



## NOTTINGHAM CITY HOSPITAL

### ASHP Noise Impact Assessment

Reference: 11629.RP01.PNA.1

Prepared: 01 April 2022

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0	First issue of report	24 March 2022	Sebastian Chesney	David Johnston
1	Revised collector module noise levels	01 April 2022	Sebastian Chesney	David Johnston

### *Terms of contract:*

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The recommendations within this report relate to acoustics performance only and will need to be integrated within the overall design by the lead designer to incorporate all other design disciplines such as fire, structural integrity, setting-out, etc. Similarly, any sketches appended to this report illustrate acoustic principles only and will need to be developed into full working drawings by the lead designer to incorporate all other design disciplines.



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## 1. INTRODUCTION

It is proposed to locate 3no. new Air Source Heat Pump (ASHP) at Nottingham City Hospital. As part of the planning application, Nottingham City Council requires consideration be given to atmospheric noise emissions from the proposed equipment to the nearest noise-sensitive receptors.

RBA Acoustics have been commissioned to undertake measurements of the prevailing noise conditions at the site and to determine the atmospheric noise emission limits in accordance with Nottingham City Council's anticipated requirements. This report presents the results of the noise measurements, associated criteria and provides the required assessment.

A summary of acoustic terminology is included in Appendix A.

## 2. SITE DESCRIPTION

The site is shown in relation to its surroundings in the site plan in Figure 1 in Appendix E.

The location of the proposed plant is at ground level between the Urology Centre and the Maternity Unit. To the south of the units is the North Corridor, a circulation space that runs horizontally and connects the Maternity Unit to the Urology Centre.

To the north of the proposed ASHP units are the following noise sensitive receptors:

- Nottingham Hospitals Charity building, an office building approximately 25m from the proposed ASHP units
- Derwent Living Residence, on-site accommodation approximately 45m from the proposed ASHP units
- Residential premises along Wyton Close, off-site accommodation approximately 95m from the proposed ASHP units

It was noted that there are currently other items of operational plant within the surrounding area, mainly located in vented plant rooms or on the roofs of buildings within the hospital.

The noise climate at the residential receptors along Wyton Close consisted of general road traffic from the surrounding road networks. It was noted that noise from existing plant associated with Nottingham City Hospital was only perceptible during the daytime during lulls in road traffic movements.

## 3. ENVIRONMENTAL NOISE SURVEY

### 3.1 Survey Methodology

Monitoring of the prevailing background noise was undertaken over the following period:

- 11:15 Thursday 17 March to 10:45 Friday 18 March 2022.

As the survey was unattended it is not possible to comment with certainty regarding meteorological conditions throughout the entire survey period. However, based on observations during the site visits and weather reports for the area, conditions were generally considered suitable for obtaining representative noise measurements, being predominantly dry with a gentle breeze.

Measurements were made of the  $L_{A90}$ ,  $L_{Amax}$  and  $L_{Aeq}$  noise levels over sample periods of 15 minutes.

### 3.2 Measurement Location

To determine the existing noise climate around the site measurements were undertaken at the following location:

#### *Measurement Position 1 - Nottingham Hospitals Charity Building*

The microphone was positioned out of the second-floor window of the Nottingham Hospitals Charity building, along the northern façade. The microphone was positioned approximately 7m from ground level and 1m from the façade. Measurements at this position are therefore subject to façade reflections.

The noise climate consisted of general road traffic from the surrounding road networks along with intermittent traffic along hospital roads and low-level noise from existing plant within Nottingham City Hospital.

The measurement position is also illustrated on the site plan attached in Figure 1 in Appendix E.

### 3.3 Instrumentation

For information regarding the equipment used for the measurements please refer to Appendix B.

The sound level meter was calibrated both prior to and on completion of the survey with no significant calibration drift observed.

### 3.4 Results

The noise levels measured are shown as time-histories on the attached Graphs 1 & 2 of Appendix E. A histogram showing the distribution of measured  $L_{A90}$  levels is presented in Graph 3 of Appendix E.

The typical-lowest  $L_{A90}$  and the period averaged  $L_{Aeq}$  noise levels measured are summarised in Table 1.

