Heathrow Community Noise and Track-keeping Report: Holyport

This document reports on an 94-day period of continuous noise monitoring from 12 July 2011 to 13 October 2011 using a Larson Davies LD 870 sound monitor placed at the 'Holyport' site (positioned at 51° 28′ 55.93" N, 0° 43′ 43.76" W, 98 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.

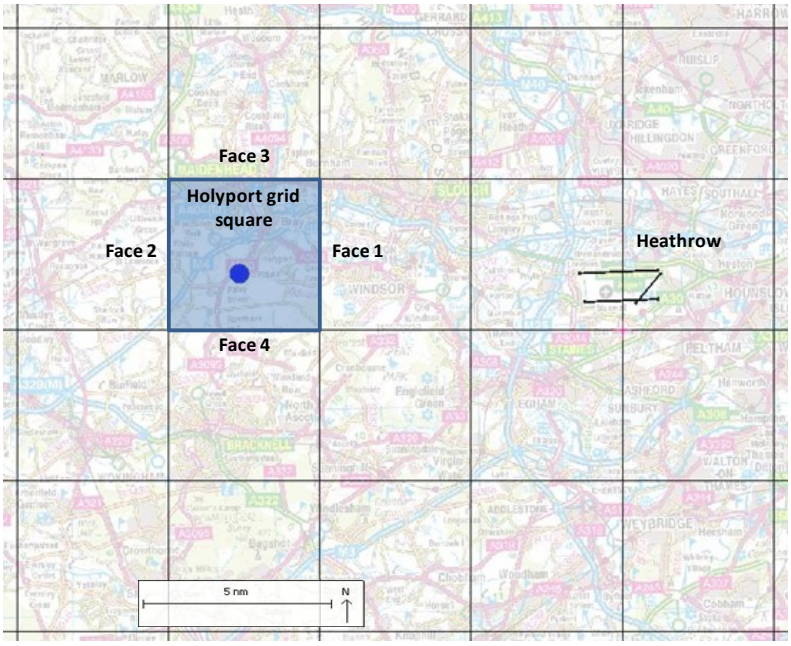

Figure 1. Map of the Heathrow area with noise monitoring grid; position of the noise monitor shown as a blue dot in the centre of the blue shaded grid (the Holyport community grid square area)

This report describes the noise levels and aircraft tracks affecting the Holyport grid square, shown above. Noise levels were recorded by a temporary noise monitor situated at Foxleigh Grove, its position is indicated by the blue dot. The noise monitor itself was positioned close to the extended centreline of runway 09L (and outside any of the departure Noise Preferential Routes [NPRs]). Flight movements of air traffic through the grid square were derived from the Airport's noise and track-keeping system. Parts of the Holyport grid are overflown by westerly departing aircraft either following or after they have left the westerly Compton, Southampton and Woburn NPRs. No arrivals overflew the grid on westerly operations and very few departures overflew the grid during easterly operations (explanations of "westerly" & "easterly" operations are provided below). Explanations of technical terms 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 used 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 29%. 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 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 maybe, 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.

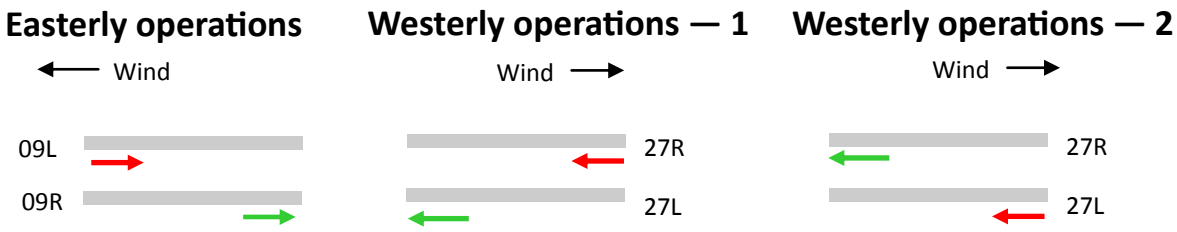

Figure 2. Illustration of the direction of easterly and westerly operations | **Key: Departures** → **Arrivals** →

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 79% of the time - higher than the long term average. Over the period, there were 50,231 westerly arrivals and 49,830 westerly departures. Easterly operations were in place for the remaining 21% of the time - lower than the long term average with a total of 13,050 easterly arrivals and 12,795 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 Holyport 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	12,304	11,235	364	714	0	0	0	0
Departures	7	25	0	25	12,072	2,308	7,599	5,960

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 Holyport grid is located beneath the extended runway centrelines for both of Heathrow's easterly runways (09L and 09R). As there is currently no runway alternation in place for easterly operations over 90% of arrivals landed on 09L during the monitoring period, which tends to be used for easterly arrivals due to current infrastructure, as explained above.

