

WEPCo | Cardiff and Vale College (CAVC)

Advanced Technology Centre (ATC)

Building services noise assessment for planning

Reference: VG0101-ARP-XX-XX-RP-Y-00011

P02 | 11 March 2024



This report takes into account the particular instructions and requirements of our client. It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 287279-00

Arup International Projects Limited
One Centenary Way
Birmingham, B3 3AY
United Kingdom
arup.com

Document Verification

Project title Advanced Technology Centre (ATC)
Document title Building services noise assessment for planning
Job number 287279-00
Document ref VG0101-ARP-XX-XX-RP-Y-00011
File reference

Revision	Date	Filename			
P01	18 January 2024	Description	First issue for PAC		
			Prepared by	Checked by	Approved by
		Name	Laura McLeod BSc Hons MSc AMIOA	Matthew Gray MSci PgDip MIOA	Adrian Passmore BEng CEng MIOA
		Signature			
P02	11 March 2024	Filename			
		Description	Final issue for PAC		
			Prepared by	Checked by	Approved by
		Name	Laura McLeod BSc Hons MSc AMIOA	Matthew Gray MSci PgDip MIOA	Adrian Passmore BEng CEng MIOA
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			

Issue Document Verification with Document

Contents

1.	Introduction	1
1.1	Overview of the proposal development	1
2.	Noise policy, guidance and standards	1
3.	Baseline noise climate	2
4.	Building services noise emissions	3
4.1	Assessment criteria	3
4.2	Building services equipment	3
4.3	Predicted noise levels at nearest sensitive receptors	4
5.	Conclusions	5

Tables

Table 1:	Summary of baseline noise levels	2
Table 1:	Building services noise emission limits	3
Table 2:	Sound power levels for each building services items	4
Table 3:	Specific sound levels at the noise sensitive receptors	5
Table 3:	Measurement instrumentation	A-3
Table 4:	Measured sound pressure levels at Location A1	A-4
Table 5:	Measured sound pressure levels at Location A2	A-5
Table 6:	Measured sound pressure levels at Location A3	A-6
Table 7:	Measured sound pressure levels at Location A4	A-7
Table 8:	Measured sound pressure levels at Location A5	A-8
Table 9:	Measured sound pressure levels at Location A6	A-9
Table 11:	Noise levels affecting the school for façade design for the ATC site	A-11
Table 12:	Background noise levels for building services target noise levels for the ATC site.	A-11

Appendices

Appendix A	A-1
Baseline noise survey report	A-1
A.1 Introduction	A-2
A.2 Measurement results	A-3
A.3 Summary	A-11
Appendix B	B-12
MEP Plant layouts	B-12
Appendix C	C-14
Glossary of Acoustic Terminology	C-14

1. Introduction

This report provides an assessment of building services noise emissions in support of the planning application for the Advanced Technology Centre (ATC). It demonstrates how noise emissions from the proposed development have been limited through design so that there will be little risk of causing disturbance or unacceptable impact to the nearest noise-sensitive receptors at Blackton Lane.

The following appendices are included with this report:

Appendix A – Baseline Noise Survey Report

Appendix B – MEP Plant Locations

Appendix C – Glossary of Acoustic Terminology

1.1 Overview of the proposal development

The proposed development comprises a three-storey college building containing a range of vocational teaching spaces, and associated landscaping. The noise sources associated with the development that require assessment for planning approval are roof-mounted air handling equipment and an air source heat pump compound located to the north of the building, at ground level.

2. Noise policy, guidance and standards

This assessment has been undertaken with regard to the following planning policy, guidance and standards:

- Technical Advice Note 11¹ (TAN 11)
 - Provides guidance to ensure that noise generating development does not cause an unacceptable degree of disturbance and recommends that noise from industrial and commercial development be assessed following BS 4142: 1990. Arup has used the current version of this standard (see below) to assess noise emissions from the proposed development.
 - TAN 11 also requires consideration of whether proposals for new noise-sensitive development would be incompatible with the prevailing noise conditions at the site. To the extent that the proposed development is a noise-sensitive development this has been managed through the design of the building in accordance with Building Bulletin 93² (BB93), which limits the amount of noise exposure to internal teaching spaces by suitable sound insulation design of the façade.
- Vale of Glamorgan Local Development Plan 2011-2026³ (LDP)
 - Policy MD2 states that proposals should “safeguard existing public and residential amenity, particularly with regard to privacy, overlooking, security, noise and disturbance.”
 - Policy MD5 states that “new development within settlement boundaries will be permitted where the proposed development has no unacceptable impact on the amenity and character of the locality by way of noise.”
 - Policy MD7 states that “development proposals will be required to demonstrate they will not result in unacceptable impact on people, residential amenity, property and / or the natural environment from noise and vibration”

¹ Welsh Government (1997) Planning Guidance (Wales), Technical Advice Note (Wales) 11, Noise

² Education Funding Agency. Building Bulletin 93: acoustic design of schools. v17. 2015

³ Vale of Glamorgan Council (2017). Local Development Plan (2011-2026)

