Heathrow Community Noise and Track-keeping Report: Burhill

This document reports on an 100-day period of continuous noise monitoring from 14 June 2011 to 21 September 2011 using a Larson Davies LD 870 sound monitor placed at the 'Burhill' site (positioned at 51° 21′ 9.01" N, 0° 24′ 54.37" W, 56 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 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.

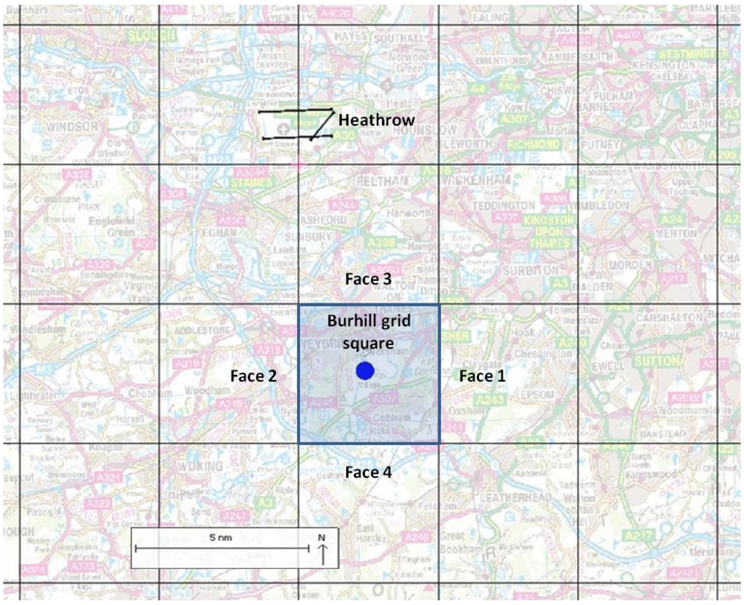


Figure 1. Map of the Heathrow area with noise monitoring grid; position of the noise monitor shown as a blue dot in the centre of the blue shaded grid (the Burhill community grid square area)

This report describes the noise levels and aircraft tracks affecting the Burhill grid square, shown above. Noise levels were recorded by a temporary noise monitor situated at Burhill Golf Club, its position is indicated by the blue dot. The noise monitor was positioned principally under the westerly Dover (DVR) Noise Preferential Route (NPR) and also just inside the 3 km-wide swathe of the easterly Midhurst (MID) NPR. Departures following the easterly Southampton (SAM) NPR also overfly the grid. The grid is also located on the northern side of the Ockham holding stack and on easterly operations is also overflown by arrivals that are flying from the Biggin holding stack, to the east of the grid, to 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 and names used 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 in force when the wind is in an easterly direction, are used for the remaining approximate 29% of the time on average. Shorter term fluctuations between westerly and easterly operations can vary considerably from this approximate long-term 70:30 split. During the daytime a westerly preference is operated. This means that, during periods of light easterly winds the airport operates on a westerly operations preference. This preference does not operate at night. During westerly operations landing 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. Although, between 0600-0700 both runways may be, and typically are, used for landings. The runway alternation pattern alternates by week; in alternation pattern 1 (week commencing 2 January in 2012) the arrivals runway is designated 27R between 06:00-15:00 (Figure 2; 'Westerly operations— 1') and 27L between 1500 and the last departure of the day (Figure 2; 'Westerly operations— 2'). In alternation pattern 2 this order is reversed.

Although the Cranford Agreement, which prohibited departures from 09L other than in limited circumstances has ended, there is no runway alternation during the day on easterly operations as the necessary taxiway infrastructure is not in place. On easterly operations, therefore, the majority of departures use the southern runway, 09R, and arrivals tend to use the northern runway, 09L.

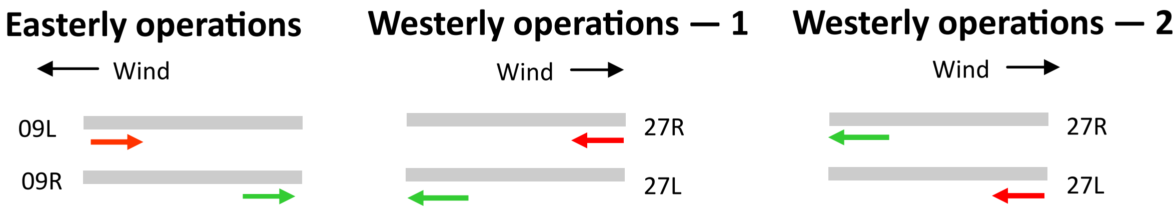


Figure 2. Illustration of the direction of easterly and westerly operations

Key: Departures → **Arrivals** →

Operations during the monitoring period: During the monitoring period Heathrow operated normally (i.e. there were no periods where the airport was closed or operated significantly reduced numbers of movements for reasons such as adverse weather or industrial action). Westerly operations prevailed for 84% of the time - higher than the long term average. Over the period, there were 55,950 westerly arrivals and 55,248 westerly departures. Easterly operations were in place for the remaining 16% of the time - lower than the long term average with a total of 10,882 easterly arrivals and 10,815 easterly departures, mainly using runway 09R.

