Date: 31 January 2018

AAD
applied acoustic design

DRAFT REPORT OF

NOISE MONITORING AT EAST GRINSTEAD

JULY 2016 TO JUNE 2017

Client: Gatwick Airport Limited

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CONTENTS

1.0 Introduction

A mobile Noise Monitoring Terminal (NMT) has been deployed at East Grinstead in West Sussex, by Gatwick Airport Ltd. This report presents a summary of the results of continuous noise monitoring for the 12-month period from July 2016 to June 2017 which covers a complete seasonal cycle of aircraft movements.

The site is approximately 10 km south-east of Gatwick Airport. The following information about the site derives from the observations of the AAD Field Engineer who regularly visited the site, on weekdays during the noise monitoring period, at approximately monthly intervals, to download data, carry out calibration checks and routine maintenance as required. The NMT at East Grinstead is located in the garden of a private house in a housing estate. The site is out of earshot of the nearest main road but there is a drive (a private road) about 50 metres away, leading to garages belonging to the occupants of the estate. Apart from the noise from passing aircraft, and birdsong in spring and summer there will be occasional noise from the houses and vehicles using the garages.

On the basis of this information this would appear to be a quiet site. However, as with all unattended noise monitoring sites there can be periods when higher than usual noise levels are recorded, for example during periods of adverse weather conditions such a heavy rain and high winds affecting the microphone.

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 58 dBA to be exceeded for 10 seconds.

Figures 1, and 2 (page 13) show the location of the NMT at East Grinstead, together with typical aircraft radar tracks for both westerly and easterly departures. These show that aircraft noise events recorded at the site arise mainly from departures to the east.

Further information about the NMT is given in Appendix 1, and a glossary of acoustical and aircraft noise related terms (including departure routes and noise preferential routes) is given in Appendix 2.

2.1 Data validity checks

Aircraft noise event data

A total of approximately 12,500 aircraft noise events were recorded at the noise monitor during the monitoring period from July 2016 to June 2017. Examination of these data indicated a small number (16) 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 aircraft noise but prolonged by other sources of noise, including noise from the wind, which continues long after the aircraft has moved away.

It was decided to remove these 'long duration' events from the database to be used for subsequent analysis presented in this report, using a criterion that events with a duration of more than 60 seconds should be removed.

Hourly total noise level data

Investigations at a previous site into the effects of high wind speed on hourly total noise levels had concluded that unexpectedly high values of hourly total noise levels of over 65 dBA are probably caused by the effects of wind passing over the microphone. Accordingly it was decided to remove all total average hourly noise levels above 65 dBA from the data set used for subsequent data analysis. The same procedure has been adopted at this site, which has led to 21 hours (0.24%) of data being removed from the data base used for subsequent analysis.

Completeness of the hourly data set

Data has been collected for 98% of the hours in the 12 months noise monitoring period.

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 9 below (pages 13 to 17) and are also summarised in the Table in section 6 of this report (page 12).

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

Almost all of these events (about 98%) arose from easterly aircraft departures using runway 08R, with the remaining events arising from overflights (about 2%) and a few (0.06%) recorded as arrivals. Almost all of the events (94%) occurred during the daytime period (07.00 to 23.00 hours, local time) and 6% at night-time.

The number of aircraft noise events recorded by the NMT each month at East Grinstead during the noise monitoring period will vary month by month depending on the seasonal variation in total number of movements occurring at the airport, and the wind direction at the airport, which determines runway usage and take off direction

Figure 3 (page 14) shows the variation of the total number of movements at the airport each month from July 2016 to June 2017. It can be seen that the number of movements is lowest in the winter months from November to February, reaching a maximum in the summer between May and September. The percentage of easterly runway usage each month over the same period is shown graphically in Figure 4 (page 14) and also in the Table below.

Month	% westerly	% easterly
July 2016	94	6
August 2016	76	24
September 2016	84	16
October 2016	37	63
November 2016	62	38

December 2017	64	36
January 2017	56	44
February 2017	67	33
March 2017	80	20
April 2017	80	20
May 2017	48	52
June 2017	81	19

Figure 5 (page 15) shows the total number of aircraft noise events recorded by the NMT at East Grinstead each month from July 2016 to June 2016.

The number of aircraft noise events varies, hour by hour, throughout each day. Figure 6 (page 15) shows this variation. It can be seen that, on average over the 12-month period, the highest numbers of aircraft noise events per hour recorded at the site occur in the morning period from 06.00 to 09.00 hours (local time).

3.2 Maximum noise levels and durations of aircraft noise levels

The maximum noise level, L_{ASmax}, produced by aircraft noise events over the 24-month period varies from event to event, with an average value of 67 dBA and a standard deviation of 3 dBA.

There was no significant variation in the average L_{ASmax}, value from month to month or between daytime and night-time.

The duration of these aircraft noise events varied from event to event, but with an average of 25 seconds, and with a standard deviation of 6 seconds.

3.3 Aircraft altitudes

The altitudes of the aircraft responsible for these aircraft noise events ranged from about 2400 feet to 9400 feet with an average value of 4500 feet.

3.4 The total noise climate at the site

Figure 7 (page 16) 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 7 (page 16) 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 8 (page 16) shows similar data for night-time

Monthly average aircraft noise levels, day and night

Figure 7 (page 16) shows that the average level of aircraft noise level (L_{Aeq}) in the daytime generally varied from month to month between 40 and 49 dBA.

Figure 8 (page 16) shows that the average level of the night-time aircraft noise level (L_{Aeq}) generally varied from month to month between 30 to 45 dBA.

Monthly average total noise levels, day and night

Figure 7 (page 16) shows that the average daytime monthly total noise level varied between 48 and 56 dBA.

At night time Figure 8 (page 16) shows that the average night time monthly total noise level varied between 40 and 53 dBA.

Residual noise levels

The level of residual noise, as explained in Appendix 1, is deduced from the level of total noise and aircraft noise. Throughout the monitoring period this residual noise level was usually between 1 and 6 dB below the total noise level, and was sometimes lower than and sometimes higher than the level of aircraft noise,

Background noise levels

The daytime background noise level (L_{AFS90}) varied throughout the 12-month period between about 36 and 39 dBA in the daytime, and between about 29 to 33 dBA at night.

