Bickerdike Allen Partners

ATTACHMENT C

VALIDATION OF INM PREDICTION

Introduction

A validation exercise has been carried out to improve the accuracy of the noise contours produced for London Luton Airport using the Integrated Noise Model (INM). This has involved the comparison of the measured noise levels of individual aircraft operations at the Noise Monitoring Terminal (NMT) at Frogmore during 2011 with the predicted levels for those operations using INM Version 7.0c. The latest INM predictions take into account the terrain around the airport.

The validation exercise involved a comparison between the average measured SEL (Single Event Level) with the INM predicted SEL. The results from the NMT at Frogmore have been used for the comparisons, specifically the results from between 1st June and 30th December 2011. The NMT is located to the east of the airport, between Whitwell and King's Walden. It is around 4.5 km from the eastern end of the runway close to its extended centre line, and hence close to the route taken by aircraft arriving from the east, the predominant direction. Due to all three departure routes to the east not turning until they are further from the airport, it is also almost directly over flown by many departures.

In 2011 the most common aircraft at London Luton Airport were the Airbus A319 and A320, and the Boeing 737-800. In the 2028 forecast the three most common Aircraft change to the Airbus A320 and A321, and the Boeing 737-800. Looking at these four aircraft, they made up 61% of the movements in 2011 and are forecast to make up 63% in 2028. The average (mean) SELs (Single Event Levels) measured at the NMT for these four aircraft types are given in Table B1.

Table B1 – Measured Noise Levels used for Validation

Aircraft Type	Operation		
		Average	No.
Airbus A319	Arrival Runway 26	84.9	5479
	Departure Runway 08	84.3	1702
Airbus A320	Arrival Runway 26	84.8	4786
	Departure Runway 08	84.7	1369
Airbus A321	Arrival Runway 26	84.6	467
	Departure Runway 08	86.3	137
Boeing 737-800	Arrival Runway 26	86.2	2285
	Departure Runway 08	86.0	655

The validation exercise has considered a total of 28 aircraft types, including all types for which there were at least 100 measured results for either arrivals or departures. These are also the types for which there is generally the most measured results at the monitors.

For each aircraft type there are two sets of measured results, for arrivals and departures. For the individual movements within a set there is some variation, so every arrival or departure by an aircraft type does not produce exactly the same noise level. There are a number of factors which contribute to this, in particular the weather conditions.

Measured Results

The spread of results is illustrated for the four most common aircraft in Figures N(3)-A1 to N(3)-A8 below. The distributions all have the large majority of measured noise levels closely grouped together around the averages, shown as a vertical line on the figures, with a pattern that approximates to a normal distribution with a standard deviation of less than 2 dB. Such distributions of measured noise levels are commonly found at airport fixed noise monitors at a similar distance from the runway.

