REPORT

Environmental Permitting Regulations

Noise Monitoring Services

Client: Airbus Operations Limited

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Enhancing Society Together

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1 Introduction

1.1 Background

Airbus Operations Limited have commissioned Royal HaskoningDHV to undertake noise monitoring of their Installation at Broughton, Flintshire as part of the requirements of the Environmental Permit EPR /BM3965IA and the Variation EPR/BM3965IA/V005, issued pursuant to Regulation 20 and Part 1 of Schedule 5 of the Environmental Permitting (England and Wales) Regulations (EPR), 2010.

1.1.1 Industry Description

The Installation manufactures aircraft wings and components, including the delivery of raw materials and the onward despatch of completed wings. The EPR Permit and Variation covers certain operations of the manufacturing process including surface treatment, painting, cleaning and assembly, and the Combined Heat and Power generation for the site.

Condition 3.5.1 of the EPR permit states;

"Emissions from the activities shall be free from noise and vibration at levels likely to cause annoyance outside the site, as perceived by an authorised officer of the Agency, unless the operator has used appropriate measures to prevent or where that is not practicable to minimise the noise and vibration."

In Schedule 4, Table S4.4 of the permit, the noise monitoring requirements are;

"Noise survey at locations to be agreed with Agency and Flintshire County Council"

This is to be conducted every three years and in accordance with BS4142:1997.

The report presents the assessment guidance, methodology, results from the survey and assessment and comparisons made with previous years' surveys. Conclusions will be made on whether the operations at the Installation have resulted in a change in the ambient noise at the identified noise sensitive locations.

1.1.2 Site Setting

The Installation is situated to the north of the village of Broughton in Flintshire and within the boundary of the Hawarden airfield. The site is bordered by the A5104 to the south and the B5125 and B5129 to the west, north and east. Further to the south is the well trafficked A55 North Wales Expressway. To the north of the site is the rail line connecting Chester to the North Wales coast.

A large retail park, Broughton Shopping Park, is situated to the south east of the site and offers 24 hour retail opening times for some units.

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2 Survey Methodology and Assessment Guidance

2.1 Survey Methodology

The noise survey consisted of two elements. An unattended long term survey at six monitoring locations and a short term attended survey at seven locations undertaken over one night time period between the hours of midnight and 0315hrs on 21st July 2015. The unattended noise survey was conducted from 16th July 2015 until 23rd July 2015. An initial short term attended noise survey was also carried out on 19th June 2015.

The unattended survey locations consist of six points both on and off the Airbus site. It has been previously agreed with Natural Resources Wales (NRW) that survey points A, B and C are representative of the boundary of the Installation closest to the nearest noise sensitive receptors. In 2015 Airbus, with agreement from the local residents, added an additional three survey locations, D, E and F. These are located within the gardens of the noise sensitive receptors. The long term monitoring locations are detailed in **Table 1**.

Table 1: Long term unattended survey locations

Survey location	Description	Grid Reference
A	Site perimeter, rear of properties in St Mary's Way	SJ 34236 64120
B	Site perimeter in direction of Saltney	SJ 36084 65416
C	Site perimeter, rear of properties in Manor Crescent	SJ 34222 65561
D	Residential property on Bretton Lane	SJ 35466 63891
E	Residential property on Copse Lane	SJ 35477 64353
F	Residential property on Manor Lane	SJ 33979 65391

The short term attended monitoring locations have remained unchanged from previous years' surveys and are presented in **Table 2**.

Table 2: Short term attended survey locations

Survey location	Description	Grid Reference
1	St Mary's Way	SJ 34129 64067
2	Car park to the rear of the Glynne Arms public house	SJ 35026 64268
3	Copse Lane	SJ 35469 64396
4	Well House Farm	SJ 36230 64672
5	Cop House Farm	SJ 36052 66209
6	Beeches Farm	SJ 34555 66204
7	Manor Crescent	SJ 34200 65606

2.1.1 Instrumentation

The environmental noise measurements were conducted in accordance with the guidance contained in BS 7445 parts 1 and 2[1]

The sound level meters were fully calibrated, traceable to UKAS standards and satisfy the requirements of BS EN 61672-1: 2013[2] for a 'Class 1' Sound Level Meter (SLM).

The SLM's were set to record L_{Aeq}, $L_{Amax,}$ L_{A90}, and L_{A10}, data with a 'fast' time constant and A-weighting. **Appendix E** presents descriptions of these terms.

The noise measurements were conducted with the SLM mounted on a tripod at heights between 1.2m and 1.5m above ground level and 3.5m away from any reflecting surface other than the ground. The instrument was calibrated before and after the survey using the portable calibrator. No deviation in the calibration level was noted.

Details of the sound level meters and associated equipment used are presented in **Appendix B**.

2.2 Subjective description of the ambient noise

During the deployment and collection of the long term unattended sound level meters a subjective assessment at each monitoring location was undertaken. Road traffic noise was the dominant source contribution to the ambient sound scape at each survey location. Other contributions were noted to be from aircraft, domestic noise, birdsong and railway noise from the Chester to North Wales coast line.

At location B, temporary construction works were in operation during the week long survey and would have contributed to the ambient noise during the daytime construction hours (0700 hrs - 1800 hrs).

At survey point F, a pump associated with a hot tub located in the garden of the property was noted to be operating cyclically and will have contributed to the ambient noise at this location.

During the night time attended survey the ambient sound scape was composed of contributions from road traffic on the local road network, aircraft and domestic and farming activities.

At survey locations representative of the southern boundary of the Installation, the dominant daytime noise contributions were from road traffic on the A5104 and from the A55. During the night time attended survey noise from the Installation was just audible in traffic lulls at locations along the southern boundary of the site.

2.3 Assessment Guidance

The most appropriate guidance document for the assessment of this type of industrial and commercial sound source is British Standard 4142[3]. The standard describes methods for rating and assessing sound of an industrial and/or commercial nature. The methods use outdoor sound levels to assess the likely effects of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident, and combines procedures for assessing the impact.

