Heathrow Community Noise and Track-keeping Report: Windsor Great Park

This document reports on a 135-day period of continuous noise monitoring from the 17 May 2014 to the 28 September 2014 using a Larson Davies LD 870 sound monitor placed in the grounds of Cumberland Lodge, Windsor Great Park (positioned at 51° 26' 01.4"N, 0° 36' 30.6"W, 236 feet elevation). It reports on both normal operations and two airspace trials that took place during the monitoring period. 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. The Airport has agreed with local stakeholders 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 4 nautical mile by 4 nautical mile 'grid'. The impact on the community within the grid square is then reported at the end of the monitoring period.

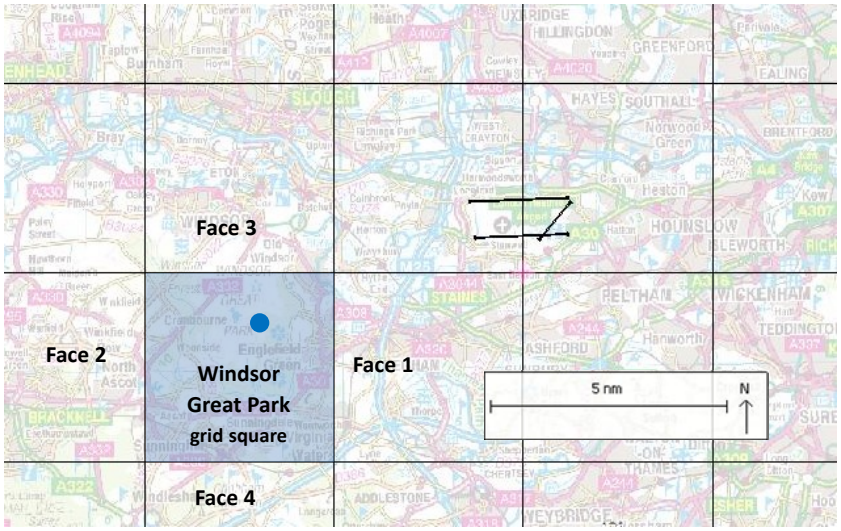


Figure 1. Map of the Heathrow area with the noise monitoring grid; position of the noise monitor shown as a blue dot in the blue shaded grid (the Windsor Great Park grid)

This report describes the noise levels and aircraft tracks affecting the Windsor Great Park grid square, shown above. Noise levels were recorded by a temporary noise monitor situated in the grounds of Cumberland Lodge, Windsor Great Park (approximate position indicated by the blue dot in Figure 1). The monitoring site was positioned under the westerly Midhurst (MID) and easterly Compton (CPT) Noise Preferential Routes (NPRs). The westerly Midhurst route is used by approximately 16% of the Heathrow departures that take-off from runways 27R and 27L, and the easterly Compton route is used by approximately 15% of departures that take-off from runways 09R and 09L. The site was located outside of the 57 L_{eq} noise contour (average 2013 contours). 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 14.

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 13 January in 2014) 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.

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. Therefore, during easterly operations, the majority of departures use the southern runway, 09R, and the majority of arrivals tend to use the northern runway, 09L.

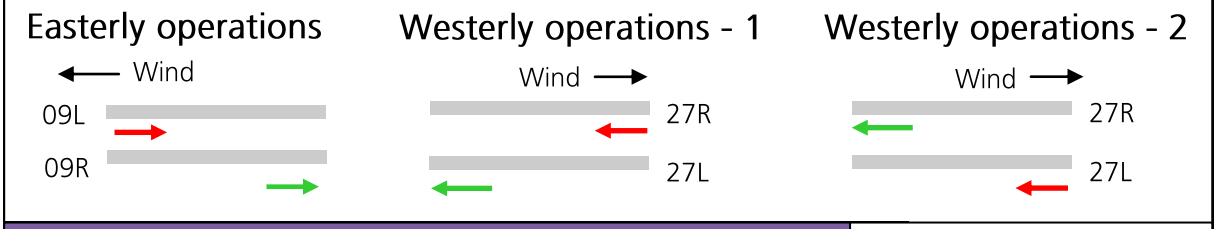


Figure 2. Illustration of the direction of easterly and westerly operations

Key: Departures → Arrivals →

Operations during the monitoring period: During the monitoring period, Heathrow handled a total of 180,796 air traffic movements (90,398 arrivals and 90,398 departures). Westerly operations prevailed for 65% of the time - 6% below the long term average - with a total of 58,596 westerly arrivals and 58,894 westerly departures taking place. Easterly operations were in place for the remaining 35% of the time and these accounted for 31,802 arrivals and 31,504 departures. During the monitoring period, Heathrow ran a series of airspace trials to inform future thinking on airspace design. The trials involved departing aircraft only; there were no changes for arriving aircraft. These trials are explained on page 4.

Flight path information is derived from radar data using a flight monitor processing programme (ANOMS) endorsed by the CAA. A public version of this flight tracking software, 'WebTrak', is available on Heathrow Airport's noise website. To track flights affecting the Windsor Great Park grid 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	846	622	90	736	15	24	0	27
Departures	4,131	4,347	12	372	2,324	4,358	10,982	7,245

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)

Normal operations during the monitoring period: The following text describes the flight paths of aircraft in the Windsor Great Park grid during typical ('normal') operations (trial periods are described on page 4).

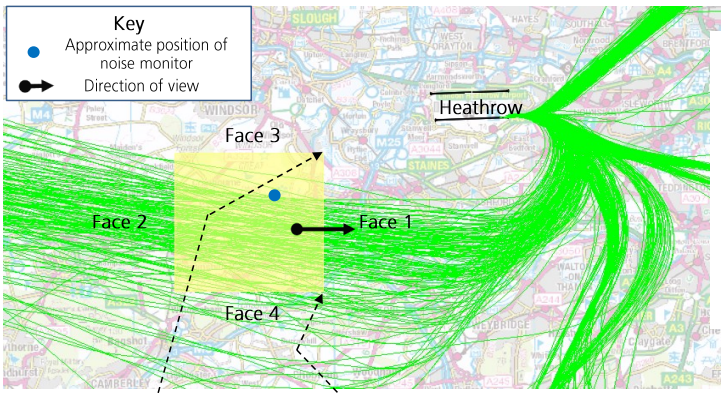
Departure flight paths during easterly operations (normal operations): Aircraft departing Heathrow follow pre-defined routes, known as Standard Instrument Departure (SID) routes, usually based upon the destination of the aircraft. During easterly operations the Windsor Great Park grid is overflown by departing aircraft that have taken off from Heathrow's easterly runways (09R and 09L) and followed the easterly Compton route. Due to there being no runway alternation during the day on easterly operations, all but two of the easterly departures that overflew the grid during the monitoring period took-off from Heathrow's southern runway (09R). The top left-hand image in Figure 4 shows the tracks of departing aircraft as they overflew the grid during a day of normal easterly operations - aircraft typically enter the grid via the easterly face (Face 1) at between 4,000 and 8,000 feet and exit the westerly face (Face 2) between 5,000 and 9,000 feet. As most aircraft are above 4,000 feet when overflying the grid, ATC will have already been able to instruct them to leave the SID and fly a more direct heading to their destination (see SIDs and NPRs on page 14 for further information). In addition, aircraft on this SID are subject to tactical vectoring. These points explain the lateral spread of tracks over the grid.

Departure flight during westerly operations (normal operations): During westerly operations departing aircraft flying through the grid have taken off from Heathrow's westerly runways (27R and 27L) and predominantly either follow the westerly Midhurst (approximately 89%) or Dover (approximately 8%) routes. The top left-hand image in Figure 5 shows the tracks of departing aircraft during a day of normal westerly operations. The two main concentrations of tracks are for aircraft following Midhurst route for their respective runways (27L or 27R) (aircraft following the Dover SID tend to 'clip' Face 1 rather than overfly the entire grid). The tracks are concentrated on entering the grid because the majority of aircraft are below 4,000 feet and must remain within in the Noise Preferential Route (NPR) associated with the SID. On passing through the grid aircraft climb above 4,000 feet and their tracks become more dispersed as they are given a more direct routing to their destination by ATC.

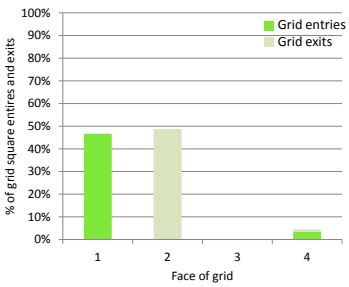
Arrival flight paths (normal operations): During the monitoring period the Windsor Great Park grid was overflown by 1,132 arrivals during easterly operations and 33 during westerly operations. During easterly operations, the arriving aircraft that overflew the grid had routed via Heathrow's southern holding stacks (Ockham and Biggin) prior to commencing their final approach. However, the majority of arrivals routing via these stacks will fly to the south of the grid. The tracks of arriving aircraft passing through the grid during a day of easterly and westerly operations are shown in figures 20 and 21 respectively (see page 15).

