EXTERNAL PLANT NOISE ASSESSMENT

ROYAL FREE HOSPITAL, LONDON

RFL Property Services

2062434-RSKA-RP-001-(03)

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General notes

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1 Introduction

1.1 Rationale for Acoustic Surveying Works

This report has been drafted in support of a forthcoming planning application, to be submitted on behalf of the Royal Free Hospital Foundation Trust (“the Trust”). This application relates to two AC units and two Magnetom chillers proposed to serve the new low-field MRI unit located at ground level on Rowland Hill Street, opposite the nearby Belle Vue apartments.

This report details acoustic surveying works undertaken to quantify the existing noise climate surrounding the Royal Free Hospital and demonstrates compliance with the local planning authority's guidance for the proposed external plant installation.

1.2 Site Description

The site, located at the Royal Free Hospital, Pond Street, London NW3 2QG, is a major teaching hospital in the Hampstead area of London. The site and surrounding area is illustrated within Appendix A of this document.

A description of the surrounding area is detailed below:

- **North –** Pond Street is a well-trafficked road comprising of commercial and residential properties. A stretch of railway runs approximately 120 metres from the site boundary, with Hampstead Heath London Overground Station existing approximately 140 metres from the site.
- **East –** Anne Bryans House is an apartment building on Fleet Road.
- **South –** A large quantity of residential properties sit within Aspern Grove.
- **West –** Hampstead Hill School exists neighbouring Rosslyn Hill and Pond street. Residential properties also exist on Rosslyn Hill. Belsize Park London Underground Station (Northern Line) is approximately 190 metres from the site boundary.

The site falls within the jurisdiction of the London Borough of Camden.

2 Plant Noise Emission Criteria

2.1 Local Authority & Standard Guidance

2.1.1 Camden Local Plan

The Local Plan currently adopted by the London Borough of Camden (July 2017), states the following regarding amenity protection from noise pollution within Policy A4: Noise and Vibration:

"The Council will seek to ensure that noise and vibration is controlled and managed.

Development should have regard to Camden Noise Vibration Thresholds (Appendix 3). We will not grant planning permission for:

A) developments likely to generate unacceptable noise and vibration impacts; or

B) development sensitive to noise in locations which experience high levels of noise, unless appropriate attenuation measures can be provided and will not harm the continued operation of existing uses.

We will only grant permission for nose generating development, including any plant and machinery, if it can be operated without causing harm to amenity. We will also seek to minimise the impact on local amenity from deliveries and from the deliveries and construction phases of development."

Within Appendix 3 of the Camden Local Plan, the following is stated regarding industrial and commercial noise sources:

"A relevant standard or guidance document should be referenced when determining values for LOAEL and SOAEL for non-anonymous noise. Where appropriate and within the scope of the document it is expected that British Standard 4142:2014 'Methods for rating and assessing industrial and commercial sound' (BS 4142) will be used. For such cases a 'Rating Level' of 10 dB below background (15dB if tonal components are present) should be considered as the design criterion)"

The following table is illustrated within the Camden Local Plan (Appendix 3, Table C):

Existing Noise sensitive receptor	Assessment Location	Design Period	LOAEL (Green)	LOAEL to SOAEL (Amber)	SOAL (Red)
Dwellings**	Garden used for main amenity (free field) and Outside living or dining or bedroom window (façade)	Day	'Rating level' 10dB* below background	'Rating level' between 9dB below and 5dB above background	'Rating level' greater than 5dB above background
Dwellings**	Outside bedroom window (façade)	Night	'Rating level' 10dB* below background and no events exceeding 57dBL_{Amax}	'Rating level' between 9dB below and 5dB above background or noise events between 57dB and 88dB L_{Amax}	'Rating level' greater than 5dB above background and/or events exceeding 88dBL_{Amax}

Figure 1 Camden Local Plan 2017, Appendix 3, Table C

The following commentary is provided to the above table:

*"*10dB should be increased to 15dB if the noise contains audible tonal elements. (day and night). However, if it can be demonstrated that there is no significant difference in the character of the residual background noise and the specific noise from the proposed development then this reduction may not be required. In addition, a frequency analysis (to include, the use of Noise Rating (NR) curves or other criteria curves) for the assessment of tonal or low frequency noise may be required.*

***levels given are for dwellings, however, levels are use specific and different levels will apply dependent on the use of the premises.*

The periods in Table C correspond to 0700 hours to 2300 hours for the day and 2300 hours to 0700 hours for the night. The Council will take into account the likely times of occupation for types of development and will be amended according to the times of operation of the establishment under consideration."