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. To track flights affecting the Burhill 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 as both arrivals and departures enter and exit the grid square — counts of daily movements through the grid square are given in Figure 6).

	Easterly				Westerly			
	Face 1 (E)	Face 2 (W)	Face 3 (N)	Face 4 (S)	Face 1 (E)	Face 2 (W)	Face 3 (N)	Face 4 (S)
Arrivals	3,742	3,285	353	2,769	15,920	5,176	4,351	19,624
Departures	603	372	2,150	2,308	6,246	13,716	283	7,890

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 Burhill grid is located beneath the Ockham holding stack which is used for both easterly and westerly operations. Heathrow has four holding stacks which are in use everyday as demand dictates. Therefore the numbers of aircraft using the stacks and the time spent in them will vary from hour to hour and day to day. Aircraft in the stack are separated by 1,000 feet vertically with only one aircraft allowed at each level.

The lateral distribution of arrival flight paths through the grid for westerly operations, and their vertical distribution through Face 1 of the grid square, for a single day are illustrated in Figure 4 overleaf. Only the northern part of the stack is within the Burhill grid and while over half of westerly arrivals 'flew through' the grid during the monitoring period some exited and re-entered the grid a number of times as they held (circled) in the stack. Aircraft join the holding stack to the south of the grid and then fly clockwise around it. As aircraft leave the stack, they will generally make their way to the east side of the grid and then depart to the east in order to make their final approach to Heathrow. The tracks of aircraft over the ground will vary due to aircraft size, weight and airspeed being flown which will all affect the radius of turn, and also external factors such as wind, which may vary at different levels in the stack. The heights of aircraft in the grid square are influenced by the levels operated in the stack, typically between 7,000 feet and 15,000 feet.On easterly operations the grid is also overflown by arrivals that have left the Biggin stack, to the east of the grid, and fly west, beneath the Ockham stack, to start their approach to Heathrow.

Departure flight paths: Aircraft departing Heathrow follow pre-defined NPRs, usually based upon the destination of the aircraft. Similar to arrivals, the numbers of aircraft using the routes will vary from hour to hour and day to day. On westerly operations the Burhill grid square is overflown by departing aircraft following the westerly Dover NPR route. The distribution of departing aircraft flight paths through the grid for westerly operations, as well as their vertical distribution through Face 2 of the grid 'square', for a single day are illustrated in Figure 5 overleaf. Aircraft entered at the north-west corner of the grid square and exited the south-east corner. The distribution of departure flight paths through the most significant face of the grid (Face 2) was more concentrated horizontally and vertically than it was for arrivals. This reflects aircraft following the route of the Dover NPR while at the same time staying below the lower levels of the Ockham stack. On easterly operations the grid square was overflown by the easterly Midhurst and Southampton NPRs, aircraft enter the north-east quadrant the grid and exit at the southern face (Face 4).

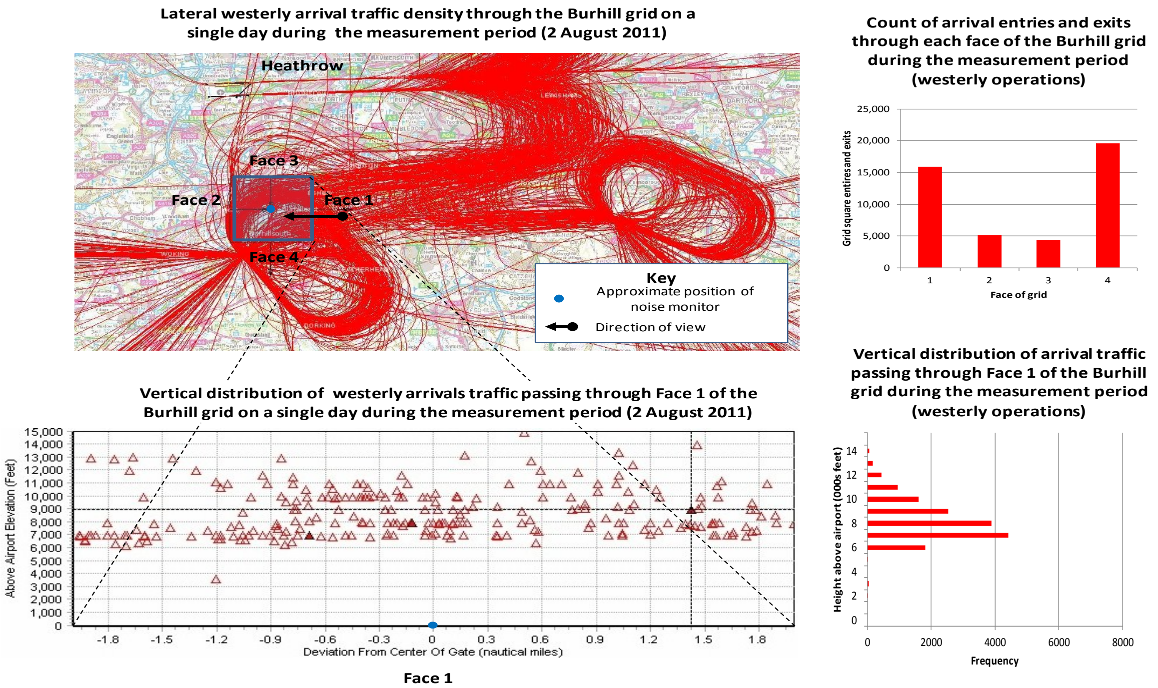


Figure 4. The lateral and vertical distribution of arriving air traffic passing through the Burhill grid square during the monitoring period (westerly operations)

