UK are expected to depart over half an hour late and many scheduled shorthaul flights would be forced to cancel due to higher numbers of daily rotations and shorter scheduled turn-around times allowing for less resilience in delays.[16]

3.7 Chart 9 illustrates the forecast increase in annual delays as traffic grows steadily from 2015 to 2030, if no additional airspace capacity is introduced.

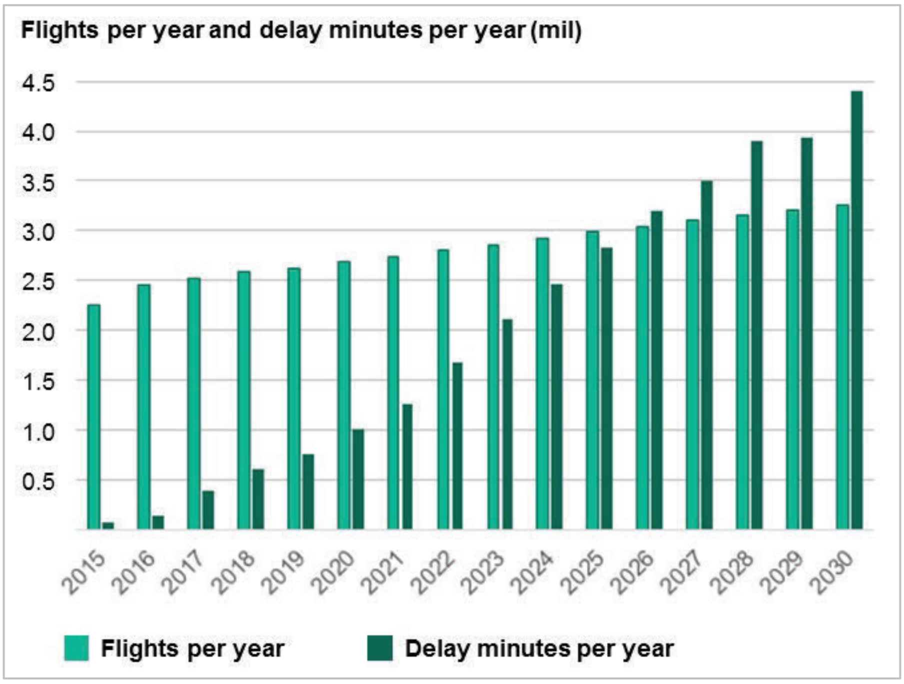

Chart 9: Traffic growth and increase in delays with no additional airspace capacity

3.8 Commercial air transport businesses are based on reliability – providing customers with the punctual and consistent service they expect and have purchased with their ticket. In this forecast, as demand grows and delays increase overtime, it is reasonable to assume that cancellations will not be scheduled because commercial carriers are forced to withdraw some services to protect punctuality and consistency.

Cancellations

3.9 Without additional airspace capacity, flight cancellations are expected to be consistently over 8,000 per year by 2030 and the cumulative effect of several years of rising delays and cancellations is forecast to lead to c16,000 flights that would have been scheduled, not being possible to operate. Beyond 2030, the delays, cancellations and lost supply are expected to continue growing at an increasing rate as demand for flights grows.

[16] Assuming that a shorthaul aircraft typically operates 5 flights per day and a turn-around time of 30 minutes, a 45 minute delay on the first rotation compounded by further delays on the next rotations cannot be recovered. The model assumes that in an increasing number of cases over time, this will result in cancellation of one rotation for the aircraft's schedule in order to protect the overall operation and avoid operating restrictions including crew hours and night flight curfews.

3.10 Chart 10 sets out the expected increase in cancellations per year caused by air traffic delays and how they are expected to transfer into a permanent loss of supply.

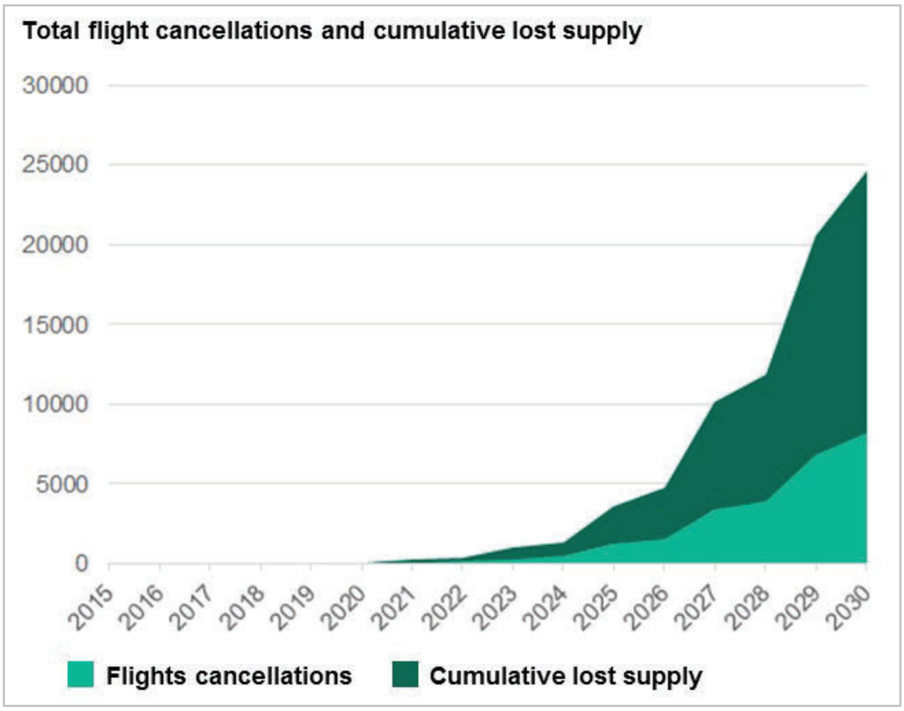

Chart 10: Forecast increase in flight cancellations per year and cumulative lost supply

3.11 There are many factors that influence these forecasts, the above NATS analysis is set out in Annex A and describes in more detail a view of the potential loss of services should the delay scenario in paragraph 3.6 develop. This analysis shows high levels of impact, whether from flight delays, short notice cancellations or constraints on the number of scheduled flights, in the absence of airspace modernisation. These impacts affect all involved in aviation and will essentially reduce the quality, value and provision of air transport services.

3.12 Aviation is an important component of this country's economy providing benefits to passengers, connecting family and friends, enabling tourism, trade and the movement of high-value goods. It facilitates growth in GDP and connects the whole of the UK to trading partners around the world. Delays, cancellations and caps on growth will inhibit these benefits and bring costs to the UK, not just to airports, airlines and their passengers.

Possible delay and cancellation costs

3.13 The DfT has considered the possible cost implications of the delay and cancellation figures suggested in the NATS analysis. The DfT analysis suggests that the cumulative additional costs of delay and cancellations for the aviation industry and passengers between 2016 and 2030 could be over £760 million in 2016 values. By 2030, the cost of air traffic delays could be running at c£140million a year added to which there would be cancellation costs in excess of £120million a year. The analysis therefore points to a scenario that with no airspace modernisation the additional costs borne by the aviation industry and its customers could be c£260million a year and rising thereafter. Annex E provides more details on the assumptions made by the DfT and a breakdown of the possible costs if airspace modernisation does not occur. These cost estimates do not account for the impact and wider costs of flights that cannot be scheduled in the absence of airspace modernisation.

4. The impact of aviation noise

Introduction

4.1 In addition to mitigating the impact of traffic growth on delays, airspace upgrades also have a significant effect on aviation noise.

4.2 The predominant source of transport noise exposure is from roads. The European Environment Agency reported that within Europe's major cities approximately 70 million people are exposed to road noise above 55 decibels compared with just under 10 million to rail noise and less than 3 million to aircraft noise.[17]

4.3 Notwithstanding these findings, aviation noise generates considerable interest as it tends to cover larger geographical areas and can be more difficult to mitigate effectively. Aviation noise currently affects more people in the UK than any other country in Europe.[18] It impacts the quality of life of not just those who live close to airports but can also be a genuine nuisance to those living many miles away.

4.4 Aviation noise performance has improved significantly in recent decades driven by the introduction of quieter aircraft. However, whilst noise levels per flight have often reduced, some residents experience significantly more noise events due to traffic growth. The community perception of noise at many airports across the UK has, if anything, worsened in recent years.

Government policy on aviation noise

4.5 The Government's policy on aviation noise is to limit and, where possible, reduce the number of people significantly affected by aircraft noise. There is no one threshold at which all individuals are adversely affected by noise in terms of health and severe annoyance, but the risk will increase as noise exposure also increases. There may therefore be instances when exposing more people to lower levels of aircraft noise may result in fewer people being adversely affected than if a smaller number of people were exposed to very high levels of noise exposure.

4.6 The Government's policy has historically been that it is better to concentrate aircraft over the fewest possible routes. This policy was established in an era of less accurate navigation. Recent trials and airspace changes have been accompanied by increased opposition to the more intense levels of aircraft concentration that typically accompanies the introduction of new routes based on satellite navigation. The Government acknowledges that multiple routes can sometimes have benefits, and wants to ensure they are considered where they can offer communities affected by

[17] Managing Aircraft Noise, CAA Publication (CAP) 1165, 2014.
http://publicapps.caa.co.uk/modalapplication.aspx?appid=11&mode=detail&id=6251
[18] Managing Aircraft Noise, CAA Publication (CAP) 1165, 2014.
http://publicapps.caa.co.uk/modalapplication.aspx?appid=11&mode=detail&id=6251

noise relief from noise, or defined periods of respite. Local circumstances and preferences should be taken into account in determining whether and which options for multiple routes should be explored. The Government also acknowledges that multiple routes may not always be a viable option, due to capacity limitations for instance, or because it may not be possible to place them far enough apart to have perceptible noise benefits. Alternatively, they may be introduced for purposes other than noise.

Revision of Government guidance on air navigation

4.7 Many in the aviation industry believe that noise has contributed more than any other factor to the lack of investment in airspace upgrades at low altitudes during recent years. Across the country, where airports have introduced new flight paths to accommodate traffic growth and offer new connections, local protests have become common. As such, the issues associated with managing aviation noise not only disturb local communities but also have a direct impact on passenger choice and value. Tackling these issues, in part through the FAS Plan described in Part B of this report, offers the potential to improve the quality of life for those living close to airports and deliver a better deal for passengers.

4.8 The Government has recognised that there is a need to provide further guidance to the aviation industry to assist it when considering new or revised flight paths. The Government is therefore due to publish revised guidance to the aviation industry later this year on how to assess environmental impacts, such as those associated with single or multiple routes options. This guidance will also set out how these impacts should be evaluated by airspace change sponsors against other relevant considerations.[19]

[19] In the forthcoming revision of the Air Navigation Guidance and also in an update of the guidance on the use of WebTAG (https://www.gov.uk/guidance/transport-analysis-guidance-webtag). The WebTAG guidance includes, or provides links to, advice on how to: set objectives and identify problems; develop potential solutions; create a transport model for the appraisal of the alternative solutions; and how to conduct an appraisal which meets the department's requirements.

5. Conclusion to Part A

5.1 The UK's aviation industry has expanded enormously since the 1950s and 1960s when much of our airspace structure was first designed. Since then airspace has been added to and adapted in response to growing traffic levels. This piecemeal approach has created several issues with today's airspace that limit the ability to add capacity without making some more fundamental changes.

5.2 The en-route airspace is structured around a fixed network of sectors and way points that are based on the position of ground navigation beacons and create bottlenecks. The terminal airspace has become a complex web of intersecting flight paths that needs a wholesale redesign to increase capacity and allow aircraft to climb and descend continuously. Airspace at lower altitudes around airports is also constrained by fixed ground based navigation. Airports' standard arrival and departure routes need to be upgraded using satellite-based navigation techniques to allow for more closely space flight paths and the flexibility to better manage noise impacts.

5.3 Traffic levels are forecast to continue growing from 2.25m flights a year in 2015 to 3.25m in 2030. If the airspace is not upgraded to tackle today's issues and add capacity, then passenger delays and flight cancellations are expected to rise sharply. Analysis conducted by NATS predicts that delays will increase from 78,000 minutes in 2015 to 5.6 million minutes a year by 2030 if no additional airspace capacity is deployed. In practice this means 1 in 3 departures from UK airports would be delayed by more than half an hour and over 8,000 scheduled flights a year would consistently be forced to cancel. The cumulative effect of rising delays and cancellations caused by a lack of airspace capacity is forecast to lead to c16,000 flights that would have been scheduled becoming lost supply by 2030. The cumulative cost of these delays and cancellations between 2016 and 2030 could be £1bn by 2030 with annual costs running in excess of £260million a year to the aviation industry and their customers.

5.4 The forecasted delays by 2030 would represent significant disruption to airline and airport operations and cause significant inconvenience to passengers. The delays would also have an adverse environmental effect. The Government recognises therefore that if we want our aviation industry, and indeed the UK in this era of global trade, to remain competitive and successful we must upgrade our airspace structure and minimise the risk of crippling air traffic delays in the future.

5.5 The aviation industry has started a major programme known as the Future Airspace Strategy to coordinate the upgrade programme and ensure that airspace capacity does not constrain the many valuable services and opportunities that aviation provides. The second part of this document describes the main features of the FAS Plan to introduce more direct routes in the en-route, redesign terminal airspace, stream traffic to avoid queuing and better manage noise impacts.

PART B

The second part of this report describes the main features of the industry led Future Airspace Strategy Plan that are intended to tackle the issues with today's airspace. Part B also considers the treatment of negative impacts that may arise from the airspace upgrades, especially those affecting local communities that may experience changes to where aircraft are usually seen and heard.

6. FAS Vision

Introduction

6.1 The FAS Plan was developed collaboratively by airports, aircraft operators, air traffic control organisations, the Military and the CAA, all of whom are aligned to a common vision, to deliver:[20]

"Safe, efficient airspace, that has the capacity to meet reasonable demand, balances the needs of all users and mitigates the impact of aviation on the environment."

The FAS Plan

6.2 To achieve this vision, the FAS Plan aims to align industry investment plans behind a common mission; to:

- **Save passenger time and avoid delays** through the provision of additional airspace capacity when and where it is needed across the air transport network;
- **Cut aviation emissions per flight and save fuel** by enabling greater efficiency;
- **Better manage noise impacts** by reducing the number of aircraft overflying population centres and holding at lower altitudes; and
- **Further enhance aviation safety** by reducing airspace complexity and introducing new technologies that help to manage the residual risks.

6.3 The FAS Plan has many components, but is based around the following key upgrades:

- **En-route airspace upgrades** to remove the fixed structures, adding capacity and enabling more direct and free routes;
- **Terminal airspace upgrades** to fundamentally redesign the route network taking advantage of advances in technology, especially satellite navigation;
- **Queue management upgrades** to stream traffic through speed controls in the en-route and reduce the reliance on stack holding in terminal airspace;

[20] www.caa.co.uk/FAS

- **Airspace upgrades at lower altitudes** to redesign airport arrival and departure routes, allowing flights to climb and descend continuously and better manage the impacts of aircraft noise; and

- **Airspace information upgrades** to provide and receive accurate data about traffic flows to better manage ground delays and airspace bottlenecks.

6.4 Chart 11 illustrates how these upgrades are expected to improve the performance of the airspace across each phase of flight – from cruise to cruise via, descent, arrival and turnaround, take-off, initial departure and climb.

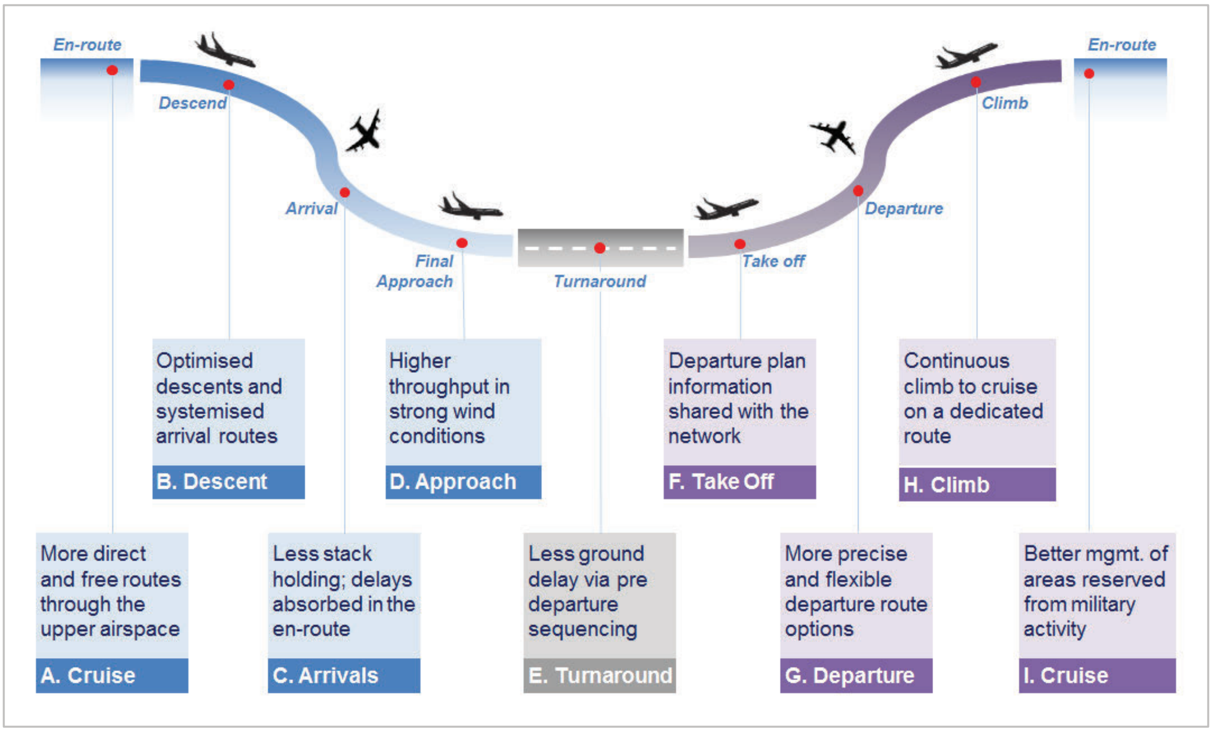

Chart 11: FAS Plan airspace upgrades by phase of flight

6.5 The remainder of Part B describes the main FAS Plan projects to deliver the airspace upgrades in each phase of flight.

7. En-route airspace upgrades

Introduction

7.1 The goal of the FAS Plan in the en-route airspace (above c25,000ft) is to remove the fixed structure of published routes and way points, adding capacity and enabling aircraft to follow more direct and environmentally efficient flight paths. There are three main projects in the FAS Plan that are delivering the en-route airspace upgrades between 2015 and 2022:

- **The introduction of Direct Route Airspace;**
- **The introduction of Free Route Airspace; and**
- **The Flexible Use of Airspace (FUA) reserved for military activity.**

Direct Route Airspace

7.2 Direct Route Airspace refers to the introduction of a significant number of additional plannable entry and exit points to each en-route sector. The additional points supplement the pre-existing framework of fixed way points that are based on the position of ground navigation beacons. Aircraft use satellite navigation to route directly between the most efficient combination of entry and exit points from sector to sector.

7.3 Direct Route Airspace allows aircraft to fly the quickest, most fuel-efficient flight paths. Air traffic controllers can manage larger volumes of traffic by removing the dependency on a few fixed way points, adding capacity to the en-route airspace. Introducing a large array of point to point combinations also increases the options available to traffic that must route around areas of poor weather or segregated areas, strengthening the resilience of the airspace.

7.4 NATS is leading the implementation of Direct Route Airspace across all regions of the UK's en-route network, starting with the airspace above Scotland and Northern Ireland. A large proportion of the transatlantic flights between North America, the UK and Europe route through this airspace. The first phase of the project was implemented in 2015 and saw 300 additional entry and exit points introduced to the en-route sectors above 25,000ft in the west of Scotland.

7.5 Chart 12 sets out the volume of Direct Route Airspace that was introduced in 2015 (notified as 'DRA'), along with the location of a major segregated area (EG D701), which is often reserved for military activities. Commercial air transport use the direct route options to plan the most efficient flight path through or around D701 depending which areas are reserved.

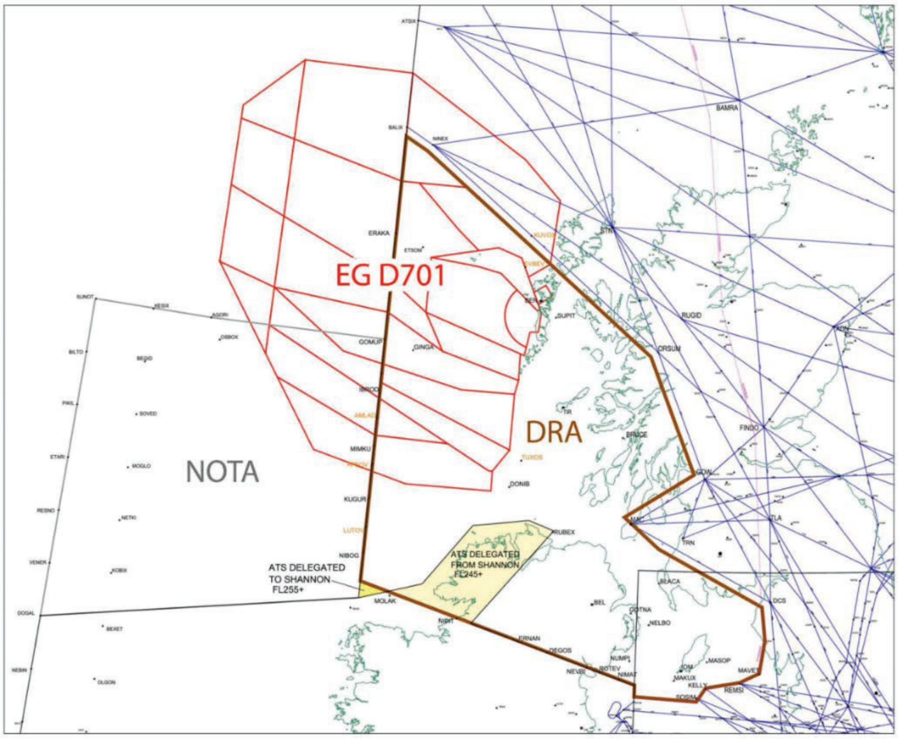

Chart 12: Volume of Direct Route Airspace (DRA) introduced to date. Source NATS

7.6 NATS has analysed traffic samples of flights using the Direct Route Airspace to estimate the average track distance and fuel burn savings. The samples were drawn from the UK flight data base and adjusted for differences in aircraft performance. Based on this modelling, the Direct Route Airspace introduced so far is expected to benefit approximately 55,000 flights per year.[21]

7.7 The next phase of Direct Route Airspace is due to go live in 2019 and will see more additional way points introduced over a much larger volume of Scotland and Northern England. Phase 2 is expected to increase the amount of traffic able to benefit from Direct Route Airspace to over 150,000 flights per year. A new set of air traffic control systems will be deployed into NATS' Prestwick Centre in the same timeframe to allow controllers to manage a larger number of flights with more routeing options, significantly increasing capacity.

7.8 The successful deployment of electronic tools to support en-route controllers in NATS' Swanwick Centre provides an indication of the potential airspace capacity benefits. The toolset known as iFACTS was implemented in 2011 and helps controllers to detect conflicts between traffic flows sooner and more easily, allowing them to comfortably accommodate more flights. NATS estimate that iFACTS has generated a 12% overall increase in airspace capacity in the London Area Control operations where it was deployed.

7.9 In addition to the capacity gains, NATS estimate that the introduction of Direct Route airspace over Scotland and Northern England will generate between 3,000 and 5,000 tonnes of fuel burn savings per year from 2019 when Phase 2 of the programme is expected to go live.

[21] Source: NATS. Approximately 50% of the total number of flights using the Direct Route Airspace.

Free Route Airspace

7.10 Free Route Airspace is a further evolution of the Direct Route Airspace concept that sees the removal of all published way points from en-route sectors. This means traffic can plan and re-plan flight paths through large volumes of the en-route airspace without reference to any established routes or fixed way points. Aircraft can fly a fully optimised trajectory taking into account flight time, fuel burn, network delays and weather.

7.11 NATS is part of an ANSP alliance known as Borealis that has been established to deliver a single volume of Free Route Airspace across the UK, Ireland, Iceland, Denmark, Sweden, Norway, Finland, Latvia and Estonia.[22] The alliance aims to ensure that traffic is free to fly an optimised trajectory across the entire region's airspace above 25,000ft with no route structure or way point constraints.

7.12 Borealis Free Route Airspace is planned for introduction between 2020 and 2022, and will replace the Direct Route Airspace deployed in the meantime. Along with the significant capacity gains, NATS estimates that by removing the constraints to an optimum flight profile in the en-route, free route airspace will generate around 4,000 tonnes of fuel burn savings per year from 2022. Chart 13 illustrates the regions to be covered by Borealis Free Route Airspace.

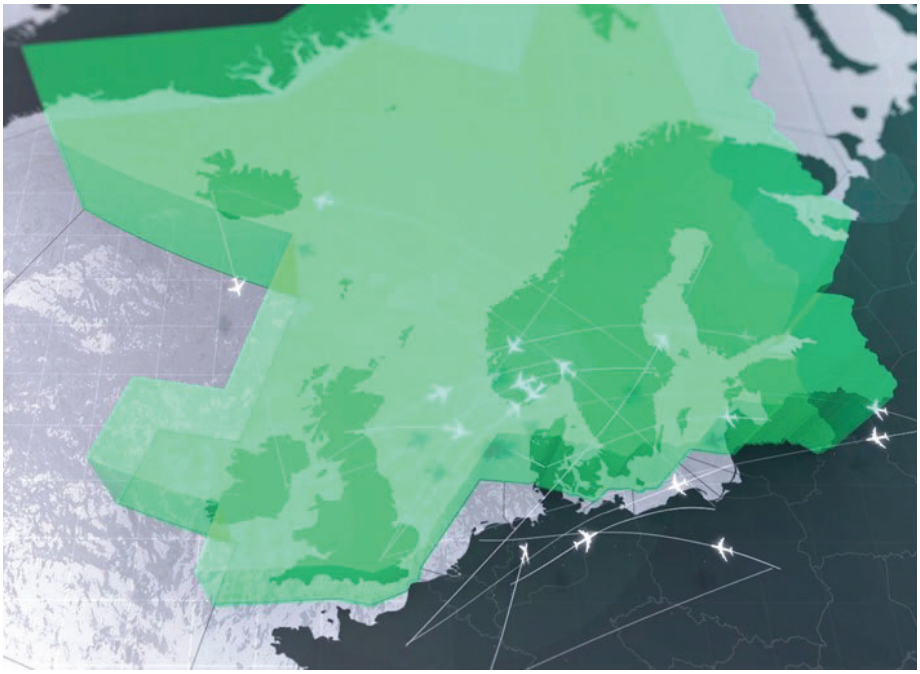

Chart 13: Region to be covered by Borealis Free Route Airspace. Source NATS

Advanced Flexible Use Airspace

7.13 Some areas of the en-route airspace are segregated for Military activities. The military book the airspace temporarily and hand it back for civil use when it is not required. The process of temporarily booking and handing back segregated areas that are shared between civil and military users is known as Flexible Use of Airspace (FUA). Upgrades to the systems and processes used to manage FUA can increase

[22] http://www.borealis.aero/Home.19.aspx

airspace capacity and flight efficiency by allowing commercial traffic to flight plan and fly directly though segregated areas more effectively when they are not booked.

7.14 Data collected by the CAA about FUA in the UK suggests that there are significant capacity benefits to improving how segregated areas are structured, reserved by the military and returned for civil operations. For example, in 2015 only 40% of the segregated airspace that was booked three hours prior to operation was used. The remaining 60% might have been made available for civil use. However even when segregated airspace was released for civil operations in 2015 only 20% of commercial flights that could have used it did.[23] Therefore a significant amount of potential airspace capacity is being lost.

7.15 Improvements in the management of FUA can optimise the use of existing capacity and help to increase capacity by supporting the implementation of Free Route Airspace. NATS, the MoD and the CAA are working together in a joint project to strengthen the technology and processes used for reserving segregated areas. A trial to introduce a new digital reservations tool for the military was completed in September 2016 along with a roadmap for its wider deployment. The tool is being accompanied by new processes to book airspace at short notice and to return it quickly if it is no longer needed.

7.16 The Government recognises that there will always remain a requirement for the military to retain some fixed segregated areas of airspace which can be reserved for hazardous activities. These areas are essential to maintain operational capability and meet a range of military training and development objectives. While the adoption of new technology and processes provides scope for greater dynamism in the reservation and use of segregated areas, to increase airspace capacity, national security requirements will mean some volumes of airspace will remain inaccessible at certain times.

[23] Data compiled by the CAA for the Single European Sky Performance Scheme. Source: CAA.

Summary of the en-route airspace upgrades

7.17 Table 1 summarises the main projects that are delivering en-route airspace upgrades, the timeframes for their implementation and their expected benefits.

Project	Description	Timeframe	Benefits
Direct Route Airspace	Deployment of additional entry and exit points to each en-route sector so that aircraft can fly more direct routes.	2015 – 2020	Capacity gains; and 3 – 5 KT(kiloton) of fuel savings per year.
Free Route Airspace	Removal of all fixed way points and routes so aircraft can fly a fully optimised trajectory across the UK en-route and State boundaries	2020 – 2022	Capacity gains; and Around 4 KT of fuel savings per year.
Advanced Flexible Use Airspace	Deployment of new technology and processes to improve the reservation and release of segregated areas for military activity.	2017 – 2022	Capacity gains and fuel burn savings by enabling greater civil uptake of segregated areas.

Table 1: Summary of the en-route airspace upgrades

8. Terminal airspace upgrades

Introduction

8.1 The goal of airspace upgrades in the terminal areas (from around 25,000ft to 7,000ft) is to completely redesign the route structure using satellite navigation, introducing a highly systemised framework that reduces the interactions between inbound and outbound traffic flows and minimises the reliance on stack holding. There are three main projects in the FAS Plan that are delivering terminal airspace upgrades between 2015 and 2024:

- **The Prestwick Lower Airspace Systemisation Programme;**
- **The Swanwick Airspace and Terminal Control Improvement Projects; and**
- **The Queue Management Programme.**

Prestwick Lower Airspace Systemisation Programme

8.2 The Prestwick Lower Airspace Systemisation (PLAS) Programme is a joint airport and air traffic control initiative to upgrade the terminal airspace in the Midlands, Northern England and Scotland between 2017 and 2020. The PLAS programme will redesign the airspace structure that serves flights to/from Manchester, Liverpool, Birmingham, East Midlands, Leeds Bradford, Newcastle, Glasgow, Glasgow Prestwick and Edinburgh airports.

8.3 The programme will improve the linkages between these airports and the south east of England, Ireland, mainland Europe, the Middle East and North America. A more advanced route structure designed to satellite navigation standards will be deployed to increase airspace capacity and separate arrival and departure flows onto dedicated routes. The airports engaged in the programme will upgrade their arrival and departure routes at lower altitudes in the same timeframes (see Section 9 of this report).

8.4 Re-designing the terminal airspace across the Midlands, Northern England and Scotland is a large and complex undertaking. It will require the production of detailed route design options, consultations with aviation stakeholders and many local communities, and a major transition planning exercise from the current airspace to a new way of working. However, the PLAS programme represents the most significant opportunity to introduce additional airspace capacity in the UK between now and 2020 and is also expected to generate large emissions and fuel burn savings per flight.

8.5 NATS estimate that the PLAS programme will generate a 5% to 10% increase in airspace capacity in the region. Along with these capacity gains, NATS estimate by systemising the inbound and outbound routes in PLAS airspace that aircraft will save between 32,000 and 42,000 tonnes of fuel burn per year by 2019.

Swanwick Airspace and Terminal Control Improvement Projects

8.6 A major upgrade to the busy terminal airspace over London will be required to support the development of an additional runway in the south east of England. The timelines for a runway development are still being debated, but a complete overhaul of the London terminal airspace is not expected before 2024. In the meantime, NATS is delivering two projects that aim to maximise the existing capacity and efficiency of London terminal airspace - The Swanwick Airspace Optimisation Project and the Terminal Control Improvement Project.

8.7 The Swanwick Airspace Optimisation Project aims to redesign sectors of London terminal airspace to add capacity and deploy new satellite-based navigation routes to reduce the track miles flown by traffic inbound to Heathrow and Gatwick airports.

8.8 The Terminal Control Improvement Project will coordinate the implementation of small-scale changes to increase capacity and efficiency in London airspace. The improvements include new electronic support tools for air traffic control and data sharing to better order departure flows. In addition, some areas of airspace that are frequently used by the GA community will be simplified as part of the project to reduce infringements into controlled airspace and further enhance safety.

8.9 Both London terminal airspace projects are expected to deliver between 2017 and 2020. NATS estimate that projects will deliver up to 5% more capacity in London terminal airspace by 2020 and the reduction in track miles flown by aircraft will generate between 10,000 and 30,000 tonnes of fuel burn savings per year depending on how the final design balances capacity and efficiency improvements.

Queue Management

8.10 Queue Management refers to the use of new sequencing tools by en-route air traffic controllers to stream arrival traffic into the terminal airspace. Flights inbound to busy areas of terminal airspace are often subject to congestion that results in queuing and delays. In today's airspace, arrival queues are managed on a 'first come, first served' basis using airborne holding stacks, as described in Section 2 of this report.

8.11 The use of holding stacks to manage arrival queues, limits the capacity of terminal airspace, burns extra fuel, and can increase noise disturbance. The main objective of Queue Management is to absorb arrival delays in the en-route, removing the need for as much stack holding in the terminal. Holding in some form may always be necessary to maintain high runway utilisation rates but this should average at around 1 to 2 minutes per delayed flight rather than 8 to 10 minutes that is typical today.

8.12 Queue Management upgrades were implemented for traffic inbound to Heathrow airport between 2013 and 2015. The upgrades are being further enhanced during 2017 and 2018 through the deployment of new measures to collaborate with Dutch, Irish and French air traffic controllers, significantly expanding the volume of airspace where Queue Management techniques can be applied and delays can be absorbed.

8.13 Traditionally, NATS controllers are only able to manage the congestion caused by inbound traffic flows when flights enter UK airspace, which can be as close as 80NM from the airport. This limits the effectiveness of Queue Management techniques and can result in additional time spent in the holding stacks.

8.14 The introduction of Cross Border Queue Management means if delays in UK holding stacks begin to build up, controllers in the Netherlands, France and Ireland will be asked to slow down aircraft at anywhere from 350NM to 550NM from landing to help minimise delays.

8.15 NATS estimate that Queue Management will transfer around 60,000 delay minutes from the holding stacks to the en-route by 2020. Along with these airspace capacity gains, NATS estimate Queue Management delivers between 5,000 and 7,000 tonnes of fuel burn savings per year by absorbing delays in a more efficient way. Chart 14 illustrates the airspace covered by Queue Management.

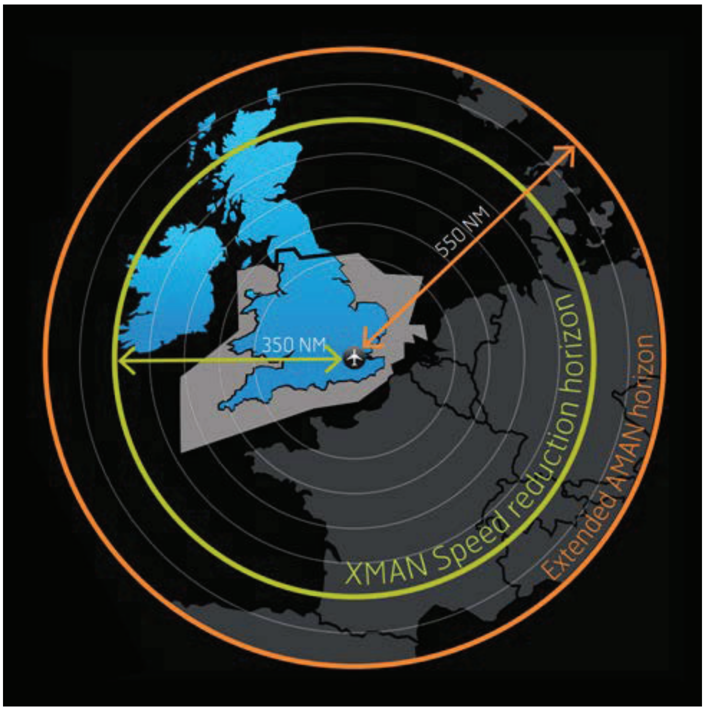

Chart 14: Range of the extended Queue Management

Summary of the upgrades in terminal airspace

8.16 Table 2 summarises the main projects that are delivering terminal airspace network upgrades and the expected timeframes for their implementation.

Project	Description	Timeframe	Estimated Benefits
Prestwick Lower Airspace Systemisation	Complete redesign of the terminal airspace serving the Midlands, Northern England and Scotland.	2017 – 2019	5% to 10% capacity increase; and 32 – 42 KT of fuel savings per year.
Swanwick Airspace and Terminal Control Improvements	Maximise existing capacity and efficiency in London terminal airspace, including new arrival routes and controller tools.	2017 – 2019	Up to 5% capacity increase; and 10 – 30 KT of fuel savings per year.
Extended Queue Management	Extension of the Queue Management horizon from 350 to 550 miles to better absorb arrival delays.	2018 – 2022	60,000 delay minutes transferred to the en-route; and 5 – 10 KT of fuel savings per year

Table 2: Summary of the upgrades in terminal airspace

9. Airspace upgrades at lower altitudes

Introduction

9.1 The goal of upgrading airspace at lower altitudes below 7,000ft, by implementing satellite-based arrival and departure routes, is to provide sufficient capacity between the terminal airspace and runway ends, while better managing the impact of aircraft noise on local communities.

Airport upgrades to arrival and departure routes

9.2 Table 3 sets out the airports that are expected to upgrade their arrival and departure routes between 2017 and 2020 – introducing more precise and flexible flight paths based on satellite navigation and removing the reliance on ground navigation beacons. The airports in the Midlands, Northern England and Scotland are designing their upgraded routes to integrate with the PLAS terminal airspace redesign programme described in section 8. Other airports are designing upgraded routes to better meet their own requirements.

