Heathrow Community Noise and Track-keeping Report: Thorney

This document reports on a 92-day period of continuous noise monitoring from the 3 March 2013 to the 2 June 2013 using a Larson Davies LD 870 sound monitor placed in fields close to Thorney Mill Road in the hamlet of Thorney, Buckinghamshire (positioned at 51° 30' 10.44" N, 0° 29' 27.66" W, 82 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.

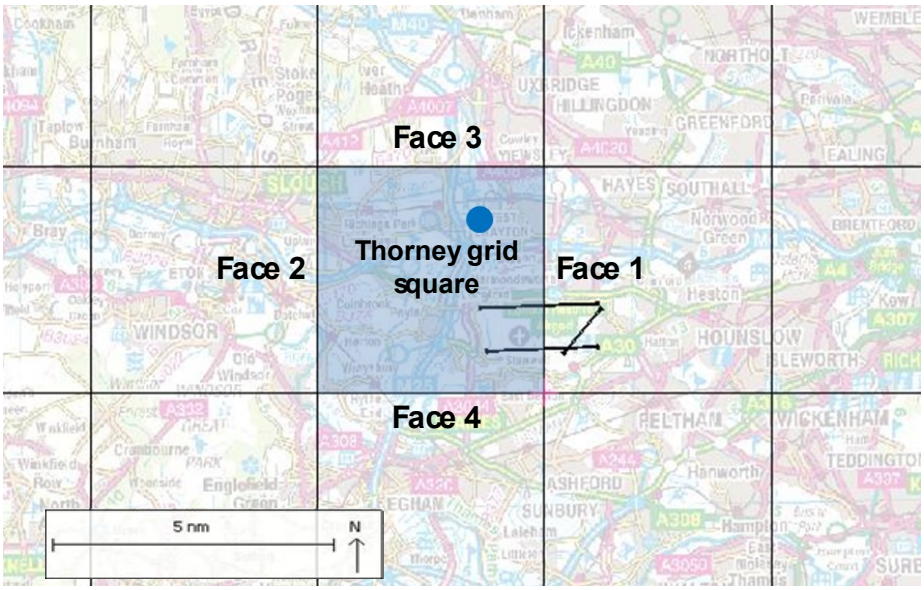

Figure 1. Map of the Heathrow area with noise monitoring grid; position of the noise monitor shown as a blue dot in the blue shaded grid (the Thorney community grid square area)

This report describes the noise levels and aircraft tracks affecting the Thorney grid square, shown above. Noise levels were recorded by a temporary noise monitor situated in the hamlet of Thorney (position indicated by blue dot). The noise monitor was located approximately 1.5NM north of the western threshold of Heathrow's northern runway, close to the intersection of the M25 and M4 motorways. Although close to Heathrow, the monitoring site was not located directly under any of the Airport's arrival or departure routes and was outside of the 57 L_{eq} noise contour (average 2011 contours, see references on page 9). 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 take place when the wind is in an easterly direction and 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. This runway alternation pattern changes by week; in alternation pattern 1 (week commencing 14 January in 2013) 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. After the last departure of the day a 4 week night-time alternation pattern will be utilised and this includes easterly operations should the weather conditions allow.

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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.

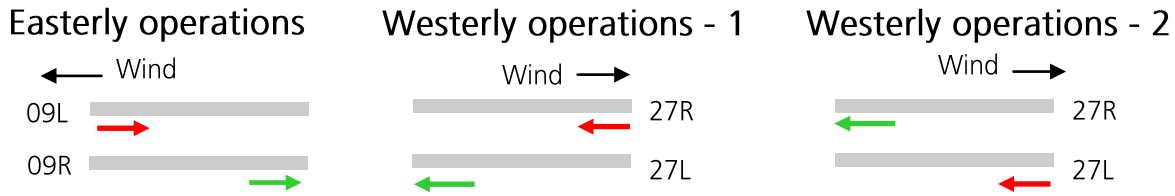

Figure 2. Illustration of the direction of easterly and westerly operations | Key: Departures → Arrivals →

Operations during the monitoring period: During the monitoring period, Heathrow handled a total of 119,316 air traffic movements (59,662 arrivals and 59,654 departures). On the 24 May there was disruption due to the emergency landing of a British Airways A319 resulting in the closure of the northern runway (09L/27R) for approximately two hours. Also during the monitoring period, an early morning noise respite trial took place (ending on the 31 March) and night-time resurfacing of the southern runway started on the 3 March. Neither had an impact on the flying schedule or increased the number of daily flights. During the monitoring period, westerly operations prevailed for 54% of the time - below the long term average - with a total of 32,113 westerly arrivals and 31,846 westerly departures taking place. Easterly operations were in place for the remaining 46% of the time and these accounted for 27,549 arrivals and 27,808 departures.

