CONABEARE ACOUSTICS

ACOUSTIC PLANT ASSESSMENT

3 Gloucester Gate
Regents Park
London
NW1 4AD

Reference : CS8169-01
Revision : Revision A
Status : Planning Issue
Issue Date : 2nd April 2019

Prepared By:

Stuart Metcalfe

Stuart Metcalfe MIOA

CLIENT:

Sohail Moussavi
c/o Q Architectural Design Consultants Ltd
32 Donovan Court
107 Drayton Gardens
London
SW10 9QT

Conabeare Acoustics Limited
11 Chiltern Enterprise Centre, Station Road, Theale, Berkshire. RG7 4AA
Telephone 0118 930 3650 Facsimile 0118 930 3912
sales@conabeare.co.uk

CONABEARE ACOUSTICS

Conabeare Acoustics Limited
11 Chiltern Enterprise Centre, Station Road, Theale, Berkshire. RG7 4AA
Telephone 0118 930 3650 Facsimile 0118 930 3912
sales@conabeare.co.uk

1 Introduction

Conabeare Acoustics Limited have been commissioned by Sohail Moussavi to undertake an Acoustic Survey and BS4142:2014 assessment in relation to noise emissions of proposed plant at 3 Gloucester Gate, Regent's Park, London NW1 4AD.

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.

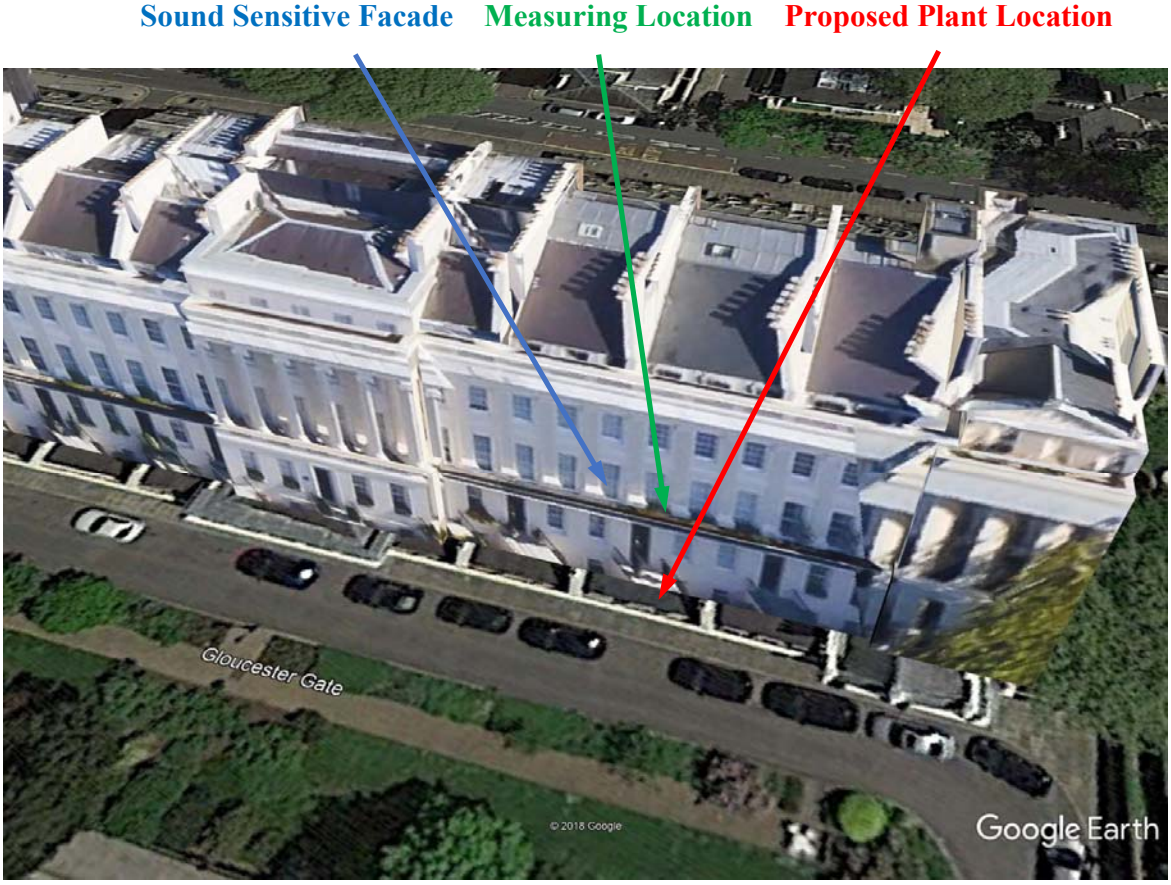
There are certain smaller pieces of equipment on commercial premises, such as extract ventilation, air conditioning units and condensers, where achievement of the rating levels (ordinarily determined by a BS:4142 assessment) may not afford the necessary protection. In these cases, the Council will generally 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 Gloucester Gate in the Regents Park District in North West London.

The area consists of a mainly residential premises with the sound sensitive façade in question being adjudged to be the residential premises adjacent to and in the same block as the property. We have discounted the ground floor windows as these appear to be non-living rooms.

The nearest sound sensitive façade is at a distance of approximately 5 metres from the proposed plant. The sound sensitive facade has partial direct line of site to the plant which is partially screened by the balcony.