Normal operations

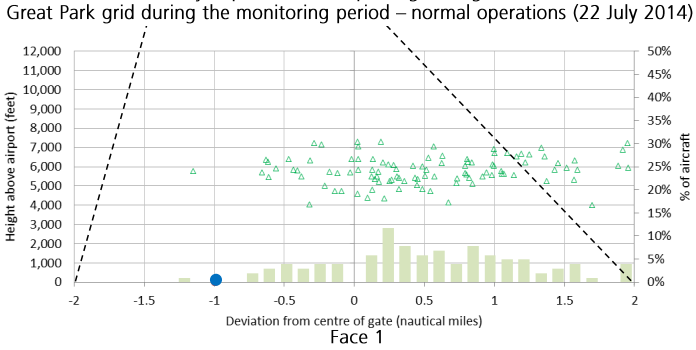
Lateral easterly departure traffic density through the Windsor Great Park grid during the monitoring period – normal operations (22 July 2014)



Departure entries and exits through the grid during the monitoring period – normal operations (easterly departures)



Distribution of easterly departure traffic passing through Face 1 of the Windsor Great Park grid during the monitoring period – normal operations (22 July 2014)



Vertical distribution of departure traffic entering and exiting the grid during the monitoring period – normal operations (easterly departures)

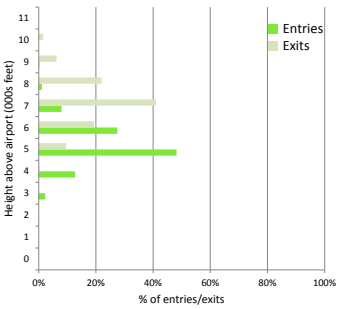
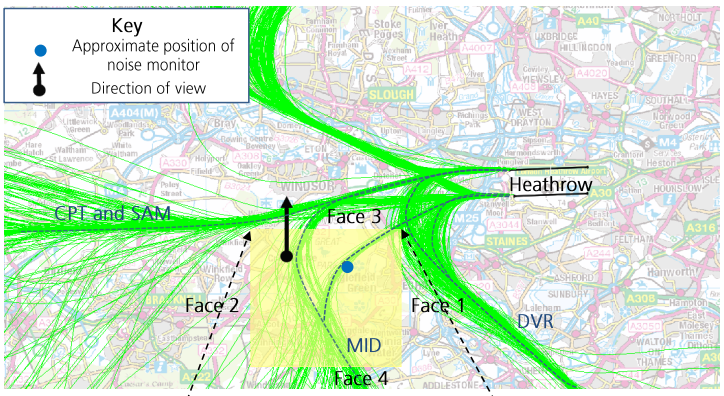
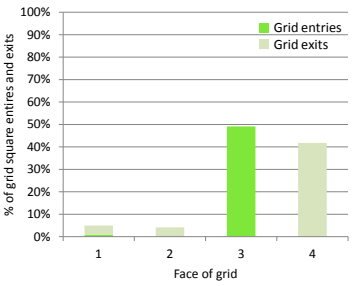


Figure 4. Lateral and vertical distribution of departing air traffic passing through the Windsor Great Park grid during normal operations (easterly departures) - representative sample (Heathrow flights only)

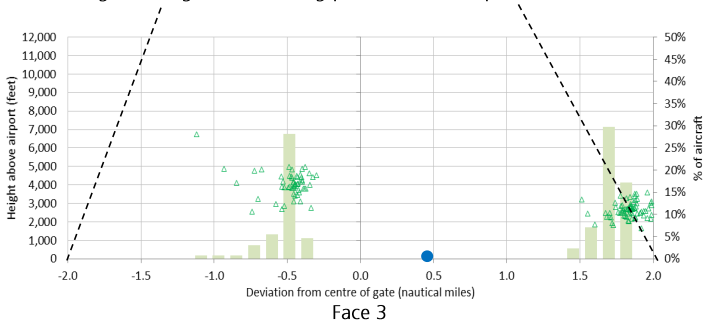
Lateral westerly departure traffic density through the Windsor Great Park grid during the monitoring period – normal operations (21 June 2014)



Departure entries and exits through the grid during the monitoring period – normal operations (westerly departures)



Distribution of westerly departure traffic passing through Face 3 of the Windsor Great Park grid during the monitoring period – normal operations (21 June 2014)



Vertical distribution of departure traffic entering and exiting the grid during the monitoring period – normal operations (westerly departures)

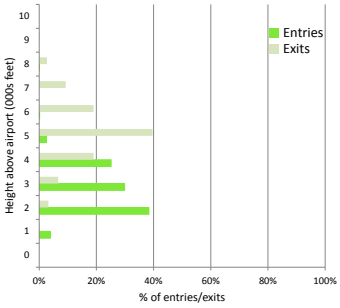


Figure 5. Lateral and vertical distribution of departing air traffic passing through the Windsor Great Park grid during normal operations (westerly departures) - representative sample (Heathrow flights only)

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Airspace trials

Airspace trials during the trial period: During the monitoring period, Heathrow undertook a series of airspace trials to inform future thinking on airspace design. Two trials, the DOKEN trial and the westerly package trial, influenced the tracks of departing aircraft flying through the Windsor Great Park grid. Both involved (temporary) trial Standard Instrument Departure routes (or SIDs) on some of the departure routes and involved all airlines that would normally fly the routes. There were no changes for arriving aircraft or the daily flying schedule. *Further information on the trials can be found on the noise pages of the Heathrow website (*www.heathrowairport.com/noise*).*

Background to the airspace trials: Each day over 600 aircraft depart from Heathrow. These aircraft follow predefined departure routes (SIDs). The routes were designed in the 1960s, an era where aircraft had different performance characteristics to those of today, and do not fully utilise the benefits of the modern navigation equipment carried by approximately 98% of the aircraft operating from Heathrow. This situation is not unique to Heathrow and applies to most other major airports in the UK.

The UK Future Airspace Strategy (FAS) is planning to modernise the airspace around the UK using, amongst other things, more precise navigation standards. A major part of FAS is the NATS London Airspace Management Project (LAMP) which will redesign the airspace around London. This, along with the gradual phasing out of ground-based navigation infrastructure across the country, means that airports will not be able to use their currently published 'conventional' departure routes from 2019/20, and therefore the routes need to be redesigned for modern navigation standards.

Rationale for the trials: Modern navigation standards such as Area Navigation (RNAV) (see page 14) allow aircraft to fly predefined routes to a higher degree of accuracy and consistency. Heathrow and NATS undertook a series of trials to further their understanding on the operation of RNAV1 routes and inform future thinking on airspace redesign. The trials aimed to explore both the operational opportunities offered by RNAV1 routes and understand the potential consequences.

DOKEN (16 December 2013 to 15 June 2014): This trial involved aircraft that would normally operate on the existing westerly Midhurst routes for runways 27L and 27R only. The Heathrow objective was to assess the feasibility and benefits of providing local communities sited beneath the departure flight path with a predictable break from aircraft noise, referred to as 'predictable respite'. To do so, four (temporary) RNAV1 departure routes were operated during the trial (routes DOK 1A and DOK 1B from runway 27R, and DOK 1C and DOK 1D from runway 27L). Each route was offset from one another and their use alternated weekly (DOK 1A and DOK 1C were operated on odd weeks of the trial, DOK 1B and DOK 1D on even weeks of the trial). The trial also provided evidence of how closely RNAV1 equipped aircraft could follow a defined trial route and determined if such trials could be undertaken without any adverse impact on the operation of Heathrow.

A day of aircraft tracks when trial routes DOK 1A/DOK 1C and DOK 1B/DOK 1D were in operation are shown in figures 6 and 7 respectively. Although there was no increase in the number of daily westerly departures overflying the grid during the DOKEN trial (see also second image in Figure 10 on page 8) comparing figures 6 and 7 with normal westerly operations (figure 5) shows that the trial routes changed the pattern of overflight. This can also be seen in the top right-hand graphs of figures 5 to 7, which show the changes in the proportion of aircraft entering and exiting each grid face during normal operations and the DOKEN trial. Additionally, unlike normal westerly operations, the tracks of aircraft remained concentrated as they overflew the grid. This was because, instead of giving aircraft more direct routings once they had climbed above 4,000 feet, ATC kept them on the SID routes for longer to achieve NATS trial objectives.

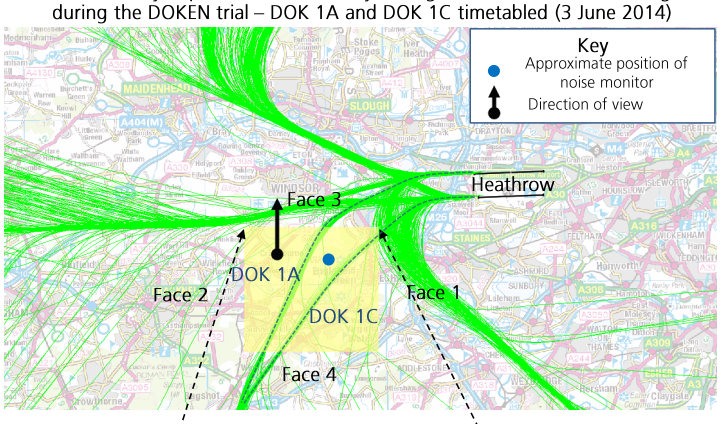
Comparing the lower left-hand images of figures 5-7 shows that during the trial aircraft were not only more laterally concentrated on entering the grid (Face 3), but the tracks of aircraft operating on the different trial routes did not overlap (DOK 1C is not shown in Figure 6 as aircraft following this route entered the grid via Face 1). This demonstrates the potential for rotating RNAV1 routes to provide a predictable break from aircraft noise, but at the same time the possibility of concentrating aircraft tracks (and by inference aircraft noise).

The bottom right-hand images of figures 5 to 7 show the heights of aircraft as they entered and exited the grid during normal operations and the DOKEN trial. At a simplistic level, the differences between the graphs reflect the distances aircraft had flown between take-off and entering/exiting the grid. For the DOKEN trial as a whole (graph not shown), the majority of departing aircraft (94%) entered the grid between 2,000 feet and 5,000 feet, and exited between 4,000 and 8,000 feet (87%). For normal operations, these figures were 93% and 87% respectively (it is noted that there were differences in the proportions of departing aircraft at different heights within the abovementioned height ranges).