The distribution of arriving aircraft flight paths through the grid for easterly operations, as well as their vertical distribution through the western face (Face 2), for the majority of August 2011 (a period chosen as being a representative sample) is illustrated in Figure 4 overleaf. The graphic shows arrivals were spread laterally as they entered the western face of the grid with many aircraft still turning onto the extended centreline after transiting from the holding stacks to the north and south of Heathrow. However further analysis shows a significant proportion were concentrated on or close to the centreline for 09L. On leaving the grid through the easterly face (Face 1) arrival flight paths were more concentrated laterally. Arriving aircraft typically entered the westerly face (Face 2) of the grid at heights of approximately 3,000 feet. On westerly operations, no arriving aircraft overflew the grid.

Departure flight paths: Aircraft departing Heathrow fly pre-defined routes, largely based upon the destination of the aircraft. On westerly operations parts of the Holyport grid were overflown by aircraft following the westerly Compton (CPT), Southampton (SAM) and Woburn (WOB) NPRs. The distribution of departing aircraft flight paths through the grid for westerly operations, as well as their vertical distribution through the eastern face (Face 1), for the majority of August 2011 is illustrated in Figure 5 overleaf. Some, but not all, aircraft following the westerly Compton and Southampton NPRs overflew the southern half of the grid. Similarly some of the aircraft which had followed the westerly Woburn NPR overflew the north-east tip of the grid. The vast majority of departing aircraft were above 3,000 feet when they entered the grid. Only a limited number of departures overflew the grid during easterly operations.

