Heathrow Community Noise and Track-keeping Report: Hendon

This document reports on an 92-day period of continuous noise monitoring from the 1 August 2012 to the 31 October 2012 using a Larson Davies LD 870 sound monitor placed on the site of the Royal Air Force Museum, Hendon (positioned at 51° 35′ 49.38" N, 0° 14′ 18.53" W, 171 feet elevation). All timings are local.

Background

Heathrow Airport is committed to limiting the impacts of noise on communities around the Airport and publishes a Noise Action Plan in accordance with National and European Regulations. An objective of the plan is to better understand local noise concerns and priorities by establishing a Community Noise and Track Monitoring Programme. As part of this Programme, the Airport has agreed with local stakeholders, represented on the Noise and Track Keeping Working Group (NTKWG), that flight tracks and (where possible) noise levels affecting local communities would be examined through a series of 3-4 month studies. The studies are organised so that the noise and flight tracks are analysed over the monitoring period based on a 'grid' of local communities, defined and agreed with the NTKWG and shown below in Figure 1. The impact on the community within the grid square is then reported at the end of the monitoring period.

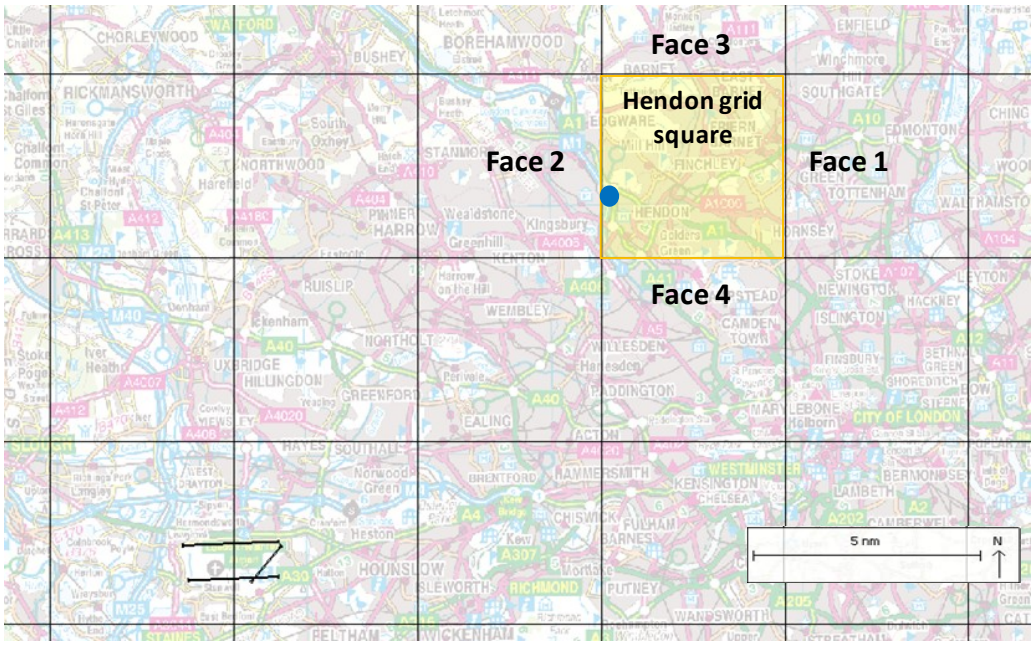

Figure 1. Map of the Heathrow area with noise monitoring grid; position of the noise monitor shown as a blue dot in the yellow shaded grid (the Hendon community grid square area)

This report describes the noise levels and aircraft tracks affecting the 'Hendon' grid square, shown above. Noise levels were recorded by a temporary noise monitor situated at the Royal Air Force Museum (position indicated by the blue dot). The noise monitor was located under the flight paths of aircraft making their approach to Heathrow's easterly and westerly runways, and under the flight paths of aircraft that had initially followed the Brookmans Park and Buzad Standard Instrument Departure (SID) routes after departing from Heathrow. Flight movements of air traffic through the grid square were derived from the Airport's noise and track-keeping system. Explanations of technical terms used in this report can be found on page 9.

Flight movements

Operational background: Heathrow Airport operates in either a 'westerly' or 'easterly' direction as shown in Figure 2 on page 2. Westerly operations are typically operated when the wind comes from the west and, as a long-term annual average over 20 years, are in force for 71% of the time. Easterly operations, typically operated when the wind is in an easterly direction, are in force for the remaining 29% of the time. Shorter term fluctuations between westerly and easterly operations can vary considerably from this approximate long-term 70:30 split. During the daytime there is a preference for westerly operations. This means that during periods of light easterly winds the Airport operates in a westerly direction. This preference does not operate at night.

During westerly operations runway alternation is applied. This provides for one runway to be used for arrivals from 06:00 until 15:00 and the other runway to be used for arrivals from 15:00 until after the last departure of the day, after which landing aircraft use the first runway again until 06:00. The runway alternation pattern changes by week; in alternation pattern 1 (week commencing 2 January in 2012) the designated arrivals runway is 27R between 06:00-15:00 (Figure 2; 'Westerly operations - 1') and 27L between 15:00 and the last departure of the day (Figure 2; 'Westerly operations - 2'). In alternation pattern 2 this order is reversed.

There is no runway alternation during the day on easterly operations due to the legacy of the Cranford Agreement, which prohibited departures from 09L, other than in limited circumstances. During easterly operations, therefore, the majority of departures use the southern runway, 09R, and the majority of arrivals tend to use the northern runway, 09L.