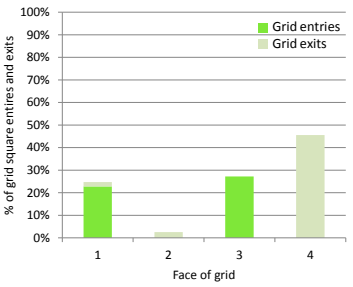
Operationally the trial was a success, a high proportion of aircraft that departed on the westerly Midhurst route during the trial flew the RNAV1 trial SIDs and there was no associated impact on the operation of Heathrow. Initial indications are that communities noticed the respite provided from rotating the routes in use, however, the change in the pattern of overflight and the increased concentration of aircraft tracks resulted in an increased level of complaints in the Bagshot area. This was due to a 'hotspot' being created where the ground tracks of the trial routes joined. *For more information refer to report of the trial that will be published on the Heathrow website in due course (*www.heathrowairport.com/noise*).*

Airspace trials

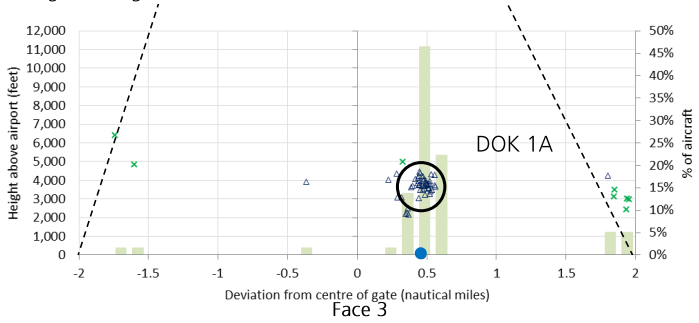
Lateral westerly departure traffic density through the Windsor Great Park grid during the DOKEN trial – DOK 1A and DOK 1C timetabled (3 June 2014)



Departure entries and exits through the grid during the DOKEN trial – DOK 1A and DOK 1C timetabled (westerly departures)



Distribution of westerly departure traffic passing through Face 3 of the Windsor Great Park grid during the DOKEN trial – DOK 1A and DOK 1C timetabled (3 June 2014)



Vertical distribution of departure traffic entering and exiting the grid during the DOKEN trial – DOK 1A and DOK 1C timetabled (westerly departures)

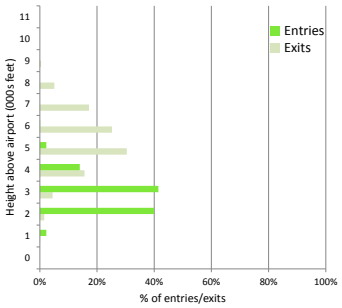
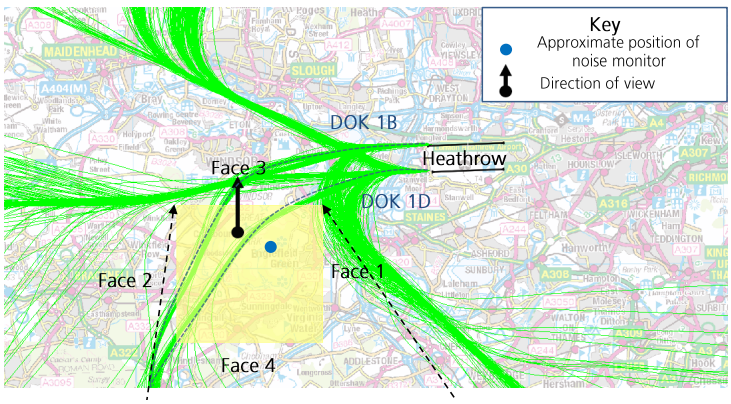
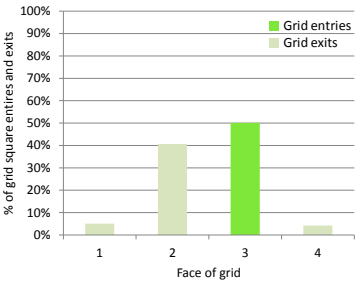


Figure 6. Lateral and vertical distribution of departing air traffic passing through the Windsor Great Park grid during the DOKEN trial (RNAV1 SID DOK1A and DOK1C timetabled) - representative sample (Heathrow flights only)

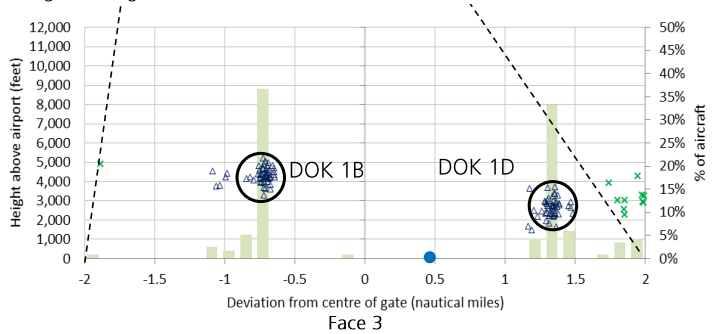
Lateral westerly departure traffic density through the Windsor Great Park grid during the DOKEN trial – DOK 1B and DOK 1D timetabled (12 June 2014)



Departure entries and exits through the grid during the DOKEN trial – DOK 1B and DOK 1D timetabled (westerly departures)



Distribution of westerly departure traffic passing through Face 3 of the Windsor Great Park grid during the DOKEN trial – DOK 1B and DOK 1D timetabled (12 June 2014)



Vertical distribution of departure traffic entering and exiting the grid during the DOKEN trial – DOK 1B and DOK 1D timetabled (westerly departures)

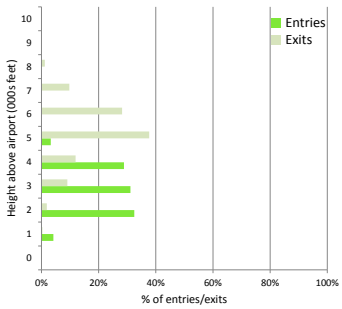


Figure 7. Lateral and vertical distribution of departing air traffic passing through the Windsor Great Park grid during the DOKEN trial (RNAV1 SID DOK1B and DOK1D timetabled) - representative sample (Heathrow flights only)

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Westerly package trial (25 August to 12 November 2014): This trial involved aircraft that would normally operate on the existing westerly Compton, Midhurst and Southampton routes for runways 27L and 27R. The trial routes were again designed to the RNAV1 navigation standard and positioned to allow two main trial objectives to be assessed. Firstly, the feasibility of providing a predictable break from aircraft noise was again investigated. However, instead of rotating the SIDs in use weekly, this trial used a combination of Heathrow's daily runway arrival alternation pattern (see page 1) and positioning of the RNAV1 trial routes to provide predictable respite in the mornings and afternoons. Secondly, in parallel with the easterly package trial (see the Feltham Community Noise Monitoring report), the trial was used to inform the possibility of decreasing holding times on the ground via new route designs. To do this, parts of the trial routes were located outside of the existing NPRs – the degree to which varied from the trial route leaving the NPR shortly after take-off to a small deviation part way along the NPR.

The tracks of departing aircraft for a single morning and afternoon of operations during the westerly package trial are shown in Figure 8 (0600-1459 local, when runway 27R was the dedicated departure runway) and Figure 9 (1500-2359 local, when runway 27L was the dedicated departure runway). Figure 9 also shows a small number of departures (7) from 27R when 27L was the dedicated runway. This was due to a temporary (approximately 30 minute) closure of runway 27L due to an aborted take-off. Comparing these images to those during normal operations (Figure 5) shows both an increase in departures overflying the grid (see also second image in Figure 10 on page 8) and changes to the pattern of overflight. This was due to aircraft that would normally follow the Southampton (for runways 27L and 27R) and Compton (for runway 27L) departure routes overflying the grid and the change in the routing of aircraft that would normally follow the westerly Midhurst routes (for runways 27L and 27R). Aircraft were also more laterally concentrated as they flew through the grid, again this demonstrates both the potential for RNAV1 routes to allow aircraft to fly pre-defined routes more precisely, but at the same time the possibility of concentrating aircraft tracks (and by inference aircraft noise) in the grid.

The concept of providing periods of predictable respite through runway alternation can be understood by comparing the bottom left-hand images of figures 8 and 9. With the exception of the far eastern quarter of Face 1, the tracks of aircraft following the trial routes did not generally overlap during the morning or afternoon. However, where they did, 'hotspots' of aircraft tracks (and by inference aircraft noise) were created. Avoiding the creation of these hotspots in future airspace design was one of the lessons learnt from the trial. Aircraft were also more concentrated vertically as they entered the grid through Face 3 - a higher proportion were above 2,000 feet but a lower proportion above 4,000 feet compared to normal operations.

The bottom right-hand images of figures 5, 8 and 9 show the heights of aircraft as they entered and exited the grid during normal operations and the westerly package trial. Again, at a simplistic level the differences between the graphs reflect the distances aircraft had flown between take-off and entering/exiting the grid. For the westerly package trial as a whole (graph not shown), the majority of departing aircraft (92%) entered the grid between 2,000 feet and 5,000 feet, and exited between 4,000 and 8,000 feet (85%). For normal operations, these figures were 93% and 87% respectively. However, there were differences in the proportions of departing aircraft at different heights within the abovementioned height ranges – in particularly, during the westerly package trial 81% of departing aircraft entered the grid between 2,000 feet 4,000 feet, for normal operations this figure was 68%.