1 *British Standards Institution, (2003). BS 7445-1:2003* - Description and measurement of environmental noise. Guide to quantities and procedures. *BSI, London*

2 *British Standards Institution (2013). BS EN 61672-1:2013* Electroacoustics. Sound level meters. Specifications. *BSI, London*

3 British Standards Institution (2014) BS4142: 2014 – Methods for rating and assessing industrial and commercial sound. BSI, London

The standard is a major update on previous editions incorporating a rigorous assessment of uncertainty in environmental noise measurements and introducing the concepts of "significant adverse impact" rather than likelihood of complaints. Common principles with the previous edition are the consideration for the characteristics of the sound under investigation, time of day and frequency of occurrence.

Assessment is undertaken by subtracting the measured background noise level from the rating level; the greater this difference the greater the magnitude of the impact.

The noise data obtained during the unattended and attended surveys includes all the prevailing sound source contributions at each identified survey location. The on-site locations include sources attributable to the operations at the Installation both as part of the permitted activities and those that fall outside of the permit such as airfield activities. These also include off-site sources such as distant road traffic and railway noise. At the off-site locations there are contributions from road traffic, aircraft and domestic sources. These make up the ambient sound at any given location and therefore the assessment is undertaken on the basis of comparison with previous years' survey data.

Any increase in the ambient sound level at each receptor location A to C may be attributed to either changes in the activities at the Installation or to other noise sources in the vicinity of those locations. For the new additional survey locations D to F there are no previous survey results to compare to and a comment will be made regarding the level of the measured sound set against the World Health Organisation (WHO) Guidelines for community noise[4].

These guidelines present health-based noise limits intended to protect the population from exposure to excess noise. It presents guideline limit values at which the likelihood of particular effects, such as sleep disturbance or annoyance, may increase. The guideline values are 50 dB or 55dB L_{Aeq} during the day, related to annoyance, and 45 dB L_{Aeq} or 60dB L_{Amax} at night, related to sleep disturbance.

[4] *Berglund* et al. *(1999) - Guidelines for Community Noise. Geneva, World Health Organisation (WHO)*

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3 Results

3.1 Long Term Unattended Survey

Table 3 summarises the seven day ambient continuous equivalent A-weighted sound pressure level (L_{Aeq}) and the background sound level (L_{A90}) at each of the monitoring locations A to F.

Table 3: Summary of long term unattended measurements

Survey location	$L_{Aeq, 1\ week}$ dB	$L_{A90, 1\ week}$ dB
A. Site perimeter, rear of properties in St Mary's Way	56	36
B. Site perimeter in direction of Saltney	52	39
C. Site perimeter, rear of properties in Manor Crescent	52	35
D. Garden of residential property on Bretton Lane	47	34
E. Garden of residential property on Copse Lane	66	45
F. Garden of residential property on Manor Lane	47	35

3.2 Short Term Attended Survey

Table 4 and Table 5 summarise the measured ambient continuous equivalent A-weighted sound pressure level (L_{Aeq}) and the background sound level (L_{A90}) at each of the monitoring locations 1 to 7 on the nights of 21st July and 19th June 2015. **Appendix D** presents the complete results and observations made during the night monitoring survey.

Table 4: Summary of short term attended measurements 21st July 2015

Survey location	Time	$L_{Aeq, 15\ min}$ dB	$L_{A90, 15\ min}$ dB
1. St Mary's Way	02:12	50	35
2. Car park to the rear of the Glynne Arms public house	01:50	48	41
3. Copse Lane	01:29	42	37
4. Well House Farm	01:07	44	37
5. Cop House Farm	00:44	47	32
6. Beeches Farm	00:22	49	38
	02:35	45	32
7. Manor Crescent	00:02	41	36
	02:56	39	36

Table 4: Summary of short term attended measurements 19th June 2015

Survey location	Time	$L_{Aeq, 15\ min}$ dB	$L_{A90, 15\ min}$ dB
1. St Mary's Way	02:14	49	36
2. Car park to the rear of the Glynne Arms public house	01:52	49	43
3. Copse Lane	01:32	44	40
4. Well House Farm	01:12	42	36
5. Cop House Farm	00:48	35	32
6. Beeches Farm	00:27	51	34
7. Manor Crescent	00:04	38	32

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4 Assessment of Results

4.1 Comparison with previous surveys

The assessment of compliance with the noise conditions of the Environmental Permit at Airbus has taken a similar approach to that used in previous reports produced for the Installation in that the short term $L_{Aeq,15min}$ and the long term $L_{Aeq,1\ week}$ values for each of monitoring locations have been compared with the results of surveys undertaken in 2004, 2008 and 2010. As the long term locations D, E and F are new additions to the monitoring network around Airbus no historical data exists to compare against. The results are therefore included for completeness and for future reference.

4.1.1 Short term noise levels

Table 6 and Table 7 present the lowest ambient continuous equivalent A-weighted sound pressure level (L_{Aeq}), measured at each of the short term monitoring locations. These are compared with the levels measured in 2004, 2008 and 2010.

Table 6: Comparison of short term L_{Aeq} noise levels (21st July 2015 survey)

Survey location	2004 L_{Aeq}, dB	2008 L_{Aeq}, dB	2010 L_{Aeq}, dB	2015 L_{Aeq}, dB	Level difference with 2015, dB		
					2004	2008	2010
1. St Mary's Way	57	53	53	50	-7	-3	-3
2. Car park to the rear of the Glynne Arms public house	52	53	57	48	-4	-5	-9
3. Copse Lane	52	49	54	42	-10	-7	-12
4. Well House Farm	50	53	47	44	-6	-9	-3
5. Cop House Farm	43	49	57	47	+4	-2	-10
6. Beeches Farm	45	48	56	45	0	-3	-11
7. Manor Crescent	38	41	41	39	+1	-2	-2

Table 7: Comparison of short term L_{Aeq} noise levels (19th June 2015 survey)

Survey location	2004 L_{Aeq}, dB	2008 L_{Aeq}, dB	2010 L_{Aeq}, dB	2015 L_{Aeq}, dB	Level difference with 2015, dB		
					2004	2008	2010
1. St Mary's Way	57	53	53	49	-8	-4	-4
2. Car park to the rear of the Glynne Arms public house	52	53	57	49	-3	-4	-8
3. Copse Lane	52	49	54	44	-8	-5	-10
4. Well House Farm	50	53	47	42	-8	-11	-5
5. Cop House Farm	43	49	57	35	-8	-14	-22
6. Beeches Farm	45	48	56	51	6	3	-5
7. Manor Crescent	38	41	41	38	0	-3	-3

The short term noise levels around the Installation have shown significant decreases when compared to the years 2008 and 2010 for the majority of locations. Although sound from some activity from the Airbus site was just audible at some survey locations along the southern boundary of the site, the night time short term levels have not shown a corresponding increase over previous survey years.