- The LDP does not set numerical requirements for noise limits to achieve these policies, however, Arup has established noise limits at a level that will avoid any noise impacts on people, residential amenity, and existing properties.
- Cardiff Airport and Gateway Development Zone Supplementary Planning Guidance⁴ (SPG)
 - Requires proposals to ensure that future occupiers are not adversely impacted by the noise created by aircraft. Arup’s baseline noise survey captured the existing noise climate (including noise from aircraft) and used this to inform the design of the building in accordance with BB93. Achieving the internal noise limits in BB93 will ensure that the future occupiers are not adversely impact by aircraft noise.
- BS4142:2014+A1:2019 Methods for rating and assessing industrial and commercial sound
- BS7445:2003 Description and measurement of environmental noise

3. Baseline noise climate

Arup conducted a baseline noise survey which was documented in the Baseline Noise Survey Report included in Appendix A. Table 1 summarises the baseline noise levels across the site (refer to Figure 1 for measurement locations).

Location (see Figure 1)	Time period	Typical daytime ambient sound level, dB L _{AeqT}	Typical daytime background sound level, dB L _{A90}
A1	Day (0700-2300)	64	45
	Night (2300-0700)	53	28
A2	Day (0700-2300)	47	41
	Night (2300-0700)	43	32
A3	Day (0700-2300)	51	41
	Night (2300-0700)	37	29
U1 (School site)	Day (0700-2300)	53	45

Table 1: Summary of baseline noise levels

⁴ Vale of Glamorgan Council (2019). Vale of Glamorgan Local Development Plan 2011-2026, Cardiff Airport & Gateway Development Zone Supplementary Planning Guidance, December 2019.

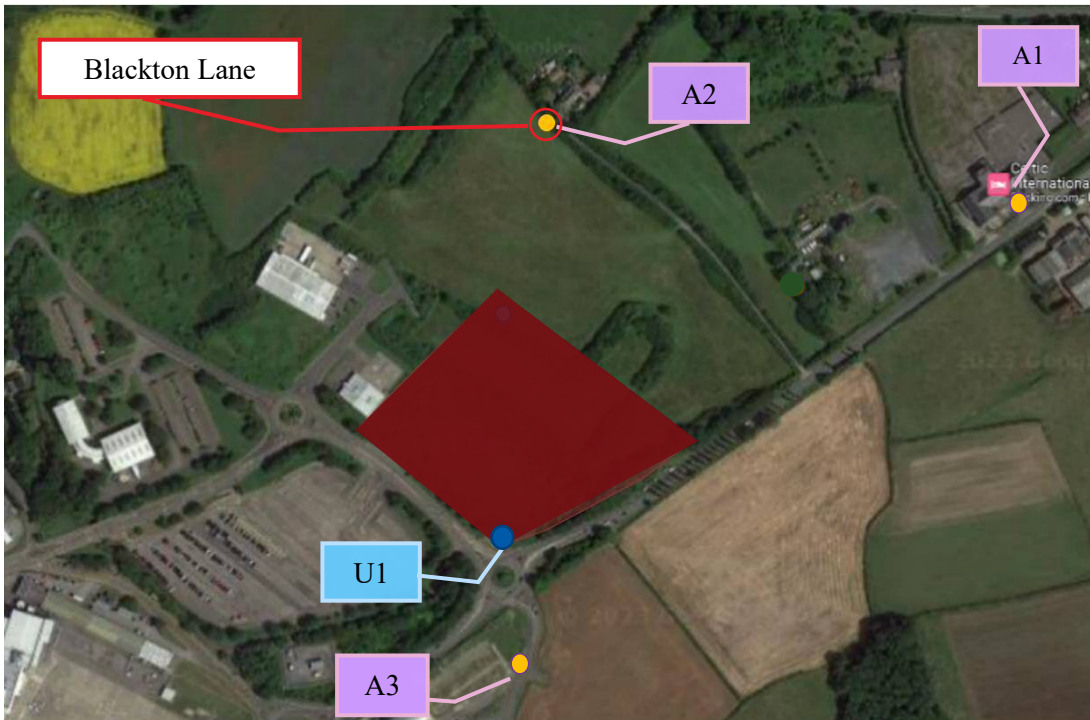


Figure 1: ATC site map and measurement locations.

4. Building services noise emissions

4.1 Assessment criteria

The proposed development is targeting BREEAM accreditation, and because of this the acoustic design has been informed by the BREEAM credit Po1 05, which requires limiting noise emissions to 5dB below the prevailing background noise level at the nearest sensitive receptors. Table 2 shows the adopted building services noise rating limits. Noise emissions at this level will typically not be discernible amongst the prevailing ambient noise and therefore would most likely result in no impact at the nearest sensitive receptors.

