RSK Acoustics

Royal Free Hospital, Imaging

Plant Noise Assessment

Report 206/0904/R2

Royal Free Hospital, Imaging

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Report 206/0904/R2

Royal Free Hospital

The Richard Stephens Limited

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Revision	Description	Date	Prepared	Approved
0	First Issue	12 April 2022	Fred Davies	Tim Fox

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Plant Noise Assessment

1 Introduction

1.1 It is proposed to refurbish part of the imaging suite at the Royal Free Hospital to develop new MRI and X-ray treatment rooms. As part of this external plant will also be installed.

1.2 This report details an evaluation of noise emissions from the proposed plant strategy to the nearest noise sensitive areas. Where necessary, mitigation measures have been set out with performance requirements for the various elements specified.

2 Site Description

2.1 The site is located at the Royal Free Hospital, Pond Street, London NW3 2QG. The site and its surrounds can be seen on the attached site plan 206/0904/SP2.

2.2 Pond Street runs to the north of the site. Rosslyn Hill runs to the west of the site and joins Haverstock Hill to the southwest. Both Rosslyn Hill and Haverstock Hill form part of the A502. Pond Street meets Fleet Road and Rosslyn Hill to the northeast and northwest respectively. These three roads see frequent traffic and are main roads in the Camden area.

2.3 Residential property is located across from the site on Pond Street. Hampstead Hill School is located on the corner between Pond Street and Rosslyn Hill. The recently constructed Belle Vue retirement home is located to the south of the site on a service road belonging to the site.

2.4 The site is within the jurisdiction of Camden Council.

3 Background Noise Survey

3.1 **Methodology**

3.1.1 An unattended noise survey was undertaken at the site commencing at 1200 hours on Tuesday 22nd March, concluding at 1200 hours on Wednesday 23rd March 2022.

3.1.2 Measurements of background noise levels were taken from two positions indicated on the attached site plan 206/0904/SP2 and described below:

- MP1: Free-field measurement position to the north of the site approximately 10 m from the kerb edge of Pond Street and 3 m above local ground level.
- MP2: Free-field measurement position at 4th floor roof level towards to the west side of the site approximately 80 m from Haverstock Hill opposite *Belle Vue* retirement home.

3.1.3 These positions were selected to quantify background noise levels representative of those at the nearest noise sensitive receivers to the proposed plant installation.

3.1.4 Measurements of the L_{Aeq}, L_{Amax} and L_{A90} indices were recorded over consecutive 15-minute periods for the duration of the survey using the equipment listed within table T1 (see attached Glossary of Acoustic Terms for an explanation of the noise units used).

Item	Manufacturer	Type
Sound Level Analyser x2	Rion	NL-52
Acoustic Calibrator x2	Rion	NC-74
Weatherproof windshield x2	Rion	WS-15

T1 Equipment used during unattended noise survey.

3.1.5 The microphones were fitted within weatherproof enclosures, and the sound level meters calibrated before and after the survey to confirm an acceptable level of accuracy. No significant drift was noted to have occurred.

3.1.6 The weather conditions when setting up and collecting the noise monitoring equipment were sunny, warm, clear and dry with a light breeze. These conditions are deemed acceptable and are not considered to have affected the measurement results. Publicly available weather data suggest that appropriate conditions prevailed for the duration of the survey.

3.2 Results

3.2.1 The results of the noise measurements are presented in attached time history graphs 206/0904/TH01 to 206/0904/TH02.

3.2.2 The noise climate at MP1 was mainly affected by road noise from Pond Street and the carpark of Royal Free Hospital. The noise climate at MP2 was mainly affected by mechanical services equipment belonging to Royal Free Hospital with some road noise from Haverstock Hill.

3.2.3 The representative[1] background noise levels derived following guidance in BS 4142:2014+A1:2019[2] are set out in table T2 below.

[1] Typical L_{A90} background levels quoted at the highest single values where the cumulative total of $L_{A90,15min}$ values in the relevant time period equals ≤20%.
[2] British Standard BS4142:2014 - Methods for rating and assessing industrial and commercial sound

Location	Representative Background Noise Level, L_{A90} dB	
	Daytime (0700-2300 only)	Night time (24-hour)
MP1: Pond Street	53	49
MP2: Belle Vue	54	53

T2 Representative measured background noise levels, L_{A90}.