4.1.2 Long term noise levels

Table 8 presents the results of the previous surveys with those obtained in 2015 at each of the long term unattended monitoring locations.

Table 8: Comparison of weekly L_{Aeq} noise levels

Survey location	2004 L_{Aeq}, 1 week dB	2008 L_{Aeq}, 1 week dB	2010 L_{Aeq}, 1 week dB	2015 L_{Aeq}, 1 week dB	Level difference with 2015, dB		
					2004	2008	2010
A. Site perimeter, rear of properties in St Mary's Way	55	60	56	56	+1	-4	0
B. Site perimeter in direction of Saltney	55	56	51	52	-3	-4	+1
C. Site perimeter, rear of properties in Manor Crescent	51	55	55	52	+1	-3	-2

D. Garden of residential property on Bretton Lane	-	-	-	47	-	-	-
E. Garden of residential property on Copse Lane	-	-	-	66	-	-	-
F. Garden of residential property on Manor Lane	-	-	-	47	-	-	-

The long term monitoring results measured over the week of 16th July to 23rd July 2015 at the 3 on-site locations A, B and C indicate that ambient noise levels have not increased at locations A and C since 2010. The ambient noise levels measured at Location B have shown a 1 dB increase over levels measured in 2010. A 1 dB change in level represents a negligible increase and would be only just noticeable under perfect laboratory conditions. It was noted at the time of the survey that temporary construction works were taking place in the vicinity of location B and that these were not occurring in 2010. Averaged over the week long period these works could contribute to this increase in the ambient noise level.

The weekly night time ambient noise levels measured between the hours of 2300hrs and 0500hrs were compared with those in 2004, 2008 and 2010. These levels were extracted from the unattended noise data and log averaged for each of the six hour night time periods.

Table 9: Comparison of weekly night time L_{Aeq} noise levels

Survey location	2004 $L_{Aeq,\ 1\ week}$ dB	2008 $L_{Aeq,\ 1\ week}$ dB	2010 $L_{Aeq,\ 1\ week}$ dB	2015 $L_{Aeq,\ 1\ week}$ dB	Level difference with 2015, dB		
					2004	2008	2010
A. Site perimeter, rear of properties in St Mary's Way	43	44	43	45	+2	-1	+2
B. Site perimeter in direction of Saltney	41	42	44	45	+4	-3	+1
C. Site perimeter, rear of properties in Manor Crescent	43	42	42	47	+4	+5	+5
D. Garden of residential property on Bretton Lane	-	-	-	39	-	-	-
E. Garden of residential property on Copse Lane	-	-	-	60	-	-	-
F. Garden of residential property on Manor Lane	-	-	-	41	-	-	-

The results indicate that the night time ambient noise levels have increased at all locations with the exception of A and B in 2008, when compared with previous years' data. The highest increase was at location C where a 4 to 5 dB increase has been observed over the results from 2004, 2008 and 2010 respectively.

When attending site to deploy the equipment and during the short term monitoring, the acoustician did not observe any audible sound from the Installation on the boundary close to location C.

It is likely that all increases at each survey location are due to the average wind speeds observed throughout the week long monitoring period and the fact that monitoring position C is close to an area of Poplar trees on the site boundary. The effect on sound levels locally at the microphone can increase due to rustling vegetation nearby.

It should also be noted that when average wind speeds exceed a velocity of 3 m/s the effects of wind dominate over other environmental factors such as temperature gradients on the propagation of sound. **Graph 1** in **Appendix C** presents the average wind speeds in metres per second for the period 16th July 2015 through to 23rd July 2015 for reference.

The measured levels at the additional survey locations D to F were compared against the World Health Organisation (WHO), Guidelines for community noise. The most appropriate level for comparison, in the absence of previous data at these locations is the weekly night time L_{Aeq} noise level. The WHO Guidelines state that a suitable external night time noise level outside a bedroom with a window open is 45 dB L_{Aeq} over the 8 hour reference night time period so as to ensure sleep is not disturbed. At locations D and F the night time levels are typically 39 and 41 dB L_{Aeq} respectively, although these are taken over a 6 hour period. Taking the measured data over the full 8 hour night time period the measured ambient noise levels at D and F were 44 and 43 dB(A) respectively. These are below the guideline level recommended outside bedroom windows for undisturbed sleep.

At location E the measured night time L_{Aeq} level was 60 dB(A). This location was dominated both day and night by road traffic on the A5103. It is likely that this road traffic source would contribute to the elevated day and night time ambient noise levels at location E.

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5 Conclusions

Noise data has been collected from six locations on and in the vicinity of the Airbus site (the Installation) over a continuous period of one week. Additional monitoring was undertaken at seven locations around the perimeter of the Installation during the night time period of 0000hrs to 0330hrs. Airbus have added a further three locations to the long term unattended monitoring network to include the nearest noise sensitive receptors.

The results from the monitoring were compared with the previous years' data and found that the ambient one week noise levels have not increased at locations A and C and have increased by 1 dB at location B when compared to 2010 data. This increase is likely attributable to temporary construction works that were present in the vicinity of the survey location.

