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A REPORT OF MONITORING OF
AIRCRAFT NOISE FROM STANSTED AIRPORT
AT HATFIELD BROAD OAK, ESSEX
BETWEEN 13 APRIL AND 6 JULY 2010

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Executive Summary

A mobile Noise Monitoring Terminal (NMT) was deployed by Stansted Airport from 13th April to 6th July 2010. The site is approximately 10 km south south-west the airport, at Hatfield Broad Oak in Essex. On days when aircraft are taking off from Stansted to the west, the site lies under the flight paths of departing aircraft.

The aim of this report is to present the results of the three months of noise monitoring at this site (mid April to mid July 2010) and to interpret the results in a way that places the contribution of the noise from aircraft using Stansted in the context of the overall noise climate from all other sources.

The NMT records noise data relating to all noise events which exceed a selected threshold noise level for a selected minimum period of time. These selected conditions were 60 dBA for a duration of 10 seconds.

These noise events are then compared by the airport's ANOMS (Airport Noise and Operations Monitoring System) noise and track keeping computer system with radar tracks of aircraft arriving at or departing from Stansted Airport. Only those noise events which are matched with Stansted aircraft tracks are called aircraft noise events, and those that are not matched are designated as residual noise events. The remainder of the noise at the site, i.e. that noise which is not captured as noise events, (because it fails to meet the capture conditions of being above 60 dBA for 10 seconds) is also classified as residual noise.

Therefore wherever reference is made to aircraft noise events within this document it should be understood that these relate only to aircraft using Stansted airport. Any noise arising from aircraft travelling to or from any other airport will be included as residual noise.

In addition to gathering data about noise events the NMT also collects and stores, on an hourly basis, information about the total level of noise at the site from all sources.

A total of 1,966 aircraft noise events occurred during the approximate three month (84 day) survey period. Almost all of these aircraft noise events were due to departing aircraft, using the 22CLN departure route. The number of aircraft noise events per day ranged from zero (on 21 days) to 55 (on 5 days), with an average of 23 events per day. This distribution almost certainly reflects the day to day variation between easterly and westerly departure directions, determined by wind direction.

The numbers of aircraft noise events per day did not show any obvious correlation with day of the week or weekends. The highest number of events per hour occurred in the morning between 06.00 and 09.00 hours and in the afternoon with lower peak numbers between 17.00 and 21.00 hours, local time. During the busiest hours there were up to 12 events per hour.

The maximum noise level (L_{ASmax}) of aircraft noise events ranged from 60 dBA to 83 dBA, but for more than 90% of the events was between 63 and 71 dBA, with an overall average of 67 dBA. There were 55 events greater than 75 dBA and 4 events with a maximum noise level greater than 80 dBA.

The average noise level (L_{Aeq} value) during aircraft noise events, which had an average duration of about 24 seconds, was 63 dBA.

The total noise climate at the site may be characterised by average hourly values of various noise percentile levels, and by the average (or equivalent) noise level (L_{Aeq}). These values were fairly constant during the daytime, between 07.00 and 19.00 hours (with average values of L_{AS10} of 49 dBA, L_{AS90} of 39 dBA and L_{Aeq} of 49 dBA), but falling to lower levels in the late evening, night-time and early morning periods. The average value over the night-time period from 23.00 to 07.00 hours (L_{Aeq} values) was 45 dBA, and for the evening period from 19.00 to 23.00 hours was 47 dBA.

The daily average (L_{Aeq}) level of the total noise at the site is a combination of that due to aircraft noise events and that due to residual noise. On the 'busiest' days of the 3 month period aircraft noise makes a major contribution to the total noise at the site during those times of day when the highest numbers of aircraft events occur, i.e. during the morning, midday and early evening peak periods, but at other times, when there were fewer aircraft noise event per hour, the average level of aircraft noise was much lower than that of the residual noise. The highest average values of aircraft noise on these 'busiest' days were between 50 and 54 dB $L_{Aeq,T}$.

When the noise from aircraft noise events is cumulatively averaged over an extended period of time (of hours, days or weeks) it makes a significant but not always a dominant contribution to the average level of total noise at the site, with noise from all other sources, i.e. the residual noise, sometimes making a greater contribution. However each individual aircraft noise event, whenever it occurs, is likely to be clearly audible and distinguishable from the residual noise because, in addition to being different in character, it results in a noticeable increase in the level of the ambient noise by 10 dBA.

It is possible to convert the hourly L_{Aeq} values into the 24 hour L_{den} noise index (day, evening, night level) used by Defra for noise mapping purposes, giving, on the basis of the data collected at this site over the three months period, an L_{den} value for the total noise of 43 dBA and of 40 dBA for the aircraft noise.

In order to place the noise climate at the site in a wider UK context the noise levels measured by the NMT have been compared with the results of the National Noise Index survey of noise levels in the UK in 2000, with World Health Organisation Guidelines, and with Stansted Airport aircraft noise contours.

Although 33 different aircraft types were involved in total, two aircraft type accounted for more than 85% of the events: Boeing 737- 800: 1244 events (63.3%), Airbus A319: 435 events (22.1 %). There were 55 aircraft noise events with a L_{ASmax} value of 75 dBA or above. Nineteen (35%) of these events occurred in the night-time period between 23.00 and 07.00 hours and thirty six (65%) in the daytime.

Most of these (36 events) were from Airbus 340 - 300 aircraft types, operated by Air Asia. The other aircraft types involved were:

Boeing 767-300 Freighter	10 events
Boeing (McDonnell Douglas) MD11 Freighter	6 events
Boeing 727-200, Airbus A340-200 and Airbus A321	1 event each

It is understood that many of these aircraft movements were long stage-length, i.e. heavily loaded long haul flights to places such as Kuala Lumpur and Hong Kong.

Examination of some flight tracks has shown that although there was one off track movement following the 22DVR route, in the main these were flights within track, but close to the northern edge of the 22CLN route and so often flying almost directly over the Hatfield Broadoak monitor.

The information presented in this report will serve as a baseline for comparison with any future noise level surveys in this format that may be undertaken at this location.

A summary of the main noise related parameters (three monthly average) for period from April 13th to July 6th 2010, at Hatfield Broad Oak are shown in the Table below:

Aircraft noise event trigger level:	60 dBA for 10 seconds
Total Number of aircraft noise events:	1,966 events
Arrivals and Departures event numbers:	Departures 22 CLN: 1,913 events Departures 22 DVR: 29 events Departures 04 DVR: 10 events Departures TOTAL: 1,952 events Arrivals: 14 events
Average maximum noise level of events:	Range 60 to 83 dBA Average 67 dBA 6 events with L_{ASmax} more than 80 dBA
Average noise level and duration of aircraft noise events:	Average level 63 dBA (range 59 to 74 dBA) Average duration 24 seconds
Average total noise level:	Day (16 h): 48 dBA Night (8 h): 45 dBA
Average aircraft noise level:	Day (16 h): 44 dBA Night (8 h): 41 dBA
Average residual noise level:	Day (16 h): 46 dBA Night (8 h): 42 dBA
Day-evening night level:	Total noise 43 dBA Aircraft noise 40 dBA Residual noise 41 dBA
Background noise (L_{AS90}):	Day (16 h): 38 dBA Night (8 h): 33 dBA

1.0 Introduction

1.1 A mobile Noise Monitoring Terminal (NMT) has been deployed by Stansted Airport for an approximate three month period from 13th April to 6th July 2010.

1.2 The noise monitor was located in a field about 50 metres from a minor road. Noise at the site is from traffic moving along the road including occasional farm machinery. The site is approximately 10 km south-west of the airport, at Hatfield Broad Oak in Essex. A map showing the location (indicated by an arrow) is presented in Appendix 1. On days when aircraft are taking off from Stansted to the west, the site lies at the northern edge of aircraft departure route 22 CLN.

1.3 The aims of this report are:

- to present the results of the three month noise monitoring survey, and
- to interpret the results in a way that places the contribution of the noise from passing aircraft using Stansted airport in the context of the overall noise climate from all other sources, and
- To provide a baseline for comparison with any future noise surveys in this format that may be undertaken at this location.

1.4 A glossary of technical terms used in this report is given in Appendix 3.

2.0 Data from the Noise Monitoring Terminal

2.1 The Noise monitoring Terminal (NMT) continuously gathers data about the number and level of aircraft noise events, and also data about the total level of noise at the site, on an hourly basis. The hourly values of total noise are a combination of the noise from the aircraft noise events and from all other noise sources, called residual noise.

2.2 Further details about the way the NMT gathers and processes noise data is given in Appendix 2.

3.0 Analysis of Noise Monitoring Survey Results

3.1 <u>The numbers of aircraft noise events</u>

3.1.1 A total of 1,966 aircraft noise events were recorded at the site during the three month period; 386 in April (13th to 30th), 608 in May, 707 in June and 265 in July (1st to 6th).

3.1.2 Almost all of these aircraft noise events were due to departing aircraft; with 1,913 (out of 1,966) from those using route 22CLN, 29 events from those using route 22DVR and 10 events from those using route 04DVR. There were 14 events arising from aircraft arrivals, including one 'go around'.

3.1.3 Figure 1 shows the total number of aircraft noise events occurring each day during the 3 months period from 13th April to 6th July 2010. There was no obvious correlation between the number of aircraft noise events and the day of the week or weekend. The number of aircraft noise events per day ranged from zero to 55, with an average of 23 events per day over the approximate three month (85 day) period. There were 13 days when there were 50 or more events per day and 21 days when there were no aircraft noise events. This distribution almost certainly reflects the day to day variation between easterly and westerly departure directions, determined by wind direction.

3.1.4 Figure 2 indicates the average distribution of numbers of aircraft noise events throughout the 24 hour day, showing that the highest number of events per hour occurred in the morning between 06.00 and 09.00 hours and in the afternoon with lower peak numbers between 17.00 and 21.00 hours, local time. During the busiest hours there were up to 12 events per hour.

3.2 Maximum noise levels of aircraft noise events

3.2.1 The NMT recorded the maximum noise level (measured using the 'A' frequency weighting and the Slow (S) time weighting) produced by each aircraft noise event, (L_{ASmax}). These values ranged from 60 dBA to 83 dBA, but more than 99% of the events have maximum noise levels of less than 79 dBA, with an overall average of 67 dBA. There are 55 events (out of a total of 1966) with a maximum noise level greater than 75 dBA, and 4 events with a maximum noise level greater than 80 dBA. Figure 3 indicates the average L_{ASmax} value of aircraft noise events recorded each day during the three month monitoring period. Figure 4 shows the variation of average hourly value of L_{ASmax} value for the three month period. Figure 5 shows a statistical distribution of L_{ASmax} values for the three month period.

3.2.2 It can be seen from Figure 3 that on most of the days when aircraft noise events occurred (i.e. all but 21 days in the period) the average maximum level per day ranged between 61 dBA and 70 dBA, except for one day, June 25th, when the average maximum noise level was 78.5 dBA. Figure 1 shows that there was only the one noise event which occurred on that day. This event is discussed again later in this report in paragraph 3.7.4 when differences between noise levels from different aircraft types are examined.

3.2.3 The variation of average maximum value of aircraft noise events by hour of day (Figure 4) shows similar results i.e. between 61 dBA and 70 dBA, except for the three hours; between 23.00 and midnight (average of 72 dBA for 9 events), between midnight and 01.00 hours (average of 77 dBA for 14 events) and between 05.00 and 06.00 hours (78 dBA for 1 event). There were no aircraft noise events between 04.00.and 05.00 hours during the monitoring period. Figure 5 shows that the maximum noise levels of most events (more than 90% of events) lie between 63 and 71 dBA.

3.3 Durations and average noise levels of aircraft noise events

3.3.1 The duration of 90% of the aircraft noise events was between 10 seconds and 31 seconds, with an average value for all events of 24 seconds.

