CONABEARE ACOUSTICS

ENVIRONMENTAL ACOUSTIC IMPACT ASSESSMENT

The Royal Free NHS Trust
Pond Street
Hampstead
London
NW3 2QG

2NA Plant Project

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Prepared By:

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Stuart Metcalfe MIOA

CLIENT:

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1 Introduction

Conabeare Acoustics Limited have been commissioned by The Royal Free London NHS Foundation Trust to undertake an Acoustic Survey and BS4142:2014 assessment in relation to noise emissions of proposed plant at The Royal Free London Hospital, Pond Street, Hampstead, London NW3 2QG.

The Survey was undertaken by Stuart Metcalfe MIOA who has been practicing in Building Services Acoustics and Noise Control Engineering for in excess of 30 years, is a Member of the Institute of Acoustics (MIOA) and is a Director at Conabeare Acoustics Ltd.

2 Acoustic Criteria

BS4142:2014 Methods for rating and assessing industrial and commercial sound.

BS4142:2014 gives a method for rating sound from industrial and commercial sources affecting people inside or outside dwellings or premises used for residential purposes.

An initial estimate of the significance of the sound from the industrial/commercial nature can be assessed by subtracting the measured background noise level from the rating level (this is the specific sound level of the source with any corrections or penalties for distinctive acoustic characteristics).

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

The site is located within the London Borough of Camden demise which has adopted the National Planning Policy Guidelines and as such References and evaluations are to be made to the National Planning Policy Framework 2012 (NPPF) and the Noise Policy Statement for England 2010 (NPSE).

There are several key phrases within the NPSE aims and these are discussed below. “Significant adverse” and “adverse”

NOEL – No Observed Effect Level - This is the level below which no effect can be detected. In simple terms, below this level, there is no detectable effect on health and quality of life due to the noise.

LOAEL – Lowest Observed Adverse Effect Level - This is the level above which adverse effects on health and quality of life can be detected. Extending these concepts for the purpose of this NPSE leads to the concept of a significant observed adverse effect level.

SOAEL – Significant Observed Adverse Effect Level - This is the level above which significant adverse effects on health and quality of life occur.

This Camden requirement for noise exposure are detailed in the Local Plan Appendix 3: Noise thresholds which is reproduced thus;

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).

Table C: *Noise levels applicable to proposed industrial and commercial developments (including plant and machinery)*

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 57dB$_{LAmax}$*	*'Rating level' between 9dB below and 5dB above background or noise events between 57dB and 88dB $_{LAmax}$*	*'Rating level' greater than 5dB above background and/or events exceeding 88dB$_{LAmax}$*

**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.

There are certain smaller pieces of equipment on commercial premises, such as extract ventilation, air conditioning units and condensers, where achievement of the rating levels (ordinarily determined by a BS:4142 assessment) may not afford the necessary protection. In these cases, the Council will generally also require a NR curve specification of NR35 or below, dependant on the room (based upon measured or predicted Leq,5mins noise levels in octave bands) 1 metre from the façade of affected premises, where the noise sensitive premise is located in a quiet background area.

3 Plant Location and Measurement Position

The site is located on Pond Street in the Hampstead District in North West London.

The area consists of a mixture of residential and commercial premises with the sound sensitive façade in question being adjudged to be the residential premises in Pond Street.

The nearest sound sensitive façades are at a distance of approximately 25 metres from the proposed plant. The sound sensitive facade has direct line of site to the plant.

