ISH8 Action 7 – A321neo vs A321ceo noise and Full Length Runway Departure Trial

Submitted by LADACAN, IP ref 20040757

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Glossary

A321ceo	Airbus A-321 aircraft fitted with older, 'current engine option' engines
A321neo	Airbus A321 aircraft fitted with 'new generation' more fuel efficient engines
LAmax	Used here to denote the maximum A-weighted sound level measured by a noise monitor during a given period of time (LASmax signifies 'slow weighting')
LLA	London Luton Airport
LLAOL	London Luton Airport Operations Ltd, the Airport Operator
NMT	Noise Monitoring Terminal (suffixed to indicate specific identity / location if fixed)
SEL	The constant sound level that has the same amount of energy in one second as the original noise event (NB: for an aircraft transit, sound below the level of the noise monitor cutoff threshold is not included in the integration)
statutory monitor	A fixed noise monitor located 6.5km from start-of-roll to measure departure noise: at LLA NMT01 also measures runway 25 arrivals noise on westerly winds
threshold	A preset level below which a noise monitor does not register sound

1. Departure noise benefit of A321neo vs A321ceo at statutory monitors

1.1 Data from Quarterly Monitoring Reports

LLA Quarterly Monitoring Reports (QMRs) published by LLAOL are on this link:

https://www.london-luton.co.uk/corporate/community/noise/quarterly-monitoring-report

Appendix 1 reproduces the graphs showing average measurements made by LLAOL at monitoring locations NMT01 (easterly) and NMT02/NMT10 (westerly), 6.5km from departure start-of-roll, for the period Q1 2022 to Q3 2023 referenced in REP1-095, p24, paragraph 171 and elsewhere.

Data from NMT03 (which forms a "gate" with NMT02) is not included as neither the Applicant nor LADACAN consider it a valid noise monitoring location due to its proximity to the M1 motorway.[1]

The QMRs do not provide numerical averages: Table 1 below shows averages read from the graphs. These indicate that, while the relative noise levels vary from quarter to quarter, the A321neo is on average only 0.75dB LAmax less noisy that the A321ceo at these locations.

It is noteworthy that for each quarter, average noise values for these aircraft types are consistently higher on Easterly operations than on Westerly. This suggests that the noise modelling should take account of this disparity. It could be due to stronger westerly than easterly winds giving more lift, or easterly operations coinciding with warmer and less dense air giving lower climb.

Table 1: Average type noise, A321ceo and A321neo (source: LLAOL QMRs)

Period	Operations	A321ceo LAmax	A321neo LAmax	neo benefit
2022 Q1	Easterly	73.8	73.6	-0.2
	Westerly	72.4	72.5	+0.1
2022 Q2	Easterly	73.3	72.7	-0.6
	Westerly	73.2	72.5	-0.7
2022 Q3	Easterly	73.5	72.6	-0.9
	Westerly	73.3	72.0	-1.3
2022 Q4	Easterly	74.7	73.8	-0.9
	Westerly	73.2	71.9	-1.3
2023 Q1	Easterly	75.0	74.3	-0.7
	Westerly	73.9	73.4	-0.5
2023 Q2	Easterly	75.0	74.2	-0.8
	Westerly	74.6	73.9	-0.7
2023 Q3	Easterly	73.5	74.5	-1.0
	Westerly	74.0	73.0	-1.0
Ave neo benefit				**-0.75 dB LAmax**

The overall easterly departure average benefit is -0.73dB LAmax, and westerly -0.77dB LAmax. Note that the 2022 Q3 and Q4 differences are anomalously high: flight trials were being conducted at the time which may have influenced the results. Removing these would reduce the neo benefit.

[1] Luton Rising PEIR, 2022, Appendix 16.1, paragraph 6.10.2 *"NMT3 is not considered to be a key location for validating departure noise."*

Appendix 2 reproduces the results of LLAOL mobile noise monitoring in South Luton during a 5-month period Jan-May 2022. This shows the A321neo on average 0.8dB LAmax less noisy on departure, and 0.9dB LAmax noisier on arrival, compared to the A321ceo, at this location also.

The average benefit of the A321neo versus the A321ceo initially used in modelling by the Applicant is -2.0dB SEL as shown in Table 6.2 below, reproduced from AS-096, PDF page 85.

Table 6.2: New Generation Aircraft Modelling with no Data

Aircraft	Surrogate Aircraft	Approach CorrectiondB	Departure CorrectiondB	Source
A319Neo	A319	-4.0	-1.0	ANP
A321Neo (assessment Phase 1)	A321	+0.6	-2.0	LLAOL data
A321Neo (assessment Phase 2a, assessment Phase 2b)	A321	-0.7	-3.7	ANP

The -2.0dB benefit, modelled for Phase 1, does not agree with the differentials we show above.