3.3.2 In addition to L_{ASmax} values the NMT also recorded the Single Event Noise Level (SEL) for each aircraft noise event. This parameter relates to the amount of sound energy in each event, and may be used to calculate the average noise level, or L_{Aeq} value, over the event duration. These L_{Aeq} values range from 59 to 74 dBA but with 90% between 59 and 66 dBA and with an overall average value of 63 dBA.

3.3.3 Thus a typical aircraft noise event might represent an average noise level of about 63 dBA for about 24 seconds, but varying within the 24 seconds, between the trigger level of 60 dBA and the average maximum value of 67 dBA.

3.4 The total noise climate at the site

3.4.1 The NMT also recorded the total noise level (i.e. from all sources, including aircraft and residual noise events) each hour, measured in terms of the hourly values of L_{Aeq}

(representing the average noise level over the hour) and the following statistical percentile levels: L_{AS1}, L_{AS10}, L_{AS50}, L_{AS90} and L_{AS99}, where, for example L_{AS10} is the noise level (measured using the 'A' frequency weighting (i.e. in dBA) and the Slow (S) time weighting) exceeded for 10% of the 1 hour measurement time interval. Figure 6 shows these values averaged over the three month noise survey period for each hour of the day.

3.4.2 It can be seen from Figure 6 that the value of each index is fairly constant from about 06.00 hours to 19.00 hours but then falls off outside these times (i.e. in the late evening, night-time and early morning periods).

3.4.3 The average values of the various noise indices over various parts of the 24 hour day (day, evening, night etc.) are shown below. For all these periods the indices were calculated from the relevant hourly levels, using arithmetic averages in the case of the statistical levels and logarithmic averages for the L_{Aeq} indices.

Noise climate index	Total Noise Level, dBA				
	Day (07.00-19.00)	Evening (19.00-23.00)	Night (23.00-07.00)	Day and Evening (07.00-23.00)	24 hours
L_1	57	56	49	57	54
L_{10}	49	46	41	48	46
L_{50}	42	39	36	41	40
L_{90}	39	35	33	38	36
L_{99}	37	33	31	36	34
L_{Aeq}	49	47	45	48	47

3.4.4 Since Figure 6 shows that, on average, the noise levels at the site do not vary much from hour to hour in the daytime they are unlikely to vary much within each hour, and so the data shown in Figure 6, and particularly the L_{Aeq} values, could be used as a good indication of 30 minute L_{Aeq} values, required in Building Bulletin 93 for the assessment of noise climates near to schools in the vicinity.

3.4.5 For a period of one hour the value of the L_{AS10} noise index is the noise level exceeded for 6 minutes in that hour, and value of the L_{AS90} noise index is the noise level exceeded for 54 minutes in the hour, so that noise levels at or below the L_{AS90} value occur for 6 minutes in the hour. Thus Figure 6 shows that for a typical hour in the daytime (07.00 to 19.00 hours) the total noise level over the entire hour at this site would exceed 49 dBA (L_{A10} value) for 6 minutes, and would be below 39 dBA (L_{A90} value) for 6 minutes, and would therefore be between 39 and 49 dBA for 48 minutes of the hour.

3.4.6 The UK Government Department, Defra, has used the 24 hour L_{den} noise index (day evening night level) for noise mapping purposes. This index is based on average levels of aircraft noise (LAeq values) throughout the day but with a weighting penalty of 5 dB applied to noise in the evening (19.00 hours to 23.00 hours) and a 10 dB penalty at night-time (23.00 hours to 07.00 hours). It is possible to convert the hourly L_{Aeq} values displayed in Figure 6 and in the above Table into an L_{den} value for the total noise at the site, of 43 dBA.

3.5 <u>The contribution of aircraft noise events to the total noise climate at the site</u>

3.5.1 By using the Single Event Noise Level (SEL) for each aircraft noise event it is possible to calculate the average, or equivalent aircraft noise level (L_{Aeq}) due to aircraft noise events over a period of time (hour, day or month). Although this average noise level

bears little relationship to the aircraft noise as heard, which occurs in short bursts of noise at higher levels rather than as a lower continuous average level, it is, nevertheless, a useful parameter for comparative purposes.

3.5.2 Since the NMT also records hourly L_{Aeq} values of the total noise from the site it is possible, by subtracting the aircraft noise level from the total noise level (using the decibel (or logarithmic) subtraction process which is appropriate in this case) to calculate the remaining component of the total noise, i.e. the residual noise level.

3.5.3 The residual noise is a combination of the noise from residual noise events (i.e. those captured noise events which did not match with aircraft movements) and from other residual noise, not captured as noise events, i.e. all other noise recorded by the monitor that did not exceed the trigger level for the required minimum time period.

3.5.4 The table below shows the average values of the levels of total noise, aircraft noise and residual noise over the various parts of the 24 hour day (day, evening, night etc.).

	Average Noise level (LAeq value), dBA				
	Day (07.00-19.00)	Evening (19.00-23.00)	Night (23.00-07.00)	Day and Evening (07.00-23.00)	24 hours
Total noise	49	47	45	48	47
Aircraft noise	44	43	41	44	43
Residual noise	47	44	42	46	45

3.5.5 On an hour by hour basis the contribution of aircraft noise to the total noise at the site will obviously depend on the number of events each hour, which varies widely with the day and time of day (as illustrated in Figures 1 and 2). Figure 7 and 8 show the hourly average values of total noise, aircraft noise and residual noise on 14th May and 24th June, two of the 'busiest' days of the three month period when there were the highest number, of 55 aircraft noise events in the day (see Figure 1). Broadly similar results were obtained from the other 'busiest' days. It can be seen that on these 'busiest', days aircraft noise makes a major contribution to the total noise during those times of day when the highest numbers of aircraft events occur, i.e. during the morning, midday and early evening peak periods, but at other times of 24 hour day, when there are fewer aircraft noise events, the average level of aircraft noise is much lower than that of the residual noise. The highest average values of aircraft noise on these 'busiest' days are between 50 and 54 dBA.

3.5.6 Figure 9 shows the hour by hour levels of total noise, aircraft noise and residual noise averaged over all the days of the three month monitoring period. It can be seen from Figure 9 and from the above Table that for most of the day and evening when most of the aircraft noise events occur, the level of total noise at the site varies between 48 and 51 dBA. Except for three hours (5.00 hours to 8.00 hours and 20.00 to 21.00 hours) the aircraft noise levels are several decibels lower than the level of the residual noise, and in the early morning hours, when there are very few aircraft noise events, it is very much lower.

Figure 7, 8 and 9 together with the Table in paragraph 3.5.4 show that when the noise from aircraft noise events is cumulatively averaged over an extended period of time (of hours, days or weeks) it makes a significant but not always a dominant contribution to

the average level of total noise at the site, with noise from all other sources, i.e. the residual noise, sometimes making a greater contribution. However each individual aircraft noise event, whenever it occurs, is likely to be clearly audible and distinguishable from the residual noise because, in addition to being different in character, it results in a noticeable increase in the level of the ambient noise by 10 dBA or more for a period of about 24 seconds.

3.6 Putting the noise climate at the site into a wider UK context

National Noise Incidence Study

3.6.1 The National Noise Incidence Study of noise levels in England and Wales in 2000 carried out by the Building Research Establishment for Defra gave a breakdown of the proportion of residents exposed to noise, as follows:

Proportion of the population of England and Wales living in dwellings exposed to daytime noise levels ($L_{Aeq,\ 16\ hour}$) in 5 dB bands, in the 2000 National Noise Incidence Study	
5 dB noise exposure level bands*	Proportion in band
Less than 50 dBA	30%
50 dBA < L < 55 dBA	37%
55 dBA < L < 60 dBA	18%
Greater than 60 dBA	15%

*The noise level exposure bands in the above Table are for 'free field ' noise levels, i.e. noise levels unaffected by sound reflections from nearby surfaces. All the noise levels from the NMT at Hatfield Broadoak are also free field values.

3.6.2 From the Table in paragraph 3.5.4 the 16 hour L_{Aeq} value for total noise at this site is 48 dBA, which puts the site in the lowest, 'Less than 50 dBA' noise exposure band, occupied by 30 % of dwellings in England and Wales. It can also be seen that without the contribution from aircraft noise the 16 hour L_{Aeq} value for residual noise at this site is 46 dBA, which would put the site in the same 'Less than 50 dBA noise exposure band.

3.6.3 The National Noise Incidence Study of noise levels was extended in 2002 to cover the entire UK and also to include the L_{den} index as shown below:

Proportion of UK population living in dwellings exposed to noise levels in 5 dB bands, according to the L_{den} noise index, in the National Noise Incidence Study 2002	
5 dB noise exposure level bands**	Proportion in band
Less than 55 dBA	33%
55 dBA < L < 60 dBA	38%
60 dBA < L < 65 dBA	16%
Greater than 65 dBA	13%

**The noise level exposure bands in the above Table are for noise levels measured at 1m from a building facade, and so will include a contribution (assumed to be 3 dBA) from sound reflected from the facade of the building. All the noise levels from the NMT are free field values and therefore 3 dB must be added for them to be comparable with the exposure bands in the above Table.

3.6.4 Since the L_{den} value for the total noise at this site is 43 dBA (calculated from the data given in the Table in paragraph 3.4.6) the addition of 3dB (i.e. a facade level of 46 dBA)

puts the site in the lowest 'Less than 55 dBA ' noise exposure band, occupied by 33% of dwellings in the UK.

World Health Organisation and PPG 24 Guidance on Community Noise

3.6.5 In 2000 the World Health Organisation issued 'Guidelines for Community Noise', which are reflected in the UK Planning Policy Guidance Note 24 (Annex 2, paragraph 4): that "general daytime outdoor noise levels of less than 55 dBA are desirable to prevent significant community annoyance" and that "at night, sound pressure levels at the outside façades of living spaces should not exceed 45 dB (L_{Aeq}) so that people may sleep with bedroom windows open."

3.6.6 The National Noise Incidence Study 2000 has estimated that 55% of the population of England and Wales live in dwellings exposed to day-time noise levels above the WHO level of 55 dB $L_{Aeq,16h}$, and that 68% are exposed to night-time levels above the WHO level of 45 $L_{Aeq, 8h}$.

3.6.7 The total noise exposure levels at this site based on the data collected during this 3 month noise survey period, (shown in the Table in paragraph 3.5.4) are an $L_{Aeq,16h}$ of 48 dBA in the daytime and 45 dBA at night-time. The daytime level at the site is therefore below the WHO Guideline of 55 dBA in the daytime, and just at the night-time Guideline value of 45 dBA. Without the contribution from aircraft noise events the noise at the site would be the residual noise level, of 46 dBA in the daytime and 42 dBA at night-time (from Table in paragraph 3.5.4), i.e. below the WHO daytime guideline levels for both daytime and night-time.

Aircraft noise contours

3.6.8 The CAA, UK's specialist aviation regulator, produces annual contours of predicted aircraft noise levels around various UK airports, including Stansted. The contours show the predicted values of the daytime 16 hour (07.00 to 23.00 hours) L_{Aeq} values produced by aircraft in flight, in 3 dB bands, from 73 dBA (closest to the airport) to an outer contour value of 57 dBA.

3.6.9 Based on research the CAA has used 57dBA Leq as the level of daytime noise marking the approximate onset of significant community annoyance. The relationship between noise and annoyance is of course not an exact one, and varies according to individuals and locations.

3.6.10 Although it is interesting to compare the Aircraft noise levels derived from the NMT data at this site with the published contours for Stansted, in making any such comparisons it must be borne in mind that the contours are based on the average summer day, where 'summer' is the 92-day period from 16 June to 15 September, and 'day' is the 16-hour period 0700-2300 (local time), whereas the aircraft noise levels in this report are for the (approximate) three month period, from 13 April to 6 July 2010.