Table 1 – Measured Levels

Measurement Period	Measurement Position 1 – South-west of Hospital	
	Typical $L_{A90,15min}$ (dB)	$L_{Aeq,T}$ (dB)
Daytime (07:00 – 23:00)	43	47
Night-time (23:00 – 07:00)	38	45

## 4. PLANT NOISE CRITERIA

### 4.1 Local Authority Criteria

After review of the *Nottingham City Local Plan Part 2* (adopted January 2020) it is understood that a numeric requirement for new items of mechanical plant has not been established. However, policies CC2 and DE1 state the following:

*“Planning permission will be granted for proposals to develop low carbon and renewable energy sources (including decentralised heat and power networks) unless there would be:*

*a) significant harm to residential amenity due to noise, traffic pollution or odour...”*

and

*“Planning applications will be considered against the following design criteria:*

*b) whether a satisfactory level of amenity would be provided for occupiers of the development and/or occupiers of neighbouring properties. In assessing this, consideration will be given to issues such as privacy, daylight, sunlight, outlook, scale/massing, security, odour, dust, noise, vibration and nuisance...”*

In line with the above requirements and BS 4142:2014+A1:2019 *Methods for rating and assessing industrial and commercial sound* we would propose items of mechanical services be designed so that noise emissions from the plant do not exceed the typical existing background noise level ( $L_{A90}$ ) when assessed at the nearest noise sensitive location. The following levels are therefore used in the assessment at nearby residential receptors:

- Daytime (07:00 to 23:00) 43 dBA
- Night-time (23:00 to 07:00) 38 dBA

In line with BS 4142, should the proposed plant be identified as having intermittent or tonal characteristics, a further penalty should be subtracted from any of the above proposed noise emission limits.

It should be noted that the above requirements are applied at the nearest residential adjacencies and alternative criteria are proposed for nearby hospital buildings and wards.

### 4.2 HTM 08-01 Criteria – Hospital Receptors

It is recommended that, to safeguard existing hospital buildings, consideration be given to the noise levels at the closest hospital windows to the proposed plant. Guidance within *Health Technical Memorandum 08-01: Acoustics* (HTM 08-01) provides the following target internal noise levels for typical spaces from mechanical plant and services.

Table 2 – HTM 08-01 Noise Level Criteria

Room Type	Noise from Mechanical and Electrical Services
Single-bed ward, overnight stay	NR30
Small office-type space	NR35
Circulation Space	NR40

The levels in Table 2 are internal NR levels. It is understood that the nearest hospital windows in the Urology Centre and Maternity Unit to the proposed plant are used as offices and treatment rooms, limited to daytime use only. Therefore, a noise limit of NR35 or below due is recommended for noise-break-in from the proposed plant.

A noise limit of NR40 is recommended for noise-break-in from the proposed plant is recommended for the North Corridor. However, due to the separation distance between the proposed units and the North Corridor and the recommended limits, it is considered that if the noise emissions from the plant are suitable at the Urology Centre and Maternity Unit, then noise emissions will be suitable at the North Corridor which is less sensitive to noise.

Please note that this is an internal noise level, and that a correction should be applied to give the corresponding limit outside a partially opened window, which is assumed to be 13dB as per the Acoustics Ventilation and Overheating (AVO) guidance. This reduction value is shown in Table 3.

Table 3 – Recommended Mechanical Plant and Services Criteria

Parameter	Noise from Mechanical and Electrical Services (dB) at Octave Band Frequencies (Hz)							
	63	125	250	500	1000	2000	4000	8000
NR35 (internal limit)	63	52	45	39	35	32	30	28
NR35 + 13dB (external limit)	76	65	58	52	48	45	43	41

The above corrected spectrum corresponds to an overall external noise level of 57dB  $L_{Aeq,T}$  and NR51 at the Urology Centre and Maternity Unit.

### 4.3 Summary

On the above basis of the above information, new ASHP units should be designed such that the cumulative noise emissions from all plant do not exceed the following levels when assessed at the nearest noise sensitive windows.

Table 4 – Plant Noise Emission Limits at Hospital and Residential Windows

Receptor	Criterion Noise Level
Residential Windows	35dB $L_{Ar}$
Hospital Windows (Urology Centre and Maternity Unit)	57dB $L_{Aeq,T}$ and NR51

## 5. PLANT NOISE ASSESSMENT

This assessment has been based on the information provided to RBA by Vital Energi and is described in the following sections.

### 5.1 Proposed Plant Items

Each of the 3no. proposed ASHP units consists of:

- 1no. compressor module
- 2no. collector modules

The following plant is proposed for the scheme:

Table 5 – Plant Types

Ref.	Manufacturer/Model/Duty	Plant Type
COM1 - COM3	OHT 80-200	Compressor module
COL1 – COL6		Collector modules

### 5.2 Plant Location

It is proposed that 3no. 200kW ASHP units are located at ground floor level between the Urology Centre and Maternity Unit. Each unit consists of 1no. compressor module and 2no. collector modules. The equipment position is indicated on the site plan in Figure 1 in Appendix E.

