Title: Clarifying Altitude Based Priorities during airspace changes **IA No:** 391 **RPC Reference No:** RPC-4155(1)-DfT **Lead department or agency:** Department for Transport **Other departments or agencies:** Civil Aviation Authority	**Impact Assessment (IA)** **Date:** 04/09/2017 **Stage:** Final **Source of intervention:** Domestic **Type of measure:** Other **Contact for enquiries:** Tom Fletcher (thomas.fletcher@dft.gsi.gov.uk)
Summary: Intervention and Options	**RPC Opinion:** GREEN

Cost of Preferred (or more likely) Option				
Total Net Present Value	**Business Net Present Value**	**Net cost to business per year** (EANDCB in 2014 prices)	**One-In, Three-Out**	**Business Impact Target Status**
-£37.2m	-£37.2m	£3.7m	N/A	N/A

What is the problem under consideration? Why is government intervention necessary?

Airports and Air Navigation Service Providers (ANSPs, such as NATS) are able to propose and make changes to the design of UK airspace in order to achieve their chosen economic, efficiency or environmental objectives. These changes can vary widely both in type and scale, but where they overfly communities on the ground, they can have significant impacts on audible noise levels.

The CAA provides regulatory oversight of these changes, based on both legally binding directions, and guidance issued by the Department for Transport. In 2014, the Department introduced 'Altitude Based Priorities', a system incorporated in guidance to the CAA, and designed to ensure that potential noise impacts were prioritised in airspace change decisions up to 7,000 feet above sea level, in line with Government's overall policy on aviation noise. This is a priority because long-term exposure to high levels of noise has been linked to a variety of serious health and quality of life impacts. In addition, there is evidence that people are now more sensitive to noise further from airports and that the frequency of aircraft movements above 4,000ft is a factor in annoyance.

However, due to the use of the word 'balance', the guidance has generally been interpreted as encouraging airspace change sponsors and the CAA to treat noise and efficiency (carbon emissions) factors, which often come at a trade off to one another, equally between 4,000 and 7,000 feet. This can mean that changes are accepted which do not minimise noise impacts and so may not be consistent with the Government's noise policy. An update to the guidance is therefore necessary.

What are the policy objectives and the intended effects?

Intervention is designed to achieve the following:

1) Bring the interpretation of the policy into line with the Government's overall policy on aviation noise (see paragraph 2.1)
2) Ensure the original intention of the guidance is adhered to, ensuring health and quality of life impacts are minimised through the design of airspace routes which optimise noise outcomes in the future

What policy options have been considered, including any alternatives to regulation? Please justify preferred option (further details in Evidence Base)

The Department already issues guidance to the CAA in this area – an update to this guidance for clarity is therefore considered the most appropriate mechanism, ensuring both industry and communities can clearly observe and understand the changes.

Will the policy be reviewed? Yes. If applicable, set review date: April 2023 (five years after implementation)

Does implementation go beyond minimum EU requirements?		N/A		
Are any of these organisations in scope?	**Micro** No	**Small** No	**Medium** Yes	**Large** Yes
What is the CO_2 equivalent change in greenhouse gas emissions? (Million tonnes CO_2 equivalent)		**Traded:** 0.05	**Non-traded:** 0.28	

I have read the Impact Assessment and I am satisfied that, given the available evidence, it represents a reasonable view of the likely costs, benefits and impact of the leading options.

Signed by the responsible Minister: ..... **Date :** Enter a date

Summary: Analysis & Evidence

Policy Option 1

Description: Clarifying guidance to the CAA for Altitude Based Priorities during airspace changes

FULL ECONOMIC ASSESSMENT

Price Base Year: 2017	PV Base Year: 2018	Time Period Years: 10	Net Benefit (Present Value (PV)) (£m)		
			Low: -17.5	**High:** -64.3	**Best Estimate:** -37.2

COSTS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Cost (Present Value)
Low	N/A	N/A	2.2	**17.5**
High	N/A		7.9	**64.3**
Best Estimate	N/A		4.6	**37.2**

Description and scale of key monetised costs by 'main affected groups'

Airlines – fuel costs: clarifying the guidance on Altitude Based Priorities is expected to lead to an average increase in flight track mileage for aircraft flying newly changed routes. This would lead to increased fuel costs for airlines, with the analysis suggesting an annual average of £4.6 million additionally versus the current guidance under the central case, though a wide degree of uncertainty is associated with this estimate – low and high estimates are £2.2 million and £7.9 million respectively. Costs increase as the appraisal period advances – this is because each new airspace change is considered permanent until it is modified again, and additional costs are therefore cumulative.

Other key non-monetised costs by 'main affected groups'

Environment – carbon: whilst not monetised (see 7.5), the expected increase in fuel burn would lead to an increase in carbon emissions, with an average of 37,000 tonnes estimated across years 1 to 10 (central case). The actual impact is largely dependent on outturn increased track length and quantity of airspace changes, and therefore, as with industry costs, is subject to a wide degree of uncertainty. 37,000 tonnes is small compared to the aviation sector's contribution of 34 million tonnes in 2014, and would have little impact on the UK's carbon budget.

BENEFITS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Cost (Present Value)
Low	N/A	N/A	NQ	**NQ**
High	N/A		NQ	**NQ**
Best Estimate	N/A		NQ	**NQ**

Description and scale of key monetised benefits by 'main affected groups'

None quantified.

Other key non-monetised benefits by 'main affected groups'

Environment (and local communities) – noise: new routes designed to prioritise noise factors mean populated areas are avoided where safe and technically feasible, ensuring noise is minimised in line with the Government's overall policy on aviation noise, leading to a reduction in expected health and quality of life disbenefits for local communities affected by airspace changes over the coming years.

Airlines and airports – successful airspace changes: the clarification is designed to ensure sponsors can show that they have prioritised noise factors as far as possible – should this lead to a reduction in community opposition then the likelihood of vital airspace changes going ahead would increase significantly, allowing a proportion of potential efficiency benefits to be realised, versus current guidance where the change may not go ahead.

Key assumptions/sensitivities/risks **Discount rate (%)** 3.5

Cost estimates are uncertain, reflected in wide range of uncertainty between low, central and high estimates.

This is due to a number of key underlying variables, which remain uncertain across the appraisal period, including:

1) Number of affected airspace changes – difficult to accurately forecast due to complex UK airspace design, and because it requires anticipating the behaviour of change sponsors such as airports and ANSPs
2) Average additional track mileage per change – inherently difficult to estimate due to airport specific features
3) Jet fuel price – oil prices are inherently volatile and known to fluctuate significantly even within a single year

The analysis has reflected this uncertainty by incorporating a range of values for each of these variables, based on established evidence from Government and commercial sources, but it is possible that outturn costs lie outside the projected range – the high and low estimates are not intended to represent extremes.