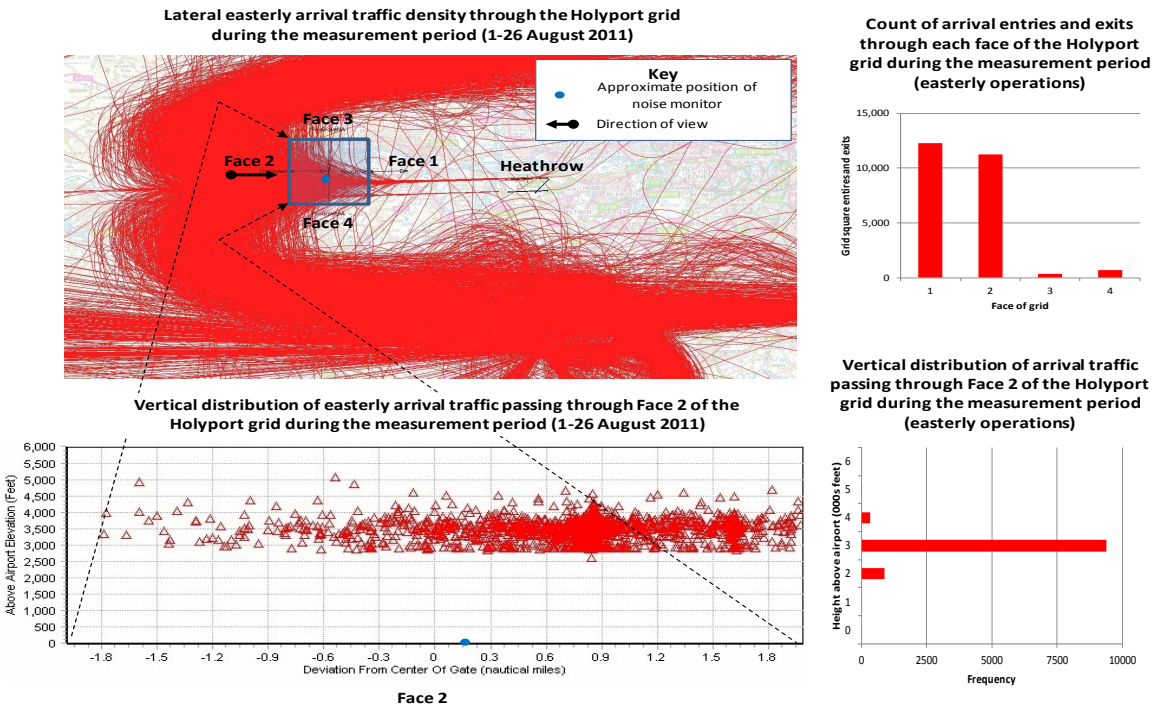

Figure 4. The lateral and vertical distribution of arriving air traffic passing through the Holyport grid square during the monitoring period (easterly operations)

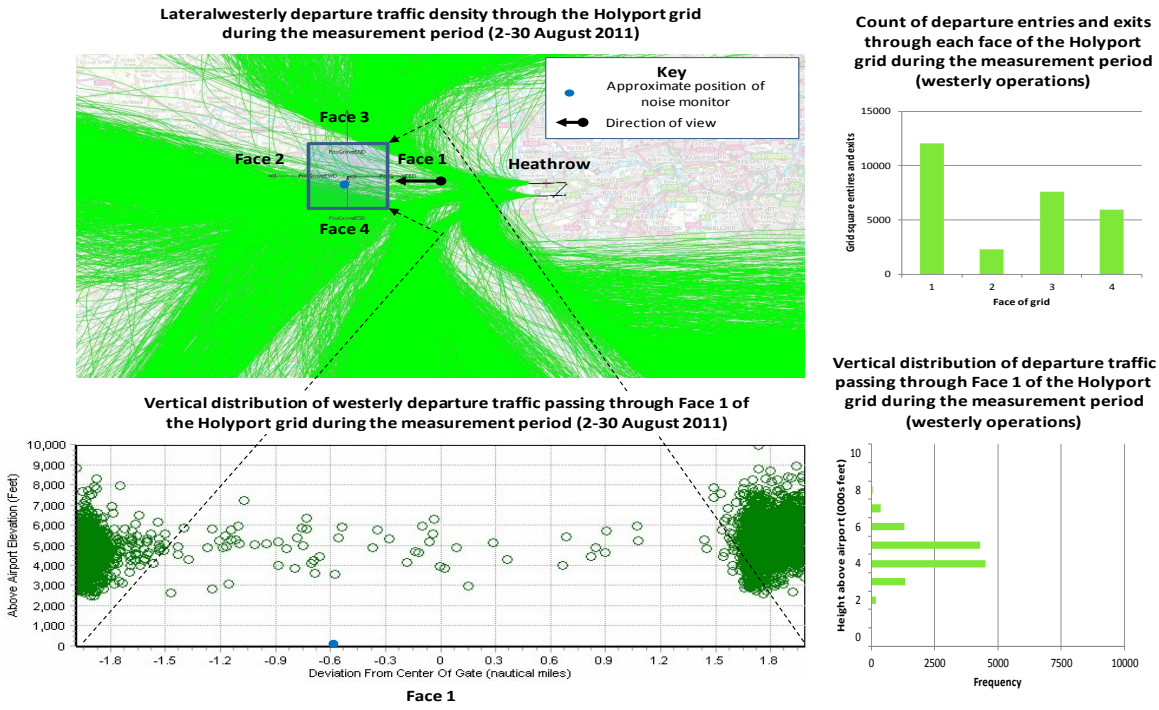

Figure 5. The lateral and vertical distribution of departing air traffic passing through the Holyport grid square during the monitoring period (westerly operations)

Figure 6 overleaf shows the proportion of traffic that passes through the grid square by direction of runway operation and hour. During the monitoring period the grid was overflown throughout the main hours of operation by arrivals on days of easterly operations and departures on days of westerly operations (a very small number of departures also overflew the grid of easterly operations but were too few in number to register on the graphs). Similar numbers of arriving and departing aircraft overflew the grid during the monitoring period, but it was overflown by many more arrivals on days of easterly operations than it was by departures on days of westerly operations. This reflects the position of the grid relative to the easterly arrival approach path.