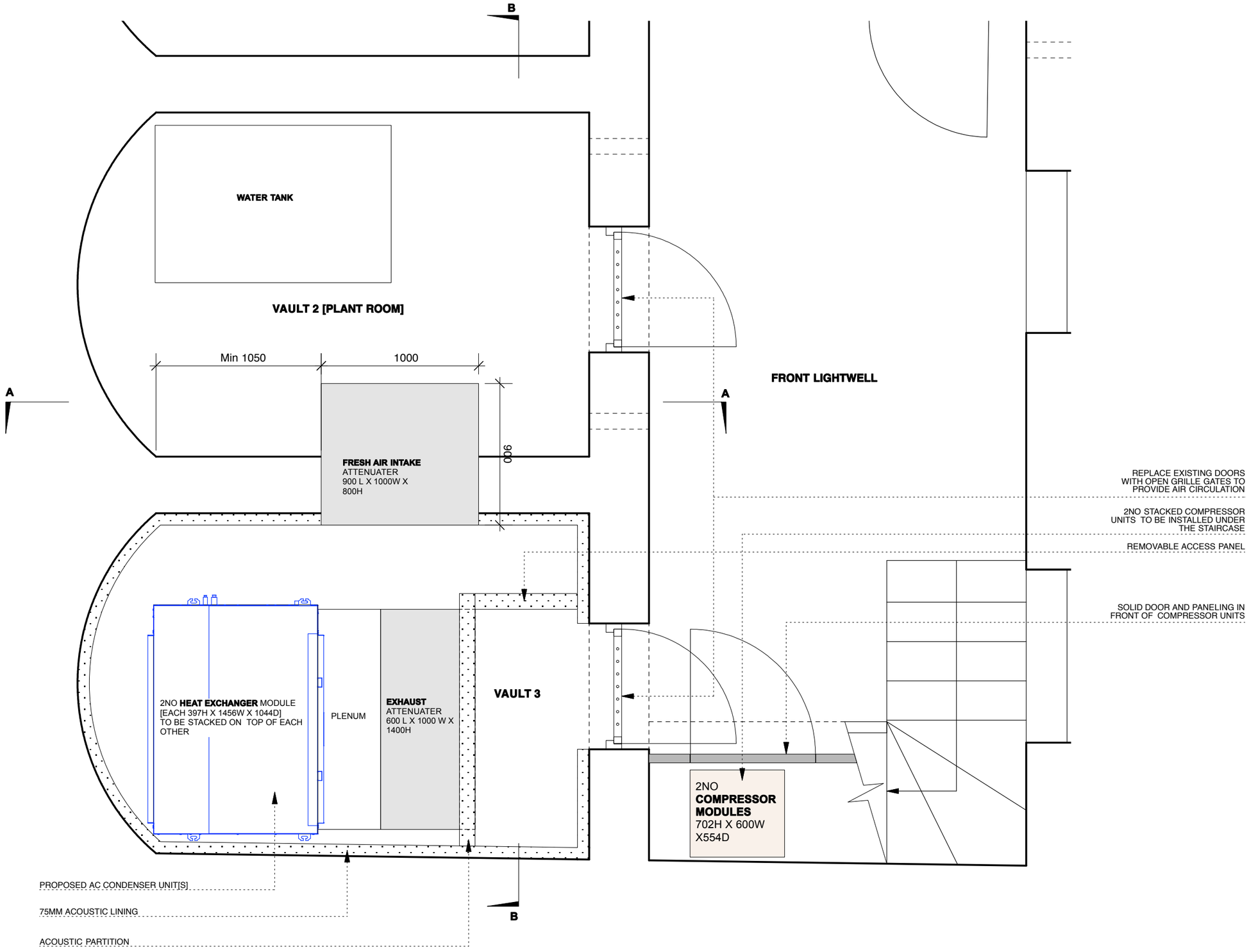


CONABEARE ACOUSTICS

Photo 1 – Measuring Location

Photo 2 – Proposed Plant Location

Conabeare Acoustics Limited
11 Chiltern Enterprise Centre, Station Road, Theale, Berkshire. RG7 4AA
Telephone 0118 930 3650 Facsimile 0118 930 3912
sales@conabeare.co.uk



PROPOSED VAULT 3 - ARRANGEMENT OF AC CONDENSER AND COMPRESSOR UNITS

1:25 @ A3

REV B [2019.03.29] position and size of opening between Vaults 2 and 3 revised

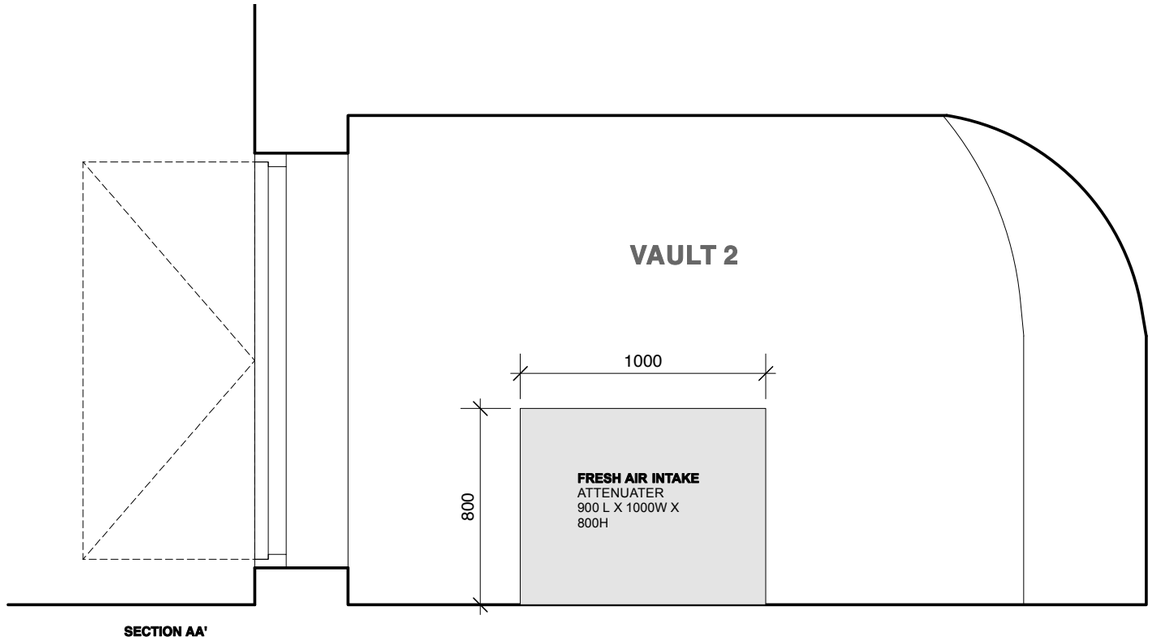
REV A [2019.03.20] drawing revised after meeting with AC and acoustic consultants

Drawing Status: PRELIMINARY

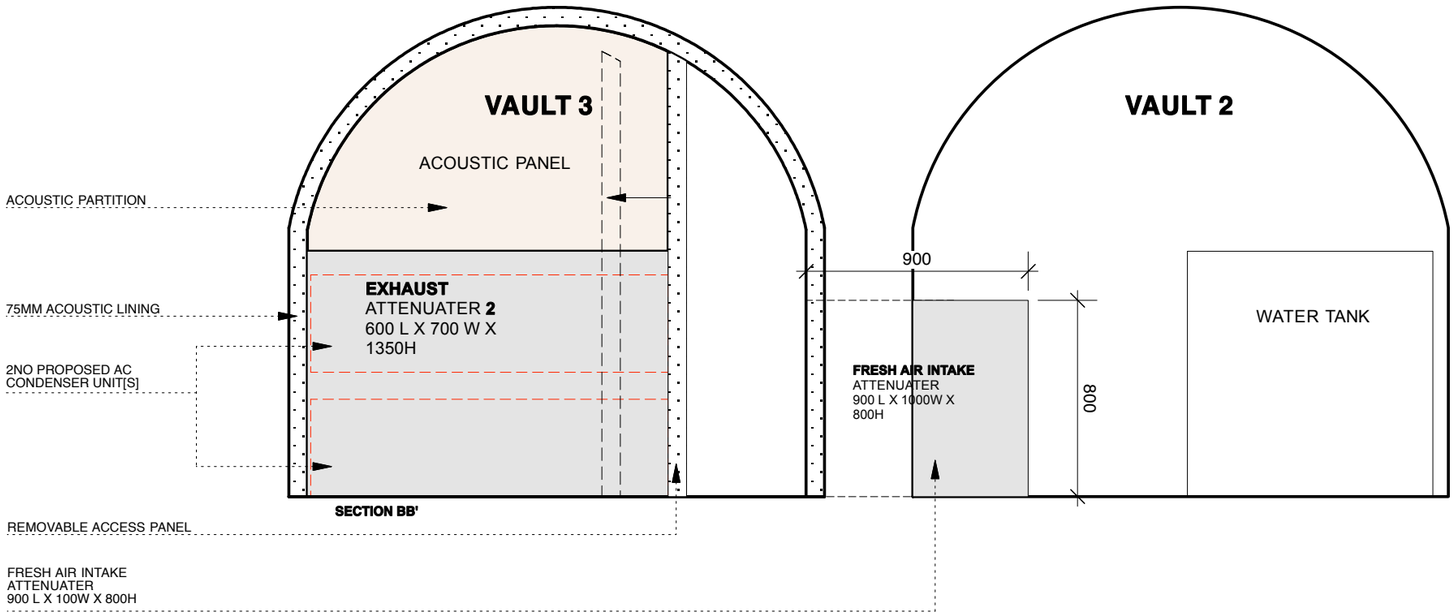
This Drawing May Only Used For Construction / Manufacture If Status Is FOR CONSTRUCTION

Q ARCHITECTURAL DESIGN CONSULTANTS LTD.