2.1.2 BS 4142:2014+A1:2019

When considering noise emission from plant, it is normal to follow guidance in BS 4142:2014+A1:2019. Section 1.1 of this standard states the following:

"This British Standard describes methods for rating and assessing sound of an industrial and/or commercial nature, which includes:

a) sound from industrial and manufacturing processes;

b) sound from fixed installations which comprise mechanical and electrical plant and equipment

c) sound from the loading and unloading of goods and materials at industrial and/or commercial premises; and

d) sound from mobile plant and vehicles that is an intrinsic part of the overall sound emanating from premises or processes, such as that from forklift trucks, or that from train or ship movements on or around an industrial and/or commercial site."

The methodology in the standard compares the measured or calculated rating level of the noise from the source and compares it to the representative existing measured LA90 background noise level for the period concerned.

The higher the excess of rating level over background noise level, the greater the likelihood of an adverse noise impact. BS 4142:2014+A1:2019 gives the following guidance:

"Typically, the greater this difference, the greater the magnitude of the impact.

A difference of around +10dB or more is likely to be an indication of a significant adverse impact, depending on the context.

A difference of around +5dB is likely to be an indication of an adverse impact, depending on the context.

The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context."

3 Environmental Noise Survey

3.1 Methodology & Instrumentation

An unattended noise survey was undertaken at the site between the following dates and times:

- **Start**: 11h45 14th June 2023
- **End**: 11h45 20th June 2023

Measurements were undertaken at two locations, indicated as MP1 and MP2 within Appendix A and are described as follows:

- **MP1**: At 1.5 metres above ground level in front of the Royal Free Hospital, adjacent to Pond Street.
- **MP2**: On a flat roof of the Royal Free Hospital at fourth floor level, opposite to Belle Vue Apartments, Rowland Hill Street, London.

These measurement positions were selected to represent the noise climate at nearby residential windows to the opposite side of Rowland Hill Street and Pond Street respectively.

Pictures of monitoring installed at these measurement positions are illustrated within Appendix B.

In both cases, the measurement positions were suitably positioned and screened from any existing operational plant equipment to ensure a representative measurement.

Measurements of the L_{Aeq}, L_{A90} and L_{Amax} indices were recorded over consecutive 15-minute periods (see the glossary of this report for an explanation of the noise units used) for the duration of the survey at both measurement positions using the equipment listed within Table 1 below.

Item	Manufacturer	Type	Serial No.	Calibration Due
Sound Level Analyser x2	Rion	NL-52	00253698	04/04/2025
			00620866	28/04/2025
Acoustic Calibrator		NC-74	34625616	14/07/2024
Weatherproof Windshield x2		WS-15	N/A	N/A

Table 1 Equipment used during unattended noise survey

The microphones were fitted within weatherproof windshields and the sound level meters were calibrated before and after the survey to confirm an acceptable level of accuracy. The calibration drift from commencement to end is noted within Table 2 below.

Sound Level Meter Serial No.	Measurement Position	Calibration Before	Calibration After
00253698	MP1	94.0 dB	93.8 dB
00620866	MP2	94.0 dB	93.9 dB

Table 2 Calibration of sound level meters before and after survey

3.2 Results

3.2.1 Time Histories

The time histories for both measurement positions are illustrated within Appendix C.

At measurement position 1 it is noted that noise level peaks occur sporadically throughout the survey period. This is chiefly due to siren noise from emergency services vehicles which frequently pass through the area of the hospital.

At measurement position 2 it is noted that the noise level remains largely consistent across the entirety of the survey period. This is due to the existing noise emitting building services plant equipment.

3.2.2 Representative Background Noise Levels

We understand that the proposed plant equipment will not have any restrictions imposed upon hours of operation. As such both daytime and night-time noise criteria will be assessed against.

Section 8.1.3 and 8.1.4 of BS 4142:2014+A1:2019 state the following:

"… the background sound level used for the assessment should be representative of the period being assessed…"

"This level should account for a range of background sound levels and should not automatically be assumed to be either the minimum or modal value."