BUSINESS ASSESSMENT (Option 1)

Direct impact on business (Equivalent Annual) £m:			Score for Business Impact Target (qualifying provisions only) £m: N/A
Costs: 3.7	Benefits: NQ	Net: -3.7	

Evidence Base

1 Background and current system

1.1 Airports and Air Navigation Service Providers (ANSPs, such as NATS) are able to propose and make changes to the design of UK airspace in order to achieve their chosen economic, efficiency or environmental objectives. These changes can vary widely both in type and scale, but where they overfly communities on the ground, they can have significant impacts on audible noise levels.

1.2 The Civil Aviation Authority (CAA) provides regulatory oversight of these changes in the form of its Airspace Change Process (ACP), which change sponsors must adhere to, and which details the formal process and considerations to be made during an airspace change proposal. The CAA then exercises a role of approval for new airspace changes proposed by sponsors.

1.3 The CAA's regulatory powers in this area are based on legally binding directions issued by the Department for Transport (DfT, issued in 2001 and last updated in 2004), who also publish guidance on how they should take into account their environmental objectives, last updated in 2014 and known as the Air Navigation Guidance (ANG)[1] (issued under section 70(2) d of the Transport Act 2000[2]).

1.4 As currently published, the ANG sets out which factors should be prioritised by the CAA in airspace change decisions at different altitudes (heights above sea level). These are known as 'Altitude Based Priorities', or ABPs. The existing guidance states that noise should be the 'focus' up to 7,000 feet, although notes the CAA may 'balance' this requirement between 4,000 and 7,000 feet with the need to ensure an 'efficient use of airspace and expeditious flow of traffic that minimises emissions'.

1.5 This is because there may be occasions where in order to minimise aviation noise impacts, aircraft would have to fly a longer route. A simplified example of this is where a longer route is proposed to avoid flying over a populated area, which may then have a disproportionate impact on CO_2 emissions, due to increased fuel burn, especially as the additional fuel burn would then apply for every flight operating on that route in the future.

1.6 When this guidance was first issued in 2014, the intention was for noise to be the focus up to 7,000 feet, unless it had a clear disproportionate impact on flight efficiency and CO_2 emissions. However, in practice, due to the inclusion of the word 'balance', both airspace change sponsors and the CAA have generally interpreted this as meaning they should treat noise and emissions equally between 4,000 and 7,000 feet.

2 Problem under consideration and policy objectives

2.1 There is a risk that the current interpretation of the ANG may conflict with the Government's overall policy on aviation noise, which is to 'limit and where possible reduce the number of people significantly affected by aviation noise'. Prioritising noise up to 7,000ft helps to achieve this policy objective, and so the current interpretation could sometimes run counter to this objective.

2.2 Whilst the CAA is currently implementing a revised ACP which requires a risk-based approach to the assessment of airspace changes from sponsors (such as use of the Department's WebTAG assessment guidance and associated noise workbook), as well as an assessment of all relevant options ('options appraisal'), this is not guaranteed to ensure that noise is treated as a priority up to 7,000 feet in new airspace changes, as originally intended.

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[1] The 2014 published version is available here: https://www.gov.uk/government/publications/air-navigation-guidance

[2] Available at: http://www.legislation.gov.uk/ukpga/2000/38/section/70

2.3 If the guidance continues to be interpreted as it is currently, then in theory, this may lead the CAA to approve airspace change proposals in which noise factors are not sufficiently prioritised over increased track length and emissions. However, the Department recognises that in reality, the ACP is more complex than this, and it may not be immediately clear if or when this has occurred.

2.4 During the 2017 Airspace Policy Consultation[3], a number of local authorities and community noise groups expressed concern that noise was not being prioritised up to 7,000 feet, and asked for the guidance to be updated to ensure this. Following analysis of all responses, and discussions with the CAA, the Department now believes a clarification of existing policy is necessary, with the objective of ensuring that noise factors are prioritised in ACP decision making, and providing confidence to the public that the future interpretation is consistent with the overall policy on aviation noise.

2.5 As noted in the parallel impact assessment looking at proposed changes to noise assessment, the World Health Organisation (WHO) has linked long-term exposure to high levels of noise to health conditions including heart attacks, strokes and dementia. Aviation noise also provides a source of general community annoyance - recent evidence from the Survey of Noise Attitudes (SoNA) 2014[4] suggests people are becoming more sensitive to noise further away from airports, and to the frequency of aircraft overflight above 4,000 feet. Noise also impacts on quality of life through sleep disturbance. Resolving this unintended interpretation of the ANG is therefore considered of importance to the Department.

2.6 In addition, there are potential benefits to industry, should the policy lead to a reduction in community opposition to important airspace changes where sponsors and the CAA can demonstrate they have sufficiently considered noise factors in their decisions. The modernisation of UK airspace over the coming decade, including the introduction of new technologies, is considered vital to ensuring the aviation sector is able to meet rising demand without incurring significant delays and cancellations[5], and the effective implementation of airspace changes is a necessary and key component of this.

3 Policy proposal

3.1 In order to improve clarity of language, and ensure the guidance is interpreted as originally intended, the Department is proposing an update to the Air Navigation Guidance to the CAA. This would read as follows (key revisions highlighted in bold);

*'in the airspace from 4,000 feet to below 7,000 feet, the environmental **priority** should continue to be minimising the impact of aviation noise in a manner consistent with the government's overall policy on aviation noise, **unless the CAA is convinced that** this would **disproportionately increase CO_2 emissions**'*

3.2 The Department believes this provides the necessary clarity and strength of language to ensure that noise is prioritised up to 7,000 feet, as originally intended when the Altitude Based Priorities were first introduced. The use of the words 'priority', 'convinced', and 'disproportionately increase' is designed to ensure that sponsors give full consideration to noise impacts up to 7,000 feet.

3.3 However, the Department recognises that there may be instances where the prioritisation of noise factors would lead to a disproportionate increase in aircraft track mileage, and resultantly fuel burn and CO2 emissions. The guidance is therefore designed to give the CAA (as the UK's airspace regulator) the power to make this judgment, should they be convinced that the impact on carbon would be too great. This is supported by the CAA's powers granted under Section 70 (3) of the Transport Act 2000[6], which would allow them to prioritise carbon emissions were the impacts to ever be truly

[3] See here for consultation documents: https://www.gov.uk/government/consultations/reforming-policy-on-the-design-and-use-of-uk-airspace

[4] Published by the CAA in 2017, available at: http://publicapps.caa.co.uk/modalapplication.aspx?appid=11&mode=detail&id=7744

[5] More information on the rationale for airspace modernisation, including delay and cancellation estimates to 2030: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/586871/upgrading-uk-airspace-strategic-rationale.pdf

[6] Available at: http://www.legislation.gov.uk/ukpga/2000/38/section/70

disproportionate. Government believes that these revisions to existing guidance are sufficient to achieve the desired policy objective, without imposing a significant burden on industry.