4 Plant Noise Limits

4.1 Local Authority Criteria

4.1.1 Policy A4 of the London Borough of Camden's *Local Plan 2017* relates specifically to noise:

'We will only grant permission for noise generating development, including any plant and machinery, if it can be operated without causing harm to amenity.

Planning conditions will be imposed to require that plant and equipment which may be a source of noise is kept working efficiently and within the required noise limits and time restrictions.

Conditions may also be imposed to ensure that attenuation measures are kept in place and are effective throughout the life of the development.'

4.1.2 With regard to noise from new mechanical services plant, Appendix 3 of the Local Plan sets out the following:

'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 (15 dB if tonal components are present) should be considered as the design criterion).'

4.2 Noise Emission Limits

4.2.1 Based on the results of the background noise survey set out within table T2 in addition to the guidance set out above, we recommend that the following plant emission limits are to apply at the nearest noise sensitive premises, illustrated in 206/0904/SP2.

Location	Noise Emission Limit, $L_{Ar,Tr}$ dB (for plant with no distinguishing feature) Daytime (0700-2300 only)	Night time (24-hour)
MP1: Pond Street	43	39
MP2: Belle Vue	44	43

T3 Plant noise emission limits at the nearest residential properties.

4.2.2 These limits are to apply to all plant items running simultaneously in the representative time periods, when running at design duty and are to apply at 1m from the outside of nearby residential windows. Any plant with a tonal component or other distinctive feature out of character with the existing environment would be subject to a further penalty.

5 Plant Noise Assessment

5.1 Proposed Installation

5.1.1 The proposed units with external noise emissions are as follows:

- 2x MRI Chiller: *Aptus ATXA 023 (Ref: CH/4.01 and CH/4.02)*
- 1x Air Handling Unit (AHU): *AHS Air Flex 85 F (Ref: AHU/5.01)*
- 3x AHU Chiller: *Climaveneta NX2-G06/UP/0112 (Ref: CH/5.01 to CH5.03)*
- 1x Air Conditioning Unit: *Mitsubishi PURY-EM200YNW-A1 (Ref: CON/5.01)*
- 2x Air Conditioning Unit: *Mitsubishi PURY-EM300YNW-A1 (Ref: CON/5.02 to CON/5.03)*

5.1.2 All plant items are proposed to be installed towards the north western side of the building. Chillers *CH/4.01* and *CH/4.02* are to be located at fourth floor roof level. *AHU/5.01,* chillers *CH/5.01 to CH5.03* and *CON/5.01* to *CON/5.03* are proposed to be installed at fifth floor roof level. The approximate locations of the installation can be seen in the attached site plan 206/0904/SP2.

5.1.3 It is assumed that plant items are to be available to run at all times.

5.1.4 Noise data for the proposed plant can be seen in the attached site plant noise schedule 206/0904/PNS1. It can be seen from the manufacturer's noise data that *CON/5.01* to *CON/5.03* display tonal elements in the 63 Hz octave band. +5 dB correction have been applied to these units within calculations.

5.2 Methodology

5.2.1 Noise levels have been calculated to three assessment positions representing the nearest and most exposed noise-sensitive receptors to the proposed plant. The assessment positions are labelled in the attached site plan 206/0904/SP2 and described below:

- AP1: Third floor window at 19 Pond Street facing the site.
- AP2: Second floor window at Hampstead Hill School facing the site.
- AP3: Eighth floor window at Belle Vue retirement home, overlooking the fifth-floor roof.

5.2.2 The noise levels generated by all mechanical services elements have been calculated by correcting the plant noise levels for distance and radiation losses, façade reflections and screening where appropriate.

5.2.3 Summary sheets showing each unit's individual contribution to the noise climate at each assessment position are set out on attached sheets 206/0904/CS1 to 206/0904/CS3. Full calculation sheets are available upon request.

5.3 Results

5.3.1 The results of our assessment indicate that mitigation of noise emissions from all proposed installations will be required to meet the noise emission limits at the assessment positions.

MRI Chillers - *CH/4.01* and *CH/4.02*

5.3.2 It will be necessary to install an acoustic screen around the proposed MRI Chillers at fourth floor roof level.

5.3.3 The screen panels should have a minimum surface mass of 10 kg/m^2 (e.g. 19 mm marine plywood).

5.3.4 The height of the acoustic screen next to *CH/4.01* and *CH/4.02* must be at least 0.15 m above the height of the top of the units. The location of the acoustic screen can be seen in the image below.