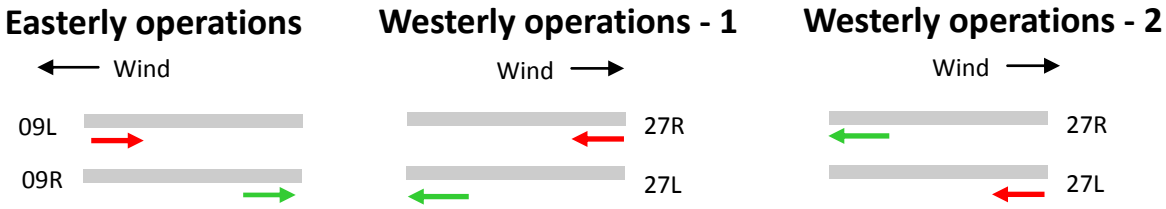

Figure 2. Illustration of the direction of easterly and westerly operations **Key: Departures** **Arrivals**

Operations during the monitoring period: During the monitoring period Heathrow operated normally, handling a total of 121,007 air traffic movements (arrivals and departures) without interruption (e.g. airport closure due to meteorological activity or industrial action). Two significant events took place during the monitoring period (the Olympics and the Paralympics) however neither of these caused any significant disruption or changes to the daily flying schedule. In addition the second phase of Operational Freedoms was running during this monitoring period. During the monitoring period, westerly operations prevailed for 80% of the time - higher than the long term average. A total of 48,453 westerly arrivals and 48,497 westerly departures were recorded on the runway logs. Easterly operations were in place for the remaining 20% of the time and these accounted for 12,064 arrivals and 11,993 departures during the monitoring period.

Flight path information is derived from radar data using a flight monitor processing programme. A public version of this flight tracking software, 'WebTrak', is available on Heathrow Airport's noise website. During the monitoring period the flight monitor processing programme recorded 0.9% fewer flights than the runway logs due to technical reasons (see Additional Information on page 9). To track flights affecting the Hendon grid square during the monitoring period, a series of monitoring 'gates' were set up on the faces of the grid square (as shown in Figure 1). The traffic count for aircraft passing through these 'faces' is given in Figure 3 (note that this table is cumulative and will count an aircraft each time it enters and exits the grid).

	Easterly				Westerly			
	Face 1 (E)	Face 2 (W)	Face 3 (N)	Face 4 (S)	Face 1 (E)	Face 2 (W)	Face 3 (N)	Face4 (S)
Arrivals	4,295	4,535	204	141	16,934	13,103	7,857	6,265
Departures	504	881	2,744	2,678	42	90	47	2

Figure 3. Arrival and departure traffic through the faces of the grid square during the monitoring period (Face 1 – East, Face 2 – West, Face 3 – North, Face 4 – South)

Arrival flight paths: The Hendon grid is located between two of Heathrow's four holding stacks. During periods of westerly operations the grid is overflown by arrivals that have left the Bovingdon and Lambourne stacks and started their approach to runways 27L and 27R. Figure 4 overleaf shows the lateral distribution of arriving flight paths through the grid and the vertical distribution through Face 1. The vertical distribution of tracks through Face 1 of the grid is concentrated into two groups. The northern grouping is aircraft entering the grid after leaving the Lambourne stack. The southern grouping is aircraft from both the Bovingdon and Lambourne stacks leaving the grid, many of the latter having turned when overflying the grid. The tracks of turning aircraft over the ground will be influenced by instructions from air traffic control, aircraft size, weight and airspeed, as well as external factors such as wind. These factors account for the lateral distribution of aircraft tracks in the grid. During westerly operations all but a small number of arriving aircraft overfly the grid above 5,000 feet. During periods of easterly operations, the grid is only overflown by aircraft that have left the Lambourne stack and started their approach to runways 09L and 09R. These aircraft fly above 6,000 feet to ensure that they remain above the departing aircraft that are also overflying the grid during easterly operations.

Departure flight paths: Aircraft departing Heathrow follow pre-defined Standard Instrument Departure (SID) routes, usually based upon the destination of the aircraft. During periods of easterly operations the grid is overflown by aircraft that have initially followed the Brookmans Park and Buzad SIDs after departing from Heathrow. Figure 5 overleaf shows the lateral distribution of departing flight paths through the grid and the vertical distribution through Face 4. Prior to overflying the grid, the majority of easterly departures have climbed above 4,000 feet and are therefore being vectored by air traffic control rather than following the SID. This explains the lateral distribution of aircraft tracks in the grid. These aircraft typically overfly the grid below 5,000/6,000 feet to ensure that they remain below the arriving aircraft that are also overflying the grid. Very few departures overfly the grid during westerly operations. Again, these aircraft have initially followed the Brookmans Park SID after departing from Heathrow and are being vectored by ATC.