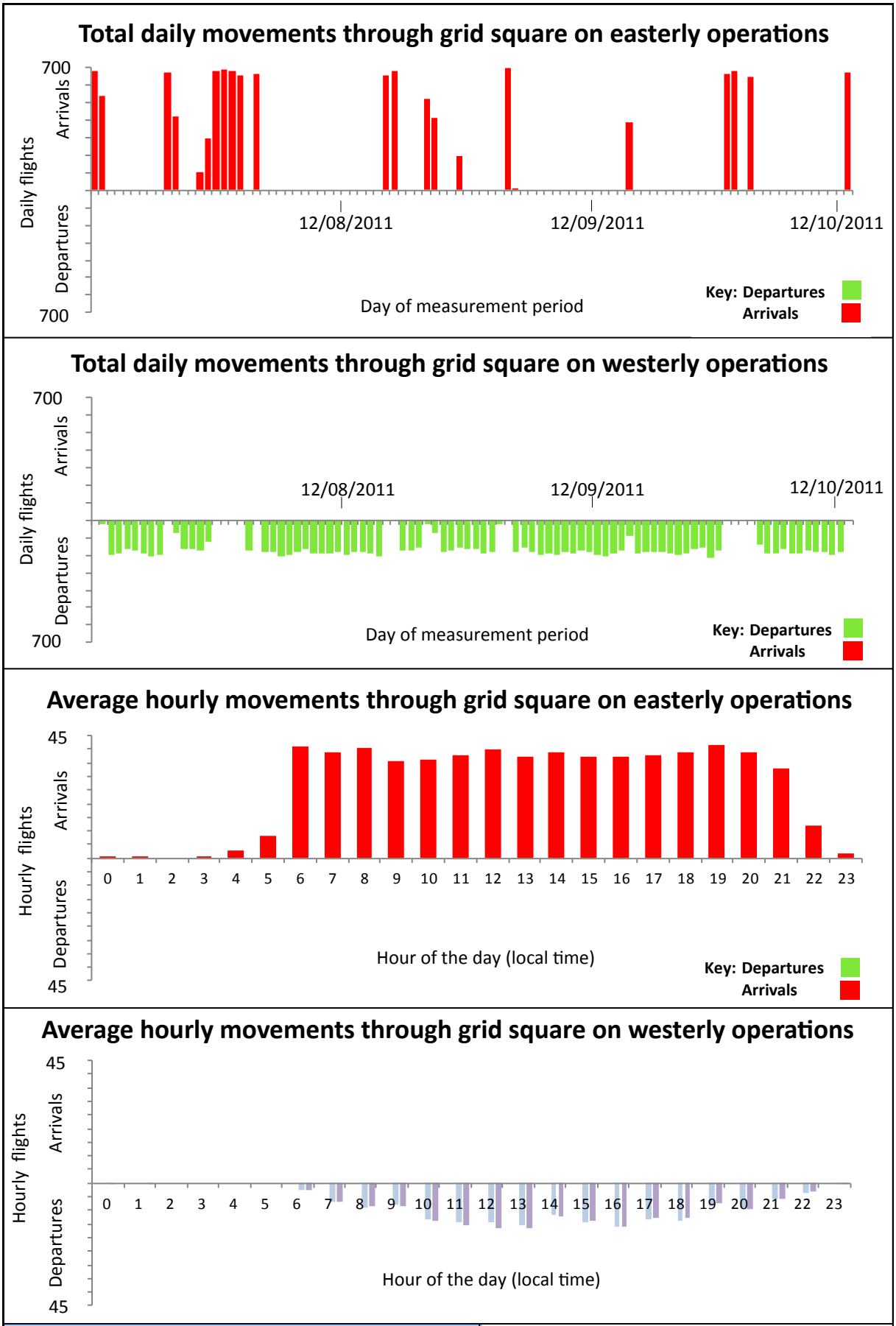

Figure 6. Daily movement totals and hourly mean averages for easterly and westerly operations through the grid square

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 Holyport 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 over the morning (rush-hour) period 06:00-09:00 hrs during periods of easterly operation; during these periods the wind direction was frequently from the north, placing the site downwind of the M4 motorway and A330 road.