A representative background noise level has thus been derived for measurement position 1 and 2 respectively for both daytime and night-time periods. This has been carried out in compliance with BS 4142:2014+A1:2019. These are illustrated within Table 3 below.

Position	Description	Representative Background Noise Level, $L_{A90,\ 15min}$ (dB)	
		Daytime Hours (07h00-23h00)	Night-time Hours (23h00-07h00)
MP1	Ground level in front of Royal Free Hospital adjacent to Pond Street	51	47
MP2	Fourth floor level opposite Belle Vue Apartments on Rowland Hill Street	53	52

Table 3 Measured representative background noise levels

Histograms of these results per respective measurement position are illustrated within Appendix D.

4 Plant Noise Assessment

4.1 Plant Noise Limits

Based on the measured noise levels and the criteria summarised in Section 2, the noise limits set out below in Table 4 are proposed:

Position	Description	Plant Noise Emission Limits, $L_{Ar,Tr}$, (dB) *(for plant with no distinguishing features)*	
		Daytime Hours (07:00-23:00)	Night-time Hours (23:00-07:00)
AP1	Belle Vue Apartments	43	42
AP2	13 Pond Street	41	37
AP3	Anne Bryans House	41	37

Table 4 Plant noise emission limits at the nearest residential properties

*For Anne Bryans House apartment building, we have selected plant noise limits derived from MP1 due to this recording the lowest background noise levels to provide a robust assessment.

The noise limits are to apply at 1 m from the nearby residential windows. Any plant with a tonal component would be subject to a further penalty, in line with BS 4142:2014+A1:2019. These limits apply to all mechanical services items being installed when running at duty with all items running concurrently during the relevant period.

We note that there are additional residential receptors within the vicinity of the site, however these are further away from and lees exposed to the plant than those assessed. Therefore, if the noise limits are met at the chosen receptors, then they will also be met at other residential receptors within the general area.

4.2 Proposed Installation

The proposed plant installation at ground level serving the low field MRI unit is detailed within Table 5 below.

Plant Item	Description	Location
AC Unit	Air conditioning unit – Toshiba RAV-GM401ATP-E	Ground level on Rowland Hill Lane, opposite Belle Vue Apartments
AC Unit	Air conditioning unit – Toshiba RAV-GM561ATP-E	
Chiller Unit	Chiller Unit – Siemens MAGNETOM SOU Chiller	
Chiller Unit	Chiller Unit – Siemens MAGNETOM SOU Chiller	

Table 5 Proposed items of plant to serve low field MRI unit at ground level

Plant noise emission source data supplied to RSKA by RFL Property Services has been utilised within our assessment can be found within Appendix E of this report.

The relevant documents detailing plant noise emission data and plant installation locations are detailed within Table 6 below.

Title	Reference	Revision	Originator	Dated
Royal Free Hospital – Pharmacy	0148543	N/A	FlaktGroup	07/05/2024
Digital Inverter R32 - 3,60 kW - R32 - RAV RAV-GM401ATP-E en	N/A	N/A	Toshiba	N/A
Digital Inverter R32 - 5,00 kW - R32 - RAV RAV-GM561ATP-E en	N/A	N/A	Toshiba	N/A
Freemax Relocatable	239002-150	N/A	Lamboo Medical	31/05/2024
Freemax Reloc	239002-020	N/A	Lamboo Medical	31/05/2024

Table 6 Proposed plant installation document schedule

4.3 Methodology

Noise levels have been calculated at the assessment positions labelled as AP1, AP2 and AP3 within Appendix A.

The assessment has taken into account radiation and distance losses, duct and bend losses, directivity, screening, and façade reflections, where each is appropriate. Analysis of the available data in octave bands does not indicate the presence of tonal components and therefore no correction for tonality as detailed within BS 4142:2014+A1:2019 need be applied.

We note that there are additional residential receptors within the vicinity of the site, however these are further away from and lees exposed to the plant than those assessed. Therefore, if the noise limits are met at the chosen receptors, then they will also be met at other residential receptors within the general area.

The assessment has been undertaken on the basis of all plant running simultaneously.

4.4 Results without Mitigation

An assessment of all proposed operational plant with no mitigation, returned the following cumulative noise level contributions at each respective receptor (most stringent plant noise limit in **blue**). The Siemens chillers prove to be the dominant noise-generating plant.