Maximum aircraft noise levels

Figures 7 and 8 show that the average of maximum aircraft noise levels each month was similar during the daytime, and always within 1 or 2 dB of the overall average value of 67 dBA. There was a slightly more variability at night-time, probably because the average level each month was based on a much smaller number of events than in the daytime (only 6 % of aircraft noise events occurred at night-time).

Figures 7 and 8: Conclusion

Figures 7 and 8 (page 16) demonstrate that the noise from aircraft noise events at this site, when cumulatively averaged over each month makes a variable contribution to the total noise level the site over the 12 month period; sometimes making the dominant contribution for some months (during the first part of the monitoring period) but making a lesser contribution for other months (during the latter part of the monitoring period) when it is the noise from other sources, i.e. the residual noise, which makes the major contribution.

However even during those months when the residual noise is dominant individual aircraft noise events, whenever they occur, are likely to be clearly audible and distinguishable from the residual noise because, in addition to being different in character, they result in a noticeable increase in the level of noise over the ambient noise level during each event.

Hour by hour variations in noise levels

Figure 9 (page 17) 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 and early evening period (06.00 to 20.00 hours) but fall during the late evening and night-time period, rising again in the early morning.

Also shown in Figure 9 (page 17) is the variation with hour of day of the average of maximum aircraft noise levels. There is very little variation in the values from 5 am to midnight. The average values between midnight and 5 am are based on very small numbers of aircraft noise events (less than 10, as compared to hundreds for the later hours) and this accounts for the much greater variability in the average values for these early morning hours, shown in Figure 9.

The average noise levels over the 12-month period for various parts of the 24-hour day are shown in the table below, for the monitoring period from July 2016 to June 2017

	Aircraft noise $L_{Aeq,T}$	Residual noise $L_{Aeq,T}$	Total $L_{Aeq,T}$	Background noise level (L_{AS90})
Day (16h) (07.00 - 23.00 h)	45	49	50	37
Night (8h) (23.00 - 07.00 h)	40	45	46	31
Day (12 h)* (07.00 - 19.00 h)	46	50	51	38
Evening (4 h)* (19.00 - 23.00 h)	41	44	46	34
24 hours	43	48	49	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).

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

4.1 Aircraft noise contours

The site at East Grinstead lies well outside 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). This is consistent with the average $L_{Aeq16hour}$ aircraft noise level for this site of 45 dBA for the 12 months from July 2016 to June 2017 as shown in the Table above. 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 57dBA 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 East Grinstead lies well 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. The Lden value calculated from noise measurements at this site over the 12-month period from July 2016 to June 2017 has been estimated as 48 dBA, for aircraft noise and 53 dBA for total noise.

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 East Grinstead 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 East Grinstead are also free field values.

The 16 hour L_{Aeq} value of total noise for this site are 50.4 dBA for the 12-month period of this noise monitoring survey. This puts the site in the second lowest, less than 55 dBA, noise exposure band, occupied by 37 % of dwellings in the UK.

It should be noted that this comparison refers to the total noise at this particular site at East Grinstead, which is a combination of aircraft noise and residual noise, i.e. noise from sources other than aircraft. The possible sources of noise at the site were described in section 1.0 above.

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 levels during the 24-month monitoring period at this site are 50 dBA, and 46 dBA for the night-time periods (please see Table in section 3.4 page 8). Therefore, daytime total noise exposure levels at this site are below the daytime WHO Guidelines, but above the night-time Guidelines.

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

Approximately 40 different aircraft types contributed to the total number of 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 over 95% of all aircraft noise events recorded at the site:

Airbus Industrie A319: 43 %
Airbus Industrie A320: 40 %
Boeing 737 - 800: 7 %
Airbus Industrie A321: 7 %

The Table below lists the 20 aircraft types responsible for more than 99% 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 (dB) 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	Number	dB	%
Airbus Industrie A319	A319	5064	66.1	42.8%
Airbus Industrie A320	A320	4704	66.5	39.7%
Boeing 737	B737	869	68.6	7.3%
Airbus Industrie A321	A321	780	67.5	6.6%
Boeing 757	B757	141	65.8	1.2%
Boeing 787	B787	50	67.5	0.4%
Boeing 777	B777	47	72.2	0.4%
Boeing 767	B767	36	69.2	0.3%
Boeing 747	B747	34	74.8	0.3%
Airbus Industrie A330	A330	30	68.6	0.3%
MD Helicopters MD900 Explorer	EXPL	20	67.5	0.2%
Airbus Industrie A380	A380	17	67.2	0.1%
McDonnell Douglas MD82	MD82	14	72.6	0.1%
Embraer 195	E195	4	69.9	0.03%
Augusta Westland 109	A109	3	70.8	0.03%
McDonnell Douglas MD83	MD83	3	74.8	0.03%
Beechjet 400	B462	2	65.5	0.02%
Embraer 190	E190	2	71.3	0.02%
Eurocopter EC-135	EC35	2	64.6	0.02%
Gulfstream GLFS	GLFS	2	73.8	0.02%

The Table below shows the same 20 most frequent aircraft (a/c) types but rearranged in order of decreasing average maximum aircraft noise event level.