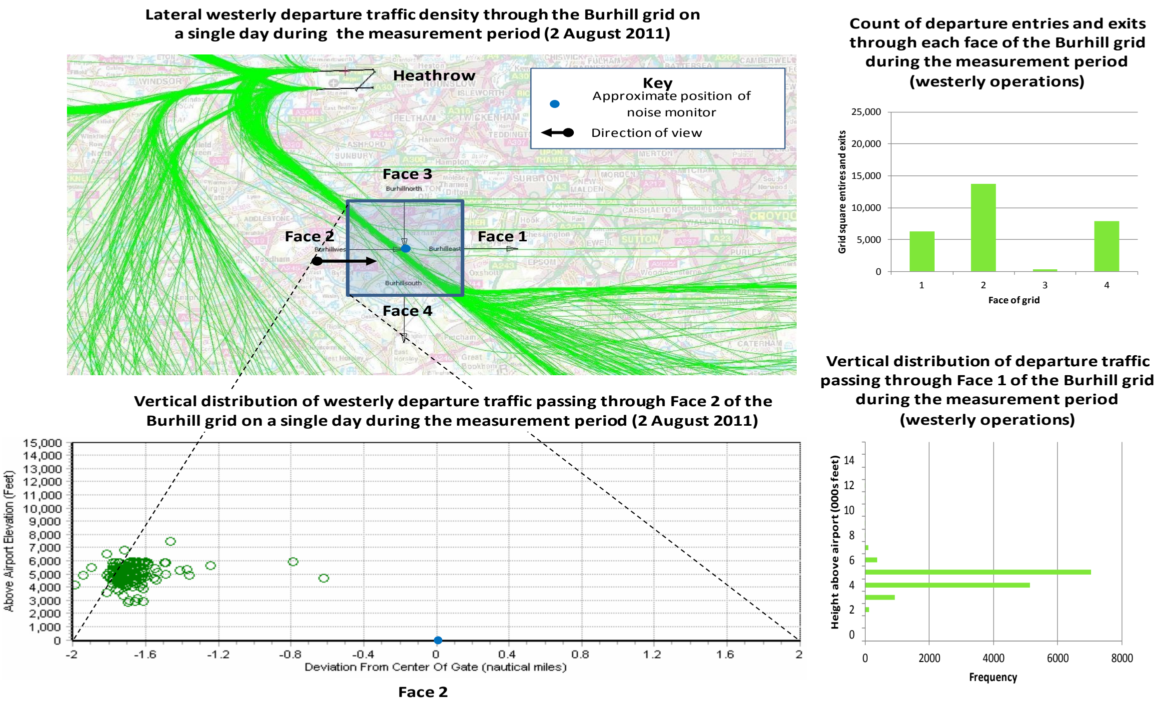
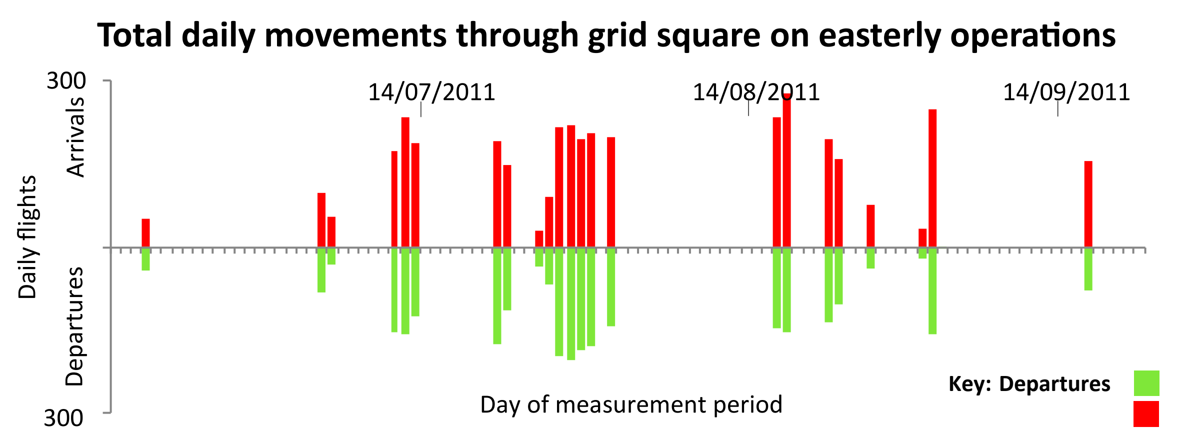
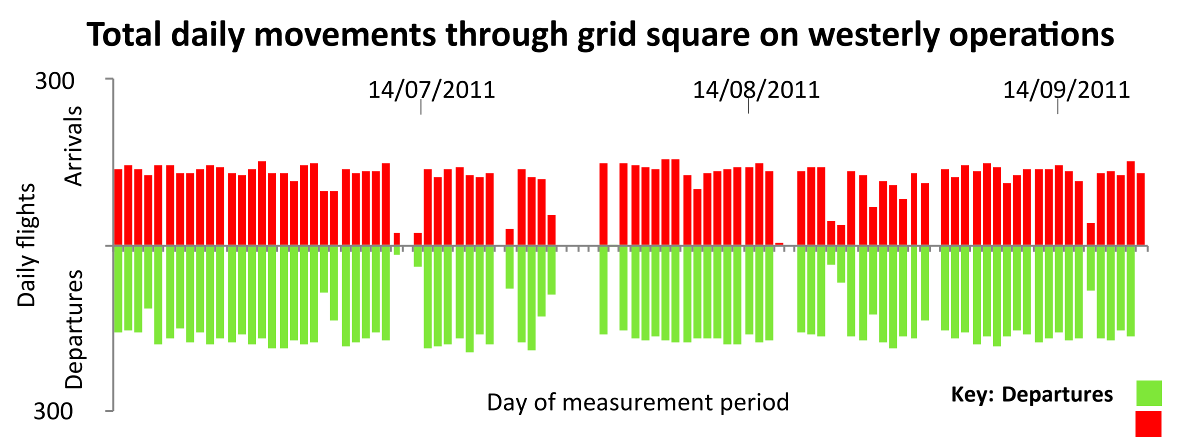
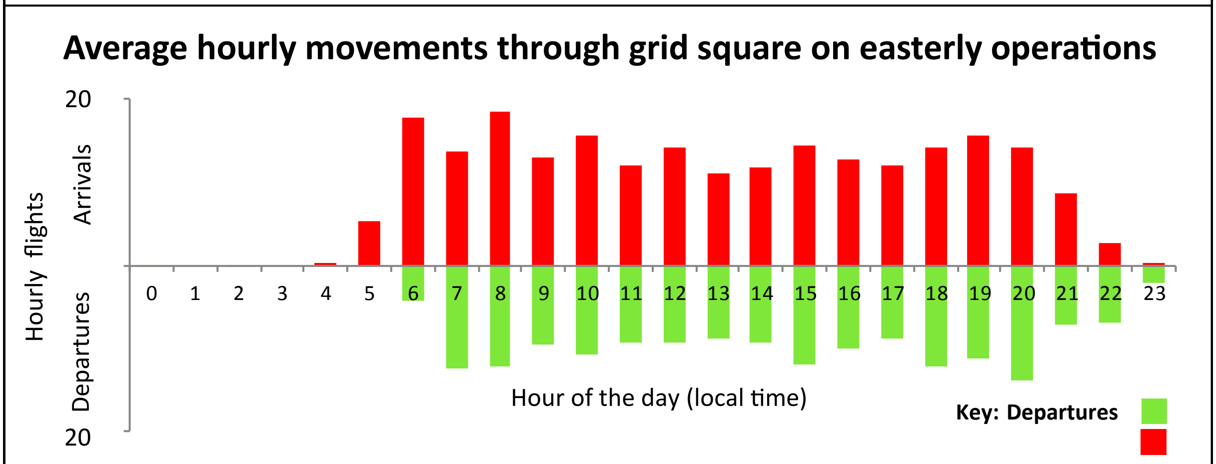


