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ACOUSTICS PLUS

Proposed Installation of Mechanical Plant

17 Branch Hill, London, NW3 7NA

Environmental Noise Assessment

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Doc Ref: 102819.ph.Issue2

Company Registration Number: 4304440
VAT Registration Number: 788 2610 94

Environmental Noise Assessment Proposed Installation of Mechanical Plant	
Project Address:	17 Branch Hill London NW3 7NA
Project Reference:	102819

Issue/Revision Record			
Issue:	**Date:**	**Remarks:**	**Author:**
1	26/11/2014	First Issue	Phil Huffer
2	10/06/2015	Revised plant schedule	Phil Huffer

	Signature:	Print:	Title:	Date:
Author:		**Phil Huffer**	**Principal Consultant**	**10/06/2015**
Reviewer:		**Andy Dodd**	**Consultant**	**10/06/2015**

1. INTRODUCTION

1.1 Acoustics Plus Ltd (APL) is an independent firm of multi-disciplinary acoustic engineers. APL is engaged by both private and public sector clients. APL is a registered member of The Association of Noise Consultants (ANC) and the author is a corporate member of The Institute of Acoustics (IOA).

1.2 APL has been instructed by the Applicant's architect, SHH Architects, to consider and advise upon the noise implications of a proposed installation of mechanical plant.

1.3 The property will feature a garden level swimming pool with associated air handling equipment and other various ventilation systems (toilets/plant rooms etc.). The property will also feature a climate control system that will require the installation of external condenser units.

1.4 It is understood the Local Planning Authority (LPA) require further information on noise levels from the proposed installation in order to fully assess the noise impact upon the surrounding neighbourhood. This report provides the response to the LPA, on behalf of the Applicant.

2. BASELINE SITUATION

2.1 The Application Site (the "site") is situated at 17 Branch Hill, London, NW3. The site comprises a 3 storey, 4 bedroom, contemporary family dwelling, accessed from Branch Hill. The dwelling sits on an isolated site of 856 m^2, is set well back from Branch Hill and has its own private gated driveway.

2.2 The site is situated within a predominantly residential area. The site and its surroundings can be seen in Figures 1 to 5.

2.3 It is understood that it is the intention to demolish the house on the site. A new house will be erected in its place.

2.4 The new house will require the installation of a number of items of mechanical plant to provide heating/cooling and ventilation of habitable spaces as required. It will also require a separate ventilation system for the proposed garden level swimming pool. It is the intention to locate the majority of the mechanical plant in a basement plant room. The external condensers associated with the climate control system will be located in a rear garden 'store' area.

2.5 The basement plant room will be subterranean and therefore ventilation will be provided mechanically by drawing air through an acoustic louvre at high level and extracting through a ground floor mesh grill. The location of the plant room and condenser units is shown in Diagram1 and 2 overleaf.