Aircraft type	Type	Number	dB	%
Boeing 747	B747	34	74.8	0.3%
McDonnell Douglas MD83	MD83	3	74.8	0.03%
Gulfstream GLFS	GLFS	2	73.8	0.02%
McDonnell Douglas MD82	MD82	14	72.6	0.1%
Boeing 777	B777	47	72.2	0.4%
Embraer 190	E190	2	71.3	0.02%
Augusta Westland 109	A109	3	70.8	0.03%
Embraer 195	E195	4	69.9	0.03%
Boeing 767	B767	36	69.2	0.3%
Boeing 737	B737	869	68.6	7.3%
Airbus Industrie A330	A330	30	68.6	0.3%
Airbus Industrie A321	A321	780	67.5	6.6%
Boeing 787	B787	50	67.5	0.4%
MD Helicopters MD900 Explorer	EXPL	20	67.5	0.2%
Airbus Industrie A380	A380	17	67.2	0.1%
Airbus Industrie A320	A320	4704	66.5	39.7%
Airbus Industrie A319	A319	5064	66.1	42.8%
Boeing 757	B757	141	65.8	1.2%
Beechjet 400	B462	2	65.5	0.02%
Eurocopter EC-135	EC35	2	64.6	0.02%

Finally the Table below shows the 12 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 some of them are overflights by helicopters and light aircraft. The helicopter activity is not associated with Gatwick Airport.

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

Aircraft Type	Type	Number	dB	%
Boeing 747	B747	34	74.8	0.3%
McDonnell Douglas MD83	MD83	3	74.8	0.03%
Gulfstream GLFS	GLFS	2	73.8	0.02%
McDonnell Douglas MD82	MD82	14	72.6	0.1%
Boeing 777	B777	47	72.2	0.4%
Embraer 190	E190	2	71.3	0.02%
Augusta Westland 109	A109	3	70.8	0.03%
Embraer 195	E195	4	69.9	0.03%
Boeing 767	B767	36	69.2	0.3%
Boeing 737	B737	869	68.6	7.3%
Airbus Industrie A330	A330	30	68.6	0.3%
Embraer 145	E145	1	68.6	0.01%

From these three Tables it can be seen that, 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 at East Grinstead, West Sussex, between July 2016 and June 2017.

The site is approximately 10 km south-east of Gatwick Airport. The NMT at East Grinstead is located in the garden of a private house in a housing estate. The site is out of earshot of the nearest main road but there is a drive (a private road) about 50 metres away, leading to garages belonging to the occupants of the estate. Apart from the noise from passing aircraft, and birdsong in spring and summer there will be occasional noise from the houses and vehicles using the garages.

The report presents analysis and description of the following aspects of the noise data gathered during the noise monitoring programme: 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 total noise levels and aircraft noise levels) from hour to hour, between day to night, and from month to month have also been described.

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.

Most of the aircraft noise events recorded at this site (98) arose from easterly aircraft departures using runway 08R, and 2% from overflights. Almost all of the events (94%) occurred during the daytime period (07.00 to 23.00 hours, local time) and 6% at night-time.

The noise from aircraft noise events at this site, when cumulatively averaged over each month makes a variable contribution to the total noise level the site over the 12 month period; sometimes making the dominant contribution for some months (during the first part of the monitoring period) but making a lesser contribution for other months (during the latter part of the monitoring period) when it is the noise from other sources, i.e. the residual noise, which makes the major contribution.

A summary of the main noise related parameters for the site at East Grinstead is shown in the Table below:

Survey period	July 2016 to June 2017
Aircraft noise event trigger level	58 dBA for 10 seconds
Length of noise monitoring period	12 months
Number of aircraft noise events	12,500 (approximately)
% Arrivals and Departures	98% arising from easterly departures using runway 08R; 0.06% Arrivals, 2 % from overflights.
% DAY and NIGHT	94 % Day, 6 % Night
Average maximum noise level of aircraft noise events	66.6 dBA; standard deviation 3 dBA
Average noise duration of aircraft noise events	25 seconds, standard deviation 6 seconds
Average total noise level	50 dBA (Day); 46 dBA (Night)
Average aircraft noise level	45 dBA (Day); 40 dBA (Night)
Average residual noise level	49 dBA (Day); 45 dBA (Night)
Background noise (L_{AS90})	37 dBA (Day); 31 dBA (Night)
Daytime level (12 hours)	51 dBA (Total noise); 46 dBA (aircraft noise)
Evening level (4 hours)	46 dBA (Total noise); 41 dBA (aircraft noise)
Day-evening- night level	53 dBA (Total noise); 48 dBA (aircraft noise)

Figure 1 showing a typical day of aircraft radar tracks (in green) for westerly departures, and location of noise monitor at East Grinstead Noise Preferential Routes (NPRs) are shown in blue. Arrival radar tracks are shown in red