3.4 As evidence of this, whilst this proposal was derived from the consultation itself, and therefore not strictly subject to further consultation with industry, the Department has had informal discussions with three major airports/ANSPs who were in broad support of the proposals as a whole.

3.5 All could see the vital importance of effective community engagement in order to ensure that their airspace change proposals have a chance of being approved, and that noise was the overwhelming concern of many. All recognised that noise considerations must be at or near the forefront of their proposals in the airspace up to 7000ft, as otherwise the chances of a successful outcome were low.

3.6 Whilst this is a clarification of existing policy, the Department recognises that, should the change prove effective, it would intuitively result in a change in behaviour on the part of change sponsors when proposing airspace changes. The role of the CAA would then be to ensure the decision on the final option proposed was reached in line with the new guidance. As a result, whilst the costs to industry estimated in this Impact Assessment are those which would have been borne had the guidance been interpreted as originally intended, they are additional versus the current status quo interpretation of the DfT ANG.

4 Potential industry costs

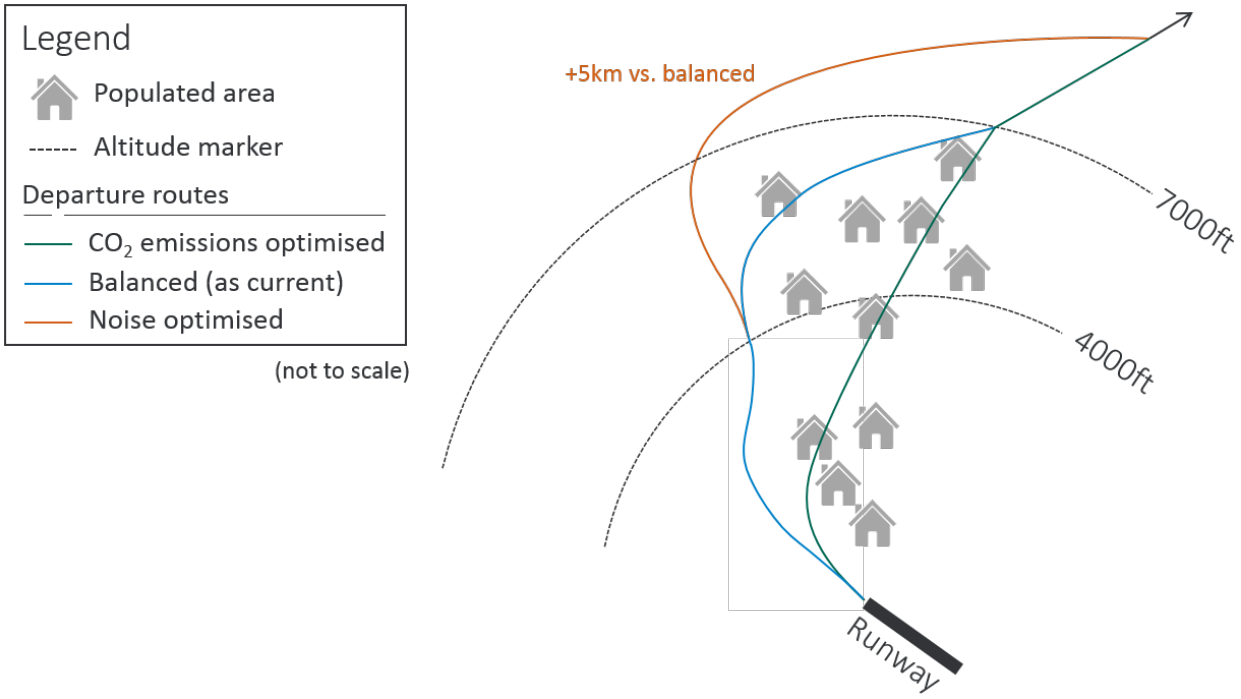
4.1 In this Impact Assessment, the Department has considered two possible ways in which the clarification could affect the behaviour of airspace change sponsors, and therefore impact on industry costs. These are based on discussions with the CAA, who confirmed these would be the most likely impacts of the proposal, and are as follows;

1) **It affects the design of route options presented during an airspace change proposal** – for example, it may mean airspace change sponsors include an additional bend in every proposed departure route to avoid overflying populated areas up to 7,000 feet.
2) **It affects the relative positioning of each option, and therefore the final option chosen** – for example, under the new guidance, an option which overflies fewer households up to 7,000 feet, but has a longer track length, is preferred to an option which balances emissions and noise factors, whereas the opposite would be true under the current guidance.

4.2 Under both of these scenarios, the expected result is that route length increases in order to avoid overflying populated areas. Where this occurs, noise experienced by people on the ground will decrease, but fuel burn and therefore emissions (including CO_2) will increase. Due to the complex nature of the ACP, which must balance numerous other factors, including safety and technical feasibility, in reality it may be difficult to discern where either of these potential mechanisms have occurred, even after the change has been approved.

4.3 However, the following attempts to present the theoretical method of action using a simplified worked example. Realistically, it is unlikely that an airspace change would ever occur with an impact as clearly defined as the one presented below.

Diagram 4.3.1. Indicative example – proposal for a new departure route at a fictional airport



4.4 In the above example, an airspace change sponsor has proposed a new departure route from their existing runway. The green line represents a fictional departure route where the CO2 emissions are prioritised as the lead factor in the options appraisal process. Whilst this option produces the shortest flight track mileage, under both current and proposed guidance, it is not chosen, due to the large population overflown, and resulting impacts of increased aviation noise on health and quality of life.

4.5 The blue line represents an approximation of what the departure route might look like under the current guidance. Between 4,000 and 7,000 feet, a balance between emissions and noise impacts is achieved, such that the majority of populated areas are no longer overflown. Below 4,000 feet, noise is already prioritised. Whilst track mileage remains shorter, some households still face noise impacts. As this line essentially represents behaviour under the current guidance, this is the baseline versus which the proposed changes would be assessed against.

4.6 The orange line represents an approximation of what the departure route might look like under the Department's proposed changes to the ANG. In this example, track mileage has increased by around 5km versus the balanced (current guidance) departure route. Whilst this produces increased fuel burn and CO_2 emissions, noise has been prioritised between 4,000 and 7,000 feet, as populated areas are no longer overflown. It should be noted that in reality, given the complicated nature of UK airspace, and the distribution of populations surrounding airports, it may be impossible to completely avoid populated areas, or at least without a disproportionate impact on emissions.