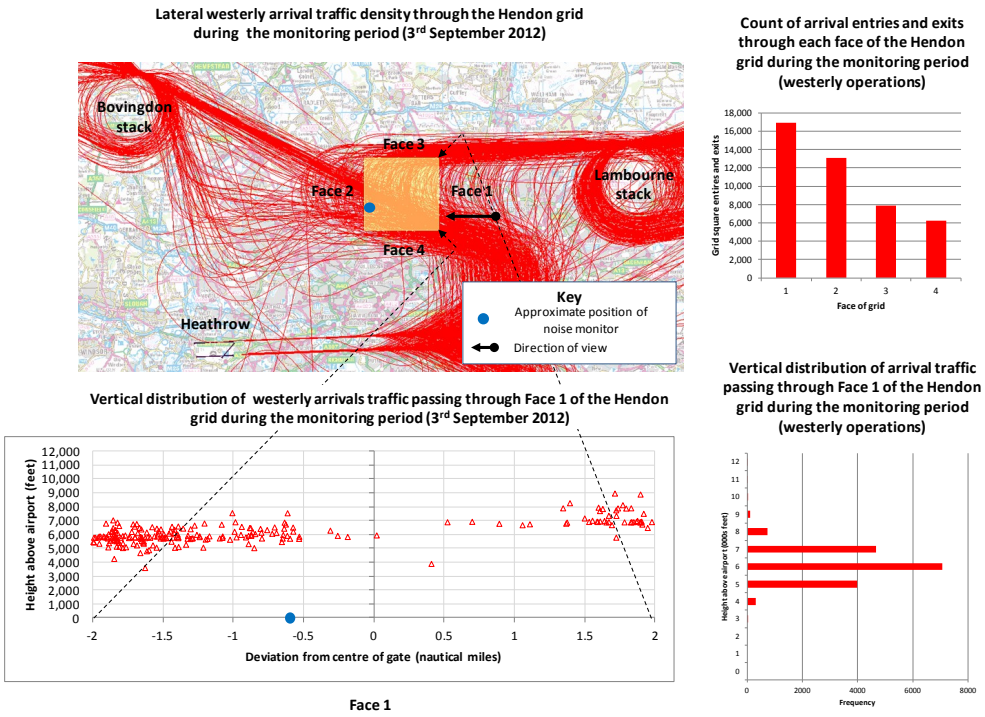

Figure 4. Lateral and vertical distribution of arriving air traffic passing through the Hendon grid during the monitoring period (westerly operations) - representative sample

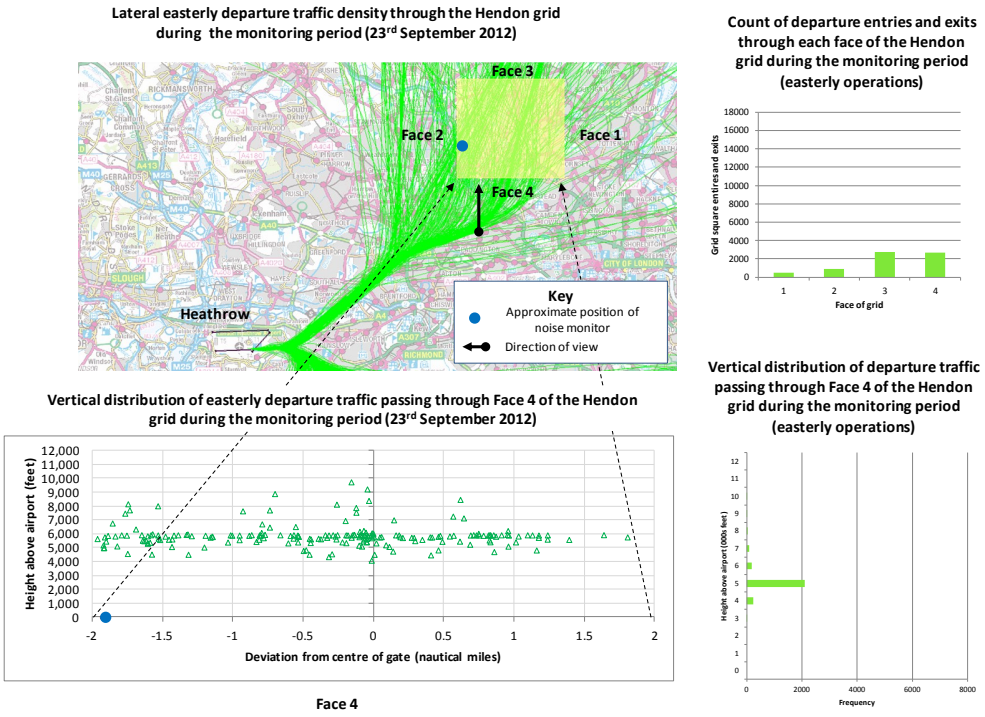

Figure 5. Lateral and vertical distribution of departing air traffic passing through the Hendon grid during the monitoring period (easterly operations) - representative sample

Figure 6 overleaf shows the proportion of aircraft that passed through the grid during the monitoring period by direction of runway operation and hour. During the monitoring period the grid was overflown throughout the main hours of operation by arrivals on days of westerly operations, and both arrivals and departures on days of easterly operations. Consequently the grid is overflown by more aircraft on the comparatively lower number of easterly days. The number of arrivals overflying the grid varies from hour to hour and day to day. This is because aircraft only use the stacks as demand dictates, and as shown in Figure 4, not all aircraft using the Bovingdon and Lambourne stacks will overfly the grid. Similarly, the number of departures overflying the grid will also vary from hour to hour and day to day, and as per Figure 5, not all aircraft following the Brookmans Park and Buzad SIDs after departing from Heathrow will overfly the grid.