3.6.11 The published contours for Stansted Airport for 2007 and 2008 (ERCD Report 0903) show that the site at Hatfield Broad Oak lies well outside the outermost 57 dBA contour, by approximately 2 to 3 kilometres, which is consistent with the data from this study which shows that the measured 16 hour daytime aircraft noise L_{Aeq} value for the three month period (paragraph 3.5.4) is 44 dBA.

3.6.12 Contours of aircraft noise L_{den} were also produced for the year 2006 (ERCD Report 0708) to meet the requirements of the first round noise mapping exercise Under EU

Directive 2002/49/EC. These contours were produced in 5 dB steps with the lowest (outermost contour) being for L_{den} of 55 dBA and were based on data for an average day over the whole year (2006). The contours show that Hatfield Broad Oak lies just outside the 55 dBA contour, by between approximately 1 and 2 kilometres. Although it is interesting to compare the L_{den} value for aircraft noise, calculated from the values presented in this report with the published contours, it should be noted that the contours and the measured values are based on two different periods of time, for which the modal split (i.e. proportion east/west departures) may be different, and which will involve different numbers and types of aircraft noise events. The value of L_{den} calculated from the values of aircraft noise level given in paragraph 3.5.4 for the (approximate) three month period from 13 April to 6 July 2010 is 40 dBA.

3.6.13 It is intended that the next round of noise mapping and L_{den} contours will be carried out for the year 2011.

3.7 The contribution of different aircraft types to aircraft noise at the site

3.7.1 Thirty three different aircraft types contributed to the total number of 1,966 aircraft noise events which occurred during the three month period. Figure 10 shows the numbers of events from the different types of aircraft. Each aircraft type shown in Figure 10 is described by a 3 character source code. A list of these codes is given in Appendix 4.

3.7.2 Although 33 different aircraft types were involved in total, two aircraft type accounted for more than 85% of the events: Boeing 737- 800: 1,244 events (63.3%), Airbus A319: 435 events (22.1 %).

3.7.3 Figure 11 shows the average maximum aircraft noise level L_{ASmax} value for each aircraft type, and it can be seen that for most aircraft types the value lies between 60 and 70 dBA. The average values of for the two most frequent types of aircraft type were; 65.5 dBA (Boeing 737- 800) and 68.5 dBA (Airbus A319). There are four aircraft types which produce average values of L_{ASmax} greater than 70 dBA, as tabulated below:

Aircraft Type	Average L_{ASmax} value	Number of events in 3 month period
Airbus 340 - 200	81 dBA	1
Boeing 727 - 200	78 dBA	2
Airbus 340 - 300	78 dBA	38
Boeing McDonnell-Douglass) MD11 Freighter	71 dBA	20

3.7.4 The single event referred to in paragraph 3.2.2 and noticeable in Figure 3, which occurred on 25th June at 00.15 hours, with an L_{ASmax} value of 78.5 dBA is one of the 38 events arising from the Airbus 340-300.

The noisiest aircraft noise events

3.7.5 There were 55 aircraft noise events with an L_{ASmax} value of 75 dBA or above. Nineteen of these events occurred in the night-time period between 23.00 and 07.00 hours and thirty six in the daytime.

Most of these (36 events) were from Airbus 340 - 300 aircraft types, operated by Air Asia. The other aircraft types involved were:

Boeing 767-300 Freighter	10 events
Boeing (McDonnell Douglas) MD11 Freighter	6 events

Boeing 727-200, Airbus A340-200 and Airbus A321	1 event each

It is understood that many of these aircraft movements were long stage-length i.e. heavily loaded long haul flights to places such as Kuala Lumpur and Hong Kong. Examination of some flight tracks has shown that although there was one off track movement following the 22DVR route, in the main these were flights within track, but close to the northern edge of the 22CLN route and so often flying almost directly over the Hatfield Broadoak monitor.

4.0 Summary and Conclusions

4.1 A total of 1,966 aircraft noise events occurred during the approximate three month (84 day) survey period. Almost all of these aircraft noise events were due to departing aircraft, using the 22CLN departure route. The number of aircraft noise events per day ranged from zero (on 21 days) to 55 (on 5 days), with an average of 23 events per day. This distribution almost certainly reflects the day to day variation between easterly and westerly departure directions, determined by wind direction.

4.2 The numbers of aircraft noise events per day did not show any obvious correlation with day of the week or weekends. The highest number of events per hour occurred in the morning between 06.00 and 09.00 hours and in the afternoon with lower peak numbers between 17.00 and 21.00hours, local time. During the busiest hours there were up to 12 events per hour.

4.3 The maximum noise level (L_{ASmax}) of aircraft noise events ranged from 60 dBA to 83 dBA, but for more than 90% of the events was between 63 and 71 dBA, with an overall average of 67 dBA,. There were 55 events greater than 75 dBA and 4 events with a maximum noise level greater than 80 dBA.

4.4 The average noise level (L_{Aeq} value) during aircraft noise events, which had an average duration of about 24 seconds, was 63 dBA.

4.5 The total noise climate at the site may be characterised by average hourly values of various noise percentile levels, and by the average (or equivalent) noise level (L_{Aeq}). These values were fairly constant during the daytime, between 07.00 and 19.00 hours (with average values of L_{AS10} of 49 dBA, L_{AS90} of 39 dBA and L_{Aeq} of 49 dBA), but falling to lower levels in the late evening, night-time and early morning periods. The average value over the night-time period from 23.00 to 07.00 hours (L_{Aeq} values) was 45 dBA, and for the evening period from 19.00 to 23.000 hours was 47 dBA.

4.6 The daily average (L_{Aeq}) level of the total noise at the site is a combination of that due to aircraft noise events and that due to residual noise. On the 'busiest' days of the 3 month period aircraft noise makes a major contribution to the total noise at the site during those times of day when the highest numbers of aircraft events occur, i.e. during the morning, midday and early evening peak periods, but at other times, when there were fewer aircraft noise event per hour, the average level of aircraft noise was much lower than that of the residual noise. The highest average values of aircraft noise on these 'busiest' days were between 50 and 54 dBA.

4.7 When the noise from aircraft noise events is cumulatively averaged over an extended period of time (of hours, days or weeks) it makes a significant but not always a dominant contribution to the average level of total noise at the site, with noise from all other sources, i.e. the residual noise, sometimes making a greater contribution. However each individual aircraft noise event, whenever it occurs, is likely to be clearly

audible and distinguishable from the residual noise because, in addition to being different in character, it results in a noticeable increase in the level of the ambient noise by 10 dBA

4. 8 Although 33 different aircraft types were involved in total, two aircraft type accounted for more than 85% of the events: Boeing 737- 800: 1,244 events (63.3%), Airbus A319: 435 events (22.1 %). There were 55 aircraft noise events with an L_{ASmax} value of 75 dBA or above. Nineteen of these events occurred in the night-time period between 23.00 and 07.00 hours and thirty six in the daytime.

4.9 Most of these (36 events) were from Airbus 340 - 300 aircraft types, operated by Air Asia. The other aircraft types involved were:

Boeing 767-300 Freighter	10 events
Boeing (McDonnell Douglas) MD11 Freighter	6 events
Boeing 727-200, Airbus A340-200 and Airbus A321	1 event each

4.10 It is understood that many of these aircraft movements were heavily loaded long haul aircraft flights to places such as Kuala Lumpur and Hong Kong. Examination of some flight tracks has shown that although there was one off track movement following the 22DVR route, in the main these were flights within track, but close to the northern edge of the 22CLN route and so often flying almost directly over the Hatfield Broadoak monitor.

4.11 The information presented in this report will serve as a baseline for comparison with any future noise level surveys at this location.

Figure 1: Number of aircraft noise events at Hatfield Broad Oak, Essex, each day from 13 April to 06 July 2010

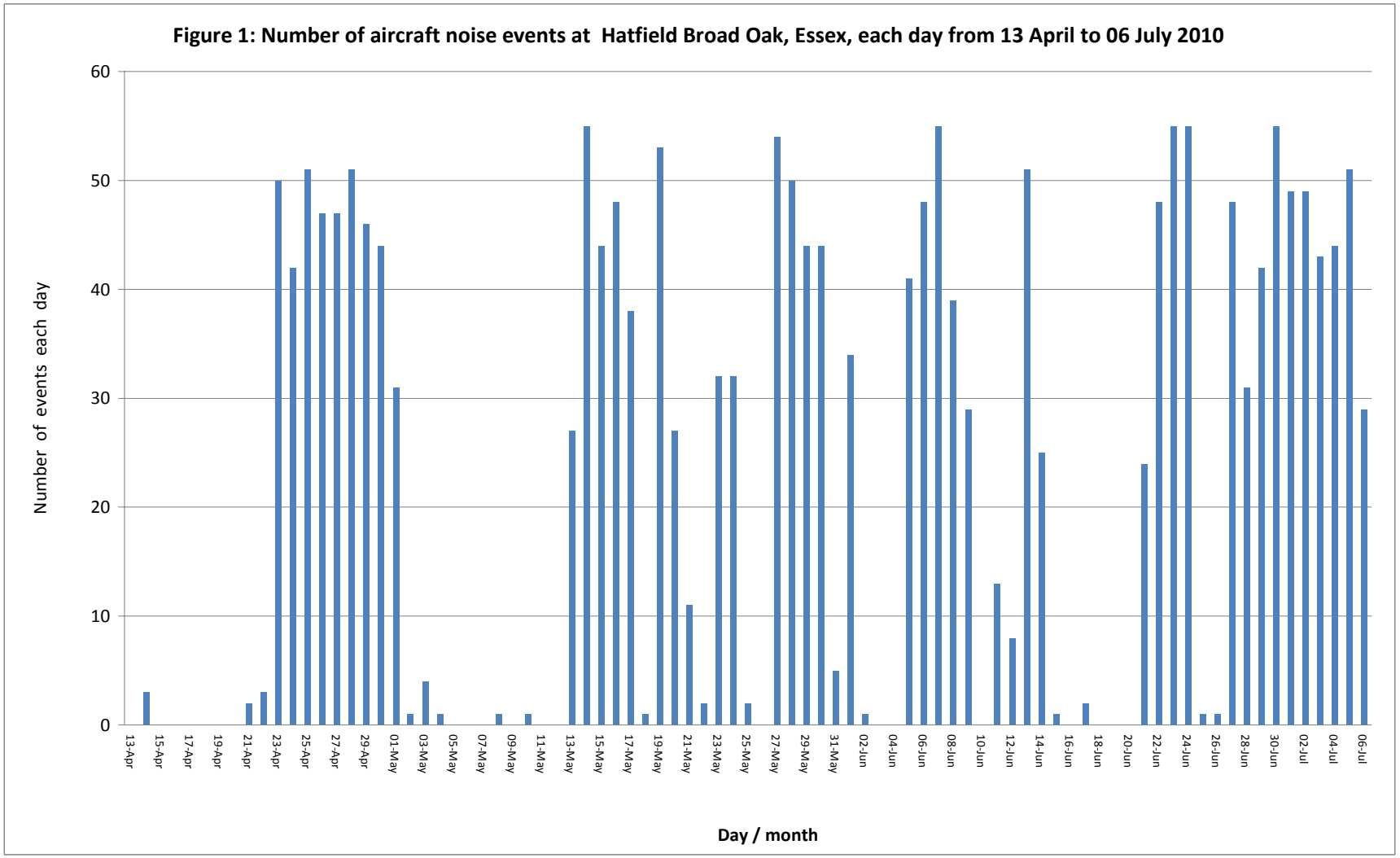


Figure 2: Average number of aircraft noise events per hour of the day at Hatfield Broad Oak, Essex, from 13 April to 06 July 2010