4.7 It follows that the mechanism of action for quantification of the industry cost implications is (note: these variable names are used throughout this document from this point onwards);

$$\text{AnnIndCost}\Delta\ (£) = (\text{NoiseOptKM} - \text{BalancedKM}) * \text{FuelPrice} * \text{AnnFlights}$$

Where...

AnnIndCostΔ	=	total change in annual costs to industry vs. current guidance
NoiseOptKM	=	total route length in km: noise optimised routes (new guidance)
BalancedKM	=	total route length in km: balanced routes (current guidance)
FuelPrice	=	average jet fuel price per km (£)
AnnFlights	=	number of affected flights per year

4.8 There is inherent uncertainty associated with many of these variables, as it would be infeasible to forecast the exact number of flights affected, or the additional route length. As a result, quantified estimation is difficult. More detail on the specific methodology adopted in order to produce numerical estimates for industry cost changes can be found in sections 6 and 12.

4.9 Whilst the CAA is the responsible party for regulating airspace changes through its ACP, the policy would be incorporated within the Department's ANG to the CAA. Therefore, within this Impact Assessment, any costs incurred via the mechanism outlined above are treated as a direct consequence of the DfT's policy clarification.

5 Potential industry benefits

5.1 Whilst the primary rationale for the guidance clarification is to ensure interpretation is consistent with the Government's overall policy on aviation noise, there are also potential benefits to industry, but these are considerably more difficult to quantify than costs, and are therefore assessed qualitatively in this Impact Assessment.

5.2 Currently, community opposition to noise is a key risk to successful airspace changes. Were the two possible mechanisms outlined in paragraph 4.1 to have a significant enough impact on the final route proposal, then it is possible that this would satisfy communities enough that they withdraw their opposition to specific changes. This would have obvious benefits to both airlines and airports in cases where new flight paths are more efficient in terms of fuel burn and airspace use (increasing capacity) than those they replace. These are common drivers behind airspace change proposals.

5.3 There are historic instances where airspace changes which are potentially beneficial for efficiency and capacity have not gone ahead due to community opposition. As an example of this, in February 2014, Gatwick Airport trialled a possible new departure route which headed towards the south-west of the airport. This created significant local opposition since it led to aircraft flying over land not usually overflown - the majority of complaints were from individuals overflown between 3,500 and 7,000 feet. After proposing three options, including the trialled route, Gatwick decided against moving forward with the change for a variety of reasons. Had the airport been more confident that the proposal could have been agreed, it may have pursued the change further.

5.4 The Department's experience suggests that airspace changes generally provide positive benefits to industry. In cases where the impact of the clarification is to change the nature of the route, we would still expect those additional costs to be less than the benefits to industry. By the same logic, if the clarification facilitates more airspace changes to go ahead, then this would lead to the realisation of positive net benefits to industry. This might occur because the proposed clarification will allow sponsors to clearly demonstrate to local communities that noise factors have been sufficiently prioritised in the airspace change decision making process, reducing local opposition to the changes. Perceptions of increased noise can form a strong rationale against approving an airspace change, and so it is important that a sponsor can defend its approach against this.

5.5 This is especially important in the context of the modernisation of UK airspace, due to take place over the next decade, which is largely dependent on the successful implementation of key airspace changes. Whilst these benefits are impossible to quantify, based on the logic outlined above the Department considers them likely to more than offset the costs outlined in section 6.

5.6 This conclusion was supported by feedback from the Department's informal discussions with airports and ANSPs, where there was a realisation that a sub optimal – from an efficiency perspective – airspace design was likely to be a price worth paying for securing the significant overall benefits of airspace modernisation (e.g. additional capacity, better airport resilience, improved fuel efficiency, as well as the possibility of reducing noise impacts).

6 Quantified costs to industry

6.1 As noted in paragraph 5.1, quantifying the potential benefits to industry would be difficult and disproportionate. This section therefore presents both the results and methodology for a quantified estimation of potential industry costs arising from the policy clarification. Following a discussion of wider impacts and policy risks, section 9 provides a summary of the expected impacts to both industry and wider society, and serves as justification for the necessity of the policy clarification.

6.2 The analysis makes use of a standard ten year appraisal period from 2018 (year of implementation) to 2027, which is considered sufficient to capture the potential costs to industry. In line with Green Book guidance, where costs are presented as 'present value', a 3.5% discount rate per year has been applied, reflecting the fact that costs borne in the present are valued more highly than costs borne in the future.

6.3 As noted previously, many of the variables associated with forecasting industry costs are highly uncertain. In order to reflect this, a range of three scenarios are presented, representing 'high', 'central' and 'low' cost worlds.

6.4 These are not intended to represent extreme maximum and minimum industry costs, rather a realistic estimate of possible costs based on available source data and DfT experience. As a result, not every possible variable is adjusted between scenarios – this would produce a range so wide as to be limited in usefulness, and also produce results for specific scenarios with a very low probability of occurring.

6.5 Instead, a limited number of uncertain factors have been varied to produce a range that the Department considers still provides a realistic and helpful reflection of uncertainty. This is not to imply that the variables held constant are not going to change, rather a sense of overall uncertainty is what is desired, instead of an exact forecast of specific variables.

6.6 More detail on each of the scenarios, and the underlying assumptions applied in each case, can be found in paragraph 6.13, and a further discussion of possible risks and sensitivities is in section 8.

6.7 Given the length of the updated guidance, any familiarisation costs for the CAA and wider industry are expected to be insignificant. Therefore, no attempt to monetise them has been made.

Results

Table 6.8.1. Summary of key results by scenario (2017 £s, to nearest £100,000, undiscounted)

Year	Annual industry cost estimate		
	Low	Central	High
2018 (year 1)	300,000	700,000	1,200,000
2027 (year 10)	4,300,000	8,900,000	15,700,000
Annual average (years 1-10)	**2,200,000**	**4,600,000**	**7,900,000**
Present Value (years 1-10, discounted)	**17,500,000**	**37,200,000**	**64,300,000**

6.8 Given the complexity of the ACP, and uncertainty surrounding future proposals, forecasting the distribution of airspace changes across the ten year appraisal period was considered infeasible – it would imply a level of certainty which is not a true reflection of reality. As such, results for the majority years are not presented in this Impact Assessment, rather costs in year 1 (2018) and year 10 (2027), as well as the annual average and Present Value (PV), are presented in the table above.

6.9 It should be noted that the Net Present Value (NPV) and Equivalent Annual Net Direct Cost to Business (EANDCB) figures quoted in this Impact Assessment are purely illustrative – the inability to quantify benefits means the actual net impact on industry remains unknown, but as the proposal is also expected to deliver benefits as well, it is clear that the net impact on industry will be better than suggested by the NPV figures alone.

