Environmental Research and Consultancy Department

Noise data for the first three years of Airbus A350 operations at Heathrow Airport

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Summary

This report presents summary information on monitored departure and arrival noise levels for the first three years of operation of the Airbus A350 at Heathrow. Noise measurements for the A350 are compared to equivalent measurements for other aircraft types of similar size whose operations are likely to be replaced by the A350 in the coming years.

At the monitor locations around Heathrow, the analysis has shown that the Airbus A350 is significantly quieter than the Airbus A330, Airbus A340 and Boeing 777. The A350 is on average up to 6 dB quieter on departure than the A330 and 777, and up to 9 dB quieter than the A340. The results also confirm that the A350 is up to 3 dB quieter on arrival than the aircraft types it is intended to replace.

Chapter 1

Introduction

The Airbus A350 is a long-range, wide-bodied, twin-engine aircraft which entered worldwide commercial airline service with Qatar Airways on 15 January 2015. Finnair became the first European operator of the all-new aircraft on 7 October 2015 and shortly after, on 16 October, became the first commercial A350 operator to fly into Heathrow. Over the following three years several other airlines also introduced the aircraft into regular service at Heathrow.

The A350-900 was the first variant of the A350 to be produced and is intended to replace existing 250-300 seat aircraft such as the twin-engine Airbus A330 and the four-engine Airbus A340, although some airlines have introduced the A350-900 on routes previously flown by larger aircraft such as the Boeing 747-400, Boeing 777-300ER and Airbus A380.

Qatar Airways also became the first airline worldwide to operate the stretched (and slightly heavier) A350-1000 variant, with the first flight landing at Heathrow on 24 February 2018. Virgin Atlantic will be the first European operator of the A350-1000 in early 2019 and British Airways is also expected to receive its first A350-1000 delivery later in the year.

As a result of improved aerodynamics, new generation engines and the use of lightweight materials, the A350 has been designed to be 25 percent more fuel efficient and significantly quieter than previous generation competitor aircraft.

The A350-900 meets the London airports' QC/0.5 night noise classification on departure, with the larger A350-1000 variant meeting QC/1 on departure, compared to QC/2 (typically) for the older A330 and A340 aircraft. On arrival, both A350 variants meet QC/0.5, compared to QC/0.5 or QC/1 for the A330 and A340 depending on the particular variant.

This report presents information and analysis on monitored noise levels for the Airbus A350 and compares them to the noise levels for other aircraft types of similar size operating at Heathrow Airport. An analysis of flight tracks and height profiles is also provided. However, a review of possible differences in measured noise level between each A350 operator was outside the scope of the study.

Chapter 2

Data collection

For this study, noise measurements and radar data were extracted from the Heathrow Noise and Track Keeping (NTK) system for the three-year period October 2015 to September 2018. Noise data were taken from suitably positioned permanent (fixed) and mobile noise monitors that were deployed during the study period.

In addition to the Airbus A350, data have also been extracted and analysed for variants of the Airbus A330 and A340, as well as for the Boeing 777-200 (which is similar in size to the A350 variants), as summarised below:

Aircraft type	Entry into service	Maximum take-off / landing weight[1] (tonnes)	Typical seating (three-class configuration[2])
Airbus A350-900	2015	280 / 207	325
Airbus A350-1000	2018	316 / 236	366
Airbus A330-200	1998	242 / 187	247
Airbus A330-300	1994	242 / 187	277
Airbus A340-300	1993	277 / 192	277
Boeing 777-200	1995	298 / 213	312

Figures 1 and 2 show the locations of noise monitors deployed during the study period that were used to measure departure noise and arrival noise respectively. Further details of the noise monitoring locations, including the particular periods of deployment, are provided in Appendix B.

Note that some of Heathrow’s permanent and mobile noise monitors are not shown in Figures 1 and 2, as they have been excluded from this assessment because they are considerably to the side of the flight paths used by the A350. This is to enable a more robust comparison to be made between the A350 monitored data and other aircraft types.

Approximately 13 percent of the noise measurements were rejected due to unacceptable weather conditions, i.e. wind speeds greater than 10 m/s (20 knots) or during periods of precipitation, in accordance with recommended international guidance[3] on aircraft noise monitoring.

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[1] Data taken from European Aviation Safety Agency (EASA) Type Certificate Data Sheet for Noise database (TCDSN)

[2] Based on data from Airbus (www.airbus.com) and Boeing (www.boeing.com)

[3] ISO 20906:2009, Acoustics - Unattended monitoring of aircraft sound in the vicinity of airports

Figure 1 Departure noise monitor locations

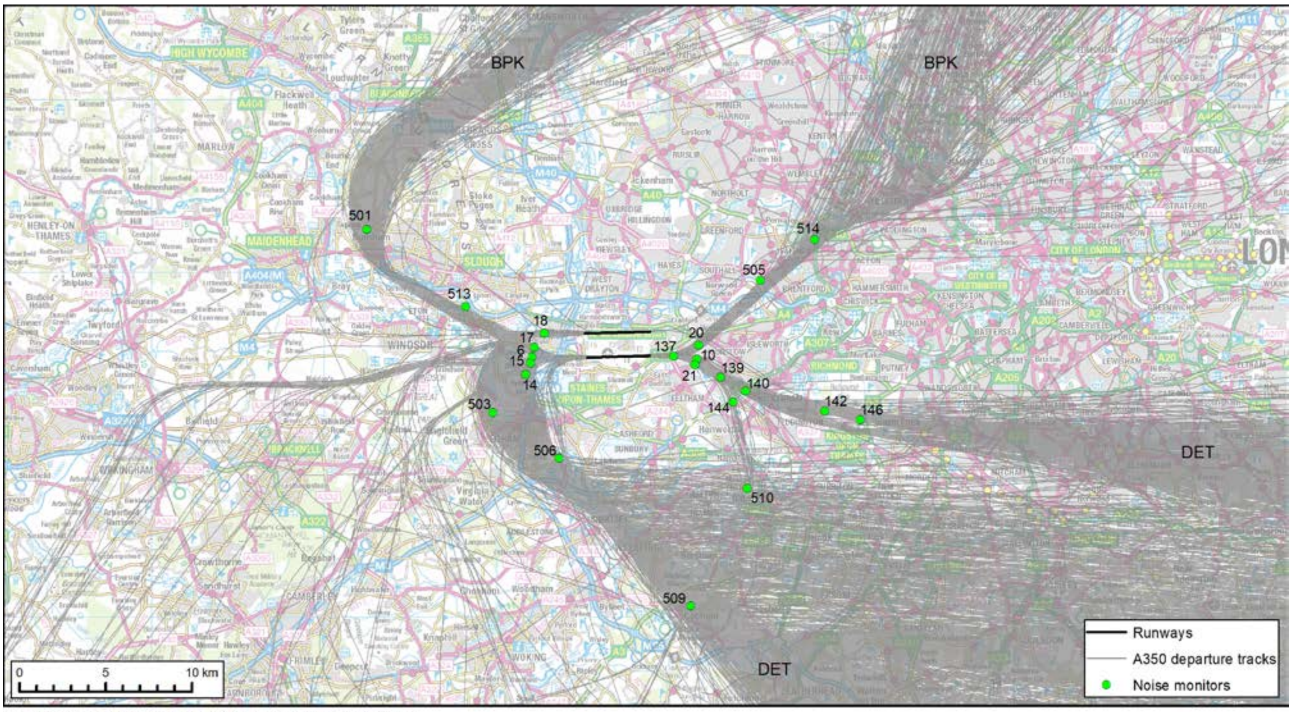

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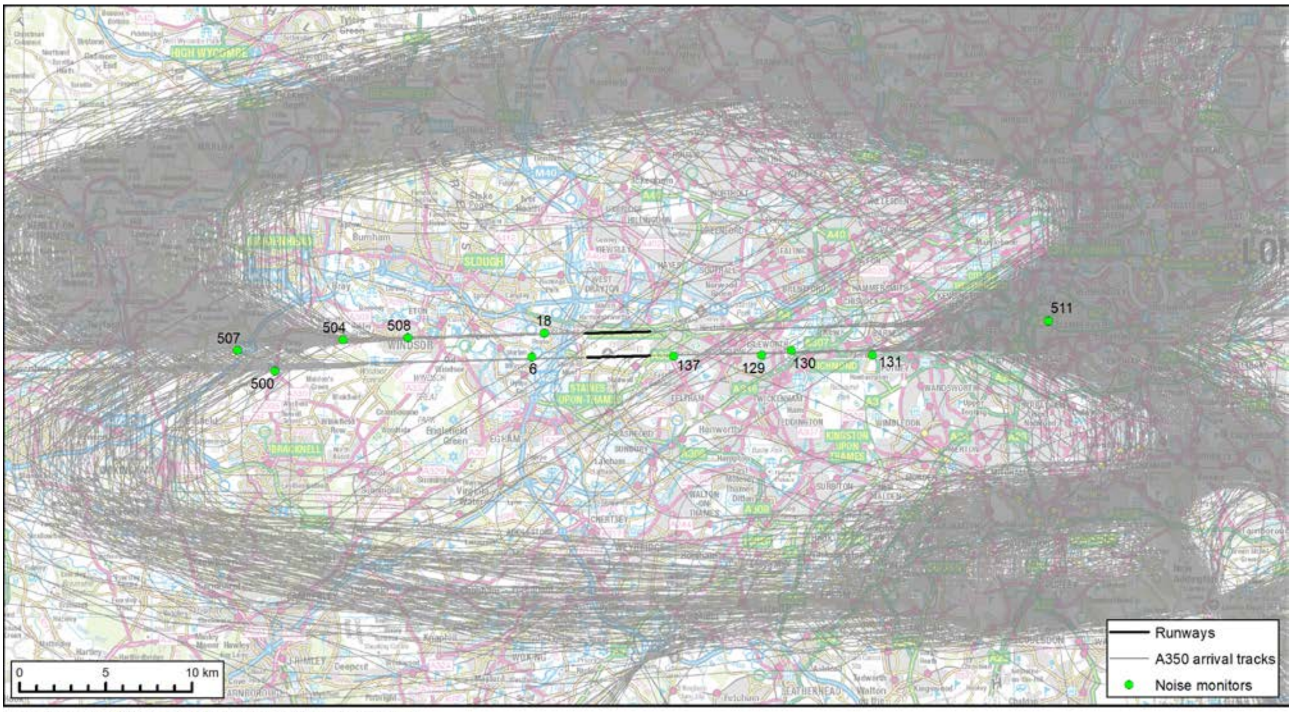
Figure 2 Arrival noise monitor locations



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Figures 1 and 2 also show the A350 flights tracks for the study period, October 2015 to September 2018. In Figure 1, the significant majority of A350 departures can be seen using one of two Standard Instrument Departure (SID) routes and the associated Noise Preferential Routes (NPRs). The SID used on departure is largely dictated by the destination, with A350 departures to Africa, the Middle East and some Asian destinations tending to use Detling (DET), and departures to Northern Europe and other Asian destinations tending to use Brookmans Park (BPK).

In Figure 2, the percentage of arrivals joining the extended runway centrelines from the north and the south (which is generally determined by the route flown from the airport of origin) is approximately 85 percent and 15 percent respectively.

Chapter 3

Departure noise monitor data

The average departure noise levels for the Airbus A350, A330, A340 and Boeing 777 aircraft types described in Chapter 2 have been calculated at each noise monitor. Data for the A330 and 777 variants have also been separated by engine type for the two most common engine models operating at Heathrow, although this was not necessarily in anticipation of any significant noise differences.