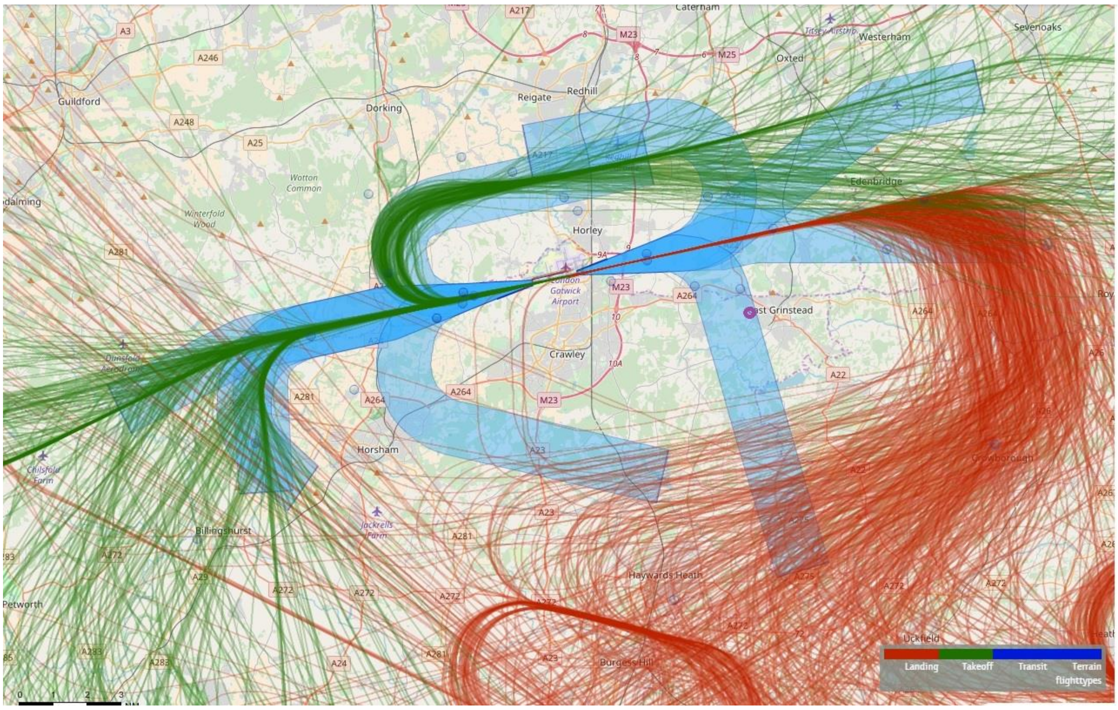
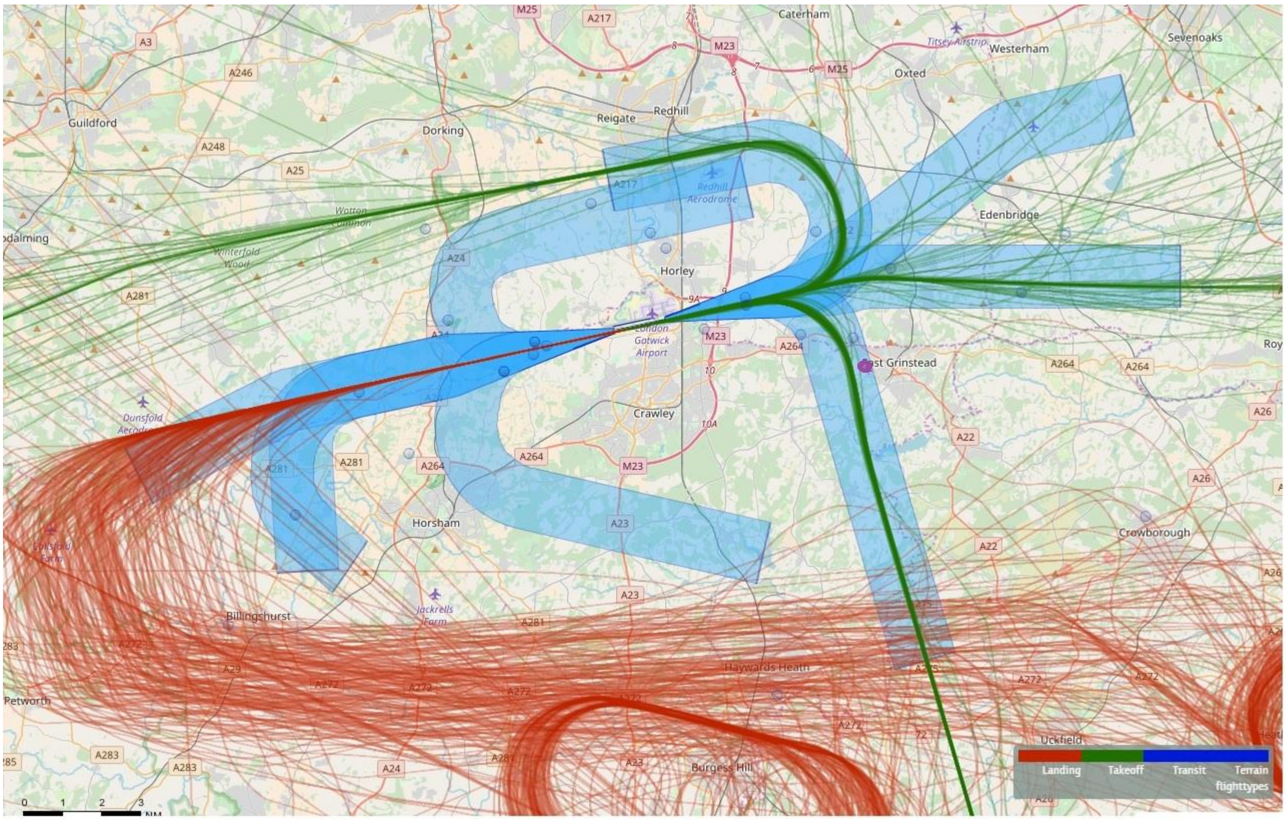


Figure 2 Location of East Grinstead NMT 82 showing a typical day of easterly radar departure tracks (green) and Noise Preferential Routes (NPRs) in blue. Arrival tracks are shown in red.