Project:	3 Gloucester Gate, London NW1 4HG
Client:	Mr Sohail Moussavi
Drawing:	AC - Vault 3
Scale:	1:25 @ A3
Date:	6.3.2019
Drawn by:	SA
Drawing no:	3GG/DET8/01 B



SECTION AA'



SECTION BB'

PROPOSED VAULTS SECTIONS

1:25 @ A3

REV B [2019.03.29] position and size of opening between Vaults 2 and 3 revised

REV A [2019.03.20] drawing revised after meeting with AC and acoustic consultants

Drawing Status: PRELIMINARY

This Drawing May Only Used For Construction / Manufacture If Status Is FOR CONSTRUCTION

Q ARCHITECTURAL DESIGN CONSULTANTS LTD.

Project:	3 Gloucester Gate, London NW1 4HG
Client:	Mr Sohail Moussavi
Drawing:	AC - Vault 3
Scale:	1:25 @ A3
Date:	12.3.2019
Drawn by:	SA
Drawing no:	3GG/DET8/02B

4 Existing Noise Climate

The area is generally residential premises with transportation 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 08:40 hours on Monday 28th January 2019 until approximately 15:30 hours on Tuesday 29th January 2019.

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

The microphone was located on a balustrade at approximately 1.5 metres above a reflecting plane and at approximately 1.2 metres from the nearest facade.

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 cold 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 are new items of equipment and were factory calibrated on 20th April 2018, Certificate Numbers 2018004098 and 2018004083 respectively.

The additional following equipment was also used

- **CEL type 284/2 Calibrator, Serial Number 4/05022369 calibrated on 21st February 2017, Certificate Number 15179.**
- **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

$L_{A90,15min}$ 48.8dB(A) between 07:00 hours to 19:00 hours.

$L_{A90,15min}$ 48.0dB(A) between 19:00 hours to 23:00 hours.

$L_{A90,15min}$ 42.9dB(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.

As the noise levels recorded can be considered as very low it is also considered appropriate to consider other pertinent sources of guidance. The following sections consider absolute criteria advocated by both the World Health Organisation: 1999: "Guidelines for Community Noise" and BS 8233:2014: "Sound insulation and noise reduction for buildings – Code of practice".

World Health Organisation: 1999: "Guidelines for Community Noise"

This document provides a review of the effects of noise and a description of the principles of the WHO health criteria and guidelines for Community Noise.

The effects of noise in dwellings are identified as sleep disturbance, annoyance and speech interference. For bedrooms, the critical effect is sleep disturbance.

The indoor guideline value for continuous noise in bedrooms is 30 dB L_{Aeq}. To enable casual conversation indoors during the daytime, the sound level of the interfering noise should not exceed 35 dB L_{Aeq}.

Table 1 of the document summarises the guideline values for community noise in specific environments and includes the noise indices to be adopted. Significantly, the corresponding time base to be used for the assessment is also included.

The relevant extracts of Table 1 are reproduced thus:

Specific environment	Critical health effect(s)	LAeq [dB]	Time base [hours]	LAmax fast [dB]
Dwelling, indoors	Speech intelligibility & moderate annoyance daytime & evening	35	16	45
	Sleep disturbance, night-time	30	8	

Furthermore BS8233:2014 *Guidance on sound insulation and noise reduction for buildings* provides guidance as to suitable internal noise levels for different areas within residential buildings.

The relevant section of the standard is shown below in Table 2.1.

Activity	Location	07:00 to 23:00	23:00 to 07:00
Resting	Living Room	35 dB $L_{Aeq, 16\ hour}$	-
Dining	Dining Room	40 dB $L_{Aeq, 16\ hour}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq, 16\ hour}$	30 dB $L_{Aeq, 8\ hour}$

Excerpt from BS8233: 2014 **[dB ref. 20µPa]**

This level should be a cumulative level from all plant running normally and makes allowance for any tonal or intermittent noise from the plant.

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 and any other new sources, in particular, should not materially add to the existing sound climate.

The background levels measured are representative of those at the nearest sound sensitive façade.

The proposed plant will operate on a 24 hour basis.

We would therefore suggest setting target levels at 1 metre from the nearest sound sensitive façade as below;

$L_{Aeq,15min}$ 33dB(A) – 24 hours.

The proposed plant being assessed is as detailed below – the noise levels provided by the Manufacturers of the plant are shown within our calculations;

The proposed plant consists of a Daikin Split System with separate Compressors and Heat Exchangers. The proposal is to install the louder items, the heat exchangers, within the vault and the compressors externally below the access staircase.

Air Conditioning Condensing Split Unit comprising the following

2 number Daikin RDXYQ5T8 – 76dBA Lw
2 number Daikin RKXYQ5T8 – 60dBA Lw

Applying the factors detailed in our calculation, we would predict a Noise Rating Level of 54dBA at 1 metre from the sound sensitive façade. This is 11dBA above the measured night time LA90 and as such will provide *SOAEL – Significant Observed Adverse Effect Level.*

8 Recommendations

It will therefore be necessary to install mitigating measures to meet the target level of 33dBA at 1 metre from the sound sensitive façade.

These mitigating measures are as detailed below;

Daikin RDXYQ5T8

The proposed Heat Exchanger Units will be positioned internally to Vault 3 with the supply air being fed from Vault 2 through an intake attenuator and then discharged from Vault 3 through a discharge attenuator, as detailed on the enclosed drawing from Messrs Q Architectural Design Consultants Limited.

We have assessed the air path and breakout for these and have suggested mitigating measures which are detailed below.

CONABEARE ACOUSTICS

Intake Air Attenuator

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

Insertion Loss (dB) at Octave Band Centre Frequencies (Hz)							
63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
7	10	18	27	33	32	23	18

The attenuator is envisaged to be 900mm long with 33% free area.

The pressure loss over the attenuator would need to be less than 50Pa based upon plenum to plenum conditions.

Discharge Air Attenuator

We would recommend that a discharge attenuator is fitted which will require the following minimum acoustic performance.

Insertion Loss (dB) at Octave Band Centre Frequencies (Hz)							
63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
7	10	18	27	33	32	23	18

The attenuator is envisaged to be 600mm long with 28% free area and will be connected to the Heat Exchanger outlets to provide a ducted connection from both units.

The pressure loss over the attenuator would need to be less than 50Pa based upon plenum to plenum conditions.

Breakout

The heat exchanger has a free air inlet treated by the inlet attenuators with regard to Vault 2 however this will allow noise from the unit to bypass the attenuation and exit Vault 3.