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 less than 40 dBA, rising to over 45 dBA after 06:00 hours for the rest of the day until 21:00-22:00 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 at night between the quietest and noisiest days. The overall noisiest day was Thursday 14 July; a day with a gentle north-westerly wind, placing the site downwind of the M4 motorway and the A330 road. The quietest day was Saturday 10 September; a day with a moderate southerly wind, placing the site upwind of the M4 and A330.

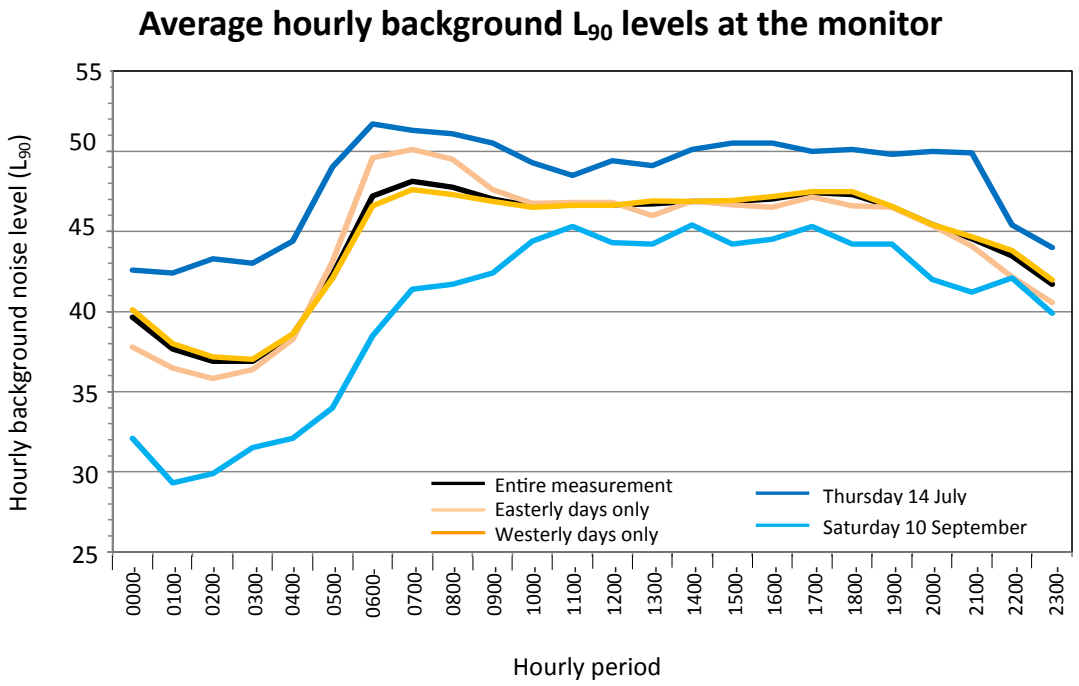

Figure 7. Hourly background L_{90} levels at the monitor averaged over 24 hour period; including Thursday 14 July (noisiest day) and Saturday 10 September (quietest day)

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 Holyport grid square generates a noise event. During the monitoring period a total of 10,535 aircraft noise events were recorded.

As the noise monitor was positioned close to the extended centreline of runway 09L (and outside any of the departure NPRs), easterly arrivals account for nearly all of the noise events recorded at the site (95%). 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, 8,858 noise events were generated by arrivals on runway 09L and 47 noise events by arrivals on runway 09R (8,905 in total). As explained above, only a small number of departure noise events were recorded at the Holyport site; 475 noise events were generated by westerly departures and just one noise event by an easterly departure (476 in total).

Figure 9 indicates that 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 Holyport monitor for each aircraft type. For arrivals, the noisiest aircraft type on average was the A300 (although there were only 28 recorded events for this type), followed by the B747, A330, A340, and A380. Note that no departure measurements were recorded for the A300, A380, B737, CRJ, and MD80. Of the remaining aircraft types on departure (and excluding the result for the A340, for which there were only three recorded noise events), the noisiest aircraft on average was the B747, followed by the B767 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). Although shown for completeness, it should be noted that the data samples for evening and night-time departures are too small for any meaningful analysis to be made. The graphs for arrivals however indicate that the overall spread of the measured noise levels is 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. In this instance the monitor threshold was set at 60 dBA, which appeared to be low enough to capture almost the entire distribution of L_{Max} levels during each time period. The use of this threshold is explained further on page 9.