Property (see Figure 1)	Assessment period	Typical daytime background sound level, dB L_{A90}	Building services noise rating limit, $dBL_{Ar,Tr}$
Blackton Lane	Day (0700-2300)	41	36
	Night (2300-0700)	32	27 ¹

Notes: ¹ Where background sound levels and rating levels are low, BS4142 states absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night. In this case, an absolute noise emissions rating limit of $35L_{Ar,Tr}$ would mean that noise intrusion to residences would be less than 25dBA assuming a worst-case open window scenario, which is 5dB less than the internal night-time noise limit in bedrooms recommended in BS8233.

Table 2: Building services noise emission limits

4.2 Building services equipment

The principal items of building services plant that require consideration are:

- 7 x Air Source Heat Pump (ASHP)
- 3 x Air Handling Unit (AHU)

Quieter plant items such as the hybrid ventilation and heat recovery units to classrooms do not require assessment because they produce noise levels of <30dBA at a distance of 2m (which would be significantly more than 10dB below the background noise level at the nearest sensitive receptors) and therefore will not contribute to the overall noise emissions at the nearest sensitive receptors.

At this point in the design (RIBA Stage 3), accurate selections and noise data for all items are not available, so we have assumed sound power levels for the air handling units (including attenuation) based on similarly-sized items from previous projects.

Table 3 shows the sound power levels for the principal building services plant items including attenuation and operating at full design duty. Other building services plant items not listed in Table 3 are much quieter and are not significant in terms of the overall noise emissions. A mark-up of plant item locations are included in Appendix B.

Item	Noise source	A-weighted sound power level, dBA
AHUs	Fresh air	68
	Exhaust	84
	Casing-radiated	58
ASHPs	Casing-radiated	83

Table 3: Sound power levels for each building services items

The following attenuation measures have been incorporated into the design and included for the purpose of this assessment:

- An acoustic louvre (NAL300C) for the ASHP enclosure of 3.5m height
- 900mm attenuators on the exhaust and fresh air connections of the AHUs

Building services will operate at design duty during teaching hours, and at a reduced duty in the evenings. As a worst-case, the assessment assumes that plant is operating at full design duty throughout the daytime and evening (0700-2300).

During the night, the air handling units will not operate and only one air source heat pump will operate (compared to six during the day). Furthermore, the one air source heat pump will operate at a maximum 50% of design duty. All of this combined means that building services noise emissions will be at least 1 dB quieter during the night, compared to the day.

4.3 Predicted noise levels at nearest sensitive receptors

Noise levels at the nearest sensitive receptors have been calculated using the methods defined in BS 4142, taking into account the following:

- Distance attenuation between the various items of plant and the receptor location
- Barrier effects from buildings and plant screens
- Hard ground conditions between source and receptor location

Table 4 compares the predicted noise level from the proposed building services (the ‘rating level’) to the noise rating limit established in section 4.1, at each assessment location.

The ‘specific sound level ($L_{Aeq,Tr}$) is the noise produced solely by the new source(s), and is subject to corrections where it displays an identifiable acoustic feature, such as tonality, impulsiveness, or intermittency (or any combination of these), to provide a ‘rating level’ ($L_{Ar,Tr}$). No acoustic feature corrections are necessary for the proposed plant items.

Property	Assessment period	Building services noise rating limit, $dB_{L_{Ar,Tr}}$	Specific sound level, $dB_{L_{Aeq}}$	Acoustic feature correction	Rating level, $dB_{L_{Ar,Tr}}$	Excess of rating level over proposed limit	Assessment outcome (in BS 4142 terms)
Blackton Lane	Day	36	31	+0	31	-6	No impact
	Night	35	20	+0	20	-15	No impact

Table 4: Specific sound levels at the noise sensitive receptors

The assessment in Table 4 shows that the rating level of the proposed building services noise satisfies the proposed limits and will be below the prevailing background noise level at the receptors. As a result, noise from the proposed building services will have no impact on the receptors.

5. Conclusions

Based on the RIBA Stage 3 design the building services noise emissions are capable of satisfying the limits established for the project, which would result in no impact at the nearest sensitive receptors.

Further design development is required to ensure that the finalised installation can achieve the noise emissions criteria.

Appendix A

Baseline noise survey report

A.1 Introduction

An environmental baseline noise survey has been undertaken to determine the existing noise climate and character at proposed site, the Advanced Technology Campus near Cardiff Airport. This report details the baseline noise survey and results.

The aims of the noise survey were to:

- Establish the noise levels to inform the building envelope and ventilation strategy of the college.
- Establish the background noise levels at the nearest sensitive receptors for specifying plant noise limits.

The noise survey work was carried out by Laura McLeod and Gina Mackworth of Arup, with attended measurements taken between 14 June and 15 June 2023 and unattended measurements taken between 14 June and 15 June 2023.

A.1.1 ATC Site description

A map of the Advanced Technology Campus (ATC) site and noise measurement locations are shown in Figure 2 below. At the ATC site, the surrounding roads are Port Road, Tredogan Road and the A4226. The general noise environment is dominated by road traffic on Port Road and A4226 which are to the Southeast and North of the site respectively. There is also noise from occasional aircraft from Cardiff Airport which is situated 500m from the site. Aircraft were observed to pass to the south of the site rather than directly over the site.