Results are reported in terms of the Sound Exposure Level (SEL) metric, which accounts for the duration of the noise event as well as its intensity. A full set of tabular results are provided in Appendix C for information, alongside the corresponding results for the L_{Amax} metric. The average distance from start-of-roll (SOR) to each noise monitor has been calculated using radar data extracted from the NTK system.

Figure 3 plots the Airbus A350-900 and A350-1000 departure noise measurements against data for the two most common A330-200 variants at Heathrow. Figures 4, 5 and 6 plot the same A350 departure data against similar measurements for the Airbus A330-300, A340-300 and 777-200 respectively. In each diagram, the 95 percent confidence intervals of the mean levels are shown as vertical error bars[4].

The results indicate that the A350-900, despite having a higher maximum take-off weight than the A330-200 and A330-300, is on average up to 6 dB quieter on departure, although there is some variation by engine type and from monitor to monitor. The results also indicate that the A350-900 is on average up to 9 dB quieter than the A340-300 and up to 6 dB quieter than the 777-200 across all noise monitors on departure.

As stated previously, the stretched A350-1000 variant is slightly heavier than the A350-900 (316 tonnes vs. 280 tonnes). The noise results indicate that the A350-1000 is, on average, 1 dB noisier than the A350-900 across all noise monitors. This is as expected, since the heavier variant has a higher QC classification on departure (QC/1 vs QC/0.5). However, it should be noted that the A350-900 is operated by a number of different airlines, whereas A350-1000 operations at Heathrow are currently limited to one airline - see Chapter 5.

Noting also that the A350-900 on departure is classified as QC/0.5 compared to QC/2 (typically) for the A330, A340 and Boeing 777, and that the midpoints of successive QC bands are 3 dB apart, the measured differences are in general agreement with the differences in QC classification[5].

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[4] Results with 95 percent confidence intervals greater than ±1 dB are not shown in the figures.

[5] It was not the objective of this study to confirm the QC classification of the Airbus A350, which would have required analysis of EPNL (Effective Perceived Noise Level) measurements.

Figure 3 Comparison of A350 and A330-200 departure SEL noise measurements

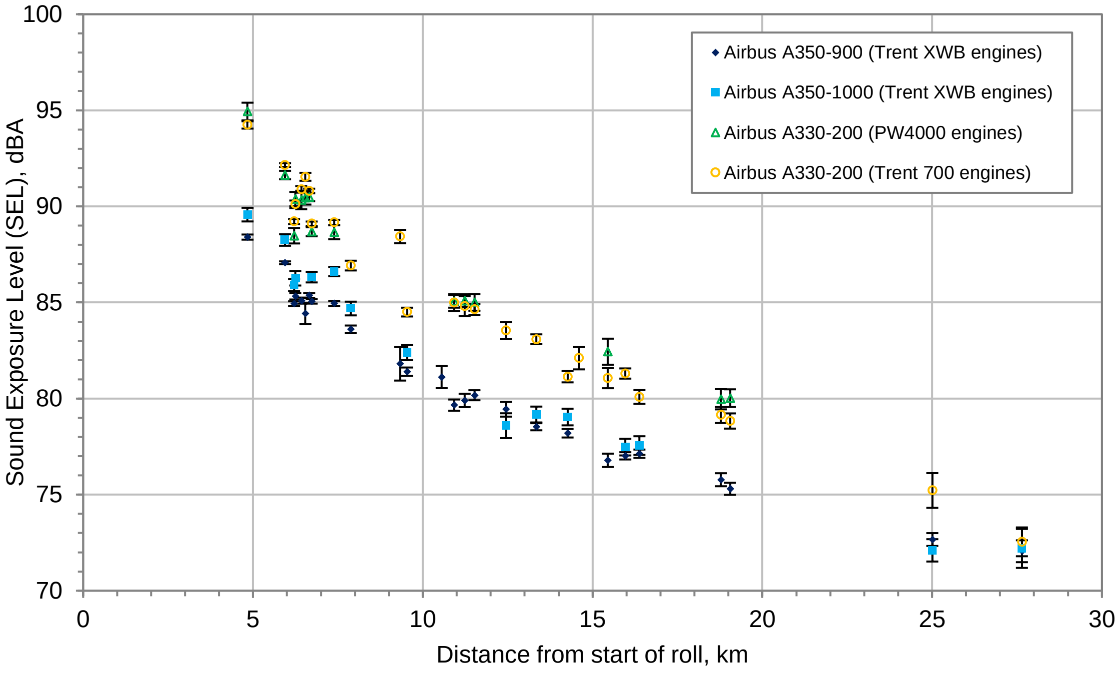


Figure 4 Comparison of A350 and A330-300 departure SEL noise measurements

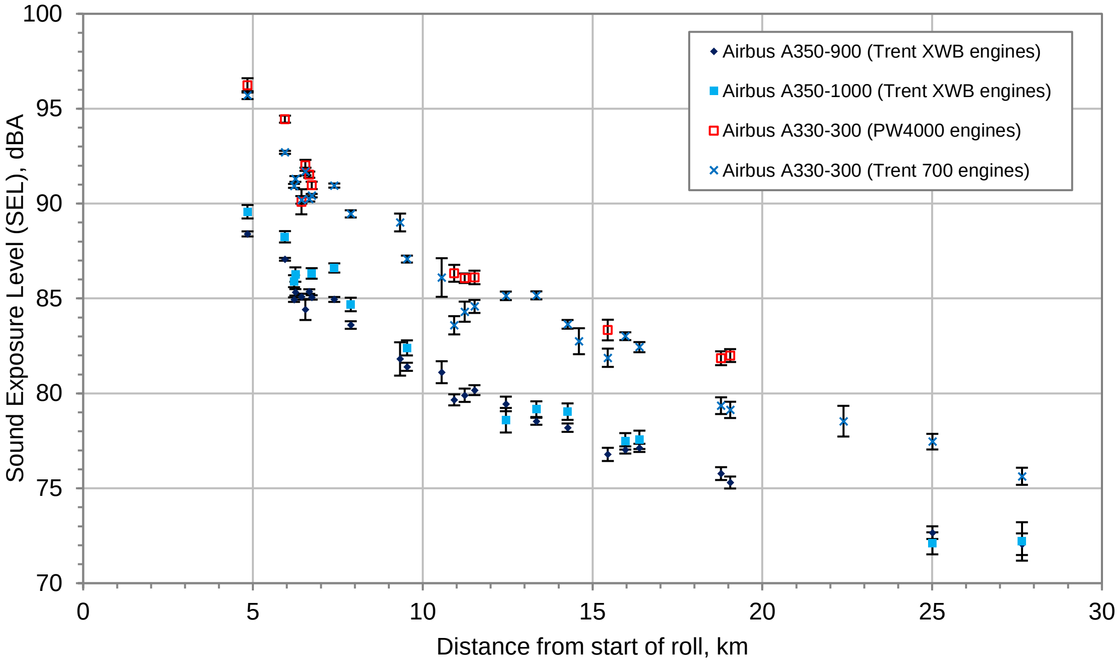


Figure 5 Comparison of A350 and A340-300 departure SEL noise measurements

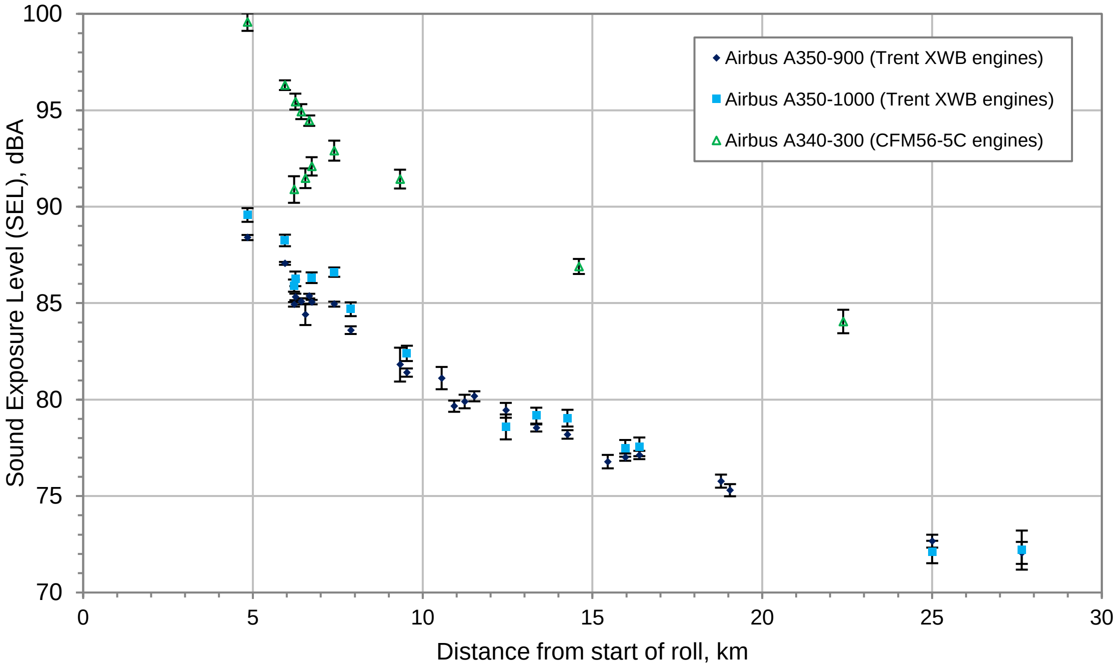
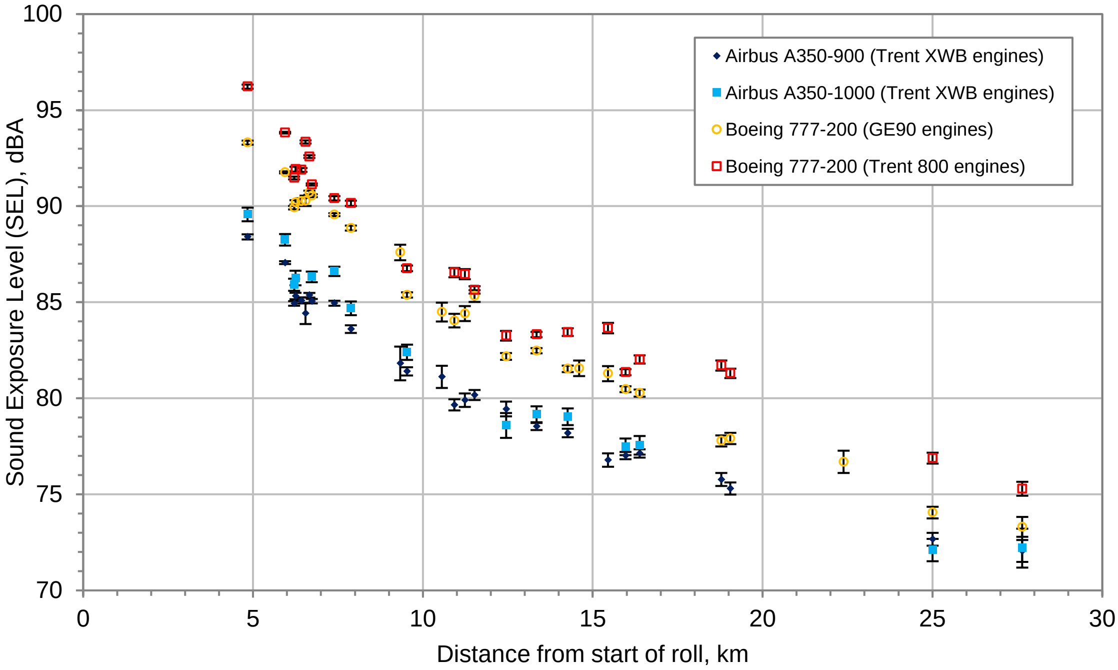