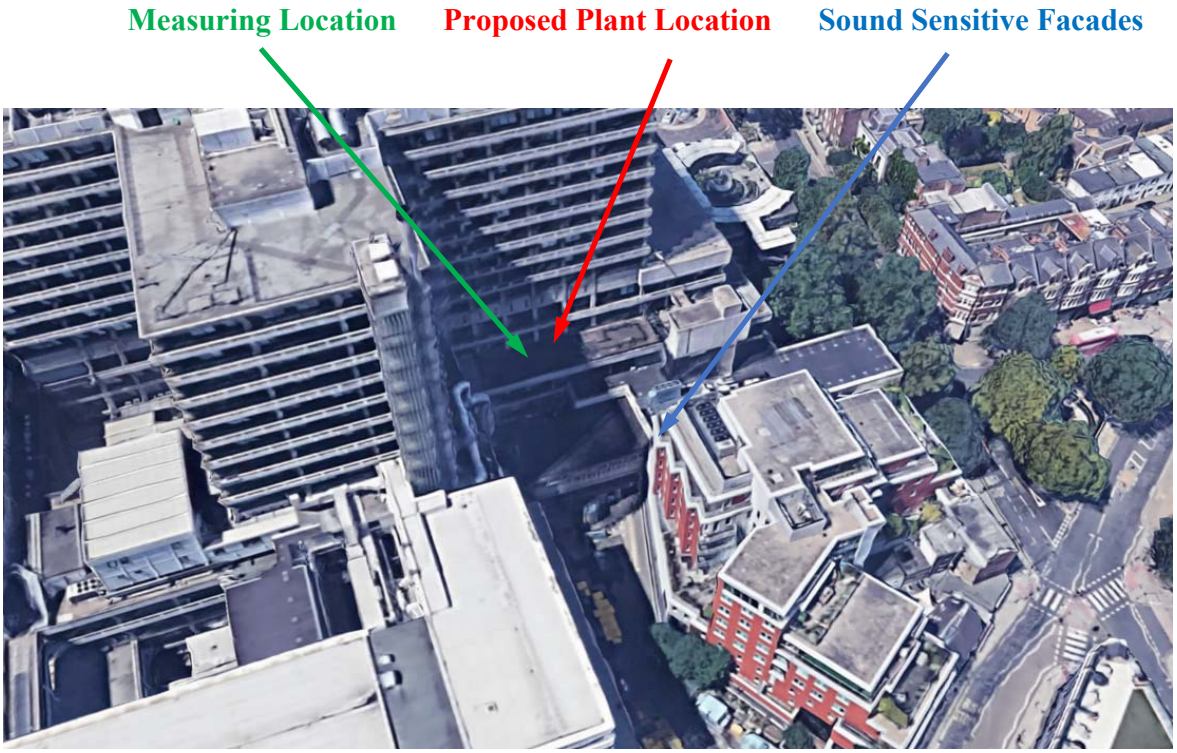

Photo 1 – Measuring Location
Showing nearest Sound Sensitive Facade

Photo 2 – Proposed Plant Location

4 Existing Noise Climate

The area is generally a mixture of healthcare and residential premises with plant noise from the area being adjudged to be the dominant background noise source during the survey period.

5 Noise Survey

5.1 Measurements

The Survey commenced at approximately 10:30 hours on Wednesday 3rd June 2020 until approximately 10:00 hours on Thursday 4th June 2020.

The Analyser was programmed to record 15 minute sampling periods over the survey duration.

The microphone was located on a tripod at approximately 1.5 metres above a reflecting plane.

The measurements and their interpretation are in accordance with BS 7445: Parts 1 and 2. All readings are Sound Pressure Levels (Lp) in dB (re 20µPa).

5.2 Weather during Survey Period

The weather was warm and dry. The weather did not, in our opinion, adversely influence the readings obtained.

5.3 Instrumentation

The instrumentation used was a Type 1 Larson Davis LxT Sound Expert Sound Level Analyser confirming to IEC 651-1979 Type 1, EN60651 Type 1 and IEC 804-1985 Type 1, EN60804 Type 1.

- **Larson Davis LxT Sound Level Analyser, Serial Number 0005588.**
- **Larson Davis PRMLxT1L Preamplifier, Serial Number 055664.**

The Sound Analyser and Preamplifier were calibrated on 5th March 2020, Certificate Number 2806.

The additional following equipment was also used

- **Larson Davis type CAL200 Calibrator, Serial Number 17720 calibrated on 19th February 2020, Certificate Number 2020002312.**
- **Extension Cable**

Field calibration checks were made using the Calibrator and no significant drift was noted against the Calibration level of 114.0dB ± 0.2dB at 1000Hz ± 0.2%.

5.4 Survey Results

The following is a summary of the Background (L_{A90}) levels recorded in Daytime, Evening and Night-time Periods

- $L_{A90,15min}$ 68.6dB(A) between 07:00 hours to 19:00 hours.
- $L_{A90,15min}$ 68.6dB(A) between 19:00 hours to 23:00 hours.
- $L_{A90,15min}$ 68.5dB(A) between 23:00 hours to 07:00 hours.

6 Assessment Methodology: BS4142:2014

A revision of British Standard BS 4142 was published at the end of October 2014 and replaces the previous 1997 edition. The main aim of the standard is to provide an assessment and rating method that is proportionate, sufficiently flexible and suitable for use by practitioners to inform professional judgement. The foreword to the standard clearly states that:

"The execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced."

It does this by providing a method for the determination of:

- rating levels for sources of an industrial and/or commercial nature; and
- ambient, background and residual sound levels.

An assessment framework is provided to allow the practitioner to use the rating, ambient, background and residual sound levels determined using the standard for the purposes of:

1) investigating complaints;
2) assessing sound from proposed, new, modified or additional source(s) of sound of an industrial and/or commercial nature; and
3) assessing sound at proposed new dwellings or premises used for residential purposes.

The scope of the standard has now been widened to rating and assessing:

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."

It can also be seen from above that the standard explicitly states that it can be used to investigate complaints and has been significantly widened to cover not only new, modified or additional sources of sound, but also the assessment of sound affecting new dwellings or premises to be used for residential purposes.

Like the 1997 edition, the standard provides a method for correcting the specific sound levels so as to account for acoustic features that are present at the assessment location. The approach in the 1997 edition was purely subjective and allowed for a +5 dB correction irrespective of how prominent the feature was or whether there was one feature only or a combination of tones, impulses or other features irregular enough to attract attention. The 2014 edition provides for scaled corrections up to +6 dB for tones and up to +9 dB for impulses, depending upon the prominence of the tones or impulses, as well as +3 dB corrections for:

- other sound characteristics that are neither tonal nor impulsive; and/or
- intermittent features when the sound has identifiable on/off conditions.