It will therefore be necessary to install an absorptive acoustic panel screen to prevent noise breakout from the units through the Vault 3 access door.

The acoustic panel screen will have the following minimum acoustic performance.

Sound Reduction (dB) at Octave Band Centre Frequencies (Hz)							
63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
17	16	21	30	38	42	44	38

Conabeare Acoustics Limited
11 Chiltern Enterprise Centre, Station Road, Theale, Berkshire. RG7 4AA
Telephone 0118 930 3650 Facsimile 0118 930 3912
sales@conabeare.co.uk

The screen is envisaged to have 75mm thick acoustic panelwork and should fully encapsulate the units with any penetrations acoustically sealed. The screen should be mounted independently from the units.

Reverberant Noise

As the vault containing the units is considered as being very reverberant it will be necessary to acoustically treat the walls and ceiling to negate the cumulative effect of these.

All faces will therefore require acoustic absorptive panels to reduce the reverberant noise and these should be installed prior to the Heat Exchanger units.

The acoustic wall lining will have the following minimum acoustic performance.

Sound Absorption Coefficient at Octave Band Centre Frequencies (Hz)

63	125	250	500	1k	2k	4k	8k
0.21	0.26	0.43	0.78	0.85	0.90	0.86	0.76

It is envisaged that this wall lining will consist of 75mm thick absorptive acoustic panels.

Daikin RKXYQ5T8

The proposed Compressor Units will be positioned below the access staircase, as detailed on the enclosed drawing from Messrs Q Architectural Design Consultants Limited.

We have assessed the breakout for these and have suggested mitigating measures which are detailed below.

The compressors will have a door and panel constructed in front of the alcove to shield the sound sensitive façade from these units.

The Door will be a proprietary acoustic solid core Rw35 door and matching side panel.

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 have been proposed.

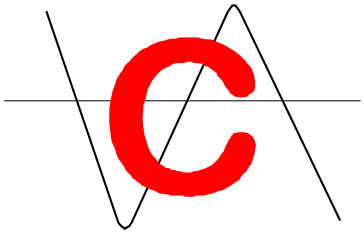
In our opinion the resultant noise levels from the proposed units, with the proposed mitigation measures installed, would be in line with the Local Authority requirements and would provide *LOAEL – Lowest Observed Adverse Effect Level*.

This would therefore give it a Green rating in line with London Borough of Camden Table C**:** *Noise levels applicable to proposed industrial and commercial developments (including plant and machinery)*

Conabeare Acoustics Limited
11 Chiltern Enterprise Centre, Station Road, Theale, Berkshire. RG7 4AA
Telephone 0118 930 3650 Facsimile 0118 930 3912
sales@conabeare.co.uk

CS8169 - 3 Gloucester Gate, Regent's Park, London NW1 4AD

- 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 : 24
Measurement Description	
Start	28/01/2019 08:42:11
Stop	29/01/2019 15:28:50
Duration	1 Day 06:46:39.5
Run Time	1 Day 06:46:39.5
Pause	0:00:00.0
Pre Calibration	28/01/2019 08:28