Figure 6 Comparison of A350 and 777-200 departure SEL noise measurements

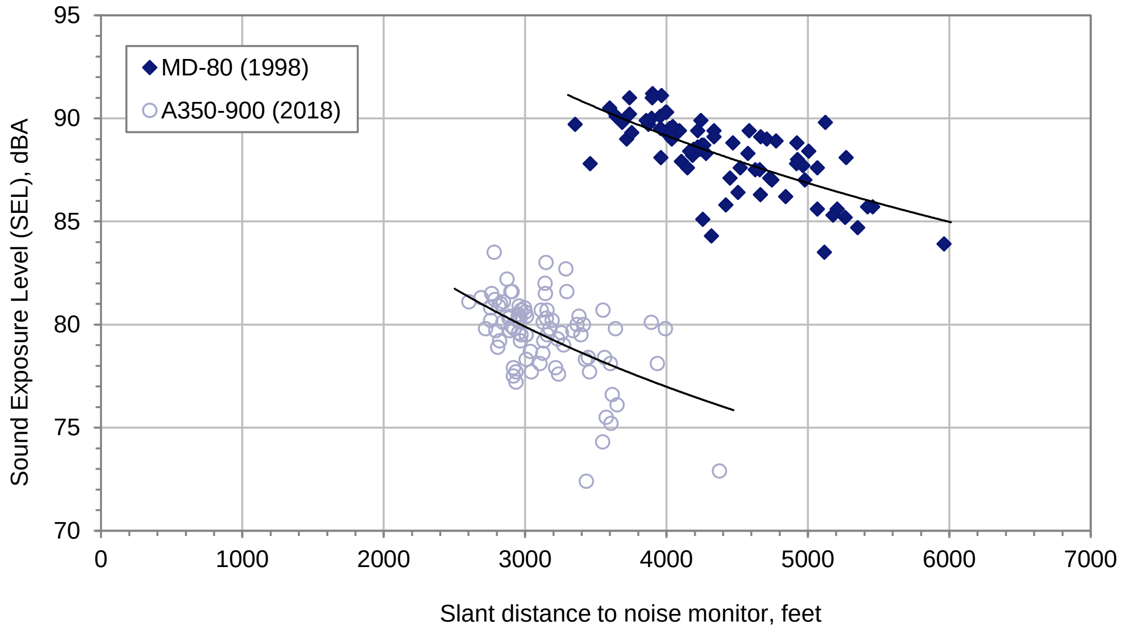


To further illustrate the improved noise performance of the A350, Figure 7 presents noise levels plotted against slant distance (closest distance to the monitor) for a sample of Finnair A350 departures measured at one particular monitor location near Heathrow in 2018 (Site 513 in Figure 1, approximately 11 km from start-of-roll).

Also shown in Figure 7 are equivalent measurements of Finnair MD-80 departures, measured at the same location in 1998, and flying along the same departure route to the same destination (via BPK to Helsinki). The MD-80 is a twin-engine, narrow-body aircraft which was introduced into worldwide commercial service in 1980 and was operating regularly at Heathrow until the early 2010s.

Despite being at least 1,000 feet lower overhead the noise monitor, Figure 7 shows that the noise performance of modern aircraft has improved significantly over recent decades at Heathrow, with the A350 being approximately 10 dB quieter than the MD-80 at this particular location. This is despite the A350 being four times heavier (280 tonnes compared to 70 tonnes) and capable of carrying more than twice the number of passengers.

Figure 7 Finnair A350-900 and MD-80 departure noise levels (Site 513)



Chapter 4

Arrival noise monitor data

Figure 8 plots the Airbus A350-900 and A350-1000 arrival SEL measurements against data for the A330-200. Figures 9, 10 and 11 plot the same A350 arrival data against equivalent measurements for the Airbus A330-300, A340-300 and 777-200 respectively. In each diagram, the 95 percent confidence intervals of the mean levels are shown as vertical error bars.

A full set of tabular results for arrivals are provided in Appendix C for information, alongside the corresponding results for the L_{Amax} metric. The average distance to touchdown from each noise monitor has been calculated using radar data.

The results indicate that the A350-900 is, on average, up to 3 dB quieter than the A330-200 and A330-300 on arrival, although there is some variation by engine type and from monitor to monitor. The results also indicate that the A350-900 is on average up to 2 dB quieter than the A340-300 and approximately 1 dB quieter than the 777-200 across all noise monitors on arrival. Beyond 20 km from touchdown, A350 noise levels appear to increase, though still remaining quieter than the A330 and A340. 20 km from touchdown equates to a height of approximately 3,500 feet. This is around the point where aircraft begin their deceleration from 180 knots to 160 knots, but the higher speed alone may not necessarily explain the noise level increase. It is recommended that HAL engage with A350 operators to better understand A350 approach operating procedures compared with the A330, especially where an airline operates both types.

Comparing the two A350 variants, the arrival results indicate that the A350-1000 is, on average, 1 dB noisier than the A350-900 across all noise monitors. In addition, the A350-1000 is also slightly noisier than the existing aircraft types at some monitor locations. However, it should also be noted that the A350-1000 has the highest maximum landing weight of all the aircraft in the study (see Chapter 2). A better comparison would be to compare A350-1000 arrival noise levels against the Boeing 777-300ER. However with only a single A350-1000 operator at this time, it is recommended that such a comparison is undertaken in the future once there are other A350-1000 operators using Heathrow.

Noting that both A350 variants meet QC/0.5 on arrival, compared to QC/0.5 or QC/1 for the A330, A340 and 777 depending on the particular variant, and that the midpoints of successive QC bands are 3 dB apart, the average measured differences are in general agreement with the QC classifications.