### 5.3 Plant Noise Levels

Information regarding the noise levels of the proposed plant has been provided by the manufacturer of the unit. The associated plant noise levels are detailed as follows:

Table 6 – Plant Noise Levels

Unit	Parameter	Sound Level (dB) at Octave Band Centre Frequency (Hz)							
		63	125	250	500	1k	2k	4k	8k
Compressor module (COM1 – COM3)	$L_w$	65	55	52	53	56	49	41	-
Collector module (COL1 - COL6)	$L_w$	-	57	53	56	54	51	46	38

Review of the octave band data provides no indication of any tonal characteristics associated with the proposed plant.



## 5.4 Location of the Nearest Noise-Sensitive Receptors

Based on observations made on site and discussions with the design team we understand the nearest noise-sensitive receptors to the proposed plant to be as follows:

### *Residential Receptor 1 – Wyton Close*

The nearest off-site residential receptor to the proposed items of plant, approximately 95m from the nearest proposed ASHP unit.

### *Residential Receptor 2 – Derwent Living Residence*

The nearest on-site residential receptor to the proposed items of plant, approximately 45m from the nearest proposed ASHP unit.

### *Hospital Receptor 1 – Urology Centre*

Nearest hospital windows to the south-east of the proposed ASHP location, approximately 5m separation distance from the units. It is understood that windows on the façade overlooking the ASHP units are only noise-sensitive during the daytime.

### *Hospital Receptor 2 – Maternity Unit*

Nearest hospital windows to the north-west of the proposed ASHP location, approximately 5m separation distance from the units. It is understood that windows on the façade overlooking the ASHP units are only noise-sensitive during the daytime.

The receptor locations are shown in the site plan in Figure 1 in Appendix E.

## 5.5 Calculation of Noise Levels at Residential Receptors

Our calculation method for predicting noise levels from the proposed plant at the nearest residential receptors, based on the information above, is summarised below.

- Source Term SPL / SWL
- Distance Attenuation
- Directivity
- Reflections

There is potential for slight screening at the receptors from the adjacent ASHP units and from the Urology Centre and Maternity Unit building envelopes. However, it is not considered that these elements would provide sufficient screening at residential receptors due to the height difference between the most affected windows and the proposed ASHP units. Therefore, screening effects have not been considered in the assessment. Calculation sheets are attached for further information in Appendix C.

The results of the calculations indicate the following noise levels at the nearest affected residential windows:

Table 7 – Predicted Noise Levels at Residential Receptors

Operating Period	Noise Level (dB) at Wyton Close		Noise Level (dB) at Derwent Living Residence	
	Prediction	Criterion	Prediction	Criterion
Daytime (07:00 – 23:00)	26	43	30	43
Night-time (23:00 – 07:00)	26	38	30	38

Noise from the proposed plant installations is, at worst, 8dB below the existing background noise level ( $L_{A90}$ ) and therefore likely within the Local Authority criteria. Due to the predicted level below the existing background and ambient noise levels, it is not likely that any distinguishable acoustic features of the proposed plant will be perceptible and therefore, rating penalties are not considered appropriate.

## 5.6 Calculation of Noise Levels at Hospital Receptors

The results of the calculations at Hospital receptors are presented in Table 8 and indicate the noise levels outside the nearest affected windows in the Urology Centre and Maternity Ward. Due to the relationship between the separation distance the dimensions of the proposed units, the calculations incorporate a distance attenuation factor of  $10 \log(R)$ .

Table 8 – Plant Noise Levels at Hospital Receptors

Sound Level (dB) at Octave Band Centre Frequency (Hz)								dBA
63	125	250	500	1k	2k	4k	8k	
57	53	49	52	51	47	42	33	55 (NR51)

Noise levels from the proposed plant installations outside the nearest hospital windows are within the recommended external noise criteria, NR51, derived from the HTM 08-01 internal noise criteria.

The attenuation provided by an open window, approximately 13dB, will ensure that the internal noise levels associated with the proposed ASHP units are below the HTM 08-01 internal noise criteria. Therefore, the proposed ASHP units are considered acceptable in terms of noise.

## 6. VIBRATION CONTROL

In addition to the control of airborne noise transfer, it is also important to consider the transfer of noise as vibration to adjacent properties (as well as to any sensitive areas of the same building).