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 approximately 0.5% fewer flights than the runway logs due to technical reasons (see Additional Information on page 9). To track flights affecting the Thorney 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	141	27,705	105	157	83	4	28	56
Departures	0	2	0	2	0	23,797	16	7,627

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: During easterly operations the Thorney grid is overflown by all arriving aircraft landing on the northern and southern runways, 09L and 09R respectively. Figure 4 overleaf shows the lateral distribution of arriving flight paths through the grid and the vertical distribution through Face 2. The images show that landing aircraft are concentrated laterally and vertically in two groups as they enter the grid through Face 2 (indicated by two black circles), with 99% of landing aircraft entering the grid between 900 and 1,200 feet (75% of them between 1,000 and 1,100 feet). This is because the aircraft are established on the Instrument Landing System (ILS) for final approach and only a short distance from touchdown. Although not evident from Figure 4, over 90% of easterly arrivals landed on runway 09L during the monitoring period. A very small number of easterly arrivals also overflew the grid, generally at heights above 6,000 feet, prior to commencing their approach. Similarly, during westerly operations a very small number of arrivals overflew the grid prior to commencing their approach. In addition, many westerly arrivals will complete their landing roll within the grid. However, they will not be visible to radar when they enter the easterly face of the grid and are therefore not included in this noise monitoring report.

Departure flight paths: During westerly operations the Thorney grid is overflown by all departing aircraft taking off from the northern and southern runways, 27R and 27L respectively. Figure 5 overleaf shows the lateral distribution of departing flight paths through the grid and the vertical distribution through Face 2. Figure 5 shows that aircraft tracks are laterally concentrated into several groups. This reflects aircraft following pre-defined Standard Instrument Departure (SID) routes, usually based on the destination of the aircraft, after departing from Heathrow. Approximately 95% of westerly departures exit the grid between 1,500 and 4,000 feet. All easterly departures commence their take-off roll inside the grid but have not left the ground or are not visible to radar when they exit the easterly face of the grid. Therefore these flights are not included in this noise monitoring report. However, two easterly departures overflew the grid during the monitoring period. Both were above 4,000 feet and would have been vectored by air traffic control.

Go-arounds: In addition to arriving and departing aircraft, the Thorney grid also experiences noise generated by aborted landings or 'go-arounds'. During the monitoring period 61 westerly go-arounds overflew the grid.

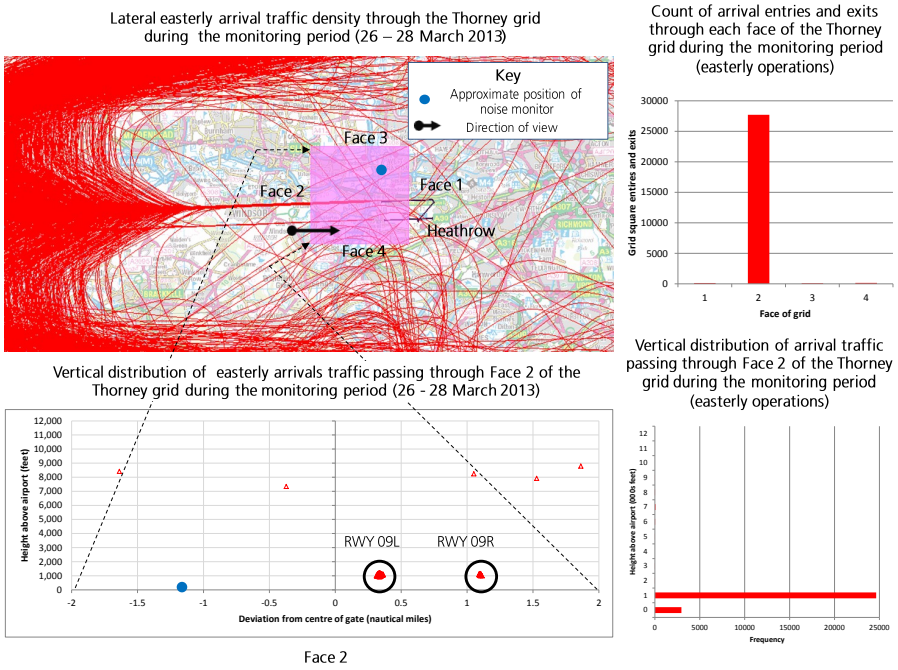

Figure 4. Lateral and vertical distribution of arriving air traffic passing through the Thorney grid during the monitoring period (easterly arrivals) - representative sample (Heathrow flights only)

