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REPORT OF

NOISE MONITORING AT HEVER CASTLE

APRIL 2013 TO JUNE 2014

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REPORT OF NOISE MONITORING AT HEVER CASTLE, APRIL 2013 TO JUNE 2014

1.0 Introduction

A mobile Noise Monitoring Terminal (NMT) has been deployed at Hever Castle in Kent by Gatwick Airport Ltd since 1st April 2013. The noise monitoring programme is ongoing but this report presents a summary of the results of continuous noise monitoring for the period from 1 April 2013 to 30 June 2014, which covers a complete seasonal cycle of aircraft movements.

The site is approximately 21 km east of the airport. The NMT is situated within the grounds of Hever Castle on open ground on a hillside overlooking a minor road a few hundred meters away with a belt of trees above also a few hundred meters away. Apart from noise from aircraft and occasional helicopters other noise arises from wind in the trees, from occasional traffic using the road, from birdsong and from activity taking place within the Castle grounds and surrounding area, for example from people (voices), motorised lawnmowers, chain saws and other machinery, equipment and activities.

2.0 The noise data from the noise monitoring terminal

The Noise Monitoring Terminal (NMT) gathers data about the number and level of aircraft noise events. Aircraft noise events are bursts of noise which activate the trigger condition, discussed below, and which also correlate with radar tracks from the airport's noise and track keeping system. In addition the NMT also gathers 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.

The monitor trigger condition was set to operate with a threshold trigger level of 55 dBA to be exceeded for 10 seconds.

Figures 1 and 2 show typical aircraft tracks for both easterly and westerly take-offs from Gatwick, also showing the location of the NMT at Hever Castle. It can be seen that from Figure 1 that when aircraft are taking off from Gatwick to the west, the prevailing condition, the monitor is overflown by aircraft arriving from the east, and also by aircraft which, having taken off to the west have followed a flight path with bends around and fly over the NMT site heading eastwards. Figure 2 shows that when aircraft are taking off to the east the NMT is overflown by departing aircraft but not by arrivals.

Further information about the NMT is given in Appendix 1, and a Glossary of acoustical terms is given in Appendix 2.

3.0 Analysis of noise monitor survey results

The results are discussed in the following sequence: the number of aircraft noise events recorded by the NMT; maximum noise levels of aircraft noise events; the noise climate at the site, including aircraft noise, total noise and residual noise; putting the noise climate into context; and the contribution of different types of aircraft to the aircraft noise level at the site.

The results of the data gathered during the survey are displayed in Figures 3 to 7 below and are also summarised in the Table in section 6 of this report.

3.1 The number of aircraft noise events

A total of approximately 116,000 aircraft noise events were recorded at the noise monitor during the monitoring period from 1 April 2013 to 30 June 2014. Examination of these data indicated a small but significant number (about 5.5%) of these events had durations much greater than could be expected from an aircraft noise event. It is considered that the most likely explanation is that these are noise events triggered by noise from wind in the nearby trees which coincide with an aircraft event and which continue long after the aircraft has moved away.

It was decided to remove these ‘long duration‘ events from the data base to be used for subsequent analysis, using a criterion that events with a duration of more than 60 seconds should be removed.

This left a data base of about 109,000 aircraft noise events, over the 15 month period, which are the subject of the analysis presented in this report. In a previous survey at a nearby site in Hever, carried out over a 12 month period, between February 2011 and January 2012 the number of aircraft noise events recorded was about 63,000. The primary reason for the significantly higher number of aircraft events recorded at this monitor, compared to the previous site at Hever is considered to be due to a pronounced increase in overall traffic numbers between the periods of the two surveys:. there has been an increase in traffic of about 15% between 2011/12 and 2013/14.

The average number events per day for each month shown in Figure 3. Most of the recorded events (85%) were due to aircraft arrivals, 12% were due to departing aircraft and about 3% were due to overflights.

The variation in the number of events recorded from month to month, as shown in Figure 3, is in part determined by wind direction, which determines take off direction. The west / east split in runway usage during the period is shown in the Table below:

Month	% westerly	% easterly
April 2013	58	42
May 2013	73	27
June 2013	61	39
July 2013	51	49
August 2013	76	24
September 2013	69	31
October 2013	75	25
November 2013	91	9
December 2013	63	37
January 2014	85	15
February 2014	89	11
March 2014	61	39
April 2014	56	44
May 2014	60	40
June 2014	51	49

The number of aircraft noise events varies, hour by hour, throughout each day. Figure 4 shows this variation. It can be seen that, on average over the twelve month period the highest numbers of aircraft noise events per hour recorded at the site occur in the daytime between 07.00 and 23.00 hours (local time).

3.2 Maximum noise levels and durations of aircraft noise levels

The maximum noise level, L_{ASmax}, produced by each aircraft noise event ranged between 55 dBA and 89 dBA, but with more than 95% of events having a maximum value of less than 69 dBA. The arithmetic average of all of these values over the 15 month period was 64 dBA, with a standard deviation of 3.6 dBA.

The average maximum noise level was higher for arrival events (64 dBA) than for either departures (60 dBA) or overflights (61 dBA), both of which generally overflew the site at higher altitudes than the arriving aircraft.

The duration of these aircraft noise events ranged between 10 and 60 seconds, but with an average duration of 36 seconds. The average level of aircraft noise during the events was 60 dBA.

3.3 The total noise climate at the site

Figure 5 shows the month by month average daytime noise levels of aircraft noise. This is the notional level of aircraft noise which would occur if the all the intermittent bursts of aircraft noise were averaged to give a continuous steady level of noise. 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, and is the internationally accepted method for comparing environmental noise.

Also shown in Figure 5 are the average monthly levels of total noise and residual noise at the site, and the average monthly values of maximum noise levels of aircraft noise events, and of background noise (L_{AS90} values). Figure 6 shows similar data for night-time

Figures 5 and 6 show that the average level of aircraft noise level (L_{Aeq}) varied between 49 to 55 dBA in the daytime, and between 44 dBA and 52 dBA at night. The level of the total noise at the site was generally between 1 and 3 dB higher than the level of aircraft noise, except during the period from December 2013 to February 2014 when the differences at night were much higher

The level of residual noise, which, as explained in Appendix 1 is deduced from the level of total noise and aircraft noise was generally lower than the levels of aircraft noise except for a few months at night time.