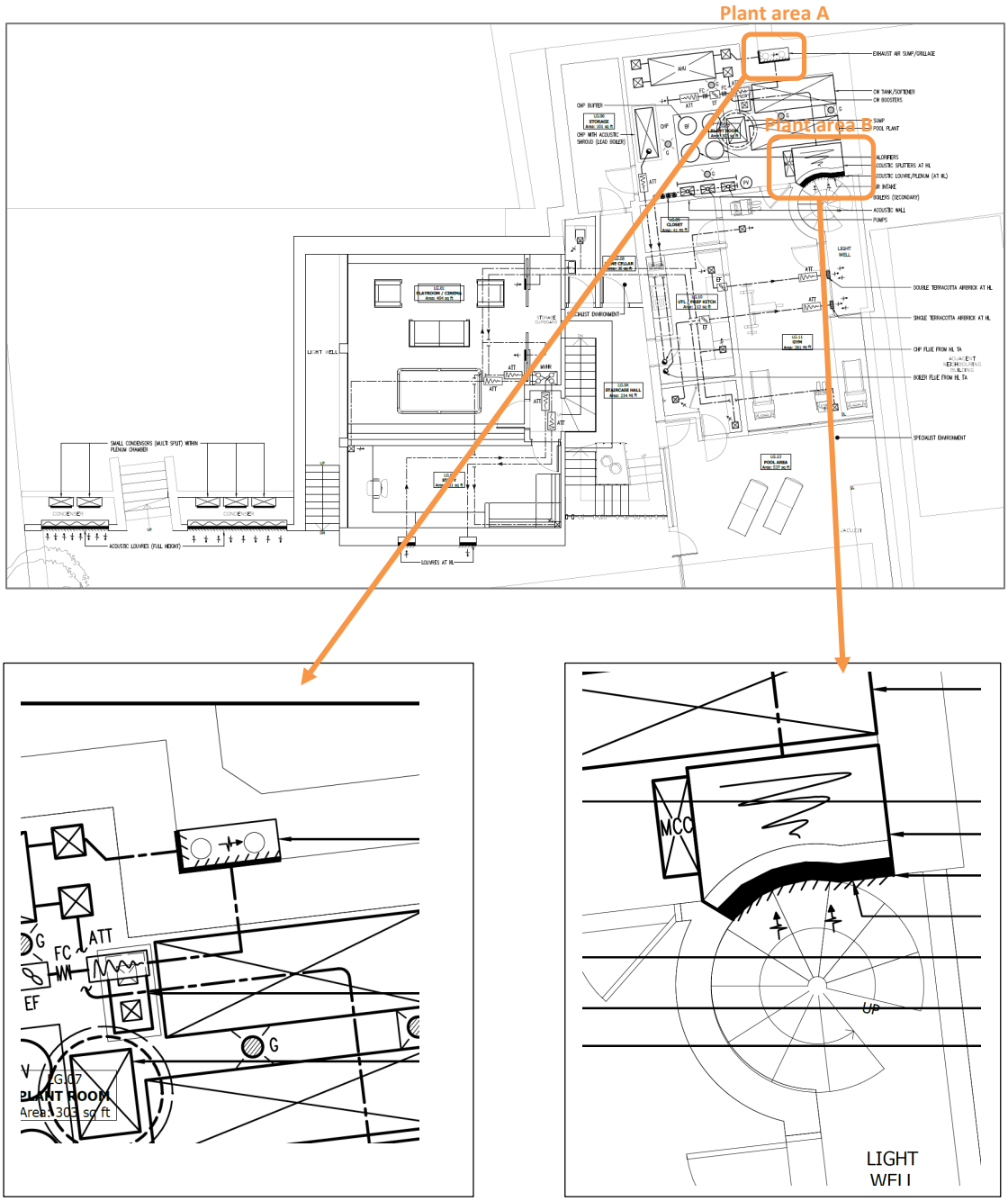


Diagram 1

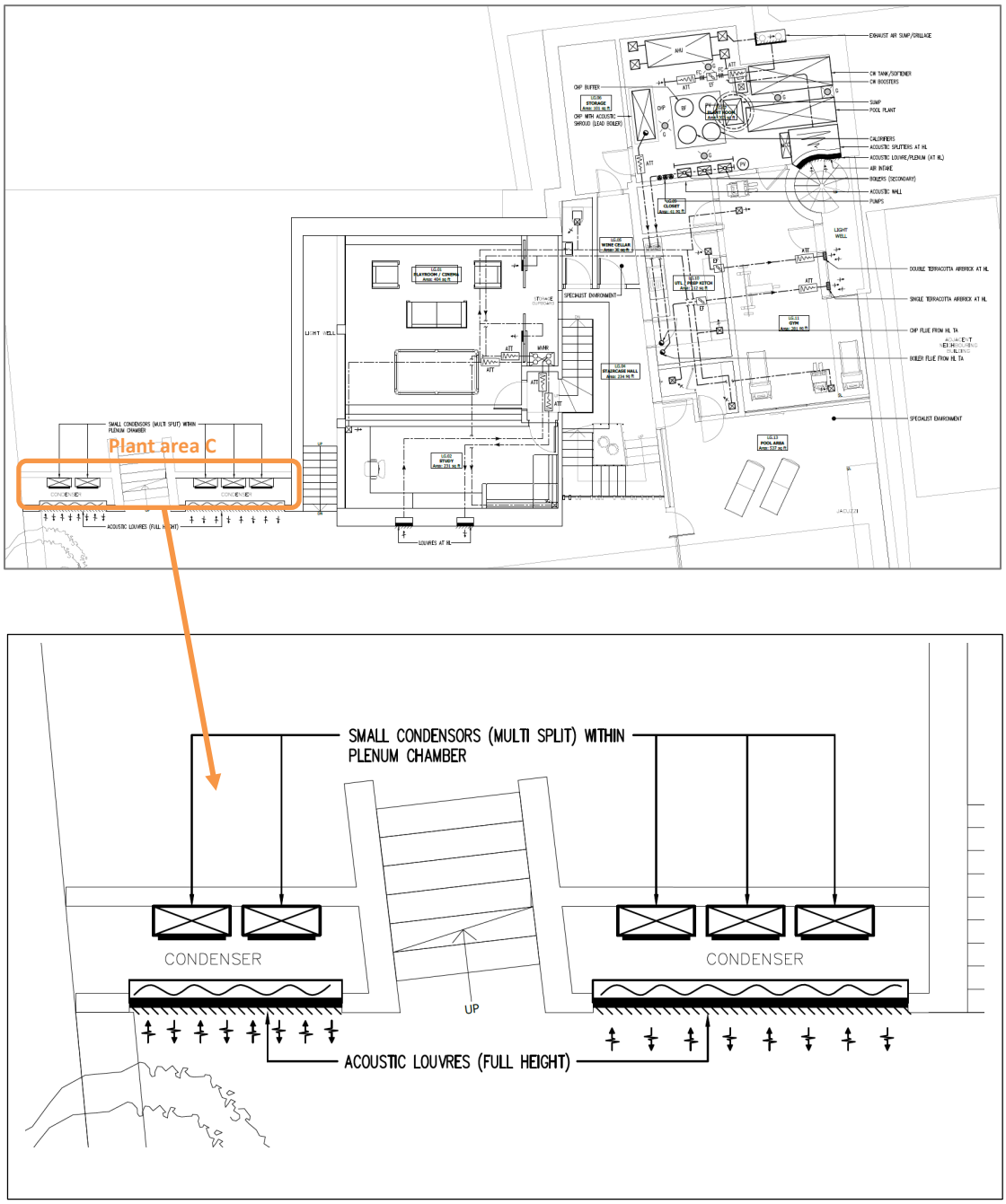

Plant area C
SMALL CONDENSORS (MULTI SPLIT) WITHIN PLENUM CHAMBER
CONDENSER
CONDENSER
UP
ACOUSTIC LOUVRES (FULL HEIGHT)

Diagram 2

2.6 The anticipated nearest noise sensitive façades to the proposed location of the items of mechanical plant are identified in Diagram 3 below.