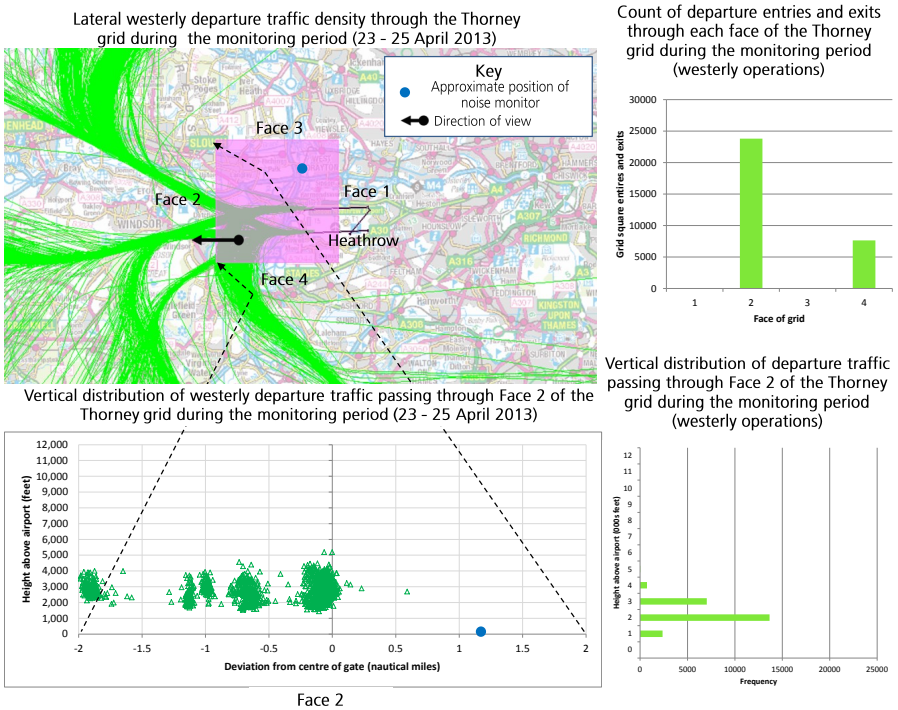

Figure 5. Lateral and vertical distribution of departing air traffic passing through the Thorney grid during the monitoring period (westerly departures) - representative sample (Heathrow flights only)

Figure 6 overleaf shows the proportion of aircraft that passed through the grid 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. As the grid includes the westerly thresholds of Heathrow's two runways, it is overflown by all easterly arrivals and westerly departures. During the monitoring period less than 1.5% of westerly departures operated out of alternation. Two thirds of these took place for safety reasons, such as strong winds or technical issues with the runway lighting on the dedicated departure runway. The remainder occurred as a result of the night-time closure of the southern runway for resurfacing.