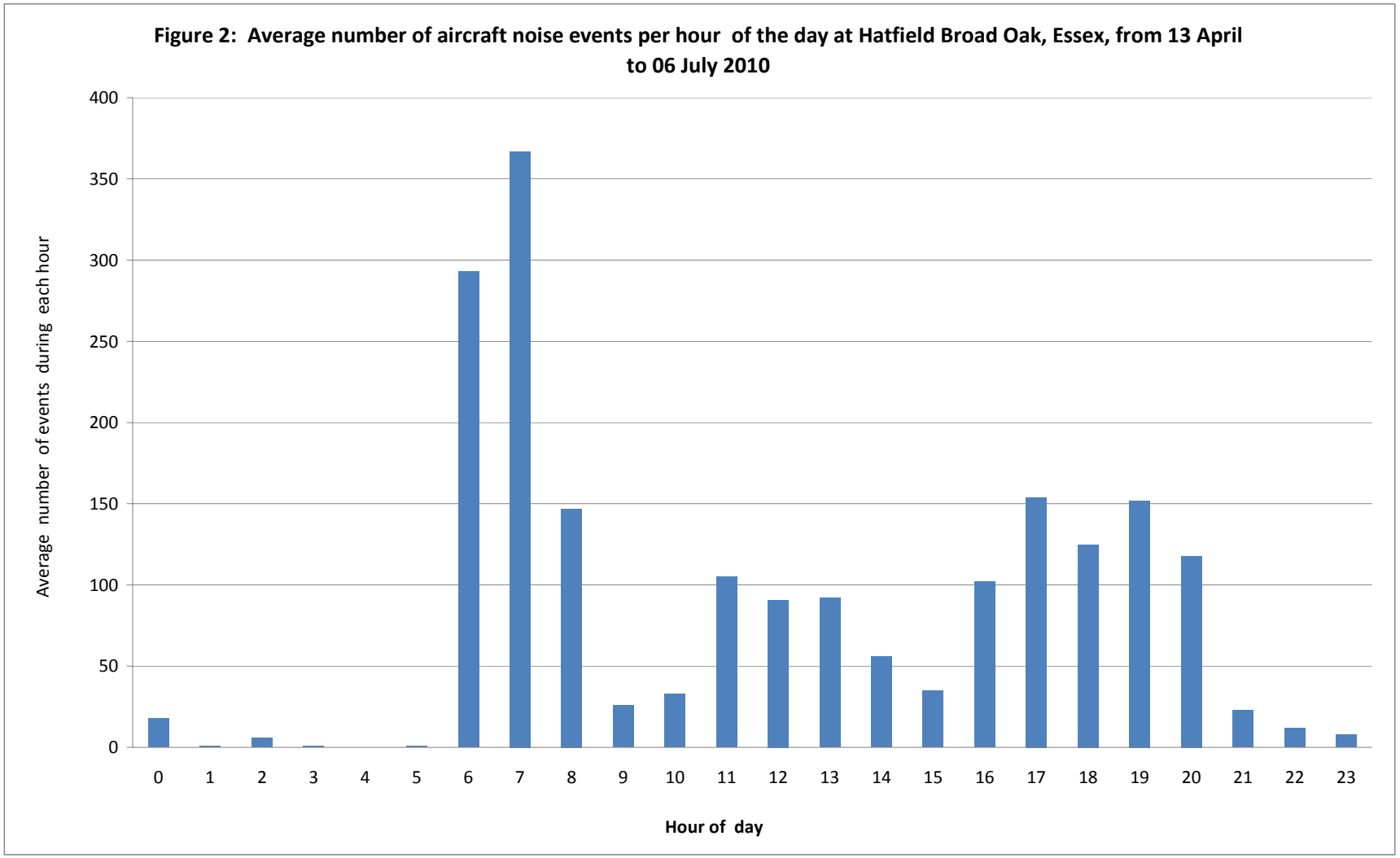


Figure 3: Average value of maximum noise levels of aircraft noise events at Hatfield Broad Oak, Essex, each day from April 13 April to 06 July 2010

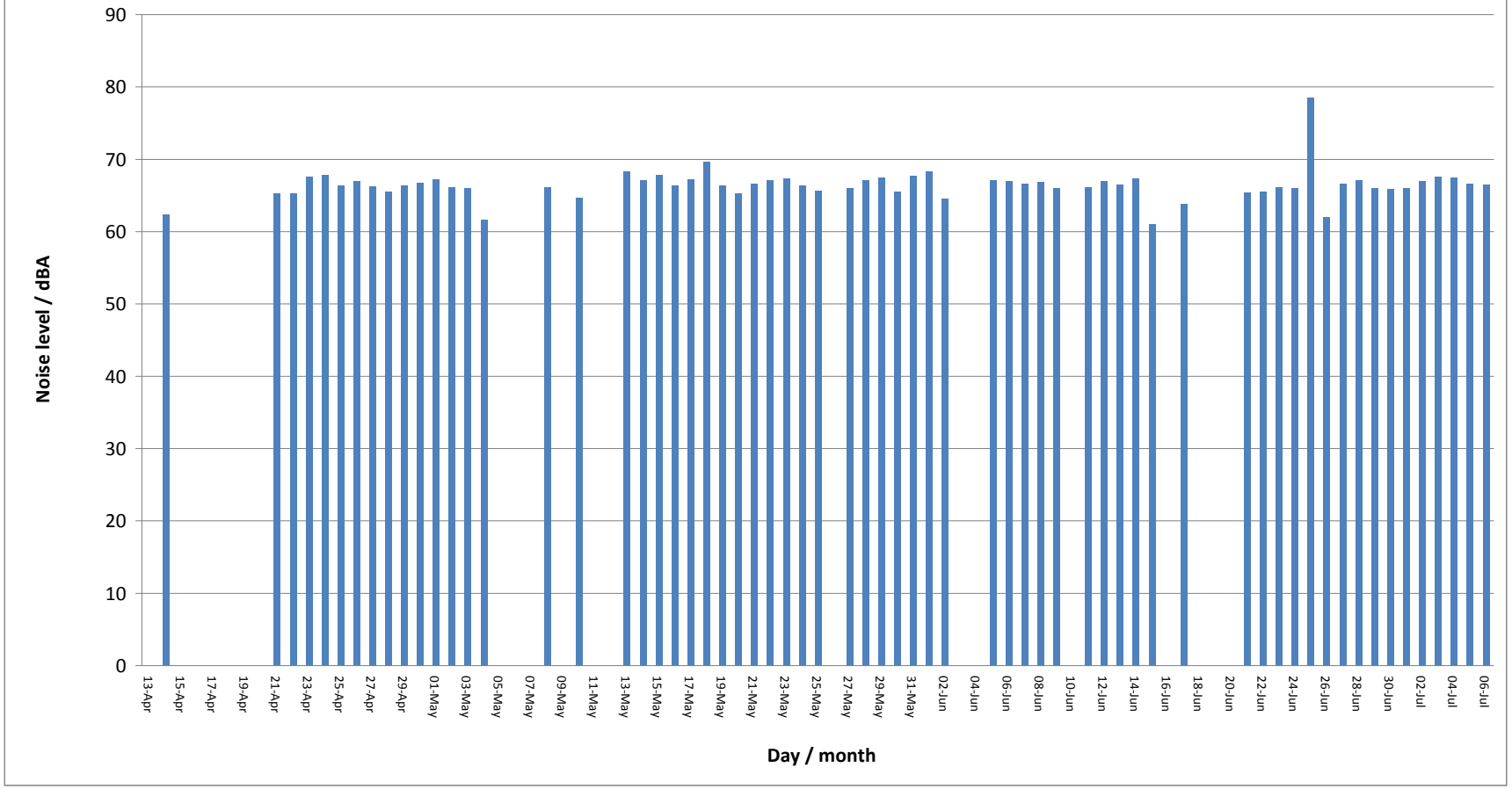


Figure 4 Average value of maximum levels of aircraft noise events per hour of day at Hatfield Broad Oak, Essex, April 13 to July 06, 2010

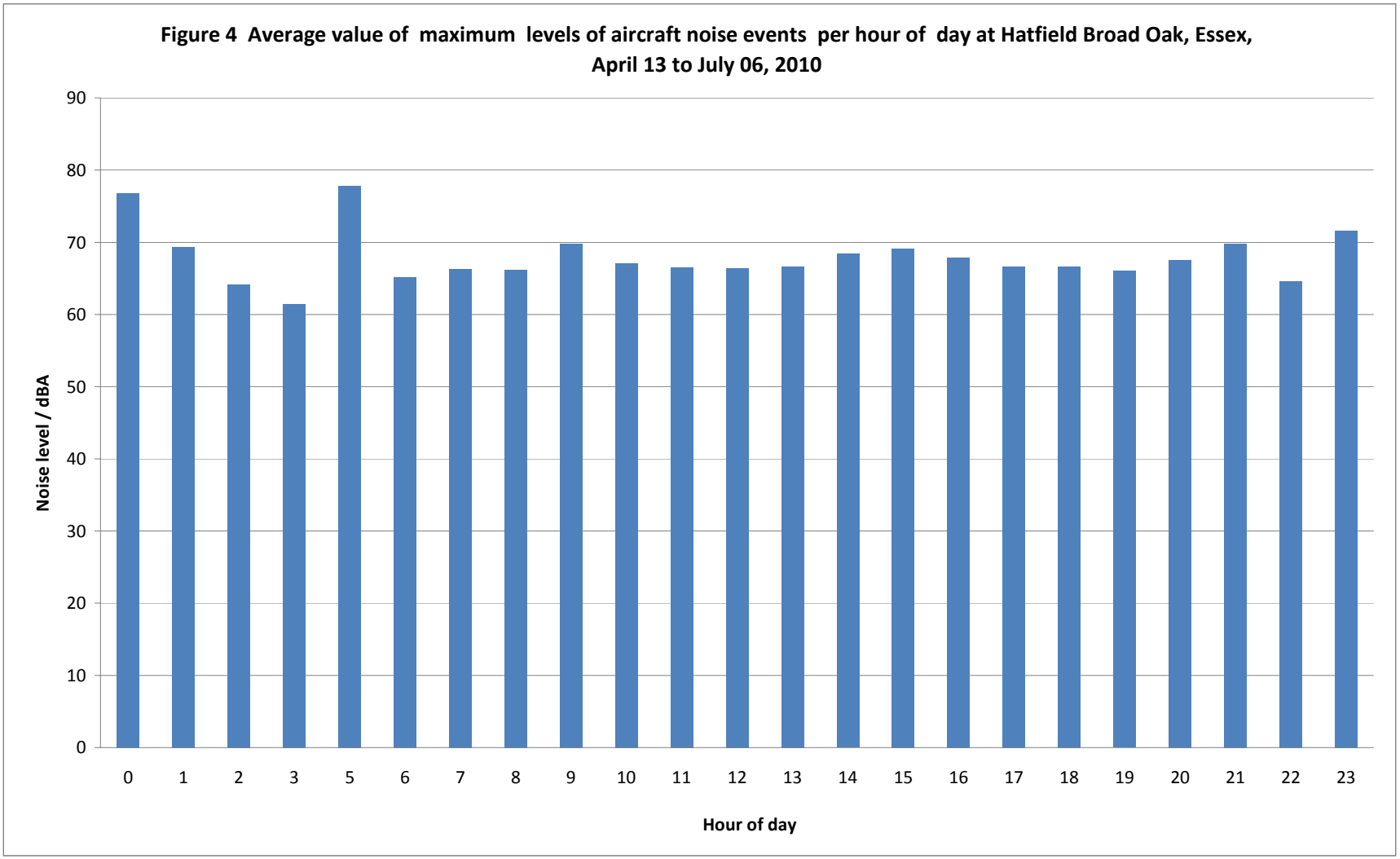


Figure 5: Statistical frequency distribution and % cumulative frequency distribution of maximum noise levels of aircraft noise events at Hatfield Broad Oak, Essex , April 13 to July 06 2010