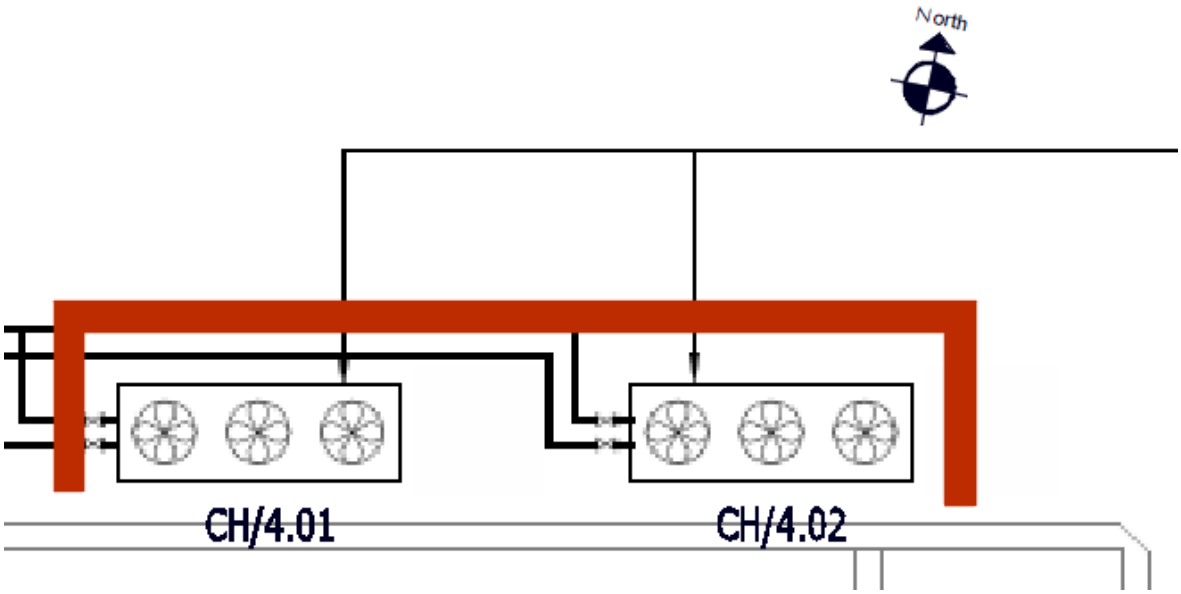

Image illustrating the acoustic screen around the MRI Chillers *CH4.01* and *CH4.02*.

Air Handling Unit – *AHU5.01*

5.3.5 It will be necessary to install attenuators within the atmospheric side ducts of the air handling unit *AHU5.01*.

5.3.6 The attenuators must meet the insertion losses in each octave band as defined in table T4.

Attenuator Ref.	Location	Insertion Loss (dB) at Octave Band Centre Frequency (Hz)							
		63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
ATT/5.01	*AHU/5.01* Air Intake	2	6	11	20	23	19	12	9
ATT/5.02	*AHU/5.01* Exhaust	2	6	11	20	23	19	12	9

T4 Attenuator insertion loss requirements (atmospheric side).

5.3.7 IT is expected that the insertion losses required for attenuators *ATT/5.01* and *ATT/5.02* to be achievable with a silencer of 1,200 mm length and 50% free area.

5.3.8 Any pressure drops from the attenuators or the atmospheric duct termination grilles should be limited to 40 Pa.

5.3.9 As best practice, the atmospheric attenuators should be located close to the unit so that noise breakout from the duct is also attenuated.

AHU Chilled Water Chillers – *CH5.01* to *CH5.03*

5.3.10 It will be necessary to install each of the AHU chilled water chillers in an acoustic enclosure.

5.3.11 This enclosure must meet the minimum insertion losses in each octave band as defined in table T5.

Enclosure	Insertion Loss, dB at Octave Band Centre Frequency, Hz							
	63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
ENC-01 (*CH/5.01* to *CH/5.03)*	5	7	11	13	15	16	14	13

T5 Attenuator insertion loss requirements (enclosure).

5.3.12 Enclosure ENC-01 must surround all of the AHU chillers, and can take the form of either a single enclosure for all units, or individual enclosures, depending on architectural constraints.

5.3.13 The required enclosure(s) can either be custom made using acoustic louvres or can be manufactured enclosure(s). Companies such as *Environ Technologies Ltd*[3], *EEC*[4] or *Sound Planning Ltd*[5] can provide specialist acoustic enclosures such as this which should meet the necessary requirements. The enclosure(s) must be sized to allow sufficient airflow to the condenser units.