The results of the long term measurements, averaged over the night time period 2300hrs to 0500hrs indicates an increase at all of the on-site locations when compared to previous years' data. This is likely due to the high average wind speeds recorded at the closest METAR weather station rather than an increase in noise levels from the Installation. This view is supported by the decrease in measured noise levels at off site locations during the short term attended measurements made on the 19th June and 21st July 2015 when compared to previous years' data.

The noise data suggests that no significant increase in noise level has occurred in the vicinity of the Installation that can be attributed to the permitted operations and therefore the risk of noise complaints remains low when compared to previous surveys undertaken.

Appendix A

Survey Locations

Figure 1: Long term unattended survey locations



Figure 2: Short term attended survey locations



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Appendix B

Instrumentation

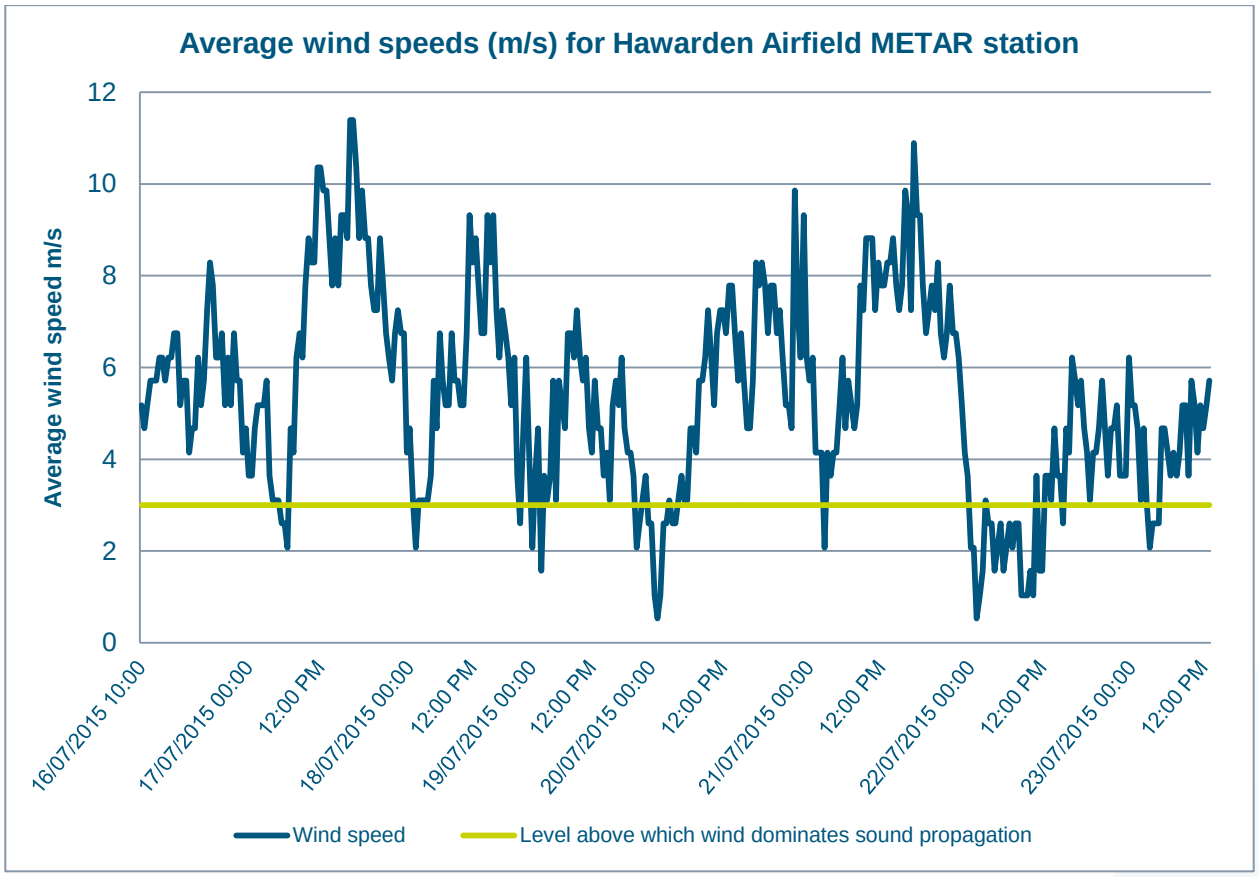
Location	Instrument	Serial number	Calibration due date at time of survey
A	Brüel and Kjær 2250	2644991	12 June 2016
	Microphone - 4189	2275433	04 June 2016
B	Norsonic Nor 118	30545	21 May 2016
	Microphone – GRas 40 AS	138396	04 February 2016
C	Brüel and Kjær 2250	2488353	31 July 2015
	Microphone - 4189	2470185	30 July 2015
D	Brüel and Kjær 2250	2506362	04 June 2016
	Microphone - 4189	2198156	04 June 2016
E	Norsonic Nor 118	30544	18 June 2016
	Microphone – GRas 40 AS	138394	04 February 2016
F	Brüel and Kjær 2250	2590499	12 June 2016
	Microphone - 4189	2275447	04 June 2016
Short term attended	Rion NL-32	00620155	26 July 2016
	Microphone Rion UC-53A	319829	26 July 2016
All	Brüel and Kjær 4231 calibrator	2343100	13 May 2016