Similar to the DOKEN trial, operationally the westerly package trial was a success. The trial ended 10 weeks early on the 12 November, as sufficient data had been collected to assess the trial against its objectives. At the same time, for the reasons mentioned in the paragraphs above, this trial, along with a parallel trial on easterly operations received a significantly higher than envisaged number of complaints, particularly from the Ascot, Bagshot and Englefield Green areas.

Other trials during the monitoring period: Two other Heathrow trials took place during the monitoring period. Both the easterly Midhurst trial (16 December 2013 and 15 June 2014) and easterly package trial (28 July to 12 November 2014) involved departing aircraft during easterly operations. With the exception of the 28 July, neither trial involved the easterly Compton departure route which overflies the Windsor Great Park grid. Therefore the tracks of aircraft passing through the grid were unaffected by these trials.

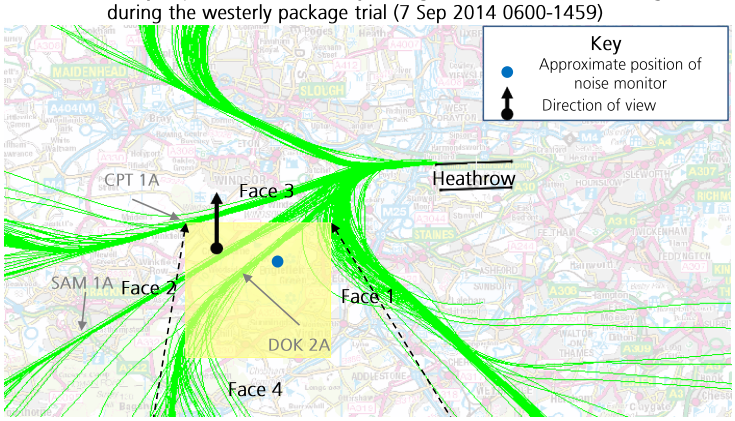
Daily and hourly flight movements

Figure 10 on page 8 shows the proportion of aircraft that passed through the Windsor Great Park grid by direction of runway operation and hour.

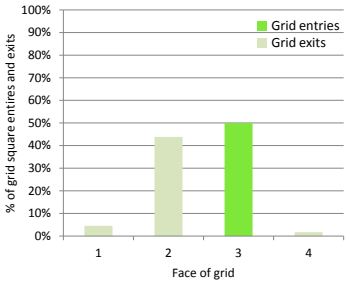
The top two graphs in Figure 10 show the number of daily movements through the grid during easterly and westerly operations respectively, and highlights when the various trials took place. On days where only westerly operations took place (i.e. there were no corresponding easterly operations on the same day), the daily number of departures overflying the grid were broadly the same for normal operations and the DOKEN trial (approximately 120-130 departures per day). During the westerly package trial, due to the temporary change to the routing of the westerly Southampton and Compton departure routes, daily departures overflying the grid increased from approximately 120-130 per day to 210-280 per day.

The bottom two images in Figure 10 show the average hourly arrivals and departures through the grid during easterly and westerly operations. For departing aircraft, the lower graph (westerly operations) has been presented separately for normal operations and the two trials. As expected, this shows that, compared to normal operations, hourly departures through the grid did not change notably a result of the DOKEN trial, but there was a considerable increase as a result of the westerly package trial.

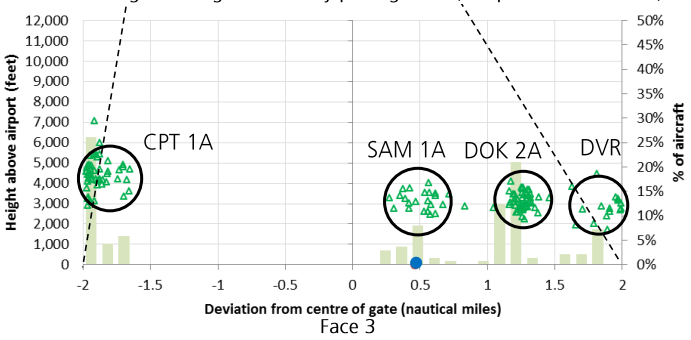
Lateral westerly departure traffic density through the Windsor Great Park grid during the westerly package trial (7 Sep 2014 0600-1459)



Departure entries and exits through the grid during the westerly package trial – runway 27R operations (westerly departures)



Distribution of westerly departure traffic passing through Face 3 of the Windsor Great Park grid during the westerly package trial (7 Sep 2014 0600-1459)



Vertical distribution of departure traffic entering and exiting the grid during the westerly package trial – runway 27R operations (westerly departures)

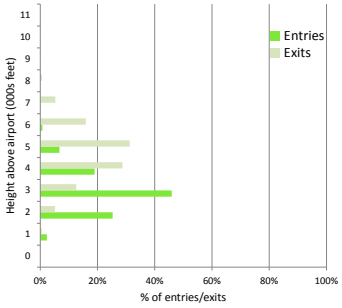
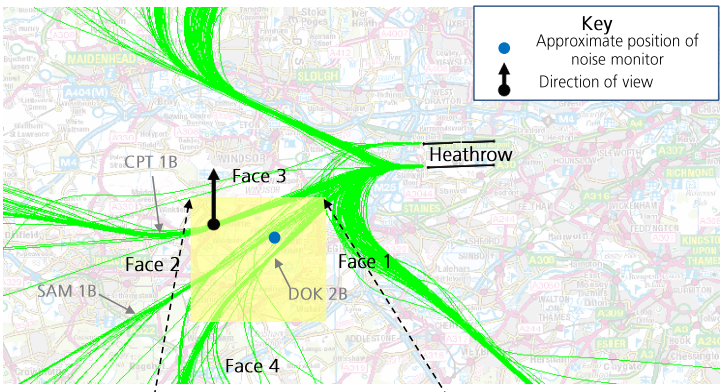
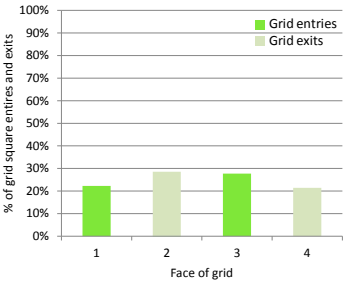


Figure 8. Lateral and vertical distribution of departing air traffic passing through the Windsor Great Park grid during the westerly departure trials (0600-1459) - representative sample (Heathrow flights only)

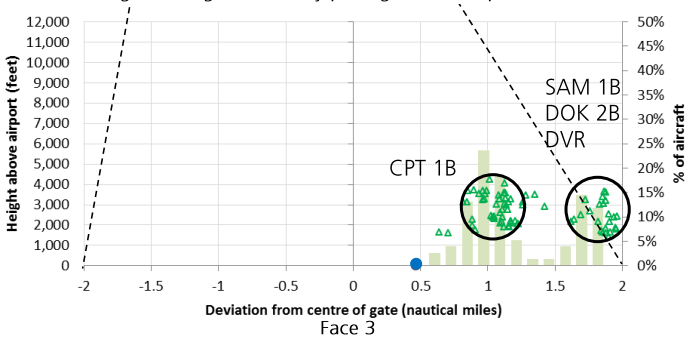
Lateral westerly departure traffic density through the Windsor Great Park grid during the westerly package trial (7 Sep 2014 1500-2359)



Departure entries and exits through the grid during the westerly package trial – runway 27L operations (westerly departures)



Distribution of westerly departure traffic passing through Face 3 of the Windsor Great Park grid during the westerly package trial (7 Sep 2014 1500-2359)



Vertical distribution of departure traffic entering and exiting the grid during the westerly package trial – runway 27L operations (westerly departures)