The daytime background noise level (L_{AS90}) varied throughout the 15 month period between 33 and 42 dBA in the daytime (average 37 dBA), and between 27 to 34 dBA at night (average 28 dBA).

The average of maximum aircraft noise levels was similar during the daytime and at night, within the range 63 dBA to 66 dBA (average 64 dBA).

Figures 5 and 6 demonstrate that the noise from aircraft noise events at this site, when cumulatively averaged over an extended period of time (of hours, days or months) makes the major contribution to the total noise at this site, but that noise from other sources, i.e. the residual noise, also makes a significant contribution.

Also 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 noise over the ambient noise level during each event.

Figure 7 shows the variation of average levels of aircraft noise, residual noise, background noise and total noise at the site with hour of day. It can be seen that the aircraft noise levels do not vary much during the daytime period (06.00 to 20.00 hours) but fall during the late evening and night-time, rising again in the early morning. Also shown in Figure 7 is the average of maximum aircraft noise levels, which does not vary significantly with hour of day.

The average levels (rounded to the nearest dB) over the 15 month period for various parts of the 24 hour day are shown below:

	Total noise $L_{Aeq,T}$	Aircraft noise $L_{Aeq,T}$	Residual noise $L_{Aeq,T}$	Background noise level (L_{AS90})
Day (16h) (07.00 - 23.00 h)	55	53	52	38
Night (8h) (23.00 - 07.00 h)	54	47	53	30
Day (12 h)* (07.00 - 19.00 h)	55	55	51	40
Evening (4 h)* (19.00 - 23.00 h)	56	53	54	32
24 hours	55	52	52	35

* The 12 hour day and 4 hour evening periods have been defined as part of the day evening night noise index, L_{den}, used for noise mapping purposes (and described later in this report).

<u>High levels of total noise at night-time</u>.

It can be seen from Figure 7 that the average hourly values of the total noise at the site taken over the 15 month period remained surprisingly high during the night-time and early morning hours. It is thought that this is because of the effects of high levels of noise from night-time wind in the nearby trees during the winter months. Support for this explanation is given by an analysis of the hourly average level of total noise broken down into three monthly periods, as shown in Figure 8. It can be seen that average hourly noise levels of total noise were much higher for the two Winter periods from October to December 2013 and from January to March 201 corresponded to a particularly stormy period, than they were for the other Spring, Summer and Autumn quarters.

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

4.1 <u>Aircraft noise contours</u>

The site at Hever lies well outside (approximately 7 nm or 13 km beyond) the lowest noise prediction contour (57 dBA LAeq16h) the shape of which is published by the Civil Aviation Authority on behalf of the Department of Transport (ERCD Report 1402, Noise Exposure Contours for Gatwick Airport 2013). The Hever site and 57 dBA LAeq 16hr contour location are consistent with the 12 month average LAeq16hour value of 53 dBA for this site, when calculated from data for the period from April 2013 to March 2014. Strictly speaking, because each set of values is based on averages over different time periods and, probably, different modal splits and different mixes of aircraft types, the values obtained from this survey are not directly comparable with the CAA noise contours.

The 57 dBA contour is the lowest contour to be published because in the view of the UK government it denotes the approximate onset of significant daytime community annoyance. The relationship between noise and annoyance is of course not an exact one, and varies according to situation and locations.

In 2011 aircraft noise contours of day evening night level (Lden) were published for Gatwick Airport (ERCD Report 1205, Strategic Noise Maps for Gatwick Airport 2011). The site at Hever lies just outside the lowest contour of 55 dB Lden. As explained previously any comparison between an estimate of Lden based on the noise measurements in this report with the Strategic noise mapping contours should recognise that the two sets of values are based on averages over different time periods, and therefore different numbers of aircraft noise events and, probably, different modal splits and different mixes of aircraft types. Then Lden value calculated from aircraft noise measurements at this site over the twelve month period from April 2013 to March 2014 has been estimated as 56 d BA.

4.2 The National Noise Incidence survey

National Noise Incidence studies of noise levels in England and Wales were carried out in 1990 and again in 2000 by the Building Research Establishment for Defra. A comparison of the data from the first two studies indicated that although there were some changes, much about the noise climate in England and Wales had not changed significantly over the 10 year period. Therefore the 2000 study remains a good basis for setting the noise levels from this study at Hever Castle into a wider context. The results of the 2000 study, published in 2001, gave a breakdown of the proportion of UK 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 Hever Castle are also free field values.

Since the 16 hour L_{Aeq} value of total noise for this site is 53 dBA this puts the site in the 50 to 55 dBA noise exposure band, occupied by 37 % of dwellings in the UK.

4.3 World Health Organisation Guidance on Community Noise

In 2000 the World Health Organisation issued 'Guidelines for Community Noise' 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."

The daytime total noise exposure level during the 12 month monitoring period at this site (53 dB $L_{Aeq,16hour}$) is below the WHO Guidelines of 55 dBA for the daytime, but the night-time total noise exposure level (47 dB $L_{Aeq,8hour}$) is above the night-time WHO Guideline value of 45 dBA.

5.0 Aircraft types contributing to the aircraft noise level at the site

5.1 Approximately one hundred and seven different aircraft types contributed to the total number of 38,000 aircraft noise events which occurred during the monitoring period, but most of the events arose from a relatively small number of aircraft types, with four types being responsible for 87% of all aircraft noise events at the site:

- Airbus Industrie A319: 33%
- Airbus Industrie A320: 18%
- Boeing 737 - 800: 14%
- Boeing 737 - 400: 10%

5.2 The Table below lists the 20 aircraft types responsible for more than 97% of all of the aircraft noise events which occurred during the period, showing the number and the % number of events and the average L_{ASmax} value for each aircraft type, presented in order, with the most frequent type at the top of the list.