Furthermore, Table 6.28 AS-096, PDF page 131 (reproduced below), includes Measured SEL dB values for these two aircraft types:

Table 6.28: A321 SEL Departure Noise Prediction Testing

Runway	Location	Measured SELdB	Predicted SELdB	DifferencedB
7	LTN_BG	91.1	92.2	+1.1
	NMT01	85.8	84.6	-1.2
25	LTN_SLTN	88.0	89.4	+1.4
	LTN_PPR	87.2	85.8	-1.4
	NMT02	85.1	83.7	-1.4
	NMT03	85.8	82.9	-2.4
	LTN_MRK	81.8	81.1	-0.7
	LTN_FLM	78.4	78.8	+0.4

Table 6.29: A321Neo SEL Departure Noise Prediction Testing

Runway	Location	Measured SELdB	Predicted SELdB	DifferencedB
7	LTN_BG	88.4	85.6	-2.8
	NMT01	84.2	82.1	-2.1
25	LTN_SLTN	85.2	82.6	-2.6
	LTN_PPR	86.3	83.2	-3.1
	NMT02	83.0	81.1	-1.9
	NMT03	83.3	80.1	-3.2
	LTN_MRK	80.1	78.4	-1.7
	LTN_FLM	75.7	76.0	+0.3

The measured A321neo easterly benefit (NMT01) is only -1.6dB SEL, westerly (NMT02) -2.1dB SEL. Not only are these both higher than the LAmax differences we have quoted, they also suggest that easterly and westerly departures ought to be modelled with different values, yet only one value is quoted in the Applicant's Table 6.2 above.

1.2 Reason for disagreement over modelled A321neo benefit

The Applicant has previously suggested (REP2-037, printed p332) that the reason for the apparent disparity in relative benefit of the A321neo is due to the Applicant basing its noise measurements on SEL values, whereas the data quoted by LADACAN from LLAOL reports is LAmax:

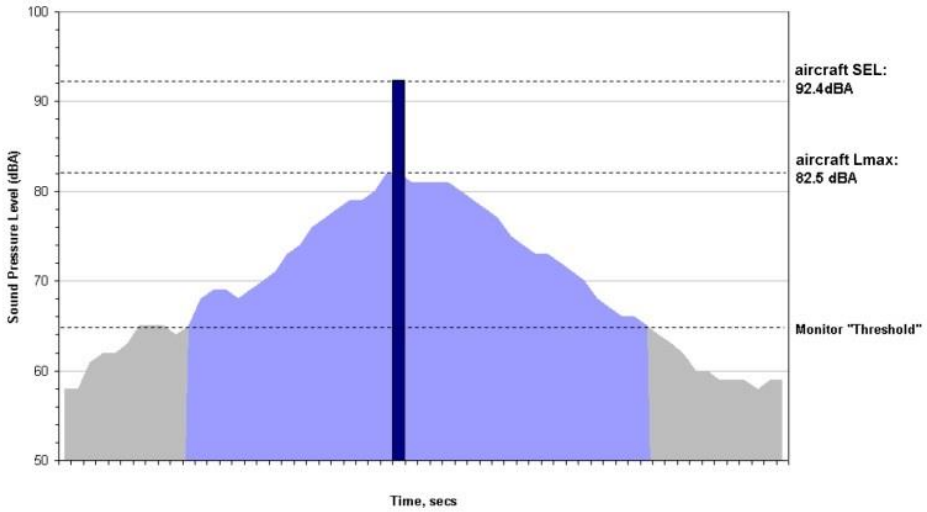
"171. The correction applied to the surrogate A321Ceo aircraft to provide A321Neo aircraft noise predictions was based on measured noise data in the 2019 baseline year. The noise data presented in the Quarterly Monitoring Reports is LASmax data, whereas the corrections applied are based on Single Event Level (SEL) data, which are not directly comparable. As such, the data in the Quarterly Monitoring Reports cannot be used to determine the difference in SEL between aircraft variants."

We respond to that comment as follows, with reference to the diagram below explaining SEL[2]:

2.2 **Sound Exposure Level - SEL**

The sound exposure level (SEL) of an aircraft noise event is the sound level, in dBA, of a one second burst of steady noise that contains the same total A-weighted sound energy as the whole event (Figure 2). In other words, it is the dBA value that would be measured if the entire event energy were uniformly compressed into a reference time of one second. Aircraft noise event SELs are usually measured using integrating sound level meters, which measure the total sound energy and normalise it to a reference duration of one second.

Figure 2: Graphical representation of SEL



Depending on the cutoff threshold of the integrating noise monitor, the width of the lower part of the noise waveform, or 'skirt', will be narrower for less noisy aircraft transits, all else being equal. The change in SEL for a given change in LAmax will vary depending on LAmax and the threshold setting: SEL is roughly 10-11dB greater but in our observation this depends on the threshold and on LAmax, as well as the transit waveform itself.

As a consequence, the difference between a louder type (A321ceo) and a less loud type (A321neo) may be more reliably stated when comparing average LAmax values: there are less dependencies.

We are willing to engage further with the Applicant to clarify this point.

[2] ERCD REPORT 0904, Metrics for Aircraft Noise, CAA, Jan 2009, printed page 2

2. Full length runway departures trial report

Appendix 3 below reproduces the report of a joint project in which LADACAN assisted LLAOL with data analysis of the full-length runway departure trial on westerly departures held during Feb and Mar 2022. The report identified three issues with the South Luton monitoring:

1) the monitoring system rejected many of the measurements due to the prevailing humidity
2) the need for noise monitors to be calibration-checked so data can be collected before, during and after such trials
3) the study only achieved a relatively small dataset

These factors were noted by LLAOL for 'future learning' in other trials, as the slides show.