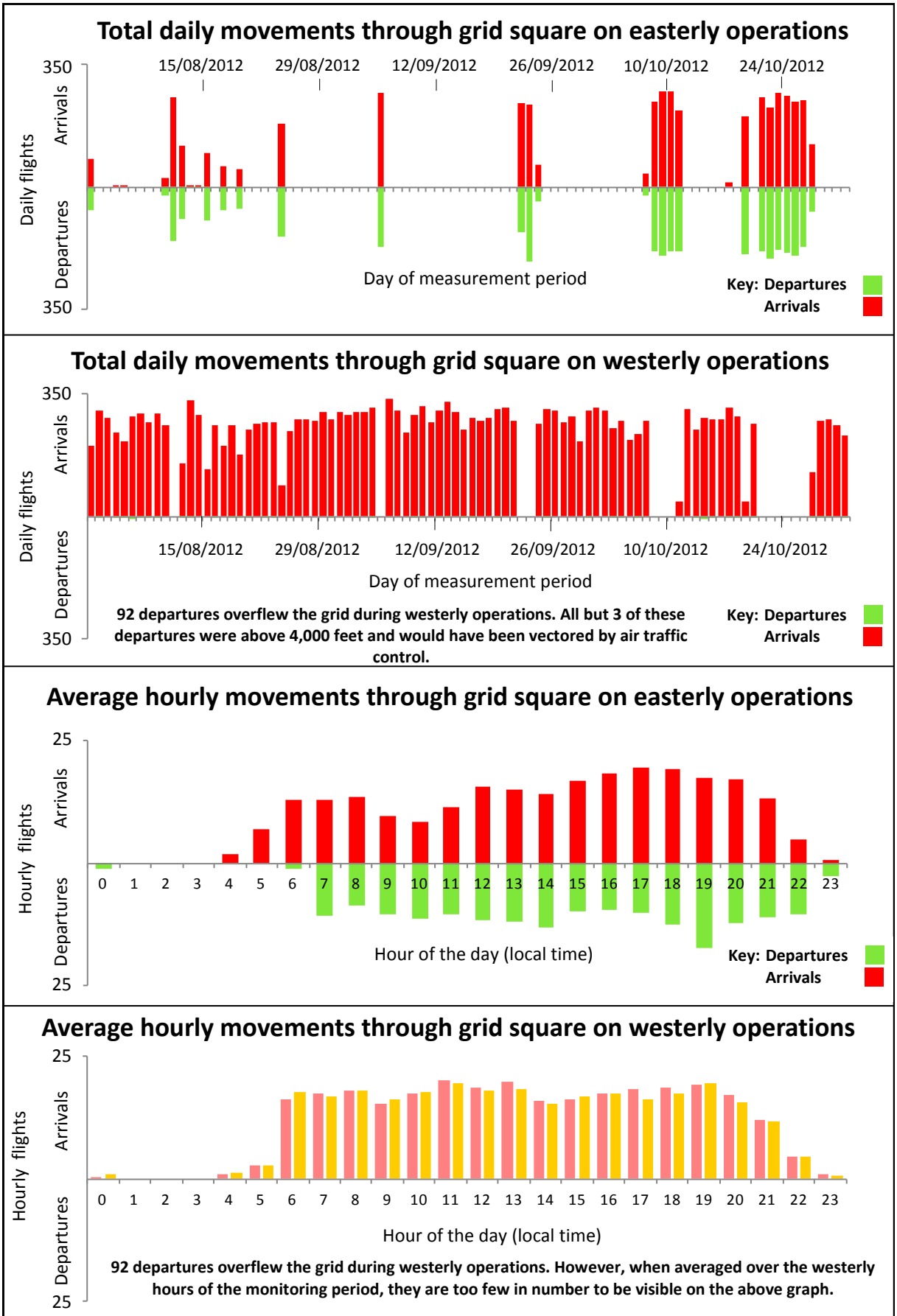

Figure 6. Daily movement totals and hourly mean averages for easterly and westerly operations through the grid square

Alternation pattern 1: Arrivals Departures
Alternation pattern 2: Arrivals Departures

Noise — background noise

The ambient noise recorded by the monitor is generated by both aircraft and other background noise sources, including local road traffic, distant motorways and railway lines. In rural areas, the ambient level can be affected by noise sources such as farm machinery and bird song. In windy conditions, the noise generated by trees, crops and long grass can also affect the measured noise level.

Figure 7 demonstrates the average background noise level (L_{90}, dBA) recorded by the Hendon monitor over a 24 hour period (black line). Figure 7 also shows the background noise level when separated by mode of operation, easterly or westerly; shown in two shades of orange. As can be seen, background noise levels are generally comparable for each mode of operation, although slightly higher background noise levels were recorded during periods of easterly operation, particularly during the day; during periods of easterly operation the prevailing wind direction would generally place the site downwind of the M1 motorway (and A1/A41 roads), and also downwind of the Midland Main Line which runs parallel to the M1 in the Hendon area.

The overall trend in Figure 7 is largely in line with expected results; during the night-time period of 01:00-05:00 hours the average background noise level was 45 dBA or less, rising to over 50 dBA after 06:00 hours for the rest of the day until 22:00-23:00 hours. This broadly coincides with the main period of Heathrow operations and the daytime increase in overall road traffic levels. The graph also illustrates the large variation in hourly background noise level at the monitoring site; up to 10 dBA during the daytime and up to 20 dBA at night between the quietest and noisiest days. The overall noisiest day was Saturday 27 October; a day with a light-to -moderate northerly wind, placing the site downwind of the M1 motorway and Midland Main Line. The quietest day was Monday 6 August; a day with a light westerly wind, placing the site upwind of the M1 and Midland Main Line.