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Appendix C

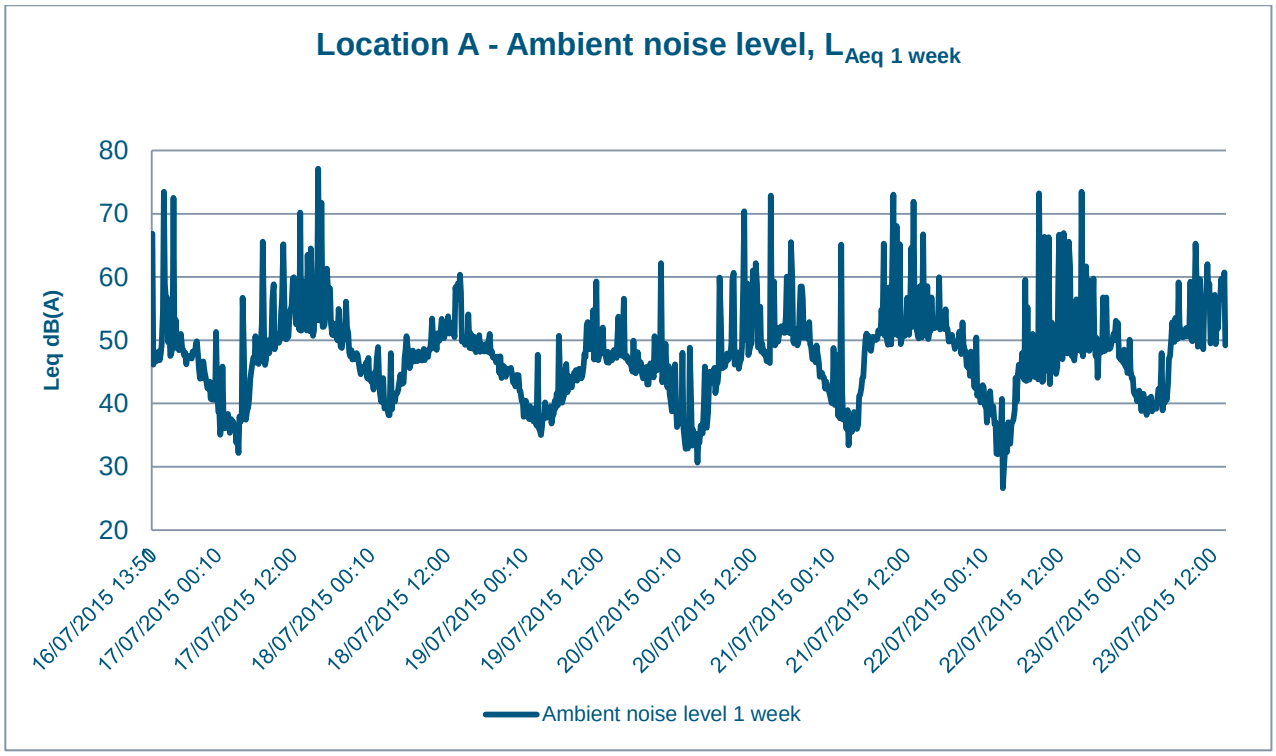
Graphs

Graph 1: Average wind speeds (m/s) for Hawarden Airfield METAR station[5] 16th July 2015 to 23rd July 2015

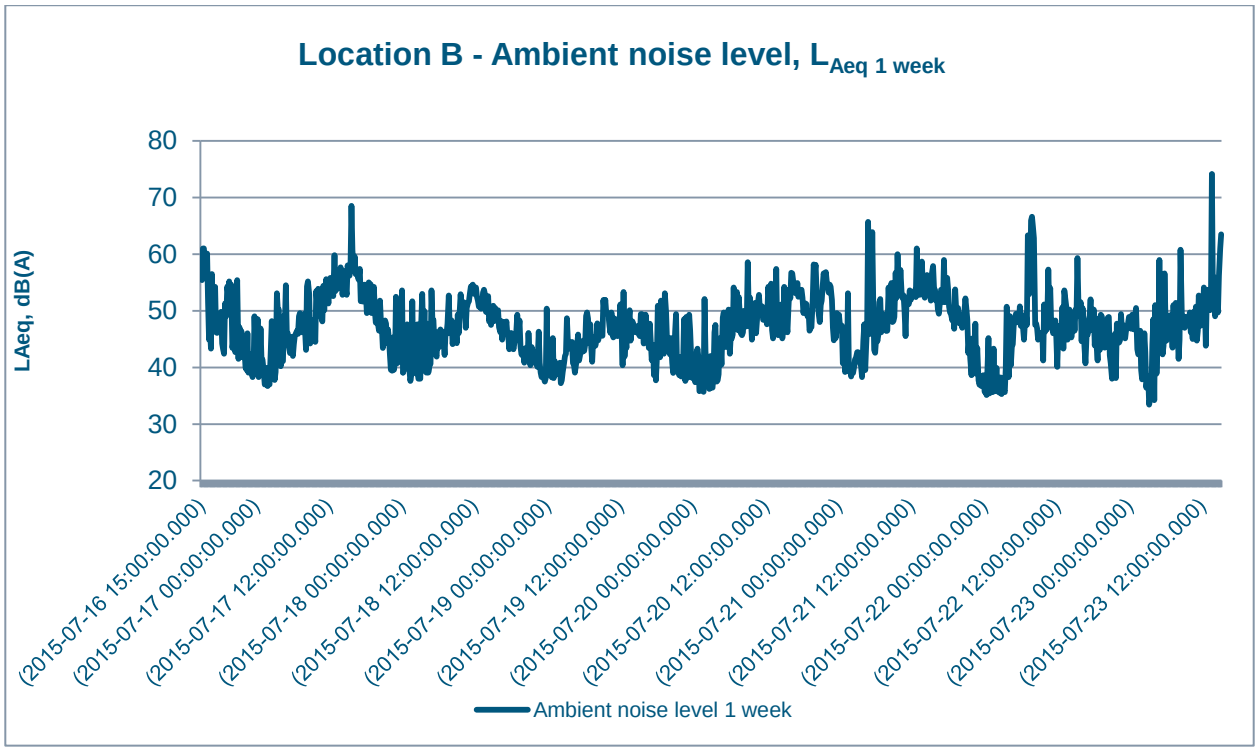


[5] *http://www.wunderground.com/history/station/03321/2015/08/06/DailyHistory.html. Data accessed 29/07/2015.*