Air Conditioning Units (*CON/5.01* to *CON/5.03)*

5.3.14 It will be necessary to install each of the air conditioning units in an acoustic enclosure.

5.3.15 This enclosure must meet the minimum insertion losses in each octave band as defined in table T6.

[3] https://www.environ.co.uk/
[4] http://eec.co.uk/
[5] https://www.soundplanning.co.uk/

Enclosure	Insertion Loss, dB at Octave Band Centre Frequency, Hz							
	63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
ENC-02 (*CON/5.01* to *CON/5.03)*	12	13	20	29	36	37	39	39

T6 Attenuator insertion loss requirements (enclosure).

5.3.16 Enclosure ENC-02 must surround all of the air conditioning units, and can take the form of either a single enclosure for all units, or individual enclosures, depending on architectural constraints.

5.3.17 The required enclosure(s) can either be custom made using acoustic louvres or can be manufactured enclosure(s) through companies detailed in Section 5.3.13 above.

5.3.18 All plant items must be installed on suitable anti-vibration mounts to control structure borne sound transmission.

5.4 Assessment Results

5.4.1 With the specified mitigation measures in place, we have assessed the following rating noise levels at the assessment positions in table T7 below.

Location	Rating Noise Level, $L_{Ar,Tr}$ dB *(Limit)*
	Night Time (24-hour)
AP1: 19 Pond Street	38 *(39)*
AP2: Hampstead Hill School	37 *(43)*
AP3: Belle Vue	39 *(39)*

T7 Resultant plant noise emission levels at the nearest noise sensitive properties.

5.4.2 Summary calculation sheets showing the expected noise levels at the assessment positions during both the day and night time hours can be seen in calculation sheet 206/0904/CS1 to 206/0904/CS3. Detailed calculation sheets can be provided upon request.

6 Conclusions

6.1 It is proposed to refurbish part of the imaging suite at the Royal Free Hospital to develop new MRI and X-ray treatment rooms. As part of this external plant will also be installed.

6.2 This report has provided details of a noise survey conducted at the site and has set noise emission limits for the proposed plant items in line with Local Authority requirements.

6.3 A noise impact assessment has been conducted of noise from the proposed plant items. The assessment has shown that with the proposed mitigation measures in place, the plant noise limits set will be achieved.

End of Section

Glossary of Acoustic Terms

L_{Aeq}:

The notional steady sound level (in dB) which over a stated period of time, would have the same A-weighted acoustic energy as the A-weighted fluctuating noise measurement over that period. Values are sometimes written using the alternative expression dB(A) L_{eq}.

L_{Amax}:

The maximum A-weighted sound pressure level recorded over the period stated. L_{Amax} is sometimes used in assessing environmental noise when occasional loud noises occur, which may have little effect on the L_{Aeq} noise level. Unless described otherwise, L_{Amax} is measured using the "fast" sound level meter response.

L_{A10} & L_{A90}:

If non-steady noise is to be described, it is necessary to know both its level and degree of fluctuation. The L_{An} indices are used for this purpose. The term refers to the A-weighted level (in dB) exceeded for n% of the time specified. L_{A10} is the level exceeded for 10% of the time and as such gives an indication of the upper limit of fluctuating noise. Similarly L_{A90} gives an indication of the lower levels of fluctuating noise. It is often used to define the background noise.

L_{A10} is commonly used to describe traffic noise. Values of dB L_{An} are sometimes written using the alternative expression dB(A) L_n.

L_{AX}, L_{AE} or SEL

The single event noise exposure level which, when maintained for 1 second, contains the same quantity of sound energy as the actual time varying level of one noise event. L_{AX} values for contributing noise sources can be considered as individual building blocks in the construction of a calculated value of L_{Aeq} for the total noise. The L_{AX} term can sometimes be referred to as Exposure Level (L_{AE}) or Single Event Level (SEL).