List of 20 most frequent aircraft types in order of event numbers:

Aircraft Type	Type	Events	% Events	Avg L_{ASmax}
Airbus Industrie A319	A319	36340	33.1	65
Airbus Industrie A320	A320	19952	18.2	65
Boeing 737-800	B738	15108	13.8	62
Boeing 737-400	B734	10637	9.7	64
Airbus Industrie A321	A321	4133	3.8	64
Boeing 757-200	B752	3762	3.4	60
Boeing 777-200	B772	2804	2.6	62
De Havilland DHC8-400	DH8D	2291	2.1	59
Embraer 175	E170	1795	1.6	61
Airbus Industrie A330-200	A332	1364	1.2	65
Embraer 190	E190	1345	1.2	63
Boeing 747-400	B744	1240	1.1	66
Boeing 777-300	B77W	1149	1.0	63
ATR 72	AT72	1113	1.0	60
Boeing 767-300	B763	982	0.9	63
Boeing 737-300	B733	600	0.5	64
Airbus Industrie A330-300	A333	565	0.5	66
Boeing 787-800 Dreamliner	B788	562	0.5	62
Boeing 757-300	B753	466	0.4	60
Boeing 737-500	B735	389	0.4	64

5.3 The table below shows the same 20 most frequent aircraft types but rearranged in order of decreasing average maximum aircraft noise event level.

Aircraft Type	Type	Events	Avg L_{ASmax}
Boeing 747-400	B744	1240	66
Airbus Industrie A330-300	A333	565	66
Airbus Industrie A330-200	A332	1364	65
Airbus Industrie A320	A320	19952	65
Airbus Industrie A319	A319	36340	65
Boeing 737-500	B735	389	64
Boeing 737-300	B733	600	64
Boeing 737-400	B734	10637	64
Airbus Industrie A321	A321	4133	64
Boeing 767-300	B763	982	63
Embraer 190	E190	1345	63
Boeing 777-300	B77W	1149	63
Boeing 777-200	B772	2804	62
Boeing 737-800	B738	15108	62
Boeing 787-800 Dreamliner	B788	562	62
Embraer 175	E170	1795	61
ATR 72	AT72	1113	60
Boeing 757-300	B753	466	60
Boeing 757-200	B752	3762	60
De Havilland DHC8-400	DH8D	2291	59

The average values of L_{ASmax} displayed in the Tables are for all aircraft noise events for each type of aircraft, i.e. including the relatively small number of departure and overflight events, as well as the predominant number of arrival events. The average values of L_{ASmax} for arrival events only will be slightly higher than the average for all events, for example by 1.2 dB for the Boeing 747-400 aircraft, and by 0.4 dB for the twenty aircraft types shown in the Tables.

5.4 Finally the Table below shows the aircraft types which produce the highest average L_{ASmax} noise levels. It can be seen that for most of these the number of aircraft noise events is very small, and several of them are overflights by helicopters and light aircraft.

List of noisiest (highest average L_{Asmax} value) aircraft types:

Aircraft Type	Type	Events	Avg L_{ASmax}
Boeing 727-200	B722	2	74
Cessna 310 (Light aircraft) Non-GAL	C310	1	72
Belkl 429 (Helicopter) Non-GAL	B429	1	72
Sikorsky S61 (Helicopter) Non-GAL	S61R	1	69
Gazelle (Helicopter)	GAZL	1	68
Antonov AN26	AN26	1	68
Airbus A300	A30B	1	68
Boeing 767-200	B762	3	67
Mc Donnel Douglas KC10 (Military)	KC10	1	67
Eurocopter EC55 (Helicopter) Non-GAL	EC55	22	67
Cessna 182 (Light aircraft) Non-GAL	C182	3	67
Cessna 404 (Light aircraft) Non-GAL	C404	4	67
Chinook (Military)	H47	1	67
McDonnell Douglas MD-82	MD82	4	67
McDonnell Douglas MD-83	MD83	47	67
Airbus Industrie A300-600	A306	291	66
Boeing 747-400	B744	1240	66
Pilatus PC-31 (Light aircraft) Non-GAL	PA31	6	66
Aerospatiale AS65 (Helicopter) Non-GAL	AS65	22	66
Airbus Industrie A330-300	A333	565	66

5.4 There are only two aircraft types, the Boeing 747-400 and the Airbus Industrie A300 - 300, which appears in all three lists, with 1240 and 565 events respectively, and an average L_{ASmax} value of 66 dB. From these three tables it can be seen that, apart from these two aircraft types, the average maximum noise level (L_{ASmax}) of aircraft noise events did not vary significantly with aircraft type for the relatively few aircraft types which make up most of the aircraft noise events, and that although there are some aircraft types which produce significantly higher values of L_{ASmax} there are only very small numbers of these types of events.

6.0 Summary and Conclusions

This report presents the results of noise monitoring at a site in Hever Castle, West Sussex, between 1 April 2013 and 30 June 2014.

The following aspects of the noise data have been presented and described: the number of aircraft noise events recorded by the noise monitor; the maximum noise levels of these aircraft noise events; the noise climate at the site, including average levels of aircraft noise, total and residual noise at the site; and the contribution of different types of aircraft to the aircraft noise level at the site.

The variation noise climate parameters (including aircraft noise levels) from hour to hour, between day to night, and from month to month have been described.

The results show that the aircraft noise at the site arises mainly from aircraft arriving from the east.

The noise climate at the site has been placed into context by comparisons with the results of the 2000 National Noise Incidence Study, and with World Health Organisation Guidelines for Community Noise.