Figure 5. The lateral and vertical distribution of departing air traffic passing through the Burhill grid square during the monitoring period (westerly operations)

Figure 6 overleaf shows the proportion of traffic that passes through the grid square by direction of runway operation and hour. The grid was overflown throughout the main daily period of operations by arrivals and departures during both easterly and westerly operations. Fewer daily arrivals flew through the grid on days of westerly operations (the predominant direction of operation) than easterly operations. On easterly operations the grid square will be overflown by both aircraft in the Ockham stack and those that come from the east, having left the Biggin holding stack to the east of the Ockham stack. They will transit at the altitudes directed in order to retain separation from aircraft within the Ockham stack. Similar numbers of departures flew through the grid on days of easterly and westerly operations. The peak in average hourly departures at the end of the day on westerly operations represents long-haul traffic following the westerly Dover NPR.







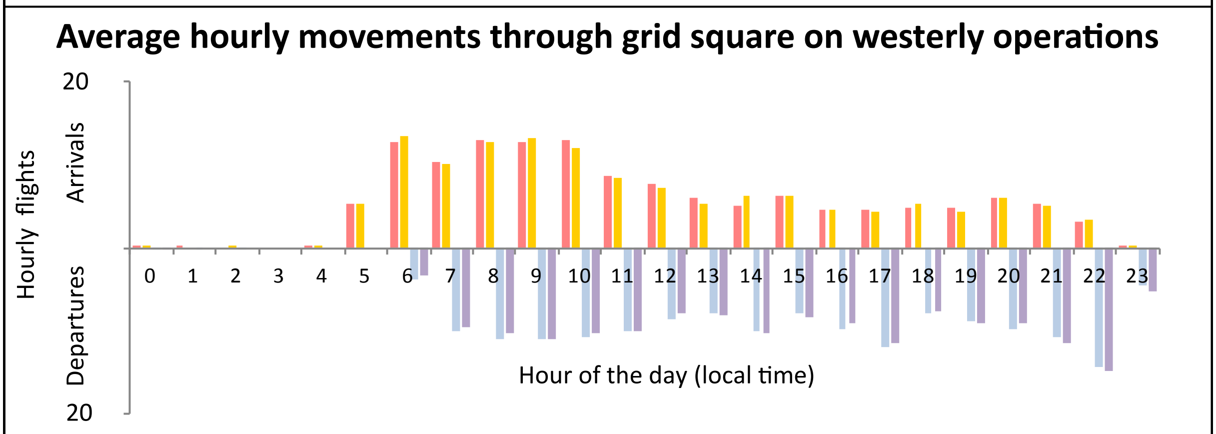


Figure 6. Daily movement totals and hourly mean averages for easterly and westerly operations through the grid square