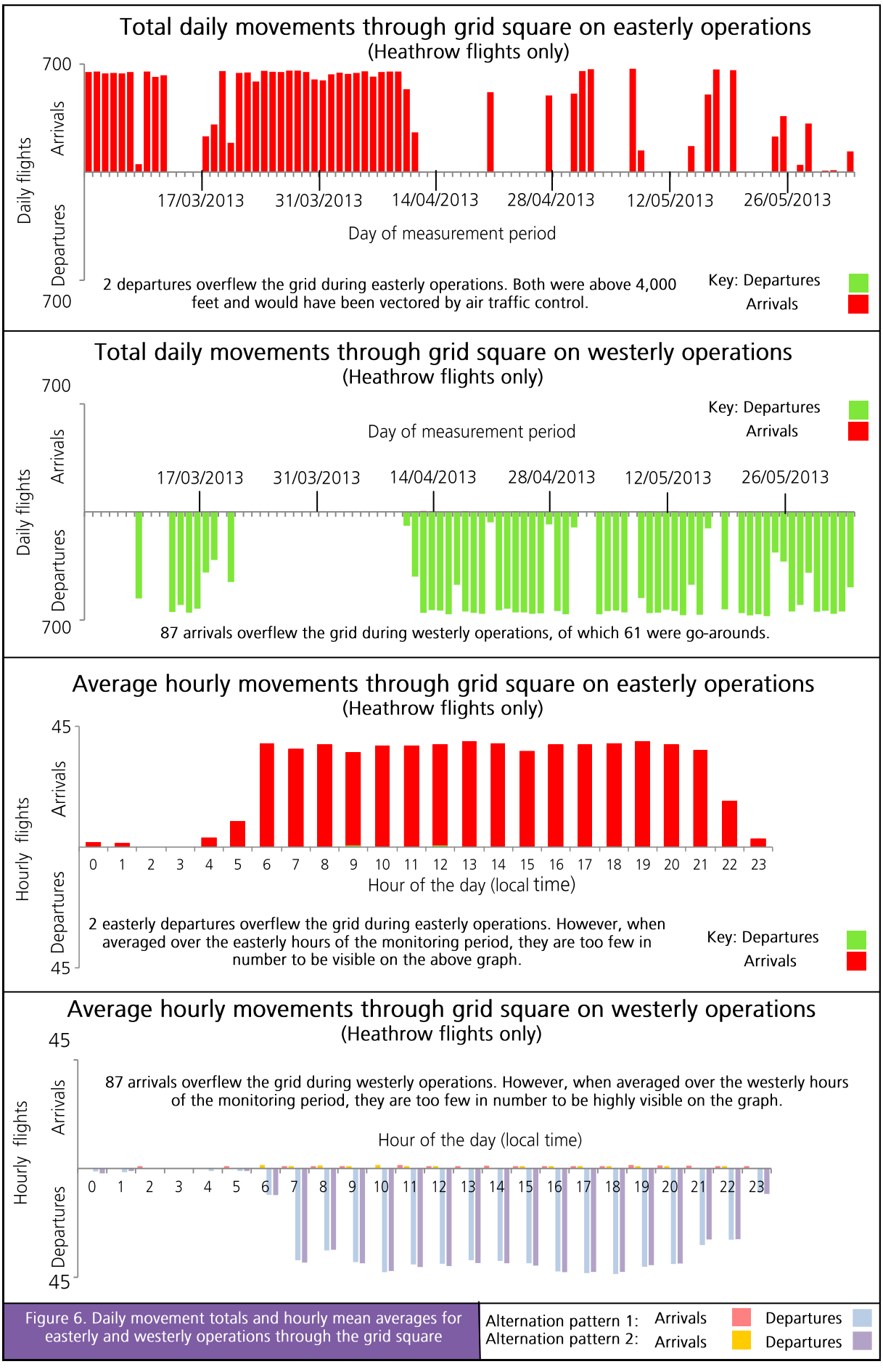

Figure 6. Daily movement totals and hourly mean averages for easterly and westerly operations through the grid square

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 Thorney 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, average background noise levels are between 4 to 7 dB higher during periods of westerly operation, when the prevailing wind direction would generally place the site downwind of the nearby M25 motorway (and also downwind of the nearby M25/M4 junction on days when the wind is in a southerly or south-westerly direction).

The overall trend in Figure 7 is largely in line with expected results given the proximity of the site to the M25/M4 motorways and the airport; during the night-time period the average background noise level was relatively high, remaining above 50 dBA between 00:00-06:00 hours. After 0600 the average background level remained above 56 dBA 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 15 dBA or more between the quietest and noisiest days. The overall noisiest day was Thursday 18 April; a day with a strong south-westerly wind, placing the site downwind of the M25 motorway and the M25/M4 junction. The reduction in background noise during the late afternoon and early evening on this day is quite likely to have been caused by heavy congestion on the anti-clockwise carriageways of the M25. The quietest day was Saturday 30 March; a day with a light north-easterly wind, placing the site upwind of the M25 but downwind of the Great Western Main Line. It should be noted that even on this 'quiet' day, the hourly background noise level at the Thorney site remained relatively high throughout the day (e.g. above 50 dBA between 06:00 and 21:00 hours).

Average hourly background L_{90} levels at the monitor

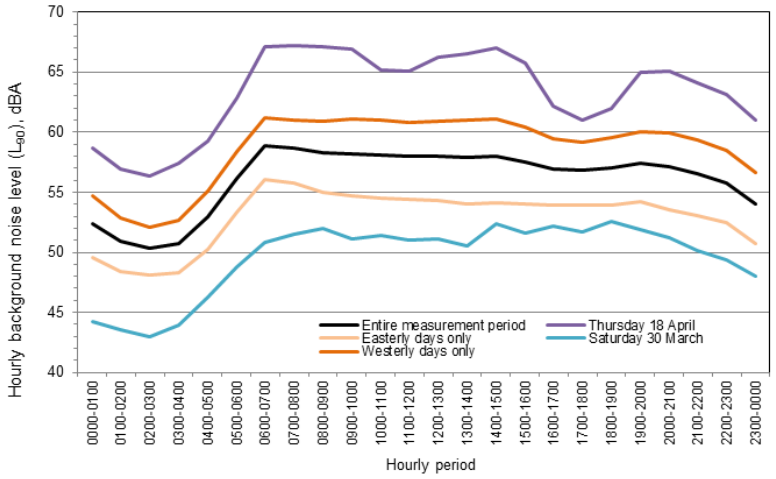

Figure 7. Hourly background L_{90} levels at the monitor averaged over 24 hour period; including Thursday 18 April (noisiest day) and Saturday 30 March (quietest day)

