Bickerdike Allen Partners
Architecture
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LONDON CITY AIRPORT

AIRCRAFT NOISE SURVEY

LAMBETH

Report to

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Acoustic Consultants: Expertise in planning and noise, the control of noise and vibration and the sound insulation and acoustic treatment of buildings.

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Contents

Page No.

1.0 Introduction 4

2.0 Survey Details 4

3.0 Survey Results and Discussion 7

4.0 Analysis of Results 12

5.0 Summary 13

Appendix 1: Glossary of Acoustic Terminology

1.0 INTRODUCTION

Bickerdike Allen Partners LLP (BAP) have been commissioned by London City Airport (LCA) to carry out a noise survey of passing aircraft at Roots and Shoots, Walnut Tree Walk, Lambeth SE11 6DN. The purpose of the survey was to measure the noise level under the flight path of LCA arrivals and also to assess the effect of aircraft using London Heathrow Airport (LHA).

The measurement location was around 11 km to the west of LCA, between Waterloo and The Oval. It is typically overflown by aircraft on an easterly approach to LCA, as they turn to line up with the runway for their final approach. Some aircraft using LHA also pass close to this location when arriving during periods of westerly operations. This report provides a summary of the noise measurements.

A glossary of acoustic terminology is provided in Appendix 1.

2.0 SURVEY DETAILS

2.1 Methodology

Environmental noise measurements were carried out in general accordance with BS 7445[1].

BAP visited the property and set up a noise monitor on the roof terrace, which faces west. The monitor recorded noise data continuously for 18 days between 18th April and 5th May.

This period was chosen as a mixture of easterly and westerly winds was forecast, meaning measurements could be taken for both westerly (runways 27L & 27R) aircraft operations at LHA, as well as the easterly (runway 09) aircraft operations at LCA. Easterly winds occurred for at least some part of 12 days during the measurement period.

2.2 Equipment

The equipment used for the long term survey was an 01dB DUO Smart Noise Monitor, mounted on a tripod. The monitor was calibrated at the start and end of the measurement, and no significant drift was observed.

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[1] BS 7445-1:2003 *Description and measurement of environmental noise*

ISO 20906 recommends that measurements of aircraft noise be taken at least 6 m above the ground and at least 10 m from any reflecting surface other than the ground, however this is not usually practical to achieve in built up areas. The monitor was located approximately 3 m above the roof terrace, and above the height of the terrace side walls to minimise any effect of reflections. Increases due to reflection effects can typically vary between 1 dB to 3 dB depending on the location of the microphone relative to surrounding reflecting objects. The monitor location is shown in Figure 1 and Figure 2.

Figure 1: Noise monitor location, view facing south east

Figure 2: Noise monitor location, view facing south west

3.0 SURVEY RESULTS AND DISCUSSION

3.1 Background Noise Levels

The main background noise sources were road traffic and birdsong. Other than aircraft using London City and London Heathrow airports, the main regular sources of noise maxima were sirens from emergency vehicles and helicopters. Some of the helicopters operate from the nearby St Thomas' Hospital and most of the remainder are flying along the river, which brings them close to the survey location. During the daytime (07:00 to 23:00), the average noise level over the survey period (total from all sources) was 55 dB $L_{Aeq,16h}$ and the average background noise level was 42 dB L_{A90}.

3.2 Flight Tracks – London City Airport

LCA have provided BAP with the aircraft movement data and flight track data for the monitoring period. Figure 3 shows the runway 09 arrival radar tracks during the monitoring period, with the measurement location marked by a green spot. It can be clearly seen that arrivals using runway 09 pass very close to directly above the property. From a review of track data aircraft approaching LCA are typically at an altitude of around 2,000 ft above sea level at this location.