The corrections for tones and impulses can be assessed using subjective or reference methods. There is also an objective method for tones, which is based upon the prominence of sound pressure levels in the one-third-octave-band containing a tone in comparison to the sound pressure levels in the adjacent one-third-octave-bands.

The objective method however, does not allow for different corrections to be applied for tones differing in prominence as it only allows for a single correction of +6 dB for clearly prominent tones.

The 1997 edition assessed the likelihood of complaints using the difference between the rating level and the background sound level. A difference of around +10 dB or more indicated complaints are likely, a difference of around +5 dB was of marginal significance and a difference of more than 10 dB below the background was considered to provide a positive indication that complaints were unlikely.

The 2014 edition no longer assesses the likelihood of complaints. Instead, it can be used to assess adverse impacts.

This change was introduced because the likelihood of complaints is not a particularly appropriate benchmark, especially when it is used in a planning context, and it also aligns the standard more closely with the type of language and benchmarks that are suitable for the assessment of sound at the planning stage for new proposed development.

It continues to use the difference between the rating level and the background sound level, though it also introduces the requirement to consider the context and states that:

a) Typically, the greater this difference, the greater the magnitude of the impact.

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

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

d) 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."

The context includes consideration of pertinent factors, such as:

- the absolute level of sound;
- the character and level of the residual sound compared to the character and level of the specific sound;

- the sensitivity of the receptor and whether dwellings or other premises used for residential purposes will already incorporate design measures that secure good internal and/or outdoor acoustic conditions.

7 Noise Assessment

The objective of any specification limiting new noises should therefore be to ensure that sound emission from the new building services plant should not materially add to the existing sound climate.

As the existing plant noise is the dominant source then it is not accurate to assume that this will be the noise level at the nearest sound sensitive faced as the noise level measured will reduce for distance and we have calculated that the noise level from the existing plant will be 58dBA at the nearest sound sensitive façade.

To ensure that the noise level is not increased it will be necessary to attenuate the proposed plant to a level of 10dBA below this level.

The proposed plant being assessed is as detailed below;

- 1 number – M&Y 10872-01-05 Air Handling Unit
- 1 number – AHS Air Flex 67 Air Handling Unit
- 3 number – Toshiba RAV-SM2244AT8-E Condensing Units

As these items of plant have the potential to run on a 24 hour basis we would recommend setting a target level at the nearest sound sensitive façade as below;

$L_{Aeq,15min}$ 48dB(A) – 24 hours.

This level is 10dB(A) below the measured background level, corrected for distance, and would provide *NOEL* – No Observed Effect Level - this is the level below which no effect can be detected. In simple terms, below this level, there is no detectable effect on health and quality of life due to the noise.

We have detailed the noise levels for the above equipment, to the nearest sound sensitive façade, as well as the proposed mitigating measures, within our calculation sheet as below.

Acoustic Feature Correction

We have allowed for a 3dB Acoustic Correction Feature for the sound sensitive façade.

The condensing units are considered to be intermittent in nature so an allowance of 5dB has been made for these items.

No allowance has been made for tonal noise as no items of plant are considered to be tonal in nature.

Distance Attenuation

The distance loss figures are shown on our calculation sheet.

Barrier Attenuation

There is some screening afforded by the glass screen and this is detailed within our calculations

Un-mitigated Noise Levels

The combined noise level for all items of plant with no mitigating measures, and with all suitable allowances made, will be 58dBA at 1 metre from the nearest sound sensitive façade within the apartments at the junction of Fleet Road and Pond Street.

These combined noise levels are equal to the calculated measured Background Level at the nearest noise sensitive façade and will provide *LOAEL – Lowest Observed Adverse Effect Level.*

This is the level above which adverse effects on health and quality of life can be detected.

Our attached calculation sheet details the plant item noise levels and proposed mitigating measures. With the proposed mitigating measures installed the resultant noise level will meet the proposed target level.

As such the resultant noise level with the mitigating measures installed can be categorised as having *NOEL – No Observed Effect Level*

This is the level below which no effect can be detected. In simple terms, below this level, there is no detectable effect on health and quality of life due to the noise.

8 Recommendations

AHU01

The proposed AHU will be positioned externally in the plant area on the roof with the fresh air intake and exhaust intaking from and discharging to atmosphere respectively.

We have assessed the air paths and have suggested mitigating measures which are discussed below.

Fresh Air Intake

We would recommend that an intake attenuator is fitted which will have the following minimum acoustic performance.

Insertion Loss (dB) at Octave Band Centre Frequencies (Hz)							
63	125	250	500	1k	2k	4k	8k
4	6	11	16	21	19	15	14

The attenuator is envisaged to be 600mm long with 43% free area. The pressure loss over the attenuator would need to be less than 50Pa based upon plenum to duct conditions.

Exhaust Air

We would recommend that an exhaust air attenuator is fitted which will have the following minimum acoustic performance.