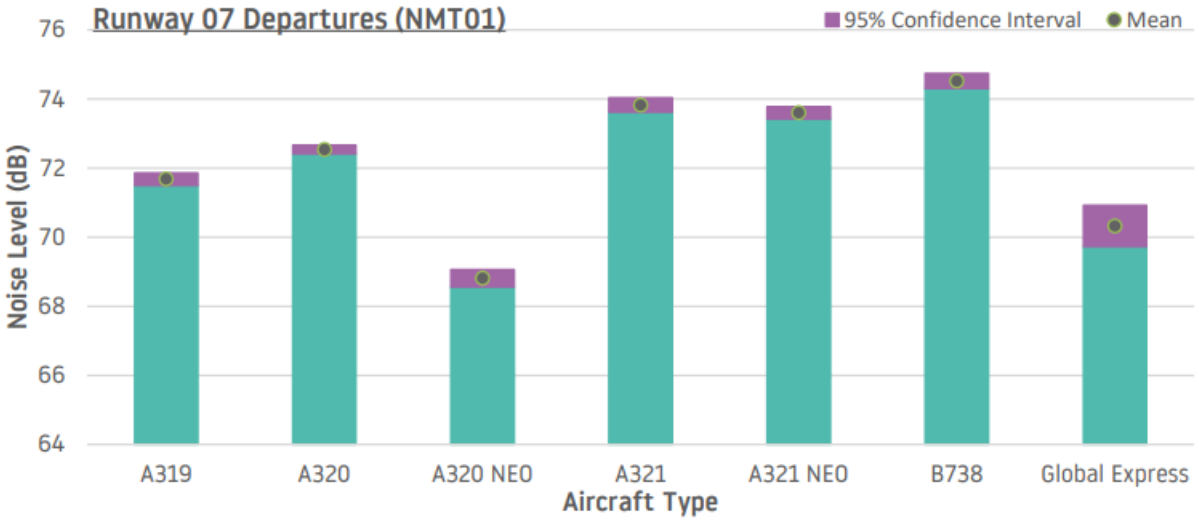
The report tentatively concludes that there is potentially a small benefit of some 0.6dB SEL in noise reduction close in to the airfield if the full runway length is used for westerly departures, but the benefit does not extend as far as the statutory monitors. The benefit may be due to a combination of different thrust settings calculated by the Flight Management System given more available runway length, and the aircraft being positioned some 300m east, more distant from South Luton, at start-of-roll.

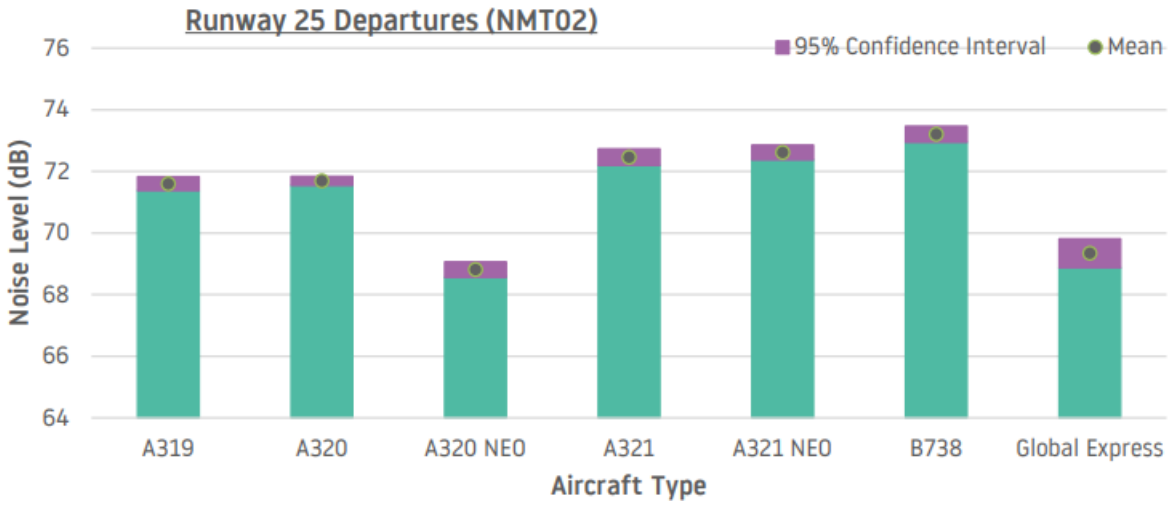
Given the caveats above, and the anomaly already highlighted concerning differences between use of SEL and LAmax, these results should be considered tentative until a more comprehensive study has been performed.