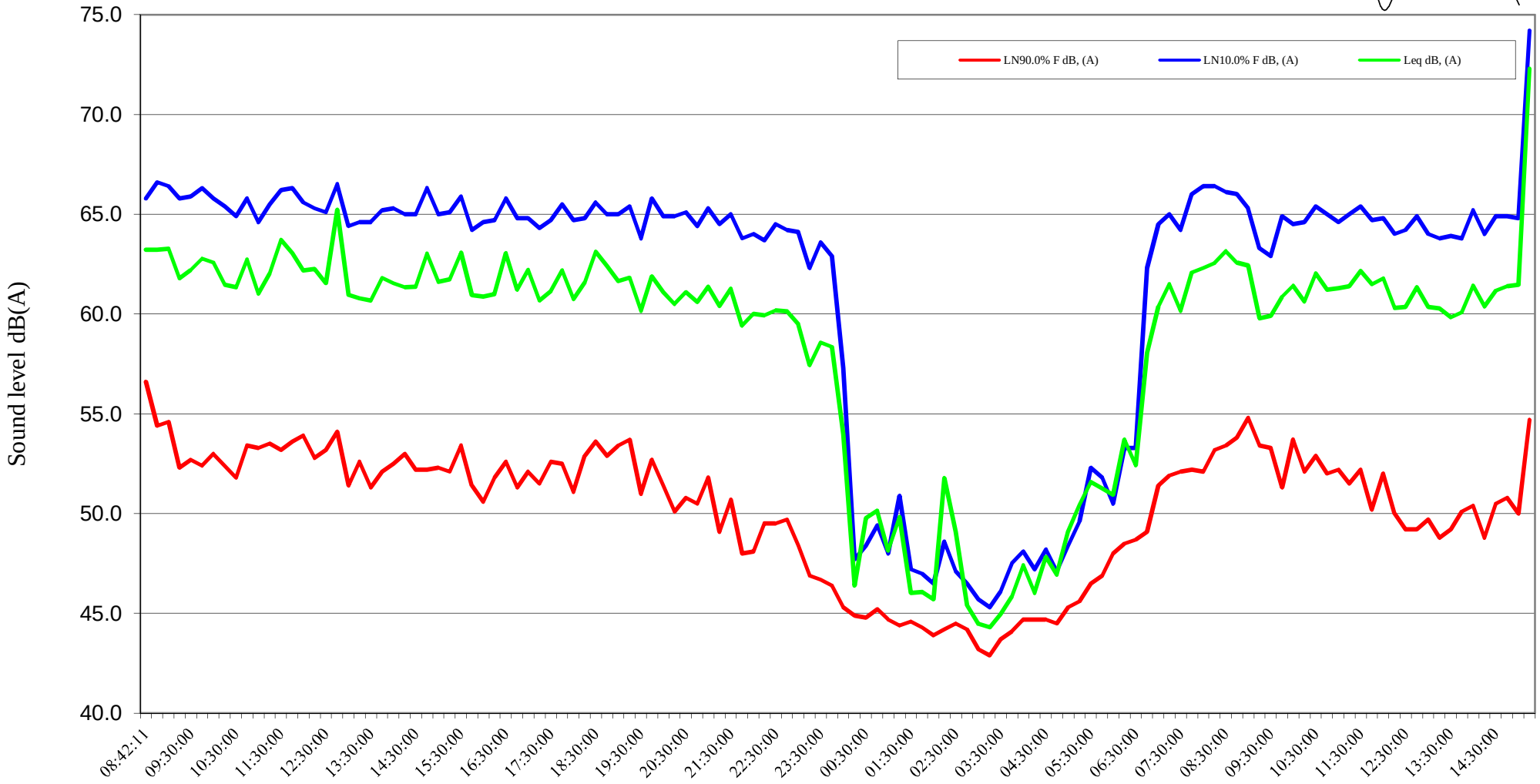


Period number	Date	Time	LN90.0% F	LN10.0% F	Leq
			dB, (A)	dB, (A)	dB, (A)
1	28/01/2019	08:42:11	56.6	65.8	63.2
2	28/01/2019	08:45:00	54.4	66.6	63.2
3	28/01/2019	09:00:00	54.6	66.4	63.3
4	28/01/2019	09:15:00	52.3	65.8	61.8
5	28/01/2019	09:30:00	52.7	65.9	62.2
6	28/01/2019	09:45:00	52.4	66.3	62.8
7	28/01/2019	10:00:00	53.0	65.8	62.6
8	28/01/2019	10:15:00	52.4	65.4	61.5
9	28/01/2019	10:30:00	51.8	64.9	61.3
10	28/01/2019	10:45:00	53.4	65.8	62.7
11	28/01/2019	11:00:00	53.3	64.6	61.0
12	28/01/2019	11:15:00	53.5	65.5	62.0
13	28/01/2019	11:30:00	53.2	66.2	63.7
14	28/01/2019	11:45:00	53.6	66.3	63.0
15	28/01/2019	12:00:00	53.9	65.6	62.2
16	28/01/2019	12:15:00	52.8	65.3	62.2
17	28/01/2019	12:30:00	53.2	65.1	61.5
18	28/01/2019	12:45:00	54.1	66.5	65.2
19	28/01/2019	13:00:00	51.4	64.4	61.0
20	28/01/2019	13:15:00	52.6	64.6	60.8
21	28/01/2019	13:30:00	51.3	64.6	60.7
22	28/01/2019	13:45:00	52.1	65.2	61.8
23	28/01/2019	14:00:00	52.5	65.3	61.5
24	28/01/2019	14:15:00	53.0	65.0	61.3
25	28/01/2019	14:30:00	52.2	65.0	61.4
26	28/01/2019	14:45:00	52.2	66.3	63.0
27	28/01/2019	15:00:00	52.3	65.0	61.6
28	28/01/2019	15:15:00	52.1	65.1	61.7
29	28/01/2019	15:30:00	53.4	65.9	63.1
30	28/01/2019	15:45:00	51.4	64.2	60.9
31	28/01/2019	16:00:00	50.6	64.6	60.9
32	28/01/2019	16:15:00	51.8	64.7	61.0
33	28/01/2019	16:30:00	52.6	65.8	63.1
34	28/01/2019	16:45:00	51.3	64.8	61.2
35	28/01/2019	17:00:00	52.1	64.8	62.2
36	28/01/2019	17:15:00	51.5	64.3	60.7
37	28/01/2019	17:30:00	52.6	64.7	61.2
38	28/01/2019	17:45:00	52.5	65.5	62.2
39	28/01/2019	18:00:00	51.1	64.7	60.7
40	28/01/2019	18:15:00	52.9	64.8	61.6
41	28/01/2019	18:30:00	53.6	65.6	63.1

Period number	Date	Time	LN90.0% F	LN10.0% F	Leq
			dB, (A)	dB, (A)	dB, (A)
42	28/01/2019	18:45:00	52.9	65.0	62.4
43	28/01/2019	19:00:00	53.4	65.0	61.6
44	28/01/2019	19:15:00	53.7	65.4	61.8
45	28/01/2019	19:30:00	51.0	63.8	60.2
46	28/01/2019	19:45:00	52.7	65.8	61.9
47	28/01/2019	20:00:00	51.4	64.9	61.1
48	28/01/2019	20:15:00	50.1	64.9	60.5
49	28/01/2019	20:30:00	50.8	65.1	61.1
50	28/01/2019	20:45:00	50.5	64.4	60.6
51	28/01/2019	21:00:00	51.8	65.3	61.4
52	28/01/2019	21:15:00	49.1	64.5	60.4
53	28/01/2019	21:30:00	50.7	65.0	61.3
54	28/01/2019	21:45:00	48.0	63.8	59.4
55	28/01/2019	22:00:00	48.1	64.0	60.0
56	28/01/2019	22:15:00	49.5	63.7	59.9
57	28/01/2019	22:30:00	49.5	64.5	60.2
58	28/01/2019	22:45:00	49.7	64.2	60.1
59	28/01/2019	23:00:00	48.4	64.1	59.5
60	28/01/2019	23:15:00	46.9	62.3	57.4
61	28/01/2019	23:30:00	46.7	63.6	58.6
62	28/01/2019	23:45:00	46.4	62.9	58.4
63	29/01/2019	00:00:00	45.3	57.3	54.0
64	29/01/2019	00:15:00	44.9	47.7	46.4
65	29/01/2019	00:30:00	44.8	48.4	49.8
66	29/01/2019	00:45:00	45.2	49.4	50.1
67	29/01/2019	01:00:00	44.7	48.0	48.1
68	29/01/2019	01:15:00	44.4	50.9	49.8
69	29/01/2019	01:30:00	44.6	47.2	46.0
70	29/01/2019	01:45:00	44.3	47.0	46.1
71	29/01/2019	02:00:00	43.9	46.5	45.7
72	29/01/2019	02:15:00	44.2	48.6	51.8
73	29/01/2019	02:30:00	44.5	47.1	49.1
74	29/01/2019	02:45:00	44.2	46.5	45.4
75	29/01/2019	03:00:00	43.2	45.7	44.5
76	29/01/2019	03:15:00	42.9	45.3	44.3
77	29/01/2019	03:30:00	43.7	46.1	45.0
78	29/01/2019	03:45:00	44.1	47.5	45.8
79	29/01/2019	04:00:00	44.7	48.1	47.4
80	29/01/2019	04:15:00	44.7	47.2	46.0
81	29/01/2019	04:30:00	44.7	48.2	47.8
82	29/01/2019	04:45:00	44.5	47.1	46.9
83	29/01/2019	05:00:00	45.3	48.4	49.1
84	29/01/2019	05:15:00	45.6	49.6	50.4
85	29/01/2019	05:30:00	46.5	52.3	51.6
86	29/01/2019	05:45:00	46.9	51.8	51.3
87	29/01/2019	06:00:00	48.0	50.5	51.0
88	29/01/2019	06:15:00	48.5	53.3	53.7
89	29/01/2019	06:30:00	48.7	53.3	52.4
90	29/01/2019	06:45:00	49.1	62.3	58.1
91	29/01/2019	07:00:00	51.4	64.5	60.4
92	29/01/2019	07:15:00	51.9	65.0	61.5
93	29/01/2019	07:30:00	52.1	64.2	60.1
94	29/01/2019	07:45:00	52.2	66.0	62.1
95	29/01/2019	08:00:00	52.1	66.4	62.3
96	29/01/2019	08:15:00	53.2	66.4	62.5
97	29/01/2019	08:30:00	53.4	66.1	63.1
98	29/01/2019	08:45:00	53.8	66.0	62.6
99	29/01/2019	09:00:00	54.8	65.3	62.4
100	29/01/2019	09:15:00	53.4	63.3	59.8
101	29/01/2019	09:30:00	53.3	62.9	59.9
102	29/01/2019	09:45:00	51.3	64.9	60.9
103	29/01/2019	10:00:00	53.7	64.5	61.4