A summary of the main noise related parameters (15 month average for the period from 1 April 2013 to 30 June 2014) for the site at Hever Castle are shown in the Table below:

Survey period	1 April 2013 to 30 June 2014
Aircraft noise event trigger level	55 dBA for 10 seconds
Length of noise monitoring period	15 months
Number of aircraft noise events	109,800 (after removal of suspected wind-noise contaminated data)
% Arrivals and Departures	85% Arrivals, 12 % Departures, (3% overflights)
% DAY and NIGHT	89% Day, 11% Night
Average maximum noise level of events	64 dBA
Average noise level and duration of aircraft noise events	60 dBA, 36 seconds
Average total noise level	55 dBA (Day); 54 dBA (Night)
Average aircraft noise level	53 dBA (Day); 47 dBA (Night)
Average residual noise level	52 dBA (Day); 53 dBA (Night)
Background noise (L_{AS90})	38 dBA (Day); 30 dBA (Night)
Daytime level (12 hours)	55 dBA (Total noise); 55 dBA (aircraft noise)
Evening level (4 hours)	56 dBA (Total noise); 53 dBA (aircraft noise)
Day-evening- night level	61 dBA (Total noise); 56 dBA (aircraft noise)

Figure 1: Flight paths for a typical day of departures to the west (Arrivals are shown in red and Departures in green). The vertical blue bar shows the location of the noise monitor at Hever Castle.

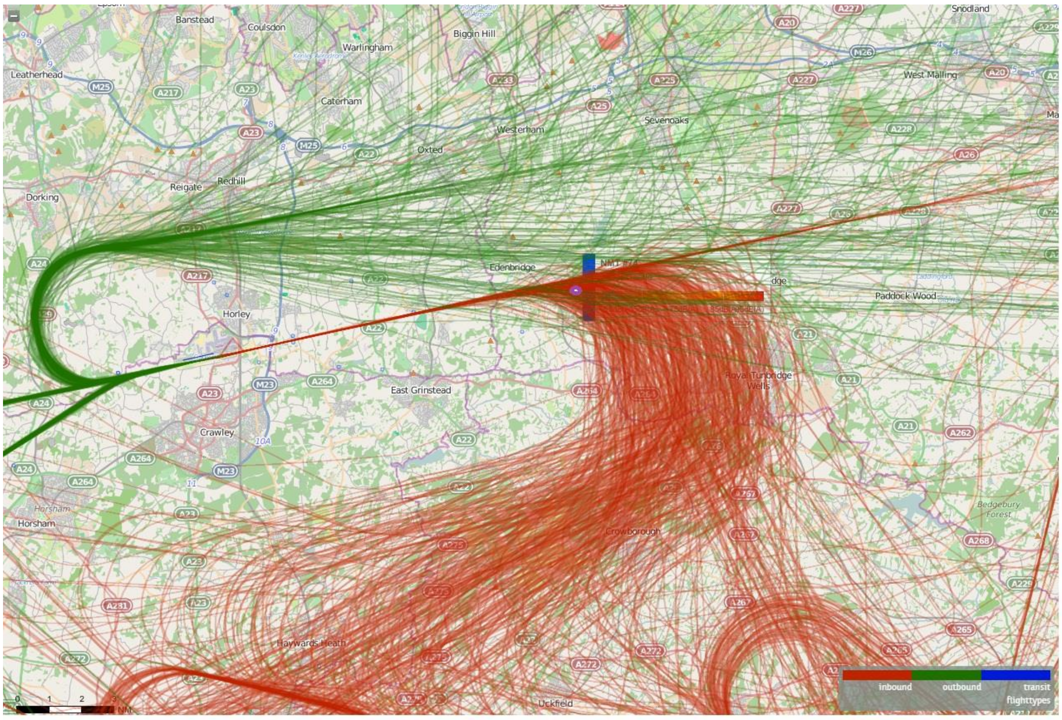


Figure 2: Flight paths for a typical day of departures to the east (Arrivals are shown in red and Departures in green). The vertical blue bar shows the location of the noise monitor at Hever Castle.

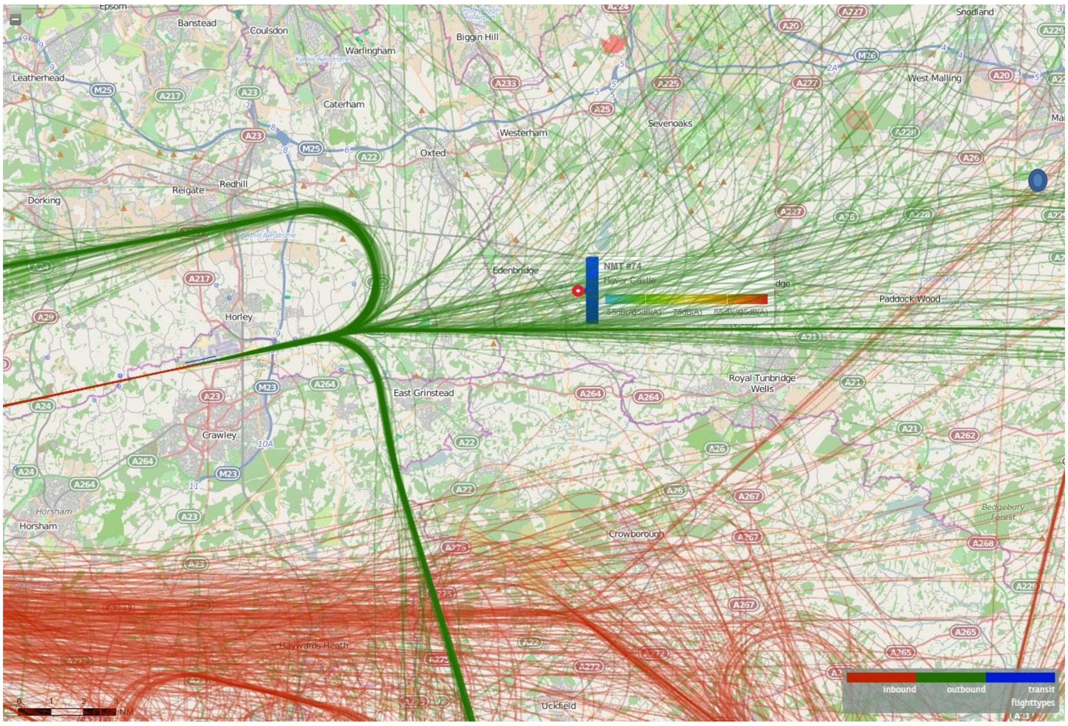


Figure 3: Average number of aircraft noise events per day at Hever Castle from April 2013 to June 2014