Key: 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 Burhill Golf Club 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, slightly lower background noise levels were recorded over the 24 hour period during periods of easterly operation (an easterly wind would mean that the site was largely upwind of the M25 motorway).

The overall trend in Figure 7 is largely in line with expected results; during the night-time period of 00:00-05:00 hours the average background noise level was 35 dBA or less, rising to over 40 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 15 dBA or more at night between the quietest and noisiest days. The overall noisiest day was Monday 12 September; a day with a strong south-westerly wind, placing the site downwind of the M25 motorway and the A3 road. The quietest day was Thursday 14 July; a day with a light north-westerly wind, placing the site upwind of the A3 road.

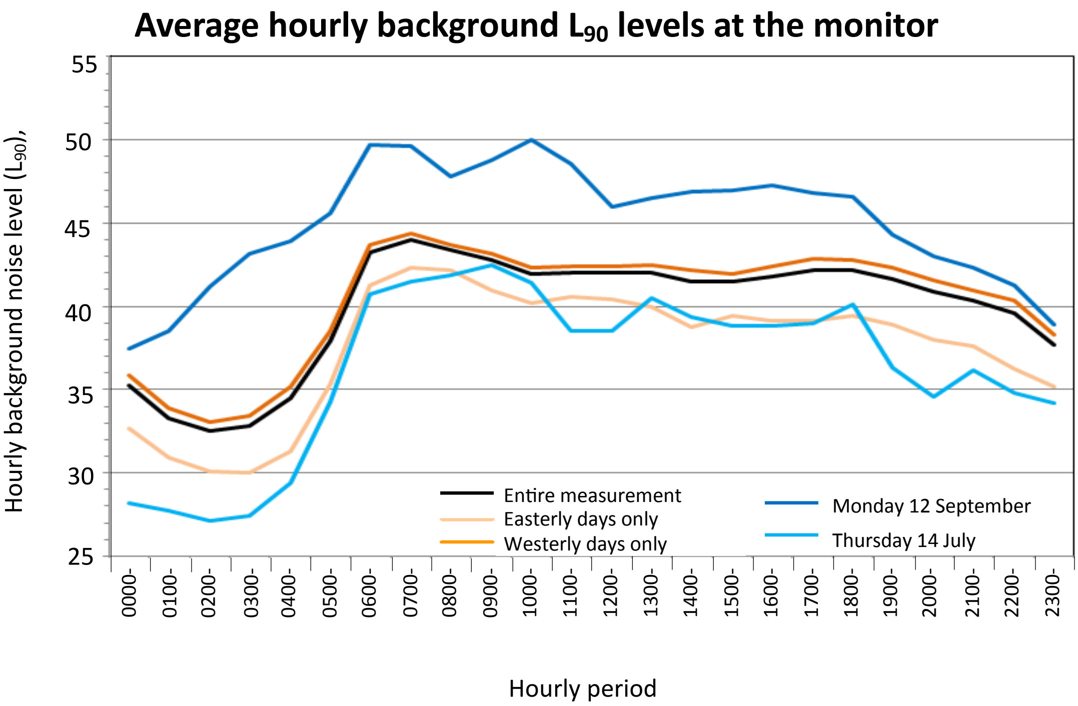


Figure 7. Hourly background L_{90} levels at the monitor averaged over 24 hour period; including Monday 12 September (noisiest day) and Thursday 14 July (quietest day)

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 Burhill Golf Club grid square generates a noise event. During the monitoring period a total of 7,897 aircraft noise events were recorded.

The noise monitor was positioned principally under the westerly Dover NPR and also just inside the 3 km-wide swathe of the easterly Midhurst NPR. Despite the site also being located close to the Ockham holding stack, departures account for nearly all of the noise events recorded at the monitor (>97%). This is unsurprising since arrivals above the Burhill Golf Club monitor are typically at a greater altitude (8,000 ft or higher) compared to departures, which are generally held below 6,000 ft as they pass under the Ockham stack.

Figure 8 provides a summary of aircraft noise events by operation and runway after filtering for bad weather (approximately 11% of noise events were rejected due to unacceptable weather conditions in accordance with international guidelines). Accounting for rejected events, 6,088 noise events were generated by westerly departures and 731 noise events by easterly departures (6,819 in total). As explained above, only a small number of arrival noise events were recorded at the Burhill Golf Club site (188 in total).