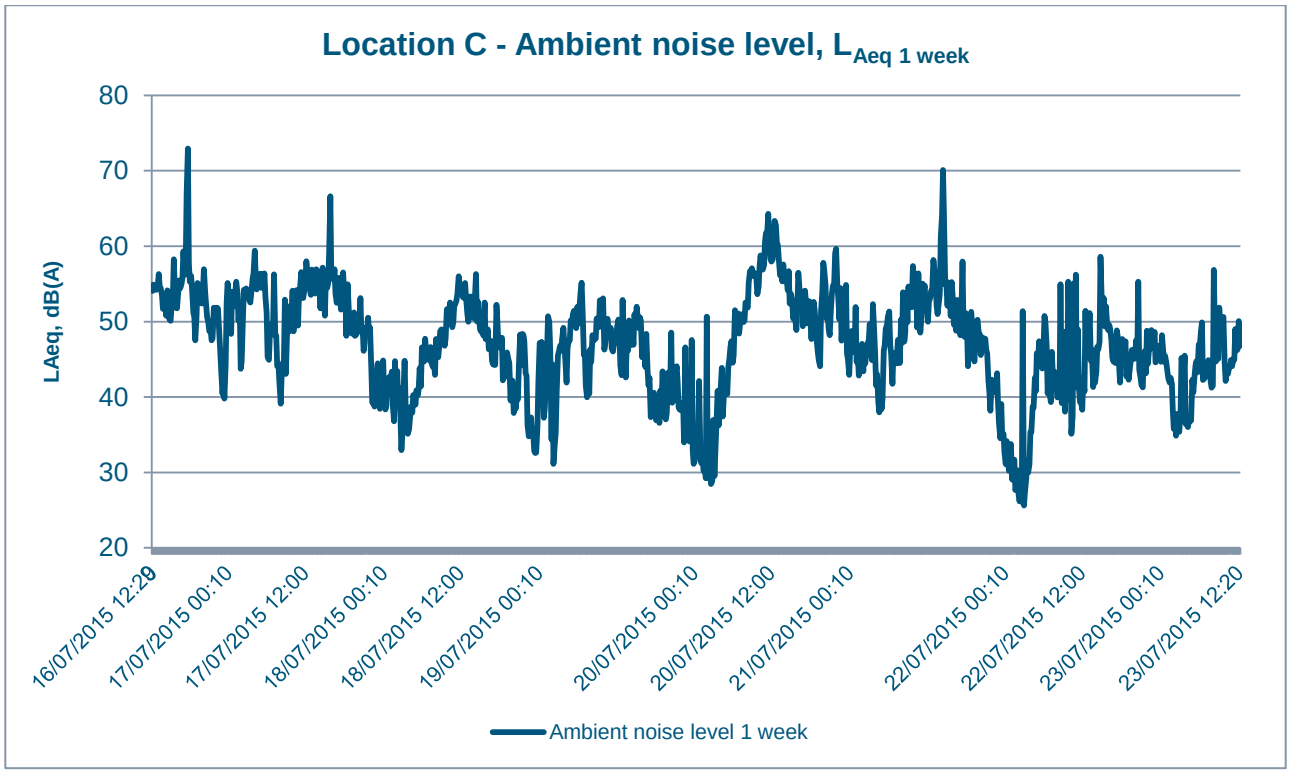
Graph 2: Location A - Long term unattended ambient noise level



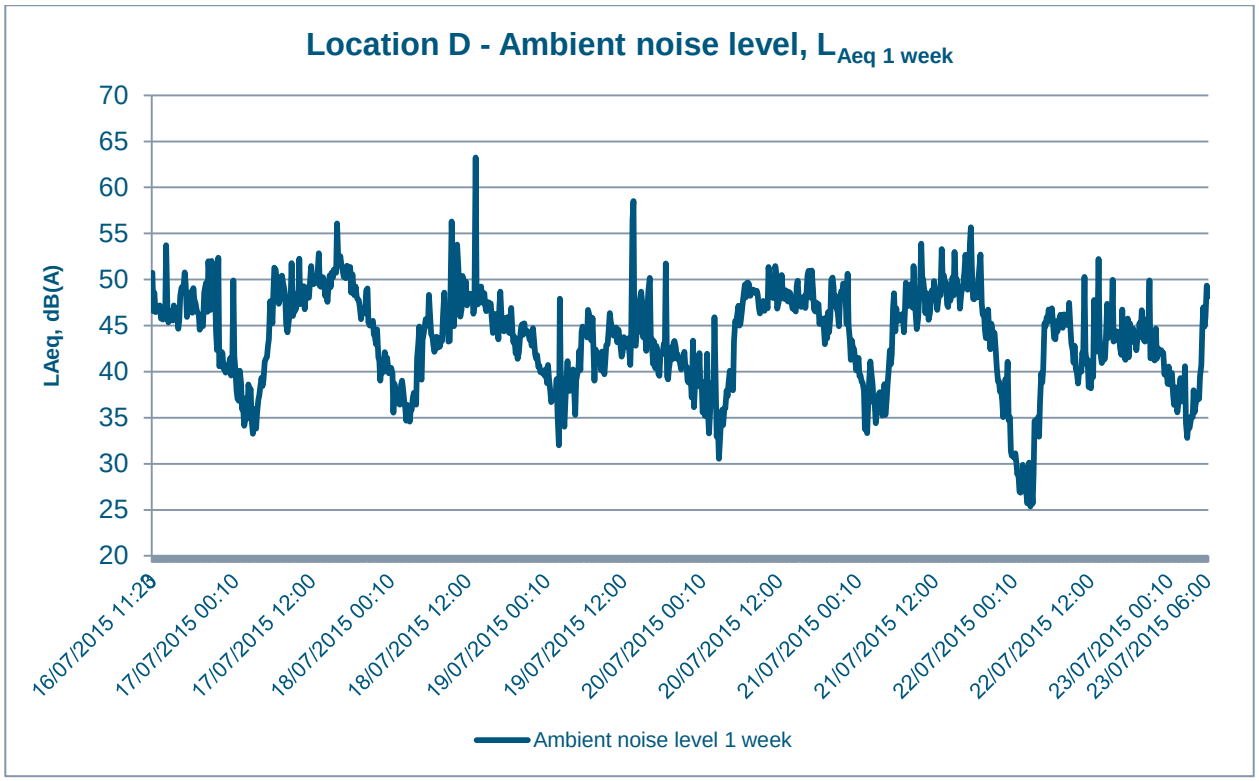
Graph 3: Location B - Long term unattended ambient noise level