We understand that the proposal is to locate the ASHPs at ground level. The amount of vibration isolation required will therefore depend on how the ground underneath the ASHPs ties into the surrounding buildings. Our standard advice is provided below, but the mitigation measures proposed may be able to be reduced if there are no structural connections.

We would typically advise that ASHPs are isolated from the supporting structure by means of either steel spring isolators or rubber footings. For particularly sensitive locations, or when on lightweight structures the mounts should ideally be caged and be of the restrained type.

It is important the isolation is not “short-circuited” by associated pipework or conduits. To this end, any conduits should be looped and flexible connectors should be introduced between the condenser and any associated pipework. Pipework should be supported by brackets containing neoprene inserts.

## 7. CONCLUSION

RBA Acoustics have undertaken noise monitoring at Nottingham City Hospital. The measured noise levels are presented within this report. The resultant noise levels have been used to determine the required criteria for atmospheric noise emissions from the proposed plant installations.

The results of the assessment indicate atmospheric noise emissions from the proposed plant are within the recommended criteria at residential receptors and within the HTM 08-01 criteria at receptors within the hospital. As such, the proposed plant installations should be considered acceptable in terms of noise.

## Appendix A – Acoustic Terminology

A-weighting (e.g. dB(A))	A correction applied across the frequency bands to take into account the response of the human ear, and therefore considered to be more representative of the sound levels people hear.
DeciBel (dB)	Unit used for many different acoustic parameters. It is the logarithmic ratio of the level being assessed to a standard reference level.
$L_{eq}$	The level of a notional steady sound which, over a stated period of time, $T$ , would have the same acoustic energy as the fluctuating noise measured over that period. Typically used to represent the average or ambient noise level.
$L_{Aeq,T}$	The A-weighted level of a notional steady sound which, over a stated period of time, $T$ , would have the same acoustic energy as the fluctuating noise measured over that period. Typically used to represent the average or ambient noise level.
$L_{An}$ (e.g. $L_{A10}$ , $L_{A90}$ )	The sound level exceeded for $n\%$ of the time. E.g. $L_{A10}$ is the A-weighted level exceeded for 10% of the time and as such can be used to represent a typical maximum level. Similarly, $L_{A90}$ is the level exceeded for 90% of the measurement period, and is often used to describe the underlying background noise.
$NR$	Noise Rating – A single figure term to describe a measured noise level which considers the frequency content of the noise, generally used for internal noise level measurements (particularly mechanical services plant).

# Appendix B – Instrumentation

The following equipment was used for the measurements.

Table B1– Equipment Calibration Details				
Manufacturer	Model Type	Serial No.	Calibration	
			Certificate No.	Expiry Date
Norsonic Type 1 Sound Level Meter	Nor140	1405945	U38055	2 June 2023
Norsonic Pre Amplifier	1209	15314		
Norsonic ½" Microphone	1225	208218	38054	
Norsonic Sound Calibrator	1251	34057	U38053	

## Appendix C – Plant Calculations

Table C1 – Example Calculation, ASHP Unit to Wyton Close

Parameter	Octave-band Noise Levels (dB) at Octave-band Centre Frequency (Hz)								dBA
	63	125	250	500	1000	2000	4000	8000	
Compressor Module ( $L_w$ )	65	55	52	53	56	49	41	-	58
Collector Module ( $L_w$ )	-	57	53	56	54	51	46	38	58
Total Sound Power Level per ASHP Unit (1no. Compressor Module & 2no. Collector Modules)	65	61	57	60	60	55	50	41	63
Distance Loss (95m, assuming directivity Factor of Q=8)	-42	-42	-42	-42	-42	-42	-42	-42	
<b>Noise level at Residential Receptor 1 (Wyton Close)</b>	<b>24</b>	<b>20</b>	<b>16</b>	<b>19</b>	<b>18</b>	<b>14</b>	<b>8</b>	<b>0</b>	<b>22</b>

\*slight discrepancies of up to 1dB as a result of rounding

Table C2 – Summary Noise Levels

Unit	Received noise level at 1m from Receptor 1 (Wyton Close)	Received noise level at 1m from Receptor 2 (Derwent Living Residence)
ASHP1 (COM1, COL1 & COL2)	22dB (95m from unit)	26dB (55m from unit)
ASHP2 (COM2, COL3 & COL4)	21dB (100m from unit)	26dB (60m from unit)
ASHP3 (COM3, COL5 & COL6)	21dB (105m from unit)	25dB (65m from unit)
<b>Total Received Level</b>	<b>24dB</b>	<b>30dB</b>