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 Thorney grid square generates a noise event. During the monitoring period a total of 350 aircraft noise events were recorded at the Thorney site. This relatively low number of events is unsurprising given the monitor's distance from the main departure and arrival routes. Despite the use of a moderately high 64 dBA monitor threshold (the use of this threshold is explained further on page 9), the Thorney noise monitor also recorded 5,705 non-aircraft events, which accounted for nearly 95 percent of all noise events recorded at the monitor. This unusually high proportion of non-aircraft events is unsurprising given the monitor's proximity to the M25 motorway.

It should be noted that for each measured noise event, the noise and track keeping system software determines whether an aircraft passed within a defined cylindrical zone (centred on the noise monitor) close to the time of L_{max}. If an aircraft is found within the zone close to the time of L_{max} then the software assumes the noise event was caused by that aircraft and correlates the event with that particular flight, otherwise the event is classed as non-aircraft. The detection zone for the Thorney monitor was 3000 m in both height and radius (which are standard values used in the system). The southern edge of the zone extended far enough to just cover the western end of the northern runway (27R/09L). Therefore, given the relatively high number of non-aircraft events in the system, and also the monitor's distance from the departure and arrival routes (meaning that aircraft will generally be quieter and more difficult to measure in practice), it is likely that a proportion of events classified by the system as aircraft noise events may not have been caused by aircraft. For example, if a non-aircraft noise event (e.g. caused by road traffic) occurred within a few seconds of an aircraft passing through the edge of the detection zone, the system software would correlate the noise event with that particular flight even if the aircraft was too quiet to have registered a valid event in the absence of any extraneous noise sources. The results from the Thorney monitor should therefore be treated with some caution.

Subject to the caution noted above regarding the measurement and detection of aircraft noise events, Figure 8 provides a summary of aircraft noise events by operation and runway after filtering for bad weather (approximately 30% of noise events were rejected due to unacceptable weather conditions in accordance with international guidelines). Accounting for rejected events, 232 noise events were generated by westerly departures from runway 27R (but none from runway 27L, as the detection zone mentioned above did not extend far enough to cover departures from the southern runway). In addition, there were 14 noise events caused by arrivals. Nine were from aircraft approaching runways 09L and 09R, and the remaining 5 from go-arounds on runway 27R. In summary, a total of 246 aircraft noise events were recorded at the Thorney monitor after filtering for bad weather.

Figure 9 indicates that medium-sized aircraft (e.g. the A320 family) and, to a lesser extent, the wide-bodied 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 Thorney monitor for each aircraft type. For arrivals the sample sizes are too small to make any meaningful conclusions from. 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 A300, followed by the B767 and A330. Again, these results should be considered in light of the caution noted above regarding the measurement and detection of noise events.

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). Although shown for completeness, it should again be noted that the data samples for arrivals are too small for any meaningful analysis to be made. It is immediately apparent from these figures that the distributions for departures appear skewed (asymmetrical) because they are truncated at the 64 dBA monitor threshold. The graphs suggest a significant 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 will be biased upwards.

Departures (94% of total noise events)					Arrivals (6% of total noise events)				
09L	09R	27L	27R	Total	09L	09R	27L	27R	Total
0	0	0	232	232	8	1	0	5	14