Departures (5% of total noise events)					Arrivals (95% of total noise events)				
09L	09R	27L	27R	Total	09L	09R	27L	27R	Total
0 (0%)	1 (0%)	222 (2%)	252 (3%)	476 (5%)	8,858 (94%)	47 (1%)	0 (0%)	0 (0%)	8,905 (95%)

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

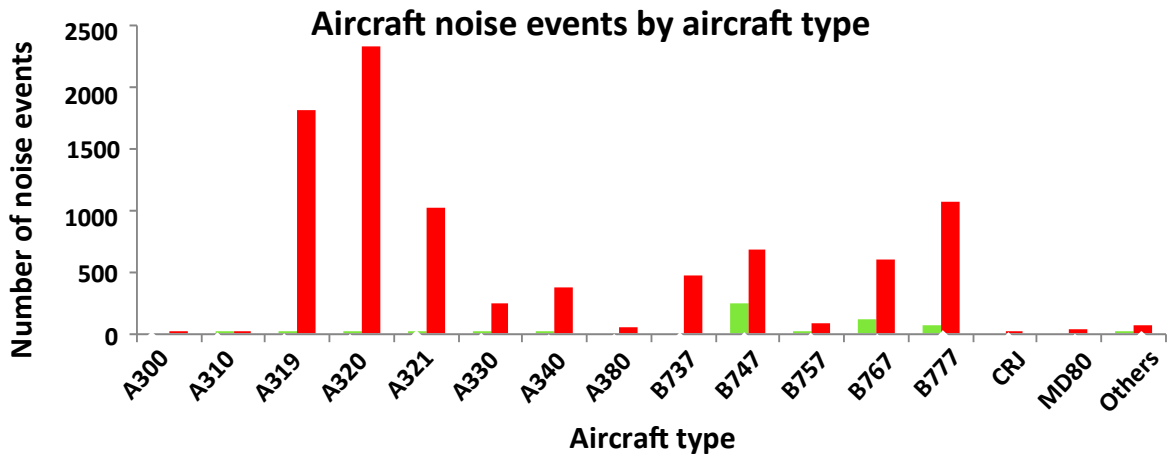

Figure 9. Number of departure and arrival aircraft noise events by aircraft type

Key: Departures, Arrivals

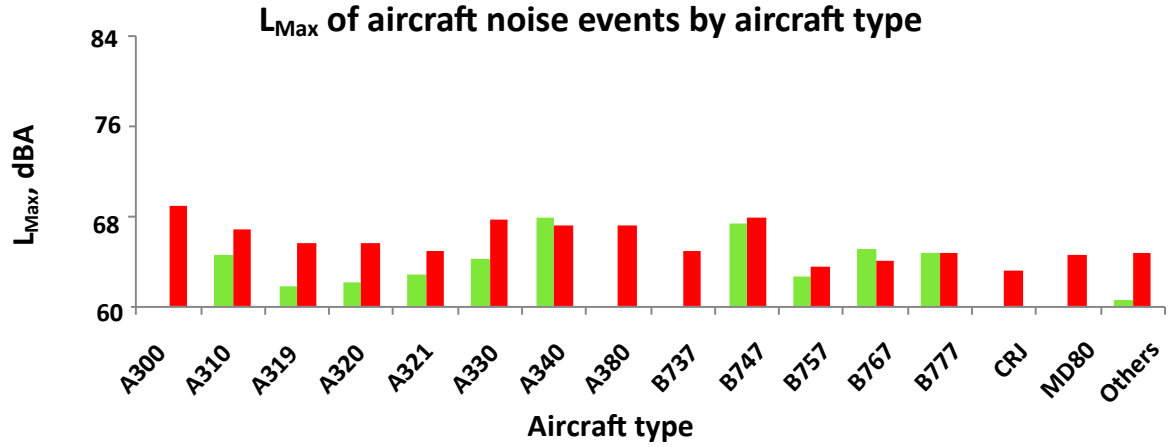

Figure 10. Mean average L_{Max} by aircraft type for departures and arrivals

Key: Departures, Arrivals

Noise distribution for departures and arrivals

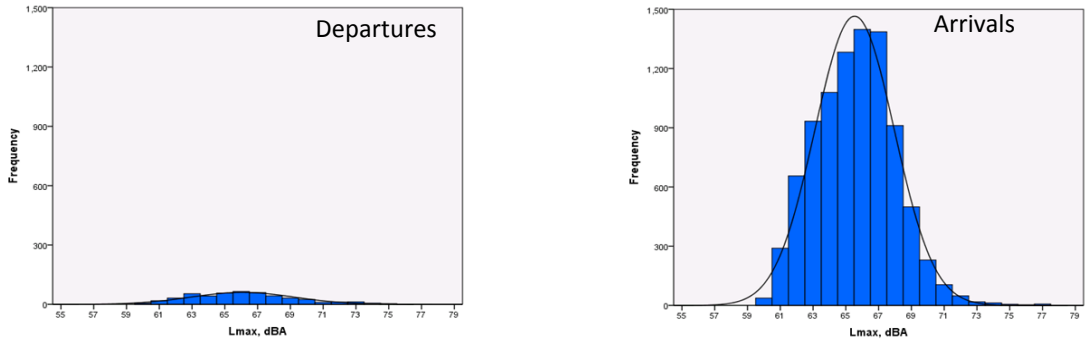

Figure 11. Above left: L_{Max} frequency distribution of departure noise levels
Above right: L_{Max} frequency distribution of arrival noise levels (frequency scale 0-1500)