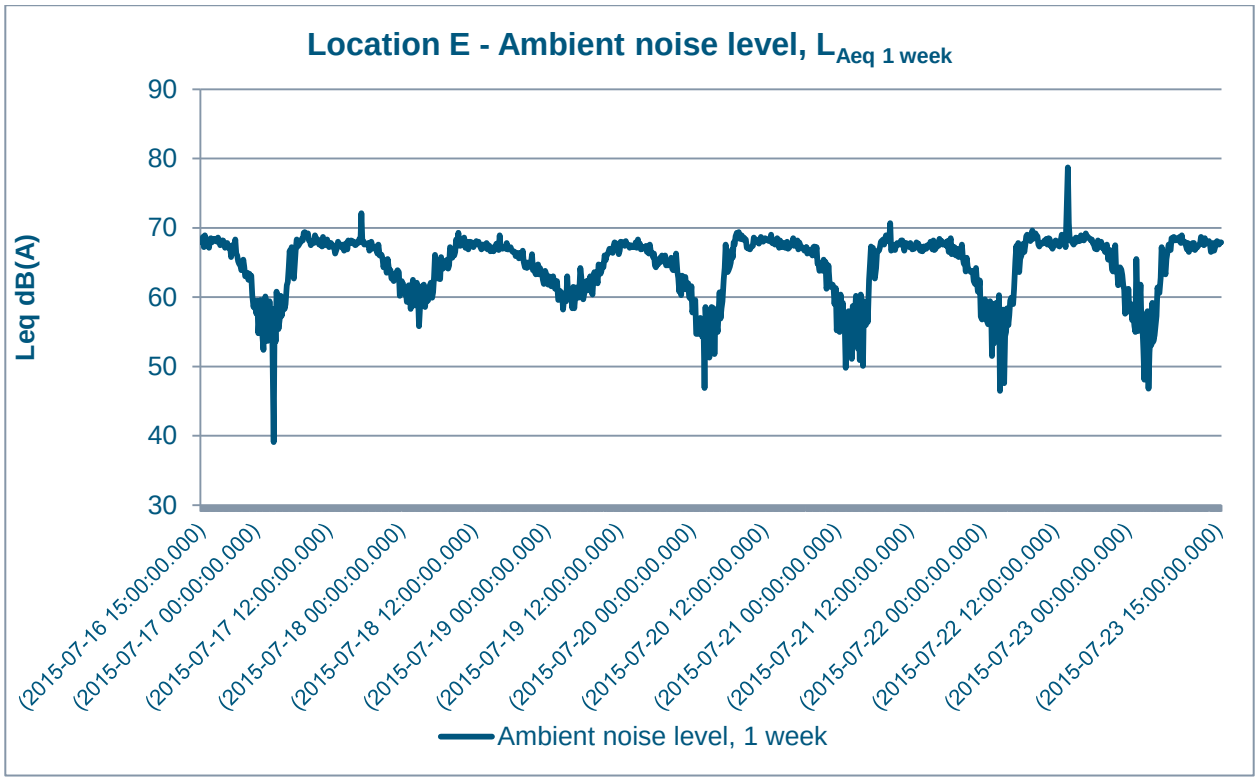
Graph 4: Location C - Long term unattended ambient noise level



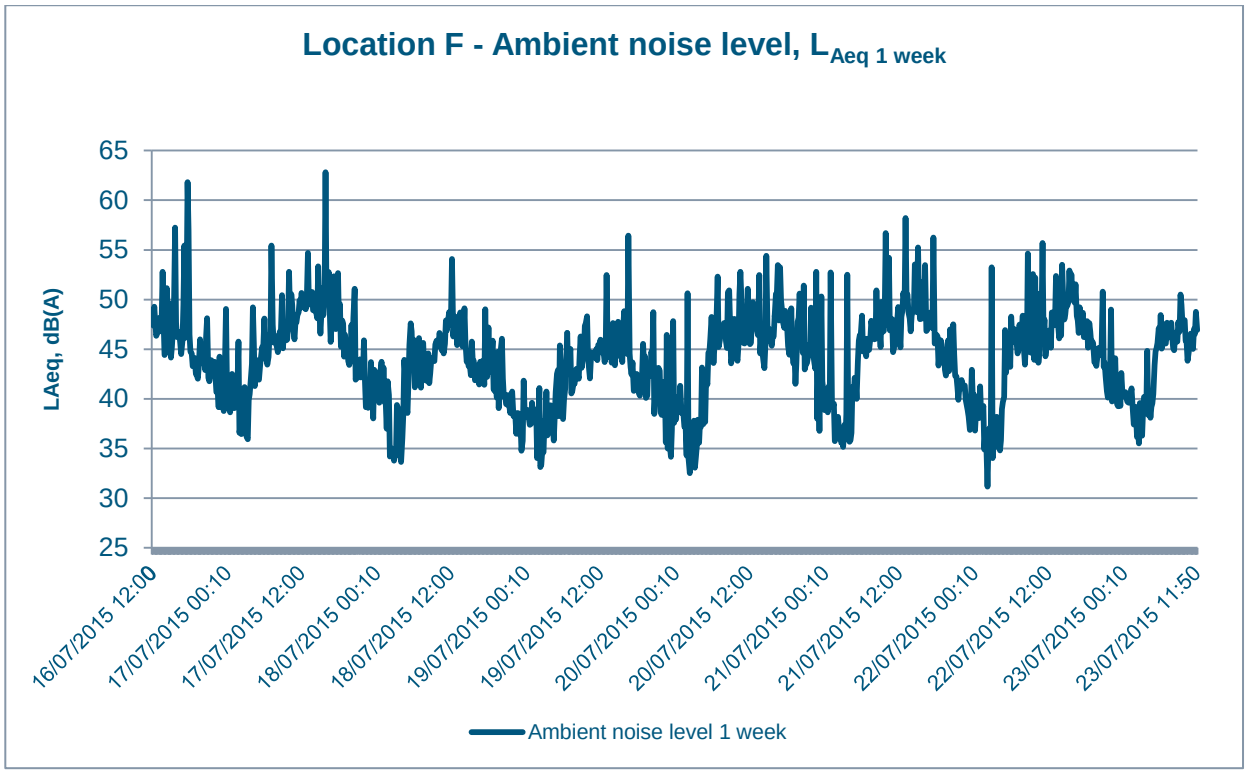
Graph 5: Location D - Long term unattended ambient noise level