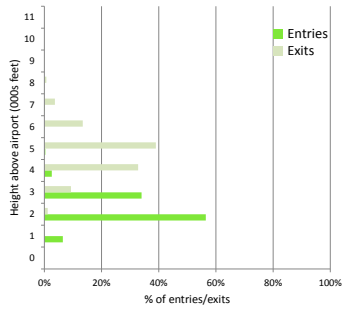
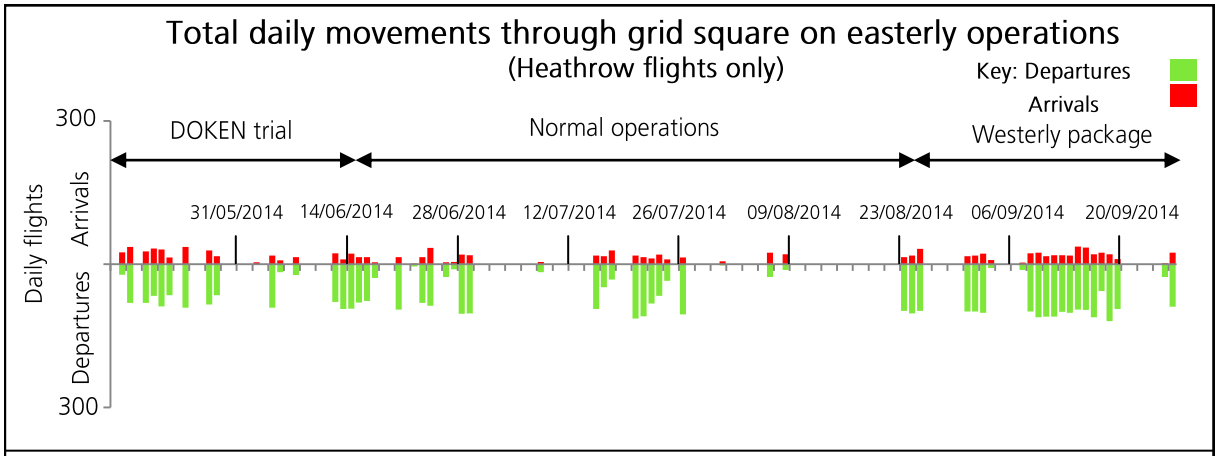
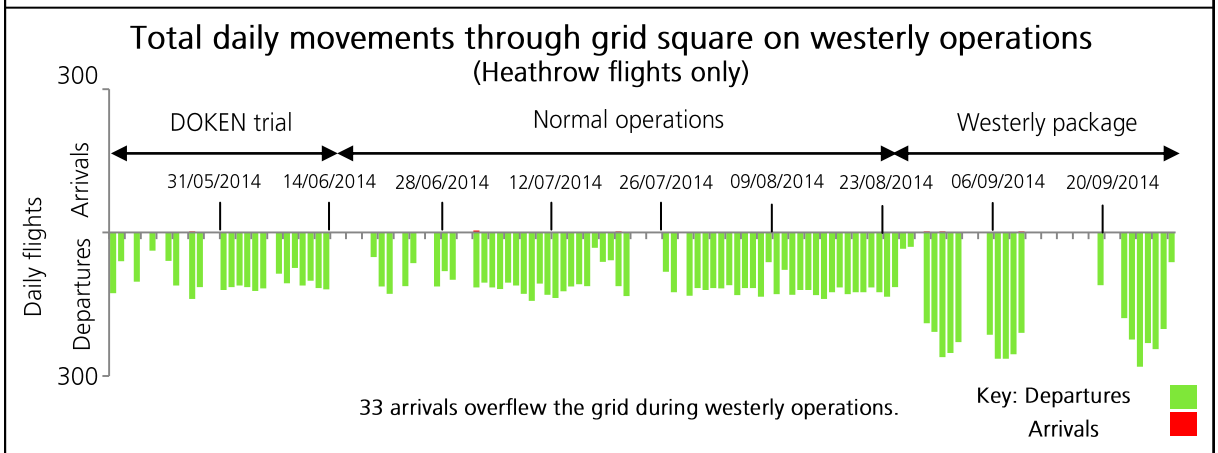
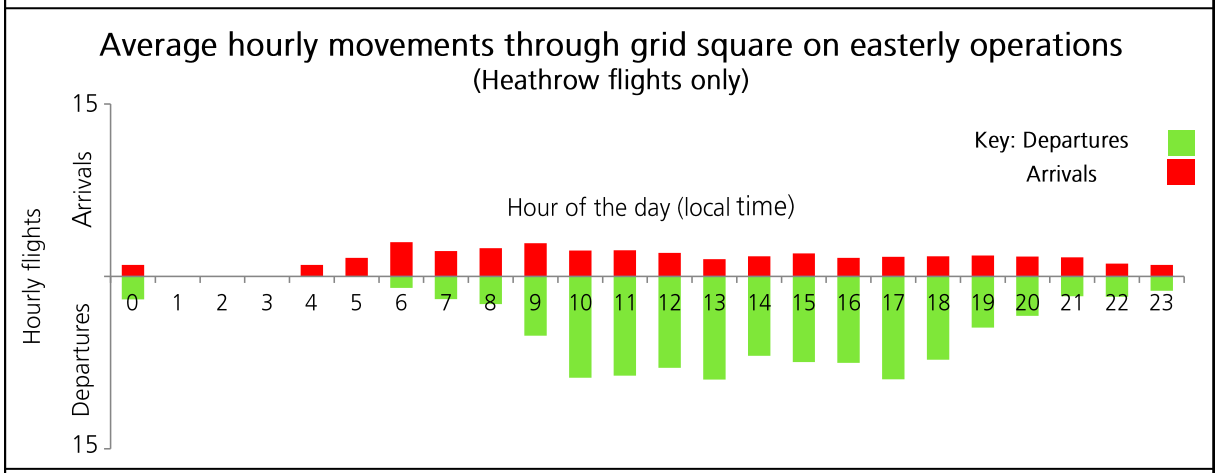


Figure 9. Lateral and vertical distribution of departing air traffic passing through the Windsor Great Park grid during the westerly departure trials (1500-2359) - representative sample (Heathrow flights only)







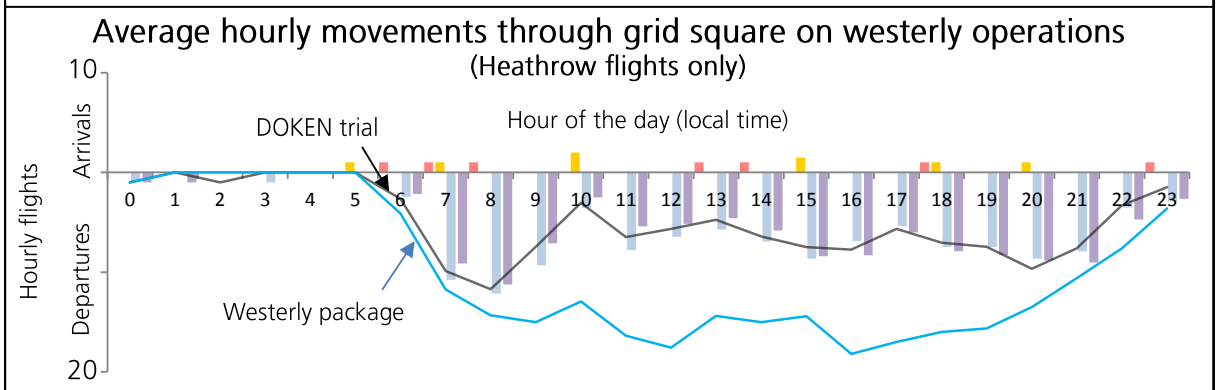


Figure 10. Daily movement totals and hourly mean averages for easterly and westerly operations through the grid square

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

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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 11 demonstrates the average background noise level (L90, dBA) recorded by the Cumberland Lodge 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 (i.e. when the prevailing wind direction during those periods would generally contain an easterly or westerly component respectively). As can be seen, average hourly background noise levels are generally comparable for each mode of operation.

The overall trend in Figure 11 is largely in line with expected results; during the night-time period 2300-0500 hours, the average background noise level was less than 30 dBA, rising to over 35 dBA after 0600 hours for most of the day (but never rising above 40 dBA). 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; typically up to 10 dBA during daytime hours between the quietest and the noisiest days, and up to 15 dBA at night. One of the noisiest days was Sunday 17 August; a day with a moderate westerly to south-westerly wind, placing the site downwind of Ascot and several main roads. However, even on this relatively noisy day the hourly background noise level only just exceeded 45 dBA on one occasion. One of the quietest days was Saturday 12 July; a day with a light wind which was variable in direction. The hourly background noise level on this day rarely exceeded 35 dBA.

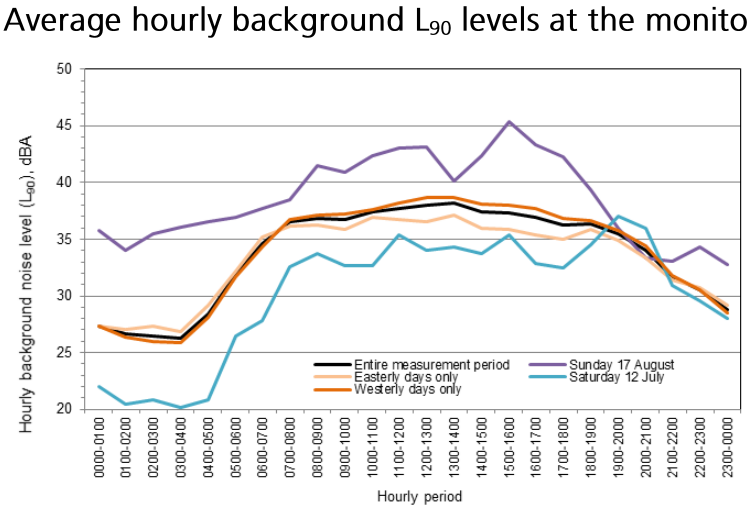

Figure 11. Hourly background L_{90} levels at the monitor averaged over 24 hour period; including Sunday 17 August (noisiest day) and Saturday 12 July (quietest day)

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 Cumberland Lodge grid square generates a noise event. During the monitoring period a total of 8,111 aircraft noise events were recorded.

Since the noise monitor was positioned close to the centreline of the westerly Midhurst Noise Preferential Route and well away from the main arrival flight paths, departures account for all of the noise events recorded at the monitor. Figure 12 provides a summary of aircraft noise events by runway after filtering for bad weather (approximately 5% of noise events were rejected due to unacceptable weather conditions in accordance with international guidelines). Accounting for rejected events, 7,391 noise events were generated by westerly departures and 325 noise events by easterly departures (the noise monitor was also located under the easterly Compton Noise Preferential Route).

Figure 13 indicates that medium-sized aircraft (e.g. the A320 family) and the wide-bodied B777 and B747 dominate the overall number of departure noise events due to the relatively high numbers of these types operating at Heathrow. As noted above, the location of the monitor relative to Heathrow's main arrival flight paths meant that there were no arrival noise events recorded at the Cumberland Lodge site.

Figure 14 shows the average (mean) departure L_{Max} values recorded at the Cumberland Lodge monitor for each aircraft type. For departures, the noisiest aircraft on average was the B747, followed by the A380, and A340. On average, the quietest aircraft type on departure was the B787.