End of Section

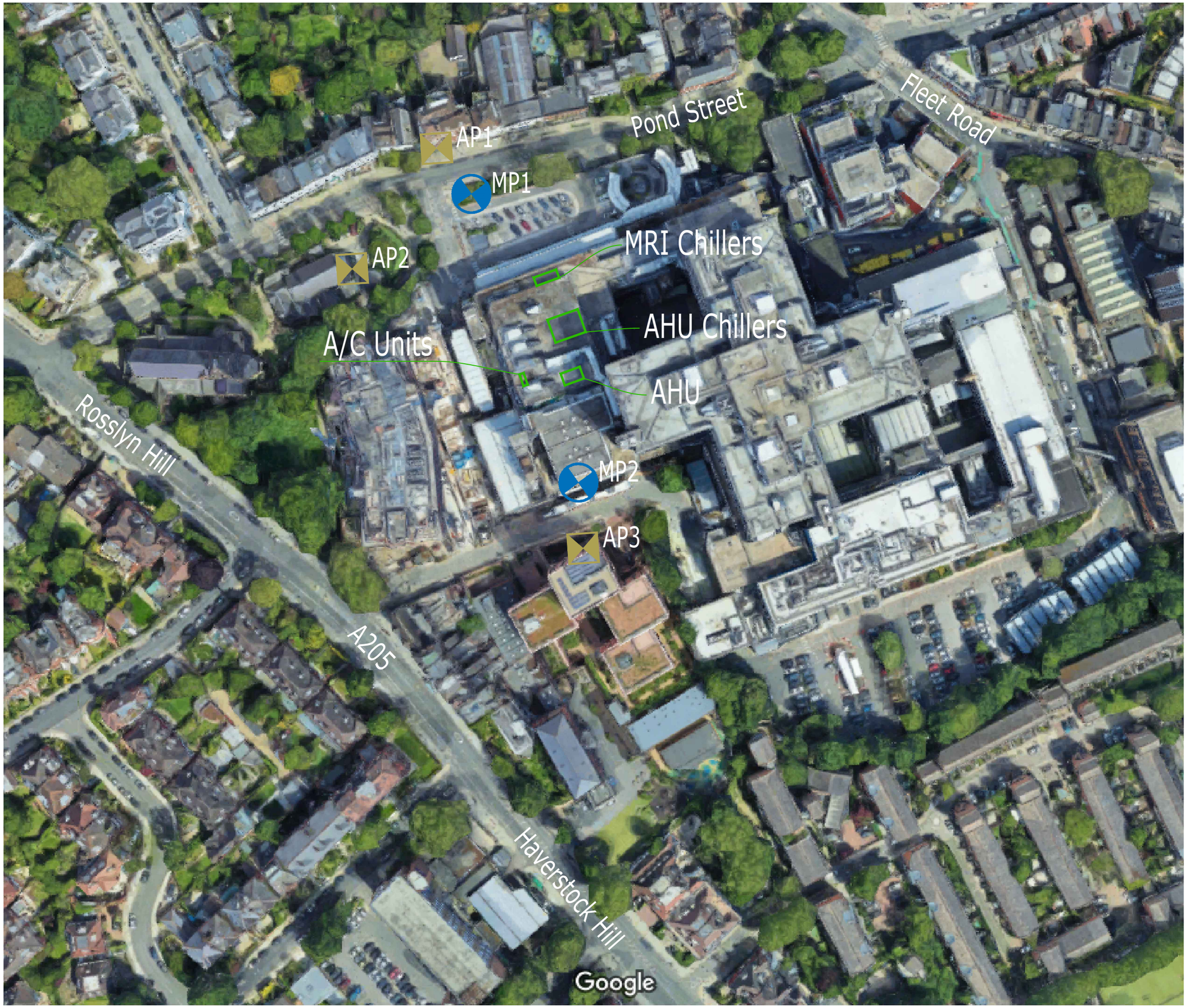

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Figure 206/0904/SP2

Title:

Site plan illustrating the measurement and assessment positions.

Key:

- Measurement Position
- Assessment Position
- Approximate Plant Locations

North

Project:

Royal Free Hospital, Imaging

Date: April 2022

Revision: -

Scale: Not to scale

Image Source: -

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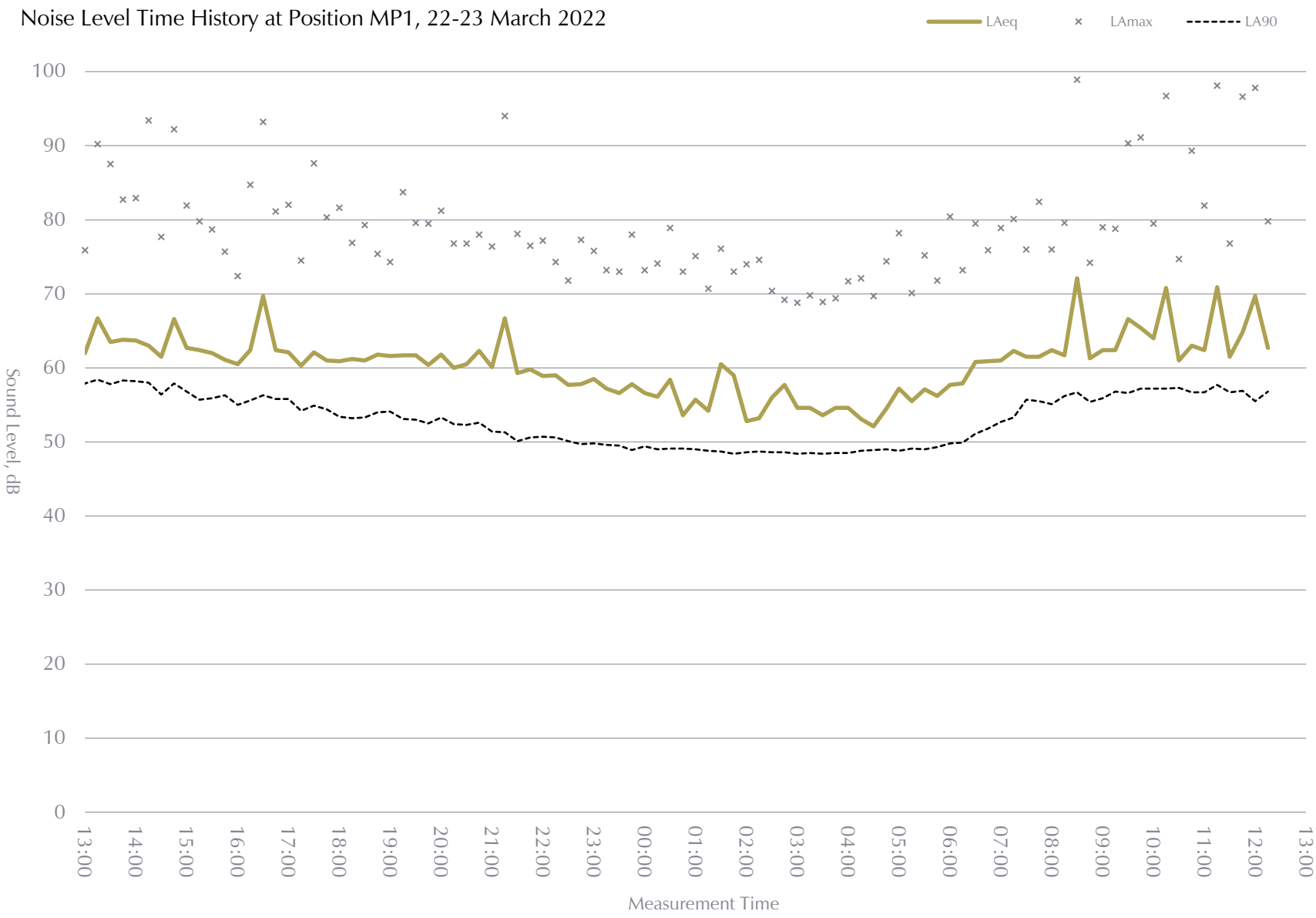