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

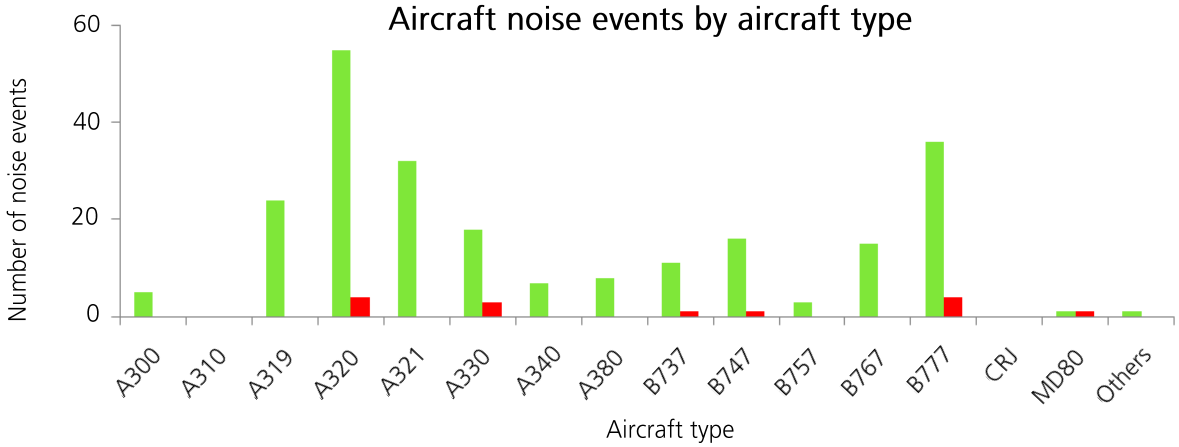

Figure 9. Number of departure and arrival aircraft noise events by aircraft type

Key: Departures Arrivals

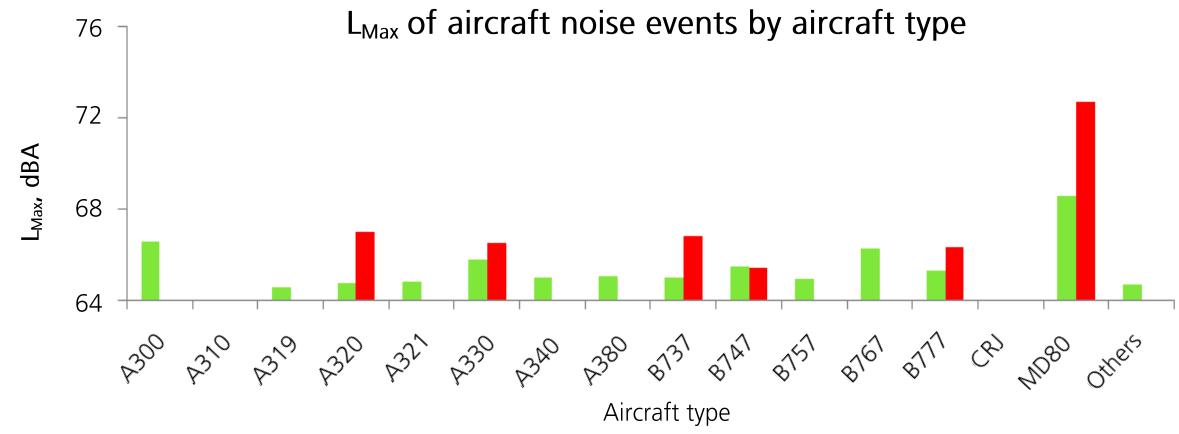

Figure 10. Average (mean) L_{Max} by aircraft type for departures and arrivals

Key: Departures Arrivals

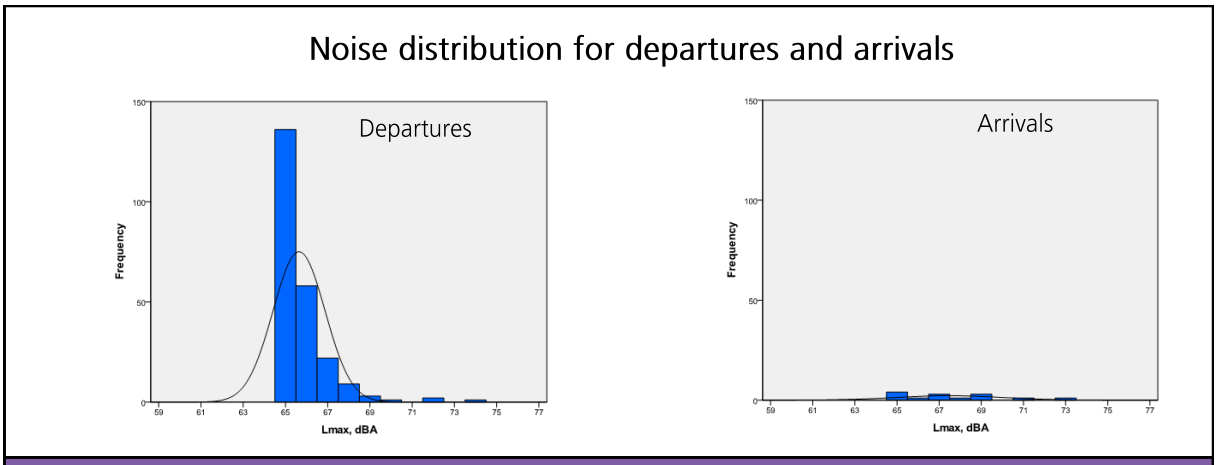

Figure 11. Above left: L_{Max} frequency distribution of departure noise levels
Above right: L_{Max} frequency distribution of arrival noise levels