Assessment Position	Octave band centre frequency (Hz)								dB(A)
	63	125	250	500	1k	2k	4k	8k	
AP1	40	44	50	55	59	56	47	39	**62/*42***
AP2	16	20	25	31	35	32	23	15	**38/*37***
AP3	16	19	25	31	35	32	23	15	**38/*37***

Table 7 Predicted noise levels from plant installation (no mitigation)

It has been demonstrated that acoustic mitigation is required for the operation of the proposed plant equipment running simultaneously to comply with the council's requirements for plant noise emissions.

4.5 Mitigation

The Siemens chillers are the dominant noise-generating plant. It is recommended that both Siemens chiller units serving the low field MRI unit be acoustically attenuated. We recommend that this mitigation take the form of acoustic louvres fully enclosing the chillers.

The minimum insertion losses for the enclosures or louvres for each scenario of air conditioning unit positioning can be found in Table 8 below.

Mitigation Specification	Plant Equipment	Minimum Insertion Loss in Octave Band Centre Frequency, Hz							
		63	125	250	500	1k	2k	4k	8k
LVR-01	Both Siemens MAGNETOM SOU Chillers	9	10	14	17	25	25	24	23

Table 8 Minimum louvre insertion losses

4.6 Results with Mitigation Applied

An assessment of all proposed operational plant with the relevant mitigation within Table 8 applied, returned the following cumulative noise level contributions at each respective receptor (most stringent plant noise limit in **blue**):

Assessment Position	Octave band centre frequency (Hz)								dB(A)
	63	125	250	500	1k	2k	4k	8k	
AP1	40	40	39	40	36	32	28	19	**41/*42***
AP2	16	15	15	15	11	8	3	0	**17/*37***
AP3	15	15	14	15	11	7	3	0	**16/*37***

Table 9 Predicted noise levels from plant installation (mitigation applied)

Including appropriate mitigation to the Siemens chillers, it is demonstrated that the council's requirements for plant noise emissions are met with all plant running simultaneously. Mitigation has not been determined to be necessary to other items of plant.

Detailed calculations are available upon request.

5 Conclusion

Planning permission is being sought for the installation of building services noise-emitting plant equipment at Royal Free Hospital, Pond Street, London NW3 2QG.

A noise survey has been undertaken at the site to quantify the existing noise climate and set noise limits in line with the typical requirements of the local planning authority, in line with BS 4142:2014+A1:2019 methodologies.

An assessment of noise emissions from the proposed units indicates that the plant proposals with the Borough's relevant noise requirements. Noise limits would be met at all times with all proposed plant running simultaneously, with no unacceptable noise impacts being generated at nearby noise-sensitive residential properties, should mitigation be provided to the Siemens chillers as described in section 4.5.

Glossary

Term	Definition
Ambient sound	The total sound at a given place, usually a composite of sounds from many sources near and far.
Background sound, $L_{A90,T}$	A-weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90% of a given time interval.
dB	Decibel. Scale for expressing sound pressure level. It is defined as 20 times the logarithm of the ratio between the root mean square pressure of the sound field and a reference pressure i.e. $2x10^{-5}$ Pascal.
dB(A)	A-weighted decibel. This provides a measure of the overall level of sound across the audible spectrum with a frequency weighting to compensate for the varying sensitivity of the human ear to sound at different frequencies. Example sound levels include: 140 dB(A) Threshold of pain 120 dB(A) Threshold of feeling 100 dB(A) Loud nightclub 80 dB(A) Traffic at busy roadside 60 dB(A) Normal speech level at 1m 40 dB(A) Quiet office 20 dB(A) Broadcasting studio 0 dB(A) Median hearing threshold (1000 Hz)
Frequency	The repetition rate 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 thousand hertz is often denoted as kHz, e.g. 2 kHz = 2000 Hz. Human hearing ranges approximately from 20 Hz to 20kHz.
$L_{Aeq,T}$	This is defined as the notional steady sound level over a stated period of time (T), would contain the same amount of acoustical energy as the A-weighted fluctuating sound measured over that period.
NR	Noise rating. A set of curves based on the sensitivity of the human ear. They are used to give a single-figure rating for a range of frequencies.
Rating level	Specific sound level of a source plus any adjustment for the characteristic features of the sound.
Residual sound	Ambient sound remaining at the assessment location when the specific sound source is suppressed to such a degree that it does not contribute to the ambient sound.
Sound absorption	Process whereby sound energy is converted in to heat. Sound absorption properties is expressed as the sound absorption coefficient α or the sound absorption class (A-E).
Sound insulation	The reduction or attenuation of airborne sound by a solid element between source and receiver.
Specific sound	Sound pressure level produced by the source being assessed at the assessment location.