Figure 8 Comparison of A350 and A330-200 arrival SEL noise measurements

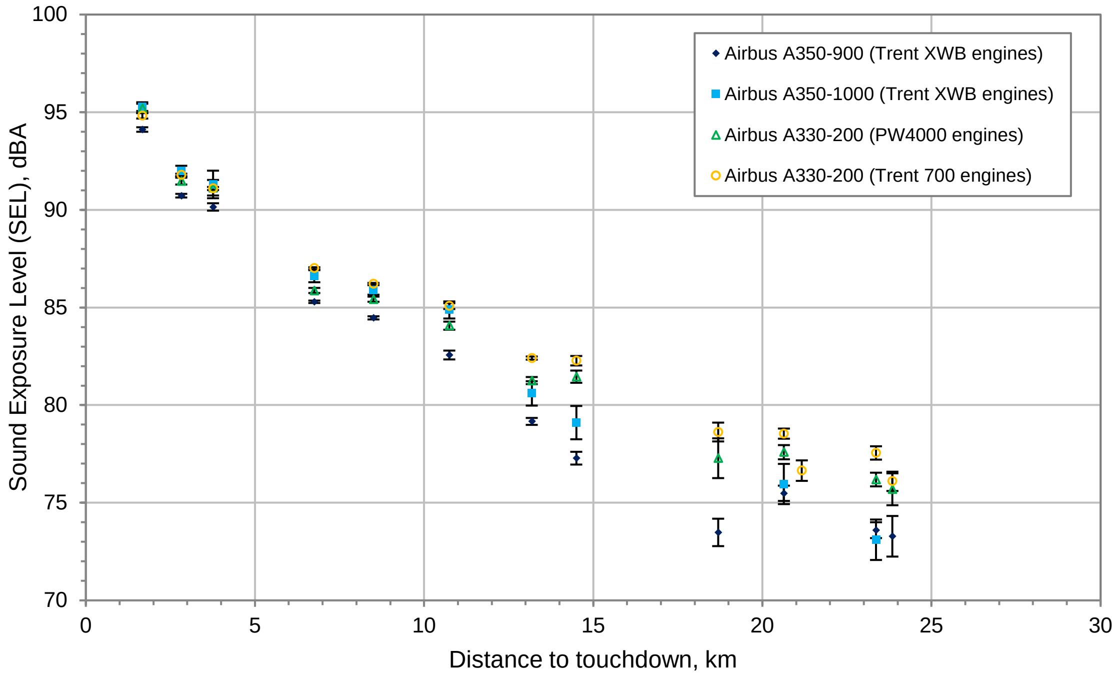


Figure 9 Comparison of A350 and A330-300 arrival SEL noise measurements

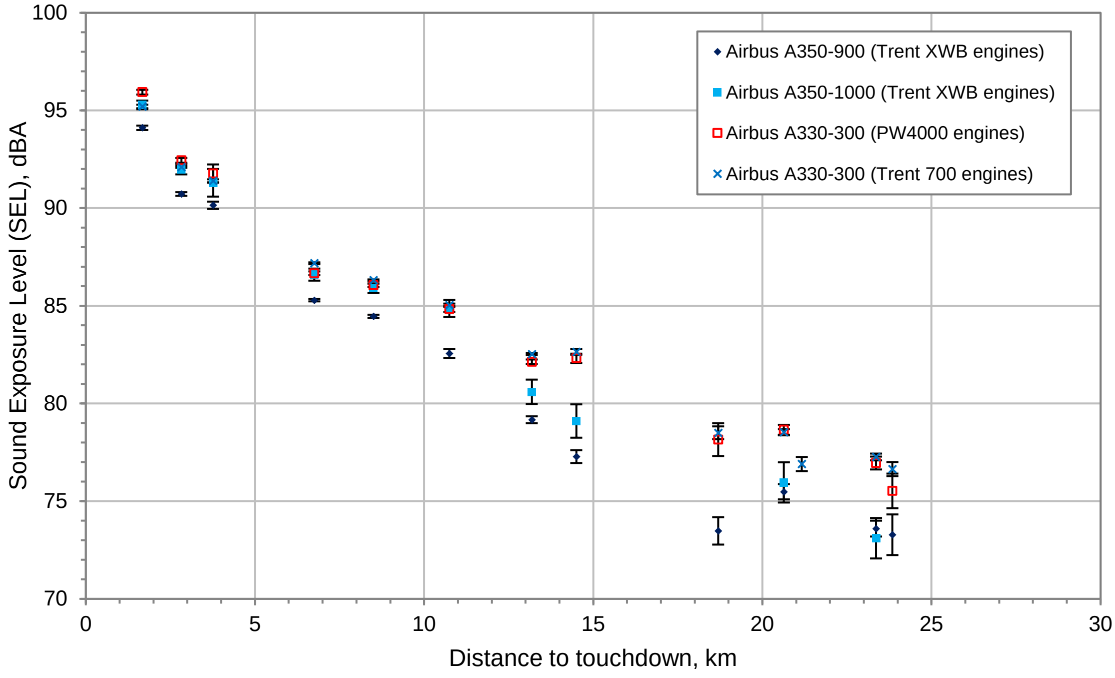


Figure 10 Comparison of A350 and A340-300 arrival SEL noise measurements

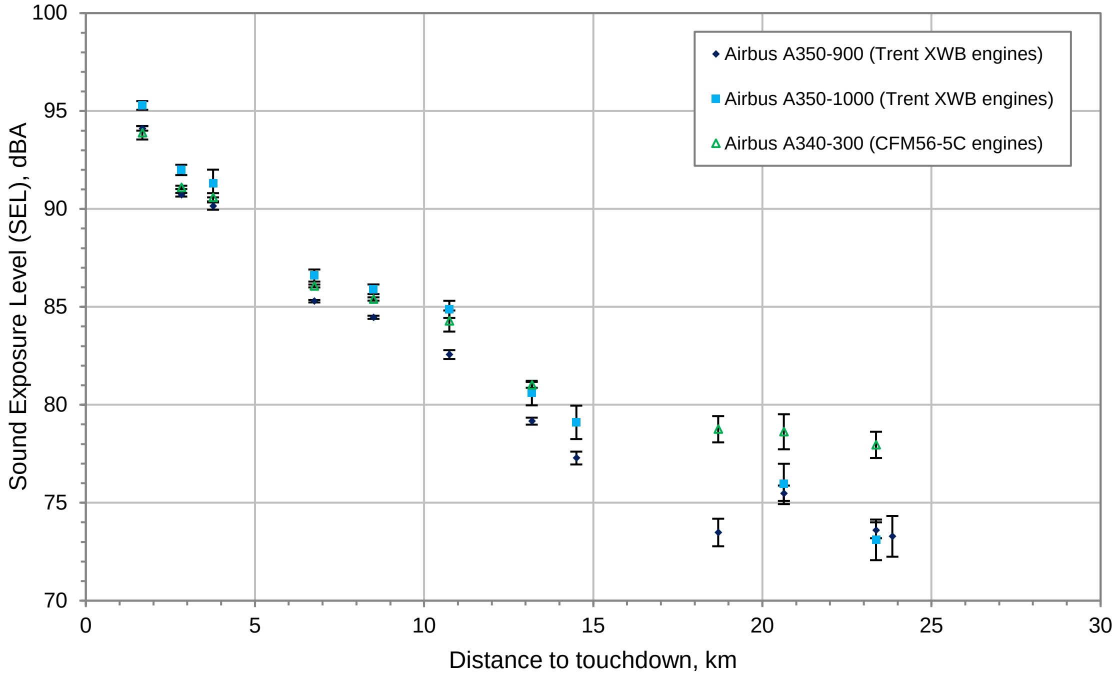
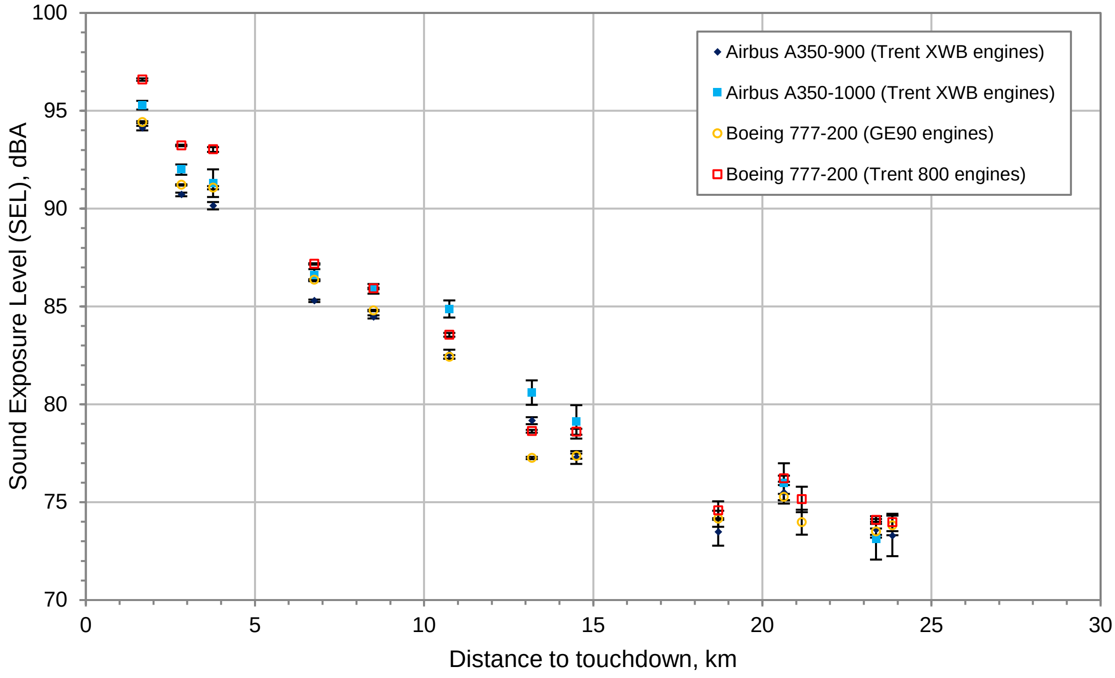


Figure 11 Comparison of A350 and 777-200 arrival SEL noise measurements



Chapter 5

Departure profiles

Departure operating procedures can vary significantly between operators of similar aircraft types. Important factors are the engine thrust and flap settings during take-off and initial climb, which together can have a major effect on the aircraft height. All other things being equal, the departure climb gradient decreases as the take-off weight increases. Airline operators will take into account the need to balance reductions in noise, engine wear and fuel consumption amongst other factors.

The International Civil Aviation Organization (ICAO) recommends two types of Noise Abatement Departure Procedure; a close-in procedure (NADP 1) designed to mitigate noise at relatively shorter distances and a further-out procedure (NADP 2) to mitigate noise at relatively greater distances from the airport.

NADP 1 prescribes that at an initial altitude, take-off power is reduced to climb thrust, whilst take-off speed is maintained until a higher altitude, before accelerating. NADP 2 prescribes that at an initial altitude, the aircraft is accelerated to a higher speed, and at the same or higher altitude take-off power is reduced to the climb thrust setting.

One procedure does not necessarily have a better overall noise impact than another. Instead, changing from one procedure to another tends to redistribute noise from one location to another, including both underneath and to the side of the flight track, resulting in both noise decreases and noise increases.

As a general rule however, an NADP 2 procedure requires less fuel to reach the cruise altitude compared to NADP 1. CAP 1691[6] provides a further discussion of NADP 1 and NADP 2 procedures.

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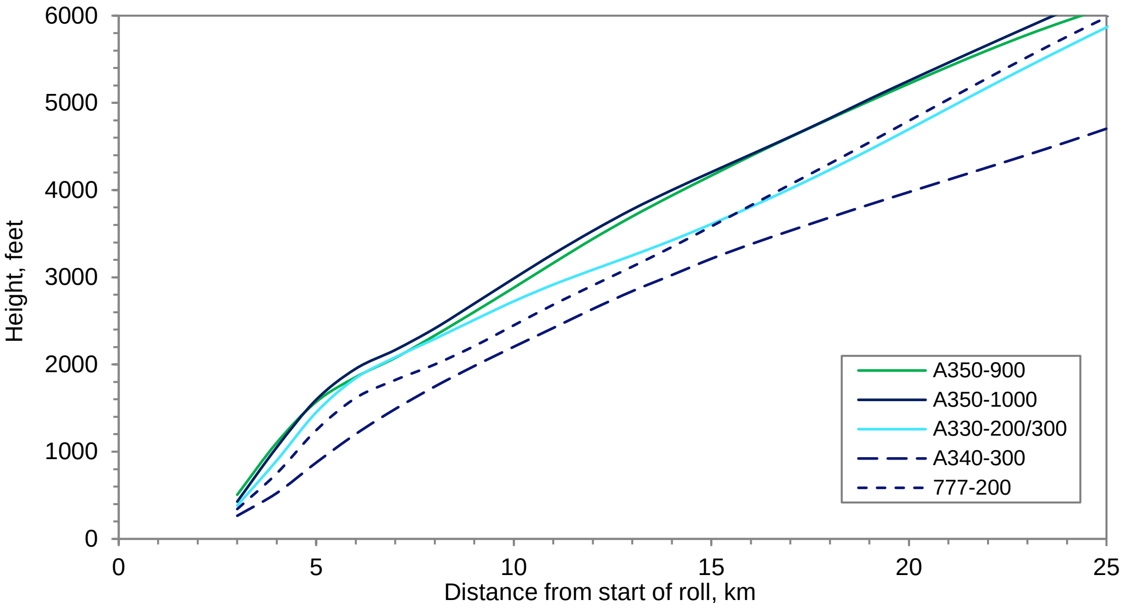
[6] CAP 1691, *Departure Noise Mitigation: Main Report,* Civil Aviation Authority, July 2018

Figure 12 compares the average departure height profiles for the Airbus A350, A330, A340 and Boeing 777. The A350 and A330 variants show very similar height profiles up to about 10 km from SOR, whereas the average 777 profile is noticeably lower up until that point.

The four-engine A340 on the other hand is significantly lower, on average, along the entire flight profile compared to the other twin-engine aircraft types in Figure 12. This finding is unsurprising, as safety requirements dictate that twin-engine aircraft need to be more over-powered than four-engine aircraft in order to cope with a single engine failure on take-off (with all engines functioning as normal, twin-engine aircraft can climb faster than four-engine aircraft).

In addition, the average height profiles for both A350 variants are almost identical and, beyond approximately 10 km from start of roll, both are higher than the profiles for the other twin-engine types.

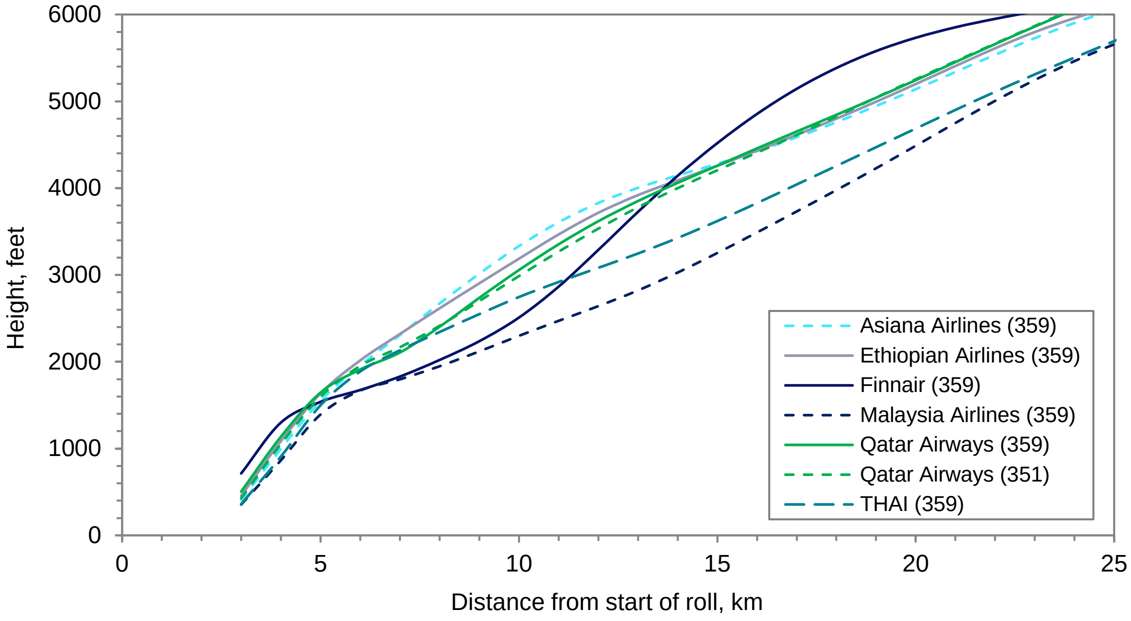
Figure 12 Comparison of average departure height profiles by aircraft type



However it should be remembered that each aircraft type shown in Figure 12 represents a number of different operators. Therefore any differences in height profiles may be more reflective of operator differences or differences in the average distance flown rather than fundamental differences in aircraft performance.

Figure 13 compares the average departure height profiles for the A350-900 (‘359’) and A350-1000 (‘351’) separated by airline operator. Results are shown for the six most common A350 operators during the study period.

Figure 13 Comparison of average A350 departure height profiles by airline



Comparison of the mean profiles in Figure 13 indicates that some A350 operators (including Finnair) are implementing an NADP 2-type departure procedure that results in a markedly different height profile compared to other A350 operators, which appear to be implementing variations of NADP 1 (or a mixture of both procedures).