## Appendix D – CDM Considerations

The likelihood the harm will occur can be assessed by applying an indicative score (from 1 to 5) as follows:

- 1 – Remote (almost never)
- 2 – Unlikely (occurs rarely)
- 3 – Possible (could occur, but uncommon)
- 4 – Likely (recurrent but not frequent)
- 5 – Very likely (occurs frequently)

The severity of harm can be assessed by applying an indicative score (from 1 to 5) as follows:

- 1 – Trivial (e.g. discomfort, slight bruising, self-help recovery)
- 2 – Minor (e.g. small cut, abrasion, basic first aid need)
- 3 – Moderate (e.g. strain, sprain, incapacitation for more than 3 days)
- 4 – Serious (e.g. fracture, hospitalisation for more than 24 hours, incapacitation for more than 4 weeks)
- 5 – Fatal (single or multiple)

The rating value is obtained by multiplying the two scores and is then used to determine the course of action.

Table D1 – Risk Ratings

Rating Bands (Severity x Likelihood)		
Low Risk (1 – 8)	Medium Risk (9 -12)	High Risk (15 – 25)
May be ignored but ensure controls remain effective	Continue, but implement additional reasonable practicable controls where possible	Avoidance action is required; therefore alternative design solutions must be examined. Activity must not proceed until risks are reduced to a low or medium level

The following hazards pertinent to our design input have been identified and control measures suggested:

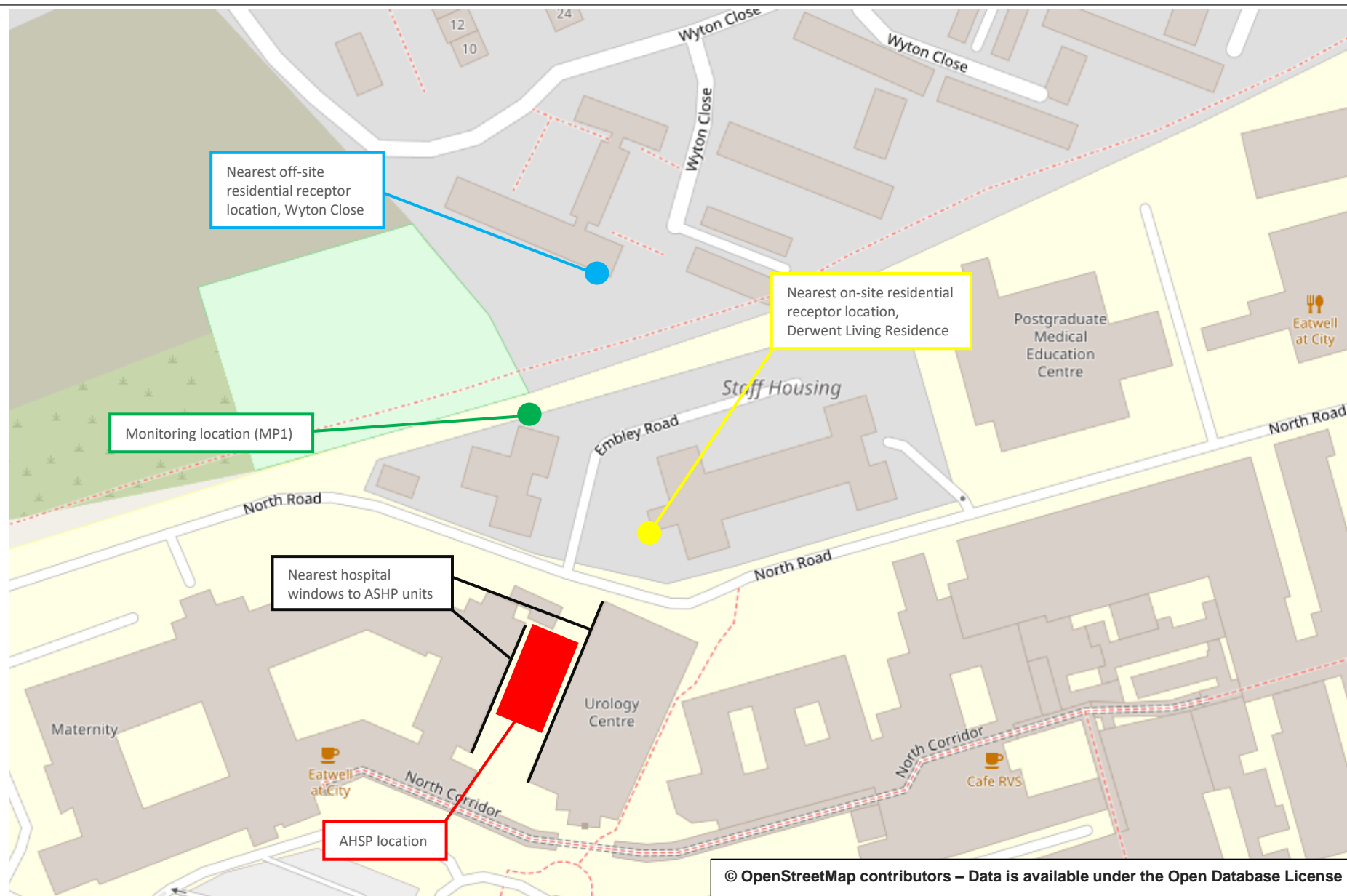
Table D2 – Risk Assessment

Hazard	Risk Of	At Risk	Rating			Control Measures	Controlled		
			L	S	R		L	S	R
Vibration Isolators	Injury to hands	Contractors	3	3	9	Care needs to be taken during adjustment. Follow manufacturers guidance	1	3	3
Attenuators/ Acoustic Lagging	Strain of neck, limbs or back.	Contractors	3	4	12	Provide sufficient manpower/ lifting gear	1	4	4
Attenuators/ Acoustic Lagging	Skin & respiratory irritation	Contractors	4	3	12	Wear gloves and mask	1	3	3