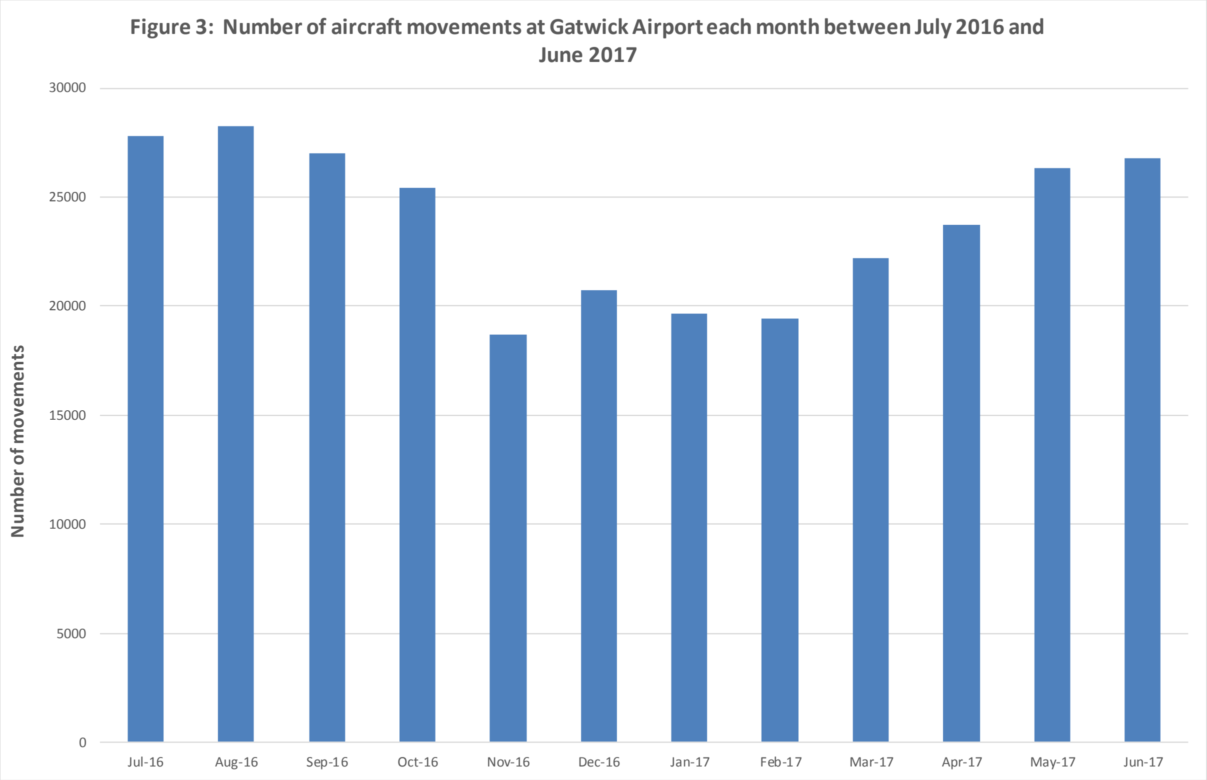


Figure 3: Number of aircraft movements at Gatwick Airport each month between July 2016 and June 2017
Number of movements
0
5000
10000
15000
20000
25000
30000
Jul-16
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17

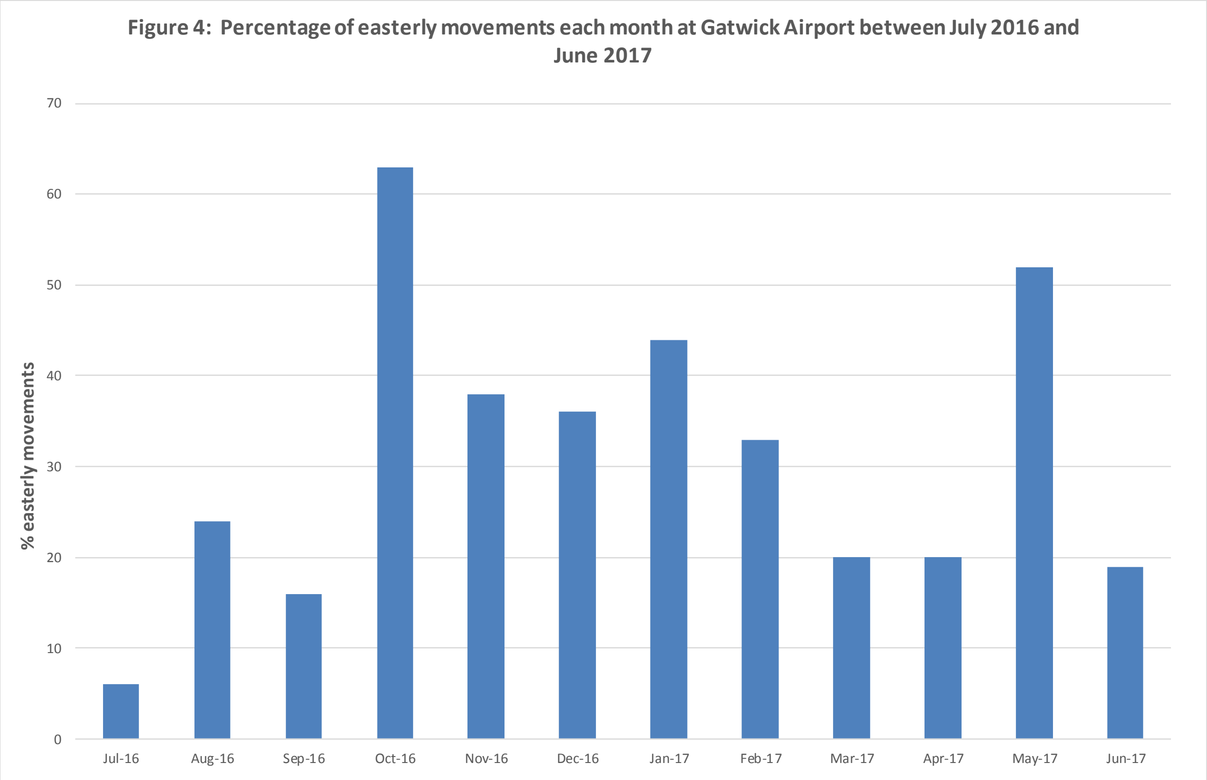


Figure 4: Percentage of easterly movements each month at Gatwick Airport between July 2016 and June 2017
% easterly movements
0
10
20
30
40
50
60
70
Jul-16
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17