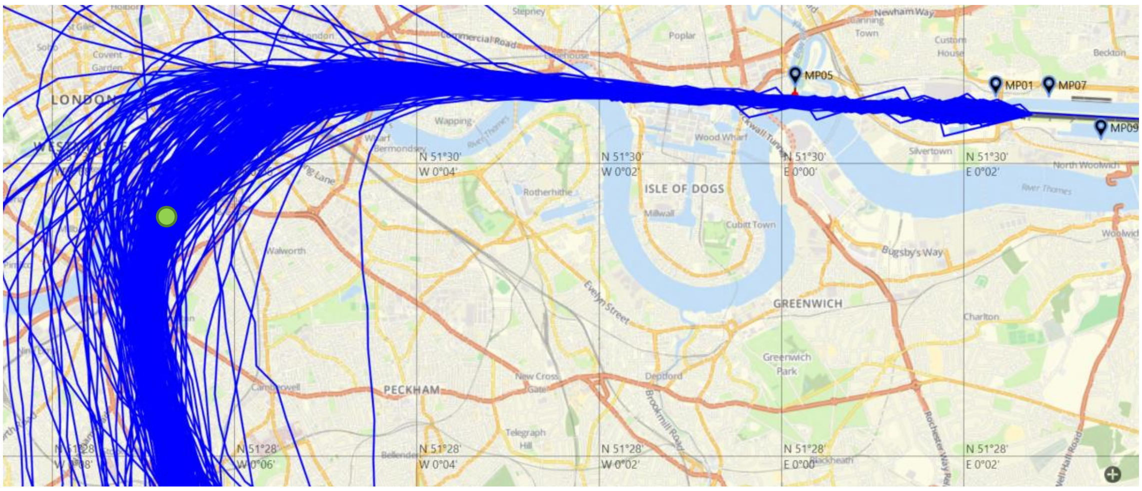

Figure 3: LCA Runway 09 Arrivals During Measurement Period

3.3 Flight Tracks – London Heathrow Airport

The property is also overflown by some aircraft arriving at LHA during periods of westerly operations (runways 27L/27R), although the majority of LHA aircraft do not pass particularly close. LHA have a publicly available tool[2] called "WebTrak My Neighbourhood" which shows the typical distribution of flights around the airport. Figure 4 shows the output from this tool for arrival tracks in the vicinity of the measurement location at Roots and Shoots, marked by the image of a house. This shows that the measurement location is at the edge of the swathe of aircraft approaching runways 27L/27R from the north. Approximately 40% of LHA arrivals use this swathe, however only those at the outer edge fly directly over the measurement location.

A related tool, "WebTrak", allows inspection of individual flights. An extract from this is shown in Figure 5 for a typical example of an LHA flight passing close to the measurement location. LHA aircraft are typically at an altitude of approximately 4,000 ft when passing the measurement location.