Airport	Description	Timeframe
Glasgow Edinburgh Glasgow Prestwick Manchester Liverpool Leeds Bradford Doncaster Birmingham East Midlands	Satellite-based arrival and departure route upgrades to align with the PLAS terminal airspace redesign programme and enable more continuous climb and descent operations.	2017 - 2020
Luton Stansted Bristol Heathrow Gatwick	Satellite-based arrival and departure route upgrades to better meet local requirements, especially multiple route options to better manage noise impacts on local communities and closely spaced departure routes that can increase runway throughput.	2017 - 2020

Table 3: Summary of planned airport arrival and departure route upgrades

9.3 At lower altitudes, the impact of aviation on those on the ground takes greater precedence. The airports are responsible for managing the effects of airspace upgrades on their local communities. Some airports may choose to replicate their existing arrival and departure routes with satellite-based upgrades to minimise any changes in the established patterns of aircraft noise. However, the track keeping precision of satellite navigation typically concentrates aircraft noise into narrower contours, which often have a more intense impact on the areas affected.

9.4 Other airports may choose to go beyond simply replicating flight paths and use the precision and flexibility of satellite navigation to offer more noise abatement and respite options to local communities, or deploy multiple departure routes that can increase runway throughput during peak times. Any proposals to change flight paths must follow the CAA's airspace change process which includes requirements to consult closely and in detail with other aviation stakeholders and those local communities which may be affected. The CAA's airspace change process follows the guidance and directions which the Government has presented to it and which is currently being revised.[24]

9.5 The introduction of satellite-based navigation provides significant opportunities to deploy innovative new noise management techniques. These have been collated in a CAA document - CAP 1378[25] that is intended to provide information for airspace change sponsors on potential options. The techniques presented in CAP 1378 are by no means exhaustive but provide a description of some of the potential airspace design concepts that may offer mitigations to those impacted by aircraft noise.

Higher throughput in strong headwind conditions

9.6 The throughput of arrival traffic landing in strong headwind conditions can be increased using advanced air traffic control tools, maintaining existing airspace capacity when bad weather would otherwise cause delays. If aircraft are flying into a strong headwind on their final approach they take longer to reach the runway, which creates delays. These delays are typically absorbed through stack holding. The Time Based Separation (TBS) tool uses real time wind data from inbound flights to calculate the optimal safe spacing between each aircraft in order to optimise the landing rate.

9.7 NATS deployed the TBS tool into service at Heathrow Airport in May 2015, where there are about 60 days a year when strong headwinds reduce the airspace capacity and are the cause of significant delays. TBS at Heathrow is expected to save 80,000 minutes of delay per year and generate significant fuel burn savings from less stacking.[26] TBS is expected to become the norm for other capacity constrained airports like Gatwick and Manchester by 2024.

9.8 A project to enhance the TBS tool at Heathrow, by introducing an even more accurate approach to spacing different combinations of aircraft on arrival is expected to generate further benefits. Enhanced TBS is currently in an R&D phase and is aimed for deployment before 2019. An initial review of the benefits suggests that the enhanced tool may generate the capacity for one additional flight per hour.

[24] Air Navigation Directions 2001 (amended 2004) issued by the SofS for Defence and SofS for Transport, and the Air Navigation Guidance, DfT January 2014, both of which are due to be revised later this year.
[25] CAP 1378 - Airspace Design Guidance: Noise mitigation considerations when designing PBN departure and arrival procedures (https://publicapps.caa.co.uk/docs/33/CAP%201378%20APR16.pdf)
[26] Source: NATS, 2015.

10. Airspace information upgrades

Introduction

10.1 The goal of airspace information upgrades is to increase airspace capacity by improving the operational decisions made by airports, airlines and air traffic control using more accurate traffic flow data. In today's operation many airspace management decisions that determine capacity are not routinely informed by accurate data about when aircraft plan to depart, when they actually take-off or when they are expected to arrive in a particular sector of airspace. Most organisations use different data sets that are refreshed at different times. This constrains capacity unnecessarily and weakens the resilience of the airspace.

10.2 A wider community of stakeholders also suffer from the lack of up to date traffic flow data upon which to base their decisions. Border control agencies, airport terminal retail providers, taxi, rail and coach operators, members of the public meeting passengers, freight companies and transport information providers would all benefit from airspace information upgrades.

10.3 There are two main projects in the FAS Plan that are delivering airspace information upgrades to improve airspace management and add capacity:

- **The roll-out of Airport Collaborative Decision Making Systems; and**
- **The roll-out of Departure Planning Information Systems.**

Airport Collaborative Decision Making Systems

10.4 Airport Collaborative Decision Making (ACDM) involves the introduction of new systems and processes at larger capacity constrained airports to enable the creation, refinement and exchange of runway and airspace data, including:

- The progress of each flight's turnaround activities;
- Up to date times for each flight to push back from stand and take off; and
- The optimal sequence of departures to maximise runway and airspace performance.

10.5 With this information ACDM systems allow air traffic controllers to construct an optimised sequence of departures tailored to maximising runway throughput and airspace capacity. ACDM systems also gather the latest estimated landing times for inbound flights to improve the management of ground operations that is often the cause of air traffic delays.

10.6 Heathrow was the first airport in the UK to introduce an ACDM system in 2013. The use of ACDM at Heathrow has demonstrably reduced the time aircraft spend taxiing and queueing on the ground and generates valuable traffic flow data to optimise airspace capacity.

10.7 Gatwick Airport also introduced ACDM in 2014. As part of the FAS Plan, it is envisaged that ACDM systems will be introduced to the UK's next five largest airports – Manchester, Stansted, Luton, Edinburgh and Glasgow – between 2017 and 2022. The capacity constraints around these airports are less acute than Heathrow and Gatwick, however departure delays are a regular feature of the operation particularly during the busy first wave of departures from 06.00 to 09.00.

Departure Planning Information

10.8 Part of the function of the ACDM systems described above is to provide network management organisations and air traffic controllers with departure planning information (DPI) messages about each flight. DPI information is needed to optimise traffic flows across the UK and European airspace.

10.9 DPI provision involves an electronic message being submitted from airports to the European Network Management Operations Centre at the exact time that each aircraft pushes back from the stand. The information is then relayed to local air traffic control centres across the UK and Europe. The DPI messages includes valuable data such as the aircraft target take off time, taxi time to the runway, actual take off time and route through the airspace that can be used by air traffic controllers to maximise airspace capacity.

10.10 The FAS Plan is developing and deploying new software for airports to share DPI messages. The Government provided the funding for an initial investment in DPI provision at 7 UK airports that do not have ACDM systems between 2013 and 2015. The project is led by the Transport Systems Catapult, a Government sponsored innovation centre. DPI messaging was rolled-out to Manchester, Stansted, Luton, London City, Edinburgh, Glasgow and Aberdeen. Flights from these airports account for around 35% of all commercial air transport in the UK.

10.11 The DPI software upgrades are planned for implementation at a further 10 to 15 UK airports between 2016 and 2019, ultimately covering around 80% of commercial air transport flights from UK airports.

11. Operational techniques to improve the management of aircraft noise

Introduction

11.1 The plans to upgrade airport arrival and departure routes at lower altitudes present an opportunity to deploy innovative new operational techniques that can improve the management of aircraft noise. The Government believes that airports, airlines and air traffic controllers should ensure that these techniques are adopted wherever feasible. Some techniques are being operated by industry already. Others are the subject of on-going research and development projects. Typically, the techniques tend to apply specifically to either arrivals or departures, although the adoption of multiple techniques may result in cumulative improvements.

11.2 The Government's current overall objective on aircraft noise is to limit and where possible reduce the number of people in the UK significantly affected.[27] Typically this has meant a priority has been placed on reducing the overall number of people over flown. The accuracy of new routes based on satellite navigation offers the potential to reduce the total number of people directly over flown as flight paths become more concentrated. However, some operating techniques propose the introduction of more routes to disperse traffic, offering some relief from aircraft noise and tackling the impacts of intense concentration generated by satellite navigation.

11.3 In broad terms the FAS Plan considers the introduction of four key noise management operational techniques which are described in greater detail below. These are:

- Traffic dispersion for noise management;
- Traffic concentration for noise management;
- Noise respite approaches; and
- The redistribution of noise impacts.

Traffic dispersion for noise management

11.4 Dispersion, or dispersed aircraft tracks, refers to air traffic control instructing departing traffic to follow the same general routing yet fly a variety of different flight paths when measured over the ground. Dispersion can be achieved by (and is often a natural consequence of) a combination of factors such as the way the routes are designed, aircraft performance and pilot or air traffic control behaviour. The introduction of techniques that offer more dispersion for noise management will inevitably spread flight paths and therefore noise impacts over a greater area. This

[27] Aviation Policy Framework, DfT, 2013.

may often result in a greater number of people impacted by aircraft noise, but to a lesser extent.

Traffic concentration for noise management

11.5 Concentration of aircraft is the opposite of dispersion and is a consequence of the accuracy of routes designed to satellite-based navigation standards. It takes place when aircraft are instructed to follow the same routing consistently and fly very similar flight paths over the ground. The accuracy and predictability associated with satellite navigation means it is possible to make a more efficient use of airspace and add capacity by allowing large volumes of traffic to route through smaller blocks of airspace potentially avoiding population centres. The obvious costs of concentration, however, fall to the minority of people that are affected by more intense noise impacts.

Noise respite approaches

11.6 In contrast to general concentration and dispersion of traffic flows for noise management, respite approaches must be planned. For example, it may be planned that different runways are used at different times of day, providing communities with predictable relief from the noise impacts of departures from either runway. Another example could be alternating or changing between multiple departure routes, following a variety of flight paths to the same point further en-route.

11.7 Respite can be designed into airspace structures more easily once arrival and departure routes are upgraded to a satellite navigation standard. There is currently no agreed minimum distance between routes such that alternating their use would result in perceptible respite for those on the ground. The extent of the respite offered will depend on how far routes are moved and at what height the aircraft operate. Respite may be both concentrating traffic, as all the flights during a period will be on a single route, and dispersing as traffic will be spread over a larger area, albeit with a distinct time driven pattern.

The redistribution of noise impacts.

11.8 The upgrade of arrival and departure routes at lower altitudes using satellite navigation offers more flexibility than the conventional ground based alternatives. This allows flight paths and the associated noise impacts to be re-distributed away from noise sensitive areas. Of course, this assumes that there is an adjacent area that is less sensitive to noise that the flight paths can be moved over. The relative noise sensitivity of respective areas is hugely complex to estimate and must be carefully considered where re-distribution is the aim.

11.9 Annex G provides some examples of low level arrival and departure concepts and potential options which could be deployed to manage the impact of aircraft noise on those communities affected.

12. Conclusion to Part B

12.1 The FAS Plan aims to tackle the issues with today's outdated and increasingly inefficient airspace structure and provide the capacity required to accommodate growing traffic levels without incurring the significant additional delays forecast in Part A if nothing is done. The Plan also considers the treatment of negative impacts related to aviation noise that may arise from airspace upgrades.

12.2 The FAS was developed collaboratively by airports, aircraft operators, ANSPs, the Military and the Regulator. The airspace related investment plans of each of the participating organisations are aligned to a common vision for the future of UK airspace. The primary mission of the organisations engaged in the FAS is to avoid a sharp increase in delays, cancellations and lost supply as traffic grows. The Plan also aims to cut aviation emissions and fuel burn per flight and better manage noise impacts.

12.3 The investments in the FAS Plan can be grouped into five main upgrades:

- Removing the fixed structures in the en-route airspace;
- Completely redesigning the terminal airspace;
- Deploying Queue Management tools to reduce congestion and the level of airborne stack holding;
- Introducing more precise and flexible airport arrival and departure routes; and
- Sharing accurate airspace information between airports and air traffic controllers to maximise available capacity.

12.4 Some FAS Plan projects, like the introduction of Time Based Separations at Heathrow and Direct Route Airspace over Scotland, Northern England and Northern Ireland are already implemented and delivering benefits. Others, like the development of Queue Management tools and the redesign of terminal airspace structures are fully underway. Several of the FAS Plan projects are scheduled for deployment before 2019 and are expected to significantly increase the airspace capacity in response to growing traffic levels. Some projects extend out to 2024 and will need to align closely with the introduction of a new runway in the south east that is expected to be entering its final stages of development in a similar timeframe.

12.5 The FAS Plan's ambition to upgrade airspace at lower altitudes presents an opportunity to deploy innovative new operational techniques that can improve the management of aircraft noise. Operational techniques like traffic dispersion and concentration for noise management reasons, noise respite approaches and the redistribution of noise impacts are enabled by the plans to upgrade airport standard arrival and departure routes to a satellite navigation standard.

12.6 The Government believes that airports and ANSPs should ensure that these techniques are adopted wherever feasible. Many of the techniques involve some form of trade off with other airspace objectives such as increasing airspace capacity and saving emissions and fuel burn, which will need to be factored in to the decision-making process, with the support of the CAA's updated Airspace Change Process.

13. Report Conclusions

13.1 This report, compiled with the assistance of the CAA and the technical support from NATS, highlights the clear rationale for airspace modernisation. The UK's airspace structure, and the technology and processes which underpin it, is increasingly becoming outdated. The Government therefore supports fully the ambitious Future Airspace Strategy, the implementation of which is now well under way. We also welcome the approach and the collaborative nature which the industry is demonstrating in pressing ahead with implementing the strategy.

13.2 The detailed analysis work by NATS, which is summarised in Section 3 of this report and in Annex A, paints a rather bleak picture of what might happen to air traffic delays if we do not modernise our airspace. The Department has taken significant effort to understand the modelling and forecasts used by NATS and we are satisfied that the high-level results are a realistic outcome and the assumptions made are sensible. For further detail on analytical assurance please see Annex F. We have already seen, for example, air traffic delays increase sharply in 2016 which helps to demonstrate the point being made in this report that our airspace structure is coming under increasing pressure. These delays affect not just the airlines and their passengers but as our aviation sector becomes less able to deal with growing demand and constraints on airspace the wider economy will begin to suffer.

13.3 Safety is, and will continue to be, the overriding priority of the Government, the CAA, and the aviation industry. If we do not modernise our airspace, the need to ensure adequate safety levels will by necessity require aircraft to be delayed on the ground or held in stacks before they land. The costs of these delays and cancellations will need to be met by passengers, airports and the airlines. Families going on their annual holiday abroad may all too frequently experience long waits in departure lounges not knowing when their aircraft will be ready or have to cope with a short notice cancellation. We have seen in the late 1980s and in 1999 the impact of air traffic control delays at airports – indeed the high level of delays experienced in 1999 (due to the Kosovo crisis at that time) led to the creation of the Single European Sky. The aviation industry was, however, able to adapt to the increasing demand for air travel and air traffic delays reduced significantly. It has only been in the last 2 or 3 years that delays have again begun to rise as the demand for air travel increases and the volume of air traffic growth continues. As happened in response to the previous bouts of high air traffic delays, the aviation industry must do what it can to put in place measures to free up capacity and provide an efficient and safe airspace that can cope with both current and future demand requirements. The FAS is the means to do this.

13.4 Fortunately, the industry is seeking to implement the FAS and we therefore do not expect that air traffic delays will reach the levels forecasted in the NATS analysis. Nevertheless, it is also important to note that air traffic-related delays are just one component of the reason why aircraft are delayed. Weather, technical issues, strike action, and disruption in other countries, will exacerbate the level of delay experienced, particularly on peak demand days of the year (for example, the start of the school holiday period). Such delays add further pressure onto the air traffic network and passengers are likely to be more concerned about the level of delay they are experiencing rather than the specific cause, particularly as delays are often the result of a number of different factors. Consequently, the aviation industry must not just address the airspace capacity issues which the FAS does, but it must also take a more holistic approach and seek to make improvements that enhance the passenger experience. The quality of this experience is at the heart of the issue, and increasing air traffic delays are bound to impact adversely on it. Over time, this will have a detrimental effect on the UK aviation industry and on the ability of the UK to trade and do business in the global market place.

13.5 Airspace modernisation must, however, be undertaken with full consideration being given to its environmental impacts. Recent experience at a number of airports has demonstrated the strength of local feeling which can be aroused if communities do not understand why airspace changes are being proposed or do not even know about them until after their implementation. The Government has therefore taken steps to reconsider its airspace and noise policies with the objective of ensuring that airspace modernisation can take place but with the industry being required to undertake more options analysis work and to consult better. Once the new proposals are put in place, the Government expects that the industry will not only learn from past experience but will also seek to adopt best practices for minimising any noise impacts. Unless the industry does this, the successful delivery of the FAS is likely to be compromised and the UK will ultimately suffer.

13.6 The Government will continue to monitor the implementation of the FAS through its membership of the FAS Deployment Steering Group and the FAS Regulatory Programme Board, as well as with its many links with the aviation industry and with local communities. We also consider that the proposed new Independent Commission on Civil Aviation Noise will play a key role in trying to ensure that the industry and communities work together for mutual advantage. Ultimately, if we see that airspace modernisation is falling behind the demands of our airspace users and that delays are increasing as suggested in the NATS analysis, the Government will need to consider if there is anything substantive it can do to help ensure that we do have an airspace structure worthy of our great aviation heritage.

Annex A: NATS Do Minimum Forecast Traffic Growth and Delays

Introduction to the Do Minimum Forecast

A.1 High-level modelling and analysis has been carried out to provide a clear indication of the degree to which current UK airspace capacity is able to deal with the forecast increase in traffic demand. This analysis provides a profile of the likely delays that air traffic would incur if demand increases as expected while only minimal airspace capacity enhancements are made.

A.2 This situation is here termed the 'Do Minimum' scenario. The assessment of that scenario could be regarded as a two-stage process:

i. Produce forecast of traffic volumes; and

ii. Assess airspace capacity in light of handling forecast traffic volumes.

A.3 Note that this analysis deals solely with NATS-attributable delay caused by a shortfall in airspace capacity. It does NOT include weather related delay, nor delay due to NATS' staffing or technical issues.

Forecasting

A.4 Forecasts are central to informing business, investment and operational planning, and allow a response to be planned for future air traffic and industry related needs. There is a well-established link between economic growth and passenger demand that is recognised industry-wide. In long term forecasting, economic forecasts will be the most significant factor in determining future passenger demand and traffic volumes.

A.5 Predictions of future traffic volumes are integral to airspace modelling and air traffic management (ATM) simulation. They are also important in assessing the impact of airspace change projects and enabling cost-benefit analysis to be conducted. In the context of ATM, en-route delays are often an indication of airspace inefficiency. Airspace needs to be assessed in terms of whether there is sufficient capacity to handle the throughput of predicted traffic. A lack of capacity will lead to delays, and these should be mitigated through effective airspace management and capacity planning to enhance the efficiency of the airspace.

Analysis

A.6 NATS' Analytics Department has constructed a UK-wide 'Do Minimum' scenario using the Eurocontrol[28] NEST tool (Network Strategic Tool). This aims to demonstrate the impact on delays and cancellations likely to be incurred if traffic grows at the rate anticipated but only minimal airspace capacity enhancements are made to the airspace and procedures to accommodate it.

A.7 The 'Do Minimum' scenario is established as a baseline against which the benefits (avoidance of the delays through provision of sufficient airspace capacity) of the proposed airspace changes can be measured in subsequent stages of the FAS programme. It is essentially a 'Do Nothing' option (in terms of changes in airspace design) but allowing for incremental small increases in capacity that come about as a result of having well-practiced procedures, staff familiarity with the airspace sectorisation, and utilisation of improved support tools.

A.8 NEST is a tool designed for network managers and Air Navigation Service Providers (ANSPs) to support airspace design, capacity planning and post operations analysis. The tool's input data include consolidated pan-European airspace and route network and traffic data provided and verified by Eurocontrol network management. The tool's functionality allows simulating traffic forecast, regulations and resulting pre-departure flow management delays taking into account the network effect. Note that only en route capacity delays have been modelled in NEST, which comprise only a small proportion of total delay.

Approach

A.9 The approach for the Do Minimum scenario comprises the following components:

i. Incorporate an Airac traffic sample (25/6/15 to 22/7/15) into NEST and set up the sector opening scheme in the model to reflect that for the sample period;

ii. Calibrate the model such that it replicates actual 2015 observed delay;

iii. Grow the traffic sample in NEST using NATS 2015 Base Case forecast, as agreed with DfT, and run the model for each year from 2016 to 2030;

iv. 'Annualise' the results based on the proportion of delay observed in the sample period relative to the delay for the whole year in 2015 (July 2015 represents approximately 22% of the delay for that year); and

v. The output is the estimated delay for each modelled year against the 'Do Minimum' change in airspace design.

A.10 The results produced in this way would be expressed purely as delay (minutes and cost). It should be recognised that, in practice, this level of delay would not be tolerated by the airspace users. The modelled results are therefore subjected to two stages of 'post-modelling' adjustments:

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[28] European Organisation for the Safety of Air Navigation, an intergovernmental organisation composed of 41 Member States, including the UK committed to delivering improved air traffic management performance across Europe. See https://www.eurocontrol.int/

i. Assume a 'cancellation assumption'. In this analysis, it has been assumed that delays over 45 minutes could be cancelled, reducing this threshold over time as traffic increases (see A.18 below); and

ii. Acknowledge that there will be 'lost movements', i.e. supply that is not possible to schedule at all given the delays and cancellations experienced in the current and previous year.

Assumptions and methodologies

A.11 The following are the major assumptions that underpin the Do Minimum scenario modelling for each of the three stages of the process – SPAM, NEST and post-modelling application.

SPAM

A.12 NATS internal traffic forecast model, the Second Passenger Allocation Model (SPAM), is predominantly used for internal business/operational planning. Key factors in running the model are as follows:

i. Economic forecasts – key driver of passenger demand growth;

ii. Load factor evolution;

iii. Evolution of aircraft size;

iv. Future airport capacity;

v. Non-commercial traffic (business/military); and

vi. Does not take into account airspace constraints.

A.13 For the Do Minimum scenario modelling, the NATS Base Case forecast for 2015 has been used to produce the year-on-year growth in traffic applied to the July 2015 traffic sample incorporated into NEST. See Annex B.2 for a more detailed description of how SPAM works.

A.14 Use of the NATS 2015 forecast was agreed with DfT's Aviation Capacity Economics team following a comparison and reconciliation of NATS and DfT UK traffic forecasts for 2015.

NEST

A.15 NEST was designed by Eurocontrol for network managers and ANSPs for airspace design, capacity planning and post operations analysis. The tool's input data include consolidated pan-European airspace and route network and traffic data provided and verified by Eurocontrol network management. The tool's functionality allows simulating traffic forecast, regulations and resulting pre-departure delays taking into account the network effect. Annex C provides more details on how NEST works.

Post-modelling application

A.16 Having modelled delays from 2015 to 2030 by setting the forecast levels of traffic against the current airspace design, the results are modified by incorporating the probability of cancellations occurring and the likelihood of lost supply where it is known in advance that flights are not worth scheduling due to the high probability of lengthy delay or cancellation.

A.17 The cancellation assumption comprises two elements:

i. A 'trigger point' in terms of delay minutes, above which a flight becomes a cancellation candidate; and

ii. An assumed percentage of those flights above the trigger point that will be cancelled.

A.18 The application of the two assumptions is captured in this table:

Year	Trigger (mins)	% impacted
2016	45	0
2017	45	5
2018	45	5
2019	45	10
2020	45	10
2021	45	15
2022	45	15
2023	45	20
2024	45	20
2025	40	25
2026	40	25
2027	35	30
2028	35	30
2029	30	35
2030	30	35

A.19 The lost supply assumption is:

i. From the following year onwards flights consistently cancelled as per the cancellation scenario will be dropped from the schedule, and

ii. The resultant flights are split between tactical cancellations and lost supply on a 1:2 ratio (the rationale being that, as cancelled flights accumulate, airlines would prefer to not schedule than to be forced to cancel tactically and would take steps to do so).

A.20 For each year, once the cancelled and 'lost' flights are estimated, the associated minutes of delay are removed from the total delay minutes to give the full composite picture. Annex D provides the context and background on these assumptions.

Forecast impact of the Do Minimum scenario

A.21 This section describes the results from the NEST modelling and the post-modelling application.

Modelled delay for sample period

A.22 First, the base year, 2015, traffic sample for 25/6 to 22/7 that is calibrated against actual observed delay, provides the following outputs:

Scenario	No. of flights (000)	Total delay (minutes)	Delay per flight (seconds)	No. of delayed flights (000)	Delay per delayed flight (minutes)
2015 Baseline	200	17,328	1.91	9	8.9

A.23 The traffic sample was then grown using the 2015 NATS Base Case forecast for each year from 2016 to 2030 to estimate the delays during the same period.

Annual delay

A.24 The NEST delays modelled for 2016 to 2030 were 'annualised' using the current proportion of 2015 delay for the sample period relative to the delays for the whole year, i.e. 22%. This provides the following 'delays only' results from the modelling:

NEST outputs

Year	No. of flights	Total delay minutes	Average delay	No. of delayed flights	Delay per delayed flight
2016	2,455,770	147,632	0.06	14,332	10.30
2017	2,519,620	398,305	0.16	33,050	12.05
2018	2,585,130	601,859	0.23	45,809	13.14
2019	2,629,077	761,264	0.29	53,995	14.10
2020	2,686,917	1,003,886	0.37	67,259	14.93
2021	2,743,342	1,277,082	0.47	80,841	15.80
2022	2,800,952	1,691,827	0.60	100,864	16.77
2023	2,859,772	2,160,227	0.76	119,241	18.12
2024	2,919,827	2,536,977	0.87	133,100	19.06
2025	2,981,144	3,028,773	1.02	149,200	20.30
2026	3,043,748	3,449,518	1.13	161,945	21.30
2027	3,101,579	4,008,959	1.29	177,318	22.61
2028	3,157,407	4,515,695	1.43	188,818	23.92
2029	3,204,768	4,918,905	1.53	199,018	24.72
2030	3,252,840	5,632,014	1.73	212,073	26.56

Cancellation/lost supply scenario

A.25 The cancellation and lost supply rationale described in Annex D has been applied to the NEST outputs to produce the following estimated cancelled and lost supply, and a modification to the delay minutes to account for those flights now re-categorised as cancelled or lost:

Year	Revised delay minutes	No. of cancellations	Lost supply	Total
2016	147,632	0	0	0
2017	398,294	0	0	0
2018	601,793	1	0	1
2019	760,954	5	1	6
2020	1,001,492	16	32	48
2021	1,264,940	80	161	242
2022	1,669,710	138	277	415
2023	2,104,953	328	656	983
2024	2,461,048	442	884	1,327
2025	2,838,274	1,215	2,430	3,645
2026	3,195,325	1,577	3,155	4,731
2027	3,496,158	3,380	6,761	10,142
2028	3,896,324	3,969	7,937	11,906
2029	3,937,129	6,852	13,704	20,556
2030	4,408,638	8,216	16,432	24,648

Confidence assessment

A.26 All models, information sources and references used in this analysis are part of NATS' standard forecasting and modelling toolkit, and in the case of NEST, is in common use by ANSPs and others across the European ATM community.

A.27 It should, however, be noted that this is a very high-level analysis, taking UK airspace as a single entity and therefore inevitably subject to generalisations. Whilst analysis of greater granularity would not be expected to radically alter the results, it would nevertheless reveal the regional and local variations that contribute to these generalised results.

A.28 Annex F provides an assurance statement, using DfT guidelines, and the content of which has been agreed with the DfT.

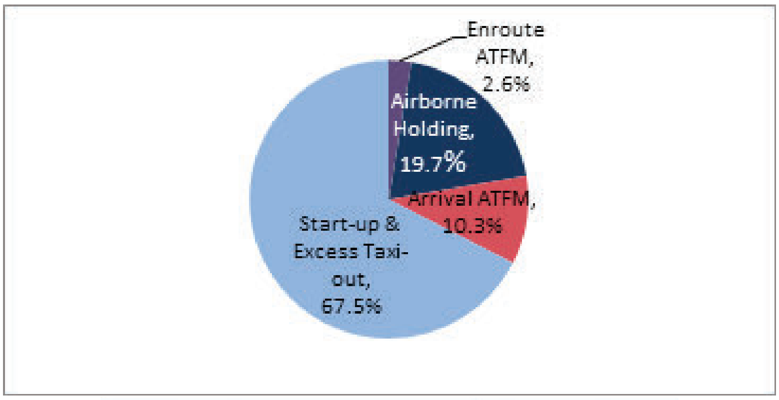
Category of delay modelled in this analysis

A.29 This section sets out an explanation of the category of delay that is modelled in the FAS 'Do minimum' scenario. In short, it is only delay caused by insufficient airspace capacity that is modelled (around 1% of all delays currently). This is only one element of NATS attributable delay and does not include staffing or technical delays, nor weather.

A.30 How this is derived can be explained with reference to actual 2015 and 2016 (year-to-date) delay.

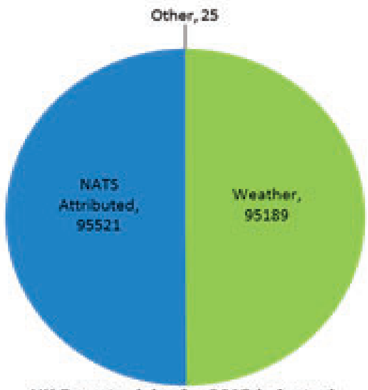
2015

A.31 The NEST modelling produced 17k minutes of capacity delay in the sample period, around 80k for the year. The following pie chart shows total en route ATFM at 2.6% or 191k, and the table gives this in the context of all categories of delay.



Flight Phase	Mins Delay
Enroute ATFM (ATFM)	191,000
Airborne Holding	1,460,000
Arrival ATFM	760,000
Start-up/Taxi-out	5,000,000

A.32 En-route ATFM can itself be broken down around 50/50 (95k each) into NATS attributed and weather delay, as follows.



UK Enroute delay for 2015 (minutes)

A.33 Capacity delay usually (2016, as shown below, is an exception) accounts for around 80-90% of the NATS attributable element; in 2015, 78k minutes of delay were categorised as en route capacity delay.[29]

2016

A.34 The NEST modelling for 2016 produced 32k minutes of delay in the sample period, around 147k for the year. Extracting year to date delay for 2016 from NATS Business Intelligence data warehouse has produced a figure of over 207K minutes in 2016. This suggests that the NEST modelling has underestimated 2016 delay by 30-40%. However, NATS considers that a good proportion of this delay was caused by abnormally high 'Project' and 'Staffing' delays experienced this year.

[29] Source for above diagrams and figures: Delay slides for NATS Board workshop, 7th April 2016 – date from NATS Analytics Business Intelligence data warehouse.

Annex B: NATS Forecasting

B.1 NATS uses software called Second Passenger Allocation Model (SPAM) to forecast passenger movements to/from UK airports, as well as air traffic movements and flights for the NATS Air Traffic Control Centres. SPAM was developed by the CAA but was transferred to NATS when CAA and NATS separated in 1999.

B.2 SPAM is a mathematical model whose main purpose is to distribute forecast passengers between the individual UK airports and then convert them into forecasts of flights. The Passenger Allocation process, of which the Shadow Cost algorithm forms the main part, uses Multinomial Logit equations to allocate passenger demand (by origin, destination and passenger type) to routings (single or multiple flights) to produce passenger forecasts by route. These in turn are converted to seat and air traffic movement forecasts by route, using LARAME (the function used to convert passengers to ATMs) and load factor graphs respectively.

B.3 NATS forecasting process produces a UK Traffic Forecast that includes High, Low and Base case scenarios. Base case is the most likely scenario given available data and knowledge at the time of the forecast. Low and High case scenarios highlight the upper and lower case risks. Apart from traffic arriving and departing in the UK, the forecast includes overflights, business jet, cargo and military flight forecasts that are modelled outside of the main process and incorporated as part of a consolidated forecast.

B.4 The main driver behind the passenger forecasts is economic growth. We base our economic growth assumptions on the data from Oxford Economic GDP forecast for the UK and other developed and emerging markets. Apart from the GDP growth, NATS forecasting process incorporates:

i. Assumptions for UK airport capacities;

ii. Changes in aircraft size and load factor over time;

iii. Impact of air passenger duty; and

iv. Potential pass-through costs to passengers from the emissions trading scheme.

B.5 A variety of data used as an input for the process include:

i. UK Flight Database (details on all flights controlled by all NATS Air Traffic Control Centres which includes some military flights);

ii. UK Airports Statistics CAA (Passengers and Flights);

iii. CAA Airport Surveys (information on passenger characteristics);

iv. International Passenger Survey (IPS);

v. EUROCONTROL STATFOR Data on Flight and Service Unit data; and

vi. Oxford Economics (OE) (Economic forecasts).

B.6 The accuracy of NATS forecasts is monitored internally on a monthly basis.

Annex C: The Network Modelling and Analysis Tool (NEST)

C.1 The network modelling and analysis tool (NEST) is owned by Eurocontrol and used by its member organisations (which includes the UK) to undertake this type of analysis. As such it is a referenceable entity/artefact, with further information available at:

https://www.eurocontrol.int/services/nest-modelling-tool

C.2 In UK airspace there are over 150 elementary and combined sectors. Each sector has an assigned capacity value to it which defines the number of flights a sector controller can handle. Knowing sector capacities along with traffic demand helps to define the opening scheme, i.e. the order in which sectors are opened and closed.

C.3 Accurate estimate of sector capacity is essential in order to be able to simulate delay in NEST. In order to make sure that sector capacities are up to date and reflect reality every year a calibration exercise is conducted. It is normally done for a selected summer month when the traffic and associated delay are at their highest. The calibration exercise consists of intuitive adjusting of sector capacities and running regulation and delay simulation until the point when NEST simulated delay for each sector coincides with the delay observed in reality. Simulated delay is compared to actual delay at sector and local area group level and also day-by-day. This exercise allows us to 'train' NEST and provide confidence that the output of the delay simulation in NEST can be relied upon for the future scenarios.

C.4 As a result of the 'by sector' calibration, delay generated in future years as a result of traffic growth is also on a sector-by-sector basis rather than simply a global figure. NEST picks up the SPAM outputs, clones traffic based on the forecast growth, and estimates the delay for each year's traffic volume.

Annex D: Rationale for constraints to growth as a result of increased Air Traffic Delays

D.1 Airport Coordination Limited (ACL) scheduling requires adherence to block times for Level 3 slot coordinated airports of +/-30 minutes and requires 80% of flights to achieve these block times. Repeated offenders are fined and may have their slot rights withdrawn.

D.2 Block times are calculated based on historic performance not on predicted data. Hence consistent delays will be dealt with tactically during the season but when planning the next equivalent season (e.g. Summer or Winter) consistent historic poor On Time Performance (OTP) will be assessed and may result in dropping the city pair from the schedule.

D.3 Lack of ability to forecast future season's performance means that, as indicated above, the reaction to poor performance will typically be 1 year in arrears.

D.4 Slots are traded between operators and slots at peak times can be scarce (as in high demand) so it may often not be possible to obtain different slots that enabled extended block times.

D.5 Missing slots/consistent delays can have knock on effect to flight rotations and connections and OTP is particularly important for corporate clients which tend to be the highest value for the airline.

D.6 Shorthaul and low cost operators business model is based on high airframe and crew utilisation and short turn-arounds of typically 25 minutes for morning rotations and again for the afternoon's rotations with typically a crew change at midday.

D.7 Consistent delays of greater than 30 minutes will knock on throughout the rotations and may mean cancellations in order that the schedule can be recovered e.g.

i. Many airports have night curfews, so build-up of delay through the day will result in cancellation if the scheduled rotations are forced into curfew;

ii. Likewise, crew hours are limited by EASA flight time limitations and crews cannot regularly exceed planned operating hours; and

iii. Even if the same schedule were to be attempted, delays effectively mean that more aircraft and crew are required to service the same schedule, hence UK operations become less commercially viable.

D.8 Strategic removal of flights will tend to be done on a commercial basis such that lower value flights such as those from lower density regions are removed first (e.g. BA tend to cancel shorthaul in favour of protecting longhaul and Virgin cancellation of Little Red and CityJet cancellation of Cork – LCY). The impact can be reduced frequency and connections to/from UK regions.

D.9 Suspended scheduled flights will release aircraft & crew which are likely to be re-deployed to other regions outside of the UK.

D.10 The issue is airspace so the scheduling committees at the airport will continue to try and fill the runway slots.

D.11 Heathrow & Gatwick will continue to try and operate a full schedule due to the value of slots but will become increasingly less economic as shorthaul connections become more of an issue

D.12 Proposal for modelling:

i. Model demand & delays in UK domestic out to 2030;

ii. Determine number of flights which would be tactically cancelled based on previous rationale for “Do Nothing Analysis”; and

iii. Assume in the following year onwards that flights consistently cancelled per item 2 will be dropped from the schedule.

Annex E: Airline cost calculations

Introduction to the analysis

E.1 As detailed in Annex A, NATS undertook the modelling of the 'Do Minimum' scenario on behalf of DfT, using the Eurocontrol NEST tool. The outputs of this process include (amongst other items) forecasts of aggregated annual flights, delay minutes and the number of cancellations.

E.2 DfT analysts have applied Eurocontrol standard values for costs of delay and cancellations[30] to these outputs in order to produce estimates for the annual and total costs to airlines of delays and cancellations, as modelled under the NATS 'Do Minimum' scenario.

E.3 This section sets out the various assumptions and methodologies behind these figures, as well as presenting the results, and provides an assessment of confidence in the analysis as a whole.

Assumptions and methodologies

E.4 The analysis itself is based on information acquired from the following sources:

i. Delay and cancellation outputs from NATS 'Do Minimum' central scenario;

ii. Eurocontrol standard values for cost of delays and cancellations;

iii. Bank of England exchange rate data;[31] and

iv. Treasury UK GDP deflator series (November 2016 update).[32]

Delays

E.5 Data is available from Eurocontrol which estimates the cost to airlines of delays. This estimate is expressed as a per minute cost in euros, in 2014 prices. We have converted this estimate into £ using the Bank of England average €/£ exchange rate for 2014 and then deflated to 2016 prices using the HM Treasury UK GDP deflator series. This produced a per minute average delay figure of £32.90 (when weighted 50/50 between ground and air delays). It should be noted this figure captures costs to airlines only (i.e. fuel, crew costs, parking charges, passenger compensation), and does not include 'passenger opportunity costs', nor APD/tax impacts, or other societal costs.

[30] See http://www.eurocontrol.int/sites/default/files/publication/files/standard-input-for-eurocontrol-cost-benefit-analyses-2015.pdf
[31] See http://www.bankofengland.co.uk/boeapps/iadb/
[32] See https://www.gov.uk/government/statistics/gdp-deflators-at-market-prices-and-money-gdp-november-2016-the-autumn-statement

E.6 The delay cost per minute figure was then multiplied by the volume of delay minutes in each year attributed to ATFM by NATS to produce annual and cumulative estimates for the costs of these delays to airlines, for the period 2016 to 2030. Output values for selected years are presented alongside corresponding NATS estimates for flight numbers[33] and delay minutes in the following table (all cost estimates presented to 3 significant figures) – note that the present value figure is discounted using the standard 3.5% rate:

	NATS 'Do Minimum' outputs		DfT estimates
Year	No. of flights	ATFM delay minutes	Cost to airlines (2016 £)
2016	**2,455,770**	**147,632**	**£4,860,000**
2020	**2,686,917**	**1,001,492**	**£32,900,000**
2025	**2,981,144**	**2,838,274**	**£93,400,000**
2030	**3,252,840**	**4,408,638**	**£145,000,000**
Present value: 2016-30	**42,941,893**	**32,182,664**	**£762,000,000**

E.7 Data is not available on UK-specific delay costs. Instead we have used Eurocontrol data for system-wide average costs. We are assuming therefore that European averages for costs of delay are a good proxy for UK-specific delay costs, but we think this is a reasonable assumption.