L: Likelihood      S: Severity      R: Rating

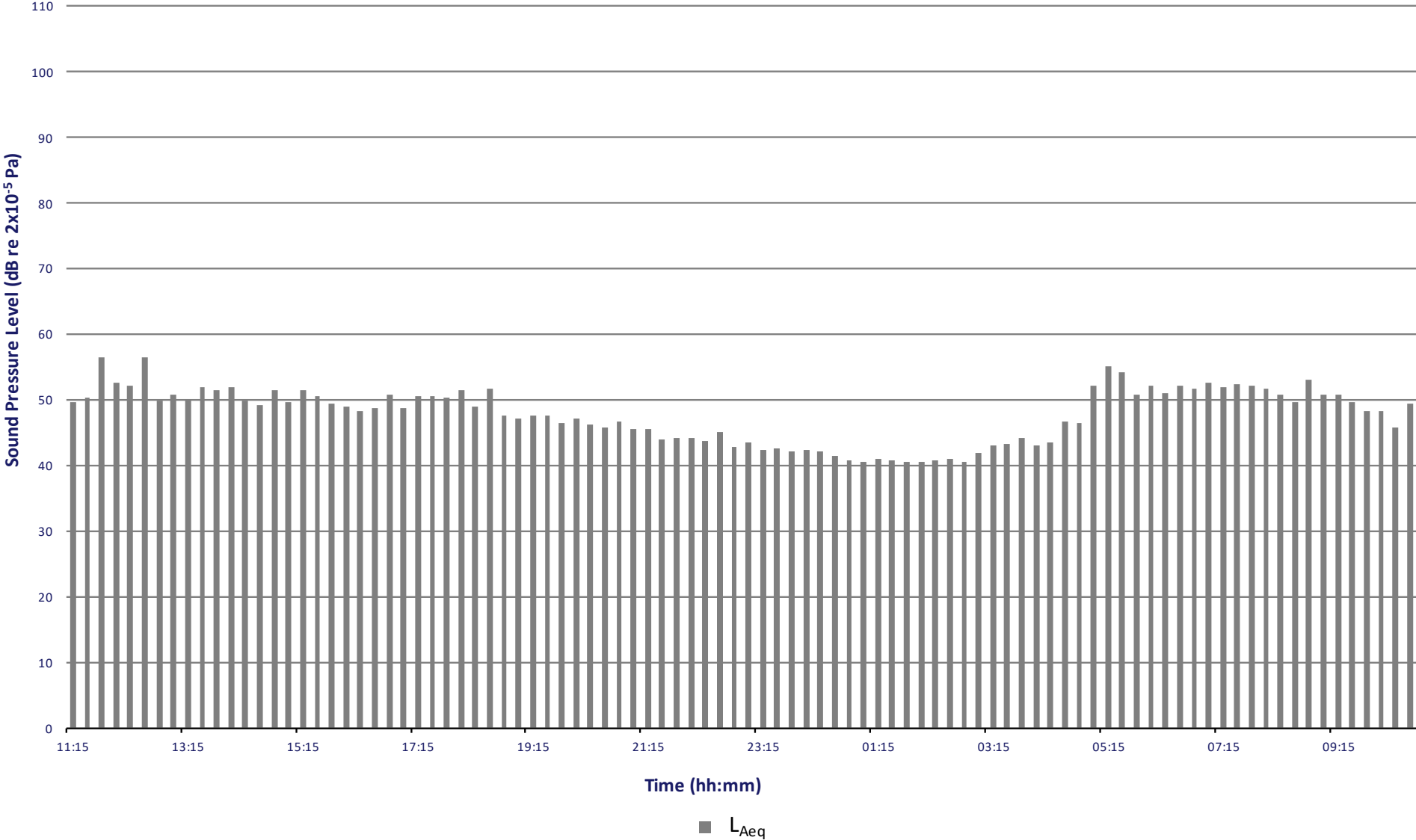
## Appendix E – Graphs and Site Plans





Nottingham City Hospital  
 Site Plan Showing Plant Location and Nearest Noise Sensitive Receptors  
 Project 11629

Figure 1  
 Not to Scale



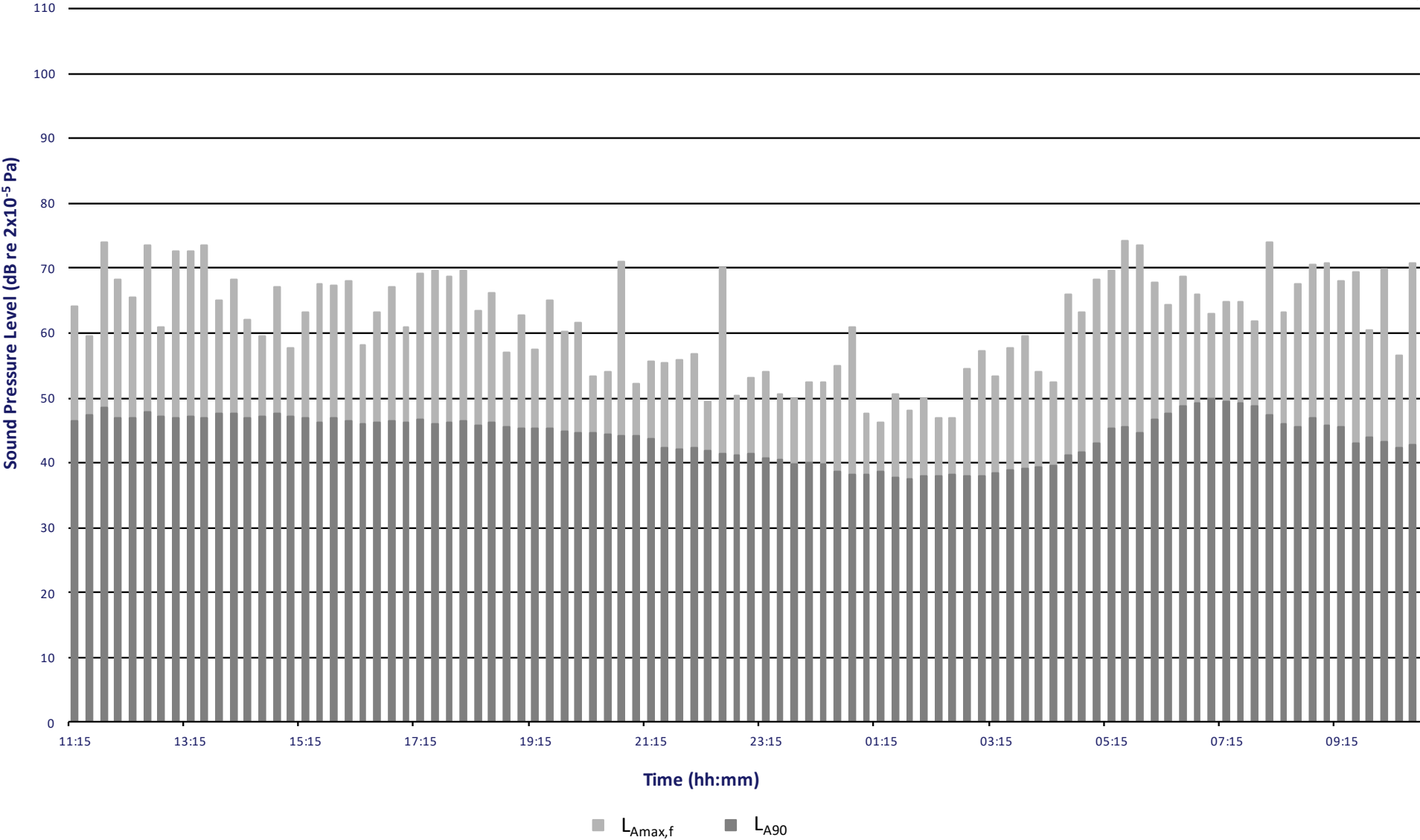
Nottingham City Hospital  
L<sub>Amax,f</sub> and L<sub>A90</sub> Time History