Figure 9 indicates that the wide-bodied B777 aircraft and medium-sized aircraft (e.g. the A320 family) 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 Burhill Golf Club monitor for each aircraft type. Note that no arrival measurements were recorded for the A300, A310, A380, CRJ, MD80, and 'other' aircraft. Of the remaining aircraft types, the noisiest arrival aircraft on average was the A330, although this only registered five arrival noise events at the monitor (as such the this result is not statically significant). For departures (and excluding the result for the MD80, for which there was only one recorded noise event), the noisiest aircraft on average was the B747, followed by the A340, A380, A330 and B777.

The overall distribution of noise for arrivals and departures is shown in Figure 11. Figure 12 indicates the trend in the noise distribution (L_{Max}) 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 slightly skewed (asymmetrical) because they are truncated at the 58 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 could mean that the average measured aircraft noise levels for some of the quieter aircraft types shown in Figure 10 may be biased slightly upwards. The graphs also indicate that the overall spread of the measured noise levels is broadly consistent during each period of the day but that there are much lower numbers of noise events during evening and night due to the lower traffic levels.

Departures (97% of total noise events)					Arrivals (3% of total noise events)				
09L	09R	27L	27R	Total	09L	09R	27L	27R	Total
3 (0%)	728 (10%)	3,340 (48%)	2,748 (39%)	6,189 (97%)	34 (1%)	2 (0%)	80 (1%)	72 (1%)	188 (3%)