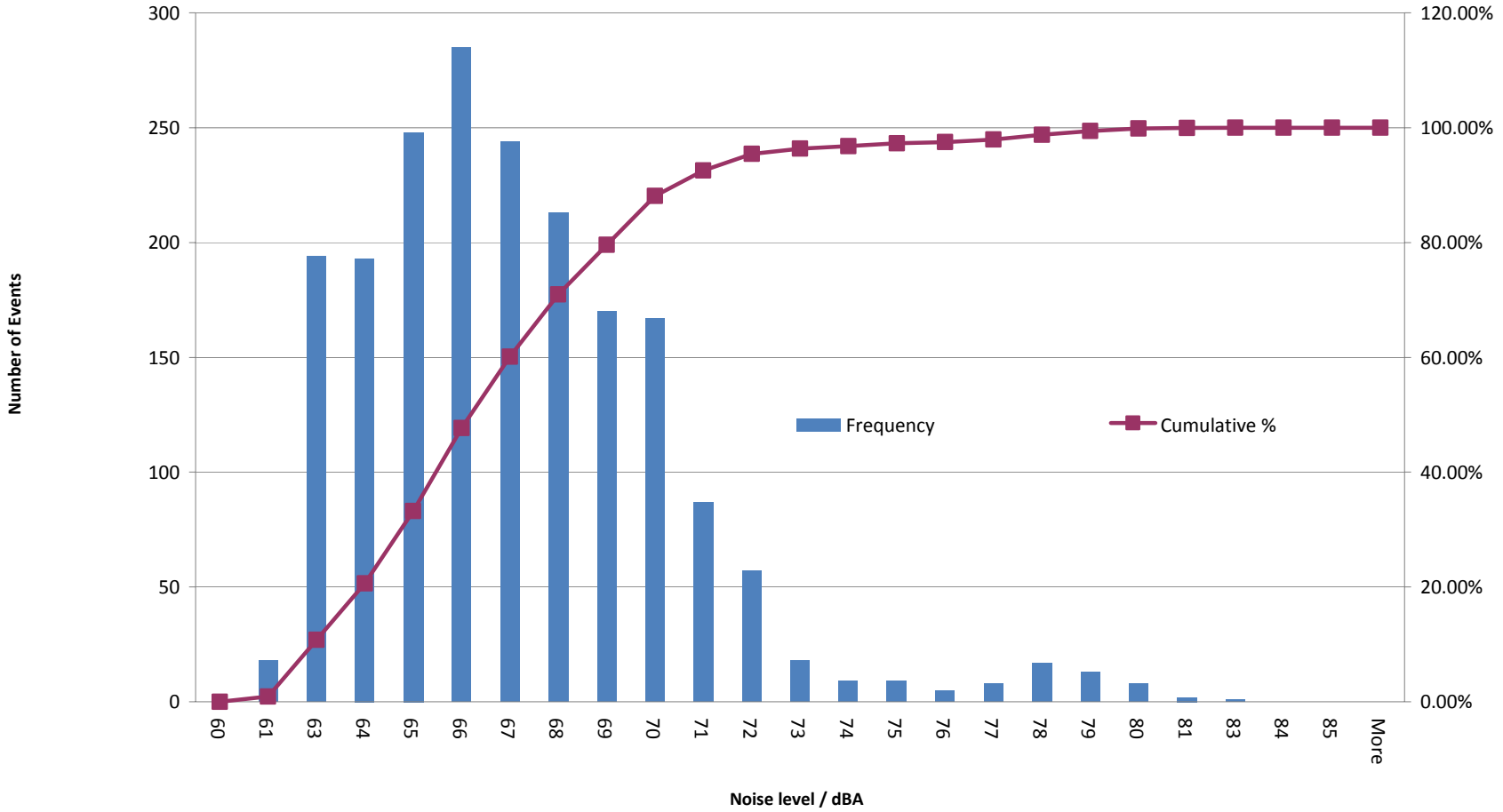


Figure 6 Noise Climate (average noise level percentile values) hour by hour at Hatfield Broad Oak, Essex, from 13 April to 06 July 2010

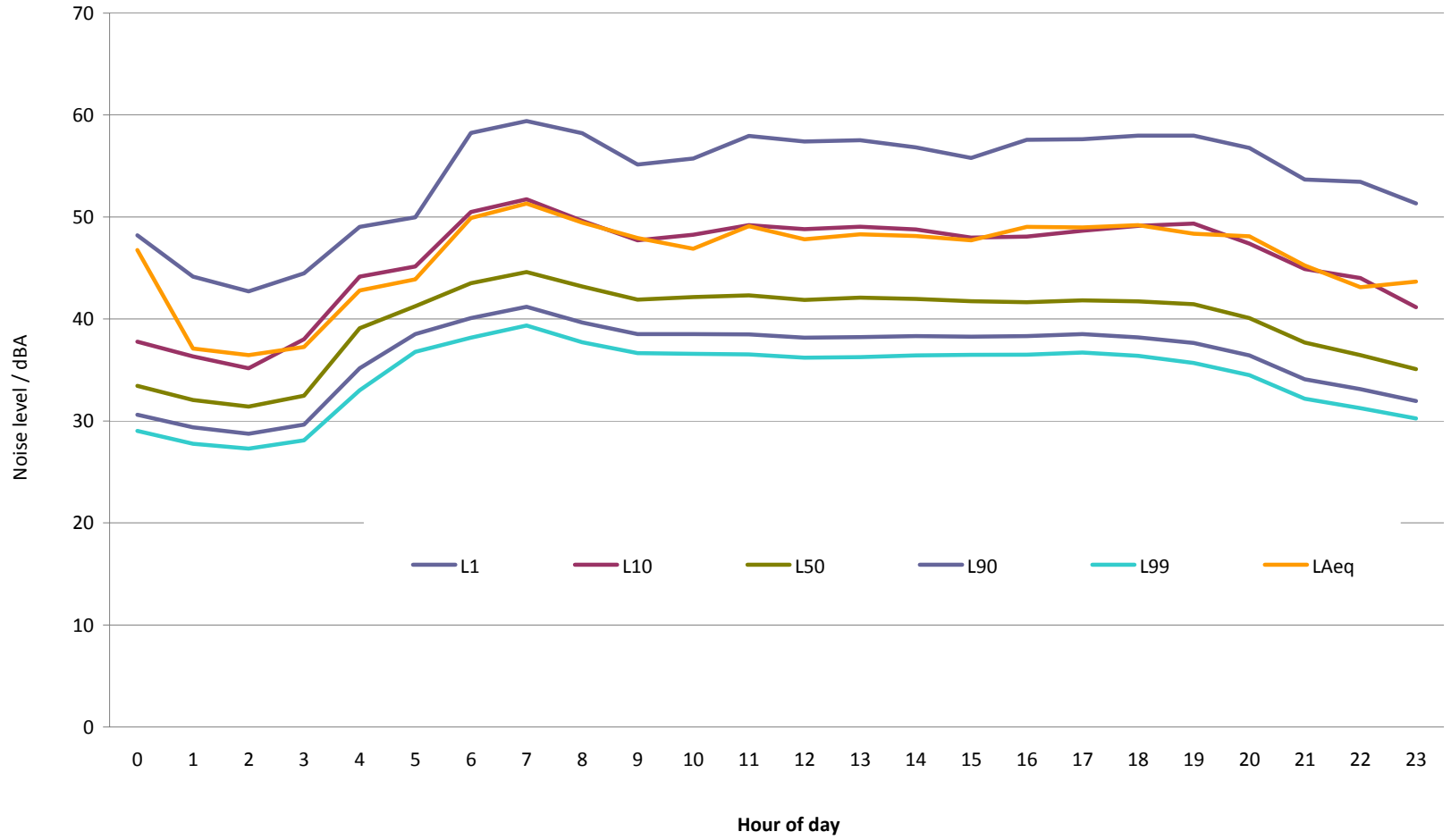


Figure 7 Noise Climate at Hatfield Broad Oak, Essex, on 14 May 2010 (one of the busiest days of the 3 month period) , showing average values for each hour of day of total noise, aircraft noise and residual noise (LAeq values)

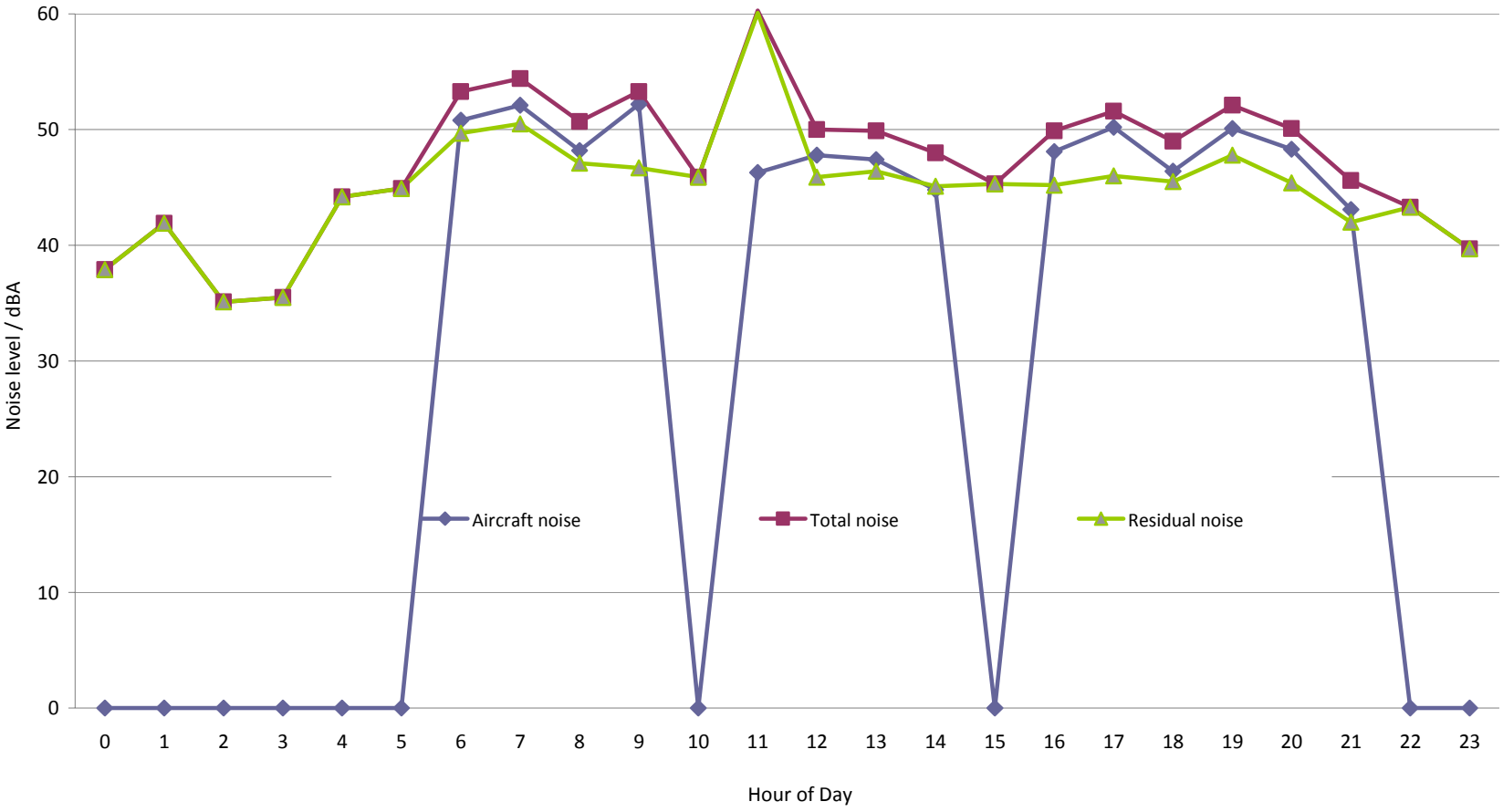


Figure 8 Noise Climate at Hatfield Broad Oak, Essex, on 24 June 2010 (one of the busiest days of the 3 month period) , showing average values for each hour of day of total noise, aircraft noise and residual noise (LAeq values)