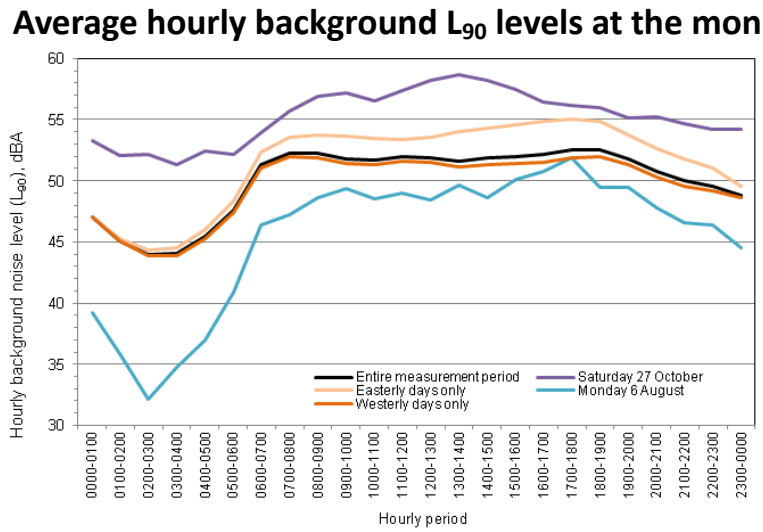

Figure 7. Hourly background L_{90} levels at the monitor averaged over 24 hour period; including Saturday 27 October (noisiest day) and Monday 6 August (quietest day)

Noise — significant aircraft noise events

The noise and track keeping monitors are set up to record noise events above a pre-determined threshold level (i.e. aircraft generated noise above background - fully defined at the end of this report). This means that not every aircraft passing through the Hendon grid square generates a noise event. During the monitoring period a total of 1,055 aircraft noise events were recorded.

As indicated above, a relatively small number of noise events were recorded at the Hendon site. This is unsurprising given the monitor's location relative to the main arrival and departure routes. As the noise monitor was positioned between the Bovingdon and Lambourne holding stacks, arrivals account for the majority of all the noise events recorded at the site. Figure 8 provides a summary of aircraft noise events by operation and runway after filtering for bad weather (approximately 26% of noise events were rejected due to unacceptable weather conditions in accordance with international guidelines). Accounting for rejected events, 432 noise events were generated by westerly arrivals approaching runways 27L and 27R, and 75 noise events by easterly arrivals approaching 09L and 09R. Thus, a total of 507 arrival noise events were recorded at the Hendon monitor after filtering for bad weather.

As the noise monitor was located beyond the end point of the easterly Buzad NPR (and close to the extent of the Brookmans Park NPR) most departing aircraft have climbed above 4,000 feet before reaching the monitor (and are therefore quieter and more difficult to measure). In addition, because aircraft above 4,000 feet may be vectored off the SIDs by air traffic control, the majority do not overfly the monitor. Both of these factors account for the low numbers of departure noise events summarised in Figure 8. Accounting for rejected events, 265 noise events were generated by easterly departures on runway 09R, and just 6 noise events by westerly departures on 27L/R, making a total of 271 departure noise events.

Figure 9 indicates that medium-sized aircraft (e.g. the A320 family) and, to a lesser extent, the wide-bodied B747 and B777, dominate the overall number of aircraft noise events due to the relatively high numbers of these types operating at Heathrow. Figure 10 shows the average (mean) departure and arrival L_{max} values recorded at the Hendon monitor for each aircraft type. For arrivals, the noisiest aircraft on average was the A321, followed by the B737. For departures, and excluding results with an overall sample size of less than 10 measurements, the noisiest aircraft on average was the B747, followed by the B777. However, all these results (particularly for arrivals) should be treated with some caution and considered in light of observations made below regarding the monitor threshold.

The overall distribution of noise (L_{max}) for arrivals and departures is shown in Figure 11. Figure 12 indicates the trend in the noise distribution for arrivals and departures by time period (day, evening and night). It is immediately apparent from these figures that the distributions for arrivals and departures appear skewed (asymmetrical) because they are truncated at the 60 dBA monitor threshold. The use of this threshold is explained further on page 9. The graphs suggest a proportion of quieter aircraft events were not recorded at the monitor, which means that the average measured aircraft noise levels for the majority of aircraft types shown in Figure 10 may be biased slightly upwards.

The graphs indicate that lower numbers of noise events were recorded during the evening and night periods compared to the daytime, which is as expected and due to the lower traffic levels during those periods. The results also indicate the overall spread of the measured noise levels is generally consistent during the daytime and evening periods, although the sample sizes for the night time distributions are too small to make any meaningful conclusions from.

Departures (34.8% of total noise events)					Arrivals (65.2% of total noise events)				
09L	09R	27L	27R	Total	09L	09R	27L	27R	Total
0	265	1	5	271	71	4	217	215	507

Figure 8. Aircraft noise events by operation and runway following filtering for bad weather