Table 10 Glossary of acoustic terms

Appendix A – Site Plan

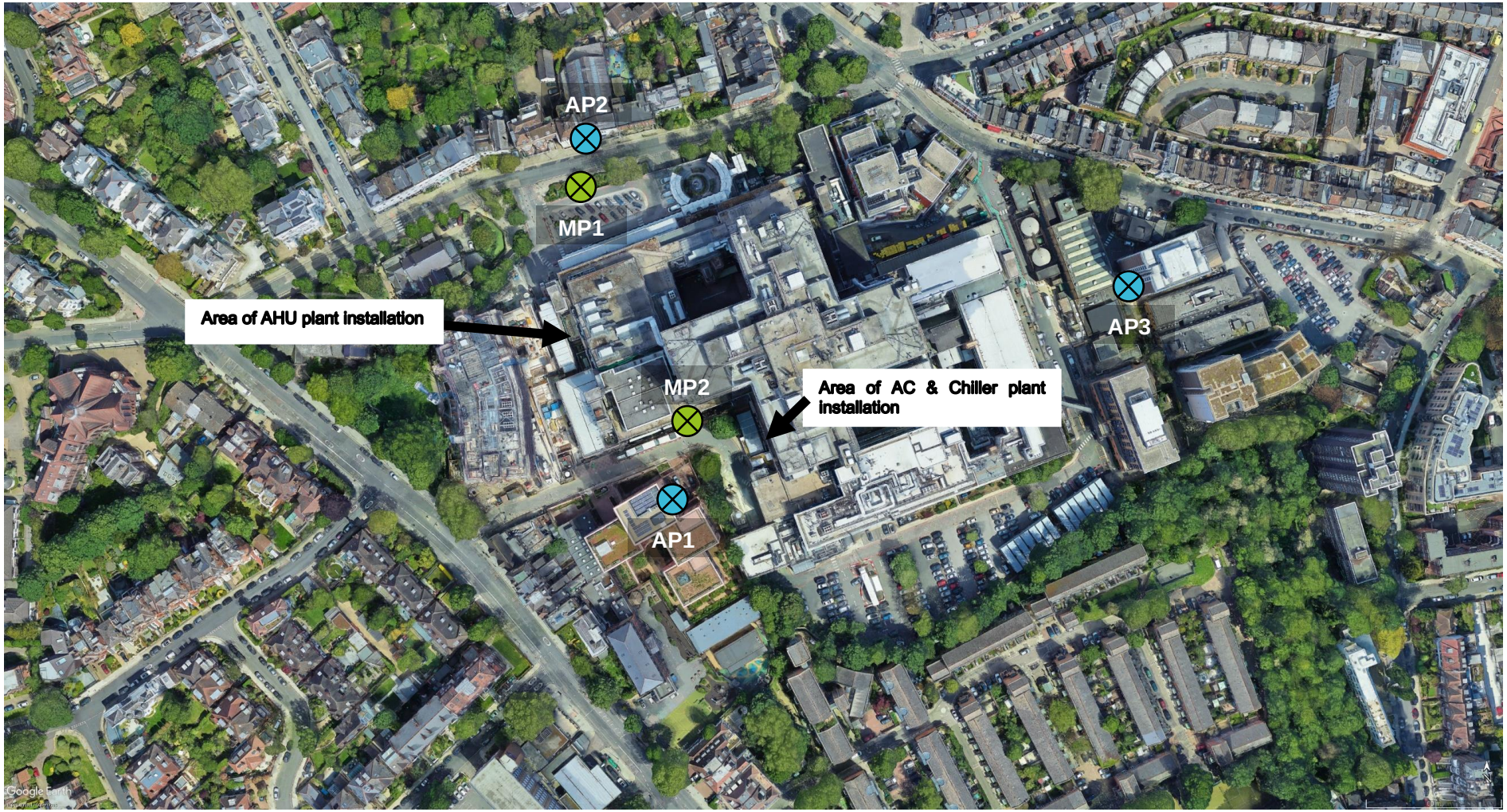

Figure 2 Site plan illustrating measurement and assessment positions

Appendix B – Site Installation Pictures

Figure 3 MP1

Figure 4 MP2

Appendix C – Time Histories