Insertion Loss (dB) at Octave Band Centre Frequencies (Hz)							
63	125	250	500	1k	2k	4k	8k
4	6	11	16	21	19	15	14

The attenuator is envisaged to be 600mm long with 43% free area. The pressure loss over the attenuator would need to be less than 50Pa based upon duct to duct conditions.

AHU02

The proposed AHU will be positioned externally in the plant area on the roof with the fresh air intake and exhaust intaking from and discharging to atmosphere respectively.

We have assessed the air paths and have suggested mitigating measures which are discussed below.

Fresh Air Intake

We would recommend that an intake attenuator is fitted which will have the following minimum acoustic performance.

Insertion Loss (dB) at Octave Band Centre Frequencies (Hz)							
63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
4	6	11	16	21	19	15	14

The attenuator is envisaged to be 600mm long with 43% free area. The pressure loss over the attenuator would need to be less than 50Pa based upon plenum to duct conditions.

Exhaust Air

We would recommend that an exhaust air attenuator is fitted which will have the following minimum acoustic performance.

Insertion Loss (dB) at Octave Band Centre Frequencies (Hz)							
63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
4	6	11	16	21	19	15	14

The attenuator is envisaged to be 600mm long with 43% free area. The pressure loss over the attenuator would need to be less than 50Pa based upon duct to duct conditions.

Condensing Units

It will not be necessary to install any additional mitigating measures to the Condensing Units.

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9 Conclusion

A background Noise Survey was carried during a typical day and night time period at a location representative of the nearest sound sensitive receivers.

An assessment has been carried out and mitigating measures proposed.

The assessment would indicate that the plant with the proposed mitigating measures will have a GREEN rating of *NOEL – No Observed Effect Level* as it is more than 10dBA below the measured background level.

In our opinion, the scheme should be acceptable to the Local Authority if these mitigating measures are incorporated into the works.

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- Period result profile -

Overload occurred	No
Low battery occurred	No
Pause was used	No
Frequency weighting	A
Band	Broadband
Period time	15 min
Periods too short for LNs	No
First period listed	1 : 96
Measurement Description	
Start	02/06/2020 10:29:52
Stop	03/06/2020 10:02:47
Duration	23:32:54.3
Run Time	23:32:54.3
Pause	00:00.0
Pre Calibration	02/06/2020 10:09:18

Period number	Date	Time	LN90.0% F	LN10.0% F	Leq
			dB, (A)	dB, (A)	dB, (A)
1	02/06/2020	10:29:52	69.0	69.8	69.4
2	02/06/2020	10:30:00	68.8	70.0	69.7
3	02/06/2020	10:45:00	68.8	69.9	69.5
4	02/06/2020	11:00:00	68.8	69.9	69.4
5	02/06/2020	11:15:00	68.7	69.8	69.3
6	02/06/2020	11:30:00	68.7	69.6	69.2
7	02/06/2020	11:45:00	68.8	69.8	69.3
8	02/06/2020	12:00:00	68.7	69.7	69.2
9	02/06/2020	12:15:00	68.7	69.6	69.2
10	02/06/2020	12:30:00	68.6	69.7	69.2
11	02/06/2020	12:45:00	68.7	70.2	69.4
12	02/06/2020	13:00:00	68.7	69.7	69.2
13	02/06/2020	13:15:00	68.7	69.7	69.2
14	02/06/2020	13:30:00	68.7	69.8	69.4
15	02/06/2020	13:45:00	68.9	70.2	70.2
16	02/06/2020	14:00:00	68.9	74.6	73.2
17	02/06/2020	14:15:00	68.8	70.0	69.5
18	02/06/2020	14:30:00	68.8	70.0	69.5
19	02/06/2020	14:45:00	68.8	70.0	69.5
20	02/06/2020	15:00:00	68.8	69.8	69.4
21	02/06/2020	15:15:00	68.8	70.4	70.2
22	02/06/2020	15:30:00	68.7	69.7	69.3
23	02/06/2020	15:45:00	68.8	73.4	75.7
24	02/06/2020	16:00:00	68.7	69.9	69.3
25	02/06/2020	16:15:00	68.7	69.9	69.5
26	02/06/2020	16:30:00	68.8	70.3	70.0
27	02/06/2020	16:45:00	68.7	70.0	70.2
28	02/06/2020	17:00:00	68.7	69.9	69.8
29	02/06/2020	17:15:00	68.7	69.6	69.2
30	02/06/2020	17:30:00	68.8	69.9	69.6
31	02/06/2020	17:45:00	68.8	69.8	69.4
32	02/06/2020	18:00:00	68.7	69.6	69.2
33	02/06/2020	18:15:00	68.8	69.6	69.2
34	02/06/2020	18:30:00	68.7	69.7	69.2
35	02/06/2020	18:45:00	68.7	69.6	69.2
36	02/06/2020	19:00:00	68.9	70.2	69.7
37	02/06/2020	19:15:00	68.9	70.5	69.9
38	02/06/2020	19:30:00	68.9	71.4	70.0
39	02/06/2020	19:45:00	68.8	69.9	69.6
40	02/06/2020	20:00:00	68.7	69.7	69.4
41	02/06/2020	20:15:00	68.7	69.6	69.2