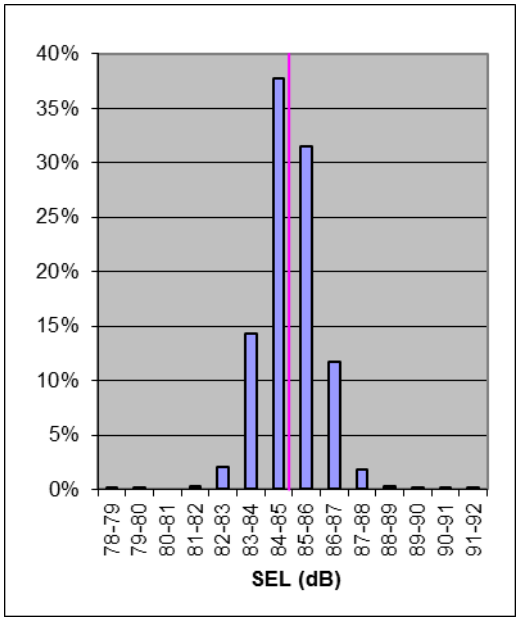

Figure N(3)-A1 – Airbus A319 Arrivals on Runway 26

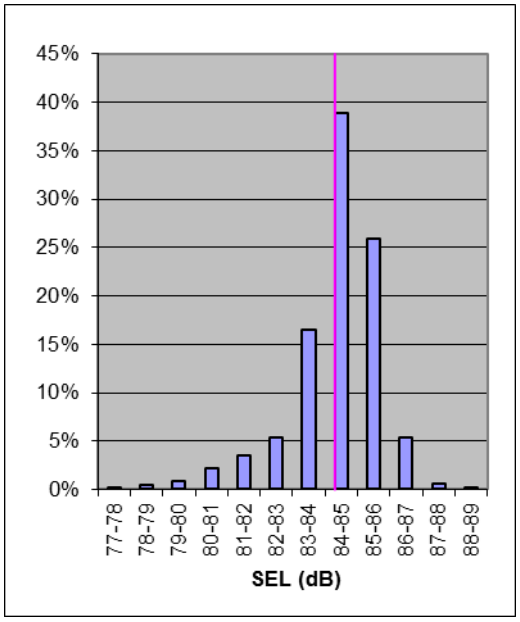

Figure N(3)-A2 – Airbus A319 Departures on Runway 08

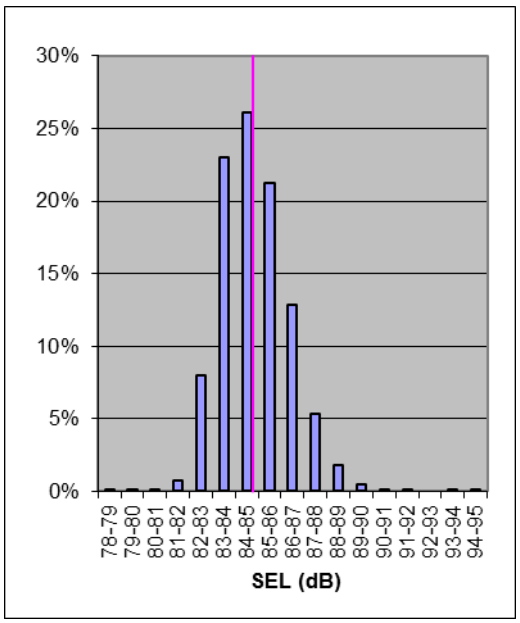

Figure N(3)-A3 – Airbus A320 Arrivals on Runway 26

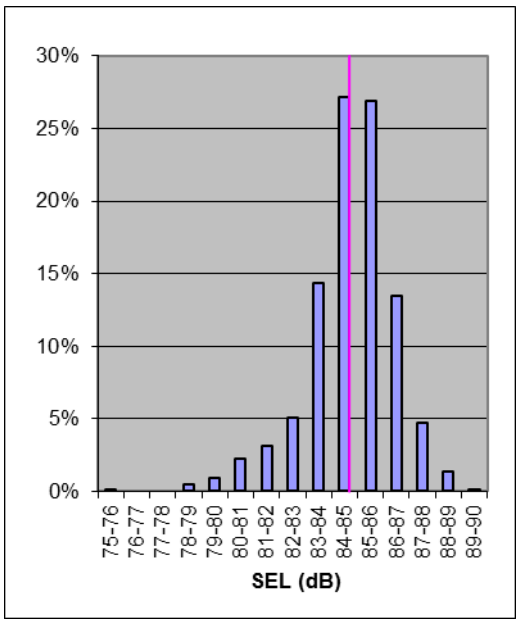

Figure N(3)-A4 – Airbus A320 Departures on Runway 08

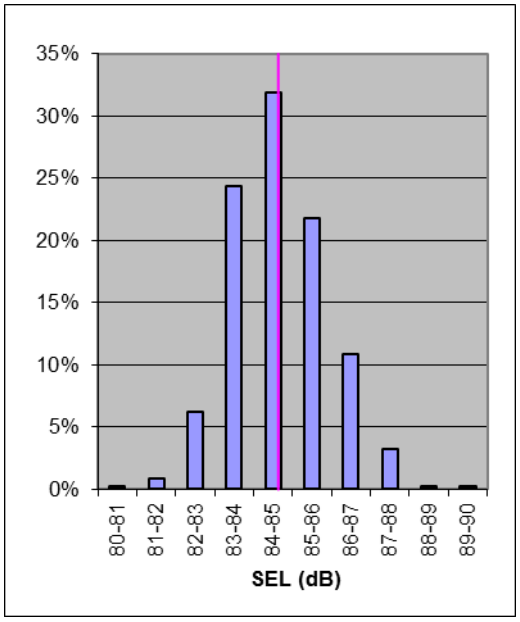

Figure N(3)-A5 – Airbus A321 Arrivals on Runway 26

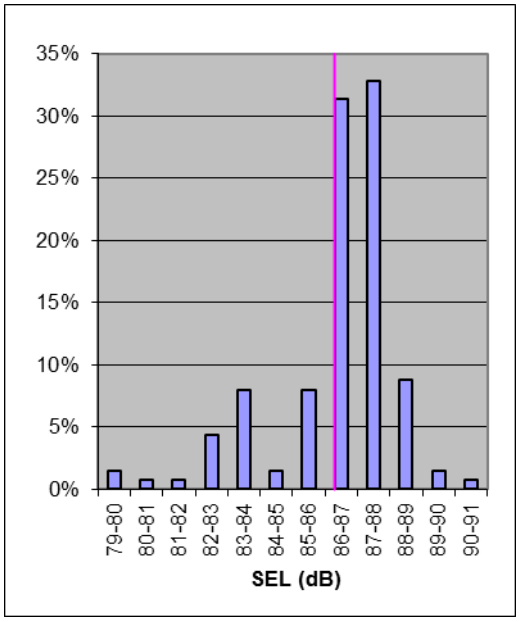

Figure N(3)-A6 – Airbus A321 Departures on Runway 08

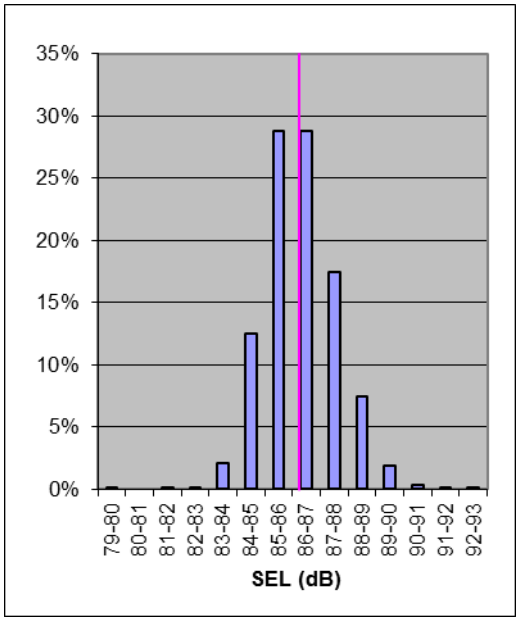

Figure N(3)-A7 – Boeing 737-800 Arrivals on Runway 26

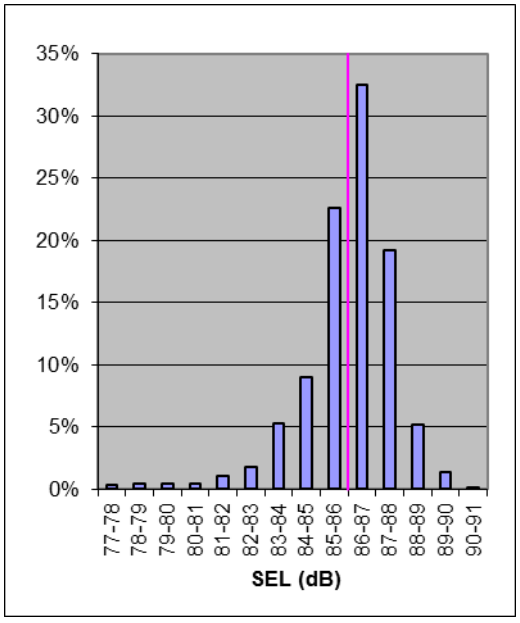

Figure N(3)-A8 – Boeing 737-800 Departures on Runway 08

From the distributions of measured noise levels for each of the aircraft types considered, the averages have been determined and compared to INM standard predicted noise levels. Table B2 gives the latest measured average noise levels for the most common aircraft types.

Table B2 – Measured and Standard Predicted Noise Levels

Aircraft Type	Operation	Stage Length	Measured Noise Levels (SEL dB)	INM Standard Assumptions	
				Type	Level (SEL dB)
Airbus A319	Arrival Rwy 26	1	84.9	A319-131	84.5
	Departure Rwy 08	2	84.3		81.4
Airbus A320	Arrival Rwy 26	1	84.8	A320-211	85.2
	Departure Rwy 08	2	84.7		83.0
Airbus A321	Arrival Rwy 26	1	84.6	A321-232	84.8
	Departure Rwy 08	4	86.3		85.3
Boeing 737-800	Arrival Rwy 26	1	86.2	737800	86.6
	Departure Rwy 08	3	86.0		85.7

Predicted Results

Also included in Table B2 are the standard INM aircraft types and the resulting predicted noise levels. For all the departure predictions above the most common Stage Lengths flown in 2011 by each aircraft type have been used.