Departures				
09L	09R	27L	27R	Total
0	325	5,646	1,745	7,716

Figure 12. Aircraft noise events by operation and runway following filtering for bad weather

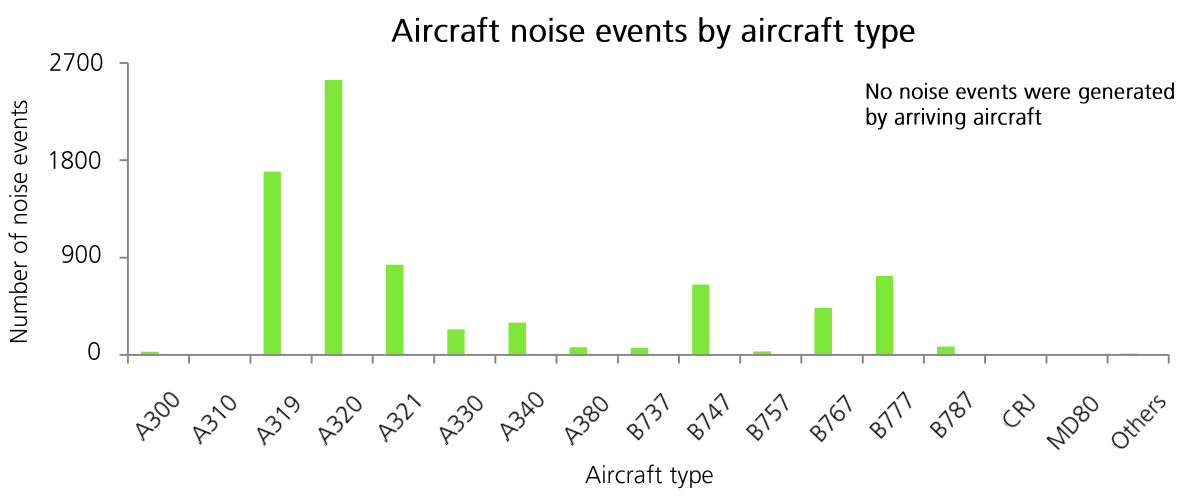

Figure 13. Number of departure and arrival aircraft noise events by aircraft type

Key: Departures Arrivals

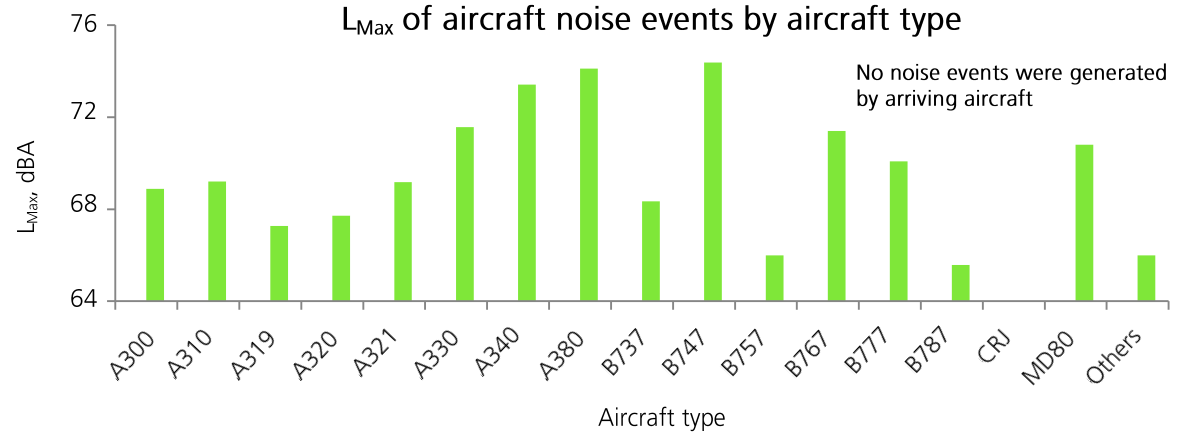

Figure 14. Average (mean) L_{Max} by aircraft type for departures and arrivals

Key: Departures Arrivals

As explained earlier, Heathrow Airport conducted a series of westerly departure airspace trials between 16 December 2013 to 15 June 2014 (DOKEN trial) and 25 August 2014 to 12 November 2014 (westerly package trial). Since the deployment of the Cumberland Lodge monitor covered the last month of the first trial and the first month of the second trial, further analysis of the noise level differences during each period is provided below.

Figures 15 to 17 show the average departure L_{Max} values for aircraft during normal operations, the DOKEN trial and westerly package trial respectively (results are only shown for departure routes where the sample sizes were large enough to allow a meaningful comparison to be made). In every case, aircraft on the DOKEN trial routes (during both the DOKEN and westerly package trials) were, on average, 1 to 9 dB quieter at the monitor location compared to aircraft on the conventional Midhurst route for runway 27L and, in nearly all cases, 1 to 7 dB noisier than aircraft on the conventional Midhurst route for runway 27R. These results can be explained by the relative distances from the noise monitor of the flight paths flown along each route; aircraft on the conventional Midhurst route for runway 27L typically passed much closer to the noise monitor compared to aircraft on all the other routes.

Comparing average departure L_{Max} values for aircraft on the westerly package trial routes and the conventional Midhurst routes shows that in nearly all cases aircraft on the SAM 1B trial route were, on average, 1 to 2 dB noisier at the monitor location compared to aircraft on the conventional Midhurst route for runway 27L. Aircraft on the CPT 1B and SAM 1A trial routes on the other hand were 5 to 12 dB quieter than aircraft on SAM 1B. Again these results can be explained by the relative distances from the noise monitor of the flight paths flown along each route; aircraft on the SAM 1B trial route typically passed much closer to the noise monitor compared to aircraft on the other routes.

The overall distribution of noise (L_{Max}) for departures is shown in Figure 18. Figure 19 indicates the trend in the noise distribution for departures by time period (day, evening and night). The graphs for departures indicate that the overall spread of the measured noise levels is generally consistent during each period of the day but that there are lower numbers of noise events during the evening and night due to the lower overall traffic levels.

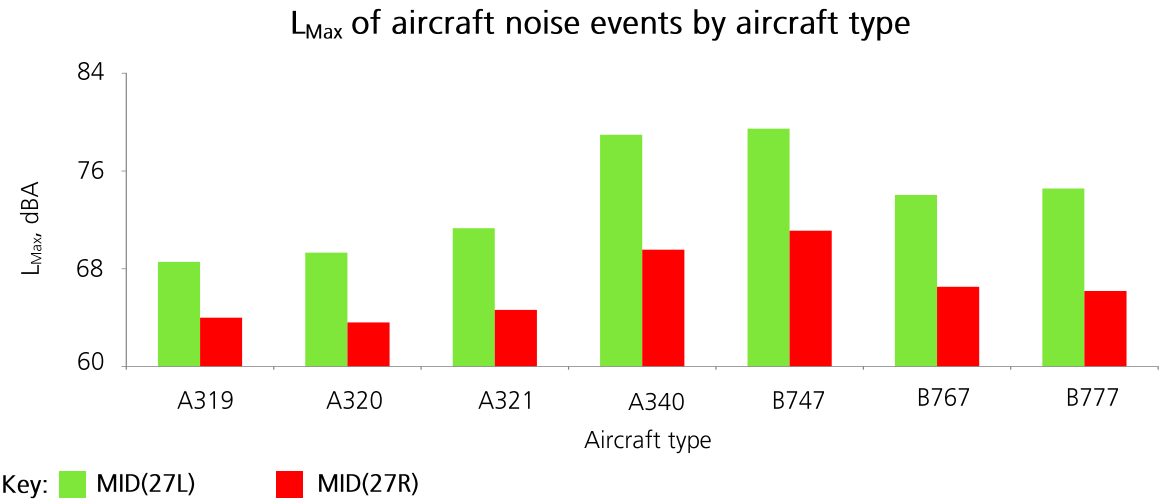

Figure 15. Average (mean) L_{Max} by aircraft type for the normal operation routes (noise events generated by aircraft following the existing CPT and SAM routes were too few in number to draw any conclusions)

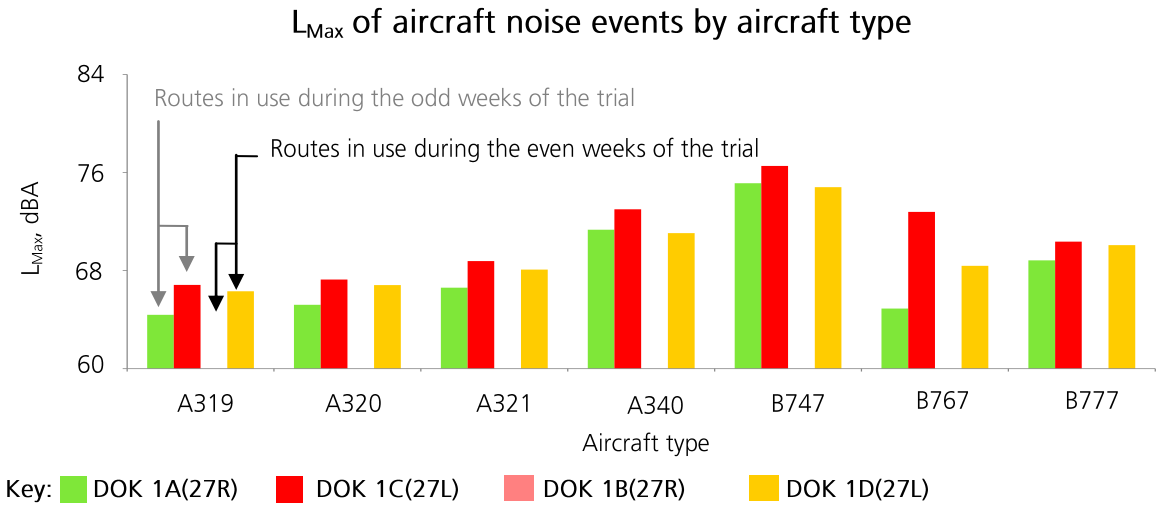

Figure 16. Average (mean) L_{Max} by aircraft type for the DOKEN trial routes (the noise events generated by aircraft following the DOK1B trial route were too few in number to draw any conclusion)