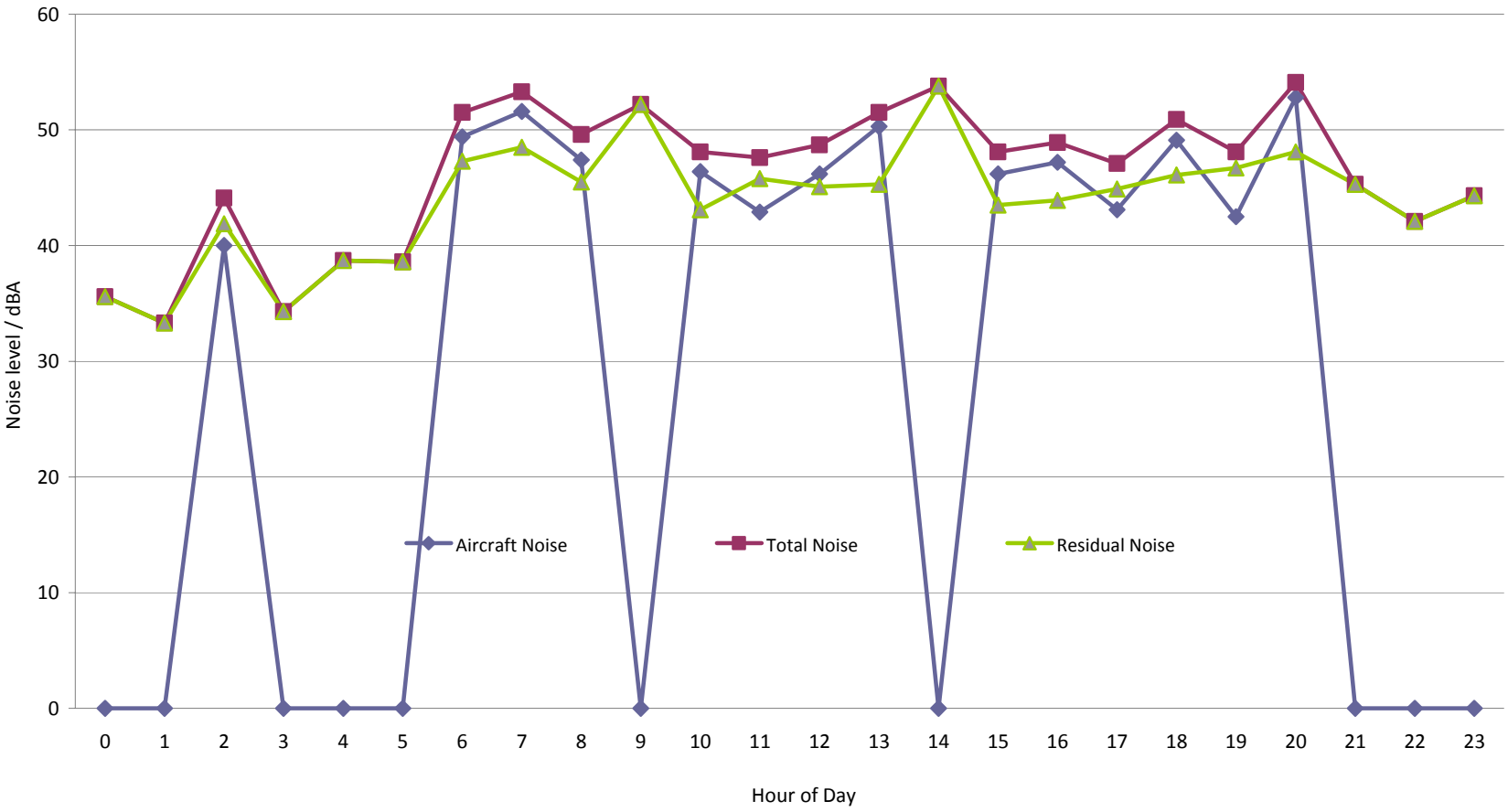


Figure 9 Noise Climate at Hatfield Broad Oak, Essex, from 13 April to 06 July 2010 showing average values for each hour of day of total noise, aircraft noise and residual noise (LAeq values)

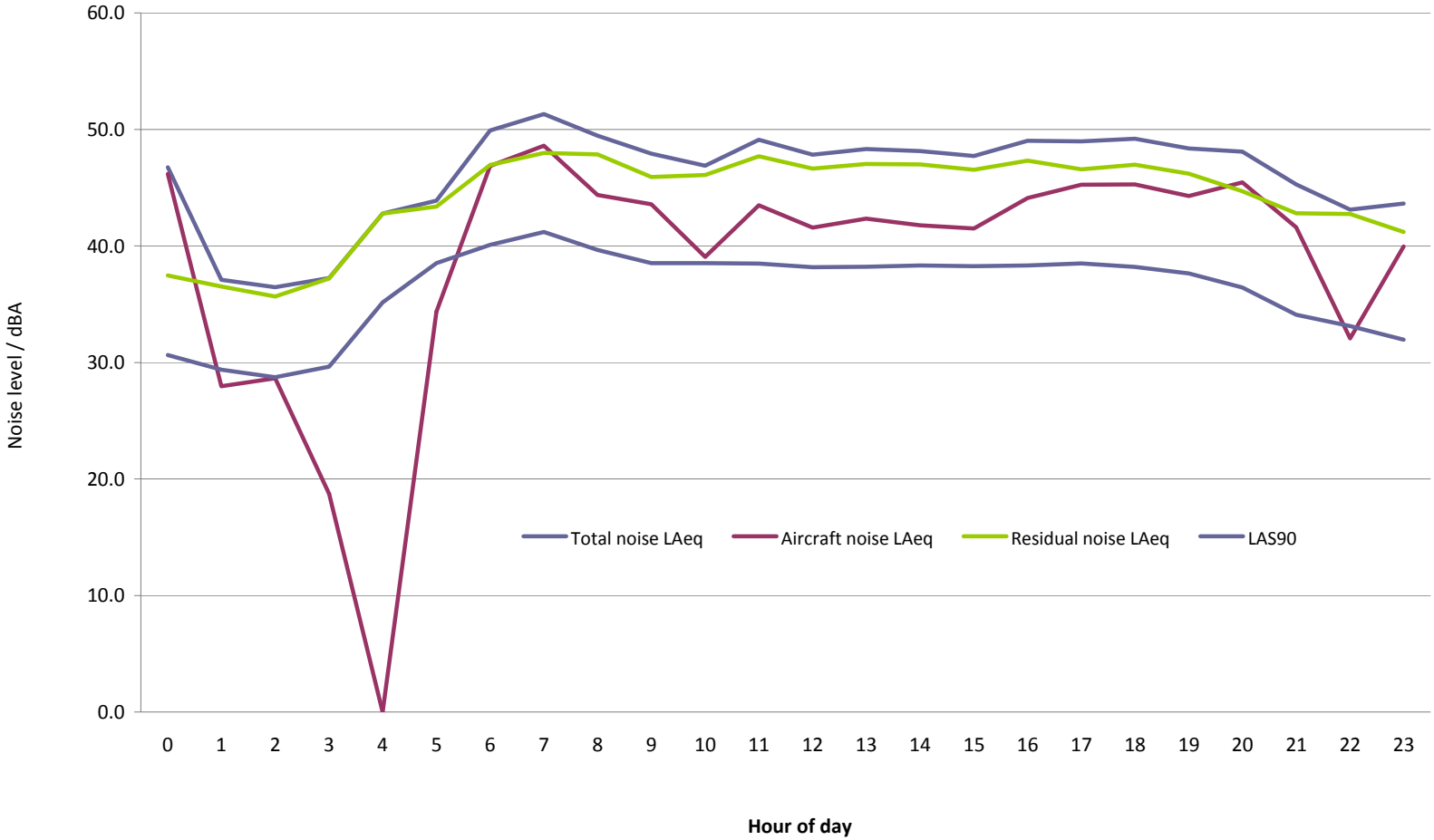


Figure 10: Numbers of aircraft noise events arising from different aircraft types at Hatfield Broad Oak, Essex, from 13 April to 06 July 2010