Period number	Date	Time	LN90.0% F	LN10.0% F	Leq
			dB, (A)	dB, (A)	dB, (A)
104	29/01/2019	10:15:00	52.1	64.6	60.6
105	29/01/2019	10:30:00	52.9	65.4	62.0
106	29/01/2019	10:45:00	52.0	65.0	61.2
107	29/01/2019	11:00:00	52.2	64.6	61.3
108	29/01/2019	11:15:00	51.5	65.0	61.4
109	29/01/2019	11:30:00	52.2	65.4	62.1
110	29/01/2019	11:45:00	50.2	64.7	61.5
111	29/01/2019	12:00:00	52.0	64.8	61.8
112	29/01/2019	12:15:00	50.0	64.0	60.3
113	29/01/2019	12:30:00	49.2	64.2	60.4
114	29/01/2019	12:45:00	49.2	64.9	61.3
115	29/01/2019	13:00:00	49.7	64.0	60.4
116	29/01/2019	13:15:00	48.8	63.8	60.3
117	29/01/2019	13:30:00	49.2	63.9	59.8
118	29/01/2019	13:45:00	50.1	63.8	60.1
119	29/01/2019	14:00:00	50.4	65.2	61.4
120	29/01/2019	14:15:00	48.8	64.0	60.4
121	29/01/2019	14:30:00	50.5	64.9	61.2
122	29/01/2019	14:45:00	50.8	64.9	61.4
123	29/01/2019	15:00:00	50.0	64.8	61.5
124	29/01/2019	15:15:00	54.7	74.2	72.3

CS8169 - 3 Gloucester Gate, Regent's Park, London NW1 4AD



24th -25th January 2019 - Time

Conabeare Acoustics Limited
11 Chiltern Enterprise Centre
Station Road, Theale
Berkshire RG7 4AA
Telephone 0118 930 3650
Facsimile 0118 930 3912
sales@conabeare.co.uk

CONABEARE ACOUSTICS

Project: CS8169 - 3 Gloucester Gate, Regent's Park, London NW1 4AD
Client : Sohail Moussavi c/o Q Architectural Design Consultants Ltd
Revision: Revision C
Date : 2nd April 2019

Calculation 01

Item **Proposed Plant - Target Level - 33dBA at 1 metre from Sound Sensitive Façade**

Vault 3

	Condensing Units			63	125	250	500	1k	2k	4k	8k	dBA
CU1	**Unit Lw - Daikin RKXYQ5T8 (Compressor)**			**68**	**65**	**58**	**57**	**56**	**49**	**49**	**41**	**60**
	Additional Unit	**1**		**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	
	Distance Loss	5	m	-25	-25	-25	-25	-25	-25	-25	-25	
	Acoustic Feature Correction for Intermittent Noise			5	5	5	5	5	5	5	5	
	Additional Surfaces - 2			6	6	6	6	6	6	6	6	
	Screening from Balcony - Line of Sight			-5	-5	-5	-5	-5	-5	-5	-5	
	Façade Effect			3	3	3	3	3	3	3	3	
	Lp at Listener			**55**	**52**	**45**	**44**	**43**	**36**	**36**	**28**	**47**
	Proposed Acoustic Door - Typical SRI for Rw35 Acoustic Door			**-17**	**-20**	**-26**	**-27**	**-30**	**-34**	**-36**	**-38**	
	Predicted Resultant at 1 metre from Sound Sensitive facade due to CU1			**38**	**32**	**19**	**17**	**13**	**2**	**0**	**-10**	**21**

Vault 2

HE1	**Unit Lw - Daikin RDXYQ5T8 (Heat Exchanger)**			**63**	**76**	**76**	**74**	**72**	**67**	**60**	**60**	**76**
	Additional Unit	**1**		**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	
	Distance Loss - Units located within acoustically lined Vault	7	m	-28	-28	-28	-28	-28	-28	-28	-28	
	Acoustic Feature Correction for Intermittent Noise			5	5	5	5	5	5	5	5	
	Additional Surfaces - Walls Acoustically Lined			0	0	0	0	0	0	0	0	
	Screening from Balcony - Line of Sight			-5	-5	-5	-5	-5	-5	-5	-5	
	Façade Effect			3	3	3	3	3	3	3	3	
	Lp at Listener			**41**	**54**	**54**	**52**	**50**	**45**	**38**	**38**	**54**
	Proposed Attenuation - Fresh Air Intake and Ducted Exhaust - Type KSD5030 - 900mm Long x 800mm Wide x 1000mm high			**-7**	**-11**	**-18**	**-27**	**-31**	**-27**	**-21**	**-17**	
	Predicted Resultant at 1 metre from Sound Sensitive facade due to CU1			**34**	**43**	**36**	**25**	**19**	**18**	**17**	**21**	**32**
	Predicted Combined From All Units With Mitigating Measures Installed			**39**	**43**	**36**	**26**	**20**	**18**	**17**	**21**	**32**

CONABEARE ACOUSTICS

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_{eq}	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.

Conabeare Acoustics Limited
11 Chiltern Enterprise Centre, Station Road, Theale, Berkshire. RG7 4AA
Telephone 0118 930 3650 Facsimile 0118 930 3912
sales@conabeare.co.uk

Calibration Certificate

Certificate Number 2018004098

Customer:

PC Environmental Ltd.
Unit 11 Mill Court
The Sawmills, Durley
Southampton, S032 2EJ, United Kingdom

Model Number	LxT SE
Serial Number	0005588
Test Results	**Pass**
Initial Condition	As Manufactured
Description	Sound Expert LxT Class 1 Sound Level Meter Firmware Revision: 2.302

Procedure Number	D0001.8384		
Technician	Ron Harris		
Calibration Date	20 Apr 2018		
Calibration Due			
Temperature	23.64	°C	± 0.25 °C
Humidity	50.4	%RH	± 2.0 %RH
Static Pressure	85.99	kPa	± 0.13 kPa

Evaluation Method

Tested with:

Larson Davis PRMLxT1L. S/N 055664
PCB 377B02. S/N 304334
Larson Davis CAL200. S/N 9079
Larson Davis CAL291. S/N 0108

Data reported in dB re 20 µPa.

Compliance Standards

Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001.8378:

IEC 60651:2001 Type 1	ANSI S1.4-2014 Class 1
IEC 60804:2000 Type 1	ANSI S1.4 (R2006) Type 1
IEC 61252:2002	ANSI S1.11 (R2009) Class 1
IEC 61260:2001 Class 1	ANSI S1.25 (R2007)
IEC 61672:2013 Class 1	ANSI S1.43 (R2007) Type 1

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 International System of Units (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 9001:2008.

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.

Correction data from Larson Davis LxT Manual for SoundTrack LxT & SoundExpert Lxt, I770.01 Rev J Supporting Firmware Version 2.301, 2015-04-30

For 1/4" microphones, the Larson Davis ADP024 1/4" to 1/2" adaptor is used with the calibrators and the Larson Davis ADP043 1/4" to 1/2" adaptor is used with the preamplifier.

Calibration Check Frequency: 1000 Hz; Reference Sound Pressure Level: 114 dB re 20 µPa

Periodic tests were performed in accordance with precedures from IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part3.

No Pattern approval for IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1 available.

The sound level meter submitted for testing successfully completed the periodic tests of IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part 3, for the environmental conditions under which the tests were performed. However, no general statement or conclusion can be made about conformance of the sound level meter to the full specifications of IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1 because (a) evidence was not publicly available, from an independent testing organization responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the class 1 specifications in IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1 or correction data for acoustical test of frequency weighting were not provided in the Instruction Manual and (b) because the periodic tests of IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part 3 cover only a limited subset of the specifications in IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1.