Finnair operate by far the shortest route (to Helsinki, a distance of 1,000 nautical miles) and this is readily apparent in the greater height achieved up to 4 km from start-of-roll and the more rapid height gain beyond 10 km. Furthermore, despite the markedly different height profiles across all A350 operators, there does not appear to be a significant variation in overall departure noise levels (which typically would be evident by larger standard deviations than those reported in Appendix C).

The average Malaysia Airlines height profile in Figure 13 is generally lower along the entire profile compared to the other airlines. Malaysia Airlines operates the A350 on the longest route currently flown by any of the A350 operators at Heathrow (to Kuala Lumpur, a distance of 5,700 nautical miles) and so this result is unsurprising, since aircraft flying longer distances will be proportionally heavier due to the additional fuel carried.

The Asiana, Ethiopian and Qatar profiles are generally higher than all the airlines up to approximately 14 km from SOR, most likely a result of using an NADP 1 departure procedure.

The similarity between the initial flight profiles shown in Figure 13, up to a height of approximately 1,500 ft, suggests that all the A350 operators are optimising take-off thrust settings in order to reduce engine wear and associated maintenance costs.

The average profiles for the Qatar Airways A350-900 and A350-1000 are also very similar along the entire profile. Again, this is unsurprising since both variants are flying to the same destination (Doha, a distance of 2,800 nautical miles) and most likely using the same Standard Operating Procedure (SOP).

Finally, it should be noted that the A350 has a maximum range of approximately 8,000 nautical miles. Flight profiles for A350s flying closer to the maximum range may therefore show different trends.

Chapter 6

Conclusions

This report presents summary information on monitored noise levels for the Airbus A350 during the first three years of its operation at Heathrow Airport. Data have been compared to the twin-engine Airbus A330 and Boeing 777 and the four-engine A340, whose operations are likely to be replaced by the A350 in the coming years.

The noise measurement data confirms that the A350 is on average up to 6 dB quieter on departure than the A330 and 777, and up to 9 dB quieter than the A340. The results also confirm that the A350 is up to 3 dB quieter on arrival than the aircraft types it is intended to replace.

An analysis of radar data has confirmed that across all airline operators, the average departure height profile for the A350 at Heathrow is broadly comparable to the average profiles for the A330 and 777. A comparison of the height profiles for each A350 operator confirms that, as expected, departure operating procedures can vary significantly between different airlines, resulting in markedly different profiles for the same aircraft type.

APPENDIX A

Abbreviations

Abbreviations	
dB	Decibel units describing sound level or changes of sound level. It is used in this report to define differences measured on the dBA scale, which incorporates a frequency weighting approximating the characteristics of human hearing.
HAL	Heathrow Airport Limited
knots	Nautical miles per hour
L_{den}	Equivalent sound level of aircraft noise in dBA for the 24-hour annual average period, with 5 dB weightings for evening and 10 dB weightings for night.
L_{Aeq}	Equivalent sound level of aircraft noise in dBA, often called ‘equivalent continuous sound level’.
L_{Amax}	The maximum sound level measured during an aircraft event.
NPR	Noise Preferential Route. The preferred route for aircraft to fly in order to minimise their noise profile on the ground in the immediate vicinity of the airport.
NTK	Noise and Track Keeping monitoring system. The NTK system associates air traffic control radar data with related data from both fixed (permanent) and mobile noise monitors at prescribed positions on the ground.
QC	Quota Count. The basis of the London airports’ night restrictions regime.
SEL	The Sound Exposure Level generated by a single aircraft at the measurement point. This accounts for the duration of the sound as well as its intensity.
SID	Standard Instrument Departure. A designated instrument flight rule (IFR) departure route linking the aerodrome or a specified runway of the aerodrome with a specified significant point, normally on a designated air traffic service route, at which the en-route phase of a flight commences.

APPENDIX B

Noise monitor locations

				Distance from start of roll (km)		Distance to touchdown (km)	
Site		Type	Period of deployment	Runway 27L / 27R	Runway 09R	Runway 27L / 27R	Runway 09L / 09R
6	Thames Water, Wraysbury	Permanent	-	6.5 / -	-	-	- / 3.8
10 (H)	Hounslow Heath	Permanent	-	-	6.2	-	-
14 (E)	Wraysbury Reservoir (South)	Permanent	-	7.4 / -	-	-	-
15 (D)	Coppermill	Permanent	-	6.7 / -	-	-	-
17 (C)	Horton	Permanent	-	6.7 / -	-	-	-
18 (B)	Poyle	Permanent	-	- / 5.9	-	-	2.8 / -
20 (J)	Hounslow Cavalry Barracks (North)	Permanent	-	-	6.4	-	-
21 (K)	Hounslow Heath Golf Course	Permanent	-	-	6.2	-	-
129	Mogdens, Isleworth	Mobile	Oct-15 to Sep-18	-	-	6.8 / -	-
130	Richmond Golf Course	Mobile	Oct-15 to Sep-18	-	-	8.5 / -	-
131	Roehampton Sports Club	Mobile	Oct-15 to Sep-18	-	-	13.2 / -	-
137	Green Man Lane, Hatton	Mobile	Apr-17 to Sep-18	-	4.8	1.7 / -	-
139	Hanworth Road	Mobile	May-17 to Sep-18	-	7.9	-	-
140	Lincoln Avenue	Mobile	May-17 to Sep-18	-	9.5	-	-
142	Richmond Park (Centre)	Mobile	May-17 to Sep-18	-	14.3	-	-
144	Fulwell Park	Mobile	Jun-17 to Sep-18	-	9.3	-	-
146	Robin Hood School, Kingston Vale	Mobile	Jun-17 to Sep-18	-	16.4	-	-
500	Bird Hills	Mobile	Aug-17 to Sep-18	-	-	-	- / 18.7
501	Burnham	Mobile	Aug-17 to Sep-18	19.1 / 18.8	-	-	-
503	Air Force Memorial	Mobile	Sep-17 to Sep-18	10.6 / 12.4	-	-	-
504	Fifield	Mobile	Oct-17 to Sep-18	-	-	-	14.5 / -
505	Hanwell	Mobile	Oct-17 to Sep-18	-	11.5	-	-
506	Chertsey Lane	Mobile	Oct-17 to Sep-18	13.3 / 16.0	-	-	-
507	White Waltham	Mobile	Oct-17 to Sep-18	-	-	-	20.6 / 21.2
508	Central Windsor	Mobile	Nov-17 to Sep-18	-	-	-	10.7 / -
509	Cobham	Mobile	Feb-18 to Sep-18	25.0 / 27.6	22.4	-	-
510	East Molesey	Mobile	Jan-18 to Sep-18	-	14.6	-	-
511	Camberwell	Mobile	Feb-18 to Sep-18	-	-	23.8 / 23.4	-
513	Eton Road Datchet	Mobile	Apr-18 to Sep-18	11.2 / 10.9	-	-	-
514	Hanger Hill, Ealing	Mobile	Apr-18 to Sep-18	-	15.5	-	-

APPENDIX C

Tables of results

Tables C1 and C2 present departure and arrival data for the Airbus A350, A330, A340 and Boeing 777 aircraft types in terms of the Sound Exposure Level (SEL) metric. Note that the data for the A330 and 777 have been separated by engine type for the two most common variants of each type at Heathrow, although this was not necessarily in anticipation of any expected noise differences. Samples with fewer than six measurements were excluded.

The noise monitor data have been sorted in terms of distance from start-of-roll (SOR), with distance increasing as one moves from left to right through the tables.

The SEL metric takes into account both the level of a noise event and the duration of the event. Thus if the level of two events were the same, but one were to last twice as long as the other the SEL level would increase by 3 dB. SEL is important since it is the ‘building block’ of overall noise indexes such as L_{Aeq} and L_{den}.

Data for the L_{Amax} metric are also provided for information in Tables C3 and C4. The L_{Amax} metric takes account of the maximum level only and not the duration of the event. Typically an SEL value is approximately 10 dB higher than the corresponding L_{Amax} for the same event. However, nearer the airport where the aircraft are lower and thus the durations shorter, the difference tends to be slightly less than 10 dB. Conversely further away from the airport where aircraft are higher and durations longer, the difference tends to be slightly more than 10 dB.

SEL (and L_{Amax}) are measured and reported on a logarithmic scale. An average SEL value can be calculated on both an arithmetic basis and a logarithmic average basis. A logarithmic average gives greater weight to higher noise levels and is the calculation method used when generating L_{Aeq} and L_{den} noise contours. Tables C1 and C2 give both logarithmic and arithmetic average (mean) SEL values at each monitor location, along with the standard deviation and 95 percent confidence interval (CI) of the mean level.

The reliability of the measured noise levels for each aircraft type can be expressed as a 95 percent confidence interval. This is the interval around the sample mean within which it is reasonable to assume the ‘true’ value of the mean lies. Due to the relatively large sample sizes obtained, the 95 percent confidence intervals of the departure noise levels in the majority of cases are very small, i.e. less than 0.5 dB.

Table C1 SEL departure noise levels

	SEL, dBA									
	Monitor site	**137**	**18**	**10**	**21**	**20**	**6**	**17**	**15**	**14**
	Runway	**09R**	**27R**	**09R**	**09R**	**09R**	**27L**	**27L**	**27L**	**27L**
Aircraft type	**Dist. from SOR (km)**	**4.8**	**5.9**	**6.2**	**6.2**	**6.4**	**6.5**	**6.7**	**6.7**	**7.4**
Airbus A330-200 (PW4000 engines)	Log Avg	95.3	91.8	88.7	90.8	90.6	90.6	90.6	88.8	88.9
	Mean	94.9	91.6	88.5	90.4	90.3	90.4	90.5	88.7	88.7
	Std Dev	1.9	1.3	1.4	2.1	1.6	1.0	0.9	1.2	1.5
	Count	65	138	46	127	45	35	66	102	66
	95% CI	0.5	0.2	0.4	0.4	0.5	0.4	0.2	0.2	0.4
Airbus A330-200 (Trent 700 engines)	Log Avg	94.8	92.6	89.5	90.9	91.3	91.6	91.1	89.4	89.5
	Mean	94.2	92.2	89.2	90.1	90.9	91.5	90.8	89.1	89.2
	Std Dev	2.3	2.0	1.7	2.8	2.1	1.0	1.6	1.7	2.0
	Count	558	1,617	642	815	558	86	692	850	776
	95% CI	0.2	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1
Airbus A330-300 (PW4000 engines)	Log Avg	96.6	94.9	89.1	-	90.5	92.2	91.7	91.1	-
	Mean	96.2	94.4	88.4	-	90.1	92.0	91.5	91.0	-
	Std Dev	1.8	1.8	2.5	-	2.1	1.5	1.3	1.0	-
	Count	88	371	13	-	40	107	231	109	-
	95% CI	0.4	0.2	1.5	-	0.7	0.3	0.2	0.2	-
Airbus A330-300 (Trent 700 engines)	Log Avg	96.5	93.1	91.2	91.8	90.7	91.8	90.6	90.7	91.3
	Mean	95.7	92.7	90.9	91.3	90.2	91.7	90.2	90.4	90.9
	Std Dev	2.9	1.8	1.6	2.4	2.1	0.8	1.8	1.6	1.9
	Count	720	1,975	978	937	418	65	622	1,278	1,186
	95% CI	0.2	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1
Airbus A340-300 (CFM56-5C engines)	Log Avg	100.0	96.9	91.4	96.2	95.6	91.7	94.7	92.6	93.2
	Mean	99.6	96.3	90.9	95.4	94.9	91.5	94.5	92.1	92.9
	Std Dev	2.3	2.3	2.6	3.1	2.5	1.3	1.6	2.1	1.7
	Count	100	323	55	225	157	29	134	75	45
	95% CI	0.5	0.3	0.7	0.4	0.4	0.5	0.3	0.5	0.5
Airbus A350-1000 (Trent XWB engines)	Log Avg	89.8	88.4	86.1	86.4	86.1	-	-	86.4	86.7
	Mean	89.6	88.3	85.9	86.3	85.8	-	-	86.3	86.6
	Std Dev	1.4	1.1	1.2	1.3	1.7	-	-	1.1	0.9
	Count	66	57	59	46	7	-	-	61	60
	95% CI	0.4	0.3	0.3	0.4	1.5	-	-	0.3	0.2
Airbus A350-900 (Trent XWB engines)	Log Avg	88.7	87.2	85.1	85.6	85.3	84.5	85.5	85.3	85.2
	Mean	88.4	87.1	84.9	85.3	85.1	84.4	85.4	85.1	84.9
	Std Dev	1.6	1.2	1.3	1.7	1.3	0.9	1.1	1.6	1.7
	Count	579	1,095	493	392	270	12	327	736	691
	95% CI	0.1	0.1	0.1	0.2	0.2	0.6	0.1	0.1	0.1
Boeing 777-200 (GE90 engines)	Log Avg	93.7	92.0	90.3	90.7	90.7	90.7	91.0	90.9	89.9
	Mean	93.3	91.8	89.9	90.2	90.3	90.3	90.7	90.5	89.6
	Std Dev	1.9	1.5	1.9	2.4	2.0	1.8	1.7	1.8	1.7
	Count	1,288	3,190	1,709	1,823	588	173	908	2,293	2,076
	95% CI	0.1	0.1	0.1	0.1	0.2	0.3	0.1	0.1	0.1
Boeing 777-200 (Trent 800 engines)	Log Avg	96.6	94.0	91.7	92.3	92.2	93.5	92.8	91.3	90.8
	Mean	96.2	93.8	91.5	91.9	91.9	93.3	92.6	91.1	90.4
	Std Dev	2.0	1.4	1.6	2.1	1.6	1.2	1.4	1.4	2.2
	Count	1,350	3,908	1,781	1,122	1,013	875	1,450	2,473	1,553
	95% CI	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1