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

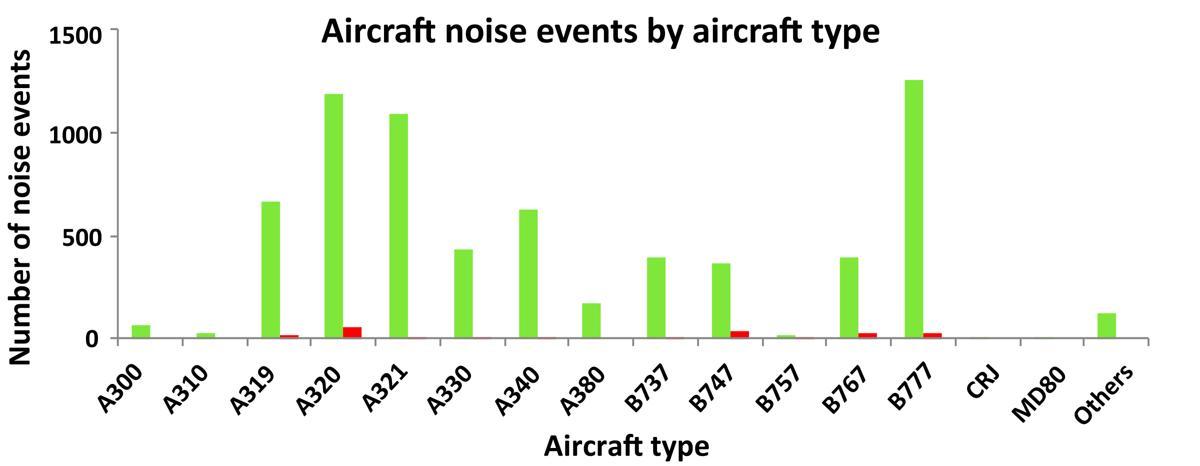


Figure 9. Number of departure and arrival aircraft noise events by aircraft type

Key: Departures
Arrivals

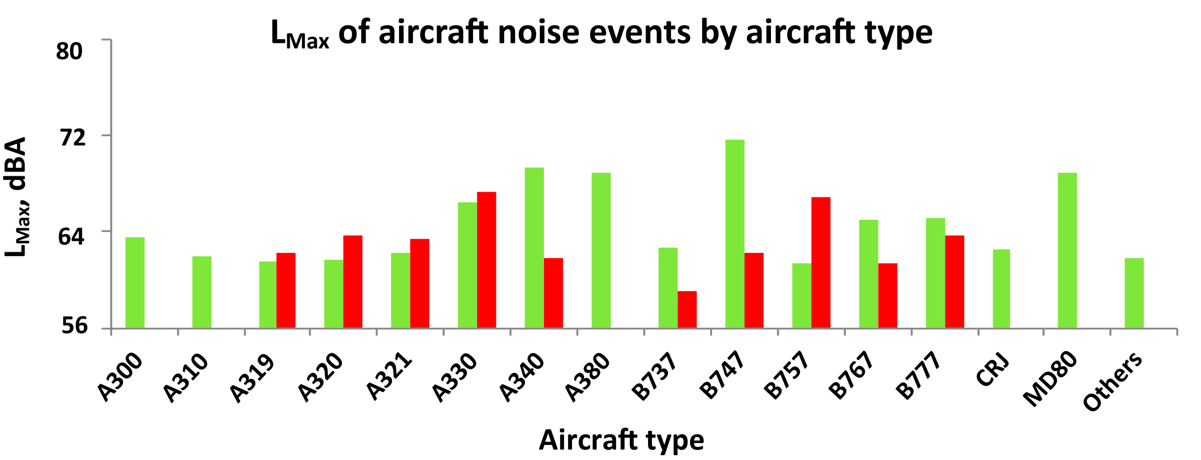


Figure 10. Mean average L_{Max} by aircraft type for departures and arrivals

Key: Departures
Arrivals

Noise distribution for departures and arrivals

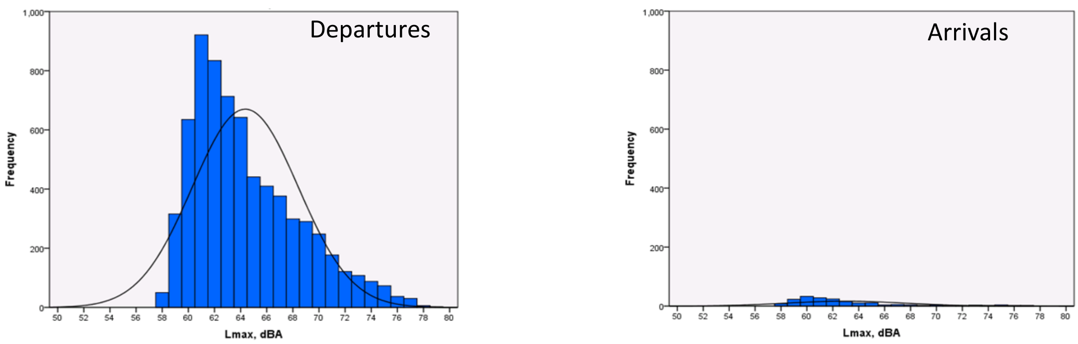


Figure 11. Above left: L_{Max} frequency distribution of departure noise levels
Above right: L_{Max} frequency distribution of arrival noise levels (frequency scale 0-1000)

Noise distribution for departures and arrivals by periods of the day

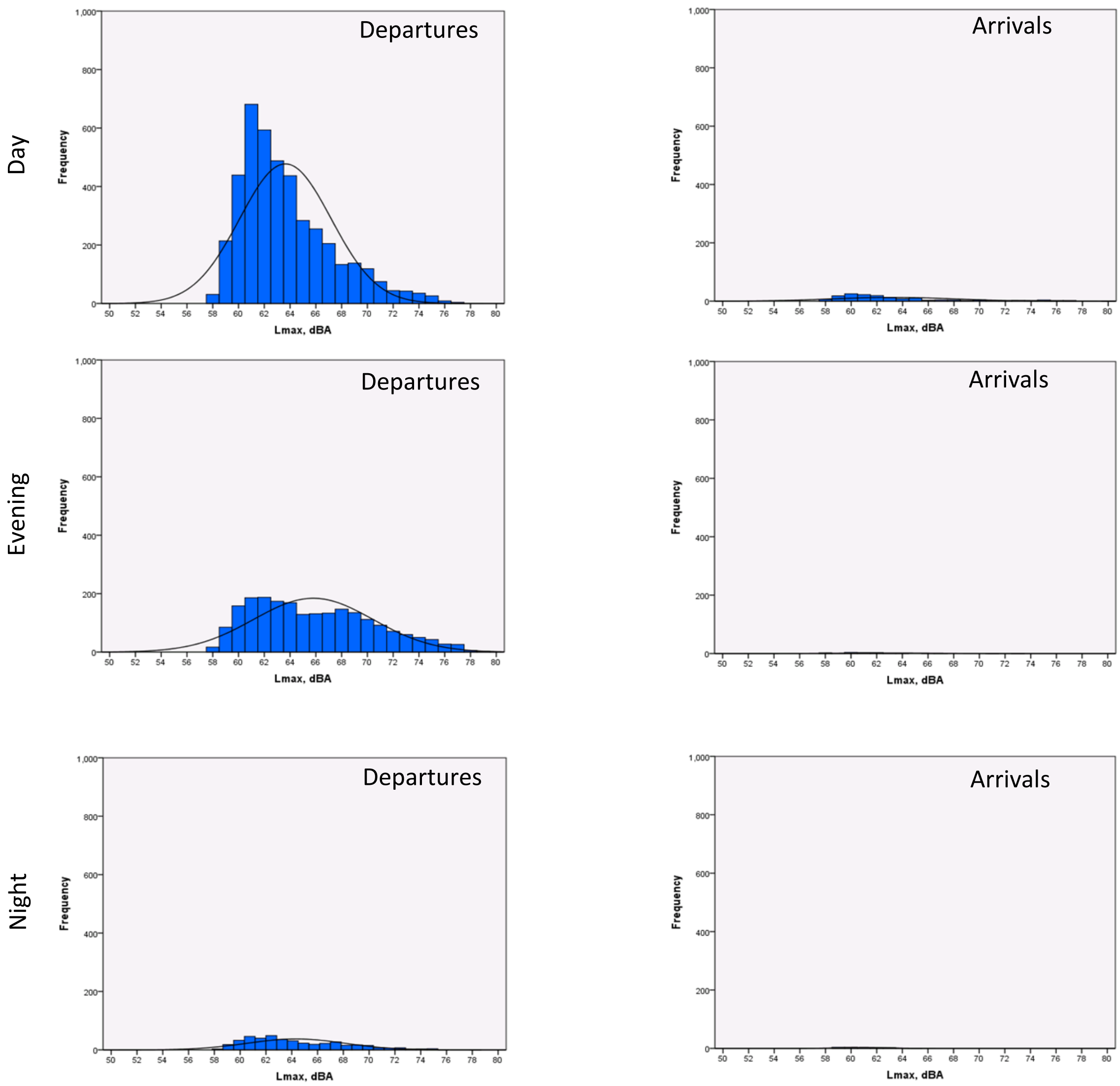


Figure 12. L_{Max} distribution of departure (left) and arrival (right) noise level recorded on the A-weighted sound level over the three averaging periods of L_{Max}(Day — 12 hour period 07:00-19:00), L_{Max}(Evening — 4 hour period 19:00-23:00) and L_{Max}(Night — 8 hour period 23:00-07:00)