Figure 206/0904/TH01

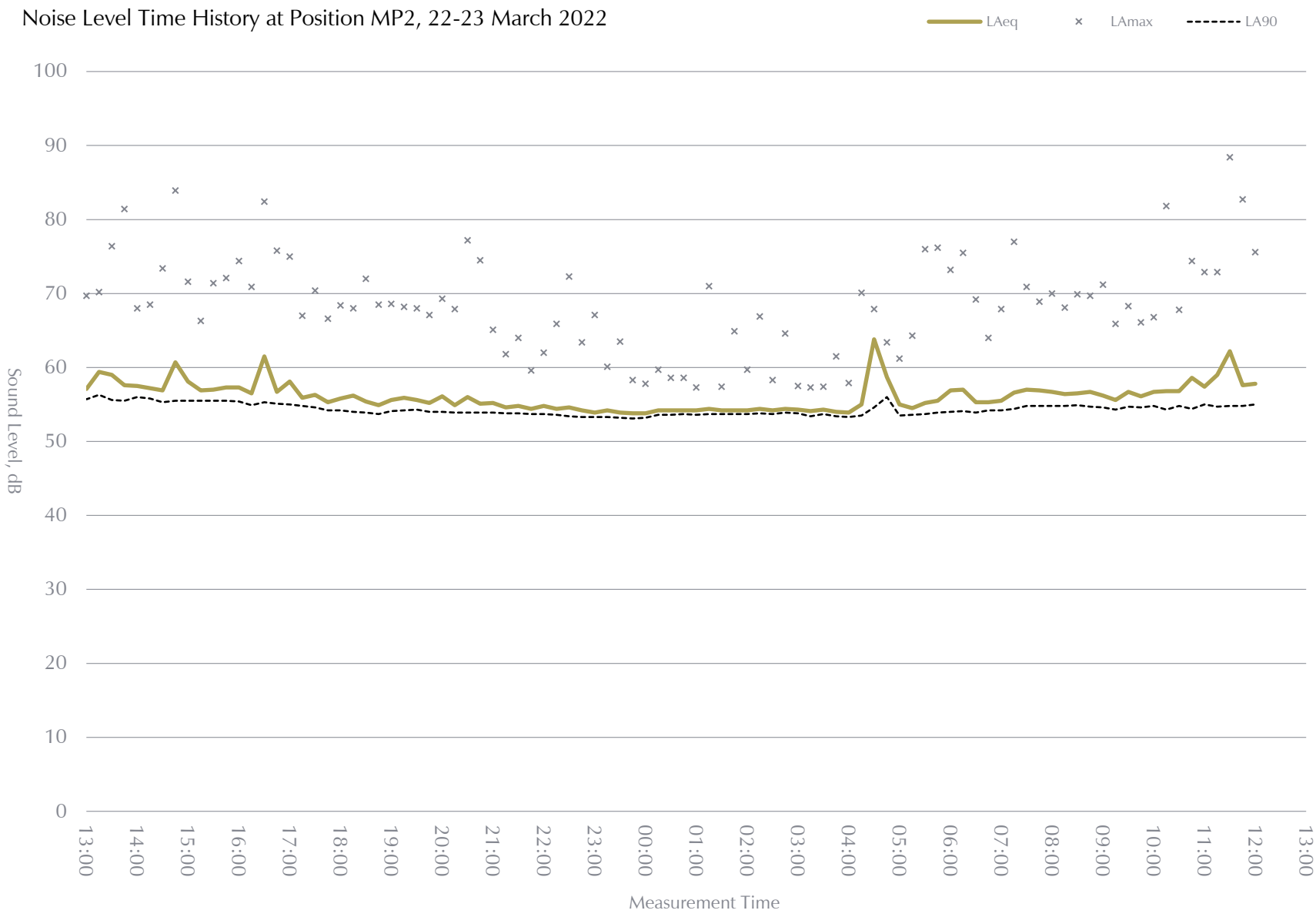


Figure 206/0904/TH02

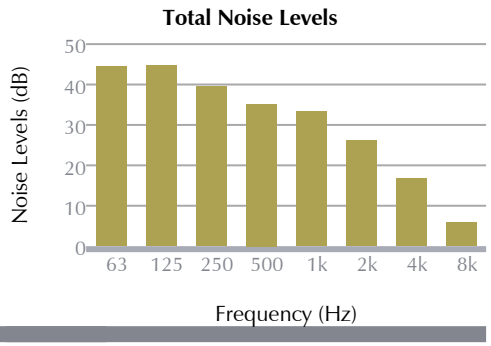
Schedule of Plant and Air Handling Equipment Sound Levels, dB

Reference	Description	Data Source [1]	Noise Level Type	Noise Levels (dB)							
				63	125	250	500	1k	2k	4k	8k
CH/4.01	Aptus ATXA 023	Man	Sound Power, Lw	72	88	84	81	81	76	69	61
CH/4.02	Aptus ATXA 023	Man	Sound Power, Lw	72	88	84	81	81	76	69	61
AHU/5.01 - Intake	AHS Air Flex 85 F	Man	Sound Power, Lw	77	84	81	77	72	69	65	65
AHU/5.01 - Exhaust	AHS Air Flex 85 F	Man	Sound Power, Lw	81	91	85	84	80	76	72	69
CH/5.01	Climaveneta NX2-G06/UP/0112	Man	Sound Power, Lw	90	90	86	85	85	81	74	62
CH/5.02	Climaveneta NX2-G06/UP/0112	Man	Sound Power, Lw	90	90	86	85	85	81	74	62
CH/5.03	Climaveneta NX2-G06/UP/0112	Man	Sound Power, Lw	90	90	86	85	85	81	74	62
CON/5.01	Mitsubishi PURY-EM200YNW-A1	Man	Sound Power, Lw	96	80	80	77	70	66	63	61
CON/5.02	Mitsubishi PURY-EM300YNW-A1	Man	Sound Power, Lw	101	88	88	86	80	75	70	66
CON/5.03	Mitsubishi PURY-EM300YNW-A1	Man	Sound Power, Lw	101	88	88	86	80	75	70	66