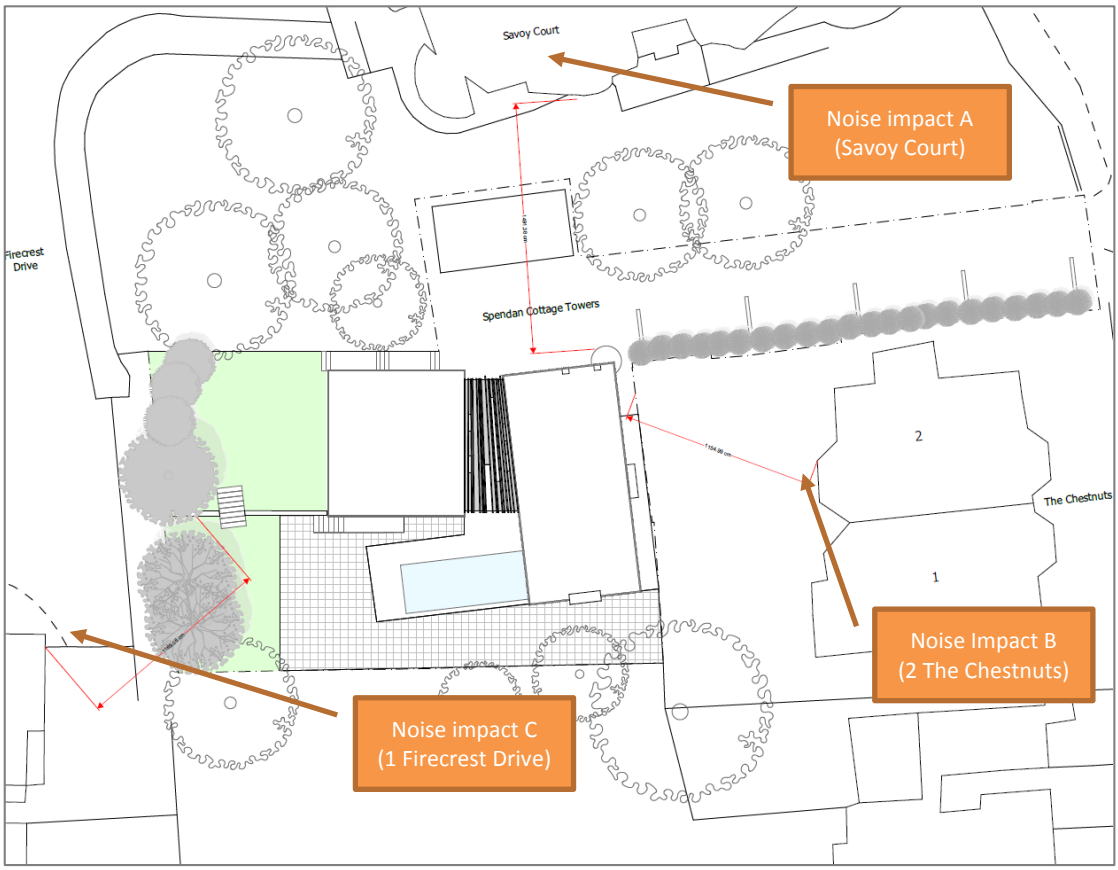


Diagram 3

2.7 The operational hours of the proposed mechanical plant for the property will be on a demand basis during residential use (at any time).

2.8 Information in regard of the mechanical plant equipment list has been provided by ME7 Ltd (a copy of the data sheets are provided in Appendix A). The units are itemised below. The equipment schedule is indicative and will be formalised during the detailed design stage of the project.

(a) Acoustic Minibox 200 Plant room vent fan
(b) Weismann Vitobloc EM5/13 CHP unit
(c) Small circulators Grundfoss Magna 3D twin
(d) Water booster set – twin pump
(e) Swimming pool AHU – Heatstar Andromeda EC 500 Super Plus
(f) 4No. Mitsubishi PUHZ-P140VHA3
(g) 1No. Mitsubishi PUHZ-P100VHA3

3. NOISE OUTLINE

3.1 In order to produce an environmental noise assessment, consideration must be given to the prevailing background noise in the locality of the installation.

3.2 Measurements of background noise were obtained over a 24 hour period at a location deemed representative of background noise levels experienced at the nearest noise sensitive façades.

3.3 The measurements obtained during the exercise were undertaken at the end of the main driveway, adjacent to the existing house (see Figure 4). The main source of ambient noise was local traffic movements.

3.4 The particulars of the measurement exercise are recorded below:

Date:	4th – 5th November 2014
Start Time:	14:00 hrs
Location:	end of driveway, 17 Branch Hill
Weather:	Occasional rain, light wind.

3.5 The measurements carried out during the exercise are recorded below:

L_{90} percentile level (dB re 20μPa) at 15 minute intervals

3.6 The measurements obtained during the exercise are presented in Appendix B.

3.7 Minimum background and average noise levels are shown in Table 1 below:

WHO period	Lowest $L_{A90,15min}$	Average $L_{Aeq,T}$
07:00-19:00hrs	45	54
19:00-23:00hrs	43	54
23:00-07:00hrs	34	45

Table 1

3.8 The noise level of the proposed plant was established from the data sheets provided (Appendix A) as follows:

(a) Plant vent fan (S&E) – Acoustic Minibox200 40dBA @ 1m
(b) Weismann Vitobloc EM5/13 CHP unit
(c) Small circulators Grundfoss Magna 3D twin @ 43dBA @ 1m
(d) Water booster set – twin pump 65dBA @ 1m
(e) Swimming pool AHU – Heatstar Andromeda EC 500 Super Plus
(f) 4No. Mitsubishi PUHZ-P140VHA3 @ 52dBA @ 1m (cooling)
(g) 1No. Mitsubishi PUHZ-P100VHA3 @ 50dBA @ 1m (cooling)

4. DESIGN CRITERIA

4.1 Information regarding the noise levels not to be exceeded by the proposed installation of externally located mechanical plant was provided by the LPA (London Borough of Camden). The Local Development Framework 2010-2025 Section DP28 (Table E) Noise and Vibration states:

Noise description and location of measurement	Period	Time	Noise level
Noise at 1 metre external to a sensitive façade	Day, evening and night	0000-2400	5dBA<LA90
Noise that has a distinguishable discrete continuous note (whine, hiss, screech, hum) at 1 metre external to a sensitive façade.	Day, evening and night	0000-2400	10dBA <LA90
Noise that has distinct impulses (bangs, clicks, clatters, thumps) at 1 metre external to a sensitive façade.	Day, evening and night	0000-2400	10dBA<LA90
Noise at 1 metre external to sensitive façade where LA90>60dB	Day, evening and night	0000-2400	55dBLAeq

Table 2

4.2 It is expected that the proposed condenser unit will not generate tonal noise. The plant noise emission criteria that should not be exceeded is therefore based on Table 2 above and is shown in Table 3 below. These levels should not be exceeded at the nearest noise sensitive premises, considered to be the first floor flats.