E.8 Eurocontrol provides information on a number of different causes why aircraft can be delayed. We have selected the most appropriate for the purposes of our analysis – this is "tactical delays without network effects".

E.9 Delays accrued on the ground, and in the air, have differing costs. For the purposes of this modelling, a 50/50 split between air and ground delays was assumed, in order to reflect the fact that limited airspace capacity would impact both areas. When weighted accordingly, this produces the per minute cost of £32.90 outlined above. This cost decreases to £24.80 per minute assuming all delays are ground based and increases to £41 per minute assuming all delays are air based.

E.10 As delay cost estimates are presented on the basis of departure delays, the analysis inherently assumes that departure and arrival delays are equivalent, i.e. the aircraft arrives at its destination without making up any of its departure delay on its journey.

E.11 The analysis is not broken down by length of delay, although the costs to airlines of a heavy delay can be higher due to the need to compensate passengers under EU legislation. This is because the Eurocontrol figure assesses the cost of an average 1 minute delay to the airline, and its values seek to take account of the potential for higher costs for a longer period of delay.

Cancellations

E.12 For cancellations, a Eurocontrol estimate for the average Europe-wide cost to an airline of a cancellation was adopted from their standard inputs. Again, this figure was converted to £ and inflated to 2016 prices using the same methods as with delays. This produced a figure of approximately £14,400 for the average per flight cost of cancellation,[34] which was then multiplied by the NATS outputs on numbers of

[33] This includes all domestic and international commercial, military, relevant general aviation and overflights (aircraft in UK airspace that do not land in the UK).

[34] This value relates to cancellation on the day of operation and includes: service recovery costs, i.e. passenger care and compensation costs (passenger vouchers, drinks, telephone calls, hotels); loss of revenues; interline costs; loss of future value, i.e. passenger opportunity costs (individual passenger delay expressed in value); crew and catering costs; passenger compensation for denied boarding and missed connection (estimated on the application of the EU regulation); luggage delivery costs; and operational savings

cancellations per year resulting from ATFM delays in order to produce annual and cumulative cost estimates, for the period 2016 to 2030. Output values for selected years are presented alongside corresponding NATS estimates for flight numbers and ATFM cancellations in the following table – again, the present value figure is discounted by 3.5% per annum:

	NATS 'Do Minimum' outputs		DfT estimates
Year	No. of flights	ATFM cancellations	Cost to airlines (2016 £)
2016	**2,455,770**	**0**	**£0**
2020	**2,686,917**	**16**	**£231,000**
2025	**2,981,144**	**1,215**	**£17,500,000**
2030	**3,252,840**	**8,216**	**£118,000,000**
Present value 2016-30	**42,941,893**	**26,219**	**£248,000,000**

E.13 When the cumulative cost to airlines across the assessed period is summed with that of delays, the total estimate of additional airline costs attributable to the 'Do Minimum' scenario is in excess of £1 billion to 2030.

E.14 As with the delay costs assessment, by relying on Eurocontrol data, the analysis inherently assumes that the Europe-wide average figures are a good proxy for UK-specific data, which was unavailable. In addition, for cancellations, the analysis assumes that the system-wide average cancellation cost is a good proxy for the short-haul cancellation cost (as it is assumed the majority of cancellations under the 'Do Minimum' scenario are on short haul services). A simple comparison of the system-wide figure with that for traditional network and low cost carriers suggests this is likely to be the case.

Confidence assessment

E.15 All additional information used in this post-modelling analysis beyond that used in the NATS forecasts was acquired from published government, central bank or inter-governmental sources, and is in line with best practice guidance.

E.16 The analysis itself is reliant on European average values for delay and cancellation costs, provided by Eurocontrol, which may differ from UK-specific values, though not drastically so, as a large proportion of delay and cancellation costs is made up by passenger compensation, for which legislation is currently set at a European level, and the market for other input costs (e.g. fuel) is global.

E.17 Cost estimates produced are at a high level, based on aggregate data, and are therefore inevitably subject to generalisations. Had data been available, analysis at a more granular level would have produced more accurate results, though it is unlikely these would have differed drastically from the values presented within this document. This analysis is relatively high level, however this is proportionate to the Strategic Case that it supports.

E.18 Annex F provides an analytical assurance statement in line with DfT guidance.

(fuel, airport and navigation fees, maintenance, handling outstations, lounges, outstations). The value does not include ground handling costs. Source: Eurocontrol, cost and benefit analyses 2015, page 11, http://www.eurocontrol.int/sites/default/files/publication/files/standard-input-for-eurocontrol-cost-benefit-analyses-2015.pdf

Annex F: Analytical Assurance Statement – Low/Medium rating

F.1 This analysis is for a report outlining the strategic rationale for UK airspace modernisation. The purpose of the analysis is to provide a relatively simplistic, high-level indication of the scale of likely flight delays and cancellations, and the associated costs to society, in the do-nothing scenario of not modernising the UK's airspace infrastructure. In doing so it supports the case for backing industry-led airspace modernisation. Although the analysis has been rated as low/medium we are confident that the results can be used as intended to inform a simplistic, high level indication of the scale of impacts in the absence of airspace modernisation.

Scope for Challenge

F.2 The analysis has not been constrained by time nor cost and due to its high level nature, does not estimate the impact on noise or carbon. Further analysis could be used to identify local 'hotspots' (almost certainly in and around Heathrow for example). The 'cancellation assumption' applied to the modelling, an assumption on what proportion of flights delayed over a certain time would be cancelled, has been varied to account for different responses by airlines. None of these would be 'different' conclusions, just different ways of looking at the same picture.

Risk of Error

F.3 The models involved – SPAM and NEST – are utilised by NATS (the UK's national air traffic controller) in its business planning. The models have been quality assured by NATS and Eurocontrol and are used regularly by industry and air navigation service providers (i.e. NATS).

F.4 NATS forecasts are regularly validated against outturn data – see Annex B of the report for further information - which increases the assurance of the forecasts.

Uncertainty

F.5 The outputs of the modelling have been reviewed several times by technical experts in NATS. DfT analysts have quality assured the post-modelling 'cancellation assumption' but do not have the technical experience to quality assure the SPAM and NEST outputs of delay minutes.

F.6 The assumptions relating to the modelling (sectorisation,[35] traffic samples, forecasts) are reliable, being those used in all NATS studies and those by counterparts across

[35] The division of airspace such that the provision of air traffic services is decomposed into manageable workloads.

Europe. However, as with any medium to long term forecast there is inherent uncertainty underpinning the analysis. The main element of the forecasts, commercial air traffic movements, is sufficiently comparable to DfT forecasts of the same type of flights. It is not possible to compare NATS forecasts of overflights, military and non-commercial aviation since DfT does not produce such forecasts.

F.7 Assumptions have been made regarding traffic mix, passengers per flight and airspace sectorisation, but these are not expected to substantially alter the basic scale of the delays issue.

F.8 The cancellation assumptions (see Annex D) are based purely on intuitive logic and can be varied. But they are cautious in terms of underestimating cancellations and any variation is likely to increase rather than decrease the number of cancellations estimated. This approach was taken given the uncertainty in the modelling and the objective to produce an estimate with higher confidence even if that was a conservative, lower bound estimate. Given the growth in traffic forecast the scale of delays and resulting cancellations are as expected – changes in the cancellation scenario may result in relatively small changes in the outputs.

F.9 Post-modelling analysis was conducted by DfT analysts in order to assess the potential future costs to airlines from delays and cancellations under the 'Do Minimum' scenario (see Annex A). This made use of established data from Eurocontrol, as well as standard conversion factors from the Bank of England and HMT. Whilst data on costs is based on European average figures, these would be expected to be very similar to UK-specific values, as explained in Annex E.7. In addition, the post modelling analysis work was assured internally by DfT analysts.

Annex G: Low Level Airspace Design Concepts, Options and Impacts

G.1 The following are some examples of low level arrival and departure concepts and potential options which could be deployed to manage the impact of aircraft noise on those communities affected as a result of airspace change utilising the aircraft navigation performance capabilities. These are more fully described in a CAA publication CAP 1378 which was drafted as part of the FAS programme of work. For each concept there are a range of potential options on how they may be applied. Concepts are described generally and then impacts are assessed against the specific options.

Height Bandings

G.2 The concepts and options refer to the height bands based on the altitude priorities described in DfT guidance.[36] It should be noted that these height bands relate to the height achieved at the minimum climb gradient, or shallowest descent profile.

G.3 With respect to departures this means that the 4,000ft threshold referred to for a departure would be expected to be towards the end of the Noise Preferential Route (NPR). However, in reality aircraft have a range of climb profiles; and the majority will climb more than the minimum gradient required. However, if these aircraft remain on the route (and are not vectored) they would follow the alignment of the routes regardless of being higher or lower than the procedure requires.

G.4 This means that care needs to be exercised when considering actual track data alongside these design solutions. For example, a design solution may refer to a threshold at 7,000ft above which populations aren't avoided by a departure route design. Real data may show departures passing 7,000ft well before this threshold; however, this does not mean that they would follow an alternative route on reaching 7,000ft (unless they are vectored).

G.5 For arrivals, the thresholds refer to shallowest descent profile. In reality there is variation in optimal descent profiles. This is because the most efficient and least noisy descent profiles are achieved with engines idling and with an aerodynamically 'clean' configuration (i.e. landing gear & flaps retracted). If their descent is too shallow they will need more power which will increase noise – if they stay high too long and descend too steeply, they may have to use flaps, landing gear, and even air brakes to slow down - all of which create more noise. Aircraft passing a 4,000ft design threshold based on the shallowest approach path may therefore be somewhat higher in reality.

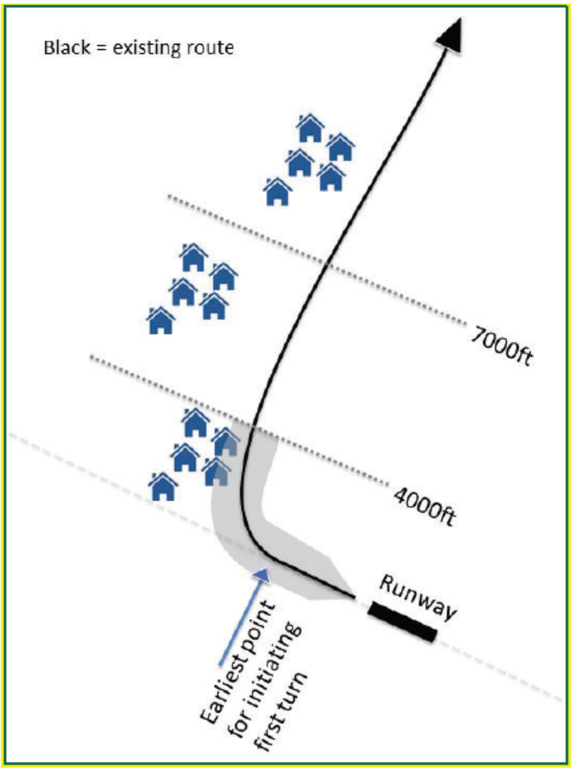
[36] https://www.gov.uk/government/publications/air-navigation-guidance

Departures

G.6 This chapter lists options for mitigating noise impacts through different departure route design concepts and options. The concepts group together options which apply the concept in different height bands.

Concept 1: Single Performance-Based Navigation (PBN) Standard Instrument Departure (SID) to Replace Conventional Routes

Option 1a. PBN SID replication



G.7 The black route signifies the historic nominal centreline. The PBN replication of this route would aim to match the nominal centreline as closely as is possible.

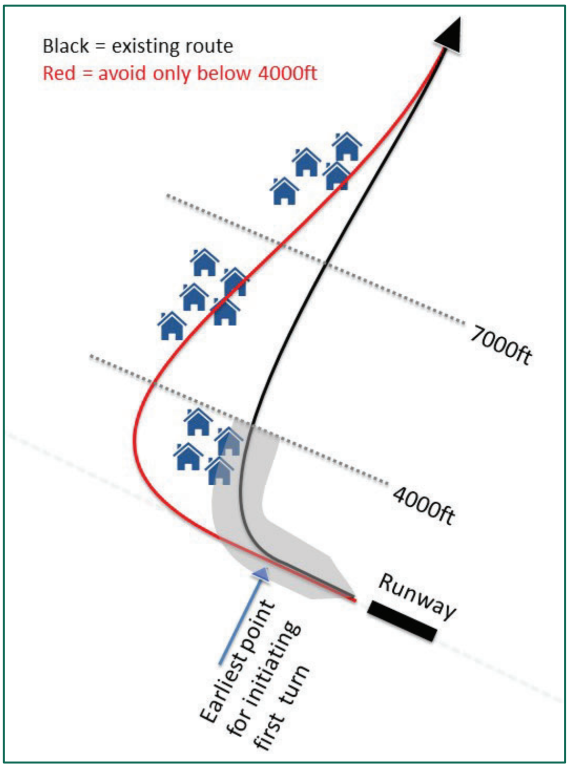
G.8 Replication does not take into account local geography as the aim is to match the existing procedure rather than redesign it.

G.9 Whilst the replication would aim to match the historic procedure in terms of centrelines, the application of PBN would be expected to lead to an increase in concentration as a consequence of improved track keeping.

Noise Objective: Concentration	
Environmental impacts	
Total number of people affected by noise	Fewer people under concentrated route
New populations exposed to noise	None[37]
Intensity/frequency of aircraft experienced by those affected	PBN more accurate therefore greater concentration
Noise Preferential Routes (NPR)	Assuming the NPR can be accurately replicated
Fuel/CO_2 efficiency	No impact
Operational impacts	
Runway Capacity	No impact
Air Traffic Control (ATC) System capacity	No direct benefit in isolation although a system of PBN routes will provide additional ATM capacity
ATC system complexity	No impact
Aircraft capability issues	
Flyability	Some conventional procedures cannot be replicated
Flight Management Computer (FMC) capacity	No impact
Applicability	Replication is the default option for modernising conventional routes

[37] An exact replication will mean no new populations exposed, but conventional procedures that cannot be replicated precisely could mean new populations are exposed.

Option 1b. PBN SID re-design avoiding populations below 4,000ft



G.10 The red route signifies a new PBN route which avoids dense population below 4,000ft. The black route is the original route which is shown for reference – in this solution the black route would be disestablished. After passing 4,000ft, the red route goes back towards the intended direction, ignoring populations which are overflown above 4,000ft.

G.11 In order to avoid the dense population below 4,000ft, the departing aircraft needs to fly straight ahead for longer, possibly outside the current NPR swathe (typically 3km wide). This adds on some distance and could affect runway throughput. It will now fly over new areas.

G.12 This solution was implemented in 2015 on the Luton RWY26 MATCH and DET SIDs although the PBN SID remained within the existing NPR swathe.

Noise Objective: Concentration	
Environmental impacts	
Total number of people affected by noise	Fewer people under concentrated route, fewer people over flown below 4,000ft (but maybe more over flown above this)
New populations exposed to noise	Yes – avoiding populations below 4,000ft will put routes over adjacent less populated rural areas. There could be an increase in the numbers overflown above 4,000ft
Intensity/frequency of aircraft experienced by those affected	PBN more accurate therefore greater concentration
Noise Preferential Routes	NPR will need to be redrawn
Fuel/CO_2 efficiency	Longer route will mean more fuel/CO_2. Possibly more delay on ground with engines running (runway capacity)
Operational impacts	
Runway Capacity	Straight ahead for longer would impact runway capacity
ATC System capacity	No direct benefit in isolation – although a system of PBN routes will provide additional ATM capacity
ATC system complexity	No impact
Aircraft capability issues	
Flyability	No impact
FMC capacity	No impact
Applicability	Noise is the priority below 4,000ft, therefore avoiding populations should be considered as an option for any SID proposal below 4,000ft which goes beyond replication

Arrival Options

G.13 This section lists options for mitigating noise impacts through different arrival route design concepts and options. The concepts group together options which apply the concept in different height bands.

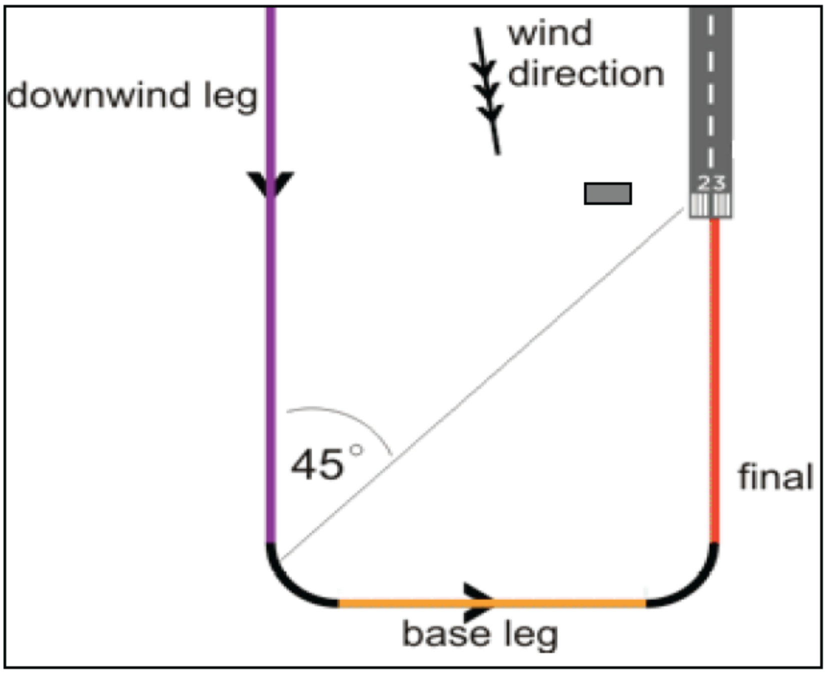
Arrivals Definitions

G.14 Aircraft have to land facing into the wind. The approach path to a runway is generally split into three segments as shown below. The downwind leg runs parallel to the runway and the base leg turns aircraft to intercept the final approach which, in today's systems, head straight on towards the runway.

G.15 In today's 'conventional' air traffic environment there are very few defined routes for everyday use for downwind and base leg, but the final approach path is usually defined by the Instrument Landing System (ILS) which aircraft follow for their approach to the airport.

G.16 This means that traffic is currently vectored on downwind and base leg. The vectoring can vary on a flight by flight basis as aircraft are positioned to achieve a safe and efficient landing sequence.

G.17 Utilisation of PBN standards allows modernising the route structure to allow PBN routes to be defined down to the final approach which will improve predictability although in busy times some vectoring will still be required to maintain the landing sequence (see Runway Capacity).



Continuous Descent Approach (CDA)

G.18 In the UK, in order to keep fuel burn, CO_2 and aircraft noise to a minimum, approach controllers and pilots are trained to try and achieve a Continuous Descent Approach[38] (CDA). When a CDA procedure is flown the aircraft stays higher for longer, descending continuously from the bottom level of the stack (or higher if

[38] http://www.caa.co.uk/docs/68/Basic_Principles_CDA.pdf

possible) and avoiding any level segments of flight prior to intercepting the final approach. A continuous descent requires significantly less engine thrust than prolonged level flight. It may sometimes not be possible to fly a CDA due to airspace constraints or overriding safety requirements.

Curved Approaches

G.19 Curved Approaches are those where aircraft are following a strictly defined PBN approach path from downwind of the airfield and round onto final approach. At some point the aircraft may even be required to switch 'mode' depending on the landing system in operation at the airfield in question.

G.20 Curved approaches vary in their technical demands on the navigational capability of the aircraft, the airfield and ATC equipment. Curved approaches provide the ability to allow a much shorter minimum final approach, from, typically, 7 or 8nm down to 4 or even 3nm. However, the technical demand on the aircraft's navigational performance, the relevant immaturity of curved approaches and the resultant reduction in runway throughput during peak hours (if they were to be used by all arrivals) means that curved approaches cannot currently be used widely enough as a method of providing noise relief in order to support all high intensity runway operations.

Network Enablers for Low Altitude Navigation noise solutions

G.21 The options presented in this section relates to PBN routes that deliver aircraft through low level airspace onto the runway. As described earlier, there will always be circumstances where aircraft need to be vectored off these PBN routes to maintain safety and capacity. However the degree to which this is required will depend on the way in which aircraft are delivered onto these routes from the network airspace that sits above. In turn, this will depend on how the network airspace is configured and managed.

G.22 Managing the way in which multiple aircraft arrive simultaneously is key to the performance of PBN routes. If the network is configured and managed so that the aircraft 'bunches' are sorted into an orderly stream before they join the low level PBN routes, it is more likely that aircraft can be left to follow the low level routes autonomously. Conversely, if 'bunching' is not addressed in the network airspace, air traffic control will be required to tactically manage the aircraft in the lower airspace – providing more instructions that lengthen or shorten flight paths which means less route adherence and a greater variation in track distribution.

G.23 Multiple aircraft arriving within a short time frame are currently managed through holds in the network airspace (for major airports these are generally at 7,000ft or above). These are effective at absorbing inbound delay but are not a particularly efficient means for generating a single, orderly stream of arrivals – hence at busy airports there is a tendency for dispersed arrival traffic patterns at low levels.

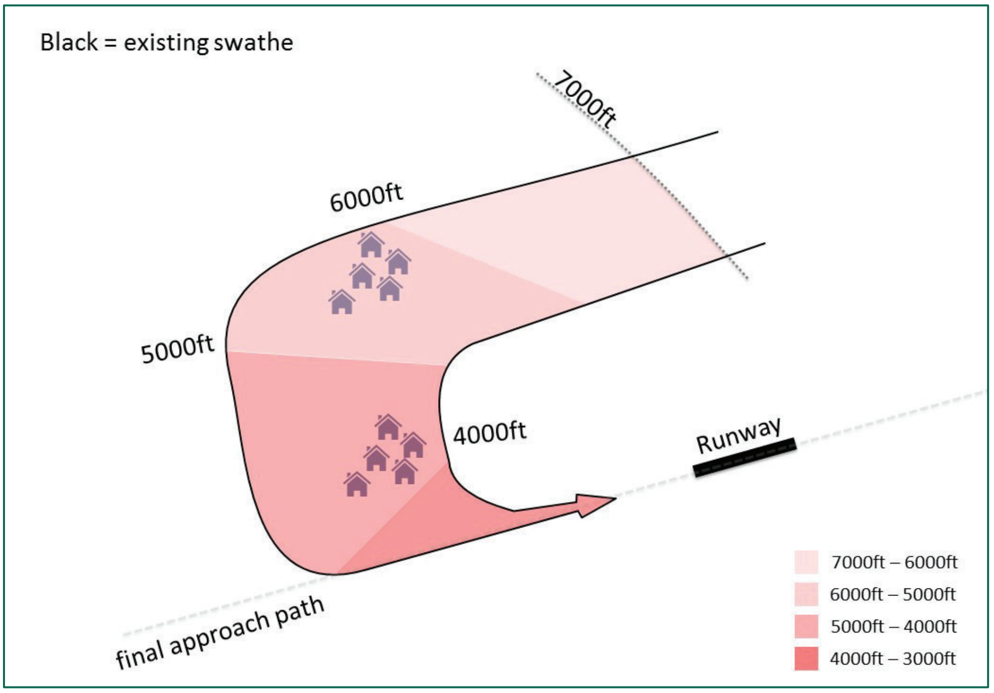
G.24 In a future PBN environment there are other techniques, with associated route structures, that can work alongside or instead of holds to generate a more orderly stream. The two principle techniques are referred to as 'Point Merge' or 'Tromboning'. These concepts are for managing airborne delay, generally[39] in higher level airspace above 7,000ft, rather than being techniques to mitigate noise. However, it is worth noting that the efficiency of any low level PBN route structure will

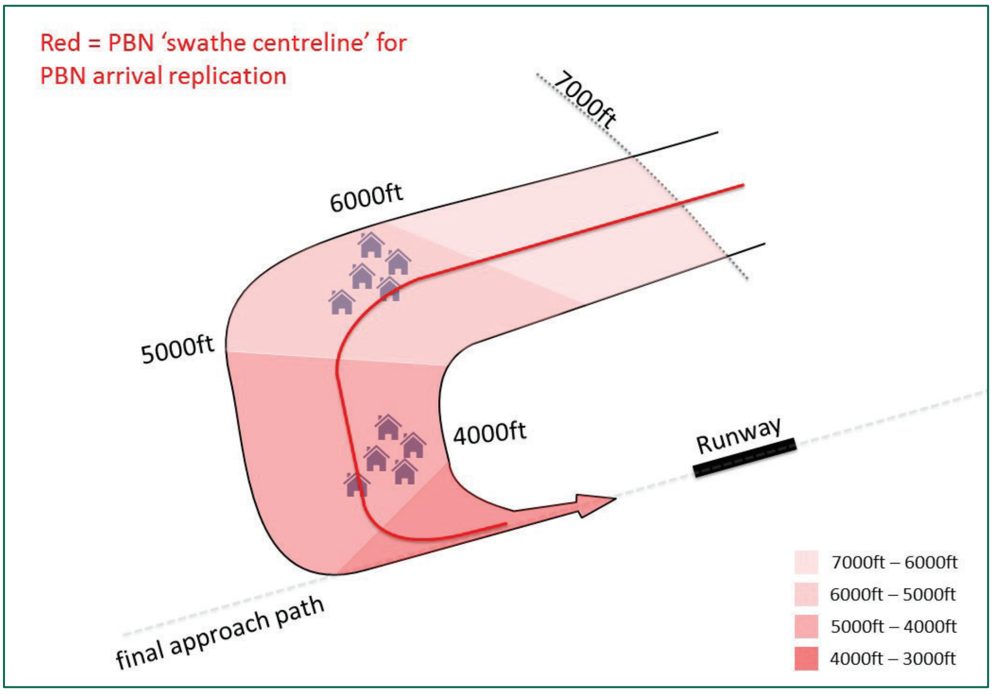
[39] These techniques are not necessarily limited to higher level airspace.

be limited unless there is an appropriate network design that delivers an orderly sequence of arrivals.

Arrival Concept 1: Single PBN routes for arrivals

Option 1a: PBN arrival "replication"



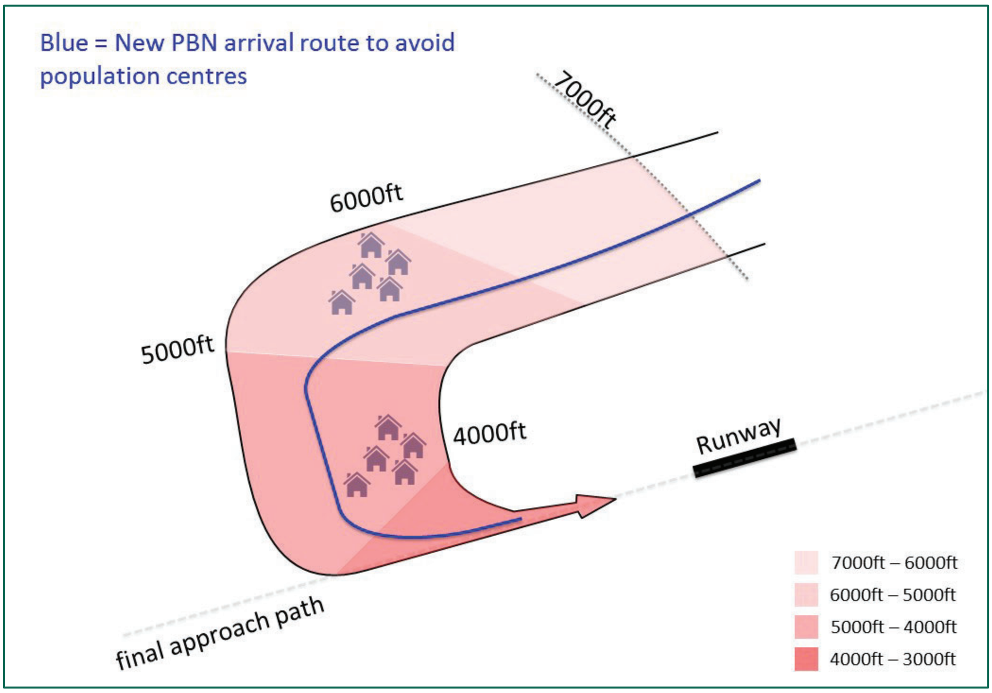


G.25 The current arrival swathe is depicted by the extremities of the black arrows. The swathe covers 2 areas of dense population. Replicating this arrival flow by means of a single PBN route requires that route to be in the middle part of that swathe (the most frequently used path) and provides a single consistent point of interception of the final approach.

G.26 Replication here means that potential PBN capabilities are not utilised to provide relief in specific areas. In this circumstance, traffic is concentrated on the red centreline. This was implemented at Bristol airport in 2014.

Noise Objective: Relief, Dispersal	
Environmental impacts	
Total number of people affected by noise	Reduced
New populations exposed to noise	No
Intensity/frequency of aircraft experienced by those affected	Increased for those under the route
Noise Preferential Routes	N/A
Fuel/CO_2 efficiency	Positive impact. Optimised final approach and the route allows the Flight Management System (FMS) to fly an optimised CDA
Operational impacts	
Runway Capacity	Reduced runway throughput unless vectoring still allowed
ATC System capacity	Reduced ATC workload means they can optimise the final approach spacing
ATC system complexity	The existence of a route reduces ATC workload even if vectoring still sometimes required
Aircraft capability issues	
Flyability	No issues – positive impact for operators
FMC capacity	No Issues
Applicability	Replication, that matches the centre of today's distribution of traffic is the default option for modernising approach tracks

Option 1b: A single PBN arrival route avoiding population centres



G.27 PBN is used to avoid overflight of specific areas, in this case, areas of dense population.

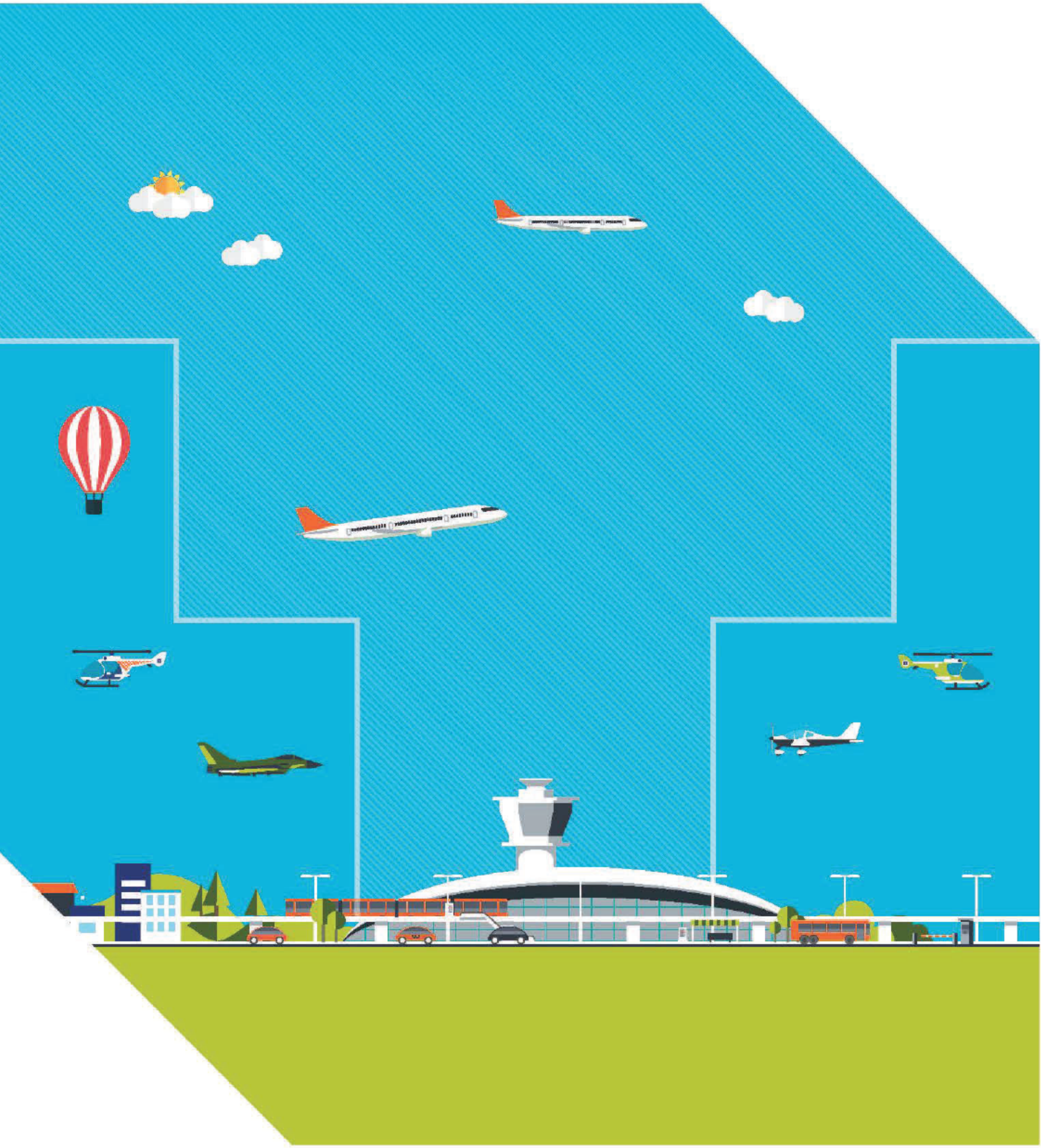
G.28 The blue route avoids those areas and concentrates arrivals onto a single track, subject to the issues described in the Runway Capacity section of this document.

G.29 This has been successfully applied at Bristol airport for their easterly approaches in 2014, as the replicated route was adapted to minimise flight over land.

Noise Objective: Relief, Dispersal	
Environmental impacts	
Total number of people affected by noise	Reduced
New populations exposed to noise	No new populations although a PBN route means concentration of aircraft along that route
Intensity/frequency of aircraft experienced by those affected	Increased for those under the route
Noise Preferential Routes	N/A
Fuel/CO_2 efficiency	A single, optimised route enables FMS to fly the aircraft, enhancing CDA performance however the route length may have increased to avoid population
Operational impacts	
Runway Capacity	Reduced runway throughput unless vectoring still allowed
ATC System capacity	Reduced ATC workload means they can optimise the final approach spacing
ATC system complexity	The existence of a route reduces ATC workload even if vectoring still sometimes required
Aircraft capability issues	
Flyability	Positive impact as FMS can fly the aircraft
FMC capacity	No impact
Applicability	Applicability depends on the height of the proposed change and local requirements for noise relief should be agreed as part of the design options

Airspace Modernisation Strategy

CAP 1711



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Contents

Executive summary

1. Airspace is a crucial part of the UK's infrastructure. It must be maintained and enhanced to provide more choice and value for consumers, through the capacity for airlines to add new flights, reduced flight delays and enhanced global connections that can help boost the UK economy, while continuing to improve safety standards. Unlocking the benefits of modernisation will make journeys faster and more environmentally friendly. Better airspace design can help with the management of noise impacts and improve access for other airspace users, including the Ministry of Defence, for whom airspace is a key resource.

2. UK airspace is some of the most complex in the world, yet its design dates back to the 1950s and 1960s. The Government has set out its support and objectives for the modernisation of UK airspace in its Green Paper[1] published in December 2018 in preparation for its forthcoming Aviation Strategy. Prior to this, in October 2017, the Government tasked the CAA with a key oversight role for airspace modernisation. Consistent with our role as specialist aviation regulator and our statutory responsibilities, we are required to prepare and maintain a co-ordinated strategy and plan for the use of UK airspace for air navigation up to 2040, including for the modernisation of the use of such airspace.

1 The Green Paper also consults on some specific new government policies to support modernisation. https://www.gov.uk/government/consultations/a-new-aviation-strategy-for-the-uk-call-for-evidence

3. This Airspace Modernisation Strategy responds to that requirement, setting out the detailed initiatives that industry must deliver to achieve the objectives envisaged in current government policy. It supersedes and replaces the Future Airspace Strategy (FAS), although many key elements of FAS remain relevant and are included in this new strategy. This strategy document has been developed by the CAA taking into account feedback from stakeholders.[2]

4. Working together, the Department for Transport and the CAA have developed a shared objective for modernising airspace. This is set out in full in Chapter 1, the Introduction. Airspace modernisation will need to be delivered and funded by a range of aviation organisations, and a wide range of stakeholders will need to be engaged throughout its delivery. The Department for Transport and the CAA are committed to working with relevant stakeholders and those tasked with delivery to ensure modernisation happens in a coherent and consistent way, giving rise to the benefits expected.

5. The strategy sets out the ends, ways and means of modernising airspace, initially focusing on the period until the end of 2024.[3] The **ends** are derived from UK Government and relevant international policy and the **ways** of achieving them include new airspace design, new operational concepts and new technologies. To establish the **means** of delivering modernised airspace, such as the resources needed, this strategy requires industry-led working groups to draw up delivery plans, with delivery overseen by the CAA. One such plan will be a macro-level co-ordinated implementation plan (an airspace change masterplan) detailing which interdependent airspace changes are deemed necessary and when.

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[2] The CAA published a draft for comments in July 2018. https://consultations.caa.co.uk/policy-development/draft-airspace-modernisation-strategy/

[3] 2024 corresponds to the end of the next Single European Sky Performance Scheme reference period (RP3). https://ec.europa.eu/transport/modes/air/single-european-sky/ses-performance-and-charging/performance-and-charging-schemes_en

6. We have also worked with the Department for Transport, NERL (the subsidiary of NATS that is sole provider of UK en-route and London Approach air traffic services) and the Infrastructure and Projects Authority to develop a new governance structure for airspace modernisation. The new governance structure includes a ‘UK Airspace Strategy Board’ chaired by the Aviation Minister. The Department for Transport and the CAA will seek to develop a vision for airspace modernisation through this new Board. Further details of the governance structure and groups are set out in Chapter 2 and a supporting Annex to this strategy document.

7. This new governance structure replaces the previous FAS groups, but many of them will remain as industry co-ordination groups that provide a useful focal point and mechanism for including representation of particular stakeholder interests.

8. The CAA must consult the Secretary of State about the preparation and maintenance of its strategy, and must give a delivery report annually. In presenting this first edition of an Airspace Modernisation Strategy to the Secretary of State, we begin this process. The CAA will review the strategy regularly in making our annual report in which we will measure progress against the delivery plans. The CAA will also take those opportunities to continue to update the strategy, bearing in mind the 2040 timescale specified by the Government, in order to accommodate new technologies or other developments. Where appropriate, the CAA may seek comments on these updates before implementing them, but will not do so in every case.