Notes

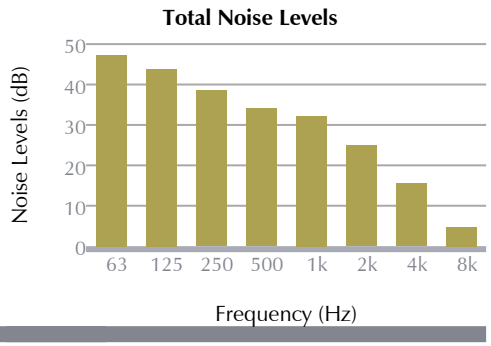
1 - Man refers to data supplied by the equipment manufacturer or supplier, Emp refers to data calculated using empirical formulae, and Meas refers to data measured by RSK Acoustics.

Project Name	Royal Free Hospital, Imaging
Project Reference	206/0904
Receiver Reference	AP1
Description	19 Pond Street
Noise Limit	39
dBA	38



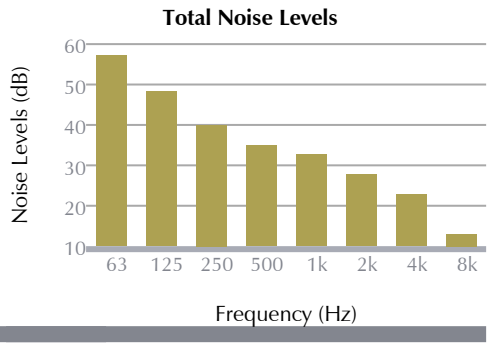
Reference	Noise Levels (dB)							
	63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
CH/4.01	26	41	36	32	30	23	14	3
CH/4.02	26	41	36	32	30	23	14	3
AHU/5.01 - Intake	14	16	0	-18	-28	-30	-27	-24
AHU/5.01 - Exhaust	17	24	8	-11	-23	-26	-25	-25
CH/5.01	32	30	20	16	11	4	-4	-18
CH/5.02	32	30	20	16	11	4	-4	-18
CH/5.03	32	30	20	16	11	4	-4	-18
CON/5.01	35	16	7	-8	-24	-32	-38	-41
CON/5.02	40	24	15	1	-15	-23	-31	-36
CON/5.03	40	24	15	1	-15	-23	-31	-36

Project Name	Royal Free Hospital, Imaging
Project Reference	206/0904
Receiver Reference	AP2
Description	Hampstead Hill School
Noise Limit	43
dBA	37



Reference	Noise Levels (dB)							
	63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
CH/4.01	25	40	35	31	29	22	12	2
CH/4.02	25	40	35	31	29	22	12	2
AHU/5.01 - Intake	13	14	-1	-20	-30	-29	-26	-23
AHU/5.01 - Exhaust	18	25	9	-5	-14	-16	-13	-13
CH/5.01	30	27	16	11	6	-1	-6	-17
CH/5.02	30	27	16	11	6	-1	-6	-17
CH/5.03	30	27	16	11	6	-1	-6	-17
CON/5.01	38	21	13	-1	-16	-24	-31	-36
CON/5.02	43	29	21	8	-7	-14	-24	-31
CON/5.03	43	29	21	8	-7	-14	-24	-31

Project Name	Royal Free Hospital, Imaging
Project Reference	206/0904
Receiver Reference	AP3
Description	Belle Vue
Noise Limit	39
dBA	39



Reference	Noise Levels (dB)							
	63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
CH/4.01	12	25	19	14	14	9	2	-6
CH/4.02	12	25	19	14	14	9	2	-6
AHU/5.01 - Intake	29	35	25	11	2	1	2	2
AHU/5.01 - Exhaust	32	40	27	13	2	2	5	5
CH/5.01	43	41	33	30	28	23	18	7
CH/5.02	43	41	33	30	28	23	18	7
CH/5.03	43	41	33	30	28	23	18	7
CON/5.01	48	31	23	11	-2	-8	-12	-15
CON/5.02	53	39	32	20	7	2	-5	-10
CON/5.03	53	39	32	20	7	2	-5	-10

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