Figure 4: LHA Typical Arrival Distribution

[2] http://myneighbourhood.bksv.com/lhr/

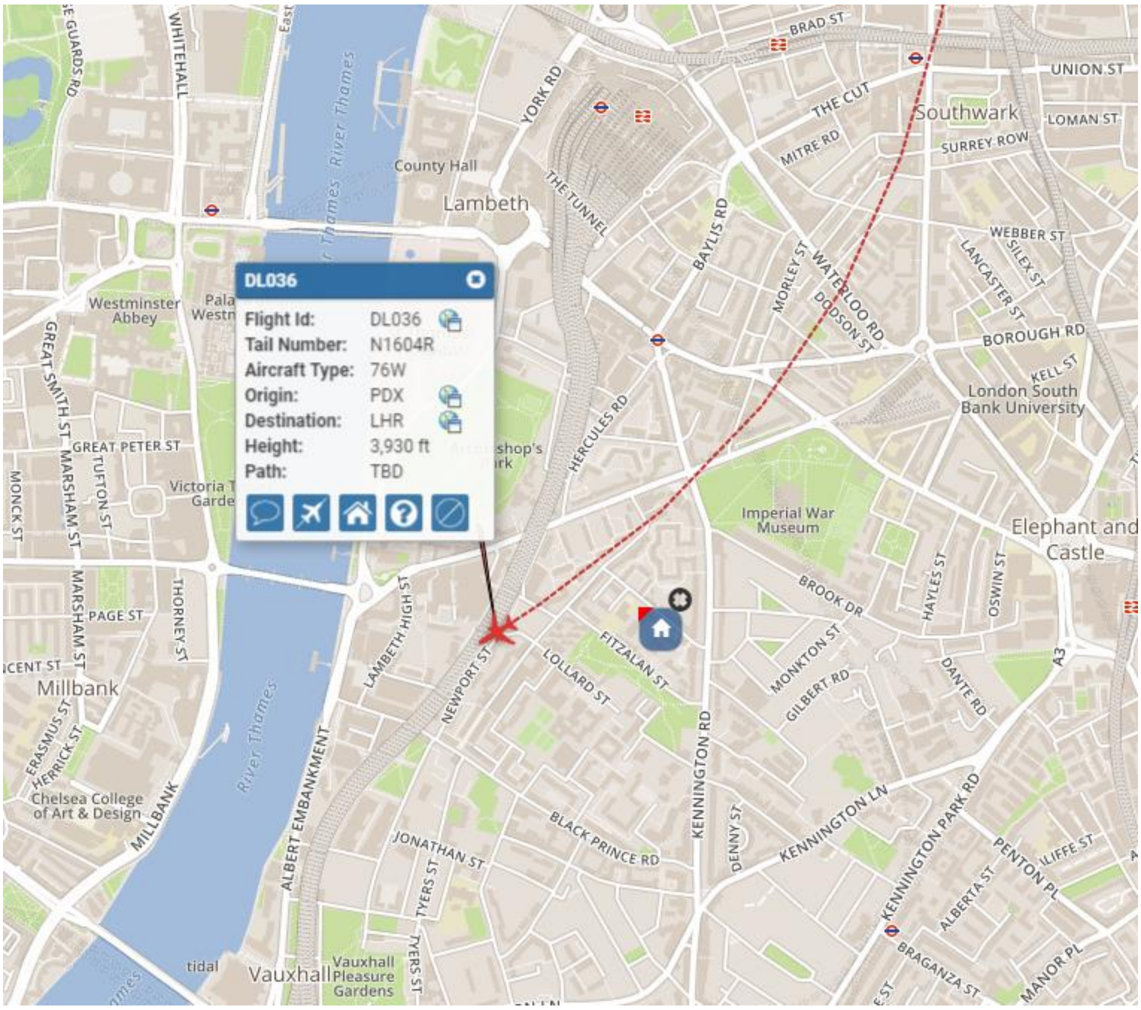

Figure 5: Example of Runway 27 Heathrow Arrival Track Passing Close to Measurement Location

3.4 Noise Measurements – LCA aircraft

The unattended noise monitoring data was processed by BAP to correlate the measured noise levels with the LCA aircraft movement data.

The LCA aircraft noise events were caused by aircraft approaching LCA using runway 09. Other aircraft using LCA do not pass close to this location and are therefore unlikely to be audible.

During the measurement period there were 1,109 arrivals at LCA using runway 09. Of these, 1,016 (92%) were correlated with a noise event. This is considered to be sufficient to give broadly representative noise levels for the most common aircraft operations. The correlated aircraft noise events are summarised in Table 1.

Aircraft	No. Correlated	Average L_{ASmax} (dB)
Airbus A220-100 (previously Bombardier CS100)	35	69
De Havilland Dash 8-400	148	66
Embraer E170	118	71
Embraer E190	587	72
Avro RJ85	52	68
Others	76	68
Total	1,016	70

Table 1: Summary of Noise Results – LCA Aircraft

3.5 Noise Measurements – LHA aircraft

The unattended noise monitoring data was processed by BAP to correlate the measured noise levels with the LHA aircraft movement data.