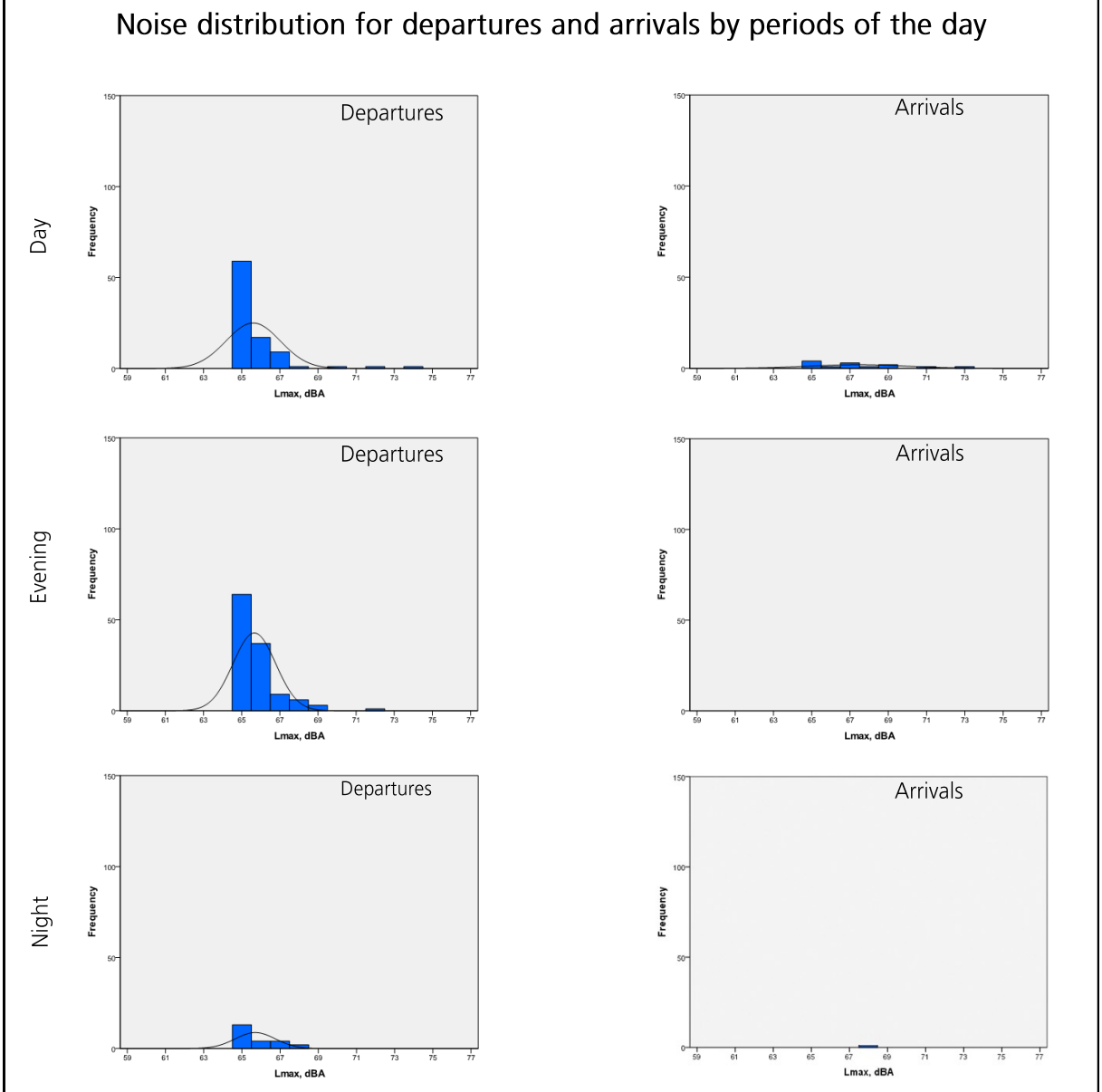

Figure 12. L_{Max} distribution of departure (left) and arrival (right) noise level recorded on the A-weighted sound level over the three averaging periods of L_{Max} (Day — 12 hour period 07:00-19:00), L_{Max} (Evening — 4 hour period 19:00-23:00) and L_{Max} (Night — 8 hour period 23:00-07:00)

Conclusions

Background

This report describes the overflight and noise experience measured for the Thorney grid square over a 92-day period from the 3 March 2013 to the 2 June 2013. During the monitoring period the grid square was overflown by a total of 119,316 Heathrow arrivals and departures.

Heathrow operates in either a westerly or easterly direction, primarily due to prevailing wind conditions. During the monitoring period westerly operations prevailed, but the proportion of westerly operations was almost 20% below the long-term average.