9. Chapter 1 of this strategy introduces the need for airspace modernisation and describes its objective, and the approach taken in this strategy.

10. Chapter 2 sets out the roles and responsibilities of the Department for Transport, the CAA, NERL and other relevant stakeholders in the new governance structure.

11. Chapter 3 sets out the ends that modernised airspace must deliver, all of which are derived from UK and international policies and laws. All the CAA's responsibilities in the Air Navigation Directions must be carried out having regard to section 70 of the Transport Act 2000. We therefore describe the ends to be achieved under the following headings consistent with our obligations:

- maintaining and enhancing high aviation safety standards
- securing the efficient use of airspace and enabling integration
- avoiding flight delays by better managing the airspace network
- improving environmental performance by reducing emissions and by better managing noise
- facilitating defence and security objectives.

12. In Chapter 4, 15 initiatives are identified focusing on the period until the end of 2024 as the primary ways of modernising airspace. They cover five areas of airspace infrastructure:

- upper airspace (above c.25,000 feet)
- terminal airspace (complex lower airspace around airports from c.25,000 feet to c.7000 feet)
- airspace at lower altitudes (below c.7000 feet)
- uncontrolled airspace
- the UK's communications, navigation and surveillance (CNS) infrastructure and air traffic management.

13. The 15 initiatives are summarised in Table 1 below showing the obligations[4] and timeframes.

14. Chapter 5 identifies that there are a number of current foreseeable 'unknowns' that could change and reshape the context for this strategy. While the current initiatives are enablers for further work to accommodate new airspace users such as drones, there are areas in which the

[4] Under the EU (Withdrawal) Act 2018 the Government is in the process of bringing EU aviation law into UK law, with certain responsibilities reassigned to the Secretary of State or the CAA.

Government has signalled it may develop new or amended policy positions, or new technologies that we think are becoming ubiquitous and may impact on how airspace is designed or used. There will be a need to consider the economic and financial models that will be used to deliver the services required by new types of airspace users. This could result in changes to current CAA or other charging mechanisms. We note what these gaps or emerging policies are, and note that they may shape future iterations of this strategy and associated delivery plans.

15. The means of delivering airspace modernisation – such as the resources needed to bring in changes – must rest with the industry organisations that will use airspace. For example, the CAA can set out, within this strategy, why airspace redesign is needed and the policy ends it must achieve, but we cannot do that airspace change ourselves. Timelines and delivery plans must be set out by the organisations that will undertake this design, and integrate the concepts and technologies.

16. The need for these plans is addressed in Chapter 6. We explain that the CAA and Department for Transport, as co-sponsors of airspace modernisation, have tasked NERL with leading the FASI South programme to create, by June 2019, a single co-ordinated implementation plan for airspace changes in Southern England. This will be followed by further commissions for the creation of masterplans covering modernisation of the rest of UK airspace.

17. In Chapter 7 we set out our assessment of progress towards completion of each major initiative and the supporting designs, operational procedures and technology enablers. This has been done in the form of a ‘RAG’ status. Seven of the 15 initiatives are assessed as on track overall, with eight requiring attention.

18. A number of risks are also presented which should be considered and managed through the new governance structure.

Table 1 Summary of 15 initiatives

		Initiative	Obligation and timeframe*
Upper airspace	1	**Direct Route Airspace:** deployment of additional waypoints to the existing route network	EU legislation (by 2022)
	2	**Free Route Airspace:** removal of all fixed routes so aircraft can fly fully optimised routes	EU legislation (by 2022)
	3	**Advanced Flexible Use of Airspace:** new airspace designs, procedures and technology to increase options for airspace configurations, to support the efficient use of airspace and to best meet military requirements while being cognisant of civil airspace users.	EU legislation (by 2022) UK strategic ambition Known and emerging defence requirements (2018–2030)
Terminal airspace	4 5	**Terminal airspace redesign in Southern England** **Terminal airspace redesign in Northern England and Scotland** Fundamental redesign of the terminal route network using precise and flexible satellite navigation	EU legislation (by 2024) UK Government Airports NPS in the London terminal airspace (by 2024)
	6	**Queue management:** streaming traffic into and out of the terminal and absorbing delays in the upper airspace	EU legislation (by 2024) EU Master Plan ambition
Lower altitude	7	**Satellite navigation route replications:** replication of existing arrival and departure routes to satellite-based navigation standards	ICAO upgrade programme priority EU legislation (by 2024)
	8	**Satellite navigation route redesign:** redesign of new arrival and departure routes using satellite-based navigation standards	EU legislation (by 2024)
Uncontrolled airspace	9	**Review of Flight Information Service provision in the UK**	EU legislation (from 2022)
	10	**Airspace classification review:** including a review of air traffic services provision in uncontrolled airspace	EU legislation (from 2022) ICAO standards
	11	**Electronic surveillance solutions**	Fully interoperable electronic conspicuity solution (ongoing, likely CAA mandate in 2022–2024)
CNS and ATM infrastructure	12	**Cross-industry plan for the efficient use of radio-frequency spectrum**	Indirectly from EU legislation (ongoing)
	13	**Cross-industry plan for the full adoption of datalink communications**	EU legislation (from 2019)
	14	**A satellite-navigation implementation plan**	EU legislation (2020–2024)
	15	**Air traffic management**	EU legislation (by 2024)

* Under the EU (Withdrawal) Act 2018 the Government is in the process of bringing EU aviation law into UK law, with certain respons bilities reassigned to the Secretary of State or the CAA.

Chapter 1

Introduction

Chapter summary

This introductory chapter sets out:

- the need for airspace modernisation
- what has been achieved so far
- how modernisation is supported by changes in government policy
- a shared objective for modernising airspace
- how this Airspace Modernisation Strategy document is structured.

The context for airspace modernisation

1.1 Demand for air travel has grown strongly in recent decades, and the Government expects that demand will continue to rise significantly between now and 2050.[5] Growth in demand for air travel means increasing pressure on our airspace. The strategic case for airspace modernisation and the resultant benefits were set out by the Department for Transport in 2017.[6] Those benefits include more choice and value for consumers, through the capacity for airlines to add new flights, reduced flight delays and enhanced global connections that can help to boost the UK economy, while continuing to improve high safety standards. Unlocking the benefits of modernisation will make journeys faster and more environmentally friendly. Better airspace design can manage noise impacts and improve access for other airspace users, including the

5 Beyond the horizon, the future of UK aviation, next steps towards an Aviation Strategy, HMG, April 2018.

6 For more information see Upgrading UK airspace, strategic rationale, Department for Transport, 2017. [redacted]

Ministry of Defence, which requires more access to airspace to support a greater number of military aircraft.

1.2 The UK's airspace structure is an essential, but largely invisible, part of our national transport infrastructure. It is divided into controlled and uncontrolled airspace. Aircraft in **controlled** airspace fly under the positive monitoring and direction of air traffic control to maintain safe distances between them. **Uncontrolled** airspace typically incorporates areas where aircraft are not identified and managed by air traffic control, although they may request information or a more limited service from air traffic controllers. Airspace is further divided into classifications.[7]

1.3 The vast majority of commercial flights operate in controlled airspace. General Aviation and aerial sports operate largely in uncontrolled airspace below 6000 feet, alongside a few commercial flights. The military also has significant requirements to use both types of airspace and occasionally also operates within the confines of segregated training or danger areas.[8] The creation of controlled airspace may impinge on the availability of airspace for other users, and an appropriate balance is needed to satisfy both the safety needs and economic requirements of the various types of, often conflicting, operational requirements. At lower altitudes there is more of a challenge in balancing the differing requirements of a wider range of affected parties.

1.4 The main interested parties in the design of airspace are, at higher altitudes, NERL (NATS En Route plc, the subsidiary of NATS which is air traffic control provider for upper airspace); at lower levels, airport operators and localised air traffic services providers; and the Ministry of Defence which has an interest in upper and lower airspace for diverse purposes.

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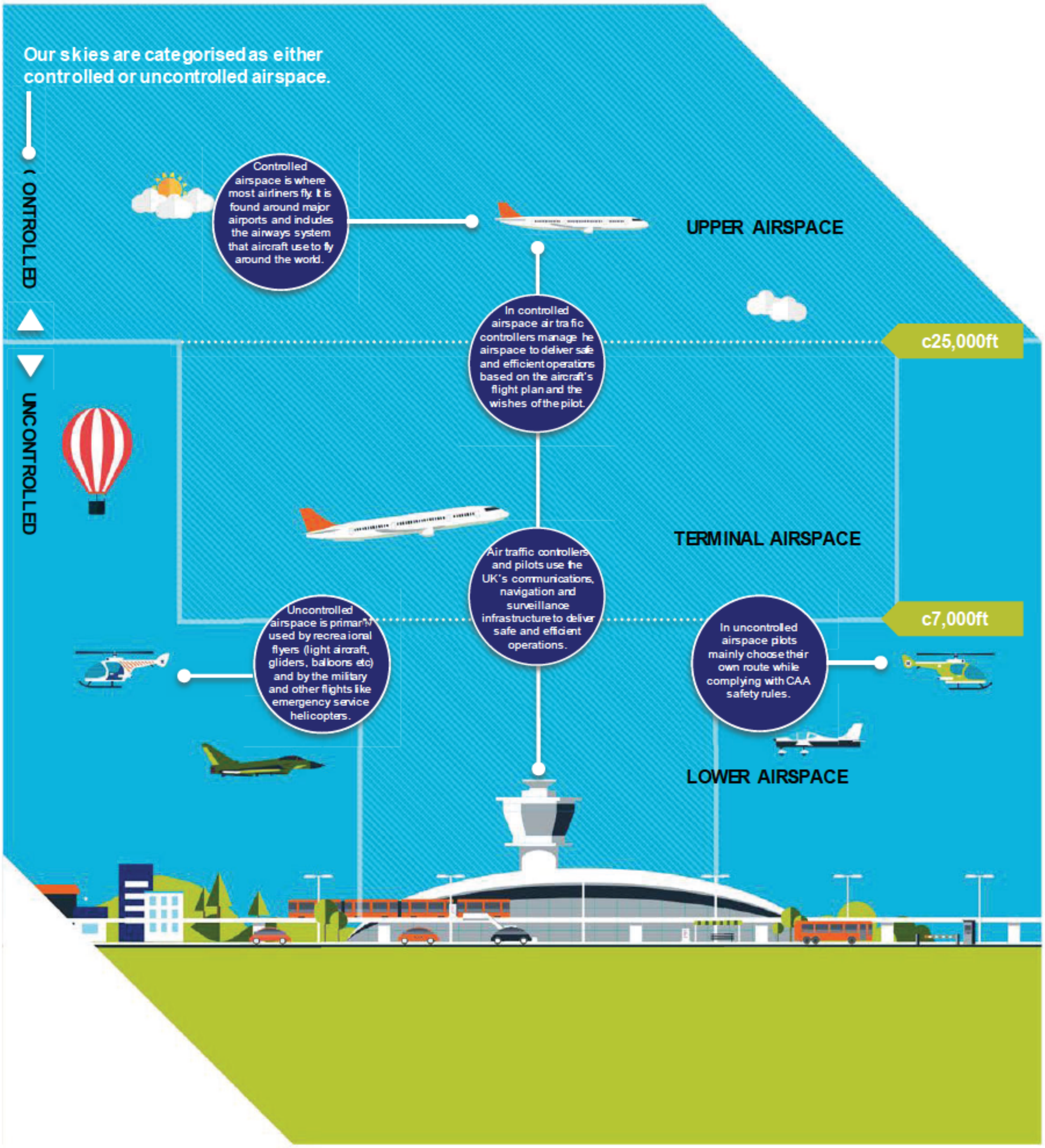
7 [redacted]

8 Military requirements vary widely from, among other things, electronic warfare training to air-to-ground ranges or access for remotely piloted air systems (drones).

Figure 1.1 Controlled and uncontrolled airspace



Note: this diagram is representational only and does not necessarily depict the specific areas in which airspace users operate.

1.5 UK airspace is also a key gateway between Europe and North America, the world's busiest intercontinental air corridor, and its efficient operation is crucial for international air traffic management.[9] It is also the case that lack of capacity leads to less ability for NATS to handle additional traffic when there is disruption in European airspace.

1.6 UK airspace is some of the most complex in the world, yet its design dates back to the 1950s and 1960s. Although it has been added to and adapted in response to growing traffic levels, many departure routes at major airports, for example, have been little changed for many years, even several decades. Successfully accommodating the growth in demand for air transport has meant adding significant complexity to the UK's airspace system, particularly where volumes of traffic are highest, principally over South-East England.

1.7 Many air routes and air traffic management practices are not utilising the modern technologies available, and aircraft continue to use flightpaths that are outdated. Those flightpaths often constrain aircraft climb performance such that more time is taken for them to reach their optimum cruising altitude. This creates inefficiencies and results in greater fuel burn and more emissions. Flightpaths may not presently be optimised to reduce noise impacts or designed to offer relief from noise. This inefficient use of airspace causes unnecessary delays for passengers and significant air traffic control workload to manage bad weather or other forms of disruption. It also has excessive impacts on the environment and those living near our airports. The outdated design is also, crucially, constraining the number of flights that the airspace can safely accommodate.

1.8 In addition, military airspace requirements are constantly changing as a result of technological developments and Government direction. Military aircraft, land and maritime systems use the full range of upper, lower and

9 Air traffic services in the eastern half of North Atlantic airspace are provided by NATS on behalf of the UK under its obligations to the International Civil Aviation Organisation (ICAO).

terminal airspace, including all classifications of airspace. The UK and its allies are bringing into service more technologically advanced and capable fast jets together with other platforms such as Remotely Piloted Aircraft Systems (drones)[10] that have new airspace demands.

1.9 Drones can be remotely piloted or autonomous, and are used for civil or military aviation purposes. They may require changes to airspace structures and rules if they are to integrate seamlessly into UK airspace. They are an example of the different types of new technology airborne vehicles that the UK's skies are now hosting, in addition to accommodating increasing commercial flights, military activities and an active General Aviation sector. In the future, UK airspace will also need to accommodate commercial spaceflight, and other new technologies are constantly being developed. These technologies affect what flies, and also how vehicles are flown, meaning new concepts for operating aircraft are also emerging.

1.10 Such a high rate of change cannot be accommodated within the current airspace structure. Incorporating this ever more complex and growing mix of traffic requires advanced technological tools and air traffic solutions. For example, in 2019 the CAA will consult on proposals to mandate full electronic conspicuity – electronic or digital means for allowing airspace users to sense all others and be seen by all others – in order to unlock safety benefits, save lives and enable future airspace design to accommodate better sharing and access among different users of airspace, including commercial aviation, the military, General Aviation and drones. The economic and financial models that will be used to deliver the services required by new types of airspace users will also need to be developed.

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10 Drones may be referred to by a variety of terms, including Unmanned Aerial Vehicles (UAV) and Remotely Piloted Aircraft Systems (RPAS). Further information is at [redacted]

1.11 It is therefore essential that the UK's airspace is modernised. Unlocking the benefits of modernisation, such as reduced stacking and allowing flights to climb and descend continuously, will make each journey faster and more environmentally friendly, benefiting consumers while maintaining already high safety standards. Modernisation of relevant airspace structures, systems and processes can also further improve the flexible use of airspace, whereby airspace is considered as a shared resource and is allocated for specific periods of time to particular users, such as the military.

1.12 As noted above, modernisation is needed to meet future military requirements: access to larger portions of segregated airspace, weapons ranges and to meet other training requirements such as electronic warfare. To allow military aircraft to operate across the differing classifications of airspace, there is a need to standardise and ensure interoperability of airborne and ground systems, such as electronic conspicuity. This will help enable more flexible designs of airspace, improve safety and encourage integration rather than segregation.

1.13 Implementing new airspace design will affect overflown communities in different ways, for example in terms of facilitating an increased number of flights at some airports or changing the flightpaths that are used. Reducing noise impacts could itself be a driver for a new design. Those who are affected by airspace change must therefore be involved in the decision-making process, and fully informed of the pros and cons of such a transformation.

1.14 If the structure of UK airspace is not modernised to incorporate new technology, the demand on the system, exacerbated by the current worldwide shortage of air traffic controllers, is expected to lead to a sharp increase in air traffic delays. Military capability will be degraded and sub-optimal airspace solutions will have an impact on other users.

1.15 In broad terms, UK airspace will require modernisation if we are to achieve the following aims:

- enable and facilitate continuous improvements in safety standards within the system through innovation
- accommodate growing demand from airspace users, including:
    - commercial airlines providing a key element of the UK's transport infrastructure supporting economic growth, and
    - ensuring defence requirements are facilitated through access to appropriate airspace
- maximise the utilisation of available runway capacity, including the government's policy for a new runway at Heathrow airport
- enable government policies in respect of the reduction and mitigation of noise and how it should be distributed to manage the impact of aviation growth on local communities
- deal with 'hotspots' of congestion within the current system
- improve resilience of the system to bad weather or other forms of disruption
- develop a genuinely sustainable framework to guide the aviation industry in its investment and technological development
- take advantage of those technological developments to improve safety and efficiency
- safely and efficiently accommodate new technologies that change the types of aerial craft and how they operate, for example drones and spacecraft
- implement internationally agreed requirements designed to increase the overall safety, capacity and efficiency of the global air traffic management system, while making commensurate environmental improvements, such as the Single European Sky
- further enable greater access to airspace for non-commercial users
- help the UK to mitigate the impact of disruptions in neighbouring European airspace
- provide flexibility within the system to enable continuing development and improvement.

1.16 Key to delivering airspace modernisation successfully is that each of the entities involved has the right role, powers and/or incentives, underpinned by appropriate governance and enforcement.

What has been achieved so far

The 2011 Future Airspace Strategy

1.17 In June 2011 the CAA published the UK's Future Airspace Strategy (FAS), which addressed the development of the UK's airspace system from 2011 to 2030. FAS was developed by the CAA, with contributions from the Department for Transport, Ministry of Defence and NATS. FAS had its genesis in the Department for Transport's *The Future of Air Transport* White Paper in 2003 and the subsequent *Future of Air Transport Progress Report* in 2006.

1.18 FAS set out how the planning, management and regulation of UK airspace should be developed to:

- maintain and improve the UK's high levels of safety
- address the many different requirements on the airspace system
- deliver balanced or 'optimal' outcomes, taking into account all those involved in, or affected by, the use of airspace.

1.19 FAS did not provide a detailed roadmap or plan for the implementation of changes to the UK's airspace system. Similarly, it did not provide a blueprint or future design for the UK's airspace structure, but it did set the direction for future detailed pieces of work.

1.20 FAS addressed UK implementation of the EU's air traffic management Master Plan and deployment of SESAR (Single European Sky Air Traffic

Management Research, the technological pillar of the EU Single European Sky initiative).[11]

Developments in government policy

1.21 In 2015 the Department for Transport and CAA both commenced work on reviewing the policy and regulatory approaches to the design and use of airspace, tackling directly some of the most pertinent challenges to airspace modernisation.

1.22 The Department for Transport subsequently published new policies in October 2017, including new Air Navigation Guidance and new Air Navigation Directions to the CAA.[12] The changes to government policy and guidance on the CAA's decision-making role included:

- clarifying how the noise impacts of airspace change should be distributed and measured
- a greater emphasis on the aviation industry working with communities to manage noise impacts
- requiring the sponsor of a given airspace change to carry out and consult on an options analysis that allows the impacts of different airspace designs to be compared
- a new power for the Secretary of State to call-in an airspace change proposal of national strategic importance
- the establishment of the Independent Commission for Civil Aviation Noise, which will provide advice on the noise aspects of airspace changes

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11 The EU Single European Sky initiative was launched in 2004 with the aim of reforming air traffic management in Europe in order to accommodate sustained air traffic growth. [redacted]

12 Air Navigation Guidance 2017: Guidance to the CAA on its environmental objectives when carrying out its air navigation functions, and to the CAA and wider industry on airspace and noise management, Department for Transport, October 2017. [redacted]

The Civil Aviation Authority (Air Navigation) Directions 2017 form Annex D to the Air Navigation Guidance.

- a commitment to give the CAA a new decision-making role over changes in air traffic control operational procedures that could result in a planned and permanent redistribution of air traffic, even though the airspace design itself is unchanged.

1.23 In December 2017 the CAA published a new process for its airspace change decision-making role and supporting guidance, based on these government policy changes and on the CAA's own review of the process.[13] The new process came into effect in January 2018.

1.24 The Government has most recently set out its support and objectives for the modernisation of UK airspace in its Green Paper[14] published in December 2018 in preparation for its forthcoming Aviation Strategy.

An updated airspace strategy to replace FAS

1.25 Since 2011, much progress has been made in delivering FAS, but the world within which it sits has also shifted. Recent and forthcoming government policy changes, coupled with technological developments, mean that while many sections of FAS remain relevant, they must be rearticulated within this new context, taking into account:

- a new runway at Heathrow: outlined in the Airports National Policy Statement designated in June 2018[15], and any other runways used more intensively or due to be developed by 2040
- the need to co-ordinate multiple inter-related airspace changes across different airports

13 Airspace Design: Guidance on the regulatory process for changing airspace design including community engagement requirements, CAP 1616 [redacted] with supporting documents CAP 1616a, CAP 1617, CAP 1618 and CAP 1619 [redacted] etc.

14 The Green Paper also consults on some specific new government policies to support modernisation.

15 Airports National Policy Statement: new runway capacity and infrastructure at airports in the South East of England, Department for Transport, June 2018. [redacted]t

- potential policy changes arising from government reviews, such as more explicit policy on how noise must be considered, and relevant international policy changes
- the airspace requirements of the most advanced, known as ‘fifth generation’, military aircraft and other new military systems
- drones
- commercial spaceflight.

1.26 The CAA has reviewed and rearticulated its strategy in light of these anticipated changes and in response to a government policy change that redefined our role when the Government’s Air Navigation Directions were updated and republished in October 2017. The CAA is now directed to prepare and maintain a **co-ordinated strategy and plan for the use of UK airspace for air navigation up to 2040, including for the modernisation of the use of such airspace**. This is consistent with the CAA’s role as specialist aviation regulator and its statutory responsibilities.

1.27 This **Airspace Modernisation Strategy** will address upper and lower airspace in the controlled and uncontrolled environments more comprehensively than FAS.

1.28 The CAA must consult the Secretary of State about the preparation and maintenance of this Airspace Modernisation Strategy and the detail to be included in the **delivery plan**, and must give a delivery report to the Secretary of State annually.

1.29 This Airspace Modernisation Strategy forms part of the Government’s new arrangements to take forward the delivery of the airspace modernisation programme, which will be a cornerstone of its forthcoming Aviation Strategy. Airports will need to develop their own airspace modernisation proposals in conjunction with each other where there are interdependencies between their airspace designs. Changes may also be necessary to comply with UK and international policy and law (such as any further new National Policy Statements, ICAO Standards and Recommended Practices, or new EU implementing regulations) for which the UK must have a delivery plan.

A shared objective for modernising airspace

1.30 Working together, the Department for Transport and the CAA have developed a shared objective for modernising airspace.

1.31 The Department for Transport and the CAA cannot deliver this objective alone. Airspace modernisation will need to be delivered by a range of aviation organisations, and a wide range of stakeholders will need to be engaged throughout this delivery. The Department for Transport and the CAA are committed to working with relevant stakeholders and those tasked with delivery to ensure modernisation happens in a coherent and consistent way, delivering the benefits described above.

Department for Transport and CAA shared objective for modernising airspace

Objective

Deliver quicker, quieter and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace.

Parameters

- create sufficient airspace capacity to deliver safe and efficient growth of commercial aviation
- progressively reduce the noise of individual flights, through quieter operating procedures and, in situations where planning decisions have enabled growth which may adversely affect noise, require that noise impacts are considered through the airspace design process and clearly communicated
- use the minimum volume of controlled airspace consistent with safe and efficient air traffic operations
- in aiming for a shared and integrated airspace, facilitate safe and ready access to airspace for all legitimate classes of airspace users, including commercial traffic, General Aviation and the military, and new entrants such as drones and spacecraft
- not conflict with national security requirements (temporary or permanent) specified by the Secretary of State for Defence.

The Department for Transport and CAA will undertake further work to consider whether and how the impact of the objective can be assessed.

Later in this introductory chapter we explain the roles of the various parties involved in airspace modernisation. As context for the shared objective, the boxes below explain how airspace modernisation relates to:

- the CAA's decision-making role on individual airspace change proposals
- government policy on managing aviation noise.

How does this objective relate to the CAA's individual airspace decisions?

- Both the CAA's strategy and its individual airspace change decisions are governed by the factors set out in section 70 of the Transport Act 2000, and relevant Government policy and guidance.
- The objective for modernisation is drawn from section 70, and will guide the work the CAA does on the UK's national strategy.
- Separately from the objective, the way in which section 70 guides airspace change decisions is set out in detail in the CAA's guidance on airspace design (CAP 1616).
- The CAA's decisions will also be informed by decisions of relevant planning authorities, guidance and directions given to it by the Secretary of State and other relevant government policy.
- The CAA's airspace design guidance requires that evidence be developed to cover every factor in section 70, and shared with the CAA (and published on the airspace change portal).
- All airspace change proposals will be required to undertake a formal cost benefit analysis conducted in accordance with the Government's WebTAG methodology. This will enable the different costs and benefits of changes to be compared on a common basis and will be used to inform CAA's decisions.
- For each proposal, WebTAG is used to measure and compare the adverse health impacts of aviation noise, to help the sponsor design – and the CAA consider – the option that creates the best possible noise outcome alongside all other factors in section 70.

How does this objective relate to government noise policy?

- The objectives of the Airspace Modernisation Strategy (AMS) interact with wider government policies on noise. This section provides context about this interaction.
- The AMS objective and parameters set out above provide a set of deliverables that the AMS is responsible for. They do not aim to encapsulate the entire government policy on aviation noise. Instead, the noise objective aims to identify where airspace has a specific role relating to noise. For example, while the Government continues to expect the ICAO Balanced Approach to be followed, the objective focuses on the measures within the Balanced Approach where airspace is most relevant. The AMS aims to progressively reduce the noise of

individual flights, through quieter operating procedures. In situations where planning decisions have enabled growth which may adversely affect noise, noise impacts are considered through the airspace design process and clearly communicated.[16]

- The AMS can only be responsible for delivering noise reduction where it has an element of control. Where a decision has been taken through the planning process to increase airport capacity, this is outside the responsibility of the AMS. The objective therefore does not focus on the overall level of noise as this is contingent on planning decisions.
- When an airport is changing airspace (for a planned increase in capacity or any other reason) it must develop its design proposal in accordance with policy and law. This means adhering to the CAA's airspace change process, through which WebTAG is used to measure and compare the adverse health impacts of aviation noise, to help the sponsor design – and the CAA consider – options that manage noise impacts using health assessments and consultation responses, and consider noise alongside all other factors in section 70.
- The Government will articulate its overarching objective on aviation noise through the Aviation Strategy.
- The Aviation Strategy will consider whether, where there is new airport growth which requires approval through the planning process, this should be accompanied by a noise cap which balances noise and growth and gives communities future certainty around noise.
- It is therefore important to note that at some airports, where a planning authority has placed a condition which limits the number of aircraft or passenger movements, and where an airport has reached that limit, additional airspace capacity created to deliver safe and efficient growth of commercial aviation can only be used if and when planning approval is given for airports to grow.
- Through the Aviation Strategy, the Government will also consider proposals for the creation of a new national performance indicator (KPI) which can be used to track the long-term performance of the UK aviation industry in reducing noise at a national level. We also want to ensure that there are suitable mechanisms in place to deliver noise reduction at airport level which are measurable and enforceable and thereby contribute to the national noise KPI.

16 Aiming to reduce the noise of individual flights means aiming for an average reduction per flight. It does not mean that there will be a reduction in noise on every individual flight, or that there will necessarily be an overall reduction in noise, as this will be dependent on the overall number of flights.

Stakeholders affected

1.32 Airspace modernisation will affect a wide range of stakeholders, including passengers, airspace users, airports, air navigation service providers, companies that rely on air transport to conduct their business and communities that may be affected by aircraft noise.

- **For passengers,** the benefits of airspace modernisation are clear. Fewer flight delays and service disruptions at short notice will save time and improve the passenger experience. A more efficient airspace will increase capacity while continuing to improve current high safety standards, leading to better value, including consistent quality of service, and more choice.
- **For aircraft operators**, the airspace structure is a key determinant of costs, punctuality and environmental performance. More direct and efficient flightpaths will mean lower costs for operators because they will save on fuel and be able to enhance the utilisation of their aircraft. Timely access to appropriate airspace is essential for the maintenance of military capability. Airspace modernisation must enable this while minimising impact on other users. Airspace modernisation is also expected to improve access to airspace for General Aviation, by enabling greater integration (rather than segregation) of different airspace user groups. The same is true for new airspace users such as drones and spacecraft.
- **For airports,** the sharing of accurate flight information about traffic using our airspace is expected to improve runway throughput and resilience. Additional airspace capacity will provide airports with the scope to develop their operations in line with their business plans (subject to planning considerations). Enhanced technology combined with updated airspace design enables safe, expeditious and efficient management of increased traffic.
- **For the UK economy,** efficiency and enhanced global connections and emerging aviation technologies can help drive growth.

- **For communities**[17], airspace modernisation offers environmental improvements because aircraft can climb sooner, descend more quietly and navigate more accurately around populated centres. In some areas, the increase in traffic can lead to an increase in noise, or the concentration of traffic can concentrate noise over a smaller area, which can reduce the areas in which noise is heard and offer the opportunity for respite routes. This means that not every community will benefit, so it is important that noise is managed as well as possible, in adherence to government policy. Airports should also consider whether they can develop airspace change proposals to reduce noise, i.e. to reduce the total adverse health effects of noise. Where aircraft are able to follow more fuel-efficient routes, wider society will also benefit because fewer CO_2 emissions will reduce greenhouse-gas impacts.

Structure of this document – ends, ways and means for modernising airspace

1.33 This Airspace Modernisation Strategy sets out the **ends**, **ways** and **means** of modernising airspace. The **ends** are the policy objectives the UK must meet. This strategy notes those ends and describes the **ways** of achieving them, such as new airspace design, new operational concepts and new technologies, initially focusing on the period until the end of 2024.[18] To establish the **means** of delivering modernised airspace, such as the resources needed, this strategy requires industry-led working groups to draw up delivery plans, with delivery overseen by the CAA. One

17 When referring to 'communities' this strategy document generally means those on the ground affected by aviation's environmental impacts in the vicinity of an airport, usually by noise but also sometimes local air quality (where there is an impact on the distribution or volume of emissions below 1000 feet). Communities may in turn be represented in different ways: by local authorities and elected representatives in national or local government; community leaders or representative groups/forums, airport consultative committees, and bodies with an interest in aviation's environmental impacts.

18 2024 corresponds to the end of the next Single European Sky Performance Scheme reference period (RP3). [redacted]

such plan will be a macro-level co-ordinated implementation plan (an airspace change masterplan) detailing which interdependent airspace changes are deemed necessary and when. This itself will require a timeline of airspace change proposals needed as part of a modernisation effort, and a critical path outlining the deadlines for individual airspace change proposals within it.

1.34 It is important to recognise that, for example, a change to the airspace at a particular airport may be completely dependent on linked changes to the lower airspace in the immediate vicinity, and cannot be implemented without it. An airspace change masterplan will therefore be a crucial element in airspace modernisation. This is discussed in Chapter 6 in the context of the coordination role that NERL will carry out.

1.35 In the following chapters we explain the CAA's airspace responsibilities; the roles played by others; our strategic airspace role; and how and why we are changing our published strategy for airspace, including the case for modernisation.

1.36 The main **ways** in which these **ends** should be delivered, namely by updating airspace designs, operational procedures and enabling technologies through 15 initiatives, are described in Chapter 4.

1.37 This strategy does not pre-empt specific solutions and allows space for innovation. There are other ends which airspace modernisation may need to deliver that are still being developed in detail – for example, the approach to integrating drones with aircraft that have a pilot on board. The initiatives set out in Chapter 4 also act as enablers for further work on accommodating drones and other new airspace users, and as we develop the strategy in the future, we will add more detail on how to integrate these new users. Current gaps such as these are considered in Chapter 5.

Reviewing the strategy

1.38 The CAA will review the Airspace Modernisation Strategy regularly in order to report to the Secretary of State annually on its delivery and to measure progress against the delivery plans. The CAA will also use those opportunities to continue to update the strategy, bearing in mind the 2040 timescale specified by the Government, in order to accommodate new technologies or other developments. This will include the need to consider developments in neighbouring air traffic management areas, especially our European neighbours, given the need to manage traffic effectively end to end. Where appropriate, the CAA may seek comments on these updates before implementing them, but will not necessarily do so in every case.

Chapter 2

Roles, responsibilities and definitions

Chapter summary

This chapter explains:

- the accountabilities of the different entities involved in airspace modernisation
- the relevant legal framework, including what powers or levers are available to enable delivery, and where there are gaps
- a new governance structure required for airspace modernisation
- any tensions between roles in airspace modernisation, and how risks will be mitigated.

Accountabilities of the entities involved

Government

2.1 The Department for Transport develops national policy and law, and also ensures the UK contributes to and meets its obligations under relevant international policy and law. As part of this policy responsibility the Government will also play a role in making the strategic case for airspace modernisation. The Government is considering whether to develop new policies to support airspace modernisation through the Aviation Strategy. The Government is in the process of setting up an Independent Commission on Civil Aviation Noise (ICCAN) which may also have a role in the future.

2.2 For certain types of airspace change, the Secretary of State may also decide to call-in a particular airspace change proposal in order to make a decision instead of the CAA.

2.3 The Ministry of Defence must have access to airspace in order to train and maintain competency for the UK's defence needs. It acts as an airspace change sponsor where requesting dedicated airspace that is reserved for activities which may be hazardous to other airspace users, such as high-energy manoeuvring and testing munitions.

CAA

2.4 The CAA is the airspace regulator and primary decision-maker. Parliament and the Government are responsible for setting the CAA's objectives, outlining the CAA's functions and responsibilities and providing guidance to the CAA. More specifically, the Air Navigation Directions[19] (given by the Secretary of State under sections 66(1) and 68 of the Transport Act 2000) set out several airspace responsibilities for the CAA. In all its responsibilities, the CAA is obliged to consider certain factors set out in section 70 of the Transport Act 2000[20] which include safety, security, operational impacts and environmental guidance from the Government (covering impacts such as aircraft noise and emissions), and the needs of all users of airspace.

2.5 The Air Navigation Directions set a strategic role for the CAA (Direction 3). The CAA is tasked with developing a strategy to modernise UK airspace and a plan setting out the best approach to new design, operational concepts and technology. The Directions and supporting government policy provide the framework for the strategy and for the roles and accountabilities of the CAA and other bodies in delivering that strategy. While the CAA must own the strategy and plan, delivery (including the design of any airspace changes) is undertaken by other entities, such as airports, air navigation service providers or airspace users.

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19 The Civil Aviation Authority (Air Navigation) Directions 2017 as amended by The Civil Aviation Authority (Air Navigation) (Amendment) Directions 2018. [redacted]

20 These factors are explained in more detail later in this chapter.

2.6 The Directions give the CAA responsibility for deciding whether to approve a proposal for a change to the published design of airspace, administering the airspace change process and providing guidance on the process to stakeholders (Direction 4).[21] Airspace design includes the airspace structure and the instrument flight procedures for the use of that airspace (i.e. procedures which enable aircraft to fly in a more technologically automated manner). The airspace designs approved by the CAA are published in the UK Aeronautical Information Publication (AIP).[22] The Directions were amended to give the CAA a new decision-making role over changes in air traffic control operational procedures that could result in a planned and permanent redistribution of air traffic.

2.7 Changes may be proposed, for example, to enable UK airspace to maintain or further improve safety, to accommodate more flights, to incorporate new technology, to mitigate or reduce the effects of aircraft noise, to allow aircraft to fly more direct routes, to keep aircraft away from particular areas, or to integrate new technologies such as drones.

2.8 The Directions and legal framework are discussed more fully below. The approach the CAA adopts when undertaking its regulatory assessment of airspace change proposals, and how it takes the factors in section 70 into account, is set out in CAP 1616 and on our website.[23]

2.9 As noted in Chapter 1, in October 2017 the CAA reformed the airspace change process to ensure that it meets modern standards for regulatory decision-making, and is transparent, consistent and proportionate. The process must be impartial and evidence-based, and must take account of the needs and interests of all affected stakeholders. To ensure that the needs of all stakeholders are met, the process emphasises the importance of engagement, i.e. developing relationships with

21 The CAA's process and guidance is set out in CAP 1616 and associated documents, as referenced in Chapter 1. [redacted]

[redacted]

stakeholders. While some changes to the UK's airspace design can be contentious with aviation stakeholders and local communities, it is a key requirement that the methods used to reach those decisions are well understood and respected.

2.10 The CAA runs an online airspace portal where airspace changes are submitted and monitored, stakeholder comments can be made and viewed, and relevant documentation can be viewed.[24]

2.11 The CAA is not responsible for developing airspace designs or instigating airspace changes, other than in exceptional circumstances.

2.12 The CAA also has additional duties in respect of the regulation of the provision of air traffic services under section 2 of the Transport Act 2000. In carrying out these duties, the CAA is responsible for the economic regulation of NATS' monopoly service provision activities under a licence.

Airspace change sponsor

2.13 The change sponsor owns the airspace change proposal and is responsible for developing it, including taking into account feedback from relevant stakeholders, in accordance with the CAA's airspace change process and the guidance provided by the CAA and by the Department for Transport. Anyone can sponsor an airspace change proposal – although it is usually an airport or an air navigation service provider. An airport will typically sponsor a change to the airspace design in its immediate vicinity (known as terminal air navigation services), while NERL (the air navigation service provider for en-route airspace, as discussed below) will typically sponsor changes to upper airspace, where traffic is in the cruise phase of the flight away from the airport environment.

Airports

2.14 The airport operator is responsible for the arrival and departure routes serving its runways. It will therefore typically sponsor a change to the

24 [redacted]

airspace design and associated routes in its immediate vicinity, and is required to consult and collaborate closely with those affected by the change. The airport will work closely with the air navigation service provider that manages the approach and en-route airspace to ensure seamless and safe connectivity.

2.15 There are two elements to these terminal air navigation services:

- the 'radar approach and departure' (approach control) service, and
- the aerodrome control service.

2.16 These two elements of terminal air navigation services are provided by the airport (acting as an air navigation service provider) itself, or by a third-party air navigation services provider (for example, NATS (Services) Ltd, see below). Thus an airspace change that affects a number of airports may involve or affect multiple air navigation services providers.

