Technical note:
Comparison of the effects on air quality of ESA and Jacobs aircraft forecasts

1. Introduction

1.1.1 Bristol Airport Limited (BAL) has submitted a planning application to increase its maximum passenger throughput from 10 million passengers per annum (mppa) to 12 mppa (the Appeal Proposal). As part of its planning application, it presented an assessment of the air quality impacts of the proposed development in an Environmental Statement (ES) and then, in updated form, in an ES Addendum (ESA).

1.1.2 North Somerset Council (NSC) refused the application, and BAL is now appealing against that decision. As part of the appeal process, NSC's advisors Jacobs have developed an alternative forecast of the aircraft fleet mix for the 12 mppa 2030 scenario. This is referred to in this document as the Jacobs fleet, in contrast to the ESA fleet used in the ESA modelling. For avoidance of doubt the ESA forecast used here is that of the core case, not the faster or slower growth scenarios.

1.1.3 The purpose of this technical note is to present a comparison of the two fleet forecasts with regard to the likely effects on air quality.

1.1.4 The two pollutants of principal concern in the appeal are nitrogen dioxide (NO_2) and particulate matter smaller than 2.5 µm in diameter ($PM_{2.5}$). For reasons explained in the ES, concentrations of NO_2 are calculated from concentrations of oxides of nitrogen (NO_x), and emissions are presented in terms of NO_x.

1.1.5 The methodology used in this comparison follows that presented in the ESA. Aircraft engine emission factors are taken from version 27 of the ICAO Emissions Databank, the same as in the ESA. More recent versions of the databank contain additional information on non-volatile PM emissions which can be used to produce improved estimates of PM emissions, but the methodology has not been changed from the ESA, in order to focus on the differences in the fleet. Other sources, such as road vehicles and background sources, are unchanged.

1.1.6 Jacobs have only provided a fleet forecast for the 2030 12 mppa scenario. Consequently no comparison has been made against the 10 mppa scenario, since that cannot be done on a like-for-like basis. An assessment of the impacts of a proposed development would compare the 'do something' scenario (i.e. 12 mppa) against the 'do minimum' scenario (i.e. 10 mppa), but that is not the purpose of this assessment, which is to compare the fleet forecasts. Inclusion of a 10 mppa scenario might be desirable to allow further comparisons, but is not necessary.

2. Comparison of fleet mixes

2.1.1 A summary of the differences in the two fleets is given in Table 2.1. This table includes commercial movements only; positioning movements and general aviation movements, which make up a small fraction of aircraft emissions, have been included on the same basis as in the ESA.

Table 2.1 Annual movements by aircraft type for the two fleets

Aircraft type	ESA	Jacobs	Difference
Airbus A320	6,540	2,765	-3,775
Airbus A320neo	20,200	23,985	3,785
Airbus A321neo	15,600	9,664	-5,936
Airbus A321neo XLR	120	0	-120
ATR 72-500	3,850	2,554	-1,296
ATR 72-600	4,510	2,554	-1,956
Boeing 737 MAX 10	2,050	2,050	0
Boeing 737 MAX 8	14,360	11,421	-2,939
Boeing 737-700	750	0	-750
Boeing 737-800	2,380	14,582	12,202
Boeing 787-8	510	879	369
Boeing 787-9	0	586	586
Embraer 190	2,240	878	-1,362
Embraer 195-E2	2,240	2,343	103
Embraer RJ145	0	1,089	1,089
Total	**75350**	**75350**	**0**

2.1.2 Key points of difference are:

- The Jacobs fleet shifts movements from A320 to A320NEO. Since these two aircraft types have similar NO_x emission factors, this does not make an appreciable difference for NO_x emissions, but tends to slightly decrease PM engine emissions relative to the ESA fleet.
- The Jacobs fleet has 3422 fewer movements in the Regional Jet class (ATR 72, Embraer 190, Embraer 195-E2, Embraer RJ145). These aircraft, being smaller than the others, have lower emissions per movement, so this will tend to increase air pollutant emissions from the Jacobs fleet relative to the ESA fleet.
- The Jacobs fleet has 955 more movements of Boeing 787-8 and 787-9. These aircraft, especially the 787-9, being larger than the others, have higher emissions per movement, so this will tend to increase air pollutant emissions from the Jacobs fleet (including PM emissions from brake wear and tyre wear) relative to the ESA fleet.
- The Jacobs fleet has substantially fewer movements of Airbus A321NEO and Boeing 737 MAX 8. These two aircraft types have quite high NO_x emissions, as discussed below, so this will tend to reduce modelled NO_x emissions from the Jacobs fleet relative to the ESA fleet. For PM, these aircraft have moderate emission factors so the difference will not greatly affect modelled emissions of PM.