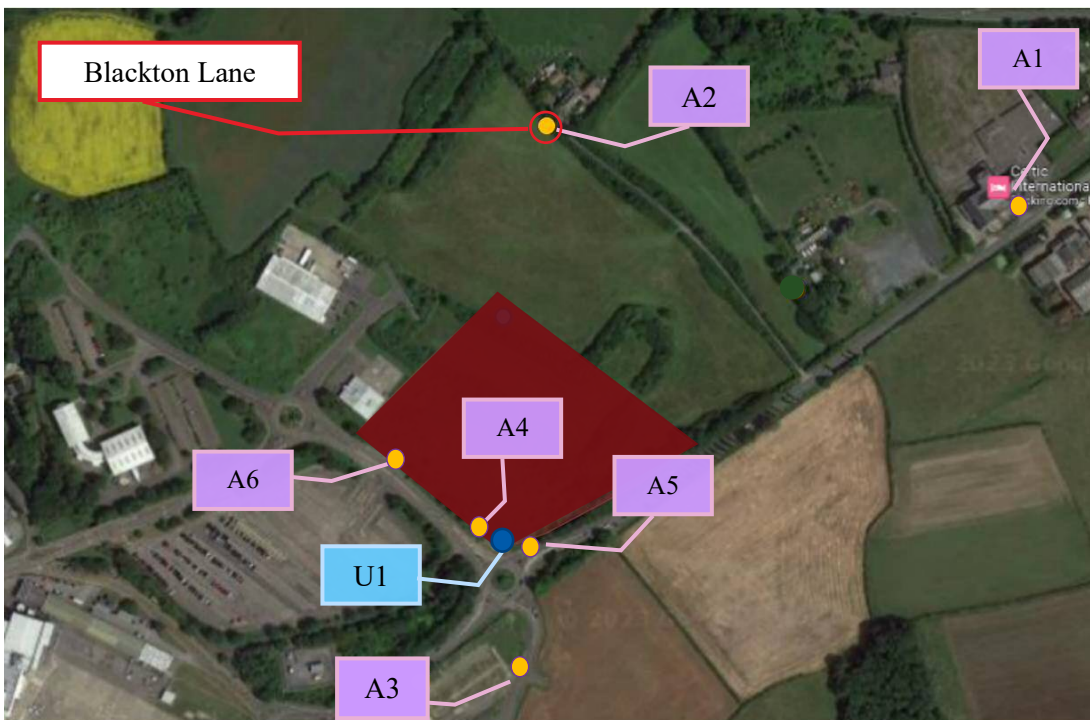


Figure 2: ATC site map and measurement locations.

A.1.2 Instrumentation

The sound level meters (SLMs), microphones and sound pressure level calibrators used by Arup are Class 1 instruments, conforming to BS EN 61672-1:2013. All Arup instrumentation is calibrated annually and has full traceable calibration to national and international standards, which are undertaken by an accredited calibration laboratory. Calibration certificates can be provided upon request.

Each SLM was checked for correct calibration before and after each series of measurements. No significant fluctuation in level was noted throughout each survey period.

All of the SLMs and other related noise monitoring instrumentation used to undertake the survey is described in Table 3 below.

Description	Serial number	Item type
Norsonic 140	1405202	Sound Level Meter
Norsonic 1225	151245	Microphone
Norsonic 1209	15264	Preamp
Norsonic 1251	33554	Calibrator
Rion NL-52	264534	Sound Level Meter
Rion UC-59	22045	Microphone
Rion NH-25	22163	Preamp
Rion NC-74	34824366	Calibrator
Rion NL-52	120480	Sound Level Meter
Rion UC-59	03152	Microphone
Rion NH-25	10479	Preamp
Rion NC-74	35015346	Calibrator

Table 5: Measurement instrumentation

A.1.3 Measurement methodology

At each location, the L_{Aeq} , L_{A90} , L_{A10} and L_{Amax} metric parameters were measured and recorded. All broadband measurements were A-weighted and used a fast time constant (0.125s).

At each measurement location, the SLM was mounted on a tripod with the microphone set between 1.2m to 1.5m above local ground level. All measurements were taken under acoustically free-field conditions. The appropriate windshield for the SLM was fitted to the microphone throughout to minimise wind-induced noise. Measurements were made in clear and dry conditions with wind speed below 5m/s.

Attended measurements of 15 minutes in duration were made at locations A1, A2, and A3 for the plant noise limits and 30 minutes in durations at A4 and A5 for building envelope and ventilation strategy measurements. Unattended measurements consisting of a set of continuous 5-minute duration measurements were made at location U1 from 14/06/2023 13:40 until 15/06/2023 13:40. In each case, the time period was appropriate to provide a good representation of the typical noise climate at the measurement location.

A.2 Measurement results

A.2.1 Attended measurements

The summary tables for each measurement location provide an arithmetic average of the individual measurements during each time period for the range of values for L_{A90} , L_{A1} , L_{Aeq} , L_{A10} and L_{Amax} .

A.2.1.1 Location A1 – Celtic International Hotel Car Park (ATC)

Location description:

Celtic International Hotel Car Park along Port Road around 5m away from the road edge.