Standards Used

Description	Cal Date	Cal Due	Cal Standard
Larson Davis CAL291 Residual Intensity Calibrator	2017-09-19	2018-09-19	001250
SRS DS360 Ultra Low Distortion Generator	2017-06-23	2018-06-23	006311
Hart Scientific 2626-S Humidity/Temperature Sensor	2017-06-11	2018-06-11	006943
Larson Davis CAL200 Acoustic Calibrator	2017-07-25	2018-07-25	007027
Larson Davis Model 831	2018-02-28	2019-02-28	007182
PCB 377A13 1/2 inch Prepolarized Pressure Microphone	2018-03-07	2019-03-07	007185

Acoustic Calibration

Measured according to IEC 61672-3:2013 10 and ANSI S1.4-2014 Part 3: 10

Measurement	Test Result [dB]	Lower Limit [dB]	Upper Limit [dB]	Expanded Uncertainty [dB]	Result
1000 Hz	114.00	113.80	114.20	0.14	Pass

Acoustic Signal Tests, C-weighting

Measured according to IEC 61672-3:2013 12 and ANSI S1.4-2014 Part 3: 12 using a comparison coupler with Unit Under Test (UUT) and reference SLM using slow time-weighted sound level for compliance to IEC 61672-1:2013 5.5; ANSI S1.4-2014 Part 1: 5.5

Frequency [Hz]	Test Result [dB]	Expected [dB]	Lower Limit [dB]	Upper Limit [dB]	Expanded Uncertainty [dB]	Result
125	-0.21	-0.20	-1.20	0.80	0.23	Pass
1000	0.19	0.00	-0.70	0.70	0.23	Pass
8000	-2.60	-3.00	-5.50	-1.50	0.32	Pass

-- End of measurement results--

Self-generated Noise

Measured according to IEC 61672-3:2013 11.1 and ANSI S1.4-2014 Part 3: 11.1

Measurement	Test Result [dB]
A-weighted	44.37

-- End of measurement results--

-- End of Report--

Signatory: *Ron Harris*

Larson Davis, a division of PCB Piezotronics, Inc
1681 West 820 North
Provo, UT 84601, United States
716-684-0001

ACCREDITED Cert. #3622.01

LARSON DAVIS
A PCB PIEZOTRONICS DIV.

Calibration Certificate

Certificate Number 2018004083
Customer:
PC Environmental Ltd.
Unit 11 Mill Court
The Sawmills, Durley
Southampton, S032 2EJ, United Kingdom

Model Number	PRMLxT1L	***Procedure Number***	D0001.8383		
Serial Number	055664	***Technician***	Ron Harris		
Test Results	**Pass**	***Calibration Date***	20 Apr 2018		
Initial Condition	As Manufactured	***Calibration Due***			
		Temperature	23.64	°C	± 0.01 °C
Description	Larson Davis 1/2" Preamplifier for LxT Class 1 -1 dB	***Humidity***	50.9	%RH	± 0.5 %RH
		Static Pressure	85.87	kPa	± 0.03 kPa

Evaluation Method Tested electrically using a 12.0 pF capacitor to simulate microphone capacitance. Data reported in dB re 20 µPa assuming a microphone sensitivity of 50.0 mV/Pa.

Compliance Standards Compliant to Manufacturer Specifications

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 9001:2008.

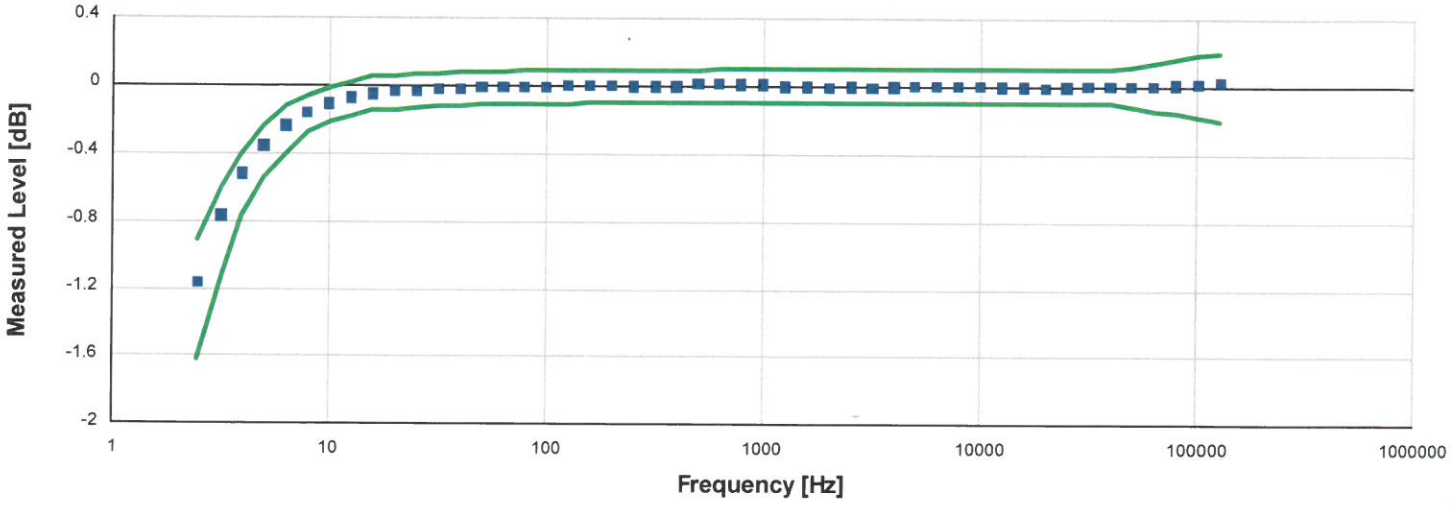
This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

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
Larson Davis Model 2900 Real Time Analyzer	03/07/2018	03/07/2019	003003
Hart Scientific 2626-S Humidity/Temperature Sensor	06/11/2017	06/11/2018	006943
Agilent 34401A DMM	06/28/2017	06/28/2018	007165
SRS DS360 Ultra Low Distortion Generator	10/05/2017	10/05/2018	007167