Graph 6: Location E - Long term unattended ambient noise level



Graph 7: Location F - Long term unattended ambient noise level



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Appendix D

Results of night noise survey – 21 July 2015

Survey location	Time	Duration mm:ss	L_{Aeq} dB	L_{AFMax} dB	L_{AF10} dB	L_{AF90} dB	Comments
1. St Mary's Way	02:12	15:00	50	61	52	35	Occasional road traffic from A5104 and B5125. One car passing and three HGV's between 02:15:24 and 02:23:26.
2. Car park to the rear of the Glynne Arms public house	01:50	15:00	48	68	48	41	Occasional noise from fork lift trucks and loading activity of HGV on Airbus site. One car passing on A5104. Delivery van moving on Airbus site at 02:00:00. Continuous broadband roar just audible from roofline of building immediately to the north, on Airbus.
3. Copse Lane	01:29	15:00	42	60	44	37	Continuous whine audible from direction of Airbus. Occasional distant road traffic noise. Helicopter passing to the south east at 01:38:00.
4. Well House Farm	01:07	15:00	44	61	47	37	Distant road traffic from the south and trees rustling. Just audible continuous broadband noise from direction of Airbus. Reversing bleeper at 01:18:29. Direction not determined.
5. Cop House Farm	00:44	15:00	47	74	43	32	Distant road traffic just audible. One train in distance and one car passing. Continuous broadband roar just audible and determined to be from a building within farmyard. Trees rustling throughout. No sound audible from Airbus.
6. Beeches Farm	00:22	15:00	49	72	48	38	Distant road traffic. Three cars passing and one van. Trees rustling throughout

							monitoring period. No sound audible from Airbus.
	02:35	15:00	45	70	41	32	Occasional road traffic from local road network. Intermittent hiss/air pressure release audible from direction of A380 building on Airbus. One lorry passing at 02:39:23. Birdsong occasional.
7. Manor Crescent	00:02	15:00	41	53	44	36	Distant road traffic and occasional domestic noise. Trees rustling throughout. No sound audible from Airbus.
	02:56	15:00	39	50	41	36	Distant road traffic noise audible throughout. Trees rustling.

Meteorology: Part cloudy, no precipitation, breezes with average wind speeds 2-3 m/s, gusts 4 m/s. Wind direction westerly. Air temperature: 16.0°C.

Results of night noise survey – 19 June 2015

Survey location	Time	Duration mm:ss	L_{Aeq} dB	L_{AFMax} dB	L_{AF10} dB	L_{AF90} dB
1. St Mary's Way	02:14	15:00	48.8	68.2	49	36.3
2. Car park to the rear of the Glynne Arms public house	01:52	15:00	48.7	67.4	50.4	43.2
3. Copse Lane	01:32	15:00	43.7	57.0	46.5	39.7
4. Well House Farm	01:12	15:00	42.4	55.9	45.7	35.5
5. Cop House Farm	00:48	15:00	34.5	47.6	36.1	31.8
6. Beeches Farm	00:27	15:00	50.6	74.5	41.2	33.6

7. Manor Crescent	00:04	15:00	38.3	50.1	41.8	31.8

Meteorology: Part cloudy, no precipitation, breezes with wind speeds measured at 2-3m/s at each location.

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Appendix E

Glossary of Acoustic Terms

Term	Description
Decibel (dB)	A unit of noise level derived from the logarithm of the ratio between the value of a quantity and a reference value. It is used to describe the level of many different quantities. For sound pressure level the reference quantity is 20 µPa, the threshold of normal hearing is 0dB, and 140dB is the threshold of pain. A change of 1dB is only perceptible under controlled conditions. Under normal conditions a change in noise level of 3dB(A) is the smallest perceptible change.
dB(A)	Decibels measured on a sound level meter incorporating a frequency weighting (A weighting) which differentiates between sounds of different frequency (pitch) in a similar way to the human ear. Measurements in dB(A) broadly agree with people's assessment of loudness. A change of 3 dB(A) is the minimum perceptible under normal conditions, and a change of 10 dB(A) corresponds roughly to halving or doubling the loudness of a sound. The background noise level in a living room may be about 30 dB(A); normal conversation about 60 dB(A) at 1 metre; heavy road traffic about 80 dB(A) at 10 metres; the level near a pneumatic drill about 100 dB(A).
$L_{Aeq,T}$	The equivalent continuous sound level – the sound level of a notionally steady sound having the same energy as a fluctuating sound over a specified measurement period (T). $L_{aeq,\ T}$ is used to describe many types of noise and can be measured directly with an integrating sound level meter.
$L_{A10,T}$	The A weighted noise level exceeded for 10% of the specified measurement period (T). L_{A10} is the index generally adopted to assess traffic noise.
$L_{A90,\ T}$	The A weighted noise level exceeded for 90% of the specified measurement period (T). In BS 4142: 1990 it is used to define the 'background' noise level.
L_{Amax}	The maximum A-weighted sound pressure level recorded during a measurement.
L_{Amin}	The minimum A-weighted sound pressure level recorded during a measurement.
R_w	The weighted sound reduction index, R_w, is a single figure description of sound reduction index which is defined in BS EN ISO 717-1: 1997. The R_w is calculated from measurements in an acoustic laboratory to BS EN ISO 140-3:1997 and ratings to BS EN ISO 717-1:1997. Sound insulation ratings derived from site (which are invariably lower than the laboratory figures) are referred to as the R'_w ratings (apparent weighted sound reduction index) and measured to BS EN ISO 140-4:1998