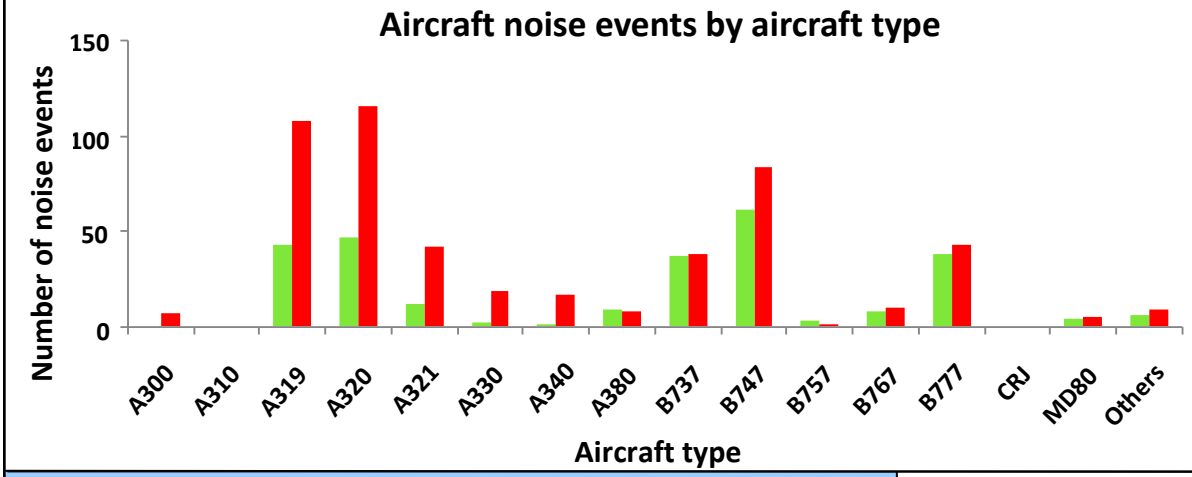

Figure 9. Number of departure and arrival aircraft noise events by aircraft type

Key: Departures Arrivals

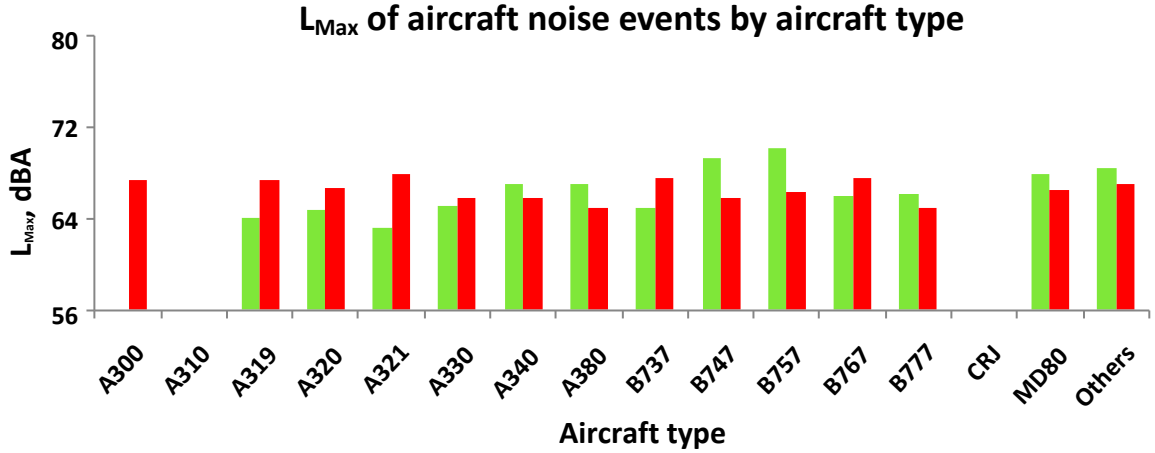

Figure 10. Mean average L_{Max} by aircraft type for departures and arrivals

Key: Departures Arrivals

Noise distribution for departures and arrivals

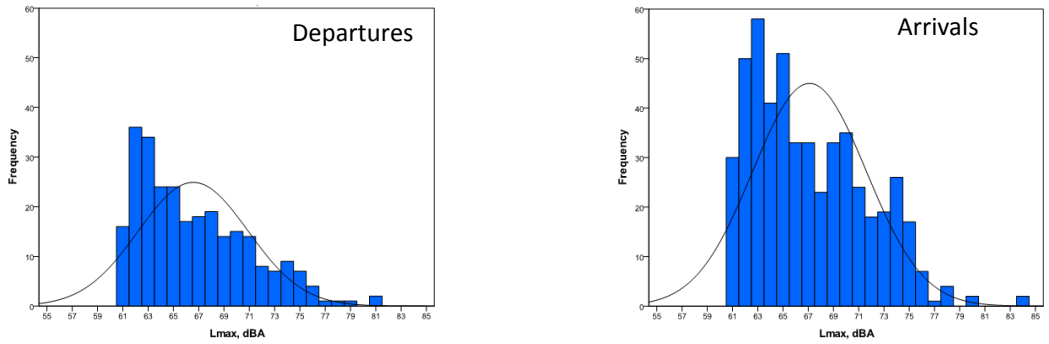

Figure 11. Above left: L_{Max} frequency distribution of departure noise levels
Above right: L_{Max} frequency distribution of arrival noise levels