Appendix 1: extracts from LLAOL Quarterly Monitoring Reports

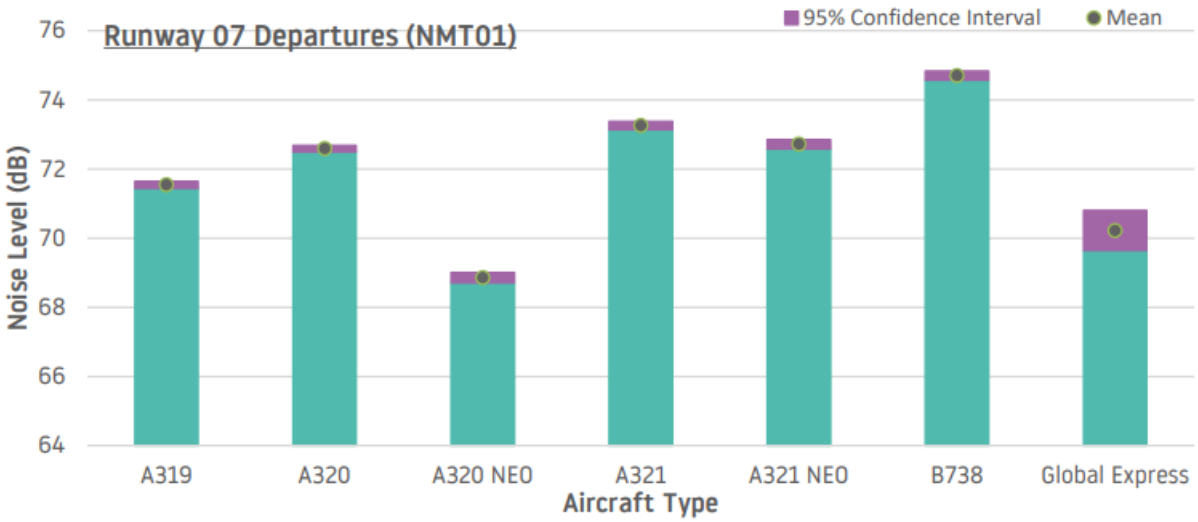
Departure LAmax values at NMT01 (easterly) and NMT02 (westerly) from Q1 2022 to Q3 2023.

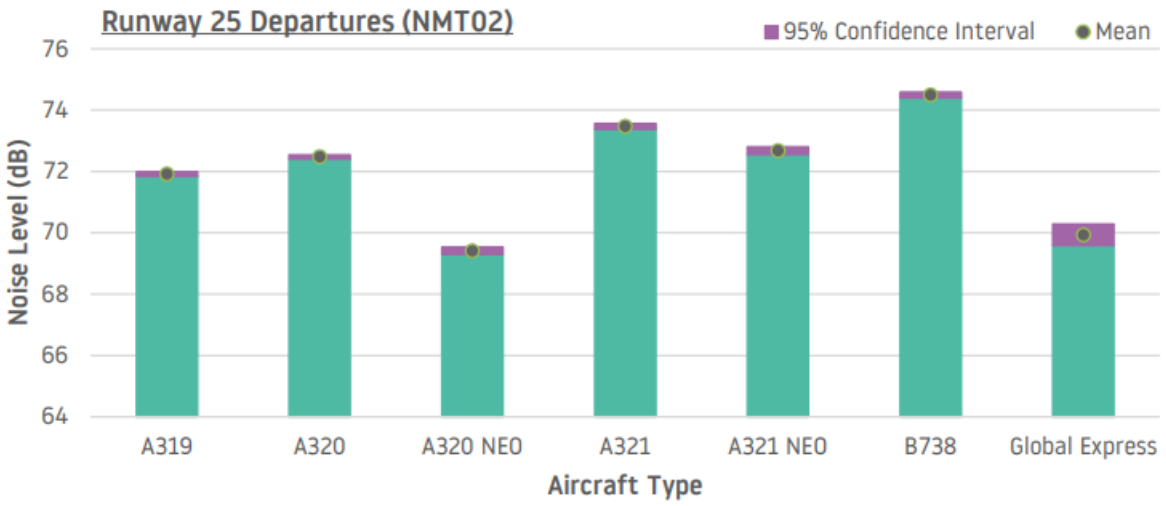
Q1 2022 page 17:



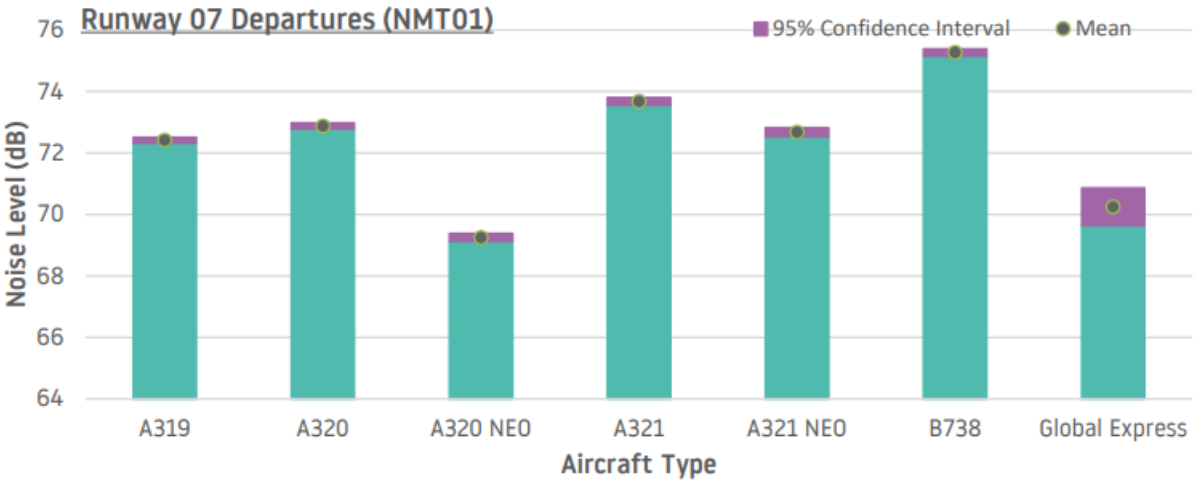


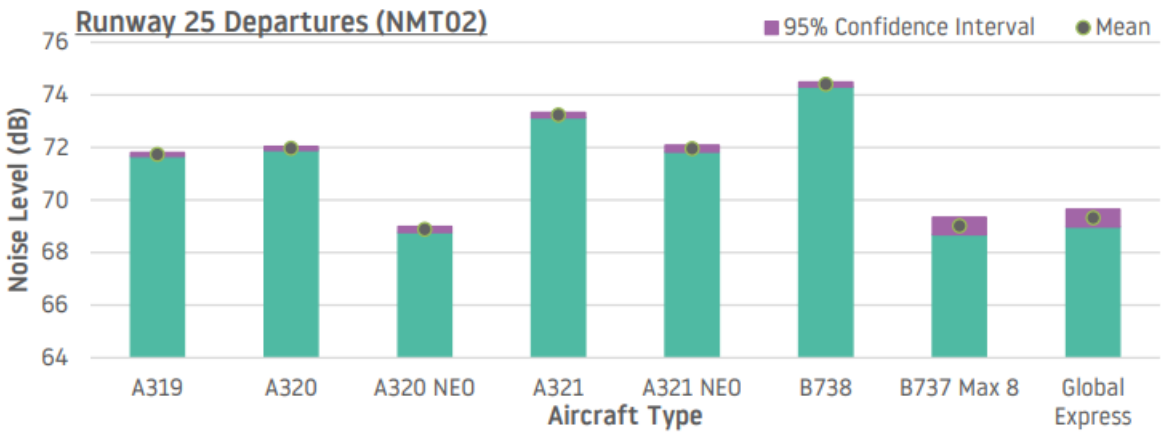
Q2 2022 Page 17:



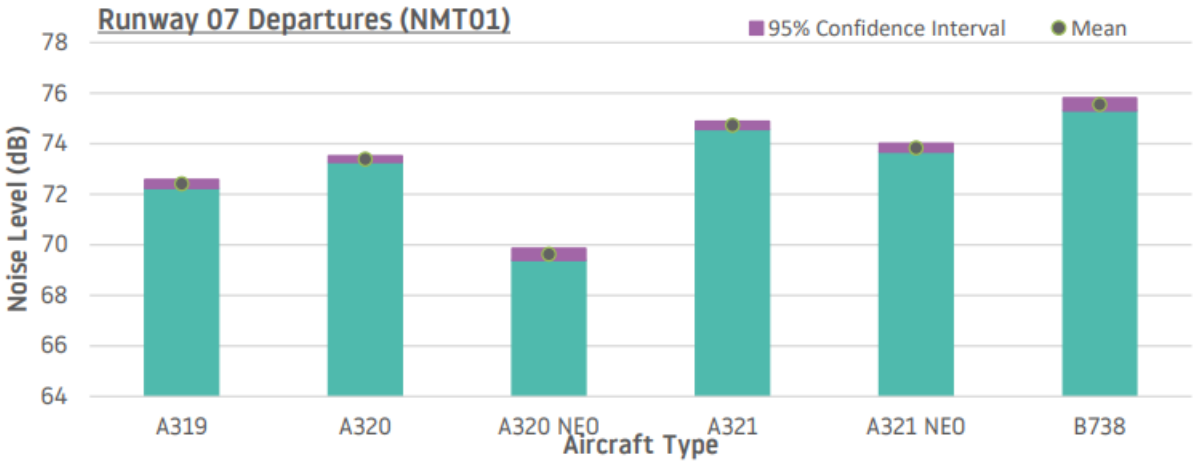


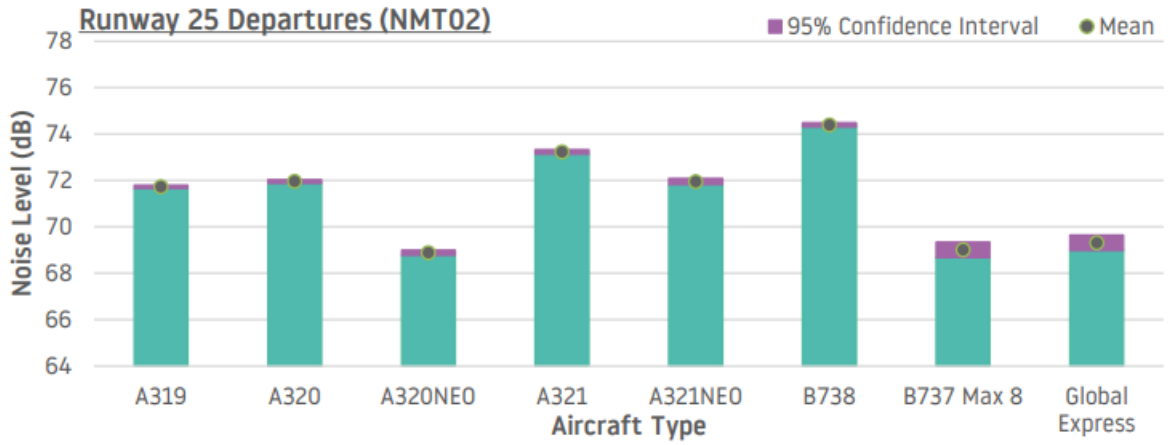
Q3 2022 page 17:



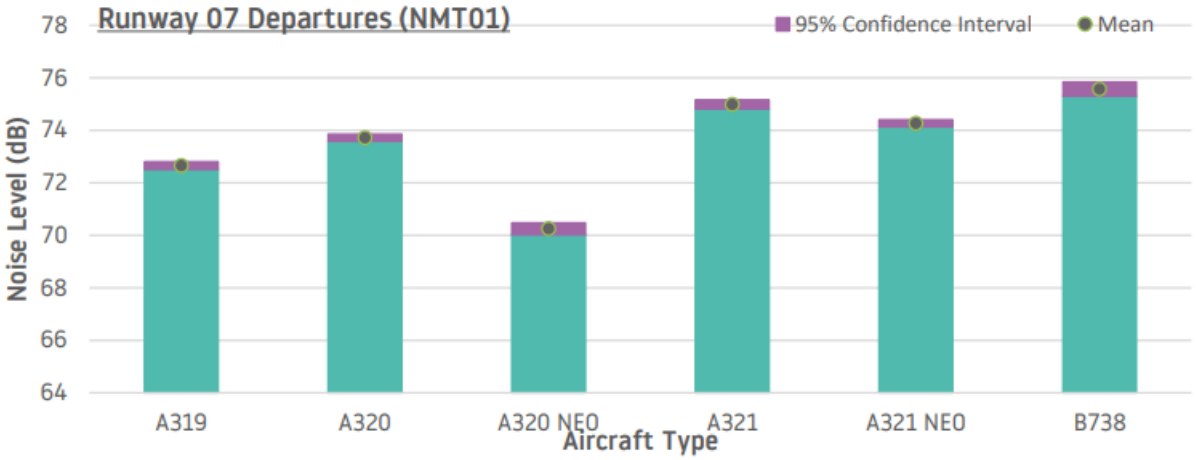


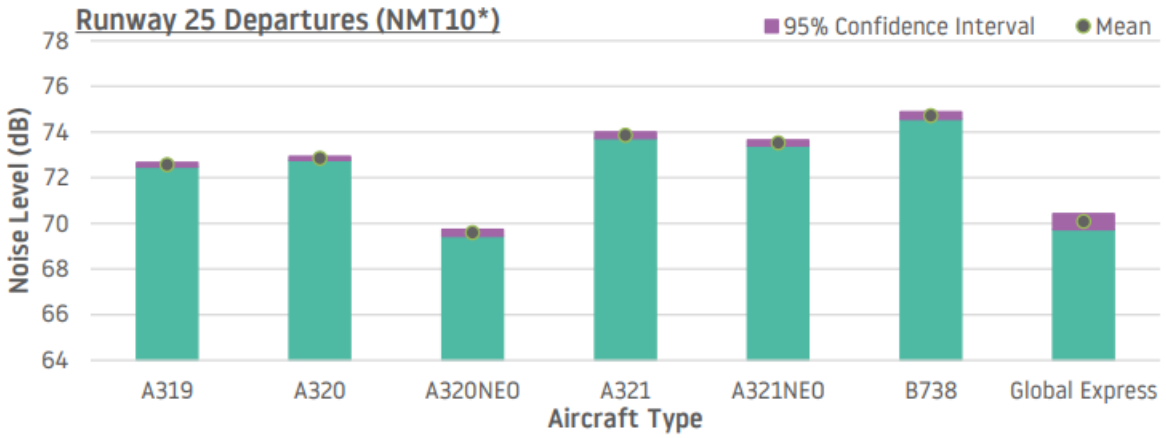
Q4 2022 page 17:



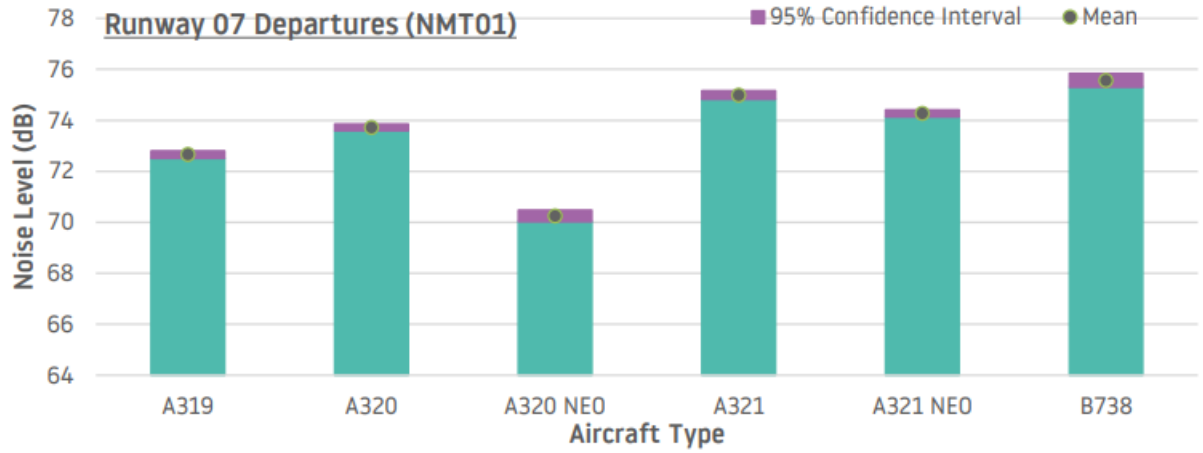


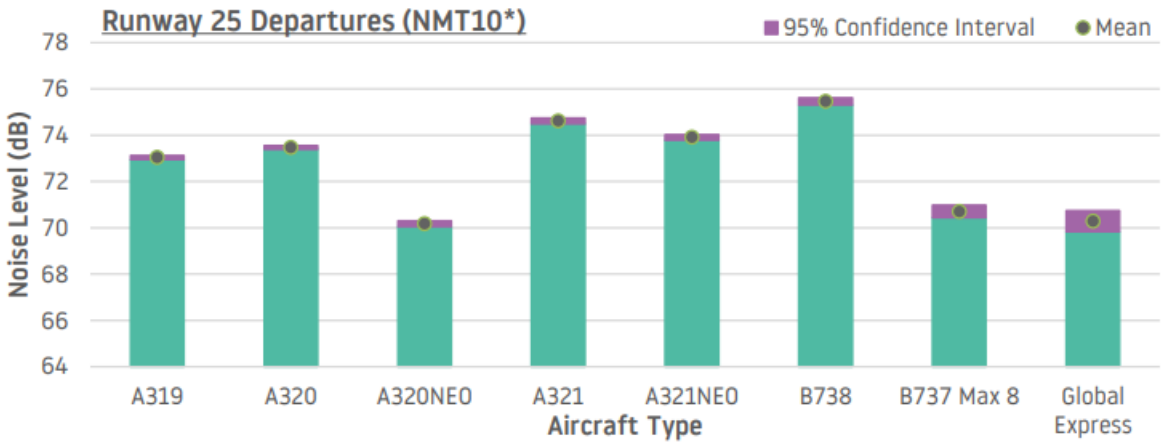
Q1 2023 page 18:





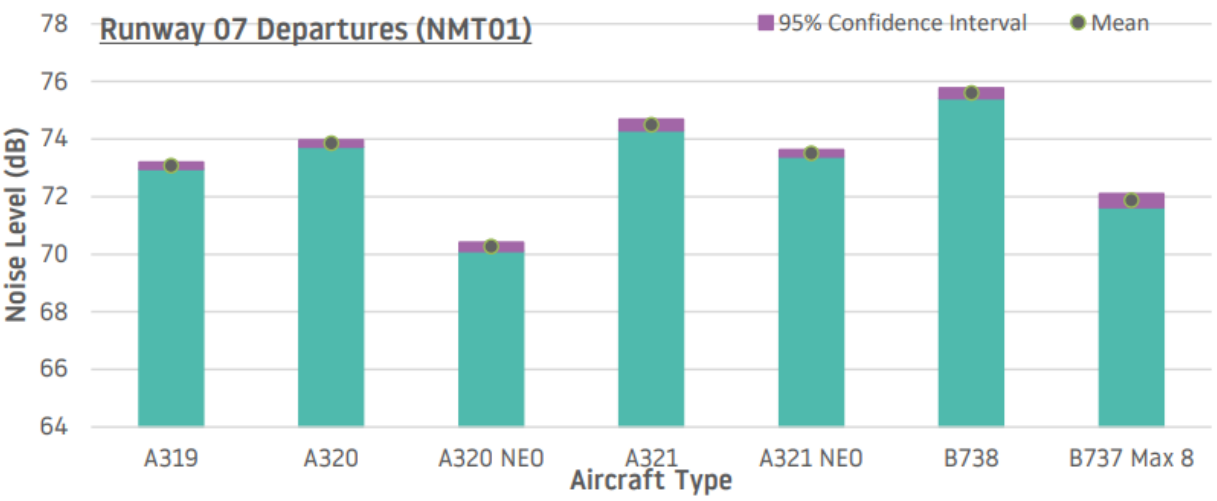
Q2 2023 page 18:

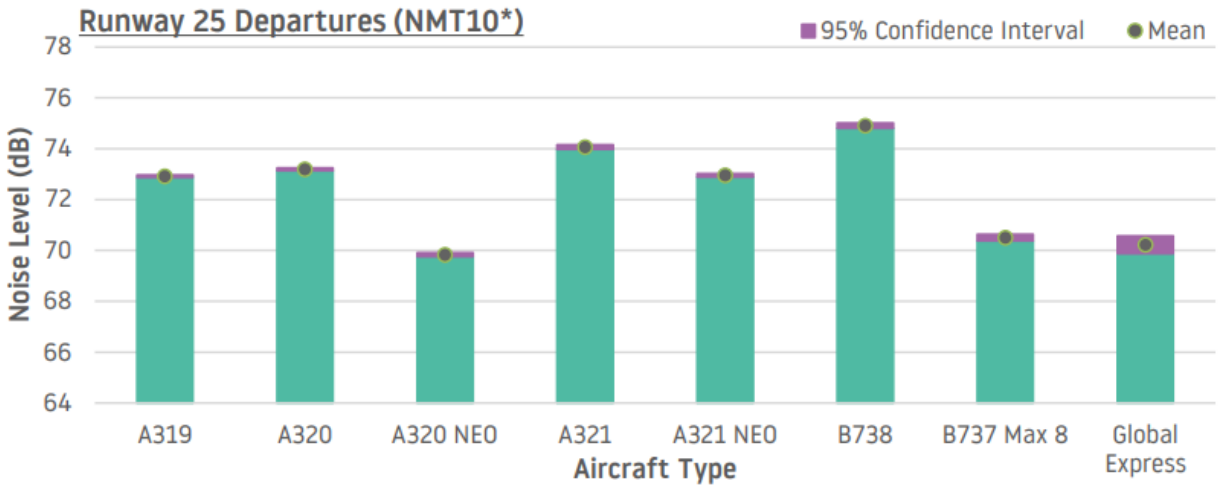




(* monitor NMT02 was replaced by monitor NMT10 at the same location)

Q3 2023 page 18:





Appendix 2: South Luton LAmax noise monitoring on arrival and departure

LLAOL publishes the results of its mobile noise monitoring programme as Community Noise Reports (CNRs), and these can be downloaded from this link:

https://www.london-luton.co.uk/corporate/community/noise/community-noise-reports

We reproduce below the table of LAmax values from the CNR relating to Cutenhoe Road, South Luton, Jan-May 2022 (p 11 and 12):

Noise Results – Easterly Arrivals

Aircraft Type	Number of movements	Average Noise (dB)
A306	50	88.7
A319	766	83.5
A320 CEO	1,542	82.4
A320 NEO (A20N)	551	81.7
A321 CEO	567	82.1
A321 NEO (A21N)	490	83.0
B737-800 NG (B738)	818	84.8
B737 Max 8 (B38M)	48	83.1
Global Express (GLEX)	229	76.9
C56X	146	82.1
GLF6	137	76.9

Noise Results – Westerly Departures

Aircraft Type*	Number of movements	Average Noise (dB)
A306	58	80.6
A319	711	79.7
A320 CEO	1,613	79.0
A320 NEO (A20N)	572	75.9
A321 CEO	475	80.8
A321 NEO (A21N)	473	80.0
B737-800 NG (B738)	749	83.2
B737 Max 8 (B38M)	49	78.5
Global Express (GLEX)	289	77.9
C56X	180	69.5
GLF6	127	75.0

This shows the A321neo on average 0.8dB LAmax less noisy on departure, and 0.9dB LAmax noisier on arrival, compared to the A321ceo.

NB: a later monitoring report from Cutenhoe Road in South Luton is available for the period Jun-Oct 2022, however this has not been used since LLAOL was conducting flight trials in this period.

Appendix 3: Full length runway departures trial report (LLAOL/LADACAN)

Full Length Runway Departure trial

Reminder of the trial arrangement

- Between 17th Feb and 31st Mar 2022 all operators were asked to use the full length of the runway rather than taking off from an intersection
- As the photo shows, this makes a significant difference to available runway length for westerly departures.

LADACAN

Revisited analysis of noise measurements

- The original analysis compared noise measurements at the 6.5km noise gate NMT2 with those for the period a year before the trial, but were inconclusive.
- The revisited analysis conducted with the assistance of LADACAN took account of data available from noise monitor NMT5 in South Luton as well.
- **Hypothesis:**
  The effect of the additional runway length is likely to be most noticeable close in, but may be small due to the way flight control systems utilise the additional distance.

  Given the problem in establishing a "control set" under the same weather conditions, we tested the hypothesis that any effects would only be noticeable at South Luton.
- The analysis looked at the difference between NMT5 and NMT2 readings per flight, therefore minimising the effects of differences in the weather during and after the trial.

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Challenges affecting the trial and useful learning

- NMT2 was recalibrated at the start of the trial and data from before that period was not able to be used because it was lower by more than the effects of the takeoff change
  => for future trials, monitor calibration will be checked before, during, and after

- The data indicated some correlation between headwind speed during takeoff and the noise/altitude achieved at South Luton
  => this effect will be more closely studied both by correlation analysis and discussion with pilots on how the flight control systems compensate for takeoff headwinds

- We noted that NMT5 in South Luton reported many fewer correlated noise events (ie noise measurements ascribed to particular flights) than NMT2
  => investigation showed that many of these had been ruled out by the TopSonic system due to Humidity: before future trials the effects of such settings will be explored

- For the purposes of analysis these readings were where possible correlated for analysis

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Tentative results and conclusion

- Sample sizes for individual aircraft types were relatively small in some cases, but for commercial types with sufficient data, a noise reduction in South Luton of between 0.5 and 0.9dB SEL was seen during the trial compared to after.

- Tentative results across all commercial types was that a benefit of around 0.6dB SEL was experienced at South Luton during trial, with little change observed at NMT2.

- There was little overall difference in average headwind between the trial period and the period after, suggesting that the results are not due to weather differences

- Fleet mix did change during and after the trial, but the overall similarity of results at NMT2 suggests this did not necessarily explain the results

- **Conclusion subject to further understanding: FLRD does slightly reduce noise close in**

LADACAN