NATS

2.17 NATS Holdings Ltd, the biggest air navigation services provider in the UK, provides air traffic control services through two principal subsidiaries: NATS (En Route) plc (called NERL) and NATS (Services) Ltd (called NSL), which provides air traffic services on a commercial basis. This strategy document concerns NERL only, and not the commercial work of NSL. NERL is the sole provider of air traffic control services for aircraft flying 'en route' in UK airspace[25] and provides some air traffic control services in the eastern part of the North Atlantic, as well as providing a combined approach function (London Approach) for five London airports. It is regulated by the CAA within the framework of:

- the EU Single European Sky, which sets out measures to improve the efficiency of air navigation services, through setting targets to drive performance in four key performance areas (safety, environment, capacity, and cost-efficiency)

25 'En route' means that part of the flight from the end of the take-off and initial climb phase to the commencement of the approach and landing phase.

- the Transport Act 2000, which sets the need for NERL to operate under a licence from the Secretary of State. NERL has duties under the Transport Act to provide, develop and maintain a safe system for the provision of air traffic services that is efficient and co-ordinated and meets the demand for air traffic services. NERL is also tasked through its licence and directions from the Government with a role in maintaining the effectiveness of the UK's air traffic management network.
- a performance plan proposed by the CAA, including targets and incentives, that covers NERL's monopoly en-route and London Approach air navigation service activities, for adoption by the Government. The performance plan has to be approved by the European Commission. NERL is required to report on its performance and delivery against targets.[26]

Airspace users

2.18 Airspace users include airlines and other commercial operators, General Aviation, the Ministry of Defence, and new entrants such as drones and spacecraft. The definition of General Aviation can vary, but essentially it means all civil flying other than commercial airline operations. It therefore encompasses a wide range of aviation activity from powered parachutes, gliding and ballooning to corporate business jets, and includes all sport and recreational flying. Airspace users are required to have the necessary aircraft equipage to use the modernised airspace design, and to ensure that the associated operational procedures are introduced and that pilots are appropriately trained.

Stakeholders impacted by airspace change

2.19 There are stakeholders who may be impacted by individual airspace changes, and who may also be interested in the national policy and

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26 [redacted] Both regulations are under review.

strategy that those changes are nested within. Stakeholders who may be impacted by individual airspace changes will normally have the opportunity to discuss with change sponsors the principles underlying the airspace change and the development of options for the change. These stakeholders may include: airspace users, such as airlines, General Aviation or the military; airports within the area of interest; affected air navigation service providers; local communities; local government and elected representatives; and non-governmental organisations.

Shared role

2.20 Some of the organisations listed above have a strategic role, meaning they have a responsibility for the management, organisation or use of airspace as a piece of national infrastructure. We will return to the strategic modernisation of airspace later in this chapter.

Law and policy governing the CAA's role

2.21 The CAA's statutory duties and functions regarding airspace are contained in The Civil Aviation Authority (Air Navigation) Directions 2017, section 70 of the Transport Act 2000 and the Air Navigation Guidance 2017.

The Civil Aviation Authority (Air Navigation) Directions 2017

2.22 All the CAA's responsibilities in the Air Navigation Directions must be carried out having regard to section 70 of the Transport Act 2000. Section 70 (see below) gives the CAA a duty to take a number of factors into account when exercising its air navigation functions. This includes our consideration of an airspace change proposal and the Directions on our strategic role.

Direction 3 on airspace design

2.23 In October 2017 the Direction to "prepare and maintain a co-ordinated strategy and plan for the use of UK airspace for air navigation" was replaced with the following three points (Direction 3, paragraphs e to g):

- (e) prepare and maintain a co-ordinated strategy and plan for the use of UK airspace for air navigation up to 2040, including for the modernisation of the use of such airspace
- (f) consult the Secretary of State in relation to the preparation and maintenance of such strategy and the detail to be included in such plan, and
- (g) report to the Secretary of State annually on the delivery of the strategy referred to in sub-paragraph (e), the first such report to be provided by the end of 2018.

Directions on airspace change process and supporting guidance

2.24 The Secretary of State has given the CAA the function to approve changes to the design of airspace in The Civil Aviation Authority (Air Navigation) Directions 2017, as amended by The Civil Aviation Authority (Air Navigation) (Amendment) Directions 2018. In particular these Directions require the CAA to develop and publish procedures, and guidance on such procedures, for the development, making and consideration of a proposal for a permanent change to airspace design, a temporary change to airspace design, or an airspace trial. As noted earlier, this is published by the CAA as CAP 1616. Any such procedure must be proportionate and reflect published Government policy, taking account of specific guidance on our environmental objectives contained within the Air Navigation Guidance. As noted in paragraph 2.6, the 2018 amendment gave the CAA a new decision-making role over the way airspace is used within an existing design.

Section 70 of the Transport Act 2000

2.25 Section 70 of the Transport Act 2000[27] places the CAA under a general duty in relation to its air navigation functions to exercise those functions so as to maintain a high standard of safety in the provision of air traffic services. That duty is to have priority over the CAA's other duties in this

27 [redacted]

area of work. Noting that priority, the CAA's duties in relation to air navigation is to exercise its functions in the manner it thinks best calculated so that:

- it secures the most efficient use of airspace[28] consistent with the safe operation of aircraft and the expeditious flow of air traffic[29]
- it satisfies the requirements of operators and owners of all classes of aircraft
- it takes account of the interests of any person[30] (other than an operator or owner) in relation to the use of any particular airspace or airspace generally
- it takes account of any guidance on environmental objectives given to the CAA by the Secretary of State
- it facilitates the integrated operation of air traffic services provided by or on behalf of the armed forces and other air traffic services
- it takes account of the interests of national security
- it takes account of any international obligations of the UK notified to the CAA by the Secretary of State.

2.26 If in a particular case there is a conflict in the application of these provisions, the CAA must apply them in the manner it thinks is reasonable having regard to them as a whole. The CAA must also exercise its air navigation functions so as to impose on providers of air traffic services the

28 As set out in CAP 1616, the CAA interprets "the most efficient use of airspace" as: *The most aircraft movements through a given volume of airspace over a period of time in order to make the best use of the limited resource of UK airspace from a whole system perspective.* In addition, the CAA may consider multiple factors in assessing a proposal against the duty of making the most efficient use of airspace. Those factors may also be relevant to the CAA's other section 70(2) duties.

29 As set out in CAP 1616, the CAA interprets "expeditious flow" as: *The shortest amount of time that an aircraft spends from gate to gate, from the perspective of an individual aircraft, rather than the wider air traffic system.*

30 As set out in CAP 1616, the CAA interprets the words "'any person (other than an operator or owner of an aircraft)" to include airport operators, air navigation service providers, members of the public on the ground, owners of cargo being transported by air, and anyone else potentially affected by an airspace change proposal.

minimum restrictions which are consistent with the exercise of those functions.

2.27 The CAA must have regard to section 70 when complying with all its airspace Directions. In respect of our strategic role, the list of factors in section 70 are applied as guiding factors that shape the ends that a modernised airspace must deliver, as discussed in Chapter 3. The objective for airspace modernisation also reflects section 70. The way in which we apply section 70 in our airspace change decision-making role is set out in detail in our CAP 1616 guidance (Appendix G).

Air Navigation Guidance 2017

2.28 Section 70(2) of the Transport Act 2000 requires the CAA to take account of any guidance on environmental objectives given to it by the Secretary of State when carrying out its air navigation functions. These functions are set out in the Secretary of State's Air Navigation Directions 2017, made under sections 66(1) and 68 of the Transport Act 2000. The Air Navigation Guidance was last issued in October 2017.[31]

2.29 The Air Navigation Guidance and Air Navigation Directions issued in October 2017 followed a consultation by the Department for Transport about airspace and noise policy.[32] The Air Navigation Guidance, in addition to being statutory guidance to the CAA on environmental objectives in respect of its air navigation functions, also gives more information on the Secretary of State's role in the airspace change process. In accordance with the 'call-in' provisions of the Air Navigation Directions 2017, in some cases the Secretary of State rather than the CAA may make decisions on a proposal to make permanent changes to airspace design. The Air Navigation Guidance is not just aimed at the

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31 Air Navigation Guidance 2017: Guidance to the CAA on its environmental objectives when carrying out its air navigation functions, and to the CAA and wider industry on airspace and noise management, Department for Transport, October 2017. [redacted]

[redacted]

CAA. The Government also expects that it will be taken into consideration by the aviation industry. The Air Navigation Guidance also acknowledges the important role which local communities have in the airspace change process.

ICAO

2.30 As an ICAO contracting state, the UK has obligations concerning airspace modernisation under the ICAO Global Air Navigation Plan. These are currently fulfilled through EU law and initiatives including SESAR (SES ATM Research), but the UK will remain committed to its ICAO obligations, which include the widespread adoption of routes based on satellite navigation, irrespective of the outcome of its exit from the EU.[33]

EU law

2.31 The Single European Sky (SES) initiative[34], through its regulatory framework and the SESAR air traffic management Master Plan[35], sets out a range of airspace and air traffic management modernisation. SES aims to increase the efficiency of air navigation services to cope with traffic growth. It sets requirements for EU States and those that have agreed to follow EU law through basic and implementing legislation. The extent to which the UK will continue to be bound by EU law is uncertain at the time of writing, but will become clearer as the UK's exit from the UK approaches.[36]

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33 Accepting that it is possible for contracting States to file differences from ICAO standards.

34 [redacted]

35 European ATM Master Plan [redacted]

Within the framework of the Single European Sky, the Master Plan is the main planning tool for defining air traffic management (ATM) modernisation priorities and ensuring that the SESAR (Single European Sky ATM Research) Target Concept becomes a reality. The Master Plan is an evolving roadmap and the result of strong collaboration between all ATM stakeholders. As the technological pillar of the Single European Sky initiative, SESAR contributes to achieving the Single European Sky high-level goals and supports its regulatory framework.

36 Under the EU (Withdrawal) Act 2018 the Government is in the process of bringing EU aviation law into UK law, with certain responsibilities reassigned to the Secretary of State or the CAA.

2.32 Under the SES initiative, a number of implementing regulations covering technical interoperability, safety, airspace and performance have been adopted and implemented. Two key regulations that directly impact on airspace are Common Requirements and Standardised European Rules of the Air.

2.33 EU Regulation 2017/373[37], which applies from 2 January 2020, lays down common requirements for air traffic management service providers and for the oversight by the competent authorities of air traffic management, air navigation services and other air traffic management network functions. The regulation is based on various ICAO Standards and Recommended Practices and includes 13 supporting annexes, known as 'Parts' (for example, Annex IV is Part-ATS).

2.34 EU Regulation 923/2012[38] Standardised European Rules of the Air (as amended) lays down the common rules of the air and operational provisions regarding services and procedures in air navigation, and is also derived from ICAO Standards and Recommended Practices.

2.35 A significant proportion of traffic to/from Europe passes through UK airspace, and there is a continuing need for greater interoperability in airspace management arrangements between the UK and the rest of Europe. Irrespective of the outcome of the UK's exit from the EU, the UK will remain part of the pan-European air traffic management system and have co-operative arrangements with other European States, principally through its membership of the EUROCONTROL intergovernmental organisation, industrial partnerships such as Borealis and, currently, the

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37 [redacted]. The regulation repeals previous Commission implementing regulations.

38 [redacted]

UK-Ireland Functional Airspace Block.[39] Subject to the terms of the UK's exit from the EU, the UK consequently remains fully committed to continuing to contribute the necessary technical resources to SESAR and EASA initiatives in air traffic management in order to remain aligned with European air traffic modernisation.

New governance structure for airspace modernisation

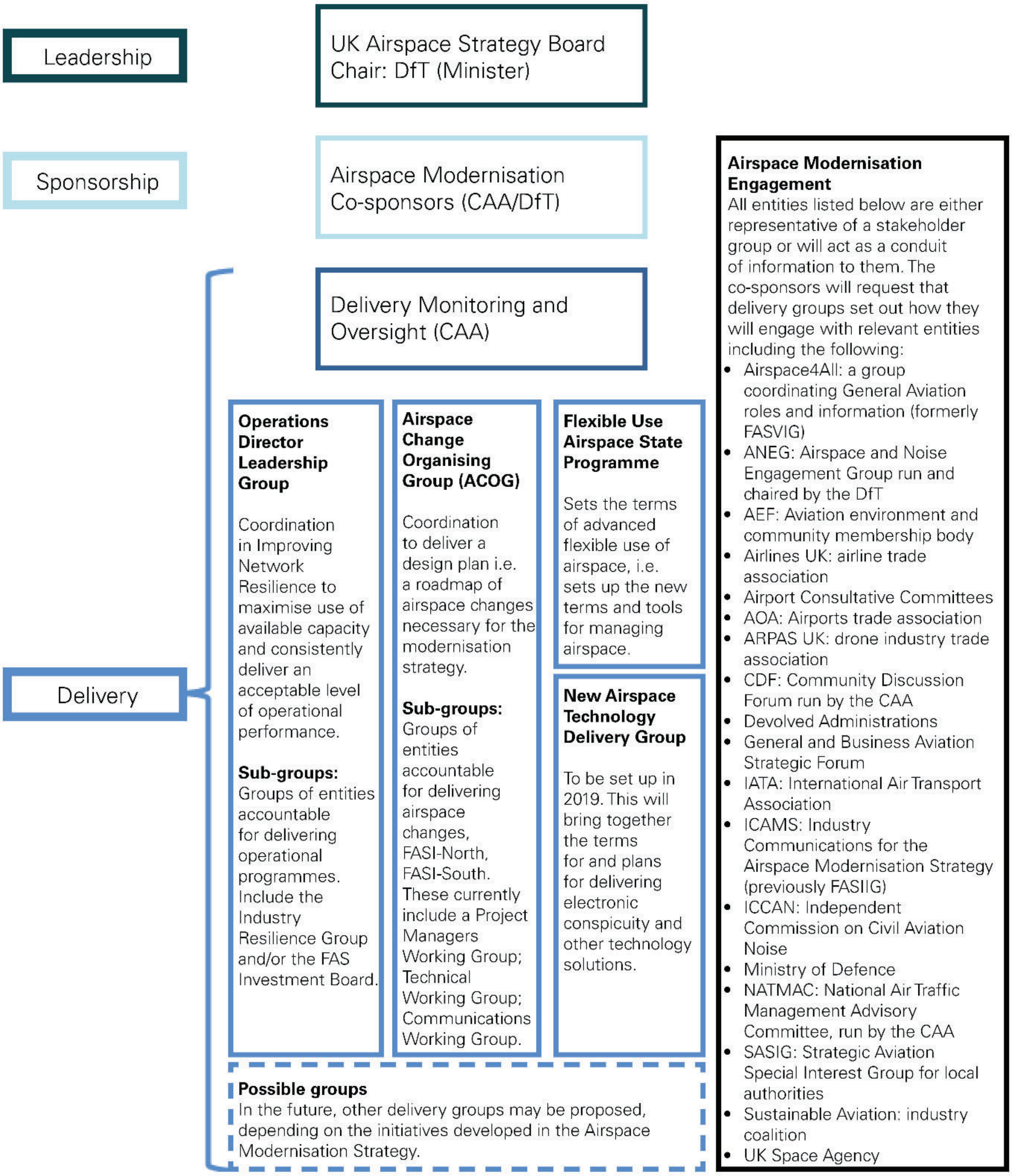
2.36 The Department for Transport and the CAA worked with NERL and the Infrastructure and Projects Authority to develop a new governance structure for airspace modernisation.

2.37 The governance structure for airspace modernisation is illustrated by Figure 2.1. It reflects the existing legal framework and Air Navigation Directions, and sets out which organisations make decisions and have accountabilities in the strategic direction of airspace, and the stakeholders they will engage and consult with as they carry out their strategic roles. Accompanying this strategy document is the Governance Annex co-authored with the Department for Transport, which names all the different groups in the structure and their role.

2.38 At the delivery level there will be a series of industry organisations, brought together into co-ordinated groups that are chaired by an appropriate member of the group. These groups will be comprised of organisations involved in the delivery of the initiatives set out in Chapter 4 of this strategy to deliver modernised design, operations and technology. The Governance Annex gives a list of groups that exist at the time of writing this strategy. Two of these groups, FASI-S and FASI-N, are being supported by a project management function that is being set up by NERL. The Governance Annex provides further detail.

39 See [redacted] for more on Borealis and [redacted] for more on the UK/Ireland Functional Airspace Block.

Figure 2.1 Governance structure for the Airspace Modernisation Strategy



Note: The Governance Annex provides further detail about the groups shown.

2.39 More groups, or amendments to the membership or roles of existing groups, may become necessary in the future, as the work to deliver the initatives changes or matures.

2.40 Between the delivery groups and the co-sponsors is a new Delivery Monitoring and Oversight function to be undertaken by the CAA. It will:

- monitor progress across all initiatives in the Airspace Modernisation Strategy
- act as the point of escalation for delivery groups and as a gateway between them and the co-sponsors (which may in turn escalate to the Minister)
- engage directly with delivery groups
- monitor risks and oversee delivery so that outputs accord with policy and legislation.

2.41 The Delivery Monitoring and Oversight function will not have decision-making powers nor influence the quality of airspace design (which must happen through the airspace change process).

2.42 The Department for Transport and CAA have a shared role as co-sponsors. They will ask the Chair of each delivery group to write Terms of Reference for how the group will operate, how stakeholders listed in the governance structure will be engaged, and that commit to producing and publishing minutes of working group meetings.

2.43 The Aviation Minister-chaired UK Airspace Strategy Board will engage stakeholders on the policies that will govern the strategy. Representatives from all interested major stakeholders will attend, including relevant public bodies such as devolved administrations and local government, the CAA and Ministry of Defence; NERL; commercial aviation including airports and airlines; General Aviation; and community and environmental groups.

This group sits at the top of the governance structure. Information about this group will be available on the Department for Transport's website.[40]

2.44 Alongside the groups that have strategy and delivery roles is an engagement plan, with stated commitments to consider the views of several industry and community groups, as noted above.

2.45 This governance structure replaces the previous FAS groups, but many of them will remain as industry co-ordination groups that provide a useful focal point and mechanism for including representation of particular stakeholder interests. For example, organisations such as Airspace4All Ltd (formerly FASVIG, the Future Airspace Strategy VFR Implementation Group Ltd) exist as a way of ensuring General Aviation organisations are involved in airspace modernisation and have representation and a focused point of engagement.

2.46 The structure is designed to support our airspace modernisation objective. The sponsors may recommend different or more radical options later on if progress is not sufficient and governance is a cause.

2.47 In the Governance Annex there is further information about all the roles set out in this governance structure, including the role of the co-sponsors; how the Delivery Monitoring and Oversight function will be set up in the CAA; the membership of the working groups, which initiatives they are delivering and how they will be expected to engage with stakeholders.

Potential tensions between roles in airspace modernisation

2.48 Some entities involved in airspace modernisation may find that their multiple roles may in some circumstances give rise to potential or perceived conflicts. The governance described here has been developed

40 [redacted].

to make such conflicts transparent and, where possible, better manage them.

Decision-making

2.49 Later in this document we describe Government-led work to consider, through the Aviation Strategy, new policies to compel the development of an airspace change proposal that is necessary, but for which no sponsor is forthcoming. If these policies are adopted, the Government could in future play a role in requesting that an airspace change is taken forward, and that decision would be taken in light of an airspace change masterplan that the co-sponsors (CAA and Department for Transport) are commissioning from NERL, which the CAA will need to technically assure. To understand whether to trigger the use of a power or policy to require that an airspace change proposal is developed, the CAA's new Delivery Monitoring and Oversight team will track delivery of the masterplan and monitor any potential delays or risks.

2.50 This will have implications for maintaining the independence of the decision-maker of that proposal, whether that be the CAA or (where the proposal has been called-in) the Secretary of State. The governance structure for the strategy has therefore being designed to derisk the accountability for

a) commissioning a masterplan of airspace changes, tracking its delivery, and advising on whether powers to force an airspace change to be developed should be triggered; and

b) deciding whether the masterplan is technically robust and deciding whether the final proposal produced for any individual airspace change should be approved.

2.51 Roles a) and b) are separate within the CAA, carried out by different teams, and they have different outcomes: the CAA will oversee a plan that will set out where airspace changes are needed, but will not participate in the design of those changes. Instead the CAA would regulate them as they are developed. Similarly, if new powers were taken forward the

Department for Transport would ensure that the team responsible for advising the Secretary of State on directing an airport to initiate an airspace change is appropriately separate from that deciding on a proposal that has been called-in.

NERL

2.52 As noted above, NATS has two separate businesses. As the sole provider of UK en-route and London Approach air traffic control services, and the designer of upper airspace, NERL has a strategic role in airspace modernisation as well as being a stakeholder where changes are proposed in lower airspace.

2.53 NERL could potentially be asked to propose airspace changes in lower airspace where an airport or other air navigation service provider was not forthcoming and the strategy airspace change masterplan required the change. Tensions could arise where there is an actual or perceived conflict from NERL taking on or initiating an airspace change proposal in such circumstances.

Challenges with delivery

2.54 The CAA will flag risks to the modernisation programme as appropriate, and before the event becomes critical, where a proposal is not fully aligned with the plan and anticipated timelines.

2.55 Chapter 5 explores how to address the issue of an airport or NERL deciding not to progress with an airspace change that has such interdependencies with other airspace changes, to prevent this holding up the modernisation programme. This includes:

- using the macro-level airspace change masterplan and timeline to identify which airspace changes not already in progress are critical and should be compelled, even when a sponsor is not forthcoming
- using the gateway approach in the CAA's airspace change process to monitor whether an airspace change proposal that is in progress

is keeping to the required timescales and is of the required quality, for example whether the sponsor has engaged or consulted appropriately with sponsors of interdependent airspace change proposals.

Chapter 3

Ends: known outcomes a modernised airspace must deliver

Chapter summary

This chapter sets out the context in which the known outcomes, or **ends**, that are expected from airspace modernisation must comply.

The known ends that airspace modernisation is expected to deliver are described under the following headings:

- maintaining and enhancing high aviation safety standards
- securing the efficient use of airspace and enabling integration
- avoiding flight delays by better managing the airspace network
- improving environmental performance by reducing emissions and by better managing noise
- facilitating defence and security objectives.

Legal, policy and other obligations with which the ends expected from airspace modernisation must comply

3.1 The **ends** to be achieved from airspace modernisation are driven by UK and international policies and laws. Section 70 of the Transport Act 2000 sets out how the CAA should fulfil its statutory obligations regarding use of the airspace, as described in the previous chapter. Other policies or pieces of legislation may also be relevant; for example, the requirement for airspace changes to accommodate additional runway capacity in the South East is driven by the Government's Airports National Policy Statement.

3.2 Policies and laws also guide the ways in which the ends should be delivered, by setting principles and methods to achieve those ends. The

Single European Sky initiative (see Chapter 2) sets out a range of airspace modernisation requirements for the UK and other European states to comply with in the form of implementing regulations that are defined in European law. The Single European Sky implementing regulations mainly focus on commercial air transport operations and larger airports with a significant impact on the core European airspace network. The Single European Sky legislation also requires en-route air navigation service providers to meet a set of performance targets for safety, cost efficiency, environmental performance and delays, which are set at the national and EU level. Other implementing regulations developed by EASA that cover navigation, surveillance and air traffic management are much broader in scope and include implications for the way a broad range of aerodromes and aircraft operations, inside and outside controlled airspace should be modernised.[41]

3.3 Some major ends are not linked directly to policies or laws but are nevertheless important aspects of airspace modernisation. For example, at most airports in the UK the redesign of arrival and departure routes using satellite navigation is not driven by any specific piece of legislation but by improved technology, and recent developments in EU law have introduced basic standards for the use of such equipment.[42] The UK's transition to a route structure designed using satellite-based navigation is recognised by the Government in recent guidance.[43] The widespread

41 [redacted].

42 Some larger airports are required by Single European Sky legislation to implement satellite-based arrival and departure routes.

43 Air Navigation Guidance 2017: Guidance to the CAA on its environmental objectives when carrying out its air navigation functions, and to the CAA and wider industry on airspace and noise management, Department for Transport, October 2017. [redacted]

adoption of routes based on satellite navigation is an international obligation for the UK set out in the ICAO Global Air Navigation Plan – a major international programme that seeks to harmonise airspace modernisation initiatives globally.[44]

3.4 Another example of a vital programme to aid airspace modernisation is the electronic conspicuity of users of UK airspace, whereby using electronic or digital means users can sense all others and be seen by all others. This will unlock safety benefits, save lives and enable future airspace design to accommodate better sharing and access among different users of airspace.

The ends that modernised airspace must deliver

3.5 The known ends expected from airspace modernisation can be grouped into six broad areas that link directly to the CAA's obligations under section 70 of the Transport Act 2000. These areas are:

- **safety:** maintaining a high standard of safety has priority over all other ends to be achieved by airspace modernisation
- **efficiency:** consistent with the safe operation of aircraft, airspace modernisation should secure the most efficient use of airspace and the expeditious flow of traffic
- **integration:** airspace modernisation should satisfy the requirements of operators and owners of all classes of aircraft across the commercial, General Aviation and military sectors
- **environmental performance:** the interests of all stakeholders affected by the use of airspace should be taken into account when it is modernised, in line with guidance provided by the Government on environmental objectives, the Air Navigation Guidance 2017, which

44 The Aviation System Block Upgrades: the Framework for Global Harmonization, ICAO, July 2016.[redacted].

sets out how carbon emissions, air quality and noise should be considered

- **defence and security:** airspace modernisation should facilitate the integrated operation of air traffic services provided by or on behalf of the armed forces and take account of the interests of national security
- **international alignment:** airspace modernisation should take account of any international recommended practices or obligations related to the UK's air navigation functions, such as those from ICAO and the EU.

3.6 The sections below explain some of the key issues with today's airspace linked to the ends described above that modernisation is expected to address.

3.7 Across all of these – and related to efficiency in particular – is the need to enable growth. In December 2018, the Government published a Green Paper consulting on how it sees sustainable growth being delivered, in preparation for its forthcoming Aviation Strategy. This followed its 'Beyond the Horizon' document (a response to the Aviation Strategy call for evidence) published in April 2018, in which the Government said that there is a need to increase aviation capacity in the South East and that it wants to ensure that this growth is sustainable.[45] The Government has also published a policy on making the best use of existing runways.[46] The sustainable growth of aviation is therefore also a clear end that airspace modernisation must deliver.

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45 Beyond the horizon, the future of UK aviation, next steps towards an Aviation Strategy, paragraphs 6.2 and 6.4, HM Government, April 2018. [redacted]

46 See paragraph 1.24 of The future of UK aviation: making best use of existing runways, HM Government, June 2018.[redacted]

3.8 This section considers each of the ends that modernised airspace must deliver. The following section goes on to describe the ways of achieving them.

3.9 In circumstances where the CAA believes the policy framework or evidence base does not provide a clear solution to any trade-offs that arise between the delivery of airspace modernisation initiatives or the different airspace design changes identified in the forthcoming airspace change masterplan, we will request guidance from the Government. Public policy ultimately rests with our democratically elected Government, and the regulator should act in accordance with policy and legislation.

Maintaining and enhancing high aviation safety standards

3.10 The UK's airspace has an excellent safety record that is underpinned by a well-established system of structures, rules and procedures. As this system has matured, its potential to deliver further safety improvements (for example by adding more rules) has become limited.

3.11 The pace of change across the aviation industry is set to quicken. Traffic levels across the commercial, General Aviation and military sectors are forecast to rise, coincident with new innovations such as drones, which are already proliferating. There is a consensus that airspace modernisation is required to enable innovation while at the same time maintaining high standards of aviation safety. This includes reducing the complexity of airspace structures and introducing new technologies that help to manage the residual risks. The goal of the Government's State Safety Programme is that the UK's aviation safety performance remains among the best in the world.[47]

3.12 In controlled airspace, air traffic controllers manage the interactions between traffic, providing voice or digital instructions to make sure that aircraft stay safely separated. The high workload placed on controllers to

47 State Safety Programme for the United Kingdom [redacted]

manage conflicting traffic itself introduces safety risks that are managed by limiting the flow of traffic. As traffic grows, new routes that are separated by design (i.e. routes that don't cross) and new technologies that automate controller tasks are needed to maintain high safety standards.

3.13 One of the areas of greatest concern in uncontrolled airspace is the risk of mid-air collision where military, General Aviation and some commercial traffic are operating in a 'see and avoid' environment with limited air traffic services and surveillance coverage. Each has responsibility for maintaining its own visibility and keeping a lookout for aircraft in order to avoid them. The widespread adoption of electronic conspicuity solutions that make all aircraft more visible is needed to maintain high safety standards in uncontrolled airspace, especially around smaller aerodromes that have no surveillance capability themselves and in areas with a high density of airspace users that may be harder to see with the naked eye, such as light aircraft, gliders, hang-gliders and drones.

3.14 An additional mid-air collision risk arises from airspace infringements – where an aircraft flying in uncontrolled airspace inadvertently enters controlled airspace and comes into conflict with, say, a commercial flight. Such infringements highlight the limitations and potential safety implications of the current airspace design. Although areas are prescribed for different users, a simple navigational error or loss of situational awareness in a complex system, combined with a lack of uniform electronic visibility, creates a safety concern.

3.15 As a vital aid to the Airspace Modernisation Strategy the CAA therefore wishes to ensure that there is full electronic conspicuity of UK airspace users, in order to unlock safety benefits, save lives and enable future airspace design to accommodate better sharing and access among different airspace users, including commercial aviation, military, General Aviation and future users such as drones.

Securing the efficient use of airspace and enabling integration

3.16 As described in Chapter 1, a piecemeal approach to development of the airspace structure has created several issues that limit the sector's ability to continue to add airspace capacity without making some more fundamental changes. For example, much of the controlled airspace that serves multiple airports in the busy lower airspace areas has become a complex web of intersecting flightpaths and requires a wholesale redesign to secure the most efficient use. The fixed number of established routes in the upper airspace limits capacity in the cruise phase of flight, constraining the flow of traffic. At lower altitudes, outdated arrival and departure routes are linked to the location of ground navigation beacons. Not only does this restrict the potential improvements in environmental performance, but those routes will become obsolete as the beacons reach the end of their service life.

3.17 Most flights using the UK's controlled airspace and route network are commercial air transport aircraft carrying passengers and freight. Traffic forecasts from NATS suggest that commercial air transport will grow by around 2% a year in the UK, from 2.25m flights in 2015 to 3.25m flights in 2030.[48] Modernisation must accommodate growing traffic levels to secure the most efficient use of airspace and the expeditious flow of traffic.

3.18 In today's airspace, to assure the safety of commercial air transport flights using the UK's controlled airspace and route network, General Aviation is constrained to an extent by the segregation between controlled and uncontrolled airspace. However, the forecast growth in traffic and technological advancements will require access to, and management within, the finite volume of UK airspace. To facilitate access by all airspace users to the greatest extent possible, there must be a transition towards greater integration of air traffic, where it is safe to do so.

48 These forecasts do not include the additional flights that might be generated by a third runway at Heathrow.

Achieving this will require a consideration of new airspace designs, operating procedures, technologies and equipment.

Avoiding flight delays by better managing the airspace network

3.19 The performance of our airspace as a transport network depends on the ability of air traffic controllers to secure the expeditious flow of traffic through designated sectors. Traffic flow restrictions are applied to individual sectors when the volume of traffic is predicted to exceed a level that controllers can manage safely, or when unforeseen circumstances occur, such as extreme weather conditions. These restrictions regularly create bottlenecks which cause flight delays in the air and congestion on the ground, as aircraft slow down, re-route or wait longer to depart.

3.20 In April 2017, a group of airports and airlines based in the congested South East, together with NATS, the airport slot-coordinator Airport Coordination Ltd and the CAA, formed the Industry Resilience Group. The purpose of this group is to pool expertise and recommend actions (for industry itself, or for the Government as part of its expected review of Aviation Strategy) to address shorter term resilience issues.

3.21 The output will support a systemised approach to the way in which the UK's aviation network is planned and operated to enhance its day-to-day operating resilience, reduce delays and the associated costs to both industry and passengers.[49]

3.22 Flight delays are forecast to increase sharply if the airspace is not modernised. In 2015, a lack of airspace capacity resulted in 78,000 minutes of flight delays. By 2017, this had risen to 160,075 minutes and would have risen further had mitigating capacity improvements not been implemented.[50] These delays, while not substantial, were forecast to grow

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49 [redacted]

50 Data provided by NATS.

to 5.6m minutes by 2030 if airspace modernisation is not delivered successfully. This is equivalent to an average of 26.5 minutes of delay per delayed flight, with more than 1 in 3 flights from all UK airports expected to depart over half an hour late due to airspace capacity shortfalls.[51]

3.23 Airspace modernisation can improve the management of airspace as a network by gathering and sharing more accurate flight information. In today's operation, the decisions made by air traffic control to manage the flow of traffic through sectors in line with available capacity are not always based on accurate flight information. Real time data about when flights plan to arrive in a particular sector, land at an airport, turnaround (reload, refuel etc) and then depart is not always available. The gaps in flight information, and the time and effort needed to close them, reduce the effective capacity of the airspace network and create delays.

3.24 Airspace modernisation can also strengthen resilience, both of the network and locally at specific airports. The gaps in flight information and lack of spare capacity has weakened the resilience of the airspace network to bad weather and disruption (for example technical problems or strike action). Unplanned events often lead to significant delays. Normal service is typically only resumed on the next day of operation.

Improving environmental performance by reducing emissions per flight

3.25 Airspace modernisation can enable aircraft to follow more efficient flightpaths. Aircraft often fly further than necessary in the upper airspace on flightpaths that are determined not by the shortest or most cost-effective route to their destination, but by airspace design or by controllers needing to safely separate traffic. Aircraft experiencing delays often have

51 [redacted]. Note that this analysis deals solely with NATS-attributable delay caused by a shortfall in airspace capacity. It does not include weather related delay, nor delay due to NATS' staffing or technical issues.

to fly sub-optimal routes, at less efficient altitudes and speeds, to avoid bottlenecks in the airspace network.

3.26 Flights in lower airspace that are transitioning between the take-off or landing phase and the cruise in upper airspace would ideally climb and descend quickly and continuously. In today's operation, controllers tactically manage the complex interactions between climbing and descending traffic. Continuous climbs and descents are interrupted by the need for aircraft to return to level flight to remain within the current outdated airspace structure, or to avoid conflicting traffic. The introduction of these 'steps' of level flight increases emissions and fuel burn per flight.

3.27 Flights inbound to airports that operate at close to maximum capacity often suffer congestion that results in queuing and delays. In today's operation, arrival queues are managed using holding patterns such as 'stacks' or 'arcs' that cause traffic to circle in lower airspace burning extra fuel and creating visual blight. Growing traffic levels are putting greater pressure on runways which, if the airspace is not modernised, will lead to greater use of 'stacks' in the future.

Improving environmental performance by better managing noise

3.28 One of the most significant environmental impacts associated with the airspace at lower altitudes is aircraft noise. Overall, airspace modernisation is expected to result in a reduction in the average noise levels per flight, for example by enabling aircraft to climb and descend continuously. Reducing noise impacts could itself be a driver for a new design. However, the redistribution of noise impacts between different areas, as changes are made, will often impact communities living under flightpaths. The effects of new, more frequent or concentrated noise may increase the risks of causing general annoyance, sleep disturbance, lower levels of productivity and health impacts.

3.29 In 2017 the Government issued revised environmental guidance to the CAA to clarify that in assessing the number of people 'significantly affected by aircraft noise', the total adverse effects must be considered.[52] This clarification of existing policy builds in an assessment of health impacts into airspace change proposals so that, for example, the creation of a respite route could reduce the total adverse health effects while increasing the absolute number of people affected. As a result, the aviation industry is required to consider options when designing airspace to find ways to manage the distribution of noise that best reflects this policy objective.

3.30 The CAA will review every initiative in the strategy in 2020, once the Government's Aviation Strategy is finalised, to determine whether the initiatives are compatible with noise policy. We may, at that point, strengthen the requirements or detail as to how initiatives should be delivered to comply with such noise policy.

Facilitating defence and security objectives

3.31 The military relies on access to airspace to enable appropriate defence of the UK, and requires dedicated areas to be reserved for activities which may be hazardous to other airspace users such as high-energy manoeuvring and testing munitions. The military's specific requirements for airspace are also changing over time with the introduction of new platforms, weapons technology and operational approaches. Over the next few years the number and capability of fast jets will increase, requiring larger portions of airspace for training; a new maritime patrol aircraft will be introduced; and Remotely Piloted Air Systems (drones) will be based in the UK.

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52 Air Navigation Guidance 2017: Guidance to the CAA on its environmental objectives when carrying out its air navigation functions, and to the CAA and wider industry on airspace and noise management, Department for Transport, October 2017.
[redacted]
Section 70(2) of the Transport Act 2000 requires the CAA to take account of any guidance on environmental objectives given to the CAA by the Secretary of State in exercising its air navigation functions.

3.32 Airspace for military training should provide aircrew with the ability to simulate realistic ingress/egress distances and weapons employment while defending against enemy tactics in a contested environment. Much of the current special-use airspace was developed to support the training needs of aircraft that are now retired, and it is neither optimal for current missions nor emerging requirements. With the transition to the latest generation of military fast jets, the need for specialised training airspace will continue to evolve. Although tactical training for this latest generation does include the use of ground-based simulators and training systems, it is anticipated that it will also drive greater airspace requirements over the next 10 years. To exercise the full capability of ‘fifth generation’ systems and present a sufficient training challenge, airspace must provide the size, structure and manoeuvring area to exercise tactics and employ weapons.

3.33 Some areas of the UK’s airspace are therefore segregated for military use, excluding other airspace users. The military reserves the airspace temporarily and releases it for civil use when it is not required. The processes of sharing airspace and temporarily reserving and releasing segregated areas that are shared between civil and military users is known as Flexible Use of Airspace. Modernisation of such structures, systems and processes can help to secure the most efficient use of airspace consistent with safety, defence and security objectives by creating greater opportunities and options for segregated airspace use, while allowing traffic to use potential segregated areas more effectively when they are not in use.

Chapter 4

Ways: the design, operations and technology needed to deliver airspace modernisation

Chapter summary

This chapter explains the **ways** of delivering modernising airspace in order to achieve the ends described in Chapter 3. Fifteen initiatives are identified, focusing on the period until the end of 2024, and grouped under five headings:

- upper airspace
- terminal airspace (complex lower airspace around airports)
- airspace at lower altitudes
- outside controlled airspace
- the UK's communications, navigation and surveillance infrastructure and air traffic management.

Each initiative is described in terms of the main airspace design, operational concepts and technologies. Key dependencies are also highlighted.