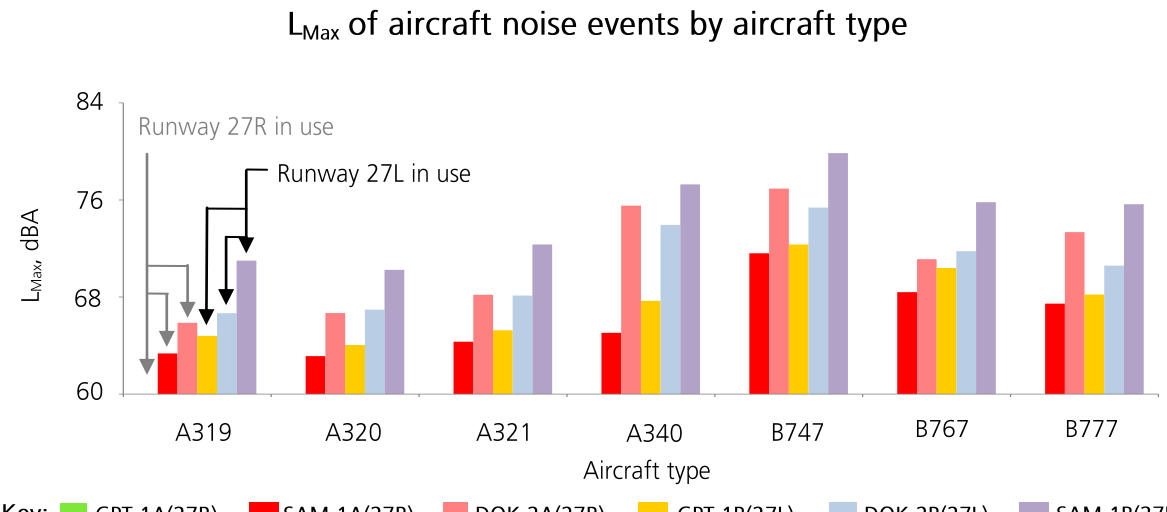

Figure 17. Average (mean) L_{Max} by aircraft type for the westerly package trial routes (there were no noise events generated at the monitoring site by aircraft following CPT 1A trial route)

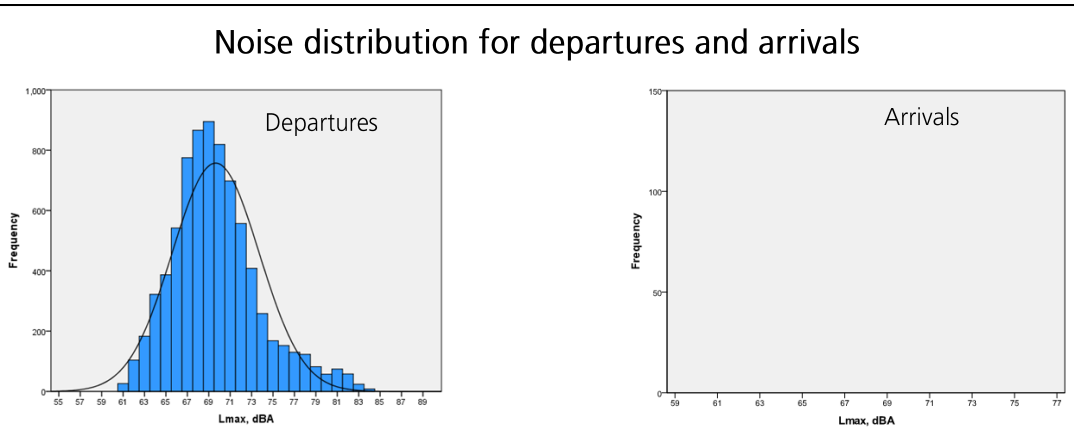

Figure 18. Above left: L_{Max} frequency distribution of departure noise levels
Above right: L_{Max} frequency distribution of arrival noise levels

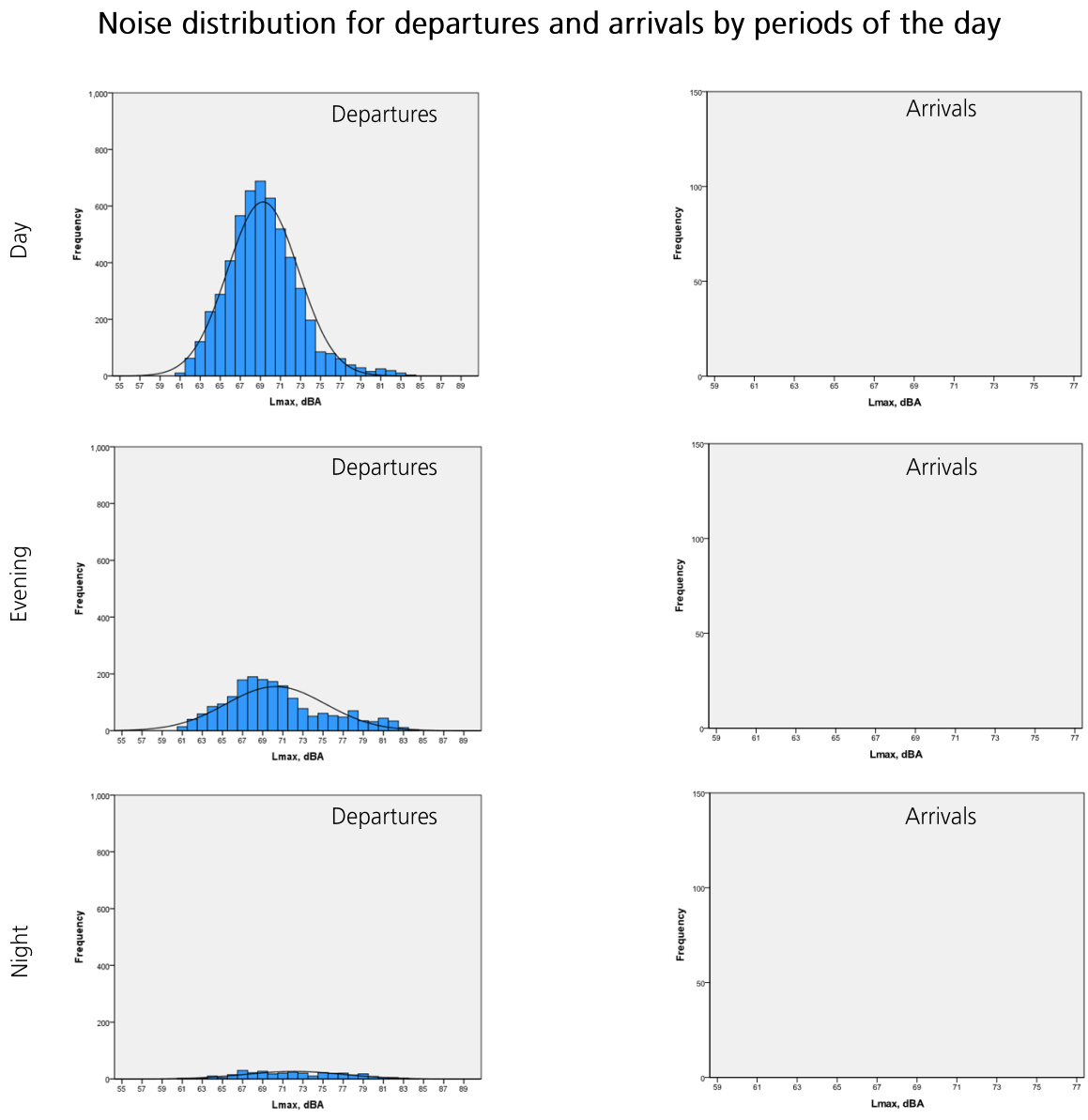

Figure 19. L_{Max} distribution of departure (left) and arrival (right) noise level recorded on the A-weighted sound level over the three averaging periods of L_{Max} (Day — 12 hour period 07:00-19:00), L_{Max} (Evening — 4 hour period 19:00-23:00) and L_{Max} (Night — 8 hour period 23:00-07:00)

Conclusions

Background

This report describes the overflight and noise experience measured for the Windsor Great Park grid square over a 135-day period from 17 May 2014 to the 28 September 2014. During this period the grid was overflown by 1,165 arrivals and 16,890 departures, an average of 134 aircraft per day.

Flight movements – 'normal operations'

The Windsor Great Park grid is overflown by both arriving and departing aircraft during 'normal' operations:

- During westerly operations departing aircraft overflying the grid take-off from Heathrow and primarily follow the westerly Midhurst departure route. These aircraft typically enter the grid below 4,000 feet, consequently their flights paths are concentrated as they are required to stay within the noise preferential route associated with each departure route. Very few arriving aircraft overfly the grid during westerly operations.
- During easterly operations departing aircraft overflying the grid take-off from Heathrow and initially follow the easterly Compton departure route. These aircraft typically overfly the grid between 4,000 and 9,000 feet and will have been vectored by ATC, causing their flights paths to be laterally spread over the grid. Some arriving aircraft will also overfly the grid prior to commencing their approach to Heathrow. These aircraft will have been vectored by ATC and typically be above 6,000 feet.