Noise distribution for departures and arrivals by periods of the day

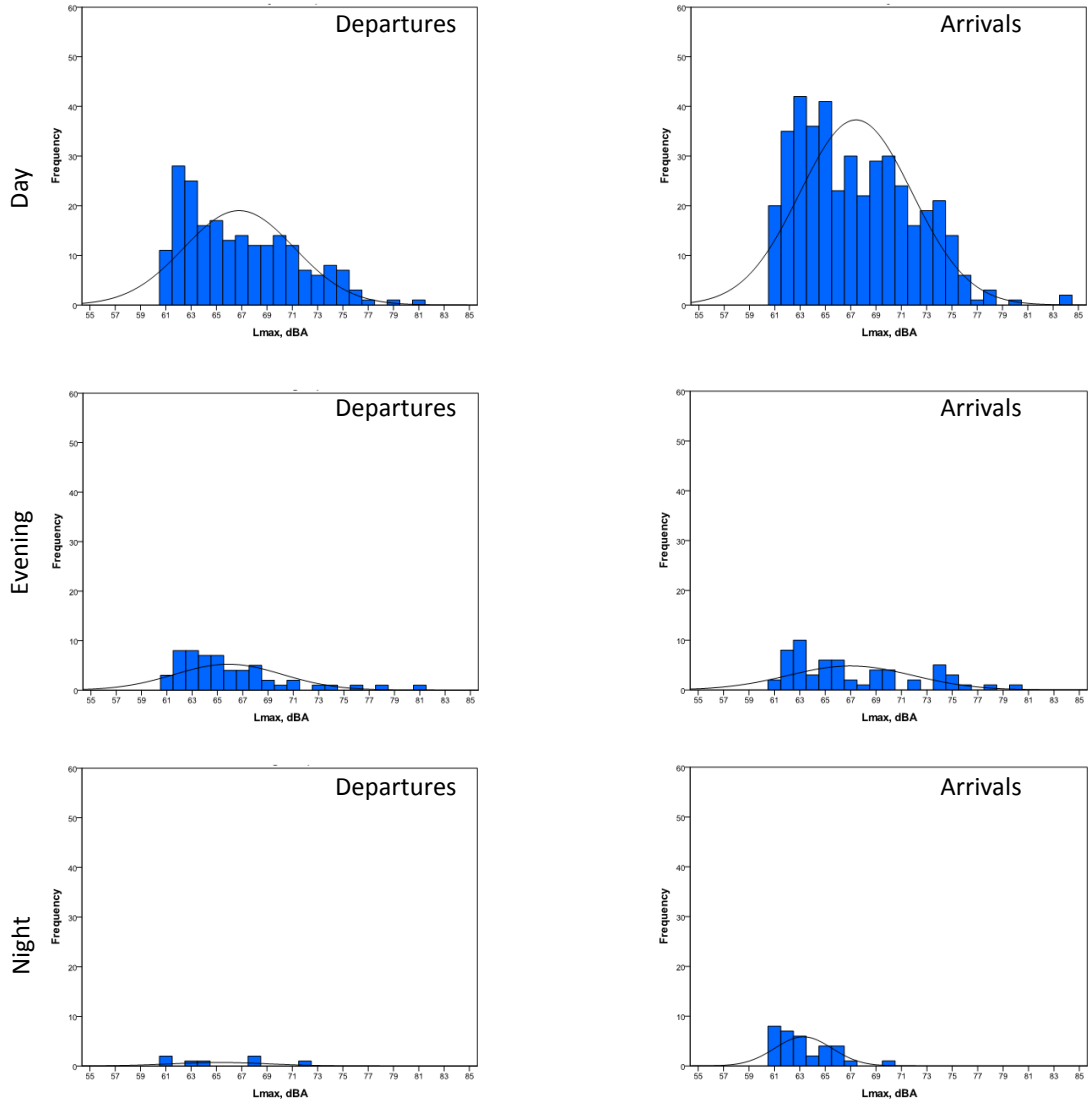

Figure 12. L_{Max} distribution of departure (left) and arrival (right) noise level recorded on the A-weighted sound level over the three averaging periods of L_{Max}(Day — 12 hour period 07:00-19:00), L_{Max}(Evening — 4 hour period 19:00-23:00) and L_{Max}(Night — 8 hour period 23:00-07:00)

Conclusions

This report describes the overflight and noise experience measured for the Hendon grid square over a 92-day period from the 1 August to 31 October 2012. During the monitoring period the Hendon grid square was overflown by a total of 28,796 Heathrow arrivals and departures. Compared to the long-term average for Heathrow Airport, the measurement period experienced a higher proportion of westerly operations overall.

The Hendon grid is located between two of Heathrow's four holding stacks. During periods of westerly operations the grid is overflown by arrivals that have left the Bovingdon and Lambourne stacks and started their approach. In all but a few instances these aircraft overfly the grid above 5,000 feet. Aircraft from the Bovingdon stack fly straight through the grid while those from the Lambourne stack are generally turning when overflying the grid. This results in the tracks of arriving aircraft being laterally distributed across the entire grid, although some portions of the grid, such as the south-east corner, are overflown more than others. Very few departing aircraft overfly the grid during westerly operations.

During easterly operations the grid is overflown by both arriving and departing aircraft. Arriving aircraft have left the Lambourne stack and started their approach to Heathrow. These aircraft fly above 6,000 feet to ensure that they remain above the departing aircraft also overflying the grid. Departing aircraft have initially followed the Brookmans Park and Buzad Standard Instrument Departure (SID) routes after taking-off from Heathrow. Before reaching the grid the majority will have climbed above 4,000 feet and been vectored off the predefined SID route by ATC. This causes the tracks of departing aircraft to be laterally distributed across the grid.

The number of arrivals and departures overflying the grid will vary from hour to hour and day to day. This is because arriving aircraft only use the stacks as demand dictates and not all aircraft leaving the Bovingdon and Lambourne stacks will overfly the grid. Similarly, not all departures that initially follow the easterly Brookmans Park and Buzad SIDs will overfly the grid.

The profile of background noise levels throughout the day at the Hendon noise monitoring site broadly reflect the main hours of operation at Heathrow and road traffic levels. On days of easterly operations the Hendon site is generally downwind of the M1 motorway, A1/A41 roads and the Midland Main Line and consequently experiences slightly more background noise than on days of westerly operations.