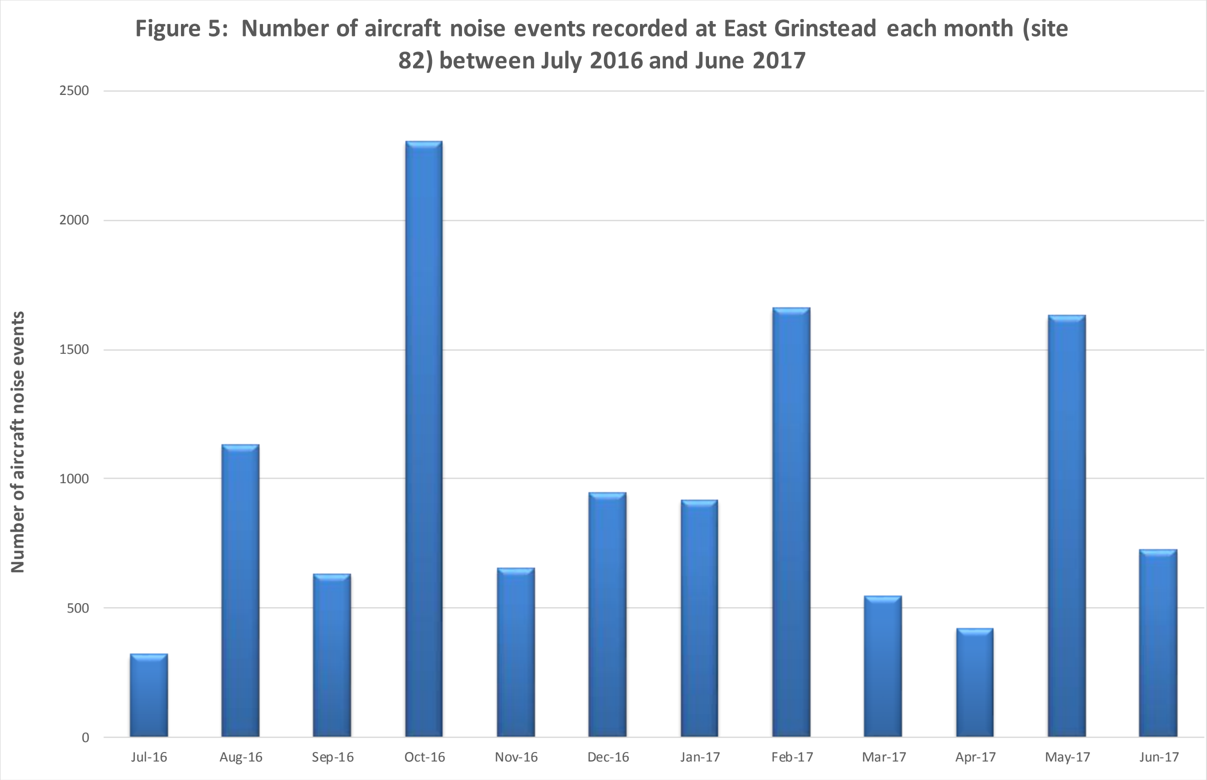


Figure 5: Number of aircraft noise events recorded at East Grinstead each month (site 82) between July 2016 and June 2017
Number of aircraft noise events
2500
2000
1500
1000
500
0
Jul-16
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17

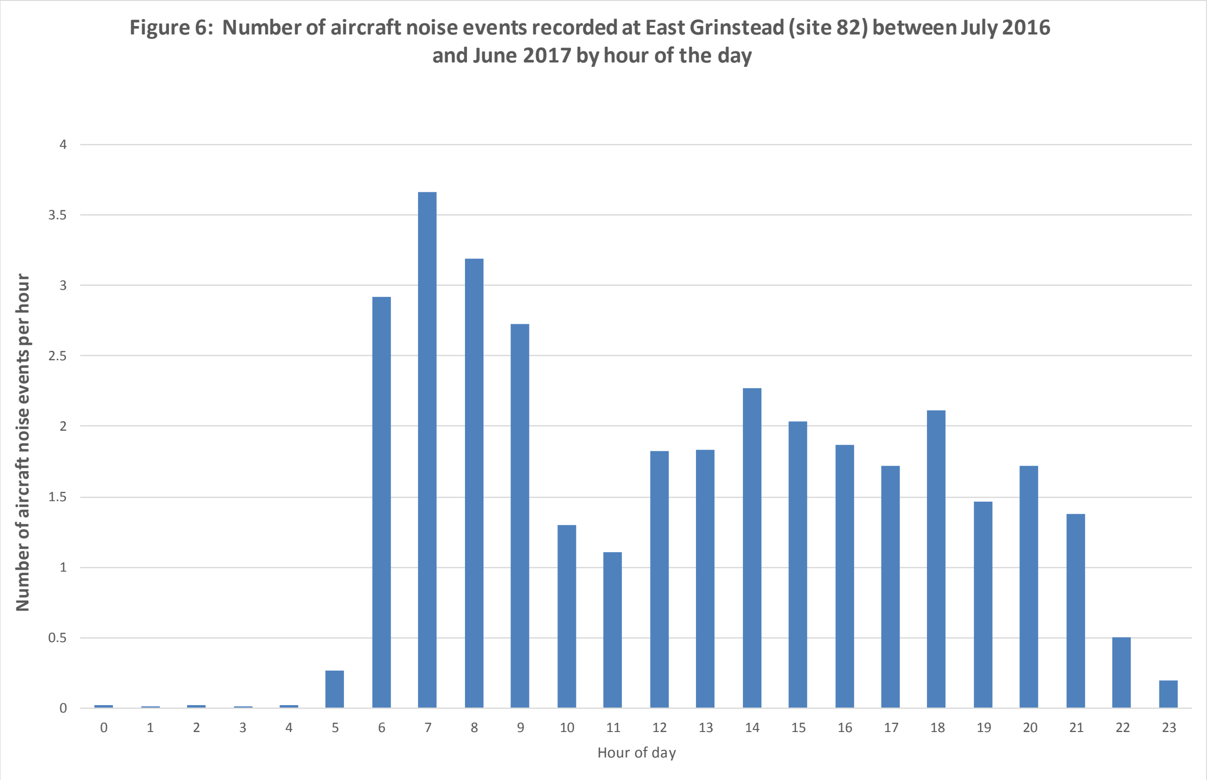


Figure 6: Number of aircraft noise events recorded at East Grinstead (site 82) between July 2016 and June 2017 by hour of the day
Number of aircraft noise events per hour
4
3.5
3
2.5
2
1.5
1
0.5
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Hour of day

Figure 7: Monthly average day time noise climate values at East Grinstead from July 2016 to June 2017