Flight movements

Given that the thresholds of Heathrow's easterly runways 09R and 09R are inside the Thorney grid, it is overflown by all arriving aircraft when the runways are operating in an easterly direction. Being close to touchdown, the flight paths of these aircraft are concentrated laterally and vertically in two streams, one for runway 09L and the other for runway 09R. As there is no runway alternation during the day for easterly operations, the vast majority will land on runway 09L. Landing aircraft typically enter the grid between 900 feet and 1,200 feet and descend until touchdown. Many westerly arrivals will complete their landing roll within the grid. However, they will not be visible to radar when they enter the easterly face of the grid and are therefore not included in this noise monitoring report.

During westerly operations the Thorney grid is overflown by all departing aircraft. Westerly departure tracks are concentrated into groups according to the SID they follow and typically only overfly the south-west quadrant of the grid. The vast majority of these departures exit the grid between 1,500 and 4,000 feet. All easterly departures commence their take-off roll inside the grid but have not left the ground, or are not visible to radar, when they exit the easterly face of the grid. Therefore these flights are not included in this noise monitoring report.

In addition to arrivals and departures, the Thorney grid also experiences noise from aborted landings or 'go-arounds'. Due to its position, all 61 westerly go-arounds during the monitoring period overflew the grid.

Noise

The noise monitor site was located approximately 1.5NM to the north of Heathrow's two runways, perpendicular to the threshold of runway 09L. The monitor was also located close to the M25 and M4 motorways meaning that the overall trend in measured background noise levels broadly coincided with daytime increases in road traffic levels. On days of westerly operations the monitoring site was downwind of the M25 and M4 motorways. Consequently the site experienced slightly higher background noise on days of westerly operations than on days of easterly operations.

Although close to Heathrow, the monitor was located away from the main arrival an departure routes meaning that not all aircraft passing through the grid generated a noise event above a pre-defined threshold level of 64 dBA. The above, combined with the proximity of the monitor to the M25 and M4 motorways, meant that the monitor recorded an unusually high proportion of non-aircraft related events. This also meant that a number of events classified as aircraft noise events may not have been caused by aircraft. For these reasons the results from the monitor should be treated with some caution.

Notwithstanding the above comments, nearly all of the aircraft noise events were for departing aircraft on runway 27R. The majority of departing noise events generated were by medium-sized aircraft (e.g. the A320 family), which reflects the traffic mix at Heathrow. Excluding small sample sizes, the nosiest departing aircraft on average was the A300, followed by the B767 and A330. There were too few noise events from arriving aircraft to draw meaningful conclusions. Similarly, the small number of noise events for both arrivals and departures meant that it was not possible to make meaningful conclusions about their distribution during the day, evening and night.

Summary

The results of the monitoring period represent a snapshot of the track and noise impact. The results generated are broadly what might be expected in the future at the Thorney Mill Road monitoring site. However, given the location of the Thorney grid relative to Heathrow, different noise levels would be expected if noise monitors were placed at other locations within the grid. 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
- Early morning noise respite trial: http://www.heathrowairport.com/noise/noise-in-your-area/early-morning-trial
- Night-time runway resurfacing: http://www.heathrowairport.com/noise/noise-in-your-area/runway-resurfacing

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.

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 Thorney monitor was set with a threshold of 64 dBA, meaning that noise events below 64 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 Thorney, where the background noise level is relatively high and frequently varying (for example, due to road traffic noise), it becomes difficult to configure the monitor and select an appropriate threshold level that is low enough to capture a suitable number of aircraft noise events, but high enough to ensure that extraneous noise is not routinely recorded. Despite setting the threshold at a relatively high level of 64 dBA, almost 95% of all noise events recorded at the Thorney monitor were non-aircraft events, which makes the identification of valid aircraft events difficult at this location.
- Approximately 30% 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.

Trials and other activities taking place during the monitoring period:

- An early morning arrival trial was conducted between 5 November 2012 and 31 March 2013 in order to examine the feasibility of providing predictable respite to some communities under the approach paths. The trial was developed together with British Airways, HACAN (Heathrow Association for the Control of Aircraft Noise) and NATS following community feedback on the value of predictable respite. A number of trial zones were designed to be free of aircraft movements and were activated on a schedule system thereby providing respite on a predictable basis. The zones were active each day between 2330 at night and 0600 in the morning. The trial is now complete and the lessons learnt will be applied to future trials.
- Between 3 March and 31 October 2013 night-time resurfacing of Heathrow's southern runway (09R/27L) is taking place. This is an essential maintenance task that takes place roughly once every decade. During the resurfacing, for five nights per week between 2230 (local) and 0600 (local), all flights will use the northern runway (09L/27R). Since Heathrow has relatively few night flights, the changes won't affect many aircraft – mostly arrivals after 0430 (local). There will be no additional night flights.

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).