Period number	Date	Time	LN90.0% F	LN10.0% F	Leq
			dB, (A)	dB, (A)	dB, (A)
42	02/06/2020	20:30:00	68.7	69.7	69.2
43	02/06/2020	20:45:00	68.7	69.7	69.2
44	02/06/2020	21:00:00	68.7	69.6	69.1
45	02/06/2020	21:15:00	68.7	69.6	69.2
46	02/06/2020	21:30:00	68.7	69.6	69.1
47	02/06/2020	21:45:00	68.7	69.6	69.2
48	02/06/2020	22:00:00	68.9	69.7	69.3
49	02/06/2020	22:15:00	69.0	69.8	69.4
50	02/06/2020	22:30:00	69.0	69.8	69.4
51	02/06/2020	22:45:00	68.7	69.6	69.2
52	02/06/2020	23:00:00	68.7	69.6	69.2
53	02/06/2020	23:15:00	68.8	69.6	69.2
54	02/06/2020	23:30:00	68.7	69.6	69.2
55	02/06/2020	23:45:00	68.7	69.6	69.2
56	03/06/2020	00:00:00	68.7	69.5	69.1
57	03/06/2020	00:15:00	68.7	69.6	69.2
58	03/06/2020	00:30:00	68.7	69.5	69.1
59	03/06/2020	00:45:00	68.7	69.5	69.1
60	03/06/2020	01:00:00	68.6	69.5	69.1
61	03/06/2020	01:15:00	68.6	69.5	69.0
62	03/06/2020	01:30:00	68.6	69.4	69.0
63	03/06/2020	01:45:00	68.6	69.5	69.0
64	03/06/2020	02:00:00	68.7	69.5	69.1
65	03/06/2020	02:15:00	68.7	69.5	69.1
66	03/06/2020	02:30:00	68.7	69.5	69.1
67	03/06/2020	02:45:00	68.6	69.5	69.1
68	03/06/2020	03:00:00	68.6	69.4	69.0
69	03/06/2020	03:15:00	68.5	69.4	69.0
70	03/06/2020	03:30:00	68.6	69.5	69.1
71	03/06/2020	03:45:00	68.5	69.4	69.0
72	03/06/2020	04:00:00	68.7	69.5	69.1
73	03/06/2020	04:15:00	68.6	69.5	69.1
74	03/06/2020	04:30:00	68.6	69.5	69.1
75	03/06/2020	04:45:00	68.7	69.5	69.1
76	03/06/2020	05:00:00	68.6	69.5	69.1
77	03/06/2020	05:15:00	68.7	69.6	69.1
78	03/06/2020	05:30:00	68.8	69.6	69.2
79	03/06/2020	05:45:00	68.7	69.6	69.2
80	03/06/2020	06:00:00	68.7	69.6	69.1
81	03/06/2020	06:15:00	68.7	69.6	69.2
82	03/06/2020	06:30:00	68.7	69.5	69.1
83	03/06/2020	06:45:00	68.7	69.6	69.2
84	03/06/2020	07:00:00	68.7	69.6	69.2
85	03/06/2020	07:15:00	68.8	70.0	69.4
86	03/06/2020	07:30:00	68.8	69.6	69.2
87	03/06/2020	07:45:00	68.7	69.6	69.3
88	03/06/2020	08:00:00	68.7	69.6	69.2
89	03/06/2020	08:15:00	68.8	69.9	69.4
90	03/06/2020	08:30:00	68.9	70.0	69.6
91	03/06/2020	08:45:00	68.9	70.2	69.7
92	03/06/2020	09:00:00	69.0	70.2	69.6
93	03/06/2020	09:15:00	69.0	70.1	69.6
94	03/06/2020	09:30:00	69.0	70.8	69.9
95	03/06/2020	09:45:00	68.9	70.1	69.7
96	03/06/2020	10:00:00	69.0	70.5	69.8