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MP1

Graph 2



# Nottingham City Hospital

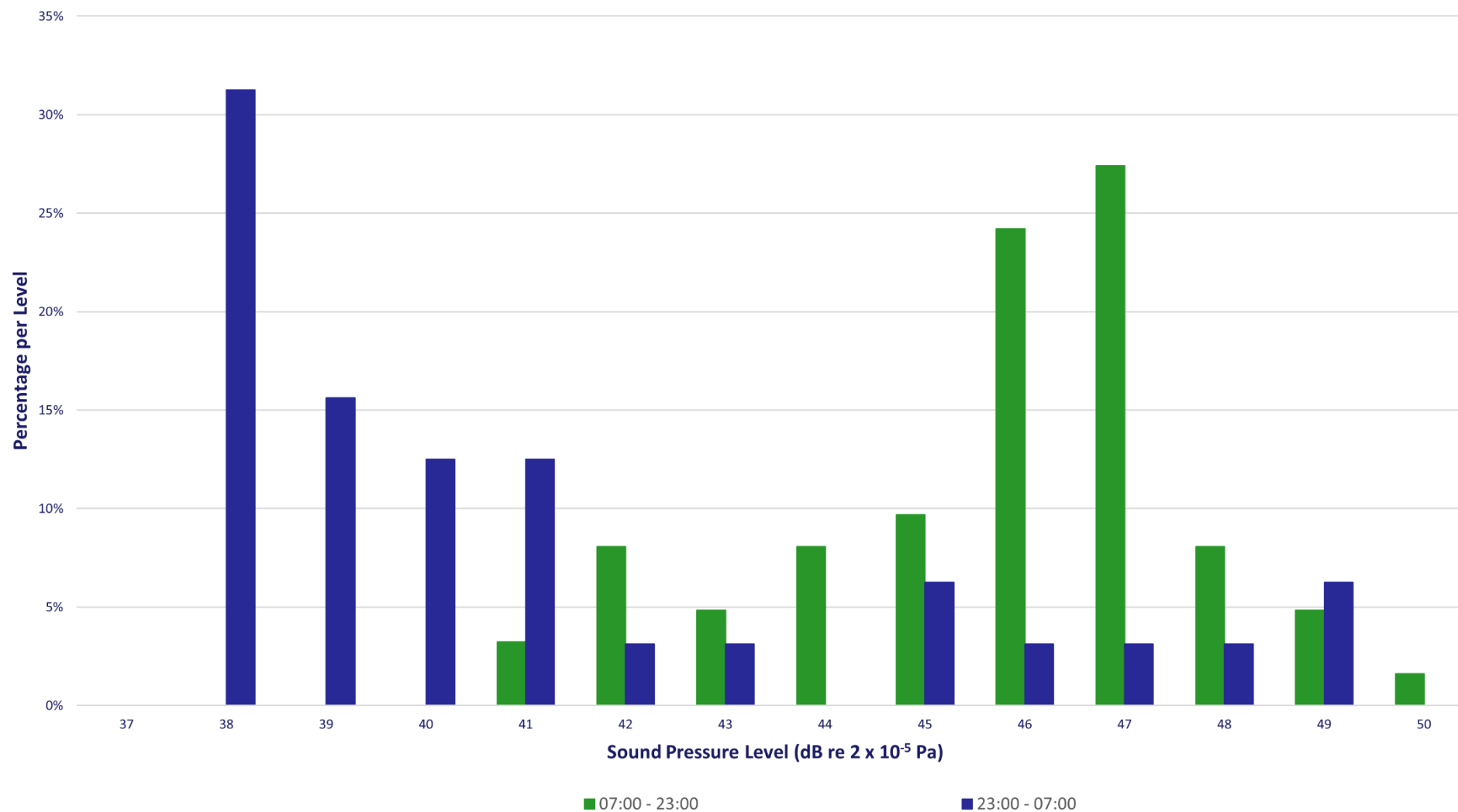
L<sub>A90,15 minutes</sub> Histogram

MP1



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Graph 3



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