Introduction

4.1 A comprehensive modernisation programme across UK airspace is needed to achieve the ends described in Chapter 3. These **ways** of modernising airspace have been grouped into five broad areas:

- **changes to the upper airspace** (c.25,000 feet and above) that feature the removal of the fixed route network, the introduction of Free Route Airspace and enhancements to the management and procedures for segregated airspace that accommodate defence requirements and ensure efficiency.
- **changes to terminal airspace** (complex lower airspace around airports from c.25,000 feet to c.7000 feet) that focus on a fundamental redesign of the route network to satellite navigation

standards and the introduction of new solutions to better manage the flow of traffic.

- **changes to airspace around airports at lower altitudes** (from c.7000 feet to the ground) that:
  - modernise airport arrival and departure routes to increase the throughput of traffic and better manage aircraft noise impacts; and
  - reconfigure controlled airspace structures to provide greater integration of different airspace user groups.
- **changes to uncontrolled airspace** that focus on the airspace structures, procedures, equipment and technologies needed to improve the integration of all users requiring access to that area. This includes commercial aircraft transiting uncontrolled airspace under a limited air traffic service, General Aviation and other recreational users flying freely without radio equipage or air traffic contact, or drones. The outcome for all users is to operate within an overall management system that is proportionate and resilient for the future.
- **the UK's communications, navigation and surveillance (CNS) infrastructure and air traffic management,** focusing respectively on:
  - the transition from primary radars, radios and ground beacons to satellite-based and datalink technologies
  - the modernisation of air traffic management systems and tools that gather and share operational and planning information with air traffic controllers, pilots and other stakeholders.

4.2 Defence airspace modernisation requirements cut across all airspace types. They will therefore be met by several initiatives in this strategy, but also by other changes in airspace design which may be proposed outside these initiatives, including at lower altitudes and outside controlled airspace.

4.3 The sections below explain the initiatives in each area in more detail.

Upper airspace

4.4 The upper airspace is considered to be the airspace above around 25,000 feet where flights have joined the airways network and entered the cruise phase. Aircraft often fly further than necessary in the upper airspace on flightpaths that are determined by a limited number of established waypoints, rather than the shortest route to their destination. A range of factors determine the sequence of waypoints that aircraft plan to follow, including weather conditions, entry into the airspace across the Atlantic which is managed in a different manner, the most efficient deconfliction points, and the locations of segregated airspace that has been reserved for military or other activity.

4.5 There are three major initiatives that will modernise upper airspace:

1. optimising Direct Route Airspace
2. the introduction of Free Route Airspace
3. Advanced Flexible Use of Airspace.

4.6 Direct Route Airspace refers to the introduction of a large number of additional waypoints in the upper airspace that supplement the established ones. Aircraft are offered a far greater number of options to fly directly between the quickest and most fuel-efficient combination of waypoints. Air traffic controllers can manage larger volumes of traffic by using the many additional waypoints to route aircraft away from common bottlenecks, adding capacity to the upper airspace. Introducing a large number of additional waypoint combinations also increases the options available to traffic that must route around areas of poor weather or segregated areas, improving flight efficiency and the resilience of the airspace network. Direct Route Airspace was introduced to key parts of the UK's upper airspace in March 2016, and its use is being optimised through close collaboration with the airline community.

4.7 Free Route Airspace is a further improvement of the Direct Route Airspace concept that sees the removal of all established routes from the upper airspace, allowing aircraft to follow the most efficient flightpath to their destination using intermediate points only where necessary. This means traffic can plan and re-plan their flightpaths through large volumes of the upper airspace without the limitations of a rigid route structure. Aircraft can fully optimise their flightpaths taking into account flight time, fuel burn, network delays and the weather.

4.8 As stated previously, some areas of the upper airspace are segregated for hazardous activities like military operations and in the future, also for spaceflight launches. Flexible Use of Airspace (FUA) refers to the arrangements for booking and releasing volumes of segregated airspace to ensure that defence and security needs are met and that the limited resource is otherwise used as efficiently as possible. Advanced Flexible Use of Airspace (AFUA) concepts will upgrade the airspace structures, procedures and technologies used to manage segregated areas. This will improve military mission effectiveness by providing suitably sized and located training airspace, while enabling increases in capacity and flight efficiency by allowing civil traffic to route directly more frequently when hazardous activities are not taking place.

4.9 In catering for military requirements in upper airspace, the AFUA initiative may also include terminal airspace and may need to be coordinated with changes in uncontrolled airspace.

4.10 The implementation of Free Route Airspace and the upgrades to implement AFUA are required by EU legislation. The changes form a core part of a Commission implementing regulation known as the SESAR Deployment Pilot Common Project (PCP) that requires all European states to remove the established routes in the upper airspace before 1 January 2022. The implementation of Direct Route Airspace in the UK in 2016 is a stepping stone towards Free Route Airspace. Improving the management of Flexible Use Airspace is also a UK strategic ambition to accommodate the next generation of military aircraft that require greater volumes of airspace for testing and training.

4.11 Table 4.1 summarises the main upper airspace initiatives and how they relate to the strategic framework.

Table 4.1 Upper airspace initiatives

<table>
<tr><th>Initiative</th><th>Policy obligation and timeframe</th><th>Ends</th></tr>
<tr><td>1) Direct Route Airspace
Deployment of additional waypoints to the existing route network.</td><td>EU legislation
SESAR Pilot Common Project AF3 (by 2022, compliance achieved in 2016)</td><td rowspan="3">Safety: Additional airspace capacity reduces the risk factors associated with traffic congestion and peaks in controller workload.
Efficiency: Increasing the number of route options available to airspace users allows air traffic controllers to manage more flights through the same sectors.
Efficiency: Aircraft have the flexibility to plan and re-plan flightpaths in response to poor weather, segregated areas and airspace restrictions.
Environment: Aircraft have the flexibility to flight plan and fly more direct routes at more efficient altitudes and speeds than with limited fixed waypoints reducing emissions per flight and saving fuel.
Security: The military has efficient and effective access to suitably sized and sited volumes of airspace to complete its missions. Information on actual planned utilisation of reserved airspace is shared in real time, enabling airspace to be handed between users with minimal unutilised time.</td></tr>
<tr><td>2) Free Route Airspace
Removal of all fixed routes so aircraft can fly fully optimised routes.</td><td>EU legislation
SESAR Pilot Common Project AF3 (by 2022)</td></tr>
<tr><td>3) Advanced Flexible Use of Airspace
New airspace designs, procedures and technology to increase options for airspace configurations, to support the efficient use of airspace and to best meet military requirements while being cognisant of civil airspace users.</td><td>EU legislation
SESAR Pilot Common Project AF3 (by 2022)
UK state requirements</td></tr>
</table>

Terminal airspace

4.12 The terminal airspace from c.25,000 feet to c.7000 feet is designed to manage high volumes of traffic climbing and descending between individual airports and the upper airspace. The result is a complex web of intersecting flightpaths to and from airports that are operating in close proximity. The complexity of the interactions between traffic flows in the terminal airspace can lead to some aircraft flying longer routes and more inefficient profiles. The workload placed on controllers to manage high numbers of traffic interactions also limits capacity and efficiency, in order to protect safety. Terminal airspace contains airborne holding structures for aircraft queuing to land at the busiest airports.

4.13 There are three major initiatives to modernise terminal airspace;

4. the fundamental redesign of the terminal airspace in southern England
5. the fundamental redesign of the terminal airspace in northern England and Scotland
6. the introduction of better queue management capabilities into terminal airspace.

4.14 The fundamental redesign of the terminal airspace is based on the widespread adoption of satellite navigation that removes the reliance on ground-based navigation aids and allows the route network to be overhauled, introducing routes with greater precision and flexibility. Significant airspace capacity gains can be achieved through terminal airspace redesign by implementing closely spaced arrival and departure routes that are dedicated to individual airports. Closely spaced routes are separated by design and do not require controllers to manage the traffic interactions tactically.

4.15 Designing routes with greater precision and flexibility reduces track miles and increases the potential for continuous climbs and descents, increasing flight efficiency and environmental performance. The redesign also offers opportunities to further enhance safety by reducing and/or removing risk factors from the operation, for example by removing pinch-points and unnecessary interactions. Additional capacity and the introduction of dedicated routes to and from each airport in the terminal area can strengthen the airspace's resilience to delays from poor weather or disruption.

4.16 Queue management refers to the use of new sequencing tools by air traffic controllers to stream arrival traffic into the terminal airspace (arrival management) and co-ordinate departures from multiple airports (departure management). The use of holding stacks to manage arrival queues limits the capacity of terminal airspace and burns extra fuel. One of the main objectives of arrival management is to absorb arrival delays in the upper airspace, removing the need for as much stack holding in the terminal. Holding in some form may always be necessary to maintain high runway utilisation rates, but this should average at around one to two minutes rather than the eight to 10 minutes that is typical today. Larger airports are expected to invest in departure management tools and procedures that improve the flow of outbound traffic and help to de-conflict flights from multiple airports that rely on the same volumes of airspace. NERL will be undertaking further work to identify where there are other interdependencies between different airports' demands for airspace, such as the impact of holding stacks on departure flows from neighbouring airports (see Chapter 6).

4.17 The queue management initiative is supported by the introduction of Airport Collaborative Decision Making (A-CDM) systems at larger airports, enabling better-informed, more consistent decision-making. A-CDM introduces new systems and processes to create, refine and exchange up-to-date runway and airspace data between the airport, air traffic control, airlines and ground handlers, including:

- the progress of each flight turnaround
- times for each flight to push back from stand and take off
- optimal departure sequencing to maximise runway and airspace performance.

4.18 A-CDM gathers the latest estimated landing times for inbound flights from arrival management tools to improve the management of ground operations that are often the cause of air traffic delays.

4.19 A-CDM also allows air traffic controllers to construct an optimised sequence of departures. A-CDM co-ordinates the process by which departing aircraft are granted permission to push back from the stand, using a key tool which calculates an optimal time for each flight to begin its start-up and departure sequence. The calculation is based on the departure plans of other aircraft, the performance of the runways and the capacity of the airspace.

4.20 A-CDM also provides network management organisations and air traffic controllers with departure planning information about each flight allowing them to optimise traffic flows across UK and European airspace. Electronic messages are submitted from the airport to the European Network Manager Operations Centre at the exact time that each aircraft pushes back from the stand, and also give target take-off time, taxi time to the runway, actual take-off time and route through the airspace. This information is then relayed to local air traffic control centres across the UK and Europe.

4.21 The introduction of satellite-based navigation and queue management solutions in the terminal airspace are core parts of the SESAR Deployment Pilot Common Project implementing rule required by 1 January 2024. The performance of queue management solutions is enhanced if they are integrated across neighbouring states. The SESAR European air traffic management Master Plan sets out the ambition for cross-border queue management that allows air traffic controllers from multiple states to work together to use the solutions to optimise the flow of traffic and avoid delays.

4.22 A major upgrade to the terminal airspace that serves the airports in London and the South East is required to support the development of an additional runway at Heathrow and any more intensive use of other runways as laid out in the Governments Airports National Policy Statement.

4.23 Table 4.2 summarises the main terminal airspace initiatives and how they relate to the strategic framework.

Table 4.2 Terminal airspace initiatives

<table>
<tr><th>Initiative</th><th>Policy obligation and timeframe</th><th>Ends</th></tr>
<tr><td>4) Terminal airspace redesign in Southern England
5) Terminal airspace redesign in Northern England and Scotland
Fundamental redesign of the terminal route network using precise and flexible satellite navigation.</td><td>EU legislation
SESAR Pilot Common Project AF1 (by 2024)
UK Government Airports NPS in the London terminal airspace (by 2024)</td><td rowspan="2">Safety: Significant capacity gains achieved by more closely spaced arrival and departure routes to individual airports, reducing reliance on stack holding and controllers tactically managing interactions.
Safety: Risk factors, pinch-points and unnecessary interactions are designed out of the route network.
Efficiency: Additional airspace capacity helps to avoid airborne delays and dedicated routes to and from each airport strengthen the resilience of the network.
Environment: Designing routes with greater precision and flexibility reduces track miles and improves climb/descent performance.
Environment: Greater precision and flexibility offers opportunities to manage the distribution or impact of noise by avoiding population centres and deploying multiple routes for noise relief.</td></tr>
<tr><td>6) Queue management
Streaming traffic into and out of the terminal and absorbing delays in the upper airspace.</td><td>EU legislation
SESAR Pilot Common Project AF1 (by 2024)
SES air traffic management Master Plan ambition (regarding departure management and cross-border queue management)</td></tr>
</table>

Lower altitudes around airports

4.24 Airspace modernisation at lower altitudes (below c.7000 feet) will provide sufficient capacity between the terminal airspace and runways, by implementing more precise and flexible satellite-based arrival and departure routes – while managing the impact of aircraft noise on local communities. Airspace developments at lower altitudes must also consider the need to safely integrate other airspace users within the airport vicinity, including General Aviation and drones.

4.25 Many of the UK's commercial airports are expected to upgrade their arrival and departure routes between 2018 and 2024 – introducing more precise and flexible flightpaths based on satellite navigation and removing the reliance on ground navigation beacons.

4.26 There are two main initiatives at lower altitudes to modernise airspace:

7. the replication of existing arrival and departure routes with satellite navigation upgrades, and
8. the deployment of new arrival and departure routes designed to satellite navigation standards.

4.27 At lower altitudes, the noise impact of aviation on those on the ground takes greater precedence than the management of aircraft emissions. The airports are responsible for managing the effects of redesigning routes on their local communities. Some airports may choose to replicate their existing arrival and departure routes with satellite navigation upgrades to minimise any changes in the established patterns of aircraft noise. However, the track-keeping precision of satellite navigation typically concentrates aircraft noise into narrower contours, which often has a more intense impact on the areas affected.

4.28 Other airports may choose to go beyond simply replicating flightpaths and use the precision and flexibility of satellite navigation to offer noise abatement and respite options to local communities or deploy multiple departure routes that can increase runway throughput during peak times. Any proposal that has the potential to affect traffic patterns below 7000 feet must follow the CAA's airspace change process for a 'Level 1' change, which includes requirements to consult closely and in detail with other aviation stakeholders and those local communities which may be affected.[53]

4.29 When redesigning arrival and departure routes at lower altitudes, there are a number of techniques that may be deployed by airspace change sponsors to better manage the impacts of aircraft noise, for example:

53 [redacted]

- **noise respite:** greater planning and predictability of noise impacts, such as:
  - the planned use of different runways at different times of day, providing communities with predictable relief from the noise impacts of movements on either runway
  - alternating between multiple departure routes to a pre-planned schedule

  Respite can be designed into airspace structures more easily once arrival and departure routes are upgraded, because they can be designed with greater accuracy and flexibility
- **noise redistribution:** the redesign of airport arrival and departure routes at lower altitudes that allows for noise impacts to be redistributed away from more sensitive areas. This is dependent on there being adjacent areas that are less sensitive to noise to which the flightpaths can be moved; the relative noise sensitivity of areas is difficult to estimate and must be carefully considered where redistribution is the aim.

4.30 The requirement for airports to upgrade their arrival and departure routes to satellite navigation standards is driven by the SESAR Deployment Pilot Common Projects regulation for the 25 largest airports across Europe (including Heathrow, Gatwick, Stansted and Manchester in the UK). The introduction of satellite navigation has been declared a top priority by ICAO for its programme to upgrade airspace[54] and is the subject of EU Regulation 2018/1048 on performance-based navigation published in July 2018, the requirements of which go wider than the airports defined by the Pilot Common Project in that they will apply to all EASA airports and air traffic services routes. Table 4.3 summarises the main lower altitude airspace initiatives and how they relate to the strategic framework.

54 The Aviation System Block Upgrades: the Framework for Global Harmonization, ICAO, July 2016. [redacted]

Table 4.3 Lower altitude airspace initiatives

<table>
<tr><th>Initiative</th><th>Policy obligation and timeframe</th><th>Ends</th></tr>
<tr><td>7) Satellite navigation route replications
Replication of existing arrival and departure routes to satellite-based navigation standards.</td><td>ICAO upgrade programme priority
EU legislation (by 2024)</td><td rowspan="2">Safety: Satellite-navigation routes are more precise and separated by design, enhancing safety.
Efficiency: Greater route precision and flexibility can be used to increase runway throughput and secure the most efficient use of airspace.
Efficiency: Satellite navigation offers resilience for established instrument landing systems, reduces the reliance on ground navigation beacons (contingency still required) and allows access to airports that may otherwise be closed in poor weather.
Environment: Designing routes with greater precision and flexibility reduces track miles and improves climb/descent performance.
Environment: Greater precision and flexibility offers opportunities to better manage noise impacts by avoiding population centres and deploying multiple routes for noise relief.</td></tr>
<tr><td>8) Satellite navigation route redesign
Redesign of new arrival and departure routes using satellite-based navigation standards.</td><td>EU legislation (by 2024)
SESAR Pilot Common Project AF1</td></tr>
</table>

Operations outside controlled airspace

4.31 Outside controlled airspace, General Aviation, predominantly recreational flying, operates alongside commercial flights and the military. While air navigation service providers provide a flight information service and alerting service to those who request such support, it is not mandatory for a pilot to be in receipt of an air traffic service. This generates an unknown and unpredictable air traffic environment. The airspace user remains responsible for avoiding collision. This was discussed in Chapter 3 under the heading ‘maintaining and enhancing high aviation safety standards’.

4.32 Further improvements are required for a simpler and more flexible airspace. It is also necessary to reduce the level of complexity and improve alignment with international standards.

4.33 There are three main initiatives to modernise uncontrolled airspace:

9. review the provision of the Flight Information Service (FIS) to align with ICAO FIS and EU Part-ATS
10. review the use of all airspace classifications, both controlled and uncontrolled, the associated airspace structures and related air traffic management requirements to ensure the arrangements are optimised for all classes of aircraft
11. electronic conspicuity: the utilisation of cost-effective electronic surveillance information and its consideration in designing new or revised airspace structures and procedures, including how electronic surveillance solutions and digital information services can be used to better integrate commercial and non-commercial operations in uncontrolled airspace such that the airspace user can sense all others and be seen by all others

The CAA will need to take the lead on these initiatives and will establish programmes of work with stakeholders in the near future.

4.34 The CAA's high-level strategy in respect of the electronic conspicuity initiative is not to require a particular technology or supplier of technology. Given global market, commercial and regulatory developments, we see ADS-B-enabled and interoperable platforms[55] as the most likely commonly adopted technology in the UK. While we do not rule out alternatives, we would expect them to be interoperable with ADS-B standards. The key point is that any technology used must be fully interoperable for the purpose of achieving the required outcome of 'sense

55 ADS-B, automatic dependent surveillance – broadcast, is a surveillance technology in which an aircraft determines its position via satellite navigation and periodically broadcasts it, enabling it to be tracked.

all others and be seen by all others' by electronic or digital means. The existing UK standard for these devices[56] will be kept up to date as a performance-based regulation to enable rapid advances where appropriate.

4.35 The CAA is not proposing an immediate general mandate to require all users to be fully electronically conspicuous. We will, however, use a rolling programme of highly focused mandates over the next few years to target particularly challenging volumes of airspace and choke points when making decisions on airspace change proposals by industry sponsors.

4.36 The CAA is minded to move to a general UK mandate requiring all users to be fully electronically conspicuous at a future date. This date will be influenced by the pace of adoption, the availability and cost of equipment, the development of ground-based infrastructure and other technological developments. We are currently minded that the earliest date for such a general mandate would be in three to five years' time (i.e. 2022–2024).

4.37 The CAA will consult interested parties early in 2019 on this high-level strategy, including the mechanisms for achieving it, before making a decision later in 2019 on its formal adoption.

56 Electronic Conspicuity Devices, CAP 1391. www.caa.co.uk/cap1391

4.38 Table 4.4 summarises the main uncontrolled airspace initiatives and how they relate to the strategic framework.

Table 4.4 Initiatives outside controlled airspace

Initiative	Policy obligation and timeframe	Ends
9) Review of FIS provision in UK	EU legislation (Part-ATS) (from 2022[57])	**Safety:** Significant potential safety enhancements from strengthening the mitigations for airspace infringements and mid-air collisions. **Efficiency:** Significant potential flight efficiency benefits from providing more airspace users with access to volumes of airspace that are in high demand.
10) Airspace classification review	EU legislation (Part-ATS) (from 2022) A review of air traffic services provision in uncontrolled airspace to align with international standards	
11) Electronic surveillance solutions	Fully interoperable electronic conspicuity solution for all airborne craft (ongoing, and likely to be mandated by the CAA in a 2022–2024 timeframe)	

Communications, navigation and surveillance (CNS) infrastructure and air traffic management

Communications, navigation and surveillance (CNS) infrastructure

4.39 Modernising air traffic management systems, tools and procedures used by air traffic controllers, network managers, flight crews and other operational stakeholders will enhance their decision-making. In addition, the transition from predominantly ground-based CNS infrastructure to a mix of ground and satellite-based capabilities providing greater resilience is a key result expected to be delivered by airspace modernisation. In the near term to 2024, some ground-based infrastructure will need to be retained for defence, security and resilience purposes. Such infrastructure

57 Date proposed by EASA in [redacted]

should be managed on a national basis, providing a comprehensive oversight of assets. In the longer term, beyond 2024, the expansion of satellite-based services will help mitigate the risk of single-source failures associated with the transition to satellite-based infrastructure and enable a further rationalisation of ground assets.

4.40 There are three main initiatives associated with the CNS infrastructure that contribute to the modernisation of airspace:

12. a cross-industry plan for the efficient use of radio-frequency spectrum
13. a cross-industry plan for the full adoption of datalink communications
14. a satellite navigation implementation plan that reduces reliance on ground-based assets
15. the modernisation of air traffic management systems, tools and procedures

Communications

4.41 Radio-frequency spectrum is an asset in high demand, mainly due to the increased usage from the telecoms industry. The growing volume of data required to be transferred between aircraft (including drones and spacecraft) and air traffic services in order to facilitate the evolution of airspace management will in the coming years place greater pressure on the radio-frequency spectrum currently allocated to aeronautical services. A cross-industry plan for the efficient use of radio-frequency spectrum is therefore required to ensure aviation needs are understood, justified and reflect a real-time requirement for safe air operations that can contribute to the ambition of an integrated airspace.

4.42 The management and protection of spectrum for aviation use is an ongoing task within the CAA, working with external bodies to ensure that access to sufficient suitable and appropriately protected spectrum is maintained. The rationalisation of the current ground infrastructure will enable the deployment of additional spectrally efficient systems that can support the expected increase in data traffic.

4.43 New technology is expected to change the method of communication to allow greater volumes of information to be shared faster and more consistently via datalink transfer, with less reliance on voice exchanges over radio. The introduction of datalink services is an international ambition that aims to drive the reduction in voice communications and support a more consistent, reliable and less workload intensive exchange of information. Initially this is likely to replace standard air traffic message exchanges, with more complex interactions developing as experience develops. Ground asset requirements for security, contingency and operational resilience of datalink communications needs to be co-ordinated and managed.

Navigation

4.44 The avionics capability of the aircraft fleet has advanced significantly in the past two decades, allowing a shift from the reliance on ground-based navigation beacons to autonomous aircraft operations dependent on a satellite-based navigation source. This capability shift enables the removal of old navigation equipment, which have high procurement and maintenance costs.

4.45 ICAO Assembly Resolution A37-11 requires member States to submit a national implementation plan concerning the introduction of satellite navigation routes. This resolution encourages States to deploy satellite navigation in the upper, terminal and lower altitude airspace (as described in the sections above). As a conseqence of the greater reliance on satellite navigation, there is a subsequent opportunity to review the requirements for ground-based infrastructure based on resilience and contingency requirements. The rationalisation of ground-based assets is enabled by the transition to a satellite-based navigation infrastructure and is expected to provide:

- an affordable airspace modernisation approach for smaller aerodromes that have less air traffic control technology and equipment

- an alternative to non-precision approaches that are safer and more efficient
- a back-up to current precision landing systems to enhance resilience.

Surveillance

4.46 The application of space-based navigation and improved communication links will allow users to transmit precise positional information to air traffic control, increasing both ground and airborne situational awareness. It is recognised that a primary surveillance capability (i.e. radars) will be required for the foreseeable future in support of the UK's defence and security objectives. However, there are opportunities that allow for the phased modernisation of the UK's surveillance capability, including:

- the greater uptake of aircraft broadcast position information and the advancements in available portable technology, allowing an affordable option for all aircraft operators (civil, military and General Aviation) to share electronic surveillance information about one another with one another
- new technologies and equipment for air traffic services to gather, process and display aircraft position information from multiple sources
- deployment of an interoperable conspicuity solution based on ADS-B and the associated ground use of the data to support air traffic services.

Air traffic management systems, tools and procedures

4.47 The modernisation of air traffic management systems, tools and procedures will provide stakeholders with more accurate and joined-up information about when flights plan to depart, when they do depart, the routes that they are expected to follow and when they are expected to arrive in particular sectors of airspace. The sharing of accurate and up-to-date flight information between air traffic controllers, network planners, flight crews and other operational stakeholders allows traffic flows to be sequenced and deconflicted earlier. Crossing traffic can be identified and resolved before the tactical interactions that characterise air traffic management today occur. This increases the options available to operational stakeholders and improves the management of network performance – increasing airspace capacity, safety, efficiency and resilience.

4.48 This modernisation is consequently a key enabler for:

- the successful implementation of initiatives described in the upper airspace and terminal airspace sections of this strategy
- the effective integration of UK airspace with the wider European and global air transport network, following a standard set of requirements laid out in the SESAR Deployment Pilot Common Project

by allowing air traffic controllers to manage a larger number of flights through the same volumes of airspace with greater efficiency, resilience and flexibility.

4.49 One of the main components of air traffic management modernisation is the deployment of a SESAR-compliant flight data processing system and associated toolset for air traffic controllers. NATS is part of the iTEC (Interoperability Through European Collaboration) consortium that also brings together air navigation service providers of Spain, Germany, Lithuania, the Netherlands, Norway and Poland. The system aims to enable widespread improvements in safety, capacity, flight efficiency and environmental performance across European airspace by enhancing interoperability between control centres and allowing aircraft operators to optimise their flightpaths. iTEC will feature advanced trajectory management functions and new conflict-management tools. It will also allow volumes of airspace to be managed in a more flexible and dynamic way, responding to changes in traffic demand, weather conditions or adapting to reservations of segregated airspace.

4.50 Advanced data exchange and sharing services are required to communicate aeronautical information (flight, weather, aerodrome, obstacles, etc) to operational stakeholders using new air traffic management systems and tools on the ground and in the air. The Aeronautical Information Exchange Model (AIXM) is a specification that enables the encoding and distribution in digital format of the aeronautical information. The aeronautical information management (AIM) concept is being delivered via the SESAR programme to provide more accurate and efficient digital aeronautical information to airspace users, air navigation service providers and airport operators.

4.51 System Wide Information Management (SWIM) supports these information exchanges through an internet-protocol-based network. The synchronisation of data involves civil and military air navigation service providers, airspace users, airport operators, meteorological service providers and the European network manager. SWIM services will enable new air traffic management systems and tools like iTEC to connect and share flight information.

Initiatives

4.52 Table 4.5 summarises the main CNS and air traffic management infrastructure initiatives and how they relate to the strategic framework.

Table 4.5 CNS infrastructure initiatives

<table>
<tr><th>Initiative</th><th>Policy obligation and timeframe</th><th>Ends</th></tr>
<tr><td>12) Cross-industry plan for the efficient use of radio-frequency spectrum</td><td>Indirectly from EU legislation (Part-ATS and surveillance implementing rule) (ongoing)[58]</td><td rowspan="4">Safety: Significant potential safety enhancements from the increase in airspace capacity, traffic flow predictability, situational awareness, aircraft navigational capabilities and resilience.

Efficiency: Significant potential to secure the most efficient use of airspace through deployment of equipment and technologies that enable all classes of aircraft with greater access to the airspace.

Efficiency: Satellite navigation offers resilience for established instrument landing systems and ground navigation beacons, and also allows access to airports that may otherwise be closed in poor weather.</td></tr>
<tr><td>13) Cross-industry plan for the full adoption of datalink communications</td><td>EU datalink implementing rule (2019)</td></tr>
<tr><td>14) An implementation plan for the introduction of satellite-based navigation routes
Includes the retention of sufficient ground navigation aids, communications and surveillance capability to ensure the continued provision of air services in the event of loss of the global navigation satellite system.</td><td>EU legislation (2020–2024)</td></tr>
<tr><td>15) Air traffic management
To modernise systems, tools and procedures.</td><td>SESAR Pilot Common Project (AF4, AF5 and AF6) (by 2024)</td></tr>
</table>

Further detail on the ways of modernising airspace

4.53 The main ways of delivering airspace modernisation are:

- changes to the established **airspace design**, meaning its structure and route network

58 [redacted]

- **new operational concepts** including procedures to manage the flow of traffic, and
- the introduction of **new enabling equipment and technologies**.

4.54 This section provides further detail on the main ways of modernising airspace for the period until the end of 2024 that were introduced earlier in this chapter under five headings:

- changes to upper airspace
- changes to complex terminal airspace around airports
- changes to airspace around airports at lower altitudes
- changes to uncontrolled airspace
- the UK's communications, navigation and surveillance (CNS) infrastructure and air traffic management.

4.55 Under each heading the 15 initiatives are summarised and the main airspace design, operational concepts and technologies have been described. Key dependencies have also been highlighted, for example there may be a reliance on future rules and regulations, training or equipment to fully realise the expected benefits.

4.56 Progress with the 15 initiatives, in the form of a RAG status, is set out in in Chapter 7.

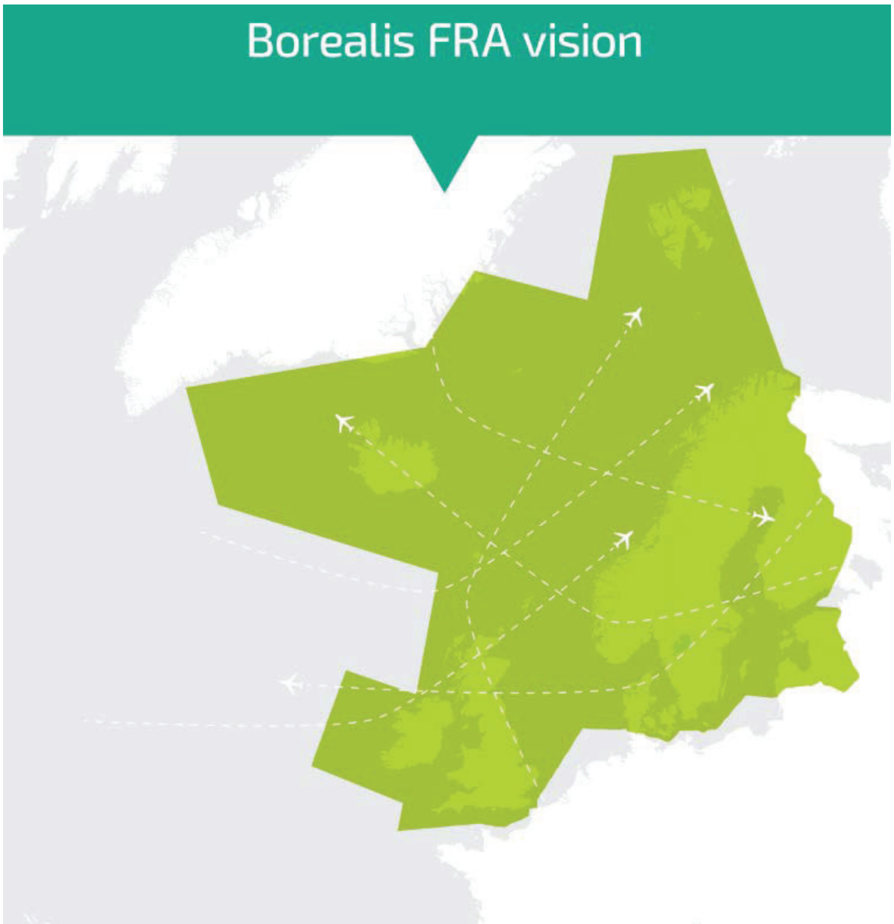
Modernisation in upper airspace

Ends

As traffic levels in upper airspace continue to grow, the ends, or known outcomes that modernisation must deliver, are:

- **safety**: reduce controller workload
- **efficiency:** remove bottlenecks and strengthen the resilience of the en-route network
- **security:** facilitate integrated civil/military operations
- **environment:** reduce emissions per flight.

Figure 4.1 Volume of Free Route Airspace (FRA) by the UK and partners to be implemented by 2022



Ways

Airspace design	Operational procedures	Technology enablers
1. Direct Route Airspace: deployment of additional waypoints to the existing route network		
1.1. New waypoints to enable Direct Route Airspace have been implemented by NERL as part of its Service and Investment Plan and funded by the unit rate.*	1.2. Flight crews and air traffic controllers use today's established procedures in Direct Route Airspace.	1.3. Airline flight-planning systems must be upgraded with the capacity to use the direct route options. The upgrades are only partly co-ordinated and funded by the airline community.
Timescale: by 2022		**Driver: Single European Sky legislation**
2. Free Route Airspace: removal of all fixed routes so aircraft can fly fully optimised routes		
2.1. Removal of the fixed route network to enable Free Route Airspace will be implemented by NERL as part of their Service and Investment Plan and funded by the unit rate.	2.2. New procedures for flight crews and air traffic controllers to operate safely and efficiently in Free Route Airspace will be developed and deployed consistently by the industry and regulators.	2.3. Airline flight planning systems must be upgraded with the capacity to operate in Free Route Airspace. The upgrades are only partly co-ordinated and funded by the airline community.
Timescale: by 2022		**Driver: Single European Sky legislation**
3. Advanced Flexible Use of Airspace: new booking and release capabilities for segregated airspace		
3.1. New airspace structures to enable Advanced Flexible Use of Airspace will be sponsored by the MoD and designed in collaboration with NERL and the airlines. Funding for the changes will be drawn from the unit rate.	3.2. New procedures for optimising booking and release within Advanced Flexible Use of Airspace will be developed collaboratively by the CAA, NERL and MoD as part of the joint and integrated approach.	3.3. Airspace management tools to share information about the booking and release of shared airspace will be implemented to military outstations.
Timescale: by 2022		**Drivers: SES legislation and UK state requirements**

Dependencies

1.3 & 2.3 For aircraft operators to flight plan and operate in Direct Route and Free Route Airspace, there is a dependency on the co-ordinated implementation of new flight planning systems.

2.2 There is a dependency on the new procedures for operating Free Route Airspace being deployed consistently across UK and European flight crews and air traffic controllers. Regulators have a key role to play in establishing efficient standard procedures.

3.3 For the operation of Advanced Flexible Use of Airspace and Free Route Airspace, there is a key dependency on the implementation of new airspace management tools by military outstations to book and release segregated airspace.

* Each EUROCONTROL member state establishes the unit rate of en-route charges levied on airspace users in the airspace for which it is responsible.

Modernisation in terminal airspace

Ends

As traffic levels in the complex terminal airspace grow, the ends, or known outcomes that modernisation must deliver, are:

- **safety**: capacity gains achieved while removing unnecessary interactions
- **efficiency:** expeditious flow of traffic
- **environment:** shorter track miles and continuous climbs / descents to reduce emissions per flight.
- **environment:** opportunities to better manage noise impacts.

Figure 4.2 Radar tracks showing high levels of crossing traffic in today's London terminal airspace

Source: NATS

Ways

Airspace design	Operational procedures	Technology enablers
4. FAS Implementation South: redesign of the terminal network in southern England		
4.1. Redesign of the southern terminal airspace above c.7000 feet will be implemented by NERL as part of their Service and Investment Plan and funded by airlines through the unit rate.	4.2. New procedures for Swanwick Centre controllers to operate in a systemised environment and minimise tactical intervention will be developed/deployed by NERL.	4.3. New tools for Swanwick Centre controllers to support systemisation, automate tasks and manage greater traffic levels will be implemented by NERL and funded by the unit rate.
Timescale: by 2024	**Drivers: Single European Sky legislation and Airports NPS**	

Airspace design	Operational procedures	Technology enablers
5. FAS Implementation North: redesign of the terminal network in northern England and Scotland		
5.1. Redesign of the northern and Scottish terminal airspace above c.7000 feet will be implemented by NERL as part of their Service and Investment Plan and funded by the airlines through the unit rate.	5.2. New procedures for Prestwick Centre controllers to operate in a systemised environment and minimise tactical intervention will be developed and deployed by NERL.	5.3. New tools for Prestwick Centre controllers to support systemisation, automate tasks and manage greater traffic levels will be implemented by NERL and funded by the unit rate.
Timescale: by 2021	**Drivers: Single European Sky legislation and NERL RP2 plan**	

Airspace design	Operational procedures	Technology enablers
6. Queue management: new capabilities to stream the flow of traffic		
6.1. Linear holding structures to replace stack holding and facilitate arrival management, along with system-wide information sharing are being implemented by NERL as part of their Service and Investment Plan and funded by the unit rate. Co-ordination on airspace design with neighbouring States' air navigation service providers.	6.2. New procedures for controllers to stream arrival traffic using speed controls and operate linear holds have been deployed by NERL. Flight planners and crew have been trained to operate with linear holds. Co-ordination on new procedures with neighbouring States' air navigation service providers.	6.3. Arrival and departure management tools that calculate the speed controls needed to stream inbound and outbound traffic flows are being deployed by NERL (through the Service and Investment Plan, funded by the unit rate) and by some larger airports. Co-ordination on technology implementation with neighbouring States' ANSPs.
Timescale: by 2024		**Driver: Single European Sky legislation**

Dependencies

4.1 & 5.1 There is a significant dependency on the replication or redesign of airport arrival and departure procedures below 7000 feet (see 7.1 and 8.1).

4.2 & 5.2 There is a major dependency on the training and changes in working practices and behaviours to support the shift from terminal ATC procedures (based on tactical separation of conflicting traffic and management of the overall flow of aircraft) to systemisation (where traffic is separated by design and the flow is managed through aircraft speed control using electronic support tools).

4.3 & 5.3 Terminal airspace systemisation requires a new suite of ATC systems and tools that predict the trajectory of flights and resolve potential conflicts long before aircraft actually need to be managed tactically. These systems and tools are a major IT transformation for the air navigation service provider and must be closely co-ordinated with the introduction of new airspace designs and operating procedures in order to be effective.