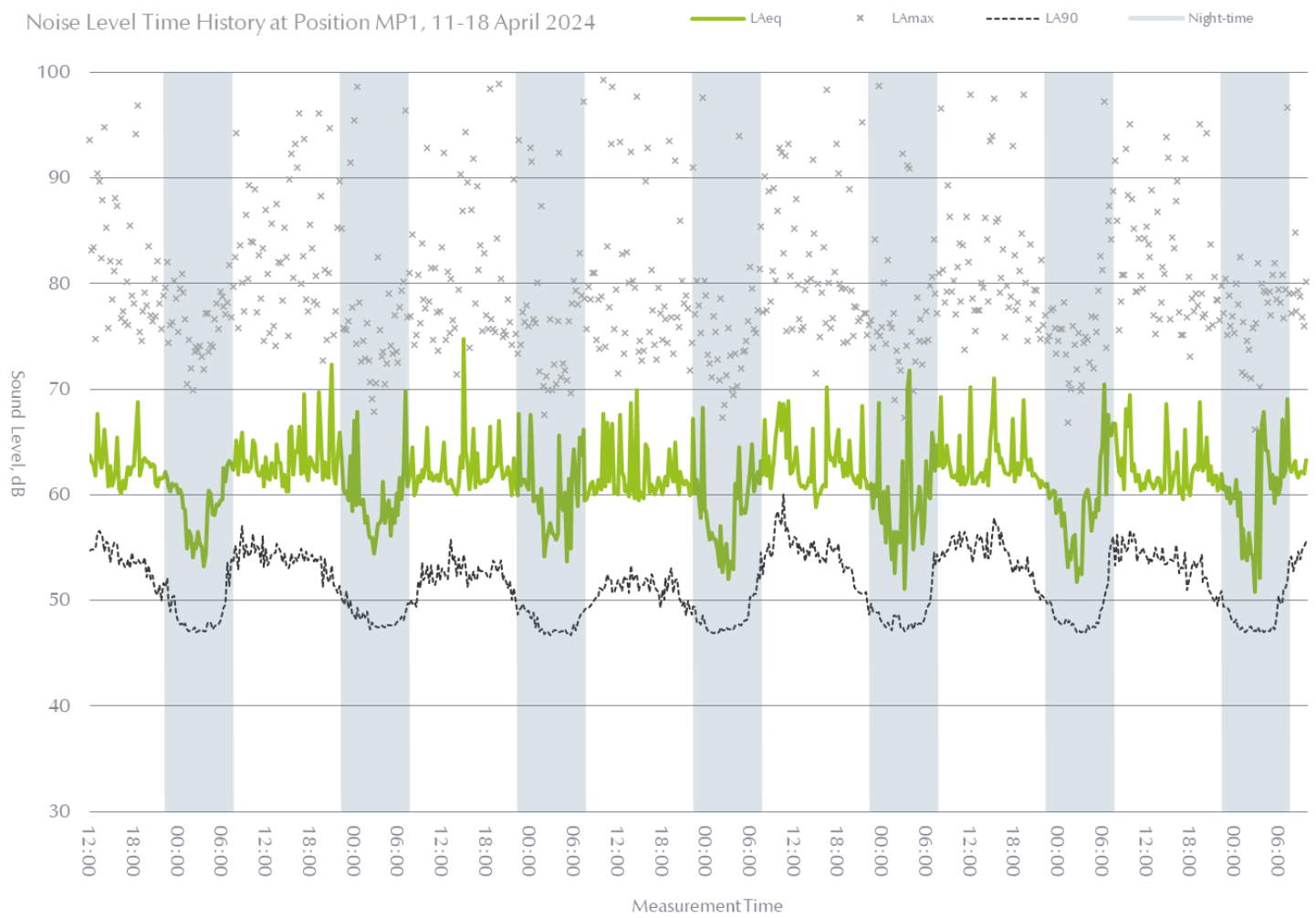

Figure 5 MP1 noise time history

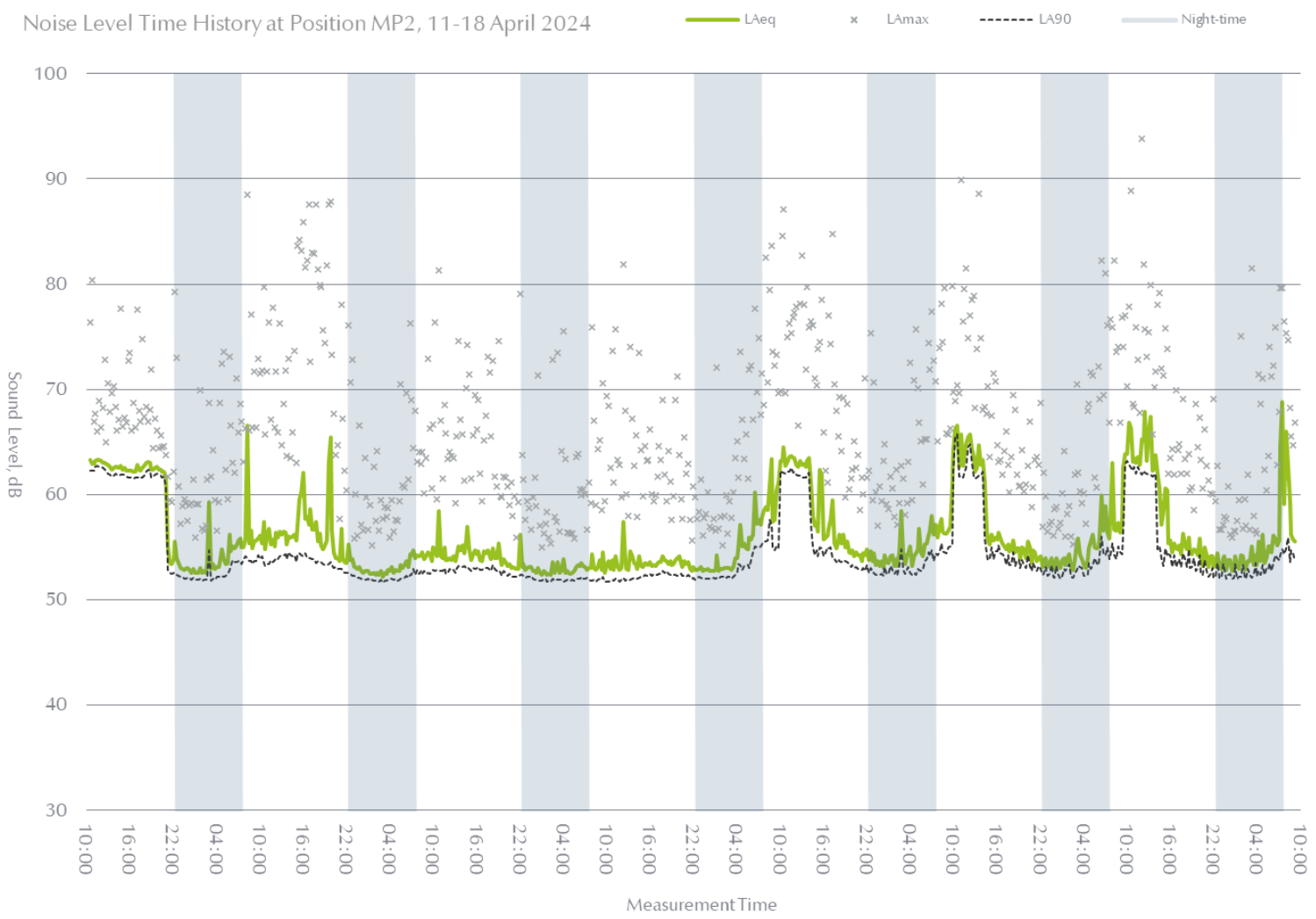

Figure 6 MP2 noise time history

Appendix D – Representative Background Noise Levels

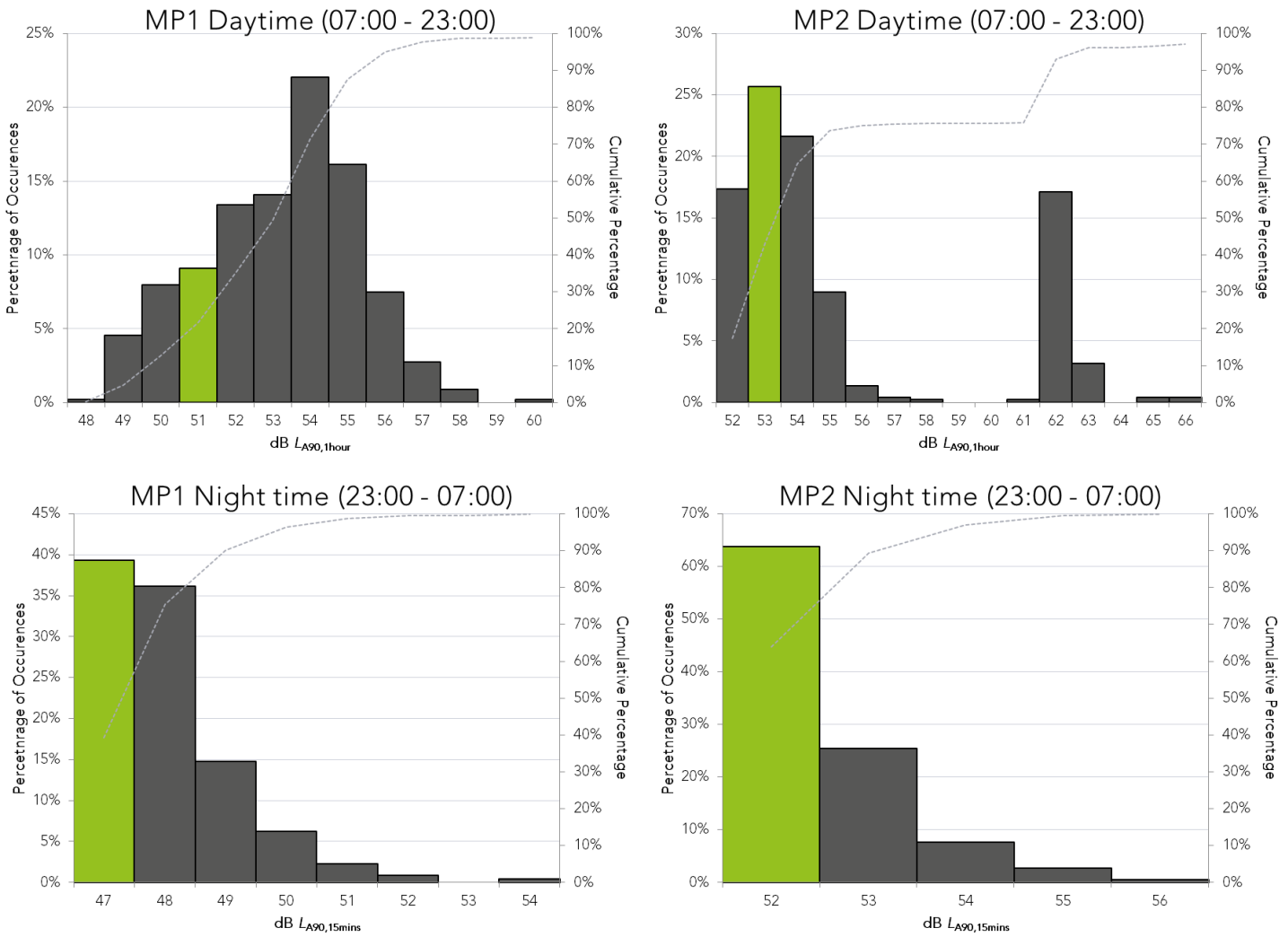

Figure 7 Representative background noise levels (chosen value in green)

Appendix E – Plant Noise Data

Plant Item	Element	Sound Power Level in Octave band centre frequency (Hz)								dB(A) L_w
		63	125	250	500	1k	2k	4k	8k	
AC Unit - RAV-GM401ATP-E	Fan & Casing	69	68	66	63	59	52	55	45	**65**
AC Unit - RAV-GM561ATP-E	Fan & Casing	69	68	66	63	59	52	55	45	**65**
Chiller Unit – Siemens MAGNETOM SOU Chiller 1	Fan & Casing	60	71	78	84	88	85	76	68	**91**
Chiller Unit – Siemens MAGNETOM SOU Chiller 2	Fan & Casing	60	71	78	84	88	85	76	68	**91**

Table 11 Plant noise data utilised within assessment

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