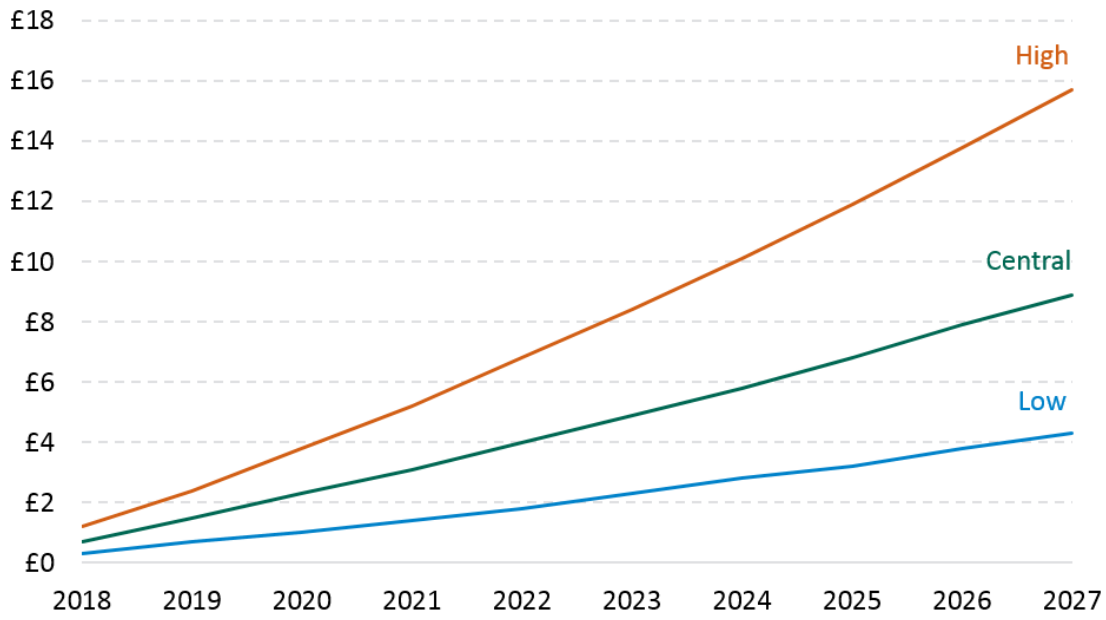
6.10 The table illustrates the wide degree of uncertainty associated with potential industry costs, with estimates ranging by almost £1 million between high and low scenarios in year 1. Naturally, uncertainty grows as the forecast advances further from the present, and the range reaches more than £10 million by year 10.

6.11 As noted previously, costs of the guidance clarification would generally be borne by airlines. Under the central scenario, industry-wide estimated costs of £700,000 in year 1 would be shared proportionately amongst the several hundred commercial airlines and business aviation providers that currently operate to/from UK airports, based on the volume of air traffic that they generate. The costs borne by individual airlines are therefore expected to be much smaller, particularly for those who operate a limited number of flights.

6.12 Because airspace changes apply permanently from the point of introduction until they are modified again, costs stack cumulatively each year, and so annual costs grow across the appraisal period (this is also partly due to forecasted rising fuel costs and growth in air traffic movements), reaching an estimated £7.6 million by year 10 under the central scenario, versus a baseline of the current guidance. In reality, the net impact on industry is likely to be much smaller than this, due to the industry benefits outlined in section 5, which are impossible to accurately quantify.

6.13 Whilst outputs for intermediate years are not presented here, the chart below attempts to illustrate the range of potential industry costs across the appraisal period, demonstrating the rising costs and increasing uncertainty as the forecast period advances.

Chart 6.13.1. Estimated range of annual additional industry costs (2017 £ millions, undiscounted)



Key assumptions under each scenario

6.14 The analysis outlined above relies on a number of key modelling assumptions, which are detailed below. Where possible, these are supported by existing evidence from reliable government and commercial sources, but in the case of route length an evidence base was not available. In this instance the assumption relies on the experience of the Department, and discussions with the appropriate technical experts in the CAA, given their role as the decision maker in the ACP, and knowledge of historic airspace change proposals. A conservative approach was taken to estimation in this case, in order to reflect uncertainty.

6.15 As the policy proposal was derived from the consultation, industry were not directly consulted on these assumptions, though the Department held informal discussions with three major airports/ANSPs who were in broad support of the proposals as a whole.

Table 6.15.1. Summary of key modelling assumptions under each scenario

Assumption (affected variable name – see 4.7)	**Assumed value under each scenario**		
	Low	Central	High
Number of additionally affected flights per year (AnnFlights)	100,000 in 2016 +0.2% growth per year (103,000 by year 10)	100,000 in 2016 +0.6% growth per year (108,000 by year 10)	100,000 in 2016 +1.1% growth per year (113,000 by year 10)
Average increased route length (NoiseOptKM - BalancedKM)	+3 km	+4 km	+5 km
Underlying oil price series (component of FuelPrice)	BEIS 'Low'	BEIS 'Central'	BEIS 'High'

6.16 **Total number of affected flights per year** (AnnFlights) – under the European Commission's Single European Sky requirements, the largest UK airports are required to introduce Performance Based Navigation (PBN) technology (essentially computer aided navigation for aircraft) on their routes by 2024[7]. This is expected to comprise the bulk of airspace changes under 7,000 feet to 2027, and so is used as baseline for calculating the number of affected flights per year. Using CAA historic air traffic data for 2016[8], an estimate for the total number of movements which would need to be moved to PBN within the appraisal period was produced. This equates to approximately 100,000 flights per year additionally affected by new airspace changes over the period (this can be compared with a total of approximately 2.2 million air traffic movements in 2016). Two competing factors suggest this may be an over or underestimate of the actual number affected flights, which has led the Department to believe that on balance this approach is a reasonable approximation;

1) Not all major UK airports are required to implement PBN by 2024 (i.e. the 100,000 figure may be an overestimate), though the analysis assumes they would do so voluntarily by 2027, due to the benefits in terms of increased capacity and more reliable track keeping
2) Other airspace changes outside of the introduction of PBN may be misinterpreted (i.e. the 100,000 figure may be an underestimate)

In order to account for potential traffic growth to 2027, a growth factor was then applied to each year (0.2%/0.6%/1.1% per year under low/central/high cases), based on outputs from the low/central/high

[7] The UK Government and CAA have also supported its introduction through the Future Airspace Strategy

[8] Published here (table 03 [1]): http://www.caa.co.uk/Data-and-analysis/UK-aviation-market/Airports/Datasets/UK-Airport-data/Airport-data-2016/

growth scenarios in the latest version of DfT's in-house Aviation Model. More detail on the specific methodology underlying this assumption can be found in section 12.