Noise distribution for departures and arrivals by periods of the day

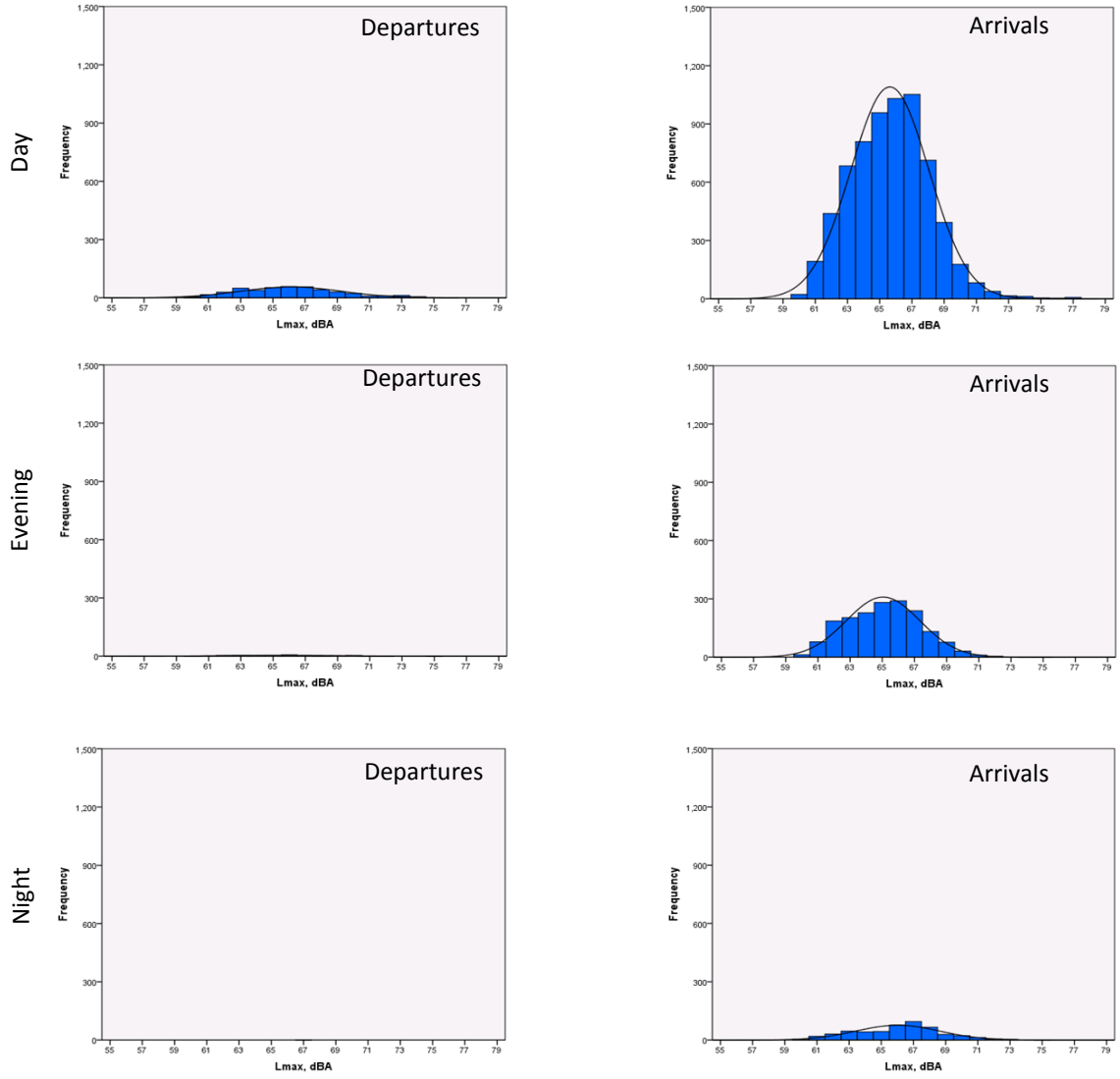

Figure 12. L_{Max} distribution of departure (left) and arrival (right) noise level recorded on the A-weighted sound level over the three averaging periods of L_{Max}(Day — 12 hour period 07:00-19:00), L_{Max}(Evening — 4 hour period 19:00-23:00) and L_{Max}(Night — 8 hour period 23:00-07:00)

Conclusions

This report describes the overflight and noise experience measured for the Holyport grid square over a 94 day period from 12 July to 13 October 2011. During the monitoring period the Holyport grid square was overflown by 25,891 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 days of easterly operation the Holyport grid is oveflown by arriving aircraft landing on Heathrow's easterly runways (09L and 09R). As there is currently no runway alternation in place for easterly operations over 90% of arrivals landed on runway 09L during the monitoring period. Arriving aircraft entered the western face of the grid at approximately 3,000 feet, some aircraft tracks were concentrated laterally on the extended runway centrelines while others were dispersed as they may still be turning onto the centrelines. On leaving the grid arriving aircraft were more laterally concentrated. Due to the proximity of the eastern runways, significantly more aircraft overflew the Holyport grid on days of easterly operations than on days of westerly operations. A limited number of departures overfly the grid during easterly operations.

During westerly days of operation the southern half of the Holyport grid was overflown by some departing aircraft followed the westerly Compton and Southampton NPRs, while the north-east tip of the grid is overflown by some aircraft following the westerly Woburn NPR. The vast majority of departing aircraft are above 3,000 feet when they enter the grid. No arriving aircraft overflew the grid on westerly operations.