The LHA aircraft noise events were caused by aircraft approaching runway 27L or 27R. Some of these aircraft approach from the north and pass close to the measurement location when turning onto the extended centreline of the runway they are approaching. As the aircraft were significantly higher than the LCA aircraft, some of the quieter aircraft did not produce high enough noise levels to register a reliable noise event.

Aircraft departing LHA using runway 09L or 09R typically turn to the north or south before reaching the measurement location. Therefore aircraft departing LHA did not register reliable noise events (at least 60 dB L_{ASmax}) at the measurement location.

During the measurement period there were a total of 8,034 arrivals at LHA using runway 27L or 27R. Of these, 203 (3%) were correlated with a noise event. This low correlation rate is due to the fact that the majority of LHA arrivals did not pass close enough to the measurement location to register a reliable noise event. The resulting events are however still considered to be sufficient to give broadly representative noise levels for the most common aircraft types when flying in the northern edge of the swathe.

Aircraft	No. Correlated	Average L_{ASmax} (dB)
Airbus A319	33	66
Airbus A320	46	65
Airbus A320neo	24	64
Airbus A321	22	65
Airbus A330	8	68
Airbus A380	13	68
Boeing 747	7	70
Boeing 777	25	66
Boeing 787	14	64
Others	11	67
Total	203	66

Table 2: Summary of Noise Results – LHA Aircraft

4.0 ANALYSIS OF RESULTS

The average maximum noise level for individual LCA aircraft during the measurement period was 70 dB L_{ASmax}. The loudest aircraft type among the LCA aircraft was the Embraer E190, which averaged 72 dB L_{ASmax}. The LHA aircraft averaged a slightly lower noise level of 66 dB L_{ASmax}. The loudest LHA aircraft type was the Boeing 747, which averaged 70 dB L_{ASmax}.

Aircraft noise in the UK is commonly assessed in terms of the $L_{Aeq,16h}$ metric for the average "summer" day, which is the average noise level produced by aircraft over a 16-hour daytime period for the 92-day "summer", defined as 16th June to 15th September inclusive. As LCA operates from 06:30 to 22:30, the full extent of operations is deemed as daytime for this purpose. This is consistent with LCA's sound insulation eligibility criteria.

The noise level of the correlated aircraft movements averaged over the measurement period was 51 dB $L_{Aeq,16h}$ for LCA aircraft and 39 dB $L_{Aeq,16h}$ for LHA aircraft. The significantly lower contribution from the LHA aircraft is mainly due fewer LHA aircraft passing close to the measurement location.

During the measurement period, 57% of the aircraft at LCA used runway 09 and 54% of the aircraft at LHA used runway 27L or 27R. The long term average runway usage has 34% of the aircraft at LCA using runway 09, and 28% of the aircraft at LHA using runway 27L or 27R. Therefore the noise level over the measurement period is considered to be higher for LCA aircraft and lower for LHA aircraft than is typical. If the measurements are extrapolated to typical runway usage, this would result in a noise level of 49 dB $L_{Aeq,16h}$ for LCA aircraft and 41 dB $L_{Aeq,16h}$ for LHA aircraft. This gives a combined noise exposure level of 49 dB $L_{Aeq,16h}$ and is the value that relates to an average summer day of operations. This is the value used to rate community response to air noise in the UK, as recommended by the Government[3].

Although at several times during the survey there were relatively short periods where runway 09 was being used at LCA and runways 27L/27R were being used at LHA at the same time, it is very rare that this occurs for an entire 16 hour daytime period. If however this did occur this would represent a worst case. The noise level would be 53 dB $L_{Aeq,16h}$ from LCA aircraft and 42 dB $L_{Aeq,16h}$ from LHA aircraft, for a total noise level of 54 dB $L_{Aeq,16h}$ on that day.

This means that the aircraft noise level at the measurement location is significantly below LCA's sound insulation First Tier Scheme eligibility criterion of 57 dB $L_{Aeq,16h}$ average daytime aircraft noise level. It is however recognised that some people will be annoyed by levels lower than this (and conversely others may find higher noise levels acceptable)[3].