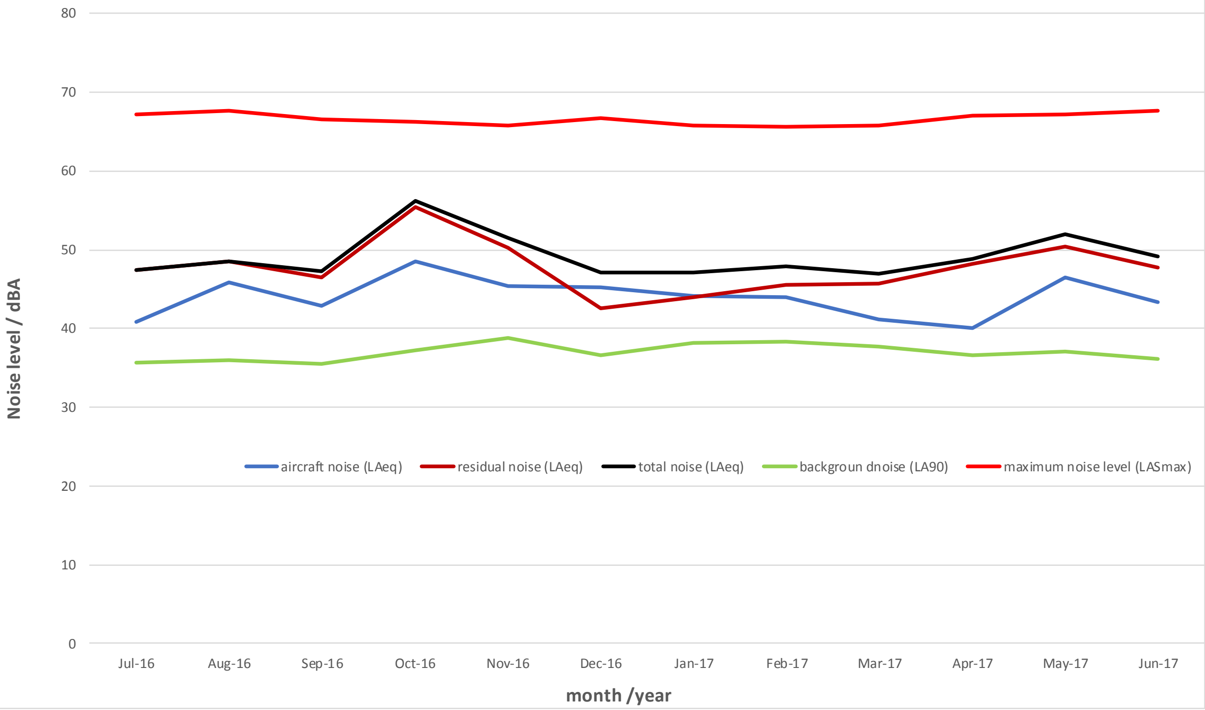
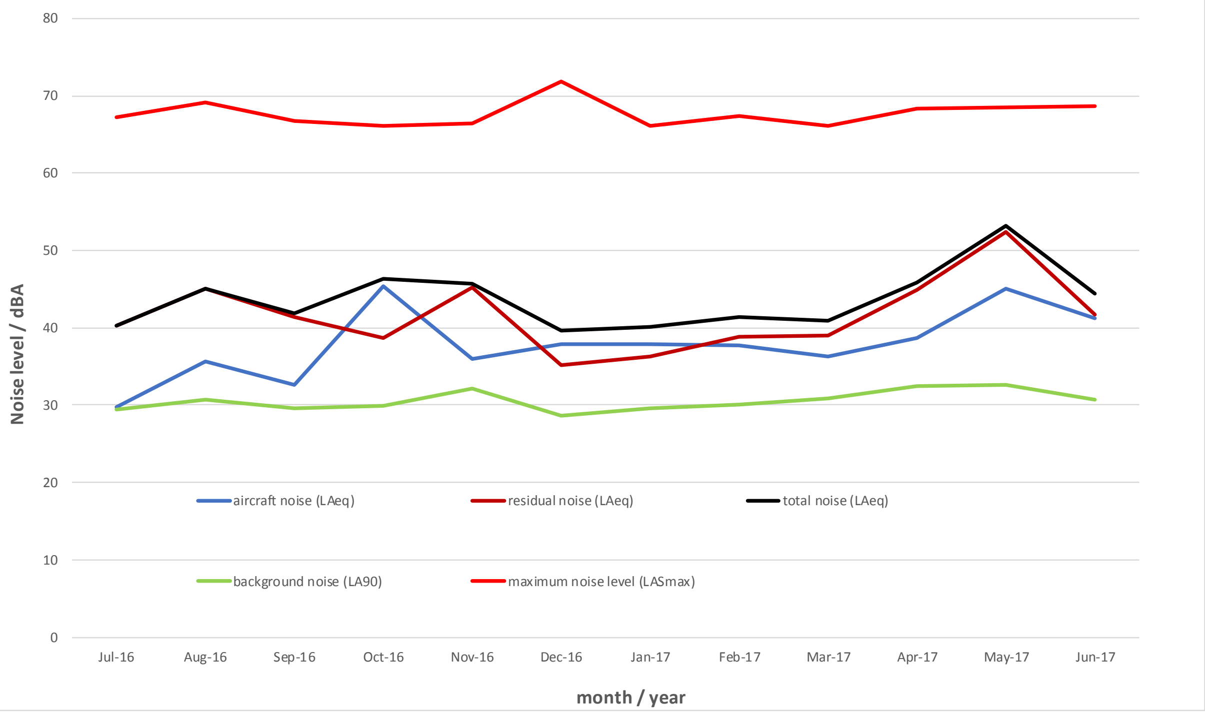


Figure 8: Monthly average night-time noise climate values at East Grinstead from July 2016 to June 2017