Environment and observations:

Dominant road traffic noise on Port Road.

Measurement period:

Wed 14/06/2023 00:30 to Thu 15/06/2023 09:15

Personnel: Laura McLeod, Gina Mackworth

Additional comments :

None



Figure 2: SLM setup at location A1

Date	Time		Sound Pressure Level, dB(A) (re 20 µPa)					Comments
	Start [hh:mm]	Duration [hh:mm:ss]	L ₁	L ₉₀	L _{eq}	L ₁₀	L _{max}	
Day (0700-1900)								
14/06/2023	18:50	00:15:00	72	43	63	68	76	Dominant noise source road traffic noise on Port Road.
15/06/2023	09:00	00:15:00	74	47	65	69	80	
Night (2300-0700)								
14/06/2023	00:30	00:15:00	65	26	53	46	81	Occasional passbys on Port Road, dominant noise source A4226. Max sound level caused by speeding vehicle.
14/06/2023	01:45	00:15:00	64	28	52	44	78	

Table 6: Measured sound pressure levels at Location A1

A.2.1.2 Location A2 – Blackton Lane (ATC)

Location description:

Located near the residential properties at the end of Blackton Lane.

Environment and observations:

Dominant road traffic source from A4226. Some occasional aircraft passbys from Cardiff airport.

Measurement period:

Wed 14/06/2023 00:55 to Wed 14/06/2023 11:55

Personnel:

Laura McLeod, Gina Mackworth

Additional comments:

None



Figure 3: SLM setup at location A2

Date	Time		Sound Pressure Level, dB(A) (re 20 µPa)					Comments
	Start [hh:mm]	Duration [hh:mm:ss]	L ₁	L ₉₀	L _{eq}	L ₁₀	L _{max}	
Day (0700-1900)								
14/06/2023	11:40	00:15:00	54	42	47	50	65	Dominant noise source road traffic noise on A4226.
Evening (1900-2300)								
14/06/2023	19:20	00:15:00	53	39	46	49	63	Dominant noise source road traffic noise on A4226.
Night (2300-0700)								
14/06/2023	00:55	00:15:00	52	28	41	45	57	Dominant noise source road traffic noise on A4226.
13/06/2023	23:35	00:15:00	52	34	44	48	57	

Table 7: Measured sound pressure levels at Location A2

A.2.1.3 Location A3 – Holiday Inn Car Park (ATC)

Location description:

Holiday Inn car park, approximately 100m from Port Road.

Environment and observations:

Dominant road traffic noise on Port Road

Measurement period:

Wed 14/06/2023 01:20 to Thu 15/06/2023 11:35

Personnel:

Laura McLeod, Gina Mackworth

Additional comments:

None



Figure 4: SLM setup at location A3

Date	Time		Sound Pressure Level, dB(A) (re 20 µPa)					Comments
	Start [hh:mm]	Duration [hh:mm:ss]	L ₁	L ₉₀	L _{eq}	L ₁₀	L _{max}	
Day								
15/06/2023	11:20	00:15:00	65	41	52	50	72	Dominant noise source road traffic noise on Port Road.
Evening								
14/06/2023	19:50	00:15:00	61	41	50	53	66	Dominant noise source road traffic noise on Port Road.
Night								
14/06/2023	01:20	00:15:00	47	28	37	40	51	Dominant noise source road traffic noise on Port Road. Occasional pedestrians.
14/06/2023	00:05	00:15:00	57	29	56	46	87	

Table 8: Measured sound pressure levels at Location A3

A.2.1.4 Location A4 – Tredogan Road (ATC)

Location description:

Adjacent to the roundabout of Port Road and Tredogan Road, closer to Tredogan Road.

Measurement duration:

Thu 15/06/2023 09:30
to
Thu 15/06/2023 10:00

Personnel:

Laura McLeod, Gina Mackworth

Additional comments :

None

Environment and observations:

Dominant road traffic noise on Port Road to the airport and occasional car passbys on Tredogan Road. Occasional aircraft noise to the south of the measurement location from Cardiff Airport.



Figure 5: SLM setup at location A4

Date	Time		Sound Pressure Level, dB(A) (re 20 µPa)					Comments
	Start [hh:mm]	Duration [hh:mm:ss]	L ₁	L ₉₀	L _{eq}	L ₁₀	L _{max}	
Day								
15/06/2023	09:30	00:30:00	68	45	58	62	78	Dominant noise source road traffic noise from Port Road. Occasional passbys on Tredogan Road. Occasional aircraft noise.

Table 9: Measured sound pressure levels at Location A4

A.2.1.5 Location A5 – Port Road roundabout (ATC)

Location description:

Adjacent to the roundabout of Port Road and Tredogan Road, closer to Port Road (around 10m).

Environment and observations:

Dominant road traffic noise on Port Road, occasional aircraft noise.