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[3] Aviation Policy Framework, 2013

5.0 SUMMARY

BAP have measured the noise levels over an 18 day period at a location in Lambeth that is overflown by aircraft using both London City Airport (LCA) and London Heathrow Airport (LHA).

Maximum noise levels from individual LCA and LHA flights were broadly similar.

The average 16 hour daytime aircraft noise level measured was 51 dB $L_{Aeq,16h}$. This is louder than typical as there were more easterly operations than average. When taking account of conditions over an average summer day, as is used to rate community response in the UK, the combined noise level from LCA and LHA flights is 49 dB $L_{Aeq,16h}$.

On the worst case assumption for this location that all LCA aircraft operate in an easterly direction, this equates to a noise level of 53 dB $L_{Aeq,16h}$ due to them. Under westerly operations, some aircraft arriving at LHA pass close to the property. Using the equivalent worst case assumption that all LHA aircraft operate in a westerly direction, this equates to a noise level of 42 dB $L_{Aeq,16h}$ due to them. The lower noise level from the LHA aircraft is mainly due fewer LHA aircraft passing close to the measurement location.

The worst case situation for this location is when LCA is operating under easterly conditions and LHA is operating under westerly conditions. In this situation, the noise contribution of the LHA flights is relatively insignificant, increasing the overall noise level by less than 1 dB.

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APPENDIX 1

GLOSSARY OF ACOUSTIC TERMINOLOGY

Sound

This is a physical vibration in the air, propagating away from a source, whether heard or not.

The Decibel, dB

The unit used to describe the magnitude of sound is the decibel (dB) and the quantity measured is the sound pressure level. The decibel scale is logarithmic and it ascribes equal values to proportional changes in sound pressure, which is a characteristic of the ear. Use of a logarithmic scale has the added advantage that it compresses the very wide range of sound pressures to which the ear may typically be exposed to a more manageable range of numbers. The threshold of hearing occurs at approximately 0 dB (which corresponds to a reference sound pressure of 2 x 10^{-5} Pascals) and the threshold of pain is around 120 dB.

The sound energy radiated by a source can also be expressed in decibels. The sound power is a measure of the total sound energy radiated by a source per second, in watts. The sound power level, L_w is expressed in decibels, referenced to 10^{-12} watts.

Frequency, Hz

Frequency is analogous to musical pitch. It depends upon the rate of vibration of the air molecules that transmit the sound and is measure as the number of cycles per second or Hertz (Hz). The human ear is sensitive to sound in the range 20 Hz to 20,000 Hz (20 kHz). For acoustic engineering purposes, the frequency range is normally divided up into discrete bands. The most commonly used bands are octave bands, in which the upper limiting frequency for any band is twice the lower limiting frequency, and one-third octave bands, in which each octave band is divided into three. The bands are described by their centre frequency value and the ranges which are typically used for building acoustics purposes are 63 Hz to 4 kHz (octave bands) and 100 Hz to 3150 Hz (one-third octave bands).

A-weighting

The sensitivity of the ear is frequency dependent. Sound level meters are fitted with a weighting network which approximates to this response and allows sound levels to be expressed as an overall single figure value, in dB(A).

Sound Transmission in the Open Air

Most sources of sound can be characterised as a single point in space. The sound energy radiated is proportional to the surface area of a sphere centred on the point. The area of a sphere is proportional to the square of the radius, so the sound energy is inversely proportional to the square of the radius. This is the inverse square law. In decibel terms, every time the distance from a point source is doubled, the sound pressure level is reduced by 6 dB.

Road traffic noise is a notable exception to this rule, as it approximates to a line source, which is represented by the line of the road. The sound energy radiated is inversely proportional to the area of a cylinder centred on the line. In decibel terms, every time the distance from a line source is doubled, the sound pressure level is reduced by 3 dB.

Factors Affecting Sound Transmission in the Open Air

Reflection

When sound waves encounter a hard surface, such as concrete, brickwork, glass, timber or plasterboard, it is reflected from it. As a result, the sound pressure level measured immediately in front of a building façade is approximately 3 dB higher than it would be in the absence of the façade.