- The Jacobs fleet has substantially more B787-800W movements. This aircraft type has moderate NO_x emission factors, as discussed below. It has relatively high PM emission factors, so this will tend to increase PM emissions from the Jacobs fleet relative to the ESA fleet.

2.1.3 The Airbus A321NEO and Boeing 737 MAX 8 are assumed to be fitted with CFM International LEAP-1A and LEAP-1B engines. This is a worst-case assumption, since these have somewhat higher NO_x emissions than the Pratt & Whitney PW1100G engines which are an alternative for the A321NEO. In particular, they have relatively high NO_x emissions at the 100% thrust setting. As explained in the ES (Appendix 8D, paragraphs 8.1.39–8.1.40), the worst-case assumption has been made that all aircraft take off at 100% thrust, but in fact it is normal to take off at around 85% thrust, for which the LEAP NO_x emission factors are much lower and more in line with other comparable engines.

2.1.4 The overall effect is that the Jacobs fleet results in slightly lower total NO_x emissions than the ESA fleet, by around 4% for ground-level NO_x emissions. The Jacobs fleet results in slightly higher PM emissions than the ESA fleet, by around 4% for ground-level $PM_{2.5}$ emissions.

3. Comparison of NO_2 concentrations

3.1.1 The Jacobs fleet results in slightly lower NO_x emissions than the ESA fleet, and this results in slightly lower concentrations of NO_2. The percentage change in total NO_2 concentrations is smaller than the percentage change in aircraft NO_x emissions, for two reasons: aircraft emissions are not the only contributor to total concentrations; and the non-linear relationship between NO_x and NO_2 means that in general, a given percentage increase in NO_x concentrations will result in a smaller percentage increase in NO_2 concentrations.

3.1.2 Overall, the Jacobs fleet results in annual mean NO_2 concentrations that are lower by between 0 $\mu g\ m^{-3}$ and 0.4 $\mu g\ m^{-3}$ than the ESA, with an average of about 0.2 $\mu g\ m^{-3}$ at the receptors modelled. This may be compared with the Air Quality Objective of 40 $\mu g\ m^{-3}$ and a maximum predicted concentration of about 30 $\mu g\ m^{-3}$ (at the old school building).

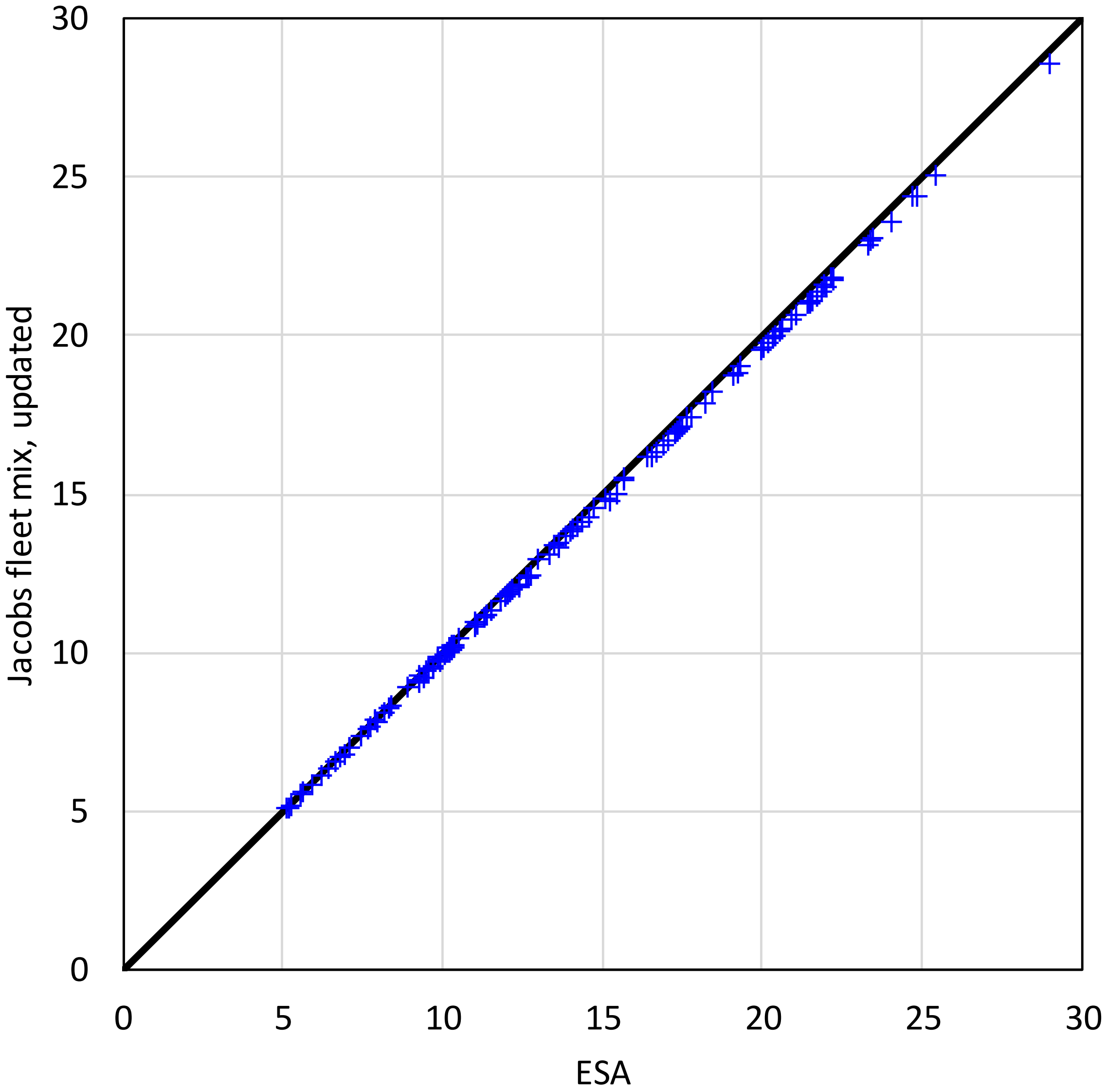
3.1.3 A graphical representation of the difference between the two forecasts is given in Figure 3.1. In this figure, each cross represents a receptor; the x axis represents the modelled NO_2 concentration in the ESA, and the y axis represents the modelled NO_2 concentration using the Jacobs fleet. It can be interpreted as follows:

- Where a cross lies on the 45° line, there is no difference between the two fleets;
- Where a cross lies below-right of the 45° line, the Jacobs fleet results in lower concentrations than the ESA; and
- Where a cross lies above-left of the 45° line, the Jacobs fleet results in higher concentrations than the ESA.

3.1.4 It can be seen that all receptor points lie very close to the 45° line, but slightly below, indicating that the Jacobs fleet results in annual mean NO_2 concentrations that are very similar to, but slightly lower than, the ESA.

3.1.5 It is concluded that the NO_2 concentrations would not be substantially different from those modelled in the ESA if the Jacobs fleet were to be used.

Figure 3.1 Comparison of annual mean NO_2 concentrations for the two fleets



4. Comparison of $PM_{2.5}$ concentrations

4.1.1 The Jacobs fleet results in slightly higher $PM_{2.5}$ emissions than the ESA fleet, and this is reflected in slightly higher concentrations of $PM_{2.5}$. The percentage change in total $PM_{2.5}$ concentrations is much smaller than the percentage change in aircraft emissions, because aircraft emissions are only a small contributor to total concentrations.

4.1.2 Overall, the Jacobs fleet results in annual mean $PM_{2.5}$ concentrations that are higher by between 0 µg m^{-3} and 0.02 µg m^{-3} than the ESA, with an average of about 0.01 µg m^{-3} at the receptors modelled. This may be compared with the Air Quality Objective of 25 µg m^{-3}, the World Health Organization guideline of 10 µg m^{-3}, and a maximum predicted concentration of about 10 µg m^{-3} (at the old school building).