Approach to Validation

The approach to validation modifications has been to only change from the INM standard type, when the measured results show clear divergence, i.e. an apparent prediction error of at least 1.5 dB. Also the approach seeks to determine any modification by aircraft type and aircraft operation, but not by runway used. This means one modification is adopted for all arrivals by an aircraft type, and one for all departures by an aircraft type.

Comparison of Measured and Predicted Results (Table B2)

For all four aircraft shown in Table B2 on arrival the predicted levels are close to the measured levels (all are within 0.5 dB) and so no modification has been made. This is also the case for departures by the Airbus A321 and the Boeing 737-800, however for departures by the Airbus A319 and A320 there are differences of more than 1.5 dB between the measured and predicted results so modifications have been made.

In cases where the measured and predicted results do not agree, there are four basic assumptions that can be varied:

- The number of actual movements can be altered resulting in an effective number of movements which are input into the model. For example if the aircraft is consistently measured as quieter than predicted by the INM model using standard assumptions, then the effective number of movements will be less than the actual number of movements. This correction between the actual and effective number of movements is made using the formula for L_{Aeq}, the unit for the contours.
- An alternative aircraft type can be used.
- A new or revised aircraft type can be created which better agrees with the measured data.

- For departures, the stage length can be varied. This relates to the departure weight of the aircraft.

In the case of the Airbus A319 and A320 departures only a modification to the number of movements is required.

This procedure has been followed for all 28 aircraft considered as part of this exercise. The resulting modelling assumptions used for INM are given in Table B3.

To ensure that measurements used for validation are robust, consideration has been given to the number available for a particular aircraft. Where these are limited they are not taken into consideration and/or findings for these aircraft at other airports are used.

Summary

The validation exercise finds that for a number of aircraft types it has been necessary to modify the INM assumptions and these are highlighted in Table B3 which shows the assumptions used for all of the aircraft assessed.

Compared to the measured noise levels in 2011, the default INM predictions are generally similar on arrival but show an underprediction for some aircraft on departure. Taking the movement-weighted average, the difference between measured and default predicted levels is 0.1 dB on arrival and 1.6 dB on departure. As a result of the validation exercise this difference is reduced to 0.1 dB on arrival and 0.0 dB on departure.

Table B3 – INM Assumptions following Validation Exercise

Aircraft Type	Modelled INM Arrival Assumptions		Modelled INM Departure Assumptions		
	INM Type	Movement Multiplier	INM Type	Movement Multiplier	Stage Length
A306	A300-622R	0.7	A300-622R	1.8	2
A30B	A300B4-203	1.5	A300B4-203	1.5	2
A319	A319-131	1	A319-131	2	2
A320	A320-211	1	A320-211	1.5	2
A321	A321-232	1	A321-232	1	4
AT43	DO328	1	DHC6	1	1
ATP	DO328	1.7	DHC6	1	1
B733	737300	1.7	737300	1.5	1
B734	737400	2	737400	1	4
B737	737700	0.6	737700	1	2
B738	737800	1	737800	1	3
B752	757RR	1	757RR	1	4
B763	767300	1	767300	1	1
C510	CNA510	1	767300	1	4
C525	CNA525C	2	CNA510	1	1
C550	CNA500	1	CNA525C	1.5	1
C56X	CNA560XL	1	CNA525C	1	1
CL30	CL601	1	CNA560XL	1.5	1
CL60	CL600	2	CL601	1.7	1
DH8D	SD330	1	CL600	0.6	1
E135	EMB145	1	DHC6	0.6	1
F2TH	CL600	1.5	EMB145	2	1
F900	CL601	1	CL600	1	1
GLEX	GV	1	F10062	1	1
GLF4	GIV	1	GV	1	1
GLF5	GV	1	GIV	2	1
H25B	LEAR35	1	GV	1	1
LJ45	LEAR35	1	CL600	1	1