6.17 **Average increased route length under new guidance** (NoiseOptKM - BalancedKM) – this variable is highly uncertain, as it is dependent on the specific airspace changes proposed over the coming ten years, which it would be infeasible to accurately forecast. The increased route length required to optimise noise is likely to vary greatly between change proposals, reflecting the differing surrounding topology and population distribution at each airport. Similarly, a consistent data source of historic changes that would allow for accurate determination of this variable with certainty does not currently exist, nor is it likely to for some time, as it is not a requirement of the existing ACP.

However, for the purposes of estimation, values of 3 and 4 km have been assumed in the low and central scenarios respectively, based on the experience of the Department and discussions around technical feasibility and historic airspace change cases with relevant technical experts within the CAA. For the high scenario, the guidance offers an upper bound on the potential industry costs through the ability for the CAA to prioritise emissions where the impact would be disproportionately large. This is supported by the CAA's own duties under Section 70 of the Transport Act 2000. Whilst it would be for the CAA to determine exactly what level is 'disproportionate', for the purposes of quantitative estimation only, a 5 km average increase is assumed, which the Department considers a reasonable upper bound.

6.18 **Underlying oil price series** (FuelPrice) – the Department of Business, Energy and Industrial Strategy (BEIS) produces annual long-term price assumptions for crude oil[9]. This, combined with historic jet fuel price data from Bloomberg, was used to construct an approximate projected jet fuel price series for the appraisal period. BEIS produce low and high oil price scenarios, which were adapted for use in the model's own low and high scenarios, in order to reflect the fact that costs borne by airlines are heavily dependent on oil prices, which can vary considerably, even within a single year. Prices were lagged by one year in order to reflect the fact that many airlines hedge their fuel purchases in advance. More information on the oil price methodology can be found in section 12.

7 Wider impacts (noise and carbon)

7.1 As noted in paragraph 2.5, exposure to high levels of aviation noise has been linked to health conditions including heart attacks, strokes, and dementia, as well as being a source of general community annoyance. Concerns around these impacts were reflected in responses to the Department's 2017 Airspace Policy Consultation, where a significant number of local authorities, community groups and individuals expressed concerns about the impact on their health and quality of life where noise has not been prioritised up to 7,000 feet.

7.2 By ensuring that noise factors are prioritised in airspace change decisions with effects up to this altitude, as originally intended, these impacts can be minimised via routings which prioritise avoiding overflying populated areas, and the policy interpretation can therefore be brought into line with the Government's overall policy on aviation noise. The potential noise benefits are highly dependent on the exact population distributions surrounding specific airports undergoing airspace changes, which it would be infeasible to forecast. As such, no attempt to quantify these benefits has been made in this Impact Assessment, though they are expected to be wide ranging, given the large number of airports and routes potentially affected. As a rough indication of scale, the Department's 'WebTAG' appraisal guidance (based on WHO recommended values) suggests the loss of a single disability adjusted day to noise for one person is worth approximately £164[10] - it is clear to see how the potential benefits could stack up, especially over populated areas surrounding airports.

[9] The most recent forecasts used in this analysis are available here: https://www.gov.uk/government/publications/fossil-fuel-price-assumptions-2016

[10] See page 11 (£60,000 for one year, divided by 365)
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/638648/TAG_unit_a3_envir_imp_app_dec_15.pdf

7.3 However, where flight track mileage increases, so does fuel burn, and therefore carbon emissions (though air quality is not affected, as it is only an issue below 1,000 feet). The Department has calculated estimates for the additional CO_2 emissions resulting from the policy clarification using a similar methodology to that used to estimate aircraft fuel consumption. A more detailed explanation of the methodology adopted can be found in section 12.

7.4 As with industry costs, carbon impacts stack cumulatively each year, as each affected airspace change is essentially a permanent additional burden until it is modified again. Carbon impacts were estimated as a range for the low, central and high scenarios, reflecting the uncertainty in number of affected flights and aircraft kilometres flown. As with industry costs, results for intermediate years are not presented in this Impact Assessment, as it is considered infeasible to forecast the exact annual distribution of airspace changes within the forecast period. The following table presents a summary of the results from this analysis;

Table 7.4.1. Summary of key results by scenario (tonnes CO_2, to nearest thousand)

Year	Annual additional carbon emissions estimate		
	Low	Central	High
2018 (year 1)	5,000	7,000	9,000
2027 (year 10)	48,000	66,000	85,000
Annual average (years 1-10)	**27,000**	**37,000**	**47,000**

7.5 As with industry costs, uncertainty increases towards the back end of the forecast period. With an annual average additional carbon impact of 37,000 tonnes per year across the appraisal period (central case), the policy clarification would have a relatively small impact on the UK's carbon budget going forward – UK emissions from aviation are currently around 34 million tonnes per annum. Monetisation was not undertaken – it was considered disproportionate given the relatively small scale of the estimated carbon costs (the annual average being around 0.1% of the 2014 CO_2 emissions from UK aviation).

7.6 The estimated quantity of CO_2 emissions eligible for trading under the European Union Emissions Trading Scheme (EU ETS) is a total of 53,000 tonnes across the ten year period under the central case, versus 276,000 tonnes non-tradable CO_2 (see section 12 for more information).

8 Policy risks and assumptions

8.1 As noted in section 6, there is a wide degree of uncertainty associated with many of the variables underlying the analysis of potential industry costs. This includes assumptions around the number of affected changes, additional track mileage, and jet fuel prices.

8.2 Given the infeasibility of an accurate estimation of the specific number and distribution of airspace, especially as this would require forecasting changes to sponsor behaviour, the Department considers its approach a reasonable approximation of the potential costs and benefits, and has varied key assumptions between high, central and low scenarios in an attempt to provide an accurate reflection of the real and wide ranging uncertainty. The analysis itself relies on a number of underlying datasets (such as the BEIS oil price assumptions and DfT's own Aviation Model), each of which has their own

associated assumptions and uncertainties[11][12], though the Department considers them the best available evidence to base the analysis on.

8.3 The analysis highlights a risk that industry costs would increase, but as explained in paragraph 5.4, the impact is expected to be moderated, or even exceeded by the potential benefits from increased quantity of beneficial airspace change, facilitating the vital modernisation of UK airspace. There is also a risk that the policy could increase carbon emissions, though even under the high case, this is expected to be relatively small compared to the aviation sector's overall carbon contribution, and would not have a significant impact on the UK's carbon budget going forward.