Frequency Response



Frequency response electrically tested at 120.0 dB re 1 µV

Frequency [Hz]	Test Result [dB re 1 kHz]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
2.50	-1.17	-1.62	-0.91	0.07	Pass
3.20	-0.77	-1.14	-0.60	0.08	Pass
4.00	-0.52	-0.77	-0.40	0.08	Pass
5.00	-0.36	-0.54	-0.24	0.07	Pass
6.30	-0.24	-0.40	-0.12	0.07	Pass
7.90	-0.16	-0.28	-0.06	0.07	Pass
10.00	-0.11	-0.22	-0.01	0.07	Pass
12.60	-0.07	-0.18	0.02	0.07	Pass
15.80	-0.05	-0.15	0.05	0.07	Pass
20.00	-0.03	-0.14	0.06	0.07	Pass
25.10	-0.03	-0.13	0.07	0.07	Pass
31.60	-0.02	-0.12	0.07	0.07	Pass
39.80	-0.02	-0.12	0.08	0.07	Pass
50.10	-0.01	-0.11	0.08	0.07	Pass
63.10	-0.01	-0.11	0.08	0.07	Pass
79.40	-0.01	-0.11	0.09	0.07	Pass
100.00	-0.01	-0.11	0.09	0.07	Pass
125.90	0.00	-0.11	0.09	0.07	Pass
158.50	0.00	-0.10	0.09	0.07	Pass
199.50	0.00	-0.10	0.09	0.07	Pass
251.20	0.00	-0.10	0.09	0.07	Pass
316.20	0.00	-0.10	0.09	0.07	Pass
398.10	0.00	-0.10	0.09	0.07	Pass
501.20	0.01	-0.10	0.09	0.07	Pass
631.00	0.01	-0.10	0.10	0.07	Pass
794.30	0.01	-0.10	0.10	0.07	Pass
1,000.00	0.01	-0.10	0.10	0.07	Pass
1,258.90	0.00	-0.10	0.10	0.07	Pass
1,584.90	0.00	-0.10	0.10	0.07	Pass
1,995.30	-0.01	-0.10	0.10	0.07	Pass
2,511.90	0.00	-0.10	0.10	0.07	Pass
3,162.30	-0.01	-0.10	0.10	0.07	Pass

Frequency [Hz]	Test Result [dB re 1 kHz]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
3,981.10	0.00	-0.10	0.10	0.07	Pass
5,011.90	0.00	-0.10	0.10	0.07	Pass
6,309.60	0.00	-0.10	0.10	0.07	Pass
7,943.30	0.00	-0.10	0.10	0.07	Pass
10,000.00	0.00	-0.10	0.10	0.07	Pass
12,589.30	0.00	-0.10	0.10	0.07	Pass
15,848.90	0.00	-0.10	0.10	0.07	Pass
19,952.60	0.00	-0.10	0.10	0.07	Pass
25,118.90	0.00	-0.10	0.10	0.07	Pass
31,622.80	0.00	-0.10	0.10	0.07	Pass
39,810.70	0.00	-0.10	0.10	0.07	Pass
50,118.70	0.00	-0.12	0.12	0.08	Pass
63,095.70	0.01	-0.14	0.14	0.08	Pass
79,432.80	0.01	-0.16	0.16	0.08	Pass
100,000.00	0.02	-0.18	0.18	0.08	Pass
125,892.50	0.02	-0.20	0.20	0.22	Pass

Gain Measurement

Measurement	Test Result [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
Output Gain @ 1 kHz	-1.78	-2.60	-1.00	0.03	Pass

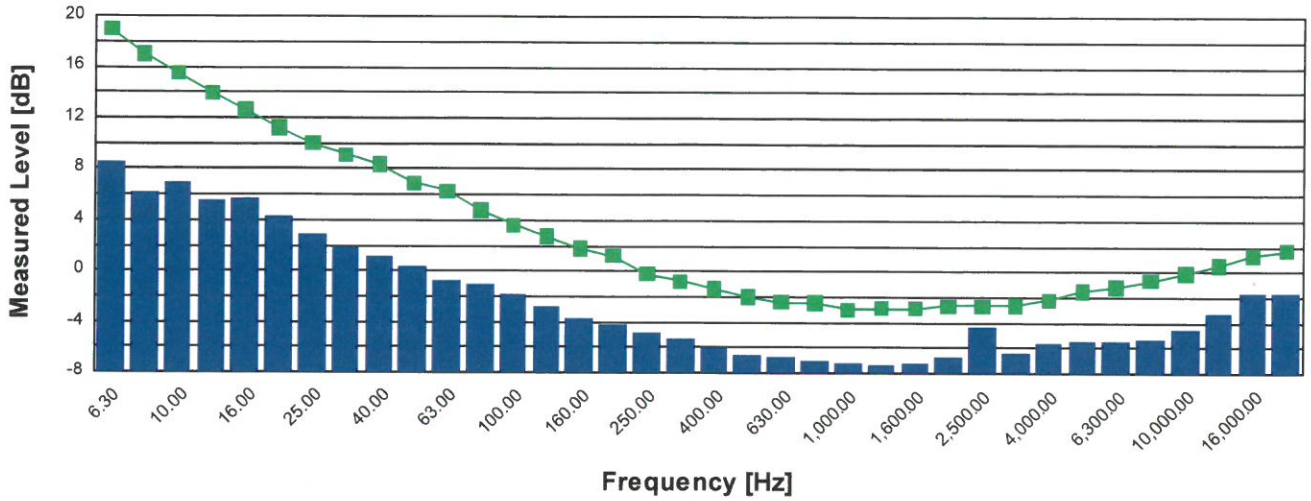
-- End of measurement results--

DC Bias Measurement

Measurement	Test Result [V]	Lower limit [V]	Upper limit [V]	Expanded Uncertainty [V]	Result
DC Voltage	3.30	2.90	3.80	0.01	Pass

-- End of measurement results--

1/3-Octave Self-Generated Noise



Frequency [Hz]	Test Result [dB re 1 µV]	Upper limit [dB re 1 µV]	Result
6.30	8.50	19.00	Pass
8.00	6.20	17.00	Pass
10.00	6.90	15.50	Pass
12.50	5.50	14.00	Pass
16.00	5.70	12.60	Pass
20.00	4.30	11.20	Pass
25.00	2.90	10.00	Pass
31.50	2.00	9.10	Pass
40.00	1.10	8.40	Pass
50.00	0.40	6.90	Pass
63.00	-0.70	6.30	Pass
80.00	-1.10	4.80	Pass
100.00	-1.90	3.60	Pass
125.00	-2.80	2.70	Pass
160.00	-3.70	1.80	Pass
200.00	-4.20	1.20	Pass
250.00	-4.80	-0.20	Pass
315.00	-5.30	-0.80	Pass
400.00	-5.90	-1.40	Pass
500.00	-6.50	-2.00	Pass
630.00	-6.70	-2.40	Pass
800.00	-7.00	-2.50	Pass
1,000.00	-7.20	-3.00	Pass
1,250.00	-7.30	-2.90	Pass
1,600.00	-7.20	-2.90	Pass
2,000.00	-6.70	-2.70	Pass
2,500.00	-4.40	-2.70	Pass
3,150.00	-6.40	-2.60	Pass
4,000.00	-5.60	-2.20	Pass
5,000.00	-5.50	-1.50	Pass
6,300.00	-5.50	-1.20	Pass
8,000.00	-5.30	-0.70	Pass
10,000.00	-4.50	-0.10	Pass
12,500.00	-3.20	0.50	Pass
16,000.00	-1.70	1.30	Pass
20,000.00	-1.70	1.70	Pass

-- End of measurement results--

Self-generated Noise

Bandwidth	Test Result [µV]	Test Result [dB re 1 µV]	Upper limit [dB re 1 µV]	Result
A-weighted (1 Hz - 20 kHz)	2.04	6.20	8.00	Pass
Broadband (1 Hz - 20 kHz)	3.98	12.00	14.00	Pass

-- End of measurement results--

Signatory: *Ron Harris*

Larson Davis, a division of PCB Piezotronics, Inc
1681 West 820 North
Provo, UT 84601, United States
716-684-0001

ACCREDITED Cert. #3622.01

LARSON DAVIS
A PCB PIEZOTRONICS DIV.