Measurement duration:

Thu 15/06/2023 10:01
to
Thu 15/06/2023 10:31

Personnel:

Laura McLeod, Gina Mackworth

Additional comments:

None



Figure 6: SLM setup at location A5

Date	Time		Sound Pressure Level, dB(A) (re 20 µPa)					Comments
	Start [hh:mm]	Duration [hh:mm:ss]	L ₁	L ₉₀	L _{eq}	L ₁₀	L _{max}	
Day								
15/06/2023	10:01	00:30:00	68	49	60	64	72	Dominant noise source road traffic noise from Port Road. Occasional passbys on Tredogan Road.

Table 10: Measured sound pressure levels at Location A5

A.2.1.6 Location A6 – Cardiff Airport Long Stay Car Park

Location description:

Along Tredogan Road opposite Cardiff Airport long stay car park.

Environment and observations:

Dominant road traffic noise on Port Road.

Measurement duration:

Thu 15/06/2023 10:35
to
Thu 15/06/2023 11:05

Personnel:

Laura McLeod, Gina Mackworth

Additional comments:

None



Figure 7: SLM setup at location A6

Date	Time		Sound Pressure Level, dB(A) (re 20 µPa)					Comments
	Start [hh:mm]	Duration [hh:mm:ss]	L ₁	L ₉₀	L _{eq}	L ₁₀	L _{max}	
Day								
15/06/2023	10:35	00:30:00	67	42	54	57	75	Dominant noise source road traffic noise from Port Road. Occasional passbys on Tredogan Road. Occasional aircraft noise.

Table 11: Measured sound pressure levels at Location A6

A.2.2 Unattended measurements

A.2.2.1 Location U1 – ATC site unattended measurement

Location description:

On the ATC site, around 10m from Port Road.

Environment and observations:

Dominant source is road traffic noise on Port Road. Occasional aircraft passbys.

Measurement duration:

Wed 14/06/2023 13:44
to
Thu 15/06/2023 13:39

Logging interval:

00:05:00

Additional comments:

None



Figure 8: Logger setup at location U1

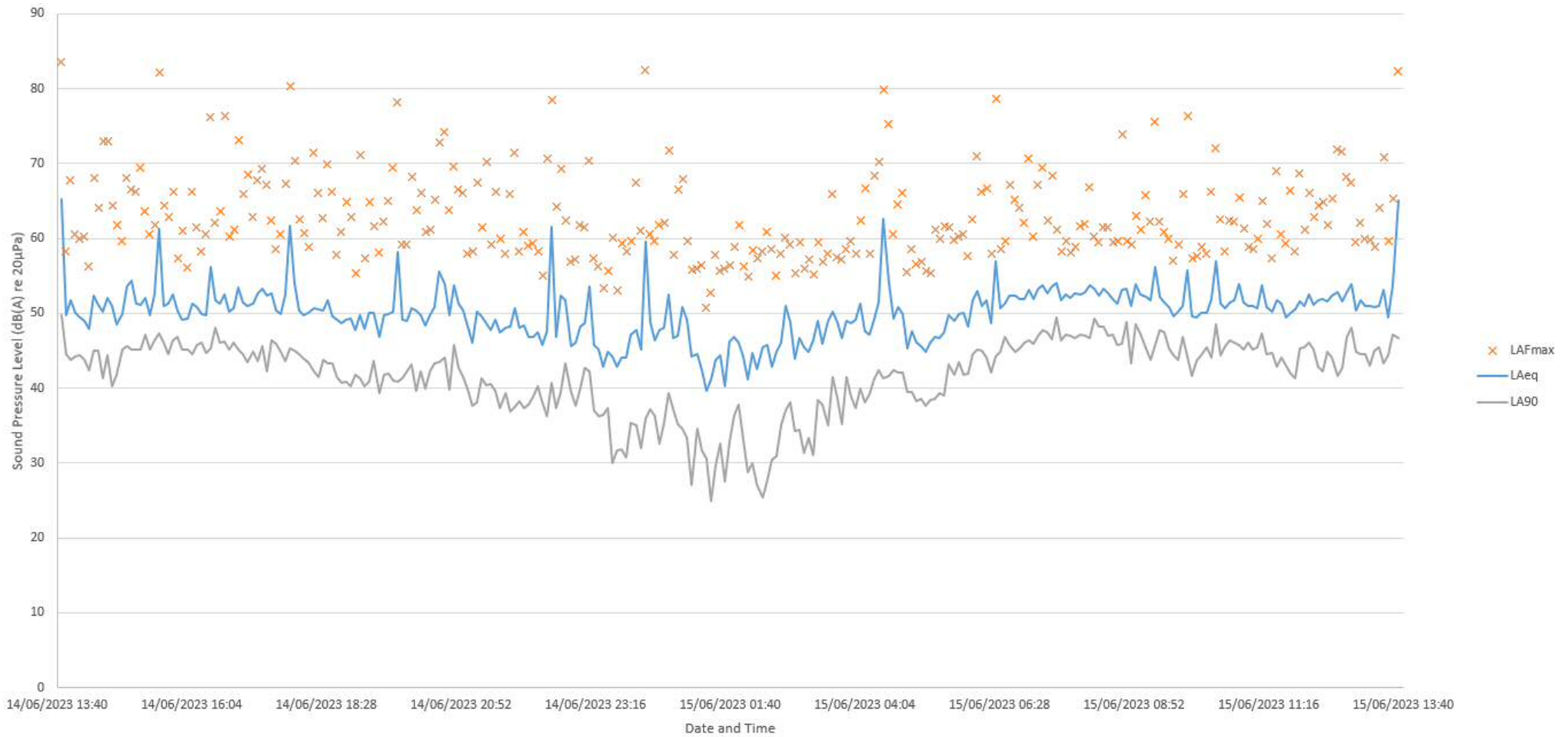


Figure 9: Time history for the unattended measurement at Location U1

A.3 Summary

An environmental baseline noise survey has been undertaken to determine the existing noise climate and character at the proposed site. This chapter summarizes the key results in the tables below.

Location	Sound Pressure Level, dB(A) (re 20 µPa)
	Highest LAeq,30min
A4	58
A5	60
A6	54
U1	53

Table 12: Noise levels affecting the school for façade design for the ATC site

Location	Assessment period	Sound Pressure Level, dB(A) (re 20 µPa)
		LA90,15min*
A1	Day (07:00-19:00)	43 to 47
	Evening (19:00-23:00)	-
	Night (23:00-07:00)	26 to 28
A2	Day (07:00-19:00)	42
	Evening (19:00-23:00)	39
	Night (23:00-07:00)	28 to 34
A3	Day (07:00-19:00)	41
	Evening (19:00-23:00)	41
	Night (23:00-07:00)	28 to 29
U1	Day (07:00-19:00)	41 to 49
	Evening (19:00-23:00)	38 to 43
	Night (23:00-07:00)	28 to 46

Table 13: Background noise levels for building services target noise levels for the ATC site.

* LA90,15min levels for the logger position U2 have been approximated from the mean of each set of three 5-minute measurements.