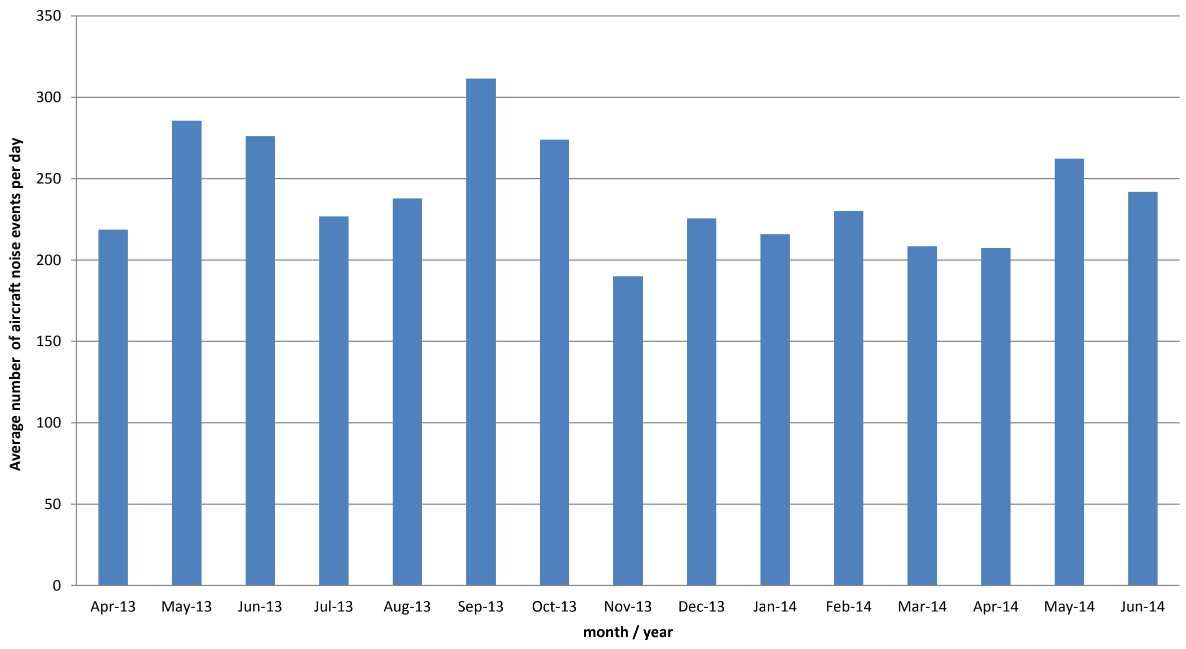
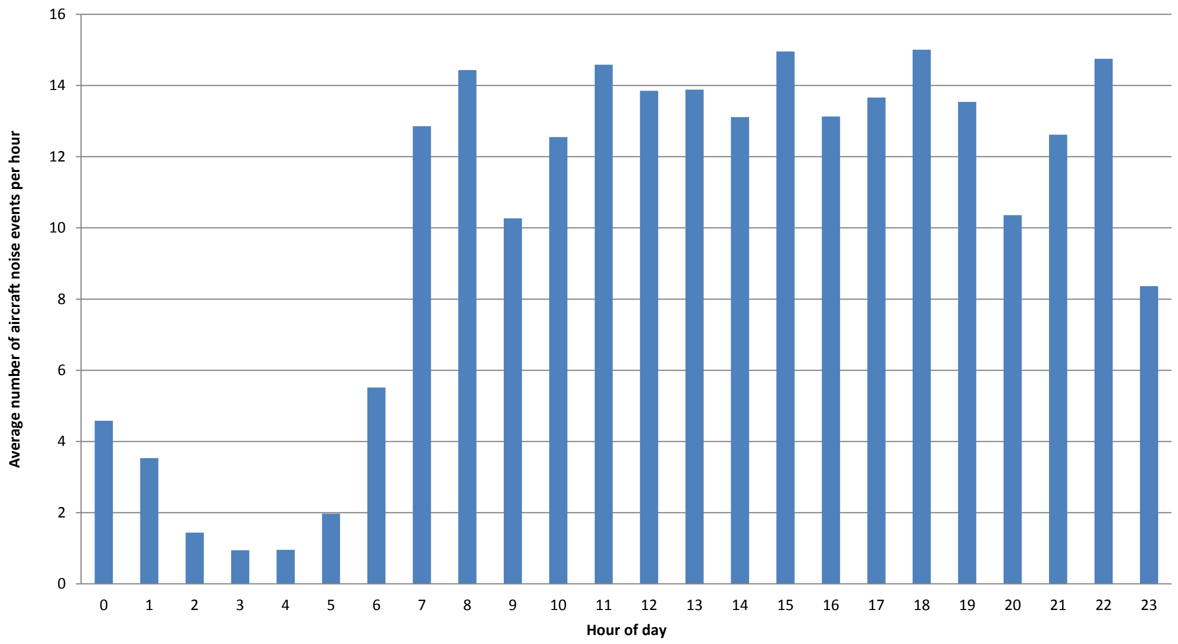


Figure 4: Average number of aircraft noise events per hour at Hever Castle from April 2013 to June 2014