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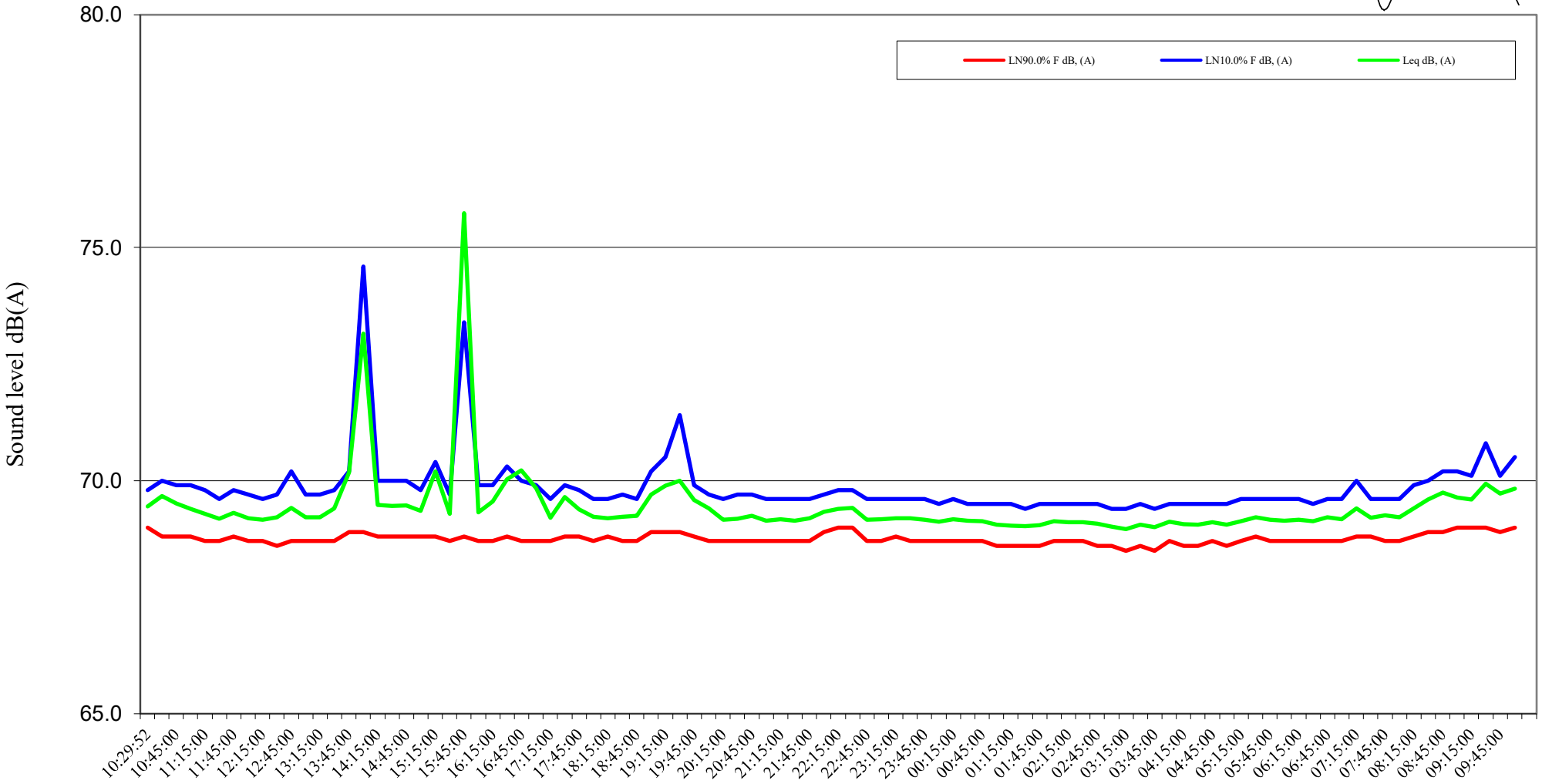

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Glossary of Terms

L_{A90}	The sound pressure level in dB(A) which is exceeded for 90% of the time and is taken to be the effective lowest background sound level for the period by such methods of sound rating as that recommended in BS4142:2014. It will also be used as a basis for selecting limiting sound levels from new plant by Local Planning Authorities when setting Planning Consent Conditions.
L_{Aeq}	The "equivalent continuous sound level" for the measuring period, defined as the level in dBA which, if held constant over the measuring period, would produce the same amount of sound energy as does the actual varying ambient sound level. It is a measure of the amount of sound energy affecting the site from sources other than new plant or operations.
L_{A10}	The sound level exceeded for 10% of the time over the sample period. Originally used as a measure of subjective reaction to traffic noise in particular, it can also be taken as an indication of the practical maximum sound level that the building envelope will have to protect against.
dBA	Describes measured on a sound level meter incorporating a frequency weighting (A weighting) which differentiates between sounds of different frequency (pitch) in a similar way to the human ear. Measurements in dBA broadly agree with people's assessment of loudness. A change of 3dBA is the minimum perceptible under normal conditions, and a change of 10dBA corresponds roughly to halving or doubling the loudness of a sound.

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CONABEARE ACOUSTICS

Project: CS8314 - Royal Free Hospital - 2NA Plant Project
Client : Royal Free London NHS Foundation Trust
Revision: Original
Date : 8th June 2020

Calculation 01

Item **Proposed Plant - Target Level - 48dBA at 1 metre from Nearest Sound Sensitive Façade - with Mitigating Measures**