Average background noise levels are generally comparable for days of easterly and westerly operations, although slightly higher background noise levels were recorded over the morning (rush-hour) period 06:00-09:00 hrs during periods of easterly operation; during these periods the wind direction was frequently from the north, placing the site downwind of the M4 motorway and A330 road.

The majority of significant aircraft noise events at the Holyport sits are generated by medium-sized aircraft (e.g. the A320 family); this reflects the traffic mix at Heathrow. Nearly all of the noise events (95%) were generated by arrivals as the noise monitor was positioned close to the extended centreline of runway 09L (and outside any of the departure NPRs). For arrivals, the noisiest aircraft on average was the A300 (although there were only 28 recorded events for this type), followed by the B747, A330, A340, and A380. For the relatively small sample of departing aircraft, the noisiest aircraft on average was the B747, followed by the B767 and B777 (this excludes the A340, for which there were only three recorded noise events).

The noise distributions measured at the monitoring site for arrivals indicate that the overall spread of the measured noise levels is 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.

The results of the Holyport 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 www.dft.gov.uk/pgr/aviation/
- Operational Freedoms at Heathrow www.heathrow.com/noise/
- South East Airports Task Force www.dft.gov.uk/publications/

Stacks and NPRs

- 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:

- 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 Holyport monitor was set with a threshold of 60 dBA, meaning that noise events below 60 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 Holyport, where the background noise level is frequently varying (for example, due to the M4 motorway, A330 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)