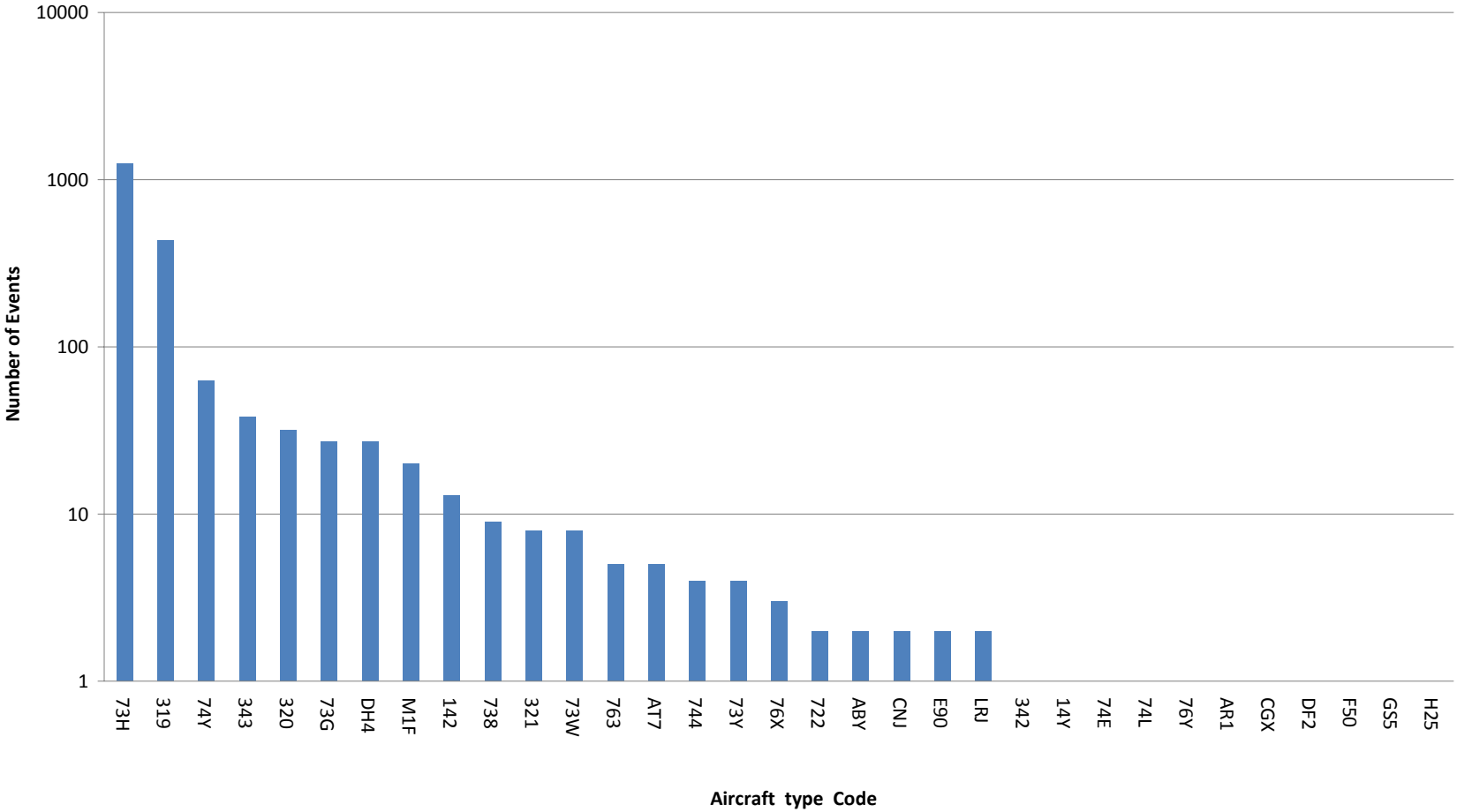
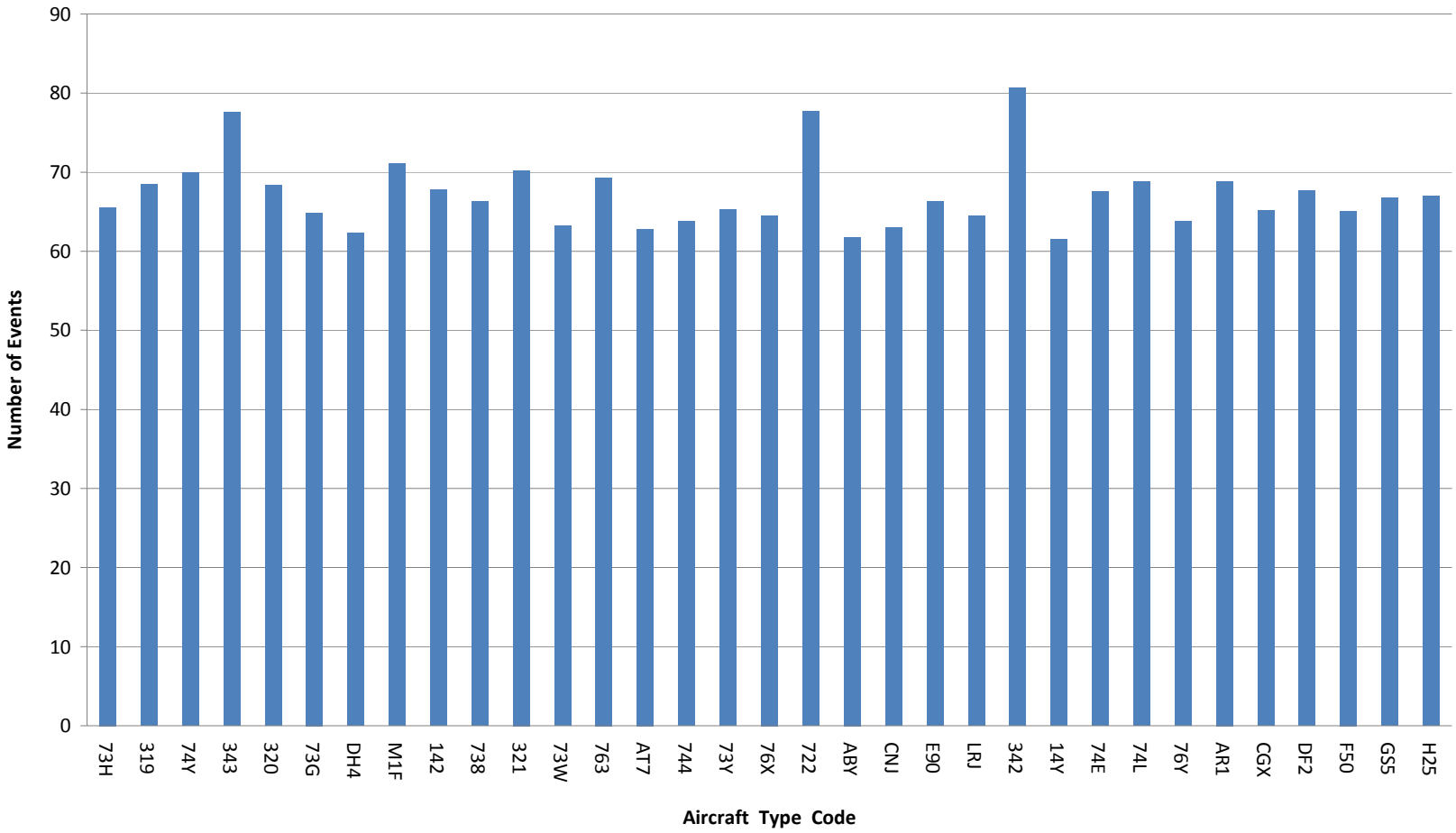


Figure 11: Average values of maximum noise levels of aircraft noise events arising from different aircraft types, at Hatfield Broad Oak, Essex, from 13 April to 06 July 2010



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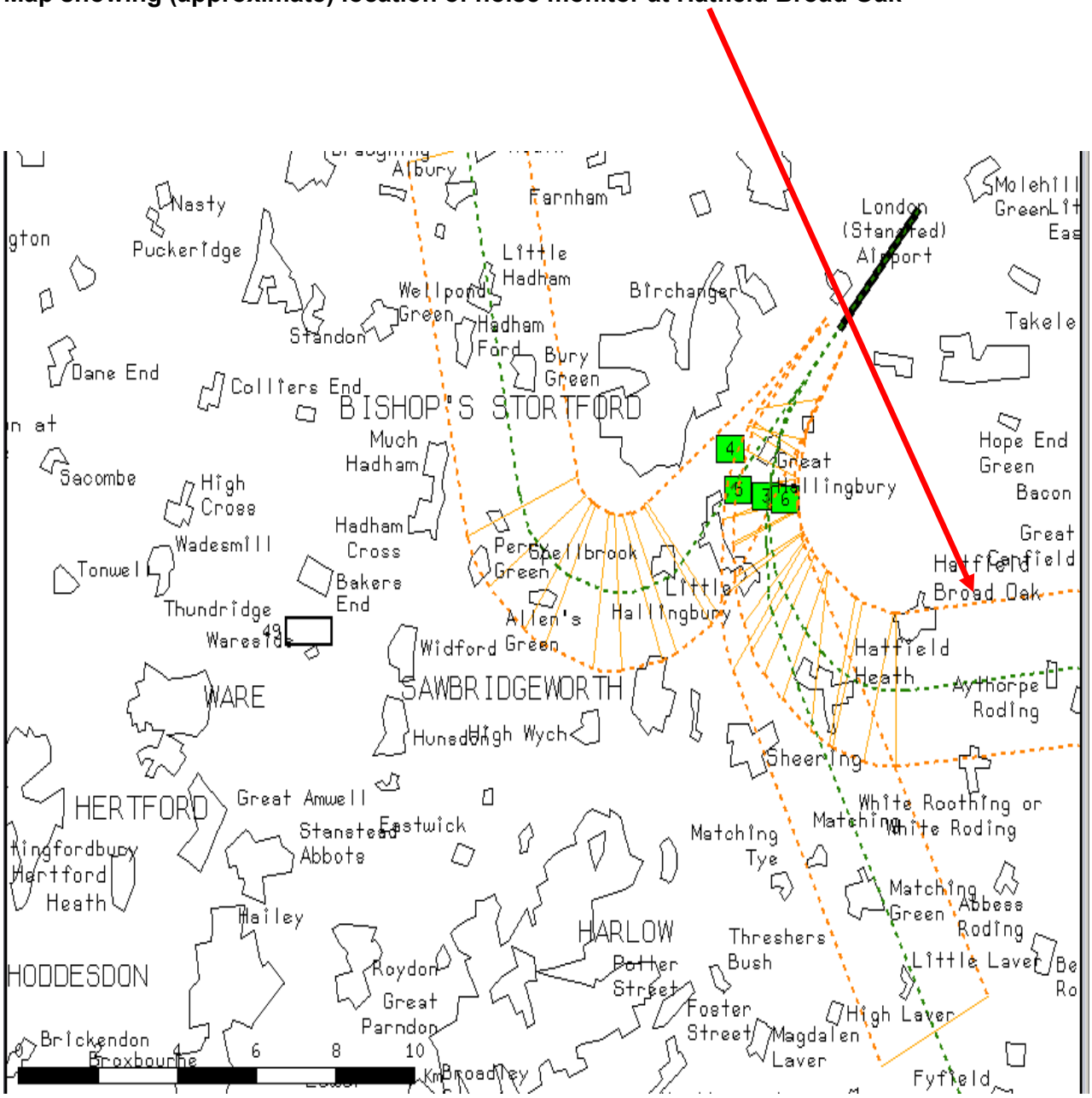
APPENDIX 1

MAP OF SITE

Map showing location of noise monitor at Hatfield Broad Oak

Map showing (approximate) location of noise monitor at Hatfield Broad Oak



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APPENDIX 2

DATA FROM THE NOISE MONITORING TERMINAL

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Data from the Noise Monitoring Terminal

The NMT always records all noise from all sources. It has, however, the facility to capture and show separately all noise events that meet particular pre-set conditions. This facility is used to capture noise events likely to arise from aircraft flying near to the monitor. The pre-set condition used for this study is that the noise must exceed a level of 60 dBA for a minimum duration of 10 seconds. This is arrived at following preliminary noise measurements at the site, and is broadly similar to conditions set for other such studies. It is of course likely that noise arising from activities other than aircraft using Stansted Airport will occasionally cause noise events to be captured.

To determine which of all those events are due to aircraft using Stansted Airport their ANOMS (Aircraft Noise Management System) 'noise to track' matching software compares all captured noise events with all Stansted Airport's air traffic radar tracks. Noise events that are matched to aircraft are combined to provide a measure of 'aircraft noise' and noise events that are not matched to aircraft are included with 'all other noise' (i.e. that noise which is not captured as noise events, because it fails to meet the capture conditions of being above 60 dBA for 10 seconds), and is called residual noise.

Therefore wherever reference is made to aircraft noise events within this document it should be understood that these relate only to aircraft using Stansted airport. Any noise arising from aircraft travelling to or from any other airport will be included as residual noise.

The selection of the threshold conditions (noise level and time period) which trigger the capture of a noise event is a compromise judgement designed to include as much of the noise from passing aircraft as possible whilst at the same time excluding, as far as possible, noise from other sources. For this survey a threshold trigger level 60 dBA for a duration of at least 10 seconds was used.

The following information is recorded for each noise event: date, time, duration, L_{ASmax} and SEL values, and, in addition, for aircraft noise events, event type (arrival/ departure), departure route, runway used, and aircraft type.

In addition to gathering data about noise events the NMT also collects and stores information on an hourly basis about the total level of noise at the site from all sources (including that from aircraft movements), including individual noise events.

Because the noise level is usually not constant, but varies continuously throughout each hour it is necessary to describe the total noise level statistically in terms of a measure of the average noise level throughout the hour (and called the hourly continuous equivalent noise level, L_{Aeq}) and also in terms of a series of hourly percentile levels. The most important of these is the L_{AS90}, which is the noise level exceeded for 90% of each hour. This level of noise is conventionally taken to be a measure of the background noise level for each hour, and is the more or less constant level of noise which underlies the variations caused by various transient sources including aircraft.

APPENDIX 3

GLOSSARY OF TERMS

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GLOSSARY OF TERMS

This glossary is presented in two parts. The first part contains definitions relating specifically to the context of this report, followed, in the second part, by a more general glossary of acoustic terms.

Definitions relating specifically to the context of this Report:

Aircraft Noise events	Noise events which have been matched by the GEMS noise and track keeping system to radar tracks in the vicinity of the NMT from aircraft arriving at or departing from Stansted airport.
Aircraft noise level	The average noise level derived from aircraft noise events, aggregated into hourly, daily or monthly average (LAeq) values.
ANOMS	Airport Noise and Operations Monitoring System. The software data analysis system currently in use at the airport (incorporating the NTK system).
Applied Acoustic Design (AAD)	Acoustic consultants retained by FEU
Average L_{ASmax} level	The arithmetic average of the L_{ASmax} values of all the events (of a particular type i.e. either aircraft noise or community noise) which occur over a particular period of time (eg hour, day or month).
Building Research Establishment	A former government organisation, now privately owned, which conducts research on noise. Carried out the National Noise Incidence Study for Defra in 2000.
Defra	UK government Department for Environment Food and Rural Affairs, which has responsibility for aspects of policy relating to environmental noise
Flight Evaluation Unit (FEU)	The unit within BAA which monitors all aircraft movements to ensure compliance with Department for Transport noise regulations relating to track keeping, noise abatement and night flights, and which also provides a means of investigating and responding to complaints and enquiries from the public.
National Noise Incidence Study 2000	A study carried out by the Building Research Establishment for Defra based on a survey of noise levels outside 1020 dwellings in England and Wales in 2000, giving proportions of the population exposed to various levels of environmental noise.