8.4 As such, whilst uncertainty remains, the Department believes that the quantitative and qualitative analysis in this Impact Assessment provides a reasonable estimate of potential costs and benefits, reflecting uncertainty, but providing an assessment of scale sufficient to allow factors to be weighed against each other.

9 Summary of expected impacts and policy justification

9.1 Expected impacts to both industry and wider society can be summarised as follows;

1) Potential costs:
   - → **Airlines – fuel costs:** an average increase in track mileage for aircraft flying newly changed routes is expected, leading to increased fuel costs for airlines, with an annual average of £4.6 million additionality versus current system estimated for the ten year appraisal period (central case), though a wide degree of uncertainty is associated with this estimate - low and high estimates are £2.2 million and £7.9 million respectively.
   - → **Environment – carbon:** expected increase in fuel burn would lead to an increase in carbon emissions, with an annual average of 37,000 tonnes estimated across years 1 to 10. The actual impact is largely dependent on outturn increased track length and quantity of airspace changes, and therefore is subject to a wide degree of uncertainty. 37,000 tonnes is small compared to the aviation sector's overall carbon contribution of around 34 million tonnes (2014), and would have little impact on the UK's carbon budget.
2) Potential benefits:
   - → **Environment (and local communities) – noise:** new routes designed to prioritise noise factors mean populated areas are avoided where safe and technically feasible, ensuring noise impacts are minimised in line with the Government's overall policy on aviation noise, leading to a reduction in expected health and quality of life disbenefits.
   - → **Airlines and airports – successful airspace changes:** the clarification is designed to ensure sponsors can show that they have prioritised noise factors as far as possible – should this lead to a reduction in community opposition then the likelihood of vital airspace changes going ahead would increase significantly. Even if the final option proposed is sub-optimal in efficiency terms (due to noise optimisation), the airspace change is still likely to be net positive in terms of benefits to industry, especially versus a counterfactual where the change may not go ahead (under current guidance).

9.2 The results presented in this Impact Assessment are dependent on a wide variety of factors, including the number of changes affected by the clarification, the quantity of flights operating on these routes, the degree of re-routing required, and the efficiency of aircraft assumed.

[11] BEIS assumptions can be found here: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/576542/BEIS_2016_Fossil_Fuel_Price_Assumptions.pdf

[12] Methodological notes for the 2013 version of the DfT Aviation Forecasts are accessible here: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223839/aviation-forecasts.pdf

9.3 As explained in paragraph 5.4, whilst highly uncertain due to the range of underlying variables involved costs to airlines in terms of increased fuel burn are expected to be more than offset by the potential benefits to industry resulting from the facilitation of greater airspace changes, and even in cases where the nature of the route is affected, the impacts are still expected to be net positive. In addition, any costs borne by industry would be spread across a large number of airlines and business aviation providers, and the costs borne by each individual company are therefore much smaller.

9.4 There is a risk that the policy could increase carbon emissions, though this impact would be relatively small compared to the aviation sector's overall carbon contribution. On the other hand, given the large number of airports and routes expected to be affected, the potential benefits for populations across the country in terms of reduced health and quality of life disbenefits from noise exposure are expected to be wide ranging.

9.5 As such, whilst the benefits are not quantifiable, the Department is confident that the proposed policy clarification, bringing the interpretation of the existing ANG in line with the Government's overall policy on aviation noise, and reflecting feedback from the consultation, has significant potential net benefits that support the clarification. DfT is therefore recommending that this guidance clarification be adopted as part of the wider programme of Airspace Policy Framework revisions.

10 Small and Micro Business Assessment (SaMBA)

10.1 This policy is not expected to significantly impact small or micro businesses – the vast majority of estimated costs would be borne by large commercial airlines, as costs increase in line with the number of aircraft kilometres flown (fuel purchases are the primary cost expected to be affected by the policy clarification).

10.2 Even for aircraft not operated by commercial airlines (e.g. private business jets), small and micro businesses are unlikely to be directly affected – these types of aircraft are typically owned by large corporations or their subsidiaries, which can be assumed to have more than 50 employees.

10.3 The policy is unlikely to affect other aircraft – small, privately owned aircraft (non-commercial or business aviation) do not normally operate within controlled airspace, which is what this policy affects. In addition, the Department does not have access to a consistent data source that would allow assessment of any impact on these parties, which is likely to be very small.

11 Equality

11.1 Communities affected by aircraft are expected to benefit from this policy equally. The Department believes there are no race, gender or disability equality impacts.

12 Annex: detailed methodological notes

Affected flights methodology (AnnFlights**)**

12.1 Reflecting the requirement for the largest UK airports to introduce PBN technology on their routes by 2024, the model uses this as a baseline for estimating the number of flights affected by airspace changes using the new guidance under the 10 year appraisal period. This is because the introduction of PBN would require the design of new routes. Airspace changes related to PBN are expected to comprise the bulk of all proposals within the ten year appraisal period. Given the complicated nature of UK airspace, the Department considered it infeasible to forecast future proposals outside of those introducing PBN, so no attempt to do so is made under the methodology used to estimate the annual number of affected flights.

12.2 Historic data from the CAA was sourced for 2016, which was summed (excluding Gatwick and Newcastle which have already introduced PBN, and the smaller airports outside of the CAA's ACP) to estimate the total number of air transport movements (ATMs) eligible for transfer to PBN. This produced an estimate of approximately 1,000,000 ATMs. This is a conservative assumption as it is not currently clear to what extent airports without SIDs will be required to implement PBN, but using the higher figure moderates the fact that airspace changes outside the transition to PBN are not estimated as part of this methodology. The Department therefore considers this a reasonable approximation.

12.3 As a simplifying assumption, it was assumed the transfer will be spread evenly over the 10 year appraisal period to 2027 (implicitly assuming there is some slippage versus the 2024 target), meaning approximately 100,000 flights per year additionally affected by airspace changes under the new guidance.

12.4 From this, a growth factor of 0.2%/0.6%/1.1% per year was applied under the low, central and high scenarios respectively, in order to account for anticipated growth in air traffic movements to 2027. These growth rates are derived from the latest version of the Department's in-house Aviation Model, using the difference in ATMs between 2016 and 2027 and interpolating between the two. The different growth rates reflect uncertainty in future growth of UK air traffic across the appraisal period. By 2027, this means that the estimated number of annual additionally affected flights grows to approximately 103,000, 109,000 and 115,000 under the low, central and high scenarios respectively.

12.5 Once the estimate for total affected flights per year has been calculated, this is then multiplied by the estimated average increase in route length (in km), and then by the fuel price (per km) to produce the cost estimate for each scenario.