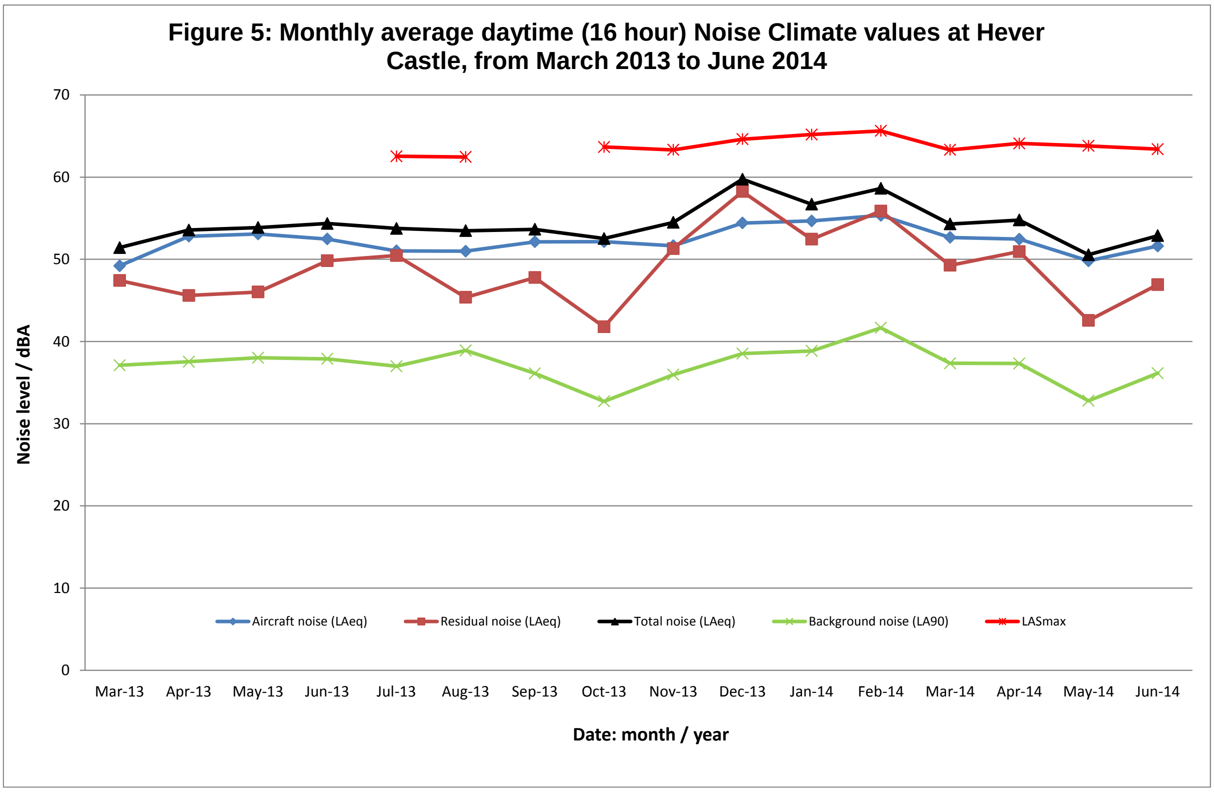


Figure 5: Monthly average daytime (16 hour) Noise Climate values at Hever Castle, from March 2013 to June 2014
Noise level / dBA
0
10
20
30
40
50
60
70
Mar-13
Apr-13
May-13
Jun-13
Jul-13
Aug-13
Sep-13
Oct-13
Nov-13
Dec-13
Jan-14
Feb-14
Mar-14
Apr-14
May-14
Jun-14
Date: month / year
Aircraft noise (LAeq)
Residual noise (LAeq)
Total noise (LAeq)
Background noise (LA90)
LASmax

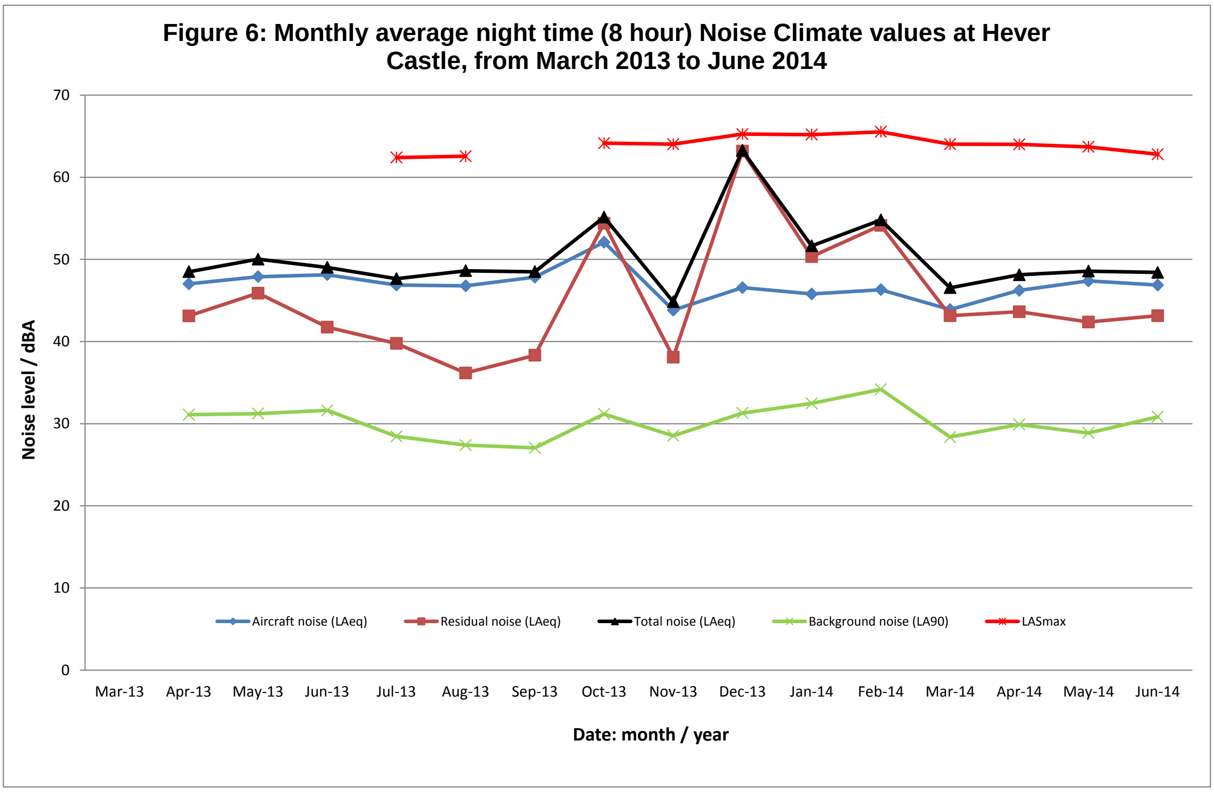


Figure 6: Monthly average night time (8 hour) Noise Climate values at Hever Castle, from March 2013 to June 2014
Noise level / dBA
0
10
20
30
40
50
60
70
Mar-13
Apr-13
May-13
Jun-13
Jul-13
Aug-13
Sep-13
Oct-13
Nov-13
Dec-13
Jan-14
Feb-14
Mar-14
Apr-14
May-14
Jun-14
Date: month / year
Aircraft noise (LAeq)
Residual noise (LAeq)
Total noise (LAeq)
Background noise (LA90)
LASmax