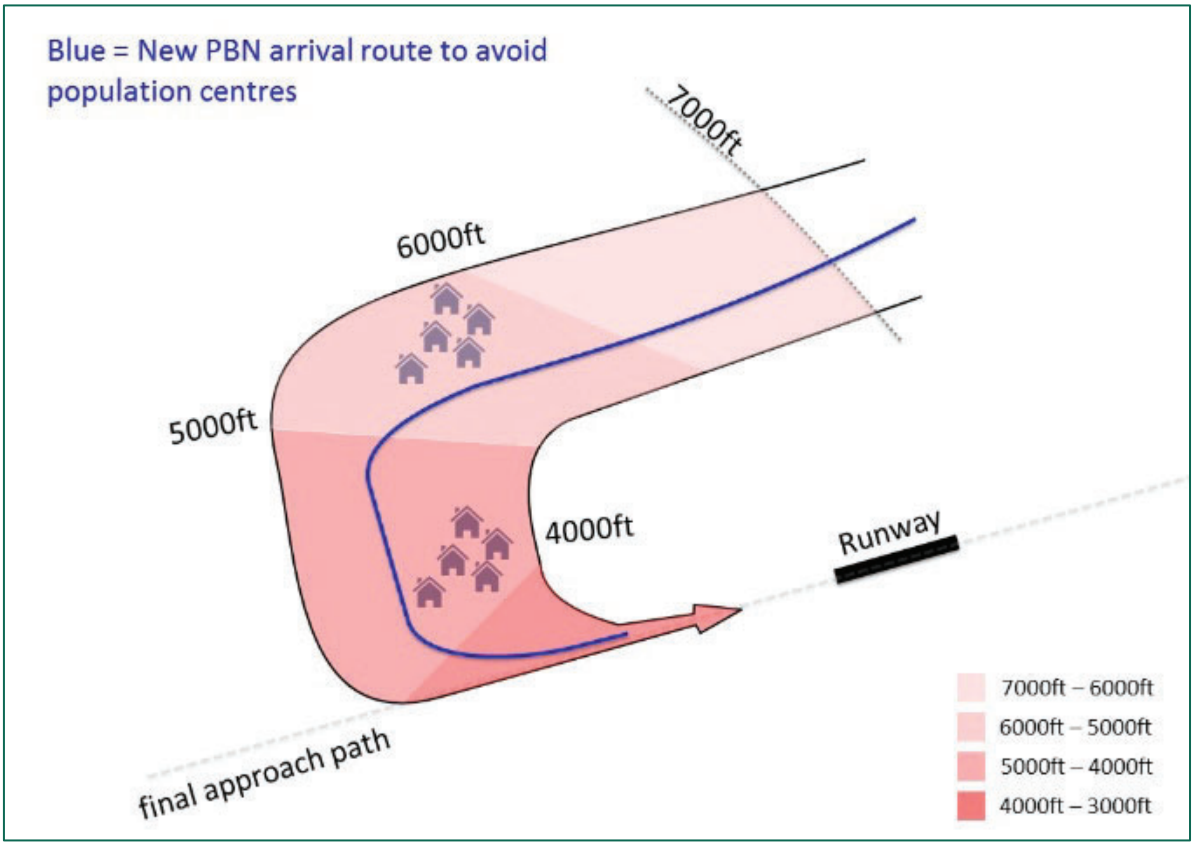
Modernisation in airspace at lower altitudes

Ends

As airports expand their operations, the ends, or known outcomes that modernisation must deliver, are:

- **safety**: precision routes, separated by design
- **efficiency:** greater runway throughput by deploying dedicated routes for each airport to secure more efficient use of airspace and strengthened resilience
- **environment:** shorter track miles and continuous climbs / descents to reduce emissions per flight
- **environment:** opportunities to better manage noise impacts

Figure 4.3 Illustration of a new arrival route to manage noise impacts by avoiding population



Ways

Airspace design	Operational procedures	Technology enablers

7. Replication of existing arrival and departure routes with satellite navigation upgrades		
7.1. Route replications below c.7000 feet to a satellite-based standard, enabling more precise and flexible flightpaths will be implemented and funded directly by the airports.	7.2. New procedures for controllers to minimise tactical intervention will be deployed by NERL. Procedures for flight crews to fly satellite-based routes are being implemented by the aircraft operators.	7.3. Aircraft avionics upgrades required to fly satellite-based routes are being implemented and funded by aircraft operators.
Timescale: by 2024		**Drivers: ICAO GANP, EU PBN implementing rule**

8. Deployment of new arrival and departure routes designed to satellite navigation standards		
8.1. Route upgrades below c.7000ft to a satellite-based standard, enabling more precise and flexible flightpaths will be implemented and funded directly by the airports.	8.2. New procedures for controllers to minimise tactical intervention will be deployed by NERL. Procedures for flight crews to fly satellite-based routes are being implemented by the aircraft operators.	8.3. Aircraft avionics upgrades required to fly satellite-based routes are being implemented and funded by aircraft operators.
Timescale: by 2024		**Driver: Single European Sky legislation**

Dependencies

7.1 & 8.1 There is a major dependency on airspace design to effectively manage the trade-offs between different stakeholders that are impacted by aircraft noise, for example by deploying multiple alternating routes.

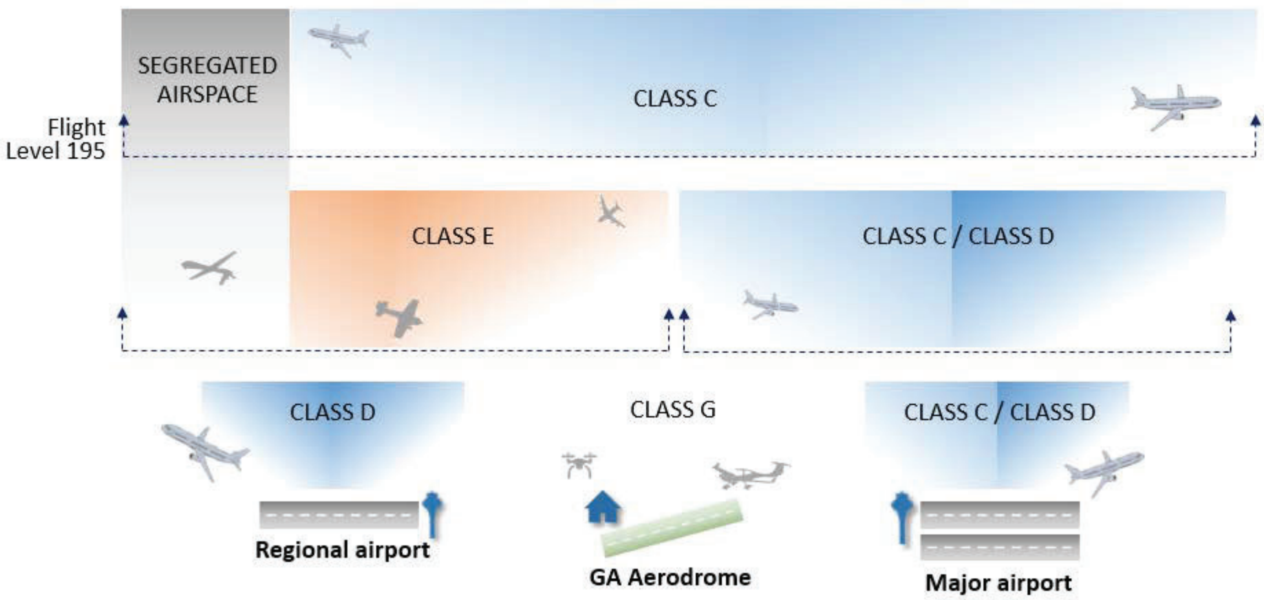
Modernisation outside controlled airspace

Ends

As General Aviation and commercial traffic expand operations outside controlled airspace:

- **safety**: improve the situational awareness of all aircraft and aerodromes operating outside controlled airspace
- **efficiency:** deliver greater integration rather than segregation of airspace, to satisfy the requirements of all classes of aircraft including future market entrants (such as drones or spacecraft)

Figure 4.4 Illustration of airspace classifications



Ways

Airspace design	Operational procedures	Technology enablers

9. Review of Flight Information Service provision in the UK to ensure alignment with international standards and interoperability across airspace boundaries		
9.1. A State-sponsored programme to define the Flight Information Service requirements in the UK FIS review.	9.2. Flight Information Service task descriptions, capabilities, licensing and funding.	9.3. Not applicable.
Timescale: by 2022		**Driver: EU Part-ATS**

10. Airspace classification review to optimise the integration of all classes of aircraft		
10.1. Optimised airspace classifications and structures in line with the requirements set out in EU law (especially Part-ATS) and ICAO Standards and Recommended Practices and Procedures for Air Navigation Services. Roadmap to be developed.	10.2. New operating procedures to accompany the introduction of a refined set of airspace classifications.	10.3. Electronic conspicuity devices and air traffic services surveillance capabilities at aerodromes.
Timescale: by 2022		**Driver: EU Part-ATS**

11. Deployment of electronic surveillance solutions to aircraft and at airports to aid integration of traffic		
11.1. Development of new airspace structures such as surveillance mandatory zones that enable greater integration will be implemented and funded by the airports.	11.2. New procedures for air traffic services personnel to use electronic surveillance information displays to support the provision of flight information services will be developed and published by the CAA.	11.3. Interoperable electronic conspicuity devices and electronic surveillance information displays. The CAA will consult on a strategy for mandating adoption by airspace users.
Timescale: ongoing, mandate likely 2022–2024		**Driver: safe and efficient airspace**

Dependencies

11.1 to 11.3 The widespread introduction of interoperable electronic conspicuity devices is dependent on the further development of a commercially viable and competitive market for both airborne and ground-based equipment. It is also dependent on the development of national standards for the core requirements that electronic surveillance equipment should meet.

Modernisation of the UK's communications, navigation and surveillance (CNS) infrastructure and air traffic management

Ends

As legacy ground-based capabilities are replaced:

- **safety**: enhanced situational awareness
- **efficiency:** flexible routeings not linked to fixed ground-based aids. Resilience improved through new technologies with less risk of technical failure

Figure 4.5 Illustration of remote air traffic control tower

Source: NATS

Ways

Airspace design	Operational procedures	Technology enablers
12. Cross-industry plan for the efficient use of radio-frequency spectrum to support growing demand from aviation		
12.1. Development of airspace structures should be supportable by CNS systems that make efficient use of the radio-frequency spectrum.	12.2. Development of air traffic management operational procedures that support the efficient use of radio-frequency spectrum.	12.3. Development of national standards and specifications for new aviation technologies that optimise the use of radio-frequency spectrum.
Timescale: ongoing	**Drivers: EU Part-ATS and EU surveillance implementing rule**	
13. Cross-industry plan for the full adoption of datalink communications		
13.1. Not applicable	13.2. New operational procedures that optimise the use of datalink capabilities.	13.3. Development of national standards that enable more technology solutions to rely on datalink.
Timescale: by 2019		**Driver: EU datalink implementing rule**
14. A satellite-navigation implementation plan that includes the retention of sufficient ground navigation aids, communications and surveillance capability to ensure the continued provision of air services in the event of Global Navigation Satellite System (GNSS) loss		
14.1. Continued development of the national standards for airspace structures and routes designed to satellite-based navigation specifications.	14.2. Continued development of national standards for the air traffic management operational procedures that optimise the use of satellite navigation.	14.3. Rationalisation of legacy ground-based navigation technologies.
Timescale: 2020–2024		**Driver: EU PBN implementing rule**
15. Air traffic management to modernise systems, tools and procedures		
15.1. Not applicable.	15.2. Continued development of operational procedures to maximise the benefits of new air traffic management systems and tools.	15.3. iTEC deployment, SWIM implementation and deployment of aeronautical information management.
Timescale: by 2024		**Driver: SESAR Pilot Common Project**

Dependencies

12.1 to 12.3 The demand for radio-frequency spectrum from other sectors of the economy is a major dependency on the efficient use of the asset for aviation purposes.

13.2 & 13.3 The optimisation of datalink capabilities is dependent on the development of technologies and procedures that are interoperable across Europe and globally.

14.1 The widespread adoption of satellite-based navigation routes is dependent on the ability of airspace change sponsors (mainly airports and air navigation service providers) to redesign long-established routes to be more precise and flexible.

14.2 Air traffic management operational procedures that optimise the use of satellite navigation are dependent on the development and deployment of air traffic control support tools that introduce greater automation and predict aircraft trajectories.

14.3 The removal of ground-based navigation technologies is dependent on the implementation of satellite-based procedures and investment from aircraft operators in the avionics and flight crew approvals to use them.

15.2 & 15.3 The modernisation of air traffic management systems, tools and procedures is dependent on close cooperation across the main European air navigation service providers on the functionality of the new air traffic control technologies, timelines for deployment, interoperability arrangements and the approach to managing traffic flows collaboratively across State boundaries.

Chapter 5

Unknowns: gaps in the current policy and regulatory architecture

Chapter summary

This chapter explains:

- policy areas and emerging innovation in which development is still ongoing, which may affect future iterations of the strategy and plan
- how the CAA will identify and respond to future gaps that emerge, including blockers to delivery.

Taking account of future developments

5.1 Any nationally strategic infrastructure must respond to its immediate context – a context that is often continually developing and changing. Airspace is no exception. The political, economic, social, technological and environmental drivers within which airspace modernisation must happen will never sit still. There are innovations and disruptions that continually shift.

5.2 That the Air Navigation Directions task the CAA with an annual delivery report on the strategy and plan means we can regularly take stock of the context of the strategy and plan, including changes and innovations that are forthcoming, or gaps in the policy or regulatory framework that are affecting delivery. When it is within the CAA's remit to suggest a solution or enabler to better respond to a change or gap, we will do so. Often, this will require working with others, such as the Government, which owns all relevant UK policy and law.

5.3 In this chapter we set out the current foreseeable 'unknowns' that could change and reshape the context for this strategy. These include areas in which the Government has signalled it may develop new or amended policy positions, or new technologies that we think are becoming ubiquitous and may impact on how airspace is designed or used. The initiatives described in Chapter 4 are also enablers for further work on accommodating new airspace users such as drones, and as we develop the strategy in the future, we will add more detail on how to integrate these new users. There will also be ‘unknowns’ that are not foreseeable, and by definition, this means we cannot predict or discuss them in advance.

5.4 This chapter is included so that the CAA can give stakeholders sight of, and potentially advise the Government on:

- any known gaps that are being managed or changes that are being considered either by government or another relevant organisation, that our strategy must work around now and respond to in the future, and
- any further gaps that we have identified that are not yet being managed, that our strategy must work around, that may affect airspace modernisation and that potentially require management in the future.

5.5 The areas of change noted in this chapter, to be developed in future iterations of the strategy and plan, are grouped as follows:[59]

- emerging policy in the UK
- emerging international policy
- emerging innovations or disruptions in airspace
- spotting and responding to other emerging changes.

59 The strategy will be updated regularly, but the pace of change may mean that some of the topics raised in this chapter move on before the CAA is able to review and republish the full document. Please refer to the dates of any publications discussed in this section and be aware that there may be newer versions of those documents available.

Emerging policy in the UK

5.6 The Department for Transport announced in 2017 that it would be developing a new Aviation Strategy to address the development of aviation up to 2050. In April 2018 the Government published its response to its earlier call for evidence on the Aviation Strategy, and followed this in December 2018 with the Aviation Strategy Green Paper with the aim of publishing a final strategy in 2019. The Aviation Strategy contains several areas of policy development that could impact on the Airspace Modernisation Strategy.

Noise

5.7 Limits on noise already exist at some airports in the form of air transport movement or passenger caps, or noise contour limits set through the planning process. The Government expects that future limits will be discussed and agreed in the context of proposals for new airport capacity, including planning applications[60], and the Airspace Modernisation Strategy would need to have regard to these.

5.8 The CAA's obligations under section 70 of the Transport Act 2000 means that opportunities for noise improvements should be explored through the Airspace Modernisation Strategy and delivery plans where these are not in conflict with growth. Therefore, the Government expects the CAA's strategy and any plans developed to deliver it to identify opportunities for airspace changes which have noise benefits, and to promote and facilitate such changes where these are not in conflict with growth and do not have disproportionate disbenefits for efficiency or carbon.

5.9 Once airports have received permission to expand, they will expect to make full use of their capacity within planning conditions, and that

60 See paragraph 1.24 of The future of UK aviation: making best use of existing runways, HM Government, June 2018. [redacted]

airspace will support this. However, this can lead to growth which some may find unsustainable.

5.10 In its Aviation Strategy the Government intends to explore the relationship between growth and noise reduction, the possibility of noise reduction targets and the potential for these to be enforceable. These might be set at a national level, airport level or even at a route level. The Airspace Modernisation Strategy needs to have regard to any such binding targets which would complement limits set through the planning process at individual airports, and the CAA will look to the Government to set a clear policy on this. This development on noise policy will not be finalised until after the Government's Aviation Strategy has been consulted on and published. This will be in 2019, at which point an update to the Airspace Modernisation Strategy and related delivery plan may be required.

5.11 The CAA has welcomed the clarity in the Government's Air Navigation Guidance on noise and adverse effects, but this concerns the CAA's decisions on airspace change proposals and does not constitute a national strategic policy. Therefore in the meantime, where the CAA's work in preparing this strategy and reporting on it annually reveals the need for trade-offs and there is no policy guidance, we will seek guidance from the Government.

Compelling airspace to be changed

5.12 Neither the Government nor the CAA currently has powers to compel an airport or air navigation services provider to develop and put forward an airspace change proposal. The CAA can refuse an airspace change if it does not meet the requirements set out in section 70, but cannot compel:

- initiation: bringing about an airspace change proposal that has been identified as necessary
- quality: failure to progress/complete a necessary airspace change proposal to the required standard, either because of inadequate resourcing or not taking the necessary actions

- timeline: failure to adhere to the proposed timeline for a necessary airspace change proposal.

5.13 This means that when airspace modernisation is needed across a number of airports to restructure and rationalise the airspace they use, there is no way of ensuring that they will each sponsor the airspace changes identified as necessary. Where there are interdependencies between changes, this can hold up modernisation.

5.14 In its response to its Aviation Strategy call for evidence, the Government stated that it would explore policy mechanisms to deliver airspace change should airports or NERL not bring about the airspace changes that are necessary for modernisation. Several options were considered. These could be combined into one legislative clause that would:

- give the Secretary of State new legislative powers to direct airports to take forward airspace changes within the plan, and
- create a policy framework that enabled NERL to take forward some necessary changes.

5.15 The Government has developed this policy further in its Aviation Strategy Green Paper published in December 2018.

5.16 The CAA would support the reintroduction of legislative provisions – assuming there is sufficient space in the legislative programme – to modernise the air traffic services regulatory and licensing framework that also support the delivery of airspace modernisation. As this legislation is developed, any potential conflicts of interest would have to be managed, for example to differentiate between the decision to use the power to compel an airspace change to be developed, and the decision on whether the change eventually proposed should go ahead. This conflict would be particularly apparent where the change involves the sponsor making a significant financial investment.

5.17 Any policy developed would be incorporated into the Airspace Modernisation Strategy and any associated governance to modernise airspace.

Feasibility assessment

5.18 NATS developed a feasibility assessment for airspace in the South East at the request of the Secretary of State. The CAA reviewed this report to offer technical advice to the Secretary of State. These two reports have been published by the Government.

5.19 The feasibility assessment outlines the concept of 'letterboxes in the sky' at 7000–9000 feet, i.e. entry points to the upper route airspace. NATS will develop this concept further and propose an airspace change to the CAA for the upper route airspace, including the letterbox concept. Airports, in co-operation with NATS, will design flightpaths into and out of these letterboxes, proposing these airspace changes to the CAA. While NATS will not be required to consult on the feasibility plan it develops, both NATS and the individual airports will have to follow the CAA's airspace change process, including engagement and consultation requirements, when they design the changes the plan has deemed necessary.

5.20 The Department for Transport and CAA, as co-sponsors of airspace modernisation, have asked NERL to a) undertake further technical work on the design concept outlined in its report and b) to create a single coordinated implementation plan for airspace changes in Southern England (a south-east airspace change masterplan, or masterplan for short). Further detail on this masterplan is outlined in Chapter 6.

Further policy considerations

5.21 We may need to take account of any other new policies introduced as a result of the Aviation Strategy work, such as General Aviation access, carbon emissions, or other relevant policies.

Emerging international policy

5.22 At the time of writing this document, the UK is a member of the EU but is in the process of leaving it following a national referendum. EU policy and regulation is currently being developed on several airspace issues. What those policies look like, whether they will affect the UK, and if so how, are all open questions at the time of writing this strategy. Under the EU (Withdrawal) Act 2018 the Government is in the process of bringing EU aviation law into UK law, with certain responsibilities reassigned to the Secretary of State or the CAA. It may be the case that the UK decides to continue to follow EU air traffic management related implementing rules in order to ensure its airspace system remains interoperable with EU airspace, enabling traffic to move easily across the skies without impediment. If that is the case, all the policies currently being developed and noted here will eventually need to be enshrined in the Airspace Modernisation Strategy. Were the UK to decide not to adopt EU air traffic management related implementing rules, this would no doubt raise issues for this strategy to address, such as determining alternate means of achieving interoperability.

- The EU implementing rule Part-ATS provides the UK the opportunity to review some elements of our airspace arrangements, classifications and air traffic services delivery to better align with ICAO Standards and Recommended Practices. It is not yet clear what timeline will be defined to deliver and deploy this review, or indeed what the future elements will look like. The opportunity to review the UK airspace arrangements to meet international obligations will be a major programme of change sponsored by the State and will have a significant bearing on the Airspace Modernisation Strategy.
- The continued deployment of Single European Sky mature air traffic management technologies and tools will continue through the second Common Project implementing regulation. This Common Project is currently being defined and is likely to focus on the key airport operations with significant European network capacity implications. It will be adopted in 2019 but we do not yet know the detail or timeline and how the UK would comply. Any commitment to comply with deployment deadlines will feed into the Airspace Modernisation Strategy delivery plan.

- The European Commission has tasked the SESAR Joint Undertaking and EUROCONTROL to develop a European airspace architecture study and associated high-level modernisation goals. The UK will continue to engage with this exercise to ensure that there is continued alignment of our strategic ambitions.
- The Commission's preparations for Reference Period 3 of the Single European Sky performance scheme are currently under development, both in terms of changes to the regulatory framework and requirements, expected to be agreed imminently, but also the EU-level targets, which are expected to be adopted by May 2019. It is expected that target setting for the existing horizontal flight efficiency indicators for en-route airspace will continue to apply. The objectives of the Airspace Modernisation Strategy are consistent with EU objectives in this area, with a view to minimising excess track miles flown. The Commission is also considering the establishment of performance monitoring indicators – without targets – for the share of arrivals using Continuous Descent Operations at key airports.
- We expect that the UK will seek to keep pace with EU airspace developments until 2024, even after the UK has exited the EU. This is one of the assumptions built into the next financial settlement.[61] We also expect that we will want to remain interoperable with the EU's air traffic management systems in the future, including operational arrangements with neighbouring EU States. Subject to the terms of the UK's exit from the EU, the UK consequently remains fully committed to continuing to contribute the necessary technical resources to SESAR and EASA initiatives in air traffic management.

61 The fixed reference period around which the CAA's economic regulation of NERL is based. RP3 runs from 2020 until 2024.

Emerging innovations or disrupters in airspace

5.23 Technology is developing new ways of flying, new things that fly and new ways of controlling and managing our airspace.

5.24 Drones are just one example of an emerging technology that is fast becoming ubiquitous. A CAA survey in 2017 found that 4% of UK citizens had purchased a drone within the last two years, a further 6% were considering purchasing one in the future, and a further 10% said they had no plans but hadn't ruled out buying one.[62] There is also increasing commercial use of drones. If more people and businesses are buying and flying drones, their integration into airspace needs to be managed so that they are flown safely and securely. This could require changes to airspace design to segregate drones from other traffic, or it could require development of operational concepts to integrate drones into airspace. This could include technologies such as new systems that enable aircraft, including drones, to detect and avoid one another, and systems that render all aircraft electronically visible (conspicuous) to one another. Government policies on drones will guide how their management into airspace will work.

5.25 Global developments are being monitored and their applicability across the UK explored as a potential solution to ease congestion, unlock capacity and enable new use cases for public transport, perhaps as early as 2025. In order to facilitate and manage emerging technologies, the long-term plan will need to include how to fully and safely integrate new users alongside existing aviation participants. Consideration will need to be given for all airspace environments. A key part of this work will be addressing the interoperability of air platforms and traffic management systems and establishing appropriate mechanisms for sending and receiving data. The interaction between traditional air traffic management systems and the evolving counterpart systems being developed for

62 CAA Consumer Tracker Survey Wave 4, December 2017. [redacted]

drones (known as unmanned traffic management or UTM) are being explored to solve safety-related issues affecting all users of airspace.

5.26 Before these new systems are developed, there will need to be decisions about the market model for drones services, such as whether this will be an extension of NERL's existing monopoly activity or whether it can and should be provided on a competitive basis. The CAA has not reached any conclusions on this activity yet, or who should pay for it, or how they should pay. This could lead to changes in CAA or other charging mechanisms.

5.27 The CAA intends to engage with industry and across government as soon as practicable to develop the principles to enable detailed deployment plans to be developed.

5.28 The first UK commercial space launch is expected in the early 2020s. Beyond that, new engine designs will facilitate hypersonic flight, allowing new high-speed international commercial operations in the upper atmosphere. Commercial space operations will place additional new demands on airspace and supporting technological systems. These operations extend beyond our current upper airspace structures into a space traffic environment, and as such will require new approaches to safely manage these operations. The scope of the international rules and regulations relating to airspace may change and the UK's airspace management strategy will have to respond accordingly.

Spotting and responding to other emerging changes

5.29 Other policy developments, or new innovations and disruptions, will also impact on this strategy and plan in the future. The CAA intends to spot and plan for these by:

- continuing to work closely with the Government in developing this strategy regularly, to ensure we remain aware of new policies or laws that are being developed that will influence or change the strategy and plan

- maintaining contact with relevant policy and research officials internationally, whether in ICAO, EASA, EUROCONTROL or other EU groups (although the nature of this contact will depend in part on how the UK exits the EU)
- using horizon scanning to become aware of new technologies, changing weather trends or other changes that could affect how airspace is designed and used. The CAA does this through an engagement plan so that we regularly interact with stakeholders aware of innovations and disruptions; an internal horizon-scanning process to capture insights and new intelligence as it emerges; an external portal to allow innovators to tell us about opportunities and challenges; and an in-house think tank called Aviation Futures, which looks ahead and undertakes scenario-building to consider how regulation can best respond to change.

Chapter 6

Means: timelines and delivery plans

Chapter summary

This chapter explains that:

- the resources or **means** of delivering airspace modernisation rest with industry organisations and not the CAA
- the CAA and Department for Transport, as co-sponsors of airspace modernisation, have tasked NERL with leading the FASI South programme to create, by June 2019, a single co-ordinated implementation plan for airspace changes in Southern England
- this will be followed by further commissions for the creation of masterplans covering modernisation of the rest of UK airspace.

Delivery plans

6.1 The **means** of delivering airspace modernisation – such as the resources needed to bring in changes – must rest with the industry organisations that will use airspace. For example, the CAA can set out, within this strategy, why airspace redesign is needed and the policy ends it must achieve, but we cannot do that airspace change ourselves. Timelines and delivery plans must be set out by the organisations that will undertake this design, and integrate the concepts and technologies.

6.2 Many of the operational concepts and technologies set out in this strategy have delivery plans associated with them, which were drawn up by relevant industry bodies working together with the CAA and government under the previous Future Airspace Strategy.[63] A summary timeline is provided in Figure 6.1 at the end of this chapter.

Next steps

6.3 The CAA and Department for Transport, as co-sponsors of airspace modernisation, are commissioning design, operational and technology studies required to support the development and delivery of this strategy.

6.4 The CAA believes that any new studies needed should be based on the factors set out in section 70 of the Transport Act 2000. The factors set out how the CAA must exercise its air navigation functions, including giving priority to maintaining a high standard of safety.

6.5 The CAA, through its new Delivery Monitoring and Oversight role, will track the progress of industry-led delivery plans.

6.6 At present, there is no delivery plan for the design changes needed for modernisation, as the new Directions and this new strategy have introduced the need for clearer requirements around airspace design. The CAA and Department for Transport, as co-sponsors of airspace modernisation, have therefore tasked NERL with leading the FASI South programme to create a single coordinated implementation plan for airspace changes in Southern England (a South East airspace change masterplan, or masterplan for short).

6.7 The commission requires that through leadership and programme management, NERL prepares a South East masterplan that meets the following criteria:

63 Details of relevant industry deployment plans can be found at [redacted] and [redacted]

- identifies where airspace changes could be developed in Southern England in light of:
  - forecast growth in demand for aviation across all sectors and the required airspace capacity to accommodate that growth
  - airspace bottlenecks where delays to consumers could be alleviated by capacity
  - areas where planned development on the ground such as new runways will require new airspace designs
  - areas where more direct routes are possible that could, for example, reduce controlled airspace
- identifies other changes that may be required to deliver one or more of the following benefits:
  - where airspace changes are needed to deliver a safety benefit, for example, changes that ensure route separation
  - where airspace changes can reduce noise (more specifically, reduce the total adverse effects of noise, as set out in the Air Navigation Guidance 2017)
  - where airspace changes can deliver air quality or fuel efficiency benefits
  - where airspace changes are needed to allow improved access to airspace for all users, for example where the existence of controlled airspace is no longer justified
  - where airspace changes are needed to enable the military to fulfil their training requirements and national security functions
  - where airspace changes are needed to introduce new technology, for example the introduction of performance-based navigation
- identifies:
  - the operational concepts required to deliver these changes and their level of maturity
  - the set of assumptions on which the proposed changes are based and are dependent

- the key risks associated with delivering the plan and how they could be mitigated
- the recommended coherent sequence of individual or modules of changes against the evaluated alternatives
- the preferred timescale for their adherence against each step of the CAA's CAP 1616 process and subsequent implementation
- the party responsible for taking each individual airspace change forward
- the interdependencies between individual changes
- the degree of commitment offered by each individual party.

6.8 NERL was also asked the minimum number of changes that are necessary to ensure that major airspace projects (for example, to accommodate new runway capacity) are viable.

6.9 We have asked NERL to deliver the Southern England masterplan by the end of June 2019, and it will be published once complete.

6.10 This commission concerns Southern England only, but it will be followed by further commissions in the future to apply this rationale to the rest of the UK's airspace. We expect a similar list of factors to be considered in future commissions, including improved access to all airspace users and military user requirements.

6.11 In addition, the sponsors will ask every delivery group in the Governance Annex to prepare a delivery plan.

CAA resourcing

6.12 A new, more rigorous process for making decisions on proposed changes in airspace design was introduced in January 2018, supported by new guidance (CAP 1616). This requires the CAA to be more visibly 'hands-on' during the process and to dedicate more resources to managing it covering:

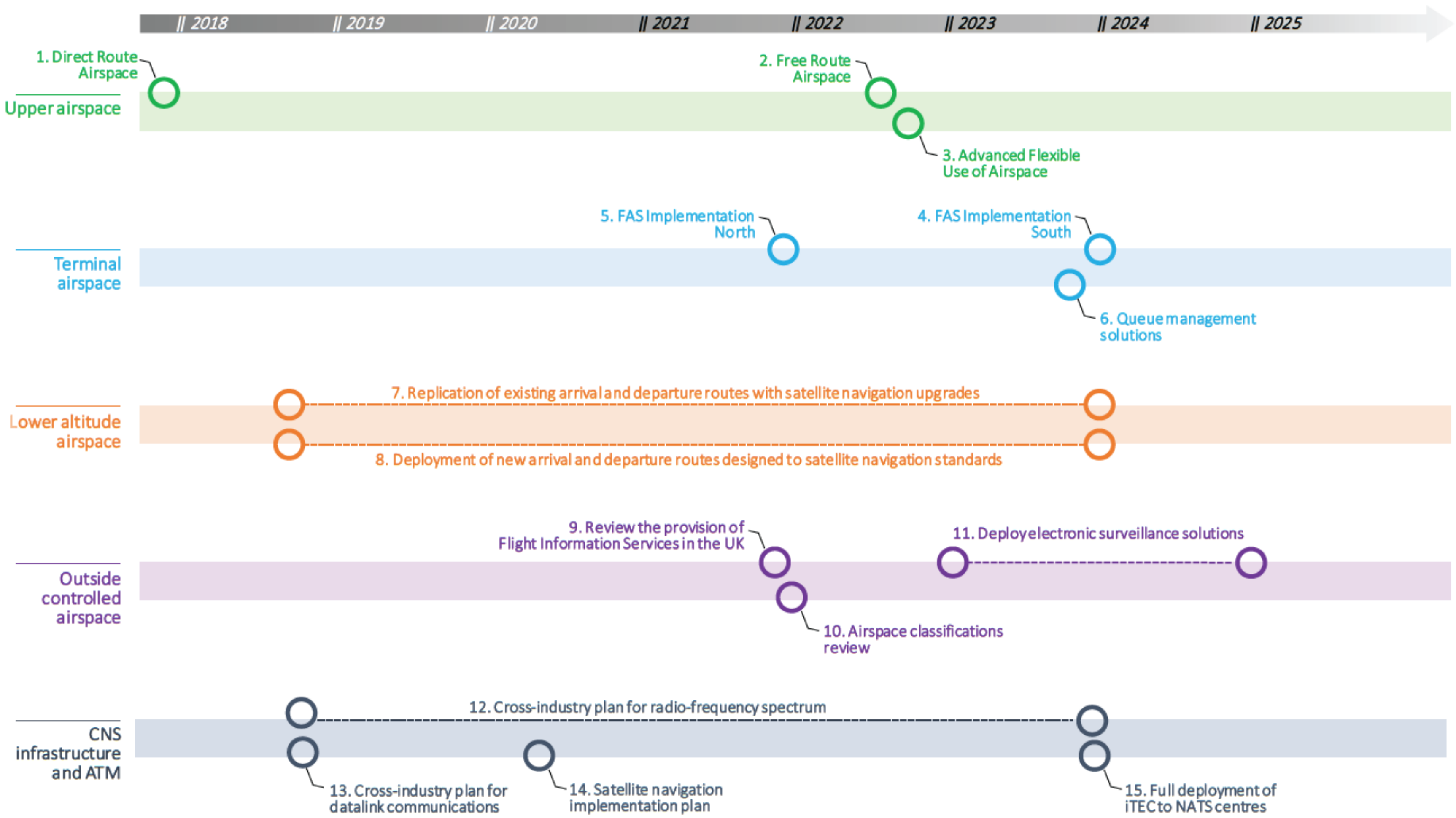
- new skills: including running an online airspace change portal, and elements new to the process such as gateway sign-offs, options appraisal, Public Evidence Session and draft decision; these airspace regulation requirements cover a broader range of economics, community engagement and web skills than the CAA previously employed in this area

- increased rigour: we have had to expand our existing airspace regulator, environmental and legal teams to handle the increased rigour of the assessment stages and related outputs
- increased workload: the demands of airspace modernisation mean more staff resources are anticipated to be needed as major airspace changes, such as those required through the Southern England masterplan, materialise.

6.13 In the immediate future CAA has plans to build its staff skillset and resources in its airspace regulation function accordingly, but currently they are still below optimum strength. The CAA has identified the posts that are required and aims to address its resourcing issues by 2021.

6.14 Completely separate from the resourcing issues for the CAA's airspace regulation function, we are also increasing our staff resource to deliver the new roles of co-sponsorship and Delivery Monitoring and Oversight that underpin the Airspace Modernisation Strategy. The CAA seeks views on proposals to increase resource as part of its regular scheme of charges consultation.

Figure 6.1 Timeline of airspace-related developments up to 2024



Chapter 7

Summary of progress with industry delivery 2018

7.1 In Table 7.1 overleaf the progress towards completion of each major initiative and the supporting airspace designs, operational procedures and technology enablers as at December 2018 is indicated by a green, amber or red status:

- green status indicates that the initiative is on track to be completed in the timescales expected
- amber status indicates that the initiative needs attention from key stakeholders to ensure completion in the timescales expected
- red status indicates there are major issues with the initiative and a significant risk that completion will not be achieved in the timescales expected.

Several key risks to the delivery of the airspace modernisation initiatives outlined in the Airspace Modernisation Strategy have been identified during the production of the strategy and are also summarised in Table 7.1. The risks are assessed on a 1 (low) to 5 (high) scale against likelihood (L), and severity (S).