A relatively small number of noise events were recorded at the Hendon site. This is unsurprising given the monitor's location relative to the main arrival and departure routes. As the noise monitor was positioned between the Bovingdon and Lambourne holding stacks, arrivals account for the majority of all the noise events recorded at the site. Fewer noise events were recorded for departures as significantly fewer departures overfly the grid and most of those that do have climbed above 4,000 feet before reaching the monitor (and are therefore quieter and more difficult to measure).

The majority of significant aircraft noise events generated were by medium-sized aircraft (e.g. the A320 family) and, to a lesser extent, the wide-bodied B747 and B777, which reflects the traffic mix at Heathrow. For arrivals the noisiest aircraft on average was the A321, followed by the B737. For departures, excluding aircraft types with a small sample size, the noisiest aircraft on average was the B747, followed by the B777. However, all these results (particularly for arrivals) should be treated with some caution and considered in light of observations made in the main text regarding the monitor threshold. Lower numbers of noise events were recorded during the evening and night periods compared to the daytime, which is as expected and due to the lower traffic levels during those periods. The noise distributions measured at the monitoring site are generally consistent between the daytime and evening periods, with the night time distribution being too small to make any meaningful conclusions.

The results of the Hendon monitoring period represent a snapshot of the track and noise impact. The results generated are broadly what might be expected in the future as the freedoms used during this period as part of Operational Freedoms Phase 2 did not impact on the flights in this grid square.

As part of this programme we hope to return to this grid square in the future to conduct further community noise monitoring.

Additional information

References

- Heathrow Airport, Noise Action Plan 2010-2015 http://www.heathrowairport.com/noise
- Department for Transport — Heathrow Noise Contours https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/3933/heathrow-2011-report.pdf
- Operational Freedoms at Heathrow http://www.heathrowairport.com/noise
- South East Airports Task Force http://assets.dft.gov.uk/publications/south-east-airports-taskforce-report/south-east-airports-taskforce-report.pdf

Explanation of terms used:

- Noise can be defined as unwanted sound. Sound in air can be considered as the propagation of energy through the air in the form of oscillatory changes in pressure. The size of the pressure changes in acoustic waves is quantified on a logarithmic decibel (dB) scale, firstly because the range of audible sound pressures is very great and secondly because the loudness function of the human auditory system is approximately logarithmic. The dynamic range of the auditory system is generally taken to be 0 dB to 140 dB. The additional noise from two sources producing the same sound pressure level, will lead to an increase of 3 dB. A 3 dB noise change is generally considered to be just noticeable, a 5 dB change is generally considered to be clearly discernible and a 10 dB change is generally accepted as leading to the subjective impression of a doubling or halving of loudness. 'A-weighting' accounts for the acoustic sensitivity of the human ear to a range of sound levels. Its application to dB produces the 'dBA' scale.
- The L_{Max} value is the maximum value that the A-weighted sound pressure level reaches during a given measurement period of time. For the measurement of aircraft noise, it is usual practice to measure L_{Max} using the sound level meter's slow (S) response setting.
- L_{90} is the noise level exceeded for 90% of the measurement period and is used to quantify the background level of noise.
- A trial of 'Operational Freedoms' started at Heathrow on 1 November 2011, to explore if the runways and the airspace around the airport can be used in a more efficient and flexible way. The trial took place in two phases, the first from 1 November 2011 to 29 February 2012, the second from 1 July 2012 to 28 February 2013. This trial is a recommendation of the Government's South East Airport Taskforce which was set up in 2010 to look at how to make London's airports 'better, not bigger'. The trial looked at whether new procedures can be used to bring benefits to the local community through less late-running flights; to passengers, by providing a more punctual service; and to the environment, by reducing aircraft stacking times and reducing emissions. This trial will not result in an increase in the number of flights operating into or out of Heathrow.

Noise monitoring details:

- To ensure that as far as possible only genuine aircraft 'noise events' are measured (i.e. noise peaks caused by aircraft movement), the noise monitors are set up to record noise events above a pre-determined threshold level. The Hendon monitor was set with a threshold of 60 dBA, meaning that noise events below 60 dBA L_{Max} were not recorded by the monitor (note, the choice of monitor threshold does not affect the measurement of L_{90}). The choice of threshold level is often a compromise between (i) losing a proportion of quieter aircraft events and (ii) recording a large number of spurious non-aircraft events. At locations such as Hendon, where the background noise level is frequently varying (for example, due to road traffic noise or railway noise), it becomes difficult to select an appropriate threshold level that is low enough to capture a suitable number of lower-level aircraft noise events, but high enough to ensure that extraneous noise is not recorded. Setting the threshold at 60 dBA meant that, unavoidably, the average measured aircraft noise levels for the majority of aircraft types shown in Figure 10 may be biased slightly upwards.
- Approximately 26% of all measurements were rejected due to unacceptable weather conditions, i.e. wind speeds greater than 10 m/s or during periods of precipitation (in accordance with recommended international guidance on aircraft noise monitoring).

Differences between the runway logs and the flight monitor processing programme

- Occasionally and infrequently felling of radar plots occurs. This happens when the number of radar returns captured by the radar for monitoring purposes exceeds its capacity. Consequently some of the radar returns are dropped. The NTKWG are aware of this and Heathrow Flight Performance log these instances.

Report prepared for Heathrow Airport by Helios and the CAA. For further information please visit the Heathrow Airport noise website www.heathrowairport.com/noise; alternatively please contact the Heathrow noise action line (on 0800 344 844) or Heathrow Flight Performance directly (Second Floor Meridian, The Compass Centre, Nelson Road, Heathrow Airport, Hounslow, TW6 2GW, UK).