Figure 7: Variation in noise climate parameters with hour of day at Hever Castle from April 2013 to June 2014

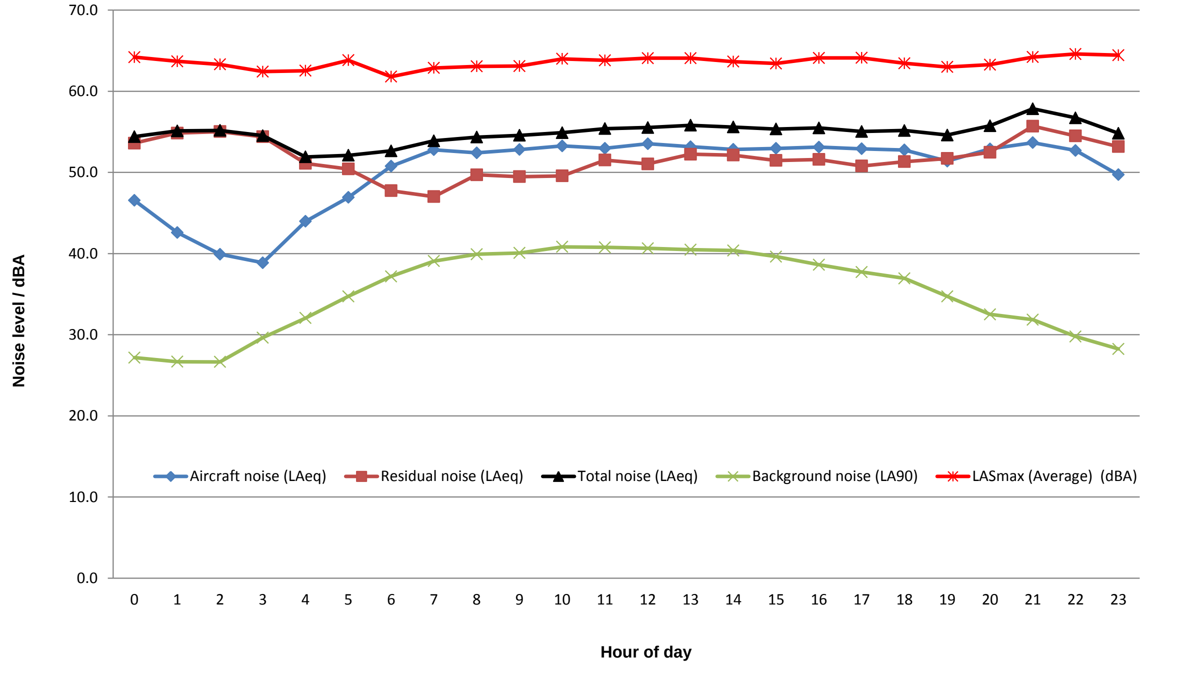
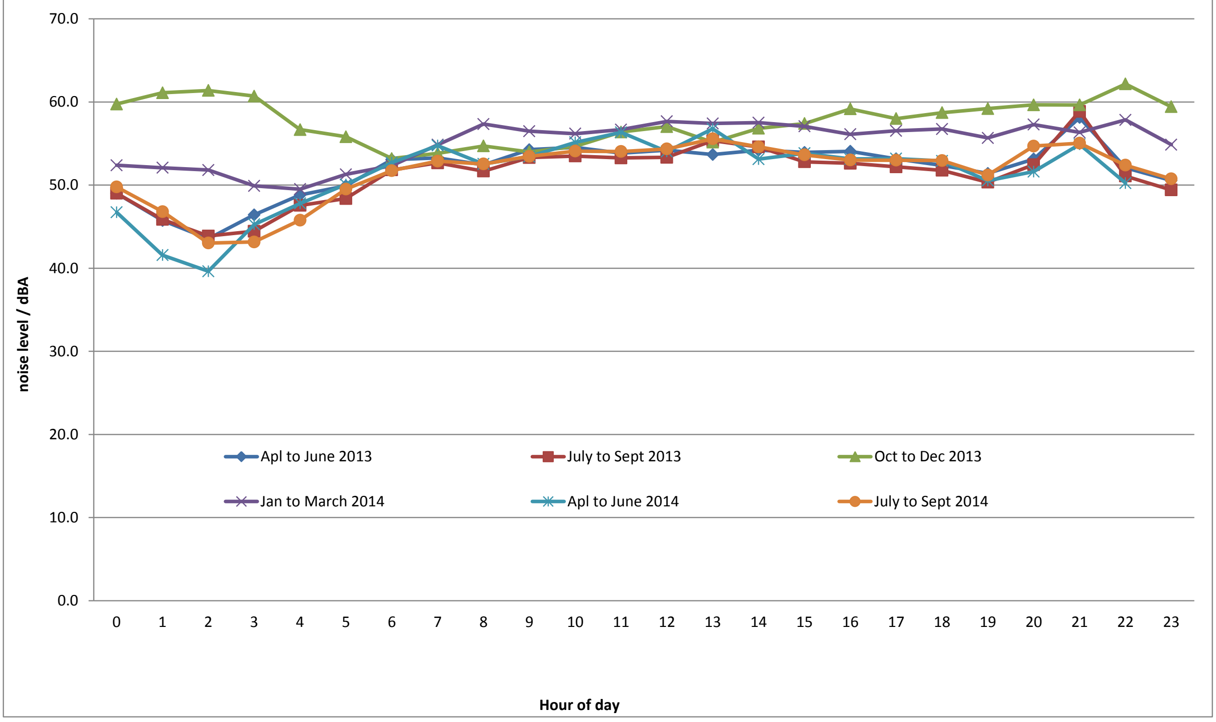


Figure 8: Average level (LAeq) of Total Noise at Hever Castle by hour of day, for three monthly periods, from April 2013 to Sept 2014



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APPENDIX 1

DATA FROM THE NOISE MONITORING TERMINAL

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Appendix 1

Data from the Noise Monitoring Terminal

The NMT records all noise regardless of its source. 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 55 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 Gatwick Airport will occasionally cause noise events to be captured.