Table C1 SEL departure noise levels, continued

	SEL, dBA									
	Monitor site	**139**	**144**	**140**	**503**	**513**	**513**	**505**	**503**	**506**
	Runway	**09R**	**09R**	**09R**	**27L**	**27R**	**27L**	**09R**	**27R**	**27L**
Aircraft type	**Dist. from SOR (km)**	**7.9**	**9.3**	**9.5**	**10.6**	**10.9**	**11.2**	**11.5**	**12.4**	**13.3**
Airbus A330-200 (PW4000 engines)	Log Avg	-	-	-	-	85.2	85.2	85.2	-	-
	Mean	-	-	-	-	85.1	85.1	85.0	-	-
	Std Dev	-	-	-	-	1.1	1.3	1.4	-	-
	Count	-	-	-	-	45	58	43	-	-
	95% CI	-	-	-	-	0.3	0.3	0.4	-	-
Airbus A330-200 (Trent 700 engines)	Log Avg	87.2	88.6	84.8	-	85.4	85.2	85.1	83.8	83.4
	Mean	86.9	88.4	84.5	-	85.0	84.8	84.6	83.5	83.1
	Std Dev	1.8	1.4	1.6	-	1.9	2.3	2.1	1.5	1.6
	Count	199	68	198	-	73	81	210	46	145
	95% CI	0.3	0.3	0.2	-	0.4	0.5	0.3	0.4	0.3
Airbus A330-300 (PW4000 engines)	Log Avg	-	-	-	-	86.5	86.2	86.4	-	-
	Mean	-	-	-	-	86.3	86.1	86.1	-	-
	Std Dev	-	-	-	-	1.5	0.9	1.7	-	-
	Count	-	-	-	-	45	49	88	-	-
	95% CI	-	-	-	-	0.4	0.3	0.4	-	-
Airbus A330-300 (Trent 700 engines)	Log Avg	89.8	89.3	87.4	86.5	83.9	85.1	85.1	85.5	85.6
	Mean	89.5	89.0	87.1	86.1	83.6	84.3	84.6	85.1	85.2
	Std Dev	1.9	1.8	1.8	2.4	2.0	2.6	2.2	1.9	1.9
	Count	394	62	392	23	68	92	162	271	318
	95% CI	0.2	0.5	0.2	1.0	0.5	0.5	0.3	0.2	0.2
Airbus A340-300 (CFM56-5C engines)	Log Avg	-	91.7	-	-	-	-	-	-	85.4
	Mean	-	91.4	-	-	-	-	-	-	85.2
	Std Dev	-	1.8	-	-	-	-	-	-	1.3
	Count	-	57	-	-	-	-	-	-	6
	95% CI	-	0.5	-	-	-	-	-	-	1.4
Airbus A350-1000 (Trent XWB engines)	Log Avg	84.9	-	82.6	-	-	-	81.6	79.0	79.5
	Mean	84.7	-	82.4	-	-	-	81.1	78.6	79.2
	Std Dev	1.4	-	1.5	-	-	-	2.2	1.9	1.6
	Count	59	-	59	-	-	-	7	35	58
	95% CI	0.4	-	0.4	-	-	-	2.0	0.6	0.4
Airbus A350-900 (Trent XWB engines)	Log Avg	84.0	81.9	81.8	81.3	79.9	80.2	80.5	80.5	78.9
	Mean	83.6	81.8	81.4	81.1	79.7	79.9	80.2	79.4	78.5
	Std Dev	1.9	0.9	2.0	1.4	1.5	1.8	1.7	3.1	1.6
	Count	356	7	348	25	106	107	169	253	307
	95% CI	0.2	0.9	0.2	0.6	0.3	0.4	0.3	0.4	0.2
Boeing 777-200 (GE90 engines)	Log Avg	89.2	88.1	85.7	84.8	84.5	84.9	85.9	82.7	82.9
	Mean	88.9	87.6	85.4	84.5	84.0	84.4	85.3	82.2	82.5
	Std Dev	1.7	2.4	1.8	1.8	2.1	2.2	2.3	2.1	1.8
	Count	693	137	689	53	139	126	225	557	663
	95% CI	0.1	0.4	0.1	0.5	0.4	0.4	0.3	0.2	0.1
Boeing 777-200 (Trent 800 engines)	Log Avg	90.4	88.4	87.1	86.1	86.9	86.8	86.0	83.7	83.7
	Mean	90.2	87.6	86.8	85.9	86.5	86.5	85.6	83.3	83.3
	Std Dev	1.7	2.9	1.8	1.7	2.0	1.9	1.9	2.0	1.8
	Count	580	27	575	12	254	203	374	242	621
	95% CI	0.1	1.2	0.1	1.1	0.2	0.3	0.2	0.3	0.1

Table C1 SEL departure noise levels, continued

	SEL, dBA										
	Monitor site	**142**	**510**	**514**	**506**	**146**	**501**	**501**	**509**	**509**	**509**
	Runway	**09R**	**09R**	**09R**	**27R**	**09R**	**27R**	**27L**	**09R**	**27L**	**27R**
Aircraft type	**Dist. from SOR (km)**	**14.3**	**14.6**	**15.5**	**16.0**	**16.4**	**18.8**	**19.1**	**22.4**	**25.0**	**27.6**
Airbus A330-200 (PW4000 engines)	Log Avg	-	-	82.8	-	-	80.3	80.4	-	-	-
	Mean	-	-	82.4	-	-	80.0	80.0	-	-	-
	Std Dev	-	-	2.1	-	-	1.8	1.8	-	-	-
	Count	-	-	38	-	-	50	61	-	-	-
	95% CI	-	-	0.7	-	-	0.5	0.5	-	-	-
Airbus A330-200 (Trent 700 engines)	Log Avg	81.5	82.4	81.7	81.6	80.6	80.2	79.7	77.1	76.4	73.0
	Mean	81.1	82.1	81.1	81.3	80.1	79.1	78.8	76.0	75.2	72.5
	Std Dev	2.0	1.7	2.6	1.7	2.3	3.3	2.9	3.1	2.8	2.0
	Count	181	33	97	160	168	238	212	28	40	30
	95% CI	0.3	0.6	0.5	0.3	0.4	0.4	0.4	1.2	0.9	0.8
Airbus A330-300 (PW4000 engines)	Log Avg	-	-	83.7	-	-	82.2	82.3	-	-	-
	Mean	-	-	83.3	-	-	81.9	82.0	-	-	-
	Std Dev	-	-	1.9	-	-	2.0	1.9	-	-	-
	Count	-	-	50	-	-	119	120	-	-	-
	95% CI	-	-	0.5	-	-	0.4	0.3	-	-	-
Airbus A330-300 (Trent 700 engines)	Log Avg	84.2	83.3	82.6	83.4	83.1	80.4	80.2	79.4	78.2	76.3
	Mean	83.6	82.7	81.9	83.0	82.4	79.4	79.1	78.5	77.5	75.6
	Std Dev	2.2	2.6	2.5	2.0	2.5	3.1	3.1	3.1	2.7	2.5
	Count	362	58	108	348	347	190	202	58	166	125
	95% CI	0.2	0.7	0.5	0.2	0.3	0.4	0.4	0.8	0.4	0.5
Airbus A340-300 (CFM56-5C engines)	Log Avg	-	87.1	-	84.8	-	-	-	84.4	77.5	78.3
	Mean	-	86.9	-	84.2	-	-	-	84.1	76.7	77.5
	Std Dev	-	1.2	-	2.2	-	-	-	1.9	3.3	2.8
	Count	-	39	-	14	-	-	-	38	6	6
	95% CI	-	0.4	-	1.3	-	-	-	0.6	3.5	2.9
Airbus A350-1000 (Trent XWB engines)	Log Avg	79.3	-	-	77.7	77.9	-	-	-	72.3	72.4
	Mean	79.0	-	-	77.5	77.6	-	-	-	72.1	72.2
	Std Dev	1.7	-	-	1.5	1.8	-	-	-	1.3	1.3
	Count	59	-	-	49	58	-	-	-	21	9
	95% CI	0.4	-	-	0.4	0.5	-	-	-	0.6	1.0
Airbus A350-900 (Trent XWB engines)	Log Avg	78.7	76.0	77.1	77.4	77.5	76.3	75.8	-	73.0	72.3
	Mean	78.2	75.8	76.8	77.0	77.1	75.8	75.3	-	72.7	72.1
	Std Dev	2.0	1.5	1.8	1.8	1.9	2.2	2.0	-	1.6	1.4
	Count	328	7	104	359	306	168	160	-	89	26
	95% CI	0.2	1.4	0.3	0.2	0.2	0.3	0.3	-	0.3	0.6
Boeing 777-200 (GE90 engines)	Log Avg	82.1	81.9	81.8	80.9	80.8	78.4	78.6	77.3	74.7	73.9
	Mean	81.5	81.6	81.3	80.5	80.3	77.8	77.9	76.7	74.1	73.3
	Std Dev	2.2	1.9	2.2	2.0	2.3	2.3	2.4	2.5	2.3	2.2
	Count	650	91	128	655	614	256	254	74	215	72
	95% CI	0.2	0.4	0.4	0.2	0.2	0.3	0.3	0.6	0.3	0.5
Boeing 777-200 (Trent 800 engines)	Log Avg	84.0	83.4	84.0	81.7	82.6	82.4	81.8	77.9	77.5	76.0
	Mean	83.4	82.6	83.7	81.4	82.0	81.7	81.3	77.3	76.9	75.3
	Std Dev	2.4	2.9	1.9	1.9	2.5	2.5	2.2	2.3	2.5	2.4
	Count	545	21	199	542	529	344	320	18	291	174
	95% CI	0.2	1.3	0.3	0.2	0.2	0.3	0.2	1.1	0.3	0.4