Screening and Diffraction

If a solid screen is introduced between a source and receiver, interrupting the sound path, a reduction in sound level is experienced. This reduction is limited, however, by diffraction of the sound energy at the edges of the screen. Screens can provide valuable noise attenuation, however. For example, a timber boarded fence built next to a motorway can reduce noise levels on the land beyond, typically by around 10 dB(A). The best results are obtained when a screen is situated close to the source or close to the receiver.

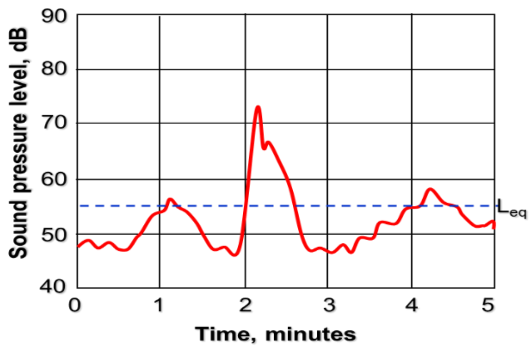
Meteorological Effects

Temperature and wind gradients affect noise transmission, especially over large distances. The wind effects range from increasing the level by typically 2 dB downwind, to reducing it by typically 10 dB upwind – or even more in extreme conditions. Temperature and wind gradients are variable and difficult to predict.

Environmental Noise Descriptors

Where noise levels vary with time, it is necessary to express the results of a measurement over a period of time in statistical terms. Some commonly used descriptors follow.

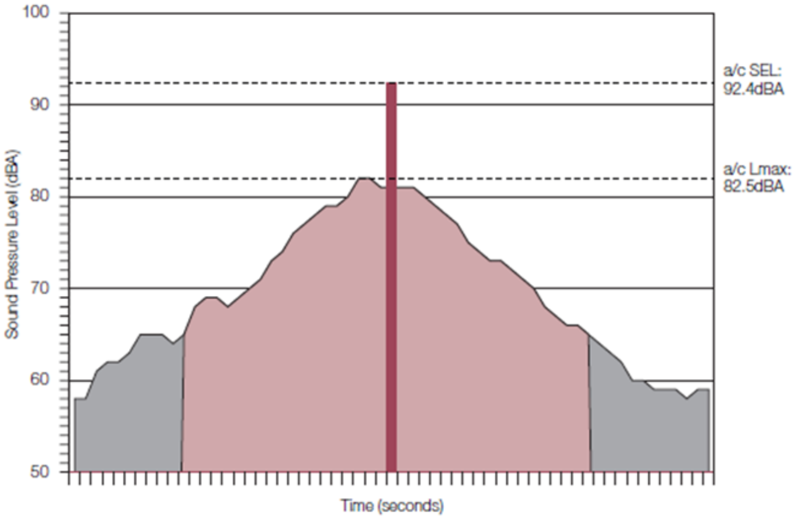
Statistical Term	Description
$L_{Aeq,T}$	The most widely applicable unit is the equivalent continuous A-weighted sound pressure level ($L_{Aeq,T}$). It is an energy average and is defined as the level of a notional sound which (over a defined period of time, T) would deliver the same A-weighted sound energy as the actual fluctuating sound. This is shown in the graph below:



L_{A90}	The level exceeded for 90% of the time is normally used to describe background noise.
$L_{Amax,T}$	The maximum A-weighted sound pressure level, normally associated with a time weighting, F (fast), or S (slow)

Sound Exposure Level (SEL)	An SEL is a measure the total noise from an aircraft movement. The SEL noise level for an aircraft movement is the sum of all the noise energy for the event expressed as an average noise level for 1 second. This is shown in the graph below:

Figure 3.1: Aircraft time history, showing maximum level L_{Amax} and associated Sound Exposure Level (SEL)[41]



Source: CAA data