Flight movements – 'airspace trials'

During the monitoring period Heathrow ran a series of trials aimed at informing future airspace design. An area of particular interest was gaining a better understanding of the opportunities and consequences of designing departure routes with a more accurate and consistent navigation standard (RNAV1). For example, could concepts intended to provide communities under the flight paths with a predictable break from aircraft noise ('predicable respite') be operated and what would be the consequences of exposing smaller (or new) populations to aircraft noise more frequently.

The tracks of departing aircraft through the Windsor Great Park grid were temporarily changed by two of the four trials conducted by Heathrow. The first trial, the DOKEN trial (16 December 2013 to 15 June 2014), involved rotating four (temporary) trial RNAV1 departure routes to test the concept of predictable respite. The second, the westerly package trial (25 August to 12 November 2014), again tested the concept of predictable respite through a combination of Heathrow's daily runway alternation pattern and six (temporary) trial RNAV1 departure routes. The six trial routes were also positioned to inform the possibility of decreasing aircraft holding times on the ground via route designs.

The trials had no adverse impact on the operation of Heathrow and identified a number of lessons for future airspace design. In particular, they demonstrated the potential for RNAV1 routes to allow aircraft to fly pre-defined routes more precisely, but at the same time the possibility of concentrating aircraft tracks (and by inference aircraft noise) and creating 'hotspots' where RNAV1 routes overlap. The DOKEN trial did not change the number of aircraft overflying the grid each day compared to 'normal' operations, but the number of daily flights approximately doubled during the westerly package trial due to the temporary change to some departure routes. In terms of community response, the DOKEN trial resulted in an increased level of complaints in the Bagshot area, and the westerly package trial received a significantly higher than envisaged number of complaints, particularly from the Ascot, Bagshot and Englefield Green areas. By the 12 November, sufficient data had been collected for the westerly package trial and it ended early on this date.

Aircraft noise – 'normal operations'

During the monitoring period a temporary noise monitor was placed in the grounds of Cumberland Lodge, Windsor Great Park, under the westerly Midhurst and easterly Compton Noise Preferential Routes. Medium-sized aircraft (e.g. the A320 family) and the wide-bodied B777 dominated the overall number of departure noise events due to the relatively high numbers of these types operating at Heathrow. The noisiest departing aircraft on average was the B747, followed by the A380, and A340. The quietest departing aircraft on average was the B787.

Aircraft noise – 'airspace trials'

Data collected by the noise monitor shows that aircraft using the DOKEN trial routes (during both the DOKEN and westerly package trials) were, on average, 1 to 9 dB quieter than aircraft on the conventional westerly Midhurst route for runway 27L and 1 to 7dB noisier than aircraft on the conventional westerly Midhurst route for runway 27R (a 3dB change is just perceptible to the human ear). These differences can be explained by the relative distances from the noise monitor of the various flight paths flown along each route. Similarly, differences in average aircraft noise levels between conventional routes and the other westerly package trial routes were also explained by their relative distances from the noise monitor. Results from the noise monitor show that it is possible to change the noise environment by rotating the departure routes in use. However, the extent of the change is likely to be location specific and will be influenced by, amongst others, the number of departure routes nearby, their relative position and the mix of aircraft types operating on each.

Summary

The monitoring period represents a snapshot of the track and noise impact in the Windsor Great Park grid. The results generated for normal operations are broadly what might be expected in the future at the Cumberland Lodge site. However, given the locations of the arrival and departure routes within the grid, different noise levels could be expected if the monitor were placed at other locations. The airspace trials were temporary and do not necessarily reflect future plans. Any proposed permanent changes will be subject to a full public consultation with the final decision being made by the Government.

Additional information

References

- Heathrow Airport, Noise Action Plan 2010-2015: www.heathrowairport.com/noise
- Department for Transport — Heathrow Noise Contours: www.gov.uk/government/uploads/system/uploads/attachment_data/file/368905/LHR_2013_report.pdf
- Heathrow airspace trials: www.heathrowairport.com/noise/future-plans/modernising-uk-airspace/heathrow%E2%80%99s-airspace-trials

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 Cumberland Lodge 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 L90). 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. However setting the threshold at 60 dBA appeared to be low enough to capture almost the entire distribution of L_{Max} departure levels during each time period.

Approximately 5% 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).

Standard Instrument Departure (SID) routes and Noise Preferential Routes (NPRs)

Aircraft taking off from Heathrow follow pre-defined routes, known as SIDs, usually based upon the destination of the aircraft. There are sets of SIDs for both easterly and westerly operations. Because all aircraft perform differently, or may be affected by weather conditions which can cause them to drift left or right, there will be some variation as to where different aircraft will fly relative to the SID. For this reason there are also corridors, known as Noise Preferential Routes (NPRs), which extend 1.5 kilometres either side of the route centreline. As long as aircraft remain within the NPR up to an altitude of 4,000 feet they are considered to be on track.

Air Traffic Control (ATC) is responsible for the routing of aircraft once airborne. When they have reached 4,000 feet, ATC can instruct the pilots to leave the SID (and by definition the NPR too) and fly a more direct heading to their destination, although aircraft can continue to follow the SID until its end (and 6,000 feet). Additionally, ATC can direct aircraft off the SID at an altitude below 4,000 feet if this is required for safe separation from other aircraft or for other safety reasons such as weather avoidance. This is known as vectoring.

Area Navigation (RNAV)

The trial routes for both the DOKEN and westerly package trials were designed using a more precise navigation standard, known as RNAV1, than is published for Heathrow's existing departure routes. When following an RNAV1 SID an aircraft will navigate between a series of waypoints held in its on-board Flight Management System (FMS). The RNAV1 standard means that the navigation systems on-board the aircraft must be able to control the navigation of the aircraft to within +/-1 nautical miles of the centreline of the RNAV1 route for 95% of the time. In practice the actual performance is normally significantly better. This allows routes to be flown to a higher degree of accuracy and consistency than those published on the basis of ground-based navigation aids.

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).

Additional images

Figure 20. Tracks of aircraft passing through the Windsor Great Park grid during normal operations (easterly arrivals) on 19 July 2014 - representative sample (Heathrow flights only)

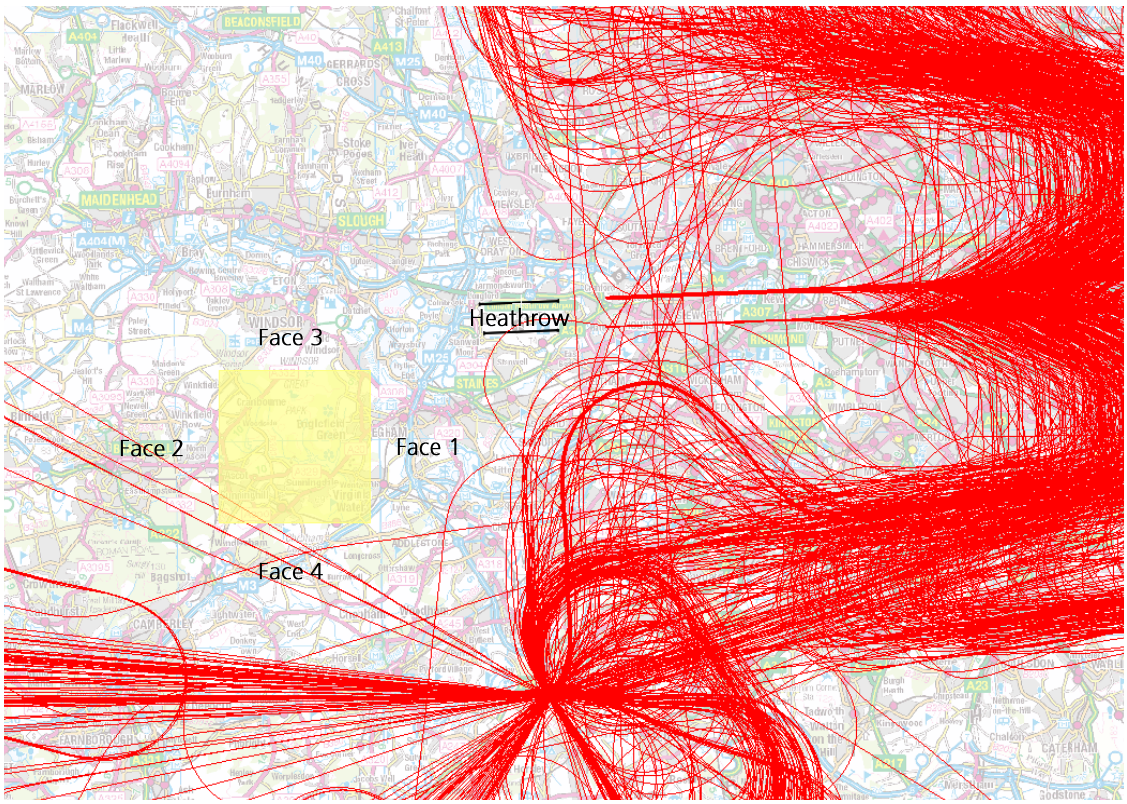

Figure 21. Tracks of aircraft passing through the Windsor Great Park grid during normal operations (easterly arrivals) on 20 July 2014 - representative sample (Heathrow flights only)

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