Table C2 SEL arrival noise levels

Aircraft type	SEL, dBA							
	Monitor site	**137**	**18**	**6**	**129**	**130**	**508**	**131**
	Runway	**27L**	**09L**	**09R**	**27L**	**27L**	**09L**	**27L**
	Dist. to touchdown (km)	**1.7**	**2.8**	**3.8**	**6.8**	**8.5**	**10.7**	**13.2**
Airbus A330-200 (PW4000 engines)	Log Avg	95.6	91.8	91.3	86.0	85.6	84.3	81.7
	Mean	95.2	91.5	91.1	85.9	85.4	84.1	81.3
	Std Dev	1.9	1.7	1.1	1.4	1.4	1.6	2.0
	Count	248	355	34	437	447	226	448
	95% CI	0.2	0.2	0.4	0.1	0.1	0.2	0.2
Airbus A330-200 (Trent 700 engines)	Log Avg	95.1	91.9	91.2	87.2	86.4	85.2	82.7
	Mean	94.8	91.8	91.1	87.0	86.2	85.1	82.4
	Std Dev	2.3	1.3	0.8	1.3	1.3	1.3	1.8
	Count	1,001	1,190	407	2,290	2,235	282	1,892
	95% CI	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Airbus A330-300 (PW4000 engines)	Log Avg	96.2	92.7	92.0	86.9	86.3	85.0	82.5
	Mean	95.9	92.4	91.8	86.7	86.0	84.8	82.1
	Std Dev	1.5	1.7	1.3	1.6	1.5	1.3	1.8
	Count	574	816	33	1010	1042	308	876
	95% CI	0.1	0.1	0.5	0.1	0.1	0.1	0.1
Airbus A330-300 (Trent 700 engines)	Log Avg	95.4	92.2	91.5	87.3	86.5	85.2	82.9
	Mean	95.2	92.1	91.4	87.2	86.3	85.0	82.5
	Std Dev	1.9	1.2	0.9	1.5	1.3	1.3	1.6
	Count	1,767	2,469	424	3,491	3,462	843	3,036
	95% CI	0.1	0.0	0.1	0.0	0.0	0.1	0.1
Airbus A340-300 (CFM56-5C engines)	Log Avg	94.2	91.2	90.7	86.2	85.5	84.5	81.4
	Mean	93.9	91.1	90.6	86.1	85.4	84.3	81.0
	Std Dev	2.4	0.8	1.2	1.0	1.1	1.5	1.9
	Count	192	358	125	713	676	32	636
	95% CI	0.3	0.1	0.2	0.1	0.1	0.5	0.1
Airbus A350-1000 (Trent XWB engines)	Log Avg	95.4	92.1	91.4	86.7	86.0	85.2	81.1
	Mean	95.3	92.0	91.3	86.6	85.9	84.9	80.6
	Std Dev	0.9	1.0	0.8	1.2	1.0	1.6	2.5
	Count	63	56	7	58	63	55	63
	95% CI	0.2	0.3	0.7	0.3	0.2	0.4	0.6
Airbus A350-900 (Trent XWB engines)	Log Avg	94.3	90.9	90.3	85.4	84.6	83.0	80.2
	Mean	94.1	90.7	90.1	85.3	84.5	82.6	79.2
	Std Dev	1.7	1.2	1.0	1.0	1.3	2.3	2.9
	Count	799	682	102	1,001	1,051	392	992
	95% CI	0.1	0.1	0.2	0.1	0.1	0.2	0.2
Boeing 777-200 (GE90 engines)	Log Avg	94.6	91.3	91.2	86.5	85.0	82.8	77.9
	Mean	94.4	91.2	91.1	86.4	84.8	82.4	77.3
	Std Dev	1.4	1.2	0.9	1.4	1.4	1.8	2.1
	Count	2,626	4,263	504	5,387	5,394	1,416	5,161
	95% CI	0.1	0.0	0.1	0.0	0.0	0.1	0.1
Boeing 777-200 (Trent 800 engines)	Log Avg	96.8	93.4	93.2	87.3	86.2	83.9	79.4
	Mean	96.6	93.2	93.0	87.2	85.9	83.6	78.6
	Std Dev	1.7	1.3	1.2	1.4	1.6	1.8	2.6
	Count	2,705	4,267	388	5,401	5,426	1,377	5,062
	95% CI	0.1	0.0	0.1	0.0	0.0	0.1	0.1

Table C2 SEL arrival noise levels, continued

	SEL, dBA						
	Monitor site	**504**	**500**	**507**	**507**	**511**	**511**
	Runway	**09L**	**09R**	**09L**	**09R**	**27R**	**27L**
Aircraft type	**Dist. to touchdown (km)**	**14.5**	**18.7**	**20.6**	**21.2**	**23.4**	**23.8**
Airbus A330-200 (PW4000 engines)	Log Avg	82.1	77.8	78.3	76.6	76.8	76.0
	Mean	81.5	77.3	77.6	76.0	76.2	75.7
	Std Dev	2.4	2.2	2.5	2.2	2.3	1.7
	Count	227	20	179	15	166	20
	95% CI	0.3	1.0	0.4	1.2	0.4	0.8
Airbus A330-200 (Trent 700 engines)	Log Avg	82.7	79.4	79.0	77.3	78.1	76.5
	Mean	82.3	78.6	78.5	76.6	77.6	76.1
	Std Dev	2.1	2.6	2.0	2.5	2.2	2.0
	Count	290	110	239	87	159	64
	95% CI	0.2	0.5	0.3	0.5	0.3	0.5
Airbus A330-300 (PW4000 engines)	Log Avg	82.9	78.4	79.2	78.0	77.5	76.2
	Mean	82.3	78.2	78.7	77.6	77.0	75.5
	Std Dev	2.2	1.6	2.2	2.1	2.1	2.4
	Count	315	16	293	13	164	30
	95% CI	0.2	0.8	0.3	1.3	0.3	0.9
Airbus A330-300 (Trent 700 engines)	Log Avg	83.2	79.1	79.0	77.4	77.7	77.3
	Mean	82.6	78.5	78.5	76.9	77.3	76.6
	Std Dev	2.2	2.2	2.1	2.1	2.0	2.2
	Count	869	181	720	137	509	145
	95% CI	0.1	0.3	0.2	0.4	0.2	0.4
Airbus A340-300 (CFM56-5C engines)	Log Avg	82.6	79.0	79.2	77.4	78.3	-
	Mean	81.0	78.8	78.6	76.7	78.0	-
	Std Dev	3.1	1.5	2.4	2.5	1.7	-
	Count	34	22	31	15	28	-
	95% CI	1.1	0.7	0.9	1.4	0.7	-
Airbus A350-1000 (Trent XWB engines)	Log Avg	80.1	74.0	76.9	-	73.6	75.5
	Mean	79.1	73.4	76.0	-	73.1	74.3
	Std Dev	3.1	2.3	2.8	-	2.2	3.3
	Count	54	6	30	-	20	9
	95% CI	0.9	2.4	1.0	-	1.0	2.5
Airbus A350-900 (Trent XWB engines)	Log Avg	78.5	74.0	76.4	75.2	74.4	74.8
	Mean	77.3	73.5	75.5	74.6	73.6	73.3
	Std Dev	3.3	2.3	2.8	2.5	2.4	2.7
	Count	382	42	203	12	135	29
	95% CI	0.3	0.7	0.4	1.6	0.4	1.0
Boeing 777-200 (GE90 engines)	Log Avg	78.2	74.8	76.1	74.7	74.0	74.2
	Mean	77.4	74.2	75.3	74.0	73.5	73.8
	Std Dev	2.5	2.3	2.6	2.6	1.9	1.9
	Count	1,443	123	1,052	64	544	59
	95% CI	0.1	0.4	0.2	0.6	0.2	0.5
Boeing 777-200 (Trent 800 engines)	Log Avg	79.7	75.4	77.0	75.9	74.7	74.5
	Mean	78.6	74.6	76.2	75.1	74.1	74.0
	Std Dev	2.9	2.6	2.6	2.7	2.2	2.1
	Count	1,406	122	1,103	67	501	92
	95% CI	0.2	0.5	0.2	0.7	0.2	0.4

Table C3 L_{Amax} departure noise levels

		L_{Amax}, dB								
	Monitor site	**137**	**18**	**10**	**21**	**20**	**6**	**17**	**15**	**14**
	Runway	**09R**	**27R**	**09R**	**09R**	**09R**	**27L**	**27L**	**27L**	**27L**
Aircraft type	**Dist. from SOR (km)**	**4.8**	**5.9**	**6.2**	**6.2**	**6.4**	**6.5**	**6.7**	**6.7**	**7.4**
Airbus A330-200 (PW4000 engines)	Mean	86.2	82.5	78.1	80.4	80.6	80.4	79.9	78.0	77.1
	Std Dev	2.4	2.4	2.2	2.2	1.9	1.6	1.4	1.8	1.8
	Count	65	138	46	127	45	35	66	102	66
Airbus A330-200 (Trent 700 engines)	Mean	85.0	82.9	78.3	80.1	81.1	80.3	79.7	78.2	78.0
	Std Dev	2.9	2.8	2.0	3.2	2.5	1.3	2.0	1.8	2.1
	Count	558	1,617	642	815	558	86	692	850	776
Airbus A330-300 (PW4000 engines)	Mean	87.8	85.9	77.8	-	80.2	81.4	81.0	80.2	-
	Std Dev	2.5	2.7	3.4	-	2.7	1.8	1.6	1.6	-
	Count	88	371	13	-	40	107	231	109	-
Airbus A330-300 (Trent 700 engines)	Mean	87.2	84.1	80.8	81.8	80.7	82.0	79.7	80.2	80.4
	Std Dev	3.6	2.8	2.1	2.7	2.5	1.2	2.2	2.3	2.2
	Count	720	1,975	978	937	418	65	622	1,278	1,186
Airbus A340-300 (CFM56-5C engines)	Mean	92.8	88.9	80.4	87.5	86.1	80.7	84.6	81.9	82.4
	Std Dev	3.3	3.2	3.0	3.7	3.5	1.9	2.3	2.8	2.0
	Count	100	323	55	225	157	29	134	75	45
Airbus A350-1000 (Trent XWB engines)	Mean	80.2	79.4	75.5	76.5	76.3	-	-	75.8	75.5
	Std Dev	1.9	1.7	1.3	1.6	2.0	-	-	1.3	1.1
	Count	66	57	59	46	7	-	-	61	60
Airbus A350-900 (Trent XWB engines)	Mean	79.2	78.7	74.8	76.2	76.0	74.2	75.6	75.0	74.3
	Std Dev	2.0	2.0	1.7	2.1	1.5	1.0	1.4	2.0	1.8
	Count	579	1,095	493	392	270	12	327	736	691
Boeing 777-200 (GE90 engines)	Mean	84.8	83.1	81.1	81.3	81.3	81.5	81.4	82.4	79.8
	Std Dev	2.7	2.0	2.5	2.9	2.7	2.5	2.5	2.6	2.5
	Count	1,288	3,190	1,709	1,823	588	173	908	2,293	2,076
Boeing 777-200 (Trent 800 engines)	Mean	87.9	85.2	82.3	83.2	83.1	84.4	83.2	82.3	80.6
	Std Dev	2.6	1.9	2.1	2.5	2.2	1.7	2.0	1.9	2.7
	Count	1,350	3,908	1,781	1,122	1,013	875	1,450	2,473	1,553