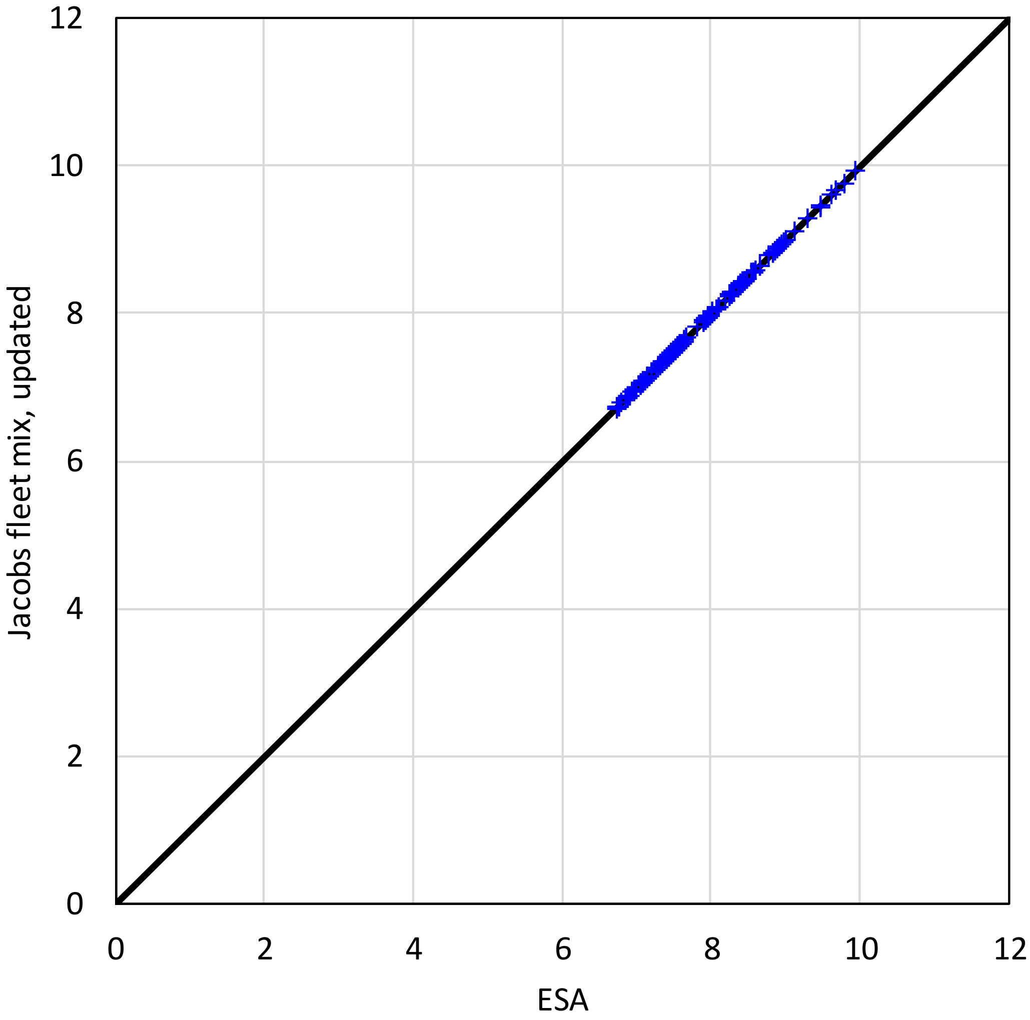
4.1.3 A graphical representation of the difference between the two forecasts is given in Figure 4.1. In this figure, each cross represents a receptor; the x axis represents the modelled $PM_{2.5}$ concentration in the ESA, and the y axis represents the modelled $PM_{2.5}$ concentration using the Jacobs fleet. It can be interpreted as follows:

- Where a cross lies on the 45° line, there is no difference between the two fleets;
- Where a cross lies below-right of the 45° line, the Jacobs fleet results in lower concentrations than the ESA; and
- Where a cross lies above-left of the 45° line, the Jacobs fleet results in higher concentrations than the ESA.

4.1.4 It can be seen that all receptor points lie very close to the 45° line, but very slightly above, indicating that the Jacobs fleet results in annual mean $PM_{2.5}$ concentrations that are very similar to, but fractionally higher than, the ESA.

4.1.5 It is concluded that the $PM_{2.5}$ concentrations would not be appreciably different from those modelled in the ESA if the Jacobs fleet were to be used.

Figure 4.1 Comparison of annual mean $PM_{2.5}$ concentrations for the two fleets



5. Summary and conclusions

5.1.1 This technical note presents a comparison of the air quality near Bristol Airport in 2030 at 12 mppa, for two different fleet mixes: the one used in the ESA, and the one prepared by Jacobs on behalf of NSC.

5.1.2 The modelling shows that modelled annual mean NO_2 concentrations around Bristol Airport would not be substantially different from those in the ESA if the Jacobs fleet were to be used, with very similar concentrations in either case. The Jacobs fleet results in slightly lower NO_2 concentrations than the ESA.

5.1.3 Further, the modelling shows that modelled annual mean $PM_{2.5}$ concentrations around Bristol Airport would not be appreciably different from those in the ESA if the Jacobs fleet were to be used, with virtually identical concentrations in either case. The Jacobs fleet results in fractionally higher $PM_{2.5}$ concentrations than the ESA.

5.1.4 It is therefore concluded that the ESA provides a robust assessment of the air quality impacts of the Appeal Proposal. The use of the Jacobs fleet forecast would not materially affect the conclusions of the air quality assessment presented in the ESA.

Issued by	**Approved by**
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