Appendix B

MEP Plant layouts

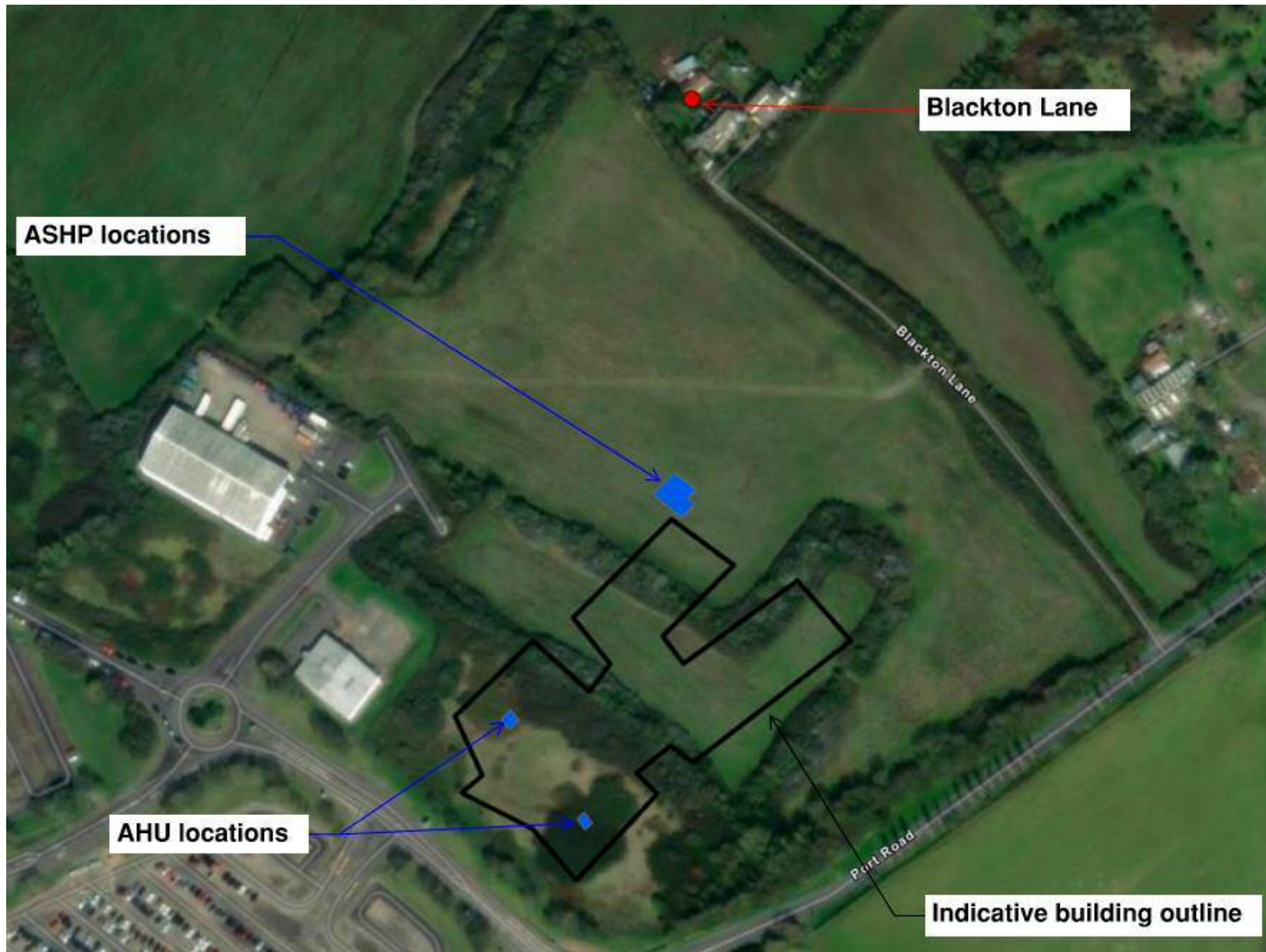


Figure 3: Building services locations relative to nearest noise sensitive receptors

Appendix C

Glossary of Acoustic Terminology

Decibel (dB)

The ratio of sound pressures which we can hear is a ratio of $10^6:1$ (one million:one). For convenience, therefore, a logarithmic measurement scale is used. The resulting parameter is called the 'sound pressure level' (L_p) and the associated measurement unit is the decibel (dB). As the decibel is a logarithmic ratio, the laws of logarithmic addition and subtraction apply.

dB(A)

The unit used to define a weighted sound pressure level, which correlates well with the subjective response to sound. The 'A' weighting follows the frequency response of the human ear, which is less sensitive to low and very high frequencies than it is to those in the range 500Hz to 4kHz.

In some statistical descriptors the 'A' weighting forms part of a subscript, such as L_{A10} , L_{A90} , and L_{Aeq} for the 'A' weighted equivalent continuous noise level.

Equivalent continuous sound level

An index for assessment for overall noise exposure is the equivalent continuous sound level, L_{eq} . This is a notional steady level which would, over a given period of time, deliver the same sound energy as the actual time-varying sound over the same period. Hence fluctuating levels can be described in terms of a single figure level.

Frequency

Frequency is the rate of repetition of a sound wave. The subjective equivalent in music is pitch. The unit of frequency is the hertz (Hz), which is identical to cycles per second. A 1000Hz is often denoted as 1kHz, eg 2kHz = 2000Hz. Human hearing ranges approximately from 20Hz to 20kHz. For design purposes the octave bands between 63Hz to 8kHz are generally used. The most commonly used frequency bands are octave bands, in which the mid frequency of each band is twice that of the band below it. For more detailed analysis, each octave band may be split into three one-third octave bands or in some cases, narrow frequency bands.

Maximum noise level

The maximum noise level identified during a measurement period. Experimental data has shown that the human ear does not generally register the full loudness of transient sound events of less than 125ms duration and fast time weighting (F) has an exponential time constant of 125ms which reflects the ear's response. Slow time weighting (S) has an exponential time constant of 1s and is used to allow more accurate estimation of the average sound level on a visual display.

The maximum level measured with fast time weighting is denoted as $L_{Amax, F}$. The maximum level measured with slow time weighting is denoted $L_{Amax, S}$.

Sound pressure level

The sound power emitted by a source results in pressure fluctuations in the air, which are heard as sound.

The sound pressure level (L_p) is ten times the logarithm of the ratio of the measured sound pressure (detected by a microphone) to the reference level of 2×10^{-5} Pa (the threshold of hearing).

Thus L_p (dB) = $10 \log (P/P_{ref})^2$ where P_{ref} , the lowest pressure detectable by the ear, is 0.00002 pascals (ie 2×10^{-5} Pa).

The threshold of hearing is 0dB, while the threshold of pain is approximately 120dB. Normal speech is approximately 60dB L_A and a change of 3dB is only just detectable. A change of 10dB is subjectively twice, or half, as loud.

Statistical noise levels

For levels of noise that vary widely with time, for example road traffic noise, it is necessary to employ an index which allows for this variation. The L_{10} , the level exceeded for 10% of the time period under consideration, and can be used for the assessment of road traffic noise (note that L_{Aeq} is used in BS 8233 for assessing traffic noise). The L_{90} , the level exceeded for 90% of the time, has been adopted to represent the background noise level. The L_1 , the level exceeded for 1% of the time, is representative of the maximum levels recorded during the sample period. A weighted statistical noise levels are denoted L_{A10} , dB_{LA90} etc. The reference time period (T) is normally included, e.g. $dB_{LA10, 5min}$ or $dB_{LA90, 8hr}$.

Typical levels

Some typical dBA noise levels are given below:

Noise Level, dBA	Example
130	Threshold of pain
120	Jet aircraft take-off at 100m
110	Chain saw at 1m
100	Inside disco
90	Heavy lorries at 5m
80	Kerbside of busy street
70	Loud radio (in typical domestic room)
60	Office or restaurant
50	Domestic fan heater at 1m
40	Living room
30	Theatre
20	Remote countryside on still night
10	Sound insulated test chamber