Table C3 L_{Amax} departure noise levels, continued

	L_{Amax}, dB									
	Monitor site	**139**	**144**	**140**	**503**	**513**	**513**	**505**	**503**	**506**
	Runway	**09R**	**09R**	**09R**	**27L**	**27R**	**27L**	**09R**	**27R**	**27L**
Aircraft type	**Dist. from SOR (km)**	**7.9**	**9.3**	**9.5**	**10.6**	**10.9**	**11.2**	**11.5**	**12.4**	**13.3**
Airbus A330-200 (PW4000 engines)	Mean	-	-	-	-	73.8	73.8	74.3	-	-
	Std Dev	-	-	-	-	1.2	1.9	1.7	-	-
	Count	-	-	-	-	45	58	43	-	-
Airbus A330-200 (Trent 700 engines)	Mean	76.3	78.2	74.2	-	73.7	73.4	74.0	73.0	72.1
	Std Dev	2.0	1.7	1.8	-	1.8	2.1	2.3	1.7	1.7
	Count	199	68	198	-	73	81	210	46	145
Airbus A330-300 (PW4000 engines)	Mean	-	-	-	-	75.7	75.6	75.5	-	-
	Std Dev	-	-	-	-	1.8	1.4	2.0	-	-
	Count	-	-	-	-	45	49	88	-	-
Airbus A330-300 (Trent 700 engines)	Mean	79.4	79.3	77.3	76.8	72.9	73.5	74.1	74.7	74.6
	Std Dev	2.4	2.1	2.1	2.7	2.2	2.9	2.4	2.6	2.4
	Count	394	62	392	23	68	92	162	271	318
Airbus A340-300 (CFM56-5C engines)	Mean	-	81.2	-	-	-	-	-	-	75.0
	Std Dev	-	2.2	-	-	-	-	-	-	1.9
	Count	-	57	-	-	-	-	-	-	6
Airbus A350-1000 (Trent XWB engines)	Mean	74.8	-	73.0	-	-	-	71.1	67.4	67.7
	Std Dev	1.8	-	1.6	-	-	-	2.5	2.2	1.8
	Count	59	-	59	-	-	-	7	35	58
Airbus A350-900 (Trent XWB engines)	Mean	73.9	70.8	72.3	71.9	68.8	68.7	69.6	69.2	67.6
	Std Dev	2.3	1.9	2.2	1.8	1.6	2.0	2.1	3.7	2.0
	Count	356	7	348	25	106	107	169	253	307
Boeing 777-200 (GE90 engines)	Mean	80.3	79.5	77.4	76.1	74.3	74.9	76.0	73.0	72.8
	Std Dev	2.5	3.1	2.7	2.7	3.1	3.7	3.3	2.9	2.6
	Count	693	137	689	53	139	126	225	557	663
Boeing 777-200 (Trent 800 engines)	Mean	81.3	78.5	78.3	77.2	76.7	76.8	75.6	73.7	73.2
	Std Dev	2.4	3.7	2.6	2.4	3.0	2.8	2.6	2.7	2.3
	Count	580	27	575	12	254	203	374	242	621

Table C3 L_{Amax} departure noise levels, continued

		L_{Amax}, dB									
	Monitor site	**142**	**510**	**514**	**506**	**146**	**501**	**501**	**509**	**509**	**509**
	Runway	**09R**	**09R**	**09R**	**27R**	**09R**	**27R**	**27L**	**09R**	**27L**	**27R**
Aircraft type	**Dist. from SOR (km)**	**14.3**	**14.6**	**15.5**	**16.0**	**16.4**	**18.8**	**19.1**	**22.4**	**25.0**	**27.6**
Airbus A330-200 (PW4000 engines)	Mean	-	-	71.9	-	-	69.2	69.3	-	-	-
	Std Dev	-	-	2.0	-	-	2.0	1.9	-	-	-
	Count	-	-	38	-	-	50	61	-	-	-
Airbus A330-200 (Trent 700 engines)	Mean	70.2	71.8	70.7	70.5	69.3	68.7	68.5	66.0	65.4	63.2
	Std Dev	2.1	1.7	2.4	1.7	2.2	3.1	2.8	2.8	2.2	1.5
	Count	181	33	97	160	168	238	212	28	40	30
Airbus A330-300 (PW4000 engines)	Mean	-	-	73.3	-	-	71.7	71.8	-	-	-
	Std Dev	-	-	2.0	-	-	2.0	2.3	-	-	-
	Count	-	-	50	-	-	119	120	-	-	-
Airbus A330-300 (Trent 700 engines)	Mean	72.9	73.0	71.5	72.2	71.8	69.0	68.8	68.6	66.9	65.3
	Std Dev	2.6	2.7	2.8	2.5	2.8	2.9	2.7	2.8	2.5	2.1
	Count	362	58	108	348	347	190	202	58	166	125
Airbus A340-300 (CFM56-5C engines)	Mean	-	76.0	-	73.4	-	-	-	73.7	66.8	67.8
	Std Dev	-	1.3	-	2.6	-	-	-	1.3	3.9	2.2
	Count	-	39	-	14	-	-	-	38	6	6
Airbus A350-1000 (Trent XWB engines)	Mean	69.0	-	-	66.2	67.2	-	-	-	62.3	62.5
	Std Dev	1.5	-	-	1.7	1.7	-	-	-	1.3	1.4
	Count	59	-	-	49	58	-	-	-	21	9
Airbus A350-900 (Trent XWB engines)	Mean	67.7	65.7	66.4	66.4	66.5	65.7	65.0	-	62.8	62.2
	Std Dev	2.4	1.2	1.8	2.1	2.0	2.1	1.9	-	1.5	1.5
	Count	328	7	104	359	306	168	160	-	89	26
Boeing 777-200 (GE90 engines)	Mean	72.4	73.0	71.7	70.8	70.7	67.7	68.0	67.2	64.6	64.3
	Std Dev	2.9	2.7	2.9	2.8	2.8	2.6	3.1	2.6	2.3	2.3
	Count	650	91	128	655	614	256	254	74	215	72
Boeing 777-200 (Trent 800 engines)	Mean	73.9	73.3	74.1	71.1	72.1	71.7	71.0	67.0	66.7	65.5
	Std Dev	3.1	3.7	2.6	2.3	3.0	3.2	2.9	2.8	2.7	2.6
	Count	545	21	199	542	529	344	320	18	291	174

Table C4 L_{Amax} arrival noise levels

	L_{Amax}, dB							
	Monitor site	**137**	**18**	**6**	**129**	**130**	**508**	**131**
	Runway	**27L**	**09L**	**09R**	**27L**	**27L**	**09L**	**27L**
Aircraft type	**Dist. to touchdown (km)**	**1.7**	**2.8**	**3.8**	**6.8**	**8.5**	**10.7**	**13.2**
Airbus A330-200 (PW4000 engines)	Mean	88.7	83.9	82.5	75.3	74.8	73.2	69.9
	Std Dev	2.1	1.8	1.4	1.5	1.5	1.6	2.1
	Count	248	355	34	437	447	226	448
Airbus A330-200 (Trent 700 engines)	Mean	89.0	85.0	82.7	76.8	75.5	74.7	71.6
	Std Dev	2.7	1.6	1.1	2.1	1.6	2.0	2.6
	Count	1,001	1,190	407	2,290	2,235	282	1,892
Airbus A330-300 (PW4000 engines)	Mean	89.6	85.0	83.4	76.2	75.2	73.9	70.8
	Std Dev	1.7	1.8	1.4	1.7	1.5	1.4	1.8
	Count	574	816	33	1,010	1,042	308	876
Airbus A330-300 (Trent 700 engines)	Mean	89.6	85.4	83.2	76.9	75.6	74.4	71.5
	Std Dev	2.3	1.5	1.3	1.9	1.5	1.7	2.3
	Count	1,767	2,469	424	3,491	3,462	843	3,036
Airbus A340-300 (CFM56-5C engines)	Mean	88.0	84.2	82.1	75.4	74.6	73.4	69.4
	Std Dev	3.0	1.1	1.1	1.0	1.1	1.1	1.8
	Count	192	358	125	713	676	32	636
Airbus A350-1000 (Trent XWB engines)	Mean	88.9	85.1	82.6	75.9	75.5	74.0	69.5
	Std Dev	1.1	1.2	1.0	1.1	1.1	1.9	2.4
	Count	63	56	7	58	63	55	63
Airbus A350-900 (Trent XWB engines)	Mean	87.3	83.3	81.5	74.6	73.6	71.8	68.1
	Std Dev	2.0	1.5	1.1	1.1	1.5	2.5	3.0
	Count	799	682	102	1,001	1,051	392	992
Boeing 777-200 (GE90 engines)	Mean	88.1	84.0	82.4	75.8	73.7	71.8	65.7
	Std Dev	1.5	1.3	1.0	1.5	1.4	1.9	2.3
	Count	2,626	4,263	504	5,387	5,394	1,416	5,161
Boeing 777-200 (Trent 800 engines)	Mean	90.1	85.4	84.4	76.6	74.8	73.0	67.8
	Std Dev	1.9	1.3	1.4	1.6	1.7	1.9	3.3
	Count	2,705	4,267	388	5,401	5,426	1,377	5,062

Table C4 L_{Amax} arrival noise levels, continued

Aircraft type	L_{Amax}, dB						
	Monitor site	**504**	**500**	**507**	**507**	**511**	**511**
	Runway	**09L**	**09R**	**09L**	**09R**	**27R**	**27L**
	Dist. to touchdown (km)	**14.5**	**18.7**	**20.6**	**21.2**	**23.4**	**23.8**
Airbus A330-200 (PW4000 engines)	Mean	70.3	66.7	66.0	63.7	64.9	64.5
	Std Dev	2.4	1.9	2.1	2.4	2.2	1.6
	Count	227	20	179	15	166	20
Airbus A330-200 (Trent 700 engines)	Mean	71.8	68.7	67.2	64.8	66.7	65.4
	Std Dev	2.8	3.3	3.0	2.6	2.6	2.3
	Count	290	110	239	87	159	64
Airbus A330-300 (PW4000 engines)	Mean	71.1	67.8	66.8	64.2	65.7	64.5
	Std Dev	2.1	1.5	2.2	1.2	2.1	2.1
	Count	315	16	293	13	164	30
Airbus A330-300 (Trent 700 engines)	Mean	71.8	68.0	67.1	65.0	66.3	66.0
	Std Dev	2.6	2.7	2.8	2.1	2.5	2.6
	Count	869	181	720	137	509	145
Airbus A340-300 (CFM56-5C engines)	Mean	69.7	68.2	66.5	64.2	66.0	-
	Std Dev	2.6	1.8	3.0	2.8	1.7	-
	Count	34	22	31	15	28	-
Airbus A350-1000 (Trent XWB engines)	Mean	68.0	63.5	64.3	-	62.1	64.3
	Std Dev	3.3	2.8	3.0	-	1.9	2.7
	Count	54	6	30	-	20	9
Airbus A350-900 (Trent XWB engines)	Mean	66.4	63.4	63.2	62.5	63.3	63.7
	Std Dev	3.3	2.1	2.4	2.4	2.6	2.5
	Count	382	42	203	12	135	29
Boeing 777-200 (GE90 engines)	Mean	66.5	63.9	63.3	62.0	62.7	63.3
	Std Dev	2.5	2.0	2.0	1.7	2.0	2.1
	Count	1,443	123	1,052	64	544	59
Boeing 777-200 (Trent 800 engines)	Mean	68.3	64.5	64.6	63.1	63.8	64.0
	Std Dev	3.4	2.9	2.8	2.8	2.6	2.8
	Count	1,406	122	1,103	67	501	92