Table 7.1 Progress status and key risks as at December 2018

Airspace design	Operational procedures	Technology enablers

1. Direct Route Airspace: deployment of additional waypoints to the existing route network			**On track**
1.1. New waypoints	1.2. Established procedures	1.3. Airline flt-planning systems	
Timescale: by 2022	**Driver: Single European Sky legislation**		
Risk: that aircraft operators do not invest in the flight planning system upgrades required to use Direct Route options effectively and maximise the benefits			Score: 6 (L2*S3)

2. Free Route Airspace: removal of all fixed routes so aircraft can fly fully optimised routes			**Needs attention**
2.1. Remove fixed route network	2.2. New procedures	2.3. Airline flt-planning systems	
Timescale: by 2022	**Driver: Single European Sky legislation**		
Risk: that aircraft operators do not invest in the flight planning system upgrades required to use Free Route options effectively and maximise the benefits			Score: 12 (L3*S4)

3. Advanced Flexible Use of Airspace: to increase airspace configuration options supporting more efficient use			**Needs attention**
3.1. New airspace structures	3.2. New procedures	3.3. Airspace management tools	
Timescale: by 2022	**Drivers: SES legislation and UK state requirements**		
Risk: that the implementation of new airspace structures restricts the access of civil and/or military traffic to key routes or volumes of airspace, generating inefficiencies and capacity constraints in certain areas of the UK; and that AFUA will not deliver sufficient airspace to facilitate military activity.			Score: 9 (L3*S3)

4. FAS Implementation South: redesign of the terminal network in southern England			**Needs attention**
4.1. Terminal airspace redesign	4.2. New procedures	4.3. New tools for controllers	
Timescale: by 2024	**Drivers: Single European Sky legislation and Airports NPS**		
Risk: that the large number of co-dependent airspace changes required to modernise terminal airspace in the south of England (involving 16+ different sponsors) are not co-ordinated effectively, leading to sub-optimal airspace designs, poor engagement with affected stakeholders, inefficient network integration and implementation delays.			Score: 20 (L4*S5)

5. FAS Implementation North: redesign of the terminal network in northern England and Scotland			**Needs attention**
5.1. Terminal airspace redesign	5.2. New procedures	5.3. New tools for controllers	
Timescale: by 2021	**Drivers: Single European Sky legislation and NERL RP2 plan**		
Risk: that the large number of co-dependent airspace changes required to modernise the terminal airspace in the north of England are not co-ordinated effectively, leading to sub-optimal airspace designs, poor engagement with affected stakeholders, inefficient network integration and delays to implementation.			Score: 12 (L3*S4)

Airspace design	Operational procedures	Technology enablers

6. Queue management: new capabilities to stream the flow of traffic			**On track**
6.1. Linear holding structures	6.2. New procedures	6.3. Queue management tools	
Timescale: by 2024		**Driver: Single European Sky legislation**	
Risk: that the implementation of multiple arrival and departure management systems focused on different airports are not integrated effectively at a network level, leading to pinch points & inefficiencies.			Score: 6 (L2*S3)

7. Replication of existing arrival and departure routes with satellite navigation upgrades			**On track**
7.1. Route replications	7.2. New procedures	7.3. Aircraft avionics upgrades	
Timescale: by 2024		**Drivers: ICAO GANP, EU PBN implementing rule**	
Risk: that many conventional arrival and departure routes at airports cannot be accurately replicated using satellite navigation capabilities (especially in the turn), creating new, or more concentrated noise impacts at lower altitudes and deterring sustainable improvements.			Score: 9 (L3*S3)

8. Deployment of new arrival and departure routes designed to satellite navigation standards			**Needs attention**
8.1. Route upgrades	8.2. New procedures	8.3. Aircraft avionics upgrades	
Timescale: by 2024		**Driver: Single European Sky legislation**	
Risk: that the redesign of arrival and departure routes at low altitudes create new, more frequent or more concentrated noise impacts that deter implementation of sustainable improvements.			Score: 12 (L4*S3)

9. Review of Flight Information Service provision in the UK to ensure alignment with international standards and interoperability across airspace boundaries			**On track**
9.1. Define FIS requirements	9.2. FIS framework	9.3. not applicable	
Timescale: by 2022		**Driver: EU Part-ATS**	
Risk: that the funding model required to deliver a Flight Information Service that serves the needs of users will not be possible.			Score: 8 (L2*S4)

10. Airspace classification review to optimise the integration of all classes of aircraft			**On track**
10.1. Optimised classifications	10.2. New procedures	10.3. Electronic conspicuity	
Timescale: by 2022		**Driver: EU Part-ATS**	
Risk: that industry cannot support the level of service provision aspired to within a revised airspace structure.			Score:12 (L3*S4)
Risk: there is potential perceived conflict for the CAA between its regulatory function and the modernisation ambition			Score: 9 (L3*S4)

Airspace design	Operational procedures	Technology enablers

11. Deployment of electronic surveillance solutions to aircraft and at airports to aid integration of traffic			Needs attention
11.1. New airspace structures	11.2. New procedures	11.3. Electronic conspicuity	
Timescale: ongoing, mandate likely 2022–2024		Driver: safe and efficient airspace	
Risk: that the adoption of electronic surveillance solutions on board aircraft and on the ground at airports does not reach the critical mass levels required for the information derived to be used effectively in the air traffic management operation.			Score: 9 (L3*S3)

12. Cross-industry plan for the efficient use of radio-frequency spectrum to support growing demand from aviation			On track
12.1. Airspace structures	12.2. New procedures	12.3. Develop standards	
Timescale: ongoing	Drivers: EU Part-ATS and EU surveillance implementing rule		
Risk: that a lack of available spectrum for the aviation sector constrains the widespread adoption of new technologies and procedures that can improve airspace safety, efficiency and capacity.			Score: 9 (L3*S3)

13. Cross-industry plan for the full adoption of datalink communications			Needs attention
13.1. Not applicable	13.2. New procedures	13.3. Development standards	
Timescale: by 2019		Driver: EU datalink implementing rule	
Risk: that a lack of co-ordination in the adoption of datalink solutions across airports, aircraft operators and air traffic control reduces the benefits of the technology.			Score: 9 (L3*S3)

14. A satellite-navigation implementation plan that includes the retention of sufficient ground navigation aids, communications and surveillance capability to ensure the continued provision of air services in the event of GNSS loss			Needs attention
14.1. National standards	14.2. National standards	14.3. Rationalise ground infrastr.	
Timescale: 2020–2024		Driver: EU PBN implementing rule	
Risk: that ongoing reliance on legacy ground navigation infrastructure by minority of aircraft operators deters transition to a fully satellite-based infrastructure.			Score: 12 (L4*S3)

15. Air traffic management to modernise systems, tools and procedures			On track
15.1. Not applicable	15.2. New procedures	15.3. New systems and tools	
Timescale: by 2024		Driver: SESAR Pilot Common Project	
Risk: that the requirements to change the airspace and upgrade air traffic management systems, tools and procedures in the same timeframe creates complex interdependencies that require significant resources, funding and additional development time to resolve.			Score: 12 (L4*S3)

Chapter 8

Glossary

Although we have only used abbreviations in this document where unavoidable, in the interests of completeness we have included below some common abbreviations – as well as other terms – that relate to airspace modernisation.

Term	Abbreviation	Description
Advisory route	ADR	A designated route along which air traffic advisory service is available.
Aerodrome traffic zone	ATZ	Aerodrome traffic zone – normally, circular zones around an aerodrome where pilots and air traffic services providers must follow specific requirements.
Aeronautical Information Publication	AIP	Long-term information essential to air navigation, including the detailed structure of UK airspace and flight procedures, which forms part of the UK Integrated Aeronautical Information Package. Sometimes informally known as the Air Pilot. Publication is the responsibility of the CAA, but is carried out under licence by NATS. www.ais.org.uk
Air Navigation Directions		The Civil Aviation Authority (Air Navigation) Directions 2017, as amended by The Civil Aviation Authority (Air Navigation) (Amendment) Directions 2018. These Directions set out the CAA's air navigation duties and were jointly issued by the Secretary of State for Transport and the Secretary of State for Defence.
Air Navigation Guidance	ANG	Guidance to the CAA on its environmental objectives when carrying out its air navigation functions, and to the CAA and wider industry on airspace and noise management, October 2017, Department for Transport. Guidance from the Secretary of State which the CAA is required to take account of when considering airspace change proposals. https://www.gov.uk/government/publications/uk-air-navigation-guidance-2017

Term	Abbreviation	Description
Air navigation service provider	ANSP	An organisation which operates the technical system, infrastructure, procedures and rules of an air navigation service system, which may include air traffic control.
Air safety report		A report raised internally within an airline/operator whereby flight crew can report safety-related concerns.
Air traffic control	ATC	Service from an air navigation service provider providing guidance to aircraft through controlled airspace.
Air traffic control surveillance minimum altitude chart	ATSMAC	The lowest altitude that a radar controller can allocate to an inbound or outbound aircraft.
Air traffic management	ATM	The combined processes of air traffic control, air traffic flow management, and aeronautical information services. ATM can also mean air transport movement.
Air traffic service	ATS	Generic term that covers flight information services, alerting services, air traffic advisory services, air traffic control services (area control service, approach control service or aerodrome control service) and aerodrome flight information services.
Air traffic services airspace	ATS Airspace	Airspace in which control by air traffic services and specific rules of operations are required.
Air transport movement	ATM	Air transport movements are landings or take-offs of aircraft used for the transport of passengers, cargo or mail on commercial terms. ATM can also mean air traffic management.
Airline customers		Those airlines which operate from an airport or use the services of an air navigation service provider.
Airport Collaborative Decision Making	A-CDM	Systems and processes to enable the creation, refinement and exchange of up-to-date runway and airspace data between the airport, air traffic control, airlines and ground handlers about the status of inbound and outbound flights, enabling better-informed, more consistent decision making.

Term	Abbreviation	Description
Airspace change process		The staged process an airspace change sponsor follows to submit an airspace change to the CAA for a decision. The process includes actions associated with implementation and post-implementation review, after the CAA or, where applicable Secretary of State, decision.
Airspace change proposal		A request (usually from an airport or air navigation service provider) for a permanent change to the design of UK airspace.
Airspace design		Together, the airspace structure and flight procedures.
Airspace infringement	Infringement	When an aircraft enters controlled airspace without having previously obtained permission to do so from air traffic services.
Airspace4All Ltd	A4A	Implementation group representing VFR (Visual Flight Rules) community interests (including General Aviation) in airspace matters, including modernisation strategy. Formerly known as the Future Airspace Strategy VFR Implementation Group Ltd (FASVIG). [redacted]
Airspace structure		Designated volumes of airspace within identified characteristics, including the equipment aircraft wanting to enter that airspace must carry and actions pilots must carry out before entering that airspace. The volumes of airspace are designed to ensure the safe and optimal operation of aircraft. Airspace structures consist of: ▪ controlled airspace, namely control zones, control areas, terminal control areas and airways ▪ airspace restrictions, namely danger, restricted and prohibited areas ▪ radio mandatory zones, transponder mandatory zones ▪ other airspaces specified by the CAA when defining the airspace change process, such as, for example, flight information zones, aerodrome traffic zones, temporary segregated areas, temporary reserved areas or free-route airspace.
Airway		A corridor of controlled airspace of defined width with a defined lower base, extending to Flight Level 245 (a nominal altitude of 24,500 feet) unless otherwise denoted.

Term	Abbreviation	Description
Area navigation	RNAV	A method of navigation which permits aircraft operation on any desired flightpath within the coverage of ground- or space-based navigation aids or within the capability of self-contained aids, or a combination of these. (ICAO Doc 9613) https://www.icao.int
Area navigation routes		An air traffic services route created for aircraft capable of employing performance-based navigation technology.
Association of Remotely Piloted Air Systems UK	ARPAS-UK	The professional body and trade association for the RPAS industry/
Automatic dependent surveillance – broadcast	ADS-B	A surveillance technology in which an aircraft determines its position via satellite navigation and periodically broadcasts it, enabling it to be tracked
Call-in (by Secretary of State)		For certain types of airspace change, the Secretary of State may decide to call-in a particular airspace change proposal and make a decision instead of the CAA, a decision which the CAA will then be required to implement.
Carbon dioxide	CO_2	Naturally occurring atmospheric gas, which causes greenhouse effects leading to global warming, and ocean acidification in increased concentrations.
Classes of airspace		Airspace is broken down into different classes, defined by ICAO. In the UK, Classes A, C, D and E are controlled airspace and Class G is uncontrolled airspace (Classes B and F are currently unused in the UK).
Communications, navigation and surveillance infrastructure	CNS infrastructure	Technological infrastructure supporting air traffic services provision.
Conditional route		An airspace route that is only available under certain circumstances.
Continuous climb (or descent) operations	CCO or CDO	Allow arriving or departing aircraft to descend or climb continuously, to the greatest extent possible.
Control area	CTA	Area of controlled airspace, usually surrounding an aerodrome, extending from ground level to a specified altitude.

Term	Abbreviation	Description
Control zone	CTR	Area of controlled airspace, usually surrounding an aerodrome, extending between two specified altitudes.
Controlled airspace	CAS	Airspace in which air traffic control must have control over aircraft to maintain safe separation between them.
Danger area		Airspace within which activities dangerous to the flight of aircraft may exist at notified times.
Direct	DCT	A term used in relation to flightplan clearances and type of approach.
Drone		Commonly used term for an unmanned aerial system or vehicle (UAS or UAV), a powered aircraft without a human pilot on board. Drones may be remotely piloted (also known as a remotely piloted air system or RPAS) or autonomous. Drones range from relatively large aircraft similar in size and complexity to an aircraft with a pilot on board, to much smaller hand-held types with minimal payload, such as those for recreational use. [redacted]
Electronic conspicuity	EC	Electronic or digital means whereby airspace users can sense all others and be seen by all others.
En-route holding		Pattern adopted by aircraft on the instruction of air traffic services to manage delay and sequencing, and hold them in the air until onward clearance (usually to land) is provided.
En-route phase		That part of the flight from the end of the take-off and initial climb phase to the commencement of the approach and landing phase.
EUROCONTROL		An intergovernmental organisation with 41 Member States acting as the central organisation for coordination and planning of air traffic control for all of Europe.
European Aviation Safety Agency	EASA	The European Union authority for aviation safety.

Term	Abbreviation	Description
Flexible use of airspace	FUA	Concept promoted by Eurocontrol wherein airspace is no longer designated as purely 'civil' or 'military' airspace, but considered as one continuum and allocated according to user requirements.
Flight information region	FIR	Specified region of airspace, co-ordinated through the International Civil Aviation Organization.
Flight procedures		Part of the airspace design. A set of predetermined segments intended to be followed by a pilot when arriving to or departing from an aerodrome.
Flight rules		Aircraft can operate under Visual Flight Rules (VFR) or Instrument Flight Rules (IFR). There is also an intermediate form, Special Visual Flight Rules (SVFR).
Future Airspace Strategy	FAS	Replaced by the Airspace Modernisation Strategy, FAS was a collaborative initiative between a range of stakeholders for modernising the UK's airspace (which set the direction, but did not include details or recommendations about specific structures or flightpaths). [redacted] [redacted]
General Aviation	GA	Essentially all civil flying other than commercial airline operations, which therefore encompasses a wide range of aviation activity from drones, powered parachutes, gliding and ballooning to corporate business jets, and includes all sport and recreational flying.
General Aviation traffic	GAT	See General Aviation.
Helicopter routes		Nominated airspace routes designed for use by helicopter traffic.
Holding patterns		Flight patterns adopted by aircraft to hold until cleared to land by air traffic control.
Holding stack		Airspace used to 'hold' aircraft until they are able to land at an airport. Heathrow airport has four stacks set by government.
Independent Commission on Civil Aviation Noise	ICCAN	The independent UK body responsible for creating, compiling and disseminating best practice to the aviation industry on the management of civil aviation noise and advising government in this area.

Term	Abbreviation	Description
Instrument approach procedure	IAP	A set series of aircraft manoeuvres from the initial approach to landing.
Industry Communications for the Airspace Modernisation Strategy	ICAMS	Implementation group representing largely commercial aviation industry interests in FAS. Formerly known as the Future Airspace Strategy Industry Implementation Group (FASIIG).
Instrument flight procedures	IFP	Procedures designed to international/ national criteria, published in the UK AIP, flown by aircraft with reference to ground-based or satellite-based navigation aids and most usually associated with arrival at or departure from an airport.
Instrument flight rules	IFR	The rules under which a pilot can fly and navigate an aircraft, in certain weather conditions, primarily through use of on-board instruments.
International Civil Aviation Organization	ICAO	The agency of the United Nations responsible for international standards for civil aviation which the UK is bound by international treaty to implement.
International Civil Aviation Organization standards and recommended practices	ICAO SARPs	Technical specifications set by the International Civil Aviation Organization for aviation, implemented and regulated national by states globally to manage safety risks.
Interoperability Through European Collaboration	ITEC	A new Flight Data Processing System and associated toolset developed by a consortium of air navigation service providers of Spain, Germany, Lithuania, the Netherlands, Norway, Poland and the UK that aims to enhance interoperability between European control centres and allow aircraft operators to optimise their flightpaths.
Judicial review		A type of court proceeding in which a judge reviews the lawfulness of a decision or action made by a public body. A judicial review is a challenge to the way in which a decision has been made, rather than the rights and wrongs of the conclusion reached. The court will not substitute what it thinks is the 'correct' decision.

Term	Abbreviation	Description
London Approach		(See also terminal air navigation services.) The approach service for a number of airports can be combined and, in the case of the airports within the London terminal manoeuvring area, these have been centralised for safety and efficiency reasons. The unified approach service, the so-called 'London Approach' service, is provided by NERL.
Lower air traffic services route	Lower ATS Route	An air traffic route notified in the UK aeronautical information publication in lower airspace.
Lower airspace		Controlled airspace below Flight Level 245 (a nominal altitude of 24,500 feet).
Magnetic variation		Magnetic variation is the angle on the horizontal plane between magnetic north (the direction the north end of a compass needle points, corresponding to the direction of the Earth's magnetic field lines) and true north (the direction along a meridian towards the geographic North Pole). Variation changes as the position of the magnetic North Pole drifts, affecting compass bearings.
Manual of Air Traffic Services Part II	MATS Pt II	A locally specific manual used by each air navigation service provider which underpins how its air traffic controllers manage aircraft, and in turn influences their decisions.
Military operations		Operations undertaken by military aircraft, or military aerodromes.
Name-code designators		Short standardised names for geographical co-ordinates.
National Air Traffic Management Advisory Committee	NATMAC	National Air Traffic Management Advisory Committee. An advisory body chaired by the CAA with representation across the UK aviation community, consulted for advice and views on airspace management and strategy matters.
NATS		The biggest air navigation service provider in the UK, formerly National Air Traffic Services. Parent company of NERL (NATS En Route plc) and NSL (NATS Services Limited). www.nats.co.uk

Term	Abbreviation	Description
NATS En Route plc	NERL	Subsidiary of NATS Holdings Ltd and the sole provider of air traffic control services for aircraft flying 'en route' in UK airspace. NERL also provides some air traffic control services in the eastern part of the North Atlantic, as well as providing a combined approach function (London Approach) for five London airports.
NATS Services Ltd	NSL	Subsidiary of NATS Holdings Ltd providing air traffic services on a commercial basis.
Noise preferential route	NPR	Aircraft departing from certain airports follow set departure routes agreed by Government or the Local Authority, with the aim of providing certainty in respect of, and, where possible, minimising noise impacts on the ground. Noise Preferential Routes are not decided by the CAA nor covered by the processes described in this guidance.
Non-directional beacon	NDB	Radio transmitter at a specified location used by aircraft as a navigational aid.
Notified airspace design		Details of airspace structure and procedures published in the UK aeronautical information publication.
Performance-based navigation	PBN	A concept developed by ICAO that moves aviation away from the traditional use of aircraft navigating by ground-based beacons to a system more reliant on airborne technologies, utilising area navigation and global navigation satellite systems. (Air Navigation Guidance 2017). More specifically, area navigation based on performance requirements for aircraft operating along an ATS route, or an instrument approach procedure or in a designated airspace. (ICAO Doc 9613) https://www.icao.int
Prohibited area		An area of airspace of defined dimensions within which the flight of aircraft is prohibited.
Radio mandatory zone	RMZ	Defined airspace structure in which the carriage and operation of radio equipment is mandatory unless previously agreed.
Radio telephony coverage	R/T coverage	The volume of airspace that a radio frequency emanating from a particular transmitter/receiver site can operationally cover.

Term	Abbreviation	Description
Remotely piloted air system	RPAS	A powered aircraft without a human pilot on board which is piloted remotely, also known as an unmanned aerial system or vehicle (UAS or UAV). See ‘drone’, which is the term we use in this document for UAS, UAVs and RPAS.
Required navigation performance	RNP	Type of performance-based navigation. See Performance Based Navigation.
Respite		Planned and notified periods where overflight or noise impact are reduced or halted to allow communities undisturbed time.
Restricted area		An area of airspace of defined dimensions within which the flight of aircraft is restricted in accordance with certain conditions.
Safety buffer requirement		CAA policy setting out requirements for a safety buffer between classes of airspace.
Secondary surveillance radar	SSR	Type of radar which both detects and sets position of aircraft in the air, and also receives information from the aircraft.
Single European sky	SES	European legislation that supports a programme of modernisation and harmonisation of airspace structures and air traffic control methods for a more systemised and efficient European air traffic management system.
Single European sky air traffic management research	SESAR	European project which concerns the roll-out of new technology across the European Union.
Single European sky regulations		Regulations which underpin the SES process.
Special visual flight rules	SVFR	A special case of operating under visual flight rules.
Sponsor (or change sponsor)		An organisation that proposes, or sponsors, a change to the airspace design in accordance with the CAA’s airspace change process.
Stakeholder		An interested third party in an airspace change proposal – neither the change sponsor nor the CAA or Department for Transport.

Term	Abbreviation	Description
Standard arrival route	STAR	Published flight procedures followed by aircraft on an Instrument Flight Rules (IFR) flightplan just before reaching a destination airport. More specifically, a STAR is a designated IFR arrival route linking a significant point, normally on an ATS route, with a point from which a published Instrument Approach Procedure (IAP) can be commenced.
Standard instrument departure	SID	Published flight procedures followed by aircraft on an Instrument Flight Rules (IFR) flightplan immediately after take-off. More specifically, a SID is a designated IFR departure route linking the aerodrome or a specified runway of the aerodrome with a specified significant point, normally on a designated ATS route, at which the en-route phase of a flight commences.
System-wide Information Management	SWIM	A new set of internet-based information sharing standards and protocols that support aeronautical data. Supports exchanges between European civil and military air navigation service providers, airspace users, airport operators, meteorological service providers and the European network manager.
Terminal air navigation services	TANS	Terminal air navigation services comprise two elements: the ‘radar approach and departure’ (approach control) service, and the aerodrome control service. The approach service typically takes control of the aircraft from the en-route service within 40–50 nautical miles of the airport, and sequences aircraft for landing before handing over to aerodrome control. It also takes control of aircraft on departure from aerodrome control. Aerodrome control manages (visually from the airport’s control tower) aircraft taking off and landing, and ground movement control of aircraft taxiing between the runway and the stands These two elements of terminal air navigation services are provided by the airport (acting as an air navigation service provider) itself, or by a third-party air navigation services provider.
Terminal control area		Area of controlled airspace surrounding an airport.
Terminal manoeuvring area	TMA	A designated area of controlled airspace surrounding a major airport where there is a high volume of traffic.

Term	Abbreviation	Description
Transponder mandatory zone	TMZ	Defined airspace structure in which the carriage and operation of transponder equipment is mandatory unless previously agreed.
Transport Analysis Guidance	WebTAG	DfT transport options analysis and modelling tool and associated guidance. https://www.gov.uk/guidance/transport-analysis- guidance-webtag
UK Space Agency		An executive agency of the UK Government sponsored by the Department for Business, Energy and Industrial Strategy. It is responsible for all strategic decisions on the UK civil space programme and provides a clear, single voice for UK space ambitions.
Uncontrolled airspace		Airspace in which aircraft are able to fly freely through the airspace without being constrained by instructions in routeing or by air traffic control, unless they require an air traffic control service.
Unmanned aerial system Unmanned aerial vehicle	UAS UAV	A powered aircraft without a human pilot on board, which may be remotely piloted (also known as a remotely piloted air system or RPAS) or autonomous. See ‘drone’, which is the term we use in this document for UAS, UAVs and RPAS.
Unmanned traffic management	UTM	The interaction between traditional air traffic management systems and the evolving counterpart systems being developed for drones.
Upper air traffic services route	Upper ATS route	An air traffic route notified in the UK aeronautical information publication in upper airspace.
Upper airspace		Controlled airspace above Flight Level 245 (a nominal altitude of 24,500 feet).
Upper information region	UIR	Flight information region in upper airspace.
Urban air mobility	UAM	An aerial solution to alleviate transport congestion in built-up areas, such as autonomous flying vehicles including air taxis.
VHF Omni Range and Distance Measuring Equipment	VOR/DME	Combination of two types of radio beacon placed together and used in the UK to provide an en-route navigation service.

Term	Abbreviation	Description
Visual flight rules	VFR	The rules under which a pilot can fly and navigate an aircraft, in certain weather conditions, by seeing where the aircraft is going.
Visual reference point	VRP	Fixed point on land or sea used by pilots to fix position of their aircraft in relation to their route.

Jet Zero Council

Chairs

CSO

Members

Delivery Groups

JZC meeting minutes

Terms of reference

Press releases and government publications

Contact details

News story

Prepare for lift-off: Jet Zero Council to deliver carbon-free flight

Jet Zero Council launches with aim of zero-emission flight by 2050.

From: Department for Transport, Department for Business, Energy & Industrial Strategy, and Robert Courts MP
Published 25 September 2020

Brexit
Check what you need to do

- Jet Zero Council sets out ambitions on sustainable aviation fuel, zero-emission aviation and aerospace technologies
- partnership between government and industry to drive forward the government's net zero-emission ambitions for the aviation and aerospace sector
- group brings together representatives across aviation, aerospace, academia and wider

The pioneering partnership between government and the aviation sector to fast-track zero-emission flight has taken its next step forward today (Friday 25 September 2020) with the publication of the group's members and key aims.

Following the first meeting of the group earlier in the summer, representatives from the UK's leading aerospace, aviation and technology sectors will work in lockstep with Transport Secretary Grant Shapps, Aviation Minister Robert Courts and Business Secretary Alok Sharma to drive forward the government's ambitions for c ean aviation.

Industry leaders from Rolls-Royce, Airbus and Shell, along with representatives from some of Britain's top aviation, tech, non-governmental organisation (NGO) and investor groups, including John Holland-Kaye (Heathrow) and Alex Cruz (IAG), will aim to turbocharge government p ans through a laser focus on UK production facilities for sustainable aviation fuels and the acceleration of the design, manufacture and commercial operation of zero-emission aircraft in the UK, helping speed the sector towards a low-carbon future.

Aviation Minister Robert Courts said:

> " Climate change is one of the greatest challenges faced by modern society, and we know we need to go further and faster if we're to make businesses sustainable long into the future.
>
> " That s why we're bringing together government, business and investors to reduce emissions in the aviation sector – through innovative techno ogies, such as sustainable fuels, hybrid and eventually electric planes, we will build a cleaner, greener and more sustainable future for all."

The council, which will establish sub-committees to accelerate progress, will focus on reducing carbon dioxide emissions and delivering clean growth. It will operate in the context of the UK's wider target for net zero emissions by 2050 – one of the most ambitious targets in the world.

The partnership will leverage the UK's world-leading aviation sector, which employs 230,000 people in the UK and contributes £33 billion to the UK economy, to effectively tack e emissions while encouraging growth and green innovation. Through this partnership, the UK will go further than ever before in developing the first zero-emission transatlantic passenger aircraft.

The publication of the group's aims today coincides with the Aviation Minister s visit to Cranfield to witness the world's first hydrogen electric passenger plane flight.

ZeroAvia, a leading innovator in decarbonising commercial aviation, supported by the Department for Business, Energy and Industrial Strategy (BEIS) through the Aerospace Technology Institute (ATI) Programme, completed the flight at the company's research and development (R&D) facility in Cranfield, England, with the Piper M-class 6-seat plane completing taxi, take-off, a full pattern circuit and landing.

Business and Industry Minister Nadhim Zahawi said:

> " The UK is unrelenting in its commitment to ensuring a cleaner world for future generations by achieving net zero emissions by 2050 – and making air travel greener will be a huge part of this.
>
> " This ambitious council will see the government working in tandem with key players from across aviation, aerospace and wider to develop innovations that will catapult aviation to a low-carbon future."

The full list of attendees can be found online, along with the terms of reference.

News desk enquiries

Media enquiries 020 7944 3021

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News story

Jet Zero Council keeps up momentum with £3 million government funding for zero emission flight infrastructure as UK pioneers first-ever net zero carbon freighter flights

Competition will fund critical research into electric and hydrogen aircraft to support aviation reach net zero by 2050.

From: Department for Transport, Department for Business, Energy & Industrial Strategy, The Rt Hon Grant Shapps MP, and The Rt Hon Kwasi Kwarteng MP
Published 30 June 2021

Brexit
Check what you need to do

- government launches first round of £3 million Zero Emission Flight Infrastructure (ZEFI) competition, supporting development of infrastructure required to aid electric and hydrogen aircraft such as charge points for planes
- British Airways completes first-ever net zero carbon freighter flights powered by waste materials such as cooking oil
- this comes as Jet Zero Council meet for a third time setting out a plan to put aviation at the heart of building back better and greener from the pandemic

The UK continues its track to deliver the world's first zero emission flight across the Atlantic within a generation following 2 progressive announcements by the Transport Secretary today (30 June 2021).

Launching the first round of the ZEFI competition, delivered by the Connected Places Catapult – the government will award businesses and universities around the UK up to £50,000 each to pioneer critical research into infrastructure, such as charge points and hydrogen fuelling tanks, that will enable the mass uptake of electric and hydrogen aircraft.

Part of the Prime Minister's Ten Point Plan, the £3 million fund will ramp-up the move towards sustainable flying to support aviation reach net zero by 2050.

This follows on from news that members of the Jet Zero Council, British Airways (BA), this week carried out the world's first net zero carbon freighter flights powered by a mix of sustainably sourced waste such as cooking oil. This is set to be the first of many flights with BA ordering 1.2 million litres of the fuel.

Offering emissions savings of more than 80% compared to conventional jet fuel, this marks a milestone moment putting UK aviation at the forefront of global decarbonisation efforts and forging the pathway to sustainable commercial flying in the future.

Transport Secretary Grant Shapps said:

> "As the first major economy to commit to net zero by 2050, we've gone further than any country in the world to slash our aviation emissions – providing leadership, funding and the framework needed to lead the charge.

> "Now is the time for organisations and companies to take advantage of the opportunities we have provided to harness the economic and environmental benefits building back better and greener has to offer."

Business Secretary Kwasi Kwarteng said:

> "Sourcing sustainable fuels are critical if we are to cut emissions and build a competitive future for Britain's aviation industry. Today's funding once again shows the Jet Zero Council is driving forward our ambition to make flight cleaner and greener.

> "As we build back better from the pandemic, it is so important to see iconic companies like British Airways leading the way and sharing in our belief that decarbonising flight doesn't just make environmental sense, but also great business sense too."

This comes as the Jet Zero Council meets for the third time today, setting out plans to put UK aviation at the heart of the UK's pandemic recovery – building back better and greener through the uptake of sustainable aviation fuel (SAF) and the development of zero emission aircraft and infrastructure.

Through the work of its dedicated delivery groups and £18 million of new funding, the Council has led the global charge on the uptake and development of trailblazing SAFs.

With COP26 on the horizon, the UK hopes to showcase the progress made by encouraging delegates to fly on planes fuelled by SAF, showing just how far the collaboration between government and industry has come.

This funding, taken together with the £3 million of ZEFI funding announced today means the government has provided over £20 million of new funding for the decarbonisation of the sector since the Council formed last year.

Aviation, Europe and technology media enquiries

Media enquiries 020 7944 3021

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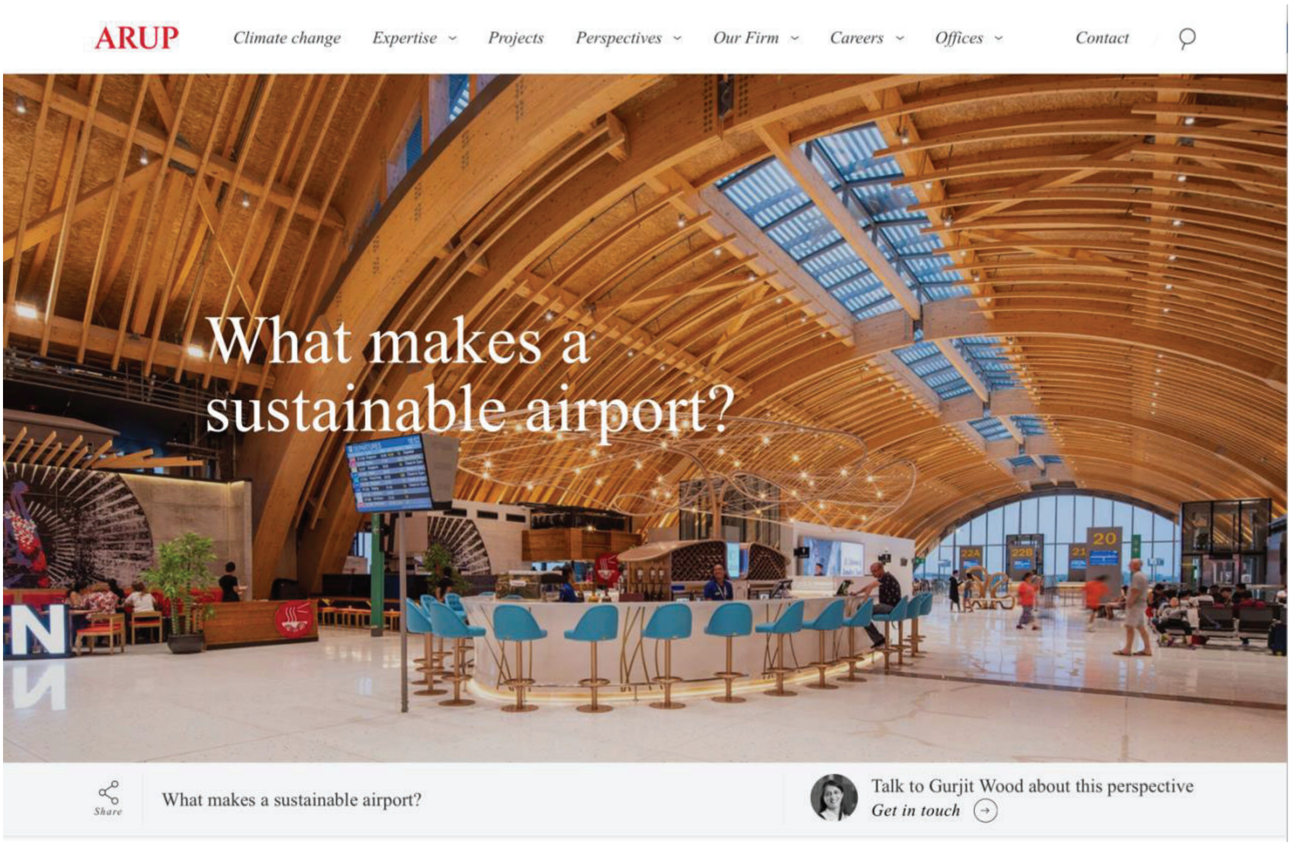
Switchboard 0300 330 3000



The push for action on climate change challenges different sectors of our economy in different ways. For ***aviation***, there are two clear priorities – the shift to sustainable aviation fuels, a transition that's a work in progress, and second, the need to develop sustainable airports. From wealth to employment to cultural exchange, airports have always made a considerable contribution to both national economy and surrounding communities, but that role is likely to come under renewed scrutiny as sustainable development continues to reframe the opinions of governments, regulators, investors and the travelling public. So, what would make an airport 'sustainable' in this emerging economic landscape?

The sustainable airport isn't simply one that is protected from physical climate risks like extreme weather and rising sea levels. At a minimum, we believe that airports will have to tackle these five questions if they're to become truly sustainable.

1. How can an airport achieve net zero emissions?

In terms of overall aviation CO_2 emissions, while the majority is produced from flying aircraft, it doesn't mean airports' ground operations can't become more sustainable. Airports will need to comprehensively switch to renewable energy and invest in energy efficiency and energy storage to reduce carbon emissions, a process we have recently scoped out in detail for ***San Francisco Airport***. Mapping and modelling energy use across airports' complex estates, including optimising airfield layout, is a vital first step.

Given airports' typical physical footprint, and with renewable infrastructure continuing to fall in cost, there are also possibilities to develop on-site energy generation from solar, wind, biomass and hydrogen sources. India's Cochin International Airport claims to produce 100% of its energy through renewables, by siting a large solar array on airport buildings and surrounding land, an idea that other airports can emulate.

Surface access is a major emissions factor at airports. Prioritising public transport can reduce surface access related emissions. In 2018, surface access caused 33% of Heathrow Airport's emissions and we developed a first of its kind ***report*** which drew on airport data to identify ways to improve the speed, reliability and sustainability of travelling to and from the airport.

To shape rapid change, ACI's Airport Carbon Accreditation scheme and new government regulation (like both the UK government's new decarbonisation plan and the European Union's recent Green Deal proposals), are beginning to set stringent targets for reductions in waste and embodied carbon, and levels of renewable energy procurement. Governments can also establish a lifecycle cost assessment for airport projects, so operators understand how to achieve net zero on existing as well as new buildings. Net zero is possible, but must be approached in an integrated way, from multiple operational angles.

2. Can we design airports to become more physically sustainable?

As in other resource heavy infrastructure, airports could shift to a 360-degree lifecycle approach to the design, construction and operation of new and existing physical assets. This would enable them to embody a circular economy approach to their built assets, adopting materials passports and other measures to enable the reuse of materials when facilities reach their end of life, lowering lifetime emissions and retaining the value of building products and assemblies as a result. In our work with one leading airport, our assessments were able to identify 8,500m2 of existing concrete pavement that could be retained and reused from upgrade works. It's a matter of adopting a different mindset and anticipating re-use wherever practical.

In effect, an airport is a complex ecosystem of environments, services, vehicles and supporting systems, which all consume a mix of energy and resources. Optimisation requires taking a system-wide approach, by reducing waste, improving recycling, using on-site waste-to-energy and anaerobic digestion systems to improve performance, and committing to zero-waste-to-landfill commitments.

3. How do airports grow without damaging nature and biodiversity?

There is likely to be growing expectation that airports commit to 'green managed growth' – the concept of setting limits to environmental impacts while continuing to grow economically. It would mean agreeing mutually acceptable methods of monitoring and enforcement regarding issues like noise, carbon emissions, surface access impacts, air quality and so on – but would also represent a spur to innovation.

To address biodiversity impacts, there are many great examples of airports already adopting practices like green roofs and expanded planting within their estates in ways that are compatible with aviation safety. These are effective but controlled ways of encouraging surrounding nature in their immediate environs. Local environmental off-setting could achieve other national goals too. Instead of simply off-setting by planting forests in other areas or regions, airports could invest in the domestic boiler replacement with heat pumps in the local community, helping to accelerate the decarbonisation of home heating and bolstering their status as socially responsible businesses.

4. How can airports become healthier for employees, communities and users?

From the quality of the passenger experience to local air quality and noise levels, airports can do more to improve the health and wellbeing impacts they produce. Policies to encourage the use of electric vehicles within their estates and ground power to aircraft can bring down air pollution, supporting local air quality goals. Reductions in light pollution and adoption of indoor air quality monitoring, limiting the use of toxic substances, introduction of biophilic design, as well as measures to reduce the risks of creating heat islands, would also all strengthen an airport's sustainability credentials.

Becoming more sustainable in terms of health and wellbeing means taking a fundamentally human-centred design approach to aviation infrastructure, operations and environments. We are collaborating with the EU Aviation Wellbeing Committee to challenge the industry to design for the needs of all those who interact with it.

5. How can airports play a bigger role in the local community?

Airports are major employers, but the sustainable airport can play a larger role in the community than merely providing jobs. As focus points for a range of technical, engineering and service skills, they have an opportunity to become a hub for local skills, offering apprenticeships, and reaching out to communities that lack educational advantages.

This, more active, posture would be a chance to demonstrate leadership on a series of interconnected urban issues. Airports are typically located in the outer reaches of urban areas, providing a potentially powerful set of connections in areas of often less-wealthy populations. Luton Airport, north of London, is focusing on green aviation technology research and development, becoming a connector between universities and engineering businesses in the area. For other airports, there's clear potential to develop low-emission agriculture on their surrounding land, helping the food industry to reduce 'food miles' and advance its own sustainability agenda. The possibilities are considerable, varied and local.

Sustainability: a license to operate?

The development of sustainable aviation fuels, including biofuels, hydrogen, and electric-powered aircraft is well underway, but will take time. The sustainable airport is something we can achieve right now. Airports have a fantastic opportunity to lead the sustainability agenda, pioneer progressive economic measures and practices, and ensure that the industry is seen as an active participant in the shift to a net zero economy. Ultimately, once the world's airports are more vocal about their sustainability commitments, and making progress on a path to net zero, they will strengthen their social license to operate. This won't just be to the benefit of the industry, but will strengthen the cities and communities it serves.