Conclusions

This report describes the overflight and noise experience measured for the Burhill grid square over a 100 day period from 14 June to 21 September 2011. During the monitoring period the Burhill grid square was overflown by 31,627 Heathrow arrivals and departures. Compared to the long-term average for Heathrow Airport, the measurement period experienced a higher proportion of westerly operations overall.

During westerly operations the Burhill grid square was overflown by both arriving and departing aircraft. Arrivals were in the Ockham stack, the northern side of which is located over the grid, and typically between heights of 7,000 feet and 15,000 feet. Nearly half of all arrivals 'flew through' the grid during the monitoring period, while some aircraft flew clockwise around the stack a number of times while waiting to land at Heathrow. Factors such as aircraft size, weight, airspeed and wind mean that arrival tracks were dispersed throughout the grid. Westerly departures flying through the grid were following the westerly Dover NPR. They entered the north-west corner of the grid and exited the south-east corner. Westerly departure tracks tended to be concentrated both laterally and vertically with aircraft being between 4,000 and 6,000 feet to stay below the lower levels of the Ockham stack.

On days of easterly operations the monitoring site was also overflown by arriving and departing aircraft. Again the grid was overflown by arrivals in the Ockham stack. Additionally some aircraft flew straight through the grid without using the Ockham stack. These were coming from the east, having left the Biggin holding stack and transiting to land at Heathrow. They will transit at the altitudes directed in order to retain separation from aircraft within the Ockham. Easterly departures flying through the grid were following the easterly Midhurst and Southampton NPRs. They entered the north-east corner of the grid and exited the south-west corner. Again they were concentrated both laterally and vertically, although not to the same degree as the Dover NPR.

On westerly days the Burhill site experiences slightly more background noise than it does on days of easterly operation (an easterly wind would mean that the site was largely upwind of the M25 motorway). Despite the site also being located close to the Ockham holding stack, departures account for nearly all of the noise events recorded at the monitor (>97%). This is unsurprising since arrivals above the Burhill Golf Club monitor are typically at a greater altitude (8,000 ft or higher) compared to departures, which are generally held below 6,000ft as they pass under the Ockham stack.

The majority of significant aircraft noise events at the Burhill site are generated by wide-bodied B777 aircraft and medium-sized aircraft (e.g. the A320 family); this reflects the traffic mix at Heathrow. Overall there were very few noise events for arrivals with the noisiest aircraft on average being the A330, although this only registered five arrival noise events at the monitor. For departing aircraft the noisiest aircraft on average were wide-boded aircraft such as the B747, followed by the A340, A380, A330 and B777 (this excludes the result for the MD80, for which there was only one recorded noise event). In the grid square, wide body and MD80 aircraft are generally much noisier on departure than arrival whereas narrow body aircraft (with the exception of the MD80) are (i) generally quieter overall; and; (ii) in the case of the A320 family generate broadly equivalent noise levels on arrival and departure.

The noise distributions measured at the monitoring point indicate that across the day departures cause louder and more frequent noise events than arrivals. For departures the overall spread of the measured noise levels is broadly consistent during each period of the day but there are much lower numbers of noise events during evening and night due to the lower traffic levels. For arrivals there are too few events to draw such conclusions.

The results of the Burhill monitoring period represent a snapshot of the track and noise impact. As part of this program we expect to return to the grid square in the future to conduct a further 3-4 month community noise study.

Additional information

References

- Heathrow Airport, Draft Noise Action Plan 2010-2015, (June 2010) www.heathrowairport.com/noise/
- Department for Transport — Heathrow Noise Contours http://www.dft.gov.uk/pgr/aviation/
- Operational Freedoms at Heathrow www.heathrow.com/noise/
- South East Airports Task Force http://www.dft.gov.uk/publications/

Further information on arrival stacks and Noise Preferential Routes can be found on the noise factsheets page of the Heathrow airport website (www.heathrow.com/noise/).

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.
- L_{90} is the noise level exceeded for 90% of the measurement period and is used to quantify the background level of noise.

Noise monitoring details:

- An initial calibration fault with the noise monitor meant that data recorded during the period 14 June to 27 June was excluded for the analysis presented in figures 7 to 12.
- 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 Burhill monitor was set with a threshold of 58 dBA, meaning that noise events below 58 dBA L_{Max} were not recorded by the monitor. 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 Burhill, where the background noise level is frequently varying (for example, due to the M25 motorway, A3 or local road traffic), 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.
- Approximately 11 percent 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).

Influence of wind on the measured noise level:

- Over long distances, the wind can have a varying influence on the measured noise level. Downwind of a noise source the noise level can, in general, increase by a few decibels depending on wind speed. Likewise, when measuring upwind of a noise source the noise level can decrease by several decibels, again depending on wind speed and distance.

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