Noise event	A burst of noise at a high level which satisfies the noise event capture conditions for a particular NMT, i.e. which exceeds the pre-set trigger noise level (in this report 62 dBA) for a pre-set time interval (in this report 10 seconds). Noise events are detected, captured and stored by the NMT, and following subsequent processing by the NTK system are classified in this report as either aircraft noise events or community noise events
Noise Monitoring Terminal (NMT)	The noise measurement and analysis system installed at each site consisting of a precision grade sound level meter (Larson Davis type 870) inside a weather proof and tamper proof metal cabinet connected to an outdoor microphone located at a height of approximately 3.5 m above ground level.
NTK system	Noise and Track Keeping system. A software system able to match noise events recorded by the NMTs with aircraft tracks.
PPG24	Planning Policy Guidance Note 24:Planning and Noise, a document issued by the UK government Department for the Environment in 1994 which gives guidance to local authorities and others on noise and planning.
Residual noise	All noise arriving at the NMT microphone apart from aircraft noise events, i.e. comprising residual noise events and all other noise which does not satisfy the trigger conditions for capture as a noise event.
Residual Noise events	Those noise events which have not been matched by the NTK system to aircraft tracks using Stansted Airport in the vicinity of the NMT.
Statistical frequency Analysis (of L_{ASmax} noise levels)	An analysis of a group of L_{ASmax} values giving the numbers of events (or percentages of total numbers) at different dBA levels
Total noise	All noise arriving at the NMT microphone, i.e. not only including all noise events (both aircraft and residual) but also all other noise which does not satisfy the trigger conditions for capture as a noise event.
Total noise level	The average or continuous equivalent level (L_{Aeq}) of the total noise at the site, recorded each hour by the NMT, which may also be aggregated into daily or monthly values.
Total noise climate	The level of the total noise at the NMT microphone varies with time. over a particular period of time e.g. one hour, this variation may be

described in terms of a number of different noise indices including the average or equivalent noise level, maximum and minimum noise level values and various percentile levels. Such a description constitutes the noise climate at the site over that period of time.

The NMT records the following total noise indices every hour: L_{Aeq}, L_{ASmax}, L_{AS10}, L_{AS50}, L_{AS90} and L_{AS99}.

World Health Organisation

Issued 'Guidelines for Community Noise' in 2000

A general Glossary of acoustic Terms:

A-weighting — A method of producing a single figure measure of a broad band noise (as opposed to the 8 or 9 figures which make up an octave band spectrum) which takes into account, in an approximate way at least, the frequency response of the human hearing system. The idea is that sound levels measured in this way should give an indication of the loudness of the sound.

A-weighted sound pressure level (dBA).

The value of the sound pressure level, in decibels, measured using an A-weighting electronic circuit built into the sound level meter. The vast majority of noise measurements are carried out in this way.

Day, evening, night level, L_{den}

An index of environmental noise based on average noise levels (L_{Aeq}) throughout the 24 hour period, but with a weighting factor of 5 dBA added to evening noise levels (19.00 to 23.00 hours), and a weighting of 10 dB added to night-time noise levels (23.00 to 07.00 hours). It is the noise index used in the UK Noise mapping exercise commissioned by Defra in response to the European Union Directive on Environmental Noise in 2002.

Decibel scale — The decibel scale is the scale on which sound pressure levels are commonly measured. It is a logarithmic scale and is used for convenience to compress the audible range of sound pressures into a manageable range, from 0 dB to 140 dB. The zero of the scale, 0 dB, corresponds to the notional threshold of hearing, 0.00002 Pa, and the upper limit, 140 dB, corresponds to 20 Pa, which would cause immediate damage to the ear.

Equivalent continuous sound level ($L_{Aeq,T}$), also called the Average noise level.

The $L_{Aeq,T}$ represents a measure of the 'average' sound level over the measurement period. It corresponds to the steady continuous level of sound which, over the same period of time, T, would contain the same amount of (A-weighted) sound energy as the time varying noise.

This is the most common method of measuring time varying noise, and within certain limits gives the best correlation with human response to noise, for example with annoyance.

Frequency

The frequency of a musical note is what gives it its pitch. It is the number of cycles of the fluctuating sound pressure which occur each second, and is measured in cycles per second, Hertz (Hz). The human ear can detect frequencies in the range 20 to 20000 Hz.

Most noises are a mixture of all frequencies, called broad-band noise.

$L_{AS90,T}$

This is the most commonly used of many possible statistical measures of a time varying noise. It is the 90th percentile of the statistical noise level distribution, or, more simply, the noise level that is exceeded for 90% of the measurement time (T). Thus over one hour for example it represents the noise level which is exceeded for all but (the quietest) six minutes of that hour.

It is commonly used as a measure of the background noise in any given situation, against which the level of any new, potentially intrusive source of noise is often compared. Background noise itself often varies with time and so the $L_{A90,T}$ is almost universally used as the best measure of the 'more or less always present' noise level which underlies short term variations from other sources of noise.

Maximum sound pressure level ($L_{ASmax,T}$)

This is the highest value of the time weighted sound pressure level, (measured using the A frequency weighting and the Slow time weighting) which occurred during the measurement period, T. It is commonly used to measure the effect of very short duration bursts of noise, such as for example sudden bangs, shouts, car horns, emergency sirens etc. which audibly stand out from the general level of, say, traffic noise, but because of their very short duration, maybe only a very small fraction of a second, may not have any effect on the $L_{Aeq,T}$ value.

In the context of this report the L_{ASmax} value for each aircraft noise event is monitored

Noise

Unwanted sound

Octave band spectra

In order investigate the frequency content of broad band sounds, called its frequency spectrum, measurements of sound pressure are carried out over a range of frequency bands. The most common method is to split the audio frequency range into 8 or 9 octave bands. An octave is a frequency range from one particular frequency to double that frequency.

Octave band measurements are not referred to in this report.

Percentile noise level, (L_{ASN}, where N is a number between 0 and100)

The noise level which is exceeded for N% of the measurement period. For example, a value of $L_{A10,1hour}$ of 57 dBA means that in that hour the noise level was at or above 57 dBA for 6 minutes (i.e.10% of an hour), or alternatively, was at or below 57 dBA for 54 minutes.

Sound exposure level (SEL)

This is a measure of the A-weighted sound energy used to describe single noise events such as the passing of a train or aircraft; it is the A-weighted sound pressure level which, if occurring over a period of one second, would contain the same amount of A-weighted sound energy as the event.

SEL values for events may be used to calculate the average noise level over a period of time (hour, day or month)

Sound pressure

sound is a disturbance or fluctuation in air pressure, and sound pressure, measured in Pascals (Pa), is used as a measure of the magnitude of the sound. The human ear can detect sound pressures in the range from 0.00002 Pa to 20 Pa. This is an enormously wide range and so for convenience sound pressures are commonly measured on a decibel (dB) scale.

Time varying noise

When the level of noise varies with time, as is often the case, for example with noise from road traffic, various measures or noise indices as they are called are used to give a single figure description of the noise over a given period of time. The three most commonly used noise indices are the $L_{Aeq,T}$ the $L_{A90,T}$ and the $L_{Amax,T}$ values.

In all three cases the 'L' stands for the level of the sound in decibels, the 'A' for the fact that it is the A- weighted value, and the 'T' for the time period over which the noise is measured, for example 5min, 1 hour, 24 hour etc.

Time weighting (Fast (F) and Slow (S))

An exponential function of time, of a specified time constant, that weights the square of the instantaneous sound pressure. (Defined in BS EN 61672 – 1:2003).

There are two time constants defined in BS EN 61672 – 1:2003, designated Fast (F) and Slow (S), and noise indices such as the maximum, or percentile noise levels which are based on instantaneous time-weighted sound pressure should indicate which time weighting has been used in the measurement.

In this report, in line with standard practice for aircraft noise measurement, it is the Slow (S) time weighting that has been used, hence reference is made to L_{ASmax} and to L_{AS90}.

APPENDIX 4

LIST OF AIRCRAFT IDENTIFICATION SOURCE CODES

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THE CAUSEWAY
STAINES
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TW18 3AL

TELEPHONE: 01784 464404
FACSIMILE: 01784 465447

List of Aircraft Identification Codes

100	Fokker 100
142	BAe 146-200
143	BAe 146-300
14Y	BAe 146-200 Freighter
14Z	BAe 146-300 Freighter
313	Airbus A310-300
318	Airbus A318
319	Airbus A319
320	Airbus A320
321	Airbus A321
332	Airbus A330-200
342	Airbus A340-200
343	Airbus A340-300
346	Airbus A340-600
721	Boeing 727-100
722	Boeing 727-200
732	Boeing 737-200
733	Boeing 737-300
734	Boeing 737-400
735	Boeing 737-500
736	Boeing 737-600
738	Boeing 737-800
73G	Boeing 737-700
73H	Boeing 737-800 (winglets)
73W	Boeing 737-700 (winglets)
73Y	Boeing 737-300 Freighter
744	Boeing 747-400
74E	Boeing 747-400 Freighter
74L	Boeing 747SP
74X	Boeing 747-200 Freighter
74Y	Boeing 747-400 Freighter
752	Boeing 757-200
75F	Boeing 757-200 Freighter
762	Boeing 767-200
763	Boeing 767-300
76X	Boeing 767-200 Freighter
76Y	Boeing 767-300 Freighter
AB6	Airbus A300-600
ABX	Airbus A300 Freighter
ABY	Airbus A300-600 Freighter
ANF	Antonov AN-12 Freighter
AR1	Avro RJ-100
AR8	Avro RJ-85
AT4	ATR-42
AT7	ATR-72
ATP	BAe ATP
BE2	Beech B200
C56	Cessna Citation 560 CGX = CCX = Global Express
CCJ	Bombardier Challenger
CCX	Bombardier Global Express
CGX	An old code no longer in use – should be CCX which is a Bombardier Global Express

CJ5	Cessna Citation Jet CL6 = Global Express Challenger 600 DF7 = Dassault Falcon 7x
CNJ	Cessna Citation
CR2	Bombardier CRJ-200
CR7	Canadair regional jet 700
CR9	Bombardier CRJ-900
D38	Dornier 328
DF2	Dassault Falcon (this covers various types) 76X= Boeing 767-200 Freighter 73C= Boeing 737-300 (winglets) G54= GS4 = Gulfstream IV = Gulfstream 4
DF3	Dassault Falcon 50/900
DH4	Dehavilland Dash 8-Q400
E90	Embraer 190
EM2	Embraer Brasillia
ER3	Embraer RJ-135
F50	Fokker 50
FRJ	Dornier 328 Jet
G52	GS2 = Gulfstream 2
G55	GS5 = Gulfstream 5
GRJ	Gulfstream II/III/IV/V
H25	Hawker HS-125
J31	BAe Jetstream 31
JET	Generic code used for small jet aircraft without a specific IATA code
LRJ	Bombardier Learjet 23/24/25/31/35/40/45/55/60
M1F	Boeing (McDonnell Douglas) MD11 Freighter
M82	Boeing (McDonnell Douglas) MD82
M83	Boeing (McDonnell Douglas) MD83
M87	Boeing (McDonnell Douglas) MD87
M90	Boeing (McDonnell Douglas) MD90
PA2	Piper
PAT	Piper, Twin Propeller
S20	Saab 2000
TU5	Tupolev TU-154
YK2	Yak 42