Air Handling Unit 01 - M&Y Ventilation Equipment Limited

AHU - Fresh Air Intake - Atmospheric Noise			**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**dBA**
Unit Lw - Manufacturers Data			**63**	**81**	**79**	**74**	**76**	**76**	**79**	**73**	**84**
Addition for mounting position of fans			**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	
End Reflection			-2	0	0	0	0	0	0	0	
Distance to Listener	25	m	-39	-39	-39	-39	-39	-39	-39	-39	
Large Source Correction			0	0	0	0	0	0	0	0	
Directivity (90 Degrees)			2	2	1	0	-2	-5	-10	-15	
Source Location (Junction)			6	6	6	6	6	6	6	6	
Line of sight screening - Glass Screen			-5	-5	-5	-5	-5	-5	-5	-5	
Acoustic Feature Correction for Tonal Noise			0	0	0	0	0	0	0	0	
Façade Effect			3	3	3	3	3	3	3	3	
Resultant			**34**	**54**	**51**	**45**	**45**	**42**	**40**	**29**	**50**
Proposed Attenuation - KSD4030 - 600mm Long x 1400mm Wide x 900mm High			**-4**	**-6**	**-11**	**-16**	**-21**	**-19**	**-15**	**-14**	
Resultant with Mitigating Measures			**30**	**48**	**40**	**29**	**24**	**23**	**25**	**15**	**36**

AHU - Exhaust - Atmospheric Noise			**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**dBA**
Unit Lw - Manufacturers Data			**71**	**79**	**78**	**80**	**80**	**77**	**82**	**72**	**86**
Addition for mounting position of fans			**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	
End Reflection			-2	0	0	0	0	0	0	0	
Distance to Listener	25	m	-39	-39	-39	-39	-39	-39	-39	-39	
Large Source Correction			0	0	0	0	0	0	0	0	
Directivity (90 Degrees)			2	2	1	0	-2	-5	-10	-15	
Source Location (Junction)			6	6	6	6	6	6	6	6	
Line of sight screening - Glass Screen			-5	-5	-5	-5	-5	-5	-5	-5	
Acoustic Feature Correction for Tonal Noise			0	0	0	0	0	0	0	0	
Façade Effect			3	3	3	3	3	3	3	3	
Resultant			**42**	**52**	**50**	**51**	**49**	**43**	**43**	**28**	**53**
Proposed Attenuation - KSD4030 - 600mm Long x 1400mm Wide x 900mm High			**-4**	**-6**	**-11**	**-16**	**-21**	**-19**	**-15**	**-14**	
Resultant with Mitigating Measures			**38**	**46**	**39**	**35**	**28**	**24**	**28**	**14**	**37**

1	**Estimated Lp at Listener - AHU01 - No Mitigating Measures**		**43**	**56**	**54**	**52**	**50**	**46**	**45**	**32**	**55**
1A	**Estimated Lp at Listener - AHU01 - With Mitigating Measures**		**39**	**50**	**43**	**36**	**29**	**27**	**30**	**18**	**40**

Air Handling Unit 02 - AHS Limited

AHU - Fresh Air Intake - Atmospheric Noise			**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**dBA**
Unit Lw - Manufacturers Data			**80**	**82**	**80**	**77**	**74**	**72**	**67**	**64**	**80**
Addition for mounting position of fans			**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	
End Reflection			-2	0	0	0	0	0	0	0	
Distance to Listener	25	m	-39	-39	-39	-39	-39	-39	-39	-39	
Large Source Correction			0	0	0	0	0	0	0	0	
Directivity (90 Degrees)			2	2	1	0	-2	-5	-10	-15	
Source Location (Junction)			6	6	6	6	6	6	6	6	
Line of sight screening - Glass Screen			-5	-5	-5	-5	-5	-5	-5	-5	
Acoustic Feature Correction for Tonal Noise			0	0	0	0	0	0	0	0	
Façade Effect			3	3	3	3	3	3	3	3	
Resultant			**51**	**55**	**52**	**48**	**43**	**38**	**28**	**20**	**49**
Proposed Attenuation - KSD4030 - 600mm Long x 700mm Wide x 600mm High			**-4**	**-6**	**-11**	**-16**	**-21**	**-19**	**-15**	**-14**	
Resultant with Mitigating Measures			**47**	**49**	**41**	**32**	**22**	**19**	**13**	**6**	**37**

AHU - Exhaust - Atmospheric Noise			**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**dBA**
Unit Lw - Manufacturers Data			**78**	**86**	**80**	**80**	**78**	**74**	**70**	**65**	**83**
Addition for mounting position of fans			**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	
End Reflection			-2	0	0	0	0	0	0	0	
Distance to Listener	25	m	-39	-39	-39	-39	-39	-39	-39	-39	
Large Source Correction			0	0	0	0	0	0	0	0	
Directivity (90 Degrees)			2	2	1	0	-2	-5	-10	-15	
Source Location (Junction)			6	6	6	6	6	6	6	6	
Line of sight screening - Glass Screen			-5	-5	-5	-5	-5	-5	-5	-5	
Acoustic Feature Correction for Tonal Noise			0	0	0	0	0	0	0	0	
Façade Effect			3	3	3	3	3	3	3	3	
Resultant			**49**	**59**	**52**	**51**	**47**	**40**	**31**	**21**	**52**
Proposed Attenuation - KSD4030 - 600mm Long x 700mm Wide x 600mm High			**-4**	**-6**	**-11**	**-16**	**-21**	**-19**	**-15**	**-14**	
Resultant with Mitigating Measures			**45**	**53**	**41**	**35**	**26**	**21**	**16**	**7**	**39**