Fuel price methodology (FuelPrice)

12.6 The assumed fuel price is an important component in estimating the potential costs to industry. Kerosene type jet fuel prices were used as this accounts for the majority of aviation fuel consumed in the UK. Historic north-west Europe price data from Bloomberg was selected as the most accurate reflection of UK wholesale prices[13]. An average of the 2016 price was chosen, to remove the effects of day-to-day fluctuations, and account for the fact that many airlines hedge their fuel purchases in advance.

12.7 Jet fuel is a derivative output from the crude oil refining process. BEIS publish long-term crude oil price assumptions annually[9]. Whilst these are long-term assumptions, DfT considers them a reasonable estimate of the direction of travel over the coming ten years, and they were therefore applied directly to the 2016 average jet fuel price data, to produce an approximate projection of jet fuel prices over the appraisal period.

12.8 BEIS assumptions are priced in $ per barrel of crude oil ($/bbl), and so in line with the price data were converted to sterling using an average of the 2016 exchange rate, sourced from the Bank of England (this implicitly assumes exchange rates remain constant over the appraisal period).

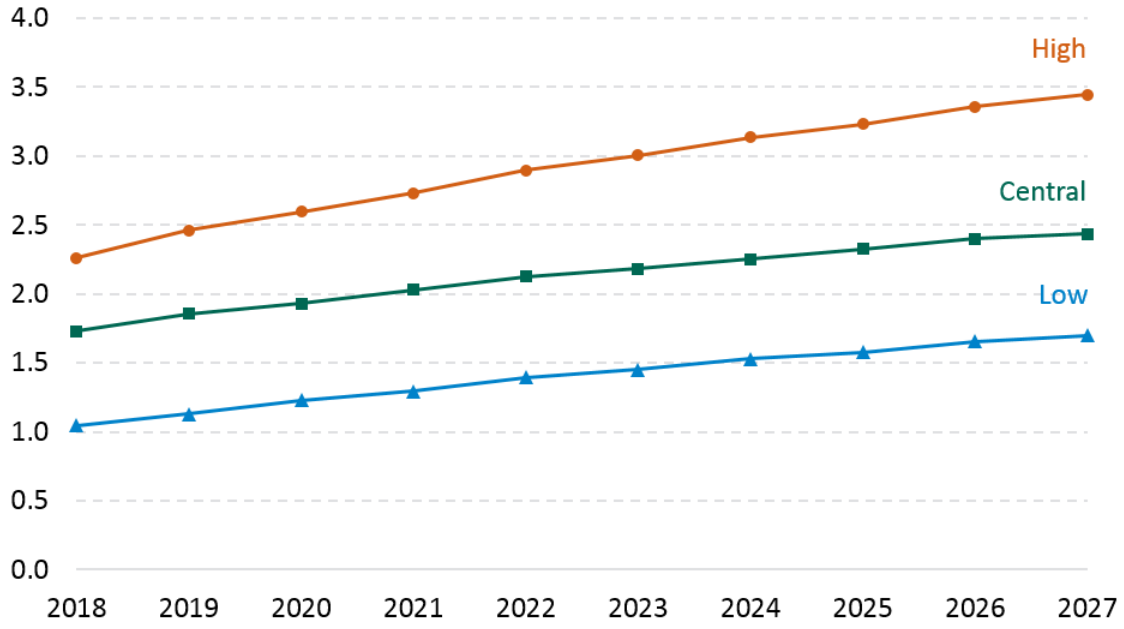
12.9 It has been assumed that the exact per barrel change in annual price feeds through to jet fuel prices on a one-to-one basis – whilst jet fuel is more expensive than crude oil, the differential between the two generally remains relatively constant over time. It should be noted, however, that oil prices are inherently volatile, and forecasts are often subject to frequent revisions. In order to reflect this, and the potential for rising future jet fuel demand, the BEIS high and low assumed future oil price scenarios was incorporated into the analysis within its own high and low scenarios.

12.10 The constructed jet fuel price projections were then converted from '£ per tonne' units to a '£ per km' basis for the purpose of applying them to route length estimates. This was achieved using outputs from the latest version of DfT's in-house Aviation Model. The model forecasts UK aviation CO_2

[13] As commercial data, raw prices have been withheld from this publication, though data was used in this analysis with permission of Bloomberg.

emissions to 2050. These were converted to fuel consumption using the model's CO_2 to fuel conversion factor, and then fuel consumption per km for the ten year appraisal period was produced by dividing this figure by total aircraft km travelled, also an output from the model. Outputs were then converted to 2017 prices using the latest available GDP deflator series, produced by HM Treasury[14].

Chart 12.10.1. Assumed jet fuel price time series under each scenario (2017 £/km)



12.11 The wide range between low and high scenarios in the final price series above reflects the fact that oil prices can vary significantly, even within a single year.

12.12 For the purposes of estimation, it is assumed that the additional fuel burn from increased track mileage is consumed at cruising altitude – this must be the case if it is assumed that time spent climbing and descending remains the same regardless of route option.

Carbon impacts methodology

12.13 As with fuel consumption, the impact on CO_2 emissions was estimated using outputs from the latest version of DfT's own in-house Aviation Model. The model produces estimates for total UK CO_2 emissions for domestic and international aviation in each year. This was then divided by the forecasted number of flight km to produce an estimate for CO_2 emissions per km in each year to 2027. Across the appraisal period, the emissions per kilometre decreases slightly, reflecting the introduction of newer, more fuel efficient aircraft across the fleet.

12.14 This series was then multiplied by the total estimated additional flight kilometres (i.e. [NoiseOptKM – BalancedKM]*AnnFlights) to produce an estimate for additional carbon emissions in tonnes per year. Finally, because the total additional carbon emitted is cumulative (airspace changes are assumed permanent), each year's additional carbon is stacked on top of the total to the previous year. This means that by 2027, the additional CO_2 emissions that year is equal to the sum of every previous year (66,000 tonnes under the central case).

12.15 As with fuel burn calculations, it was assumed that the additional time spent in the air would be spent at cruising altitude. In order to calculate an approximation of the proportion of additional CO_2 emissions which would be tradeable under the EU ETS (domestic and intra-EU flights for aviation), a rate of 16% was applied to the totals, calculated based on outputs from the latest version of the Department's Aviation Model. This produced an estimate of 53,000 tonnes of tradable CO_2 and

[14] Analysis used the June 2017 series, available at: https://www.gov.uk/government/collections/gdp-deflators-at-market-prices-and-money-gdp

276,000 tonnes of non-tradable under the central case. Non CO_2 emissions (such as sulphur) were not calculated as these make up an insignificant proportion of aviation emissions (less than 1%).

12.16 Monetisation was not undertaken as it was considered disproportionate given the relatively small scale of the estimated carbon costs (the annual average being around 0.1% of the 2014 CO_2 emissions from UK aviation).