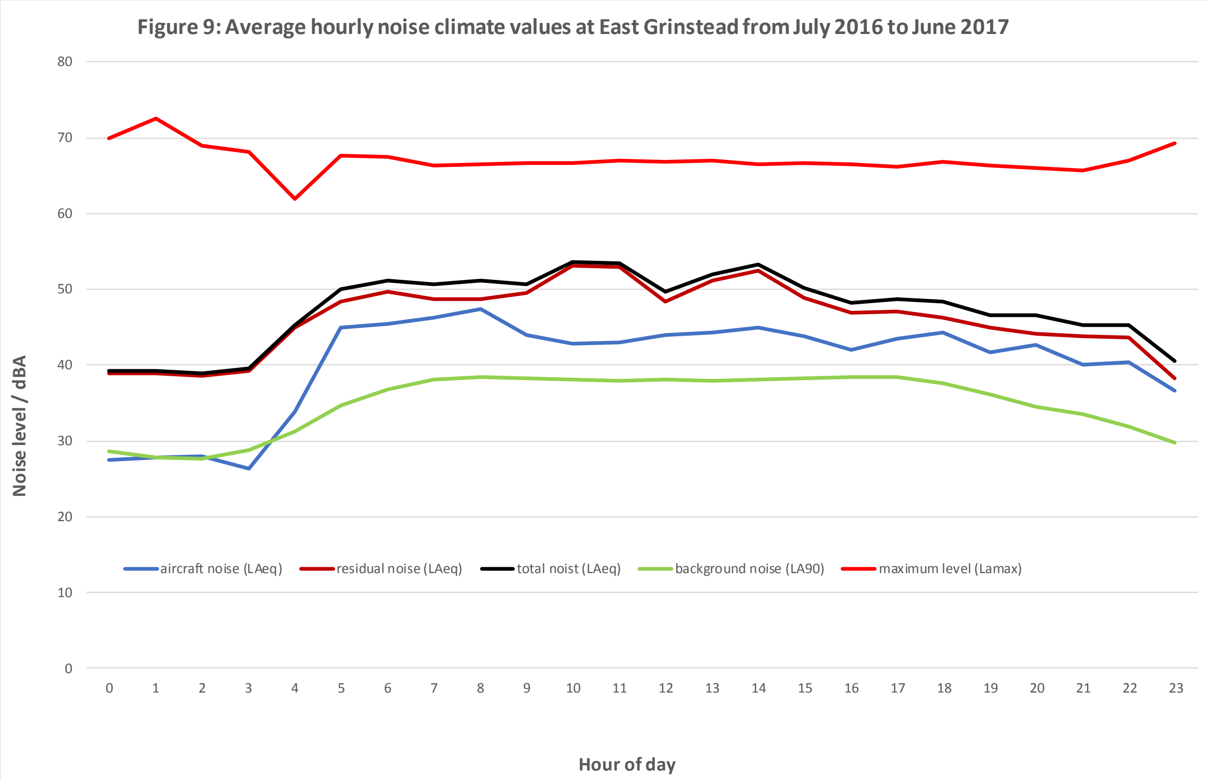


Figure 9: Average hourly noise climate values at East Grinstead from July 2016 to June 2017
Noise level / dBA
0
10
20
30
40
50
60
70
80
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Hour of day
aircraft noise (LAeq)
residual noise (LAeq)
total noist (LAeq)
background noise (LA90)
maximum level (Lamax)

AAD
applied acoustic design

APPENDIX 1

DATA FROM THE NOISE MONITORING TERMINAL

ISO 9001 001
Expert Witness™ Established 1996

THE GREEN BUSINESS CENTRE
THE CAUSEWAY
STAINES
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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 58 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 56 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 58 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.

It is therefore possible that the residual noise could also include some noise from aircraft arriving at, or departing from Gatwick, as well as from overflights, which was below the trigger level. Conversely it will sometimes be possible that some non-aircraft noise, i.e. residual noise might be captured as part of aircraft noise event. This could happen for example if a burst of residual noise occurred at the same time as an aircraft was passing overhead.

The first possibility, i.e. residual noise being counted as aircraft noise will lead to an increase in reported residual noise levels, and the second possibility, i.e. of residual noise being counted as aircraft noise, will lead to an increase in reported levels of aircraft noise level. Previous investigations have shown that in both cases these effects on the reported levels are small, and not considered to be significant, and are incorporated within the levels of uncertainty reported below.

Combined Uncertainty

This report includes results from calculations made using average noise measurement values from the 12 month monitoring period of aircraft noise level ($L_{Aeq,T}$), total noise level ($L_{Aeq,T}$), residual noise level (LAeq,T), background noise level (L_{AS90}) and maximum noise level (of aircraft noise events), LASmax.

Taking into account all the causes of variability that affect the values of these parameters, including, for example: weather conditions affecting sound propagation, variability of the noise emission and flight tracks of individual aircraft noise events, the accuracy of the noise level measurements produced by the NMT, it is considered that the estimated combined uncertainty is +/- 2 dB.

AAD
applied acoustic design

APPENDIX 2

GLOSSARY OF ACOUSTIC TERMS

THE GREEN BUSINESS CENTRE
THE CAUSEWAY
STAINES
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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 Departure Route — See Standard Instrument Departure Route (SID)

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

Departure Route — See Standard Instrument Departure Route (SID)

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 55 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.

Noise Preferential Route (NPR)

All aircraft leaving Gatwick Airport should follow flight paths known as Noise Preferential Routes (NPRs) up to an altitude of 3,000ft or 4,000ft depending on the route. NPRs were set by the Department for Transport (DfT) in the 1960s and were designed to avoid over flight of built-up areas where possible. They lead from the runway to the main UK air traffic routes, and form the first part of the Standard Instrument Departure routes (SIDs).

An NPR consists of a ‘centreline’ and an associated compliance monitoring swathe (3km across, i.e. 1.5km either side of the NPR centreline). These NPR’s have not been altered since they were established in order to give people the predictability of knowing where noise from departing planes will be heard. Their location remains the responsibility of the Government and any significant changes to the NPR’s would be subject to a public consultation.

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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.

Standard Instrument Departure Route (SID)

When an aircraft departs from Gatwick it will follow one of a number of routes depending on the runway in use and its destination. These routes are designated Standard Instrument Departures (SIDs). The purpose of a Standard Instrument Departures (SID) Route is to define a route that takes an aircraft from the point at which it departs from the runway to the point where it can join an airway. All Gatwick Airport Standard Instrument Departure (SID) Routes are contained within Noise Preferential Routes (NPRs). Once the aircraft has reached the top of the Noise Preferential Route (NPR), it continues to follow the Standard Instrument Departure (SID) until it reaches the point where it can join an airway for the en-route phase of the flight.

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.