2	**Estimated Lp at Listener - AHU02**		**53**	**60**	**55**	**53**	**48**	**42**	**33**	**24**	**54**
2A	**Estimated Lp at Listener - AHU02 - With Mitigating Measures**		**49**	**54**	**44**	**37**	**27**	**23**	**18**	**10**	**41**

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CONABEARE ACOUSTICS

Condensing Units - Mitsubishi

	Condensing Units - RAV-SM2244AT8-E			**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**dBA**
	Unit Lp at 1 metre - Manufacturers Data			**61**	**60**	**58**	**54**	**53**	**49**	**42**	**32**	**57**
	Additional Sources (2)			**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	
	Additional Distance to Listener	24	m	-28	-28	-28	-28	-28	-28	-28	-28	
	Correction for intermittent noise			5	5	5	5	5	5	5	5	
	Additional Surfaces			3	3	3	3	3	3	3	3	
	Line of sight screening - Glass Screen			-5	-5	-5	-5	-5	-5	-5	-5	
	Façade Effect			3	3	3	3	3	3	3	3	
3	**Estimated Lp at Listener - Condensing Units Only**			**44**	**43**	**41**	**37**	**36**	**32**	**25**	**0**	**40**
	Estimated Combined Lp at Listener - No Mitigating Measures			**54**	**62**	**57**	**55**	**53**	**47**	**45**	**32**	**58**
	Estimated Combined Lp at Listener - With Mitigating Measures			**51**	**56**	**47**	**41**	**37**	**34**	**31**	**18**	**45**

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ACSL
Acoustic Calibration Services Limited

CERTIFICATE OF CALIBRATION

Model: LD LxT1LC1 **Serial Number:** 025445

Organisation: Conabeare Acoustics Limited, 11 Chilton Enterprise Centre, Station Road, Theale, Berkshire RG7 4AA

Job Number: 2806 **Customer Order Reference:** 10588

The Sound Level Meter was assessed for conformance with International Standard BS EN 61672-3:2006 as modified by TPS 49 Edition 1. The manufacturer claims Class 1 accuracy conformance and it was against these requirements that all the results were evaluated.

The sound level meter was fitted with a PCB 377B02 Serial No. 304334 measurement microphone, a LD PRMLxT1L preamplifier Serial No. 055664 and an unmarked 12 ft microphone extension cable. The microphone was replaced with a suitable input device in order to apply electrical signals to the preamplifier.

A B&K 4231 Acoustic Calibrator Serial No: 2705996 was utilised in establishing the initial acoustic calibration setting.

The sound level meter passed all tests carried out with no deviations from Class 1 specification, in accordance with the modified BS EN 61672-3:2006.

The sound level meter should be set to read **113.8dB** when used with the associated acoustic calibrator, microphone, preamplifier and 12 ft microphone extension cable, as detailed above at reference atmospheric pressure.

All ACSL's calibration instrumentation is fully traceable to National Standards. The acoustic references are calibrated by laboratories which are UKAS accredited for the purpose.

Certificate No: **15766** ***Signature:***
Date of Issue: **5th March 2020** ***Print Name:*** **Trevor Lewis**

Calibration Certificate

Certificate Number 2020002312

Customer:
PC Environmental Ltd.
Unit 5,Claylands Park Claylands Road
Bishops Waltham
Southampton,SO32 1QD,United Kingdom

Model Number	CAL200	***Procedure Number***	D0001.8386		
Serial Number	17720	***Technician***	Scott Montgomery		
Test Results	**Pass**	***Calibration Date***	19 Feb 2020		
Initial Condition	As Manufactured	***Calibration Due***			
		Temperature	23	°C	± 0.3 °C
Description	Larson Davis CAL200 Acoustic Calibrator	***Humidity***	32	%RH	± 3 %RH
		Static Pressure	100.9	kPa	± 1 kPa

Evaluation Method The data is aquired by the insert voltage calibration method using the reference microphone's open circuit sensitivity. Data reported in dB re 20 µPa.

Compliance Standards Compliant to Manufacturer Specifications per D0001.8190 and the following standards:
IEC 60942:2017 ANSI S1.40-2006

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the SI through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005.
Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.

The quality system is registered to ISO 9001:2015.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

Standards Used

Description	Cal Date	Cal Due	Cal Standard
Agilent 34401A DMM	08/15/2019	08/15/2020	001021
Larson Davis Model 2900 Real Time Analyzer	04/02/2019	04/02/2020	001051
Microphone Calibration System	03/04/2019	03/04/2020	005446
1/2" Preamplifier	09/17/2019	09/17/2020	006506
Larson Davis 1/2" Preamplifier 7-pin LEMO	08/06/2019	08/06/2020	006507
1/2 inch Microphone - RI - 200V	05/21/2019	05/21/2020	006510
Pressure Transducer	06/24/2019	06/24/2020	007310