To determine which of all those events are due to aircraft using Gatwick Airport their 'noise to track' matching software compares all captured noise events with Gatwick 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 55 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 Gatwick 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 55 dBA for a duration of at least 10 seconds was used.

The following information is recorded for each noise event: date, time, duration, maximum noise level (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.

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, and is an internationally agreed parameter for the measurement of environmental noise, including aircraft noise.

Residual noise levels

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.

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. This could also include some noise from aircraft arriving at, or departing from Gatwick, as well as from overflights, which was below the trigger level.

Some short duration (two hours) sample direct measurements of residual noise at this site were recorded on 16 and 22 July 2013. The results showed that when the site was being overflown by aircraft arriving from the east, noise from some aircraft departing to the west but then following a flight path over the site to the east did not trigger the noise monitor and so would be recorded as residual noise. It was estimated that this could cause the residual noise levels in some cases to be overestimated up to 2 dB.

AAD
applied acoustic design

APPENDIX 2

GLOSSARY OF ACOUSTIC TERMS

THE GREEN BUSINESS CENTRE
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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 contours

Two types of aircraft noise contours have been produced; those based on the average daytime aircraft noise levels ($L_{Aeq16hour}$), and those based on the L_{den} parameter, introduced for noise mapping purposes

$L_{Aeq16hour}$ aircraft noise contours have been produced annually and displayed on the Defra website for many years (approximately since 1990, when they replaced NNI contours) for various UK airports, including Heathrow, Gatwick and Edinburgh. The latest contours which are available are for the year 2010.

L_{den} contours

The 24 hour day-evening-night noise index (L_{den}) has been introduced by the EU for noise mapping purposes. This index is based on average levels of aircraft noise (L_{Aeq} 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).

All UK airports have been required to produce Action Plans based on Lden aircraft noise contours as part of the Noise mapping exercise. Accordingly contours of L_{den} were 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. L_{night} ($L_{Aeq,8hour}$), L_{day} and $L_{evening}$ contours were also produced as part of this exercise.

The $L_{Aeq16hour}$ 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). They are produced in 3 dB steps from 57 dBA to 72 dBA. The 2006 L_{den} 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).

Aircraft Noise events — Noise events which have been matched by the airport's noise and track keeping system to radar tracks in the vicinity of the NMT from aircraft arriving at or departing from Gatwick airport.

Aircraft noise level — The average noise level derived from aircraft noise events, aggregated into hourly, daily or monthly average (LAeq) values.

ANOMS/ Casper BV — Airport Noise and Operations Monitoring System. The software data analysis system (incorporating the NTK system) which was in use at the airport until March 2013. The ANOMS system has been replaced by the Casper BV noise and track keeping system, which came into operation on 1 April 2013.

Applied Acoustic Design (AAD)

Acoustic consultants retained by Gatwick Airport Ltd.

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 Performance Team

The unit within Gatwick Airport 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.

Instrument Landing System (ILS)

An instrument landing system (ILS) is a ground-based instrument approach system that provides precision guidance to an aircraft approaching and landing on a runway, using a combination of radio signals and, in many cases, high-intensity lighting arrays to enable a safe landing during instrument meteorological conditions, such as low ceilings or reduced visibility due to fog, rain, or blowing snow. The standard glide-slope path is 3° downhill to the approach-end of the runway.

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, and extended to the whole of the UK in 2001, giving proportions of the population exposed to various levels of environmental noise.

A second National Noise Incidence study was carried out in 2000. A comparison of the data from the two studies indicated that although there were some changes, much about the noise climate in England and Wales had not changed significantly over the 10 year period. Therefore the 2000 study remains a good basis for setting the noise levels from this study at Leigh into a wider context.

National Planning Policy Framework

On 27th March 2012 the National Planning Policy Framework replaced all previous planning guidance including PPG24 (see below). However Local Authorities which have an adopted Core Strategy, which refers to PPG24, have 12 months to incorporate guidance on transport noise into their Core Strategy and during those 12 months it is generally considered that PPG24 can still be relied upon as the main guidance for transport related noise issues.

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 54 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.

On 27th March 2012 the National Planning Policy Framework (see above) replaced all previous planning guidance including PPG24..

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 Gatwick 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 maybe 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 (WHO)

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.

Although it is more usual to measure LA90 using the F weighting, the Slow weighting has been used for the data in this report, i.e. LAS90. It is not considered that the use of the S weighting will make any significant difference to the LA90 values in this case. (See under Time Weighting, Fast(F) and Slow(S)) below.

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 and community noise event is monitored

In this report, in line with standard practice for aircraft noise measurement, the Slow (S) time weighting has been used for measurement of maximum levels of aircraft noise, hence reference is made to L_{ASmax}. (See under Time Weighting, Fast(F) and Slow(S)) below.

Noise — Unwanted sound

Octave band spectra — In order to 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, the Slow (S) time weighting has been used for measurement of maximum levels of aircraft noise, hence reference is made to L_{ASmax}. Because the sound level meter cannot measure using both Fast and Slow weightings simultaneously this necessarily means that the 90th percentile values have also been measured using the S weighting, hence reference is made to L_{AS90}. Although it is more usual to measure L_{A90} using the F weighting, it is not considered that the use of the S weighting will make any significant difference to the L_{A90} values in this case.