Daytime and evening noise emission limit for mechanical plant	Night time noise emission limit for mechanical plant
L_{Aeq} 33dB	L_{Aeq} 24dB

Table 3

5. EQUIPMENT

5.1 All measurements were obtained using the following equipment:

- Svantek 948 Class 1
  Serial No. 6988
- Rion Calibrator Type NC-74 Class 1
  Serial No. 00410215

5.2 The relevant equipment carries full and current traceable calibration. The equipment, where necessary, was calibrated prior to and after the measurements were carried out.

6. CALCULATIONS

6.1 A prediction exercise was undertaken. The calculation exercise utilised information provided by equipment manufacturers (copy of the data sheets are provided in Appendix A).

6.2 The following noise impacts were considered:

(a) Noise Impact A – noise egress from mechanical plant located within basement plant room and the swimming pool ventilation system;

(b) Noise Impact B – noise egress from mechanical plant located within basement plant room;

(c) Noise Impact C – noise egress from condenser units.

Noise Impact A

6.3 It is proposed to install a number of items of mechanical plant within the basement plant room at the rear of the property. In order for this plant to operate effectively, the plant room will need to be adequately ventilated. It is proposed to ventilate the plant room naturally via acoustic louvred panels. Additional ventilation will be provided mechanically by drawing air through the room with an Acoustic Minibox fan.

6.4 In considering the propagation of noise from the mechanical plant within the plant room, consideration was given to the following equation.

$L_{p2} = L_{p1} – R – 6$

Where L_{p1} is the sound pressure level on the source side of the plant room
L_{p2} is the sound pressure level close to the plant room on the outside
R is the sound reduction index of the acoustic louvre

6.5 The total attenuation was calculated by considering distance attenuation from the location of the louvre to the nearest noise sensitive façade. It was assumed the plant room walls would be lined with an acoustic lining system to minimise reverberant sound created within the enclosed space.

6.6 The sound reduction index of the acoustic louvre was extracted from manufacturer's data as follows:

Louvre type	Transmission Loss Octave Band Centre Frequency (Hz)								dBA
	63	125	250	500	1k	2k	4k	8k	
Gilbert Series 15	-4	-4	-6	-9	-12	-17	-11	-10	

Table 3

6.7 A further correction to account for building edge diffraction of -10dB was assumed. This was extracted from the Department of Energy and Climate Change Planning Standard MCS020.

6.8 The planning standard MCS020 states the following (Note 5):

"Note 5: Barriers between the heat pump and the assessment position (STEP 5)
A correction should be made for attenuation due to barriers between the air source heat pump and an assessment position. A correction will be necessary if an installer is unable to see an assessment position from the top edge of the air source heat pump. Use the following instructions to determine whether a correction is appropriate:

- *For a solid barrier (e.g. a brick wall or a fence) that completely obscures an installer's vision of an assessment position from the top edge of the air source heat pump attenuation of -10 dB may be assumed.*
- *Where a solid barrier completely obscures an installer's vision of an assessment position from the top or side edges of the air source heat pump, but moving a maximum distance of 25 cm in any direction to the air source heat pump allows an assessment position to be seen, attenuation of -5 dB may be assumed.*
- *If it is possible for an installer to see any part of an assessment position from the top or side edges of the air source heat pump no attenuation may be assumed. "*

6.9 The calculation exercise can be shown as follows:

All plant room equipment	Octave Band Centre Frequency (Hz)								dBA
	63	125	250	500	1k	2k	4k	8k	
Groundfos Magna 3D	61	49	47	40	32	30	29	31	43
Water booster set	72	60	58	51	43	42	40	42	55
Plant vent fan	58	46	44	37	29	27	26	28	40
Weismann Vitobloc	78	66	64	57	49	47	46	48	60
TOTAL plant room noise level	79	67	65	58	50	48	47	49	61
Rw acoustic louvre	-4	-4	-6	-9	-12	-17	-11	-10	
Building edge diffraction	-10	-10	-10	-10	-10	-10	-10	-10	
Reverberant correction	6	6	6	6	6	6	6	6	
Distance attenuation (14.9m)	-23	-23	-23	-23	-23	-23	-23	-23	
Level at façade	41	29	25	15	4	-2	2	5	21

Table 4

6.10 For the purposes of the calculations shown in Table 4, it has been assumed that the Water Booster sets will be contained within proprietary enclosures affording 10dB attenuation.

6.11 In order to comply with the requirements of the LPA, any noise from the proposed installation of the mechanical plant should not exceed a level of 24dBA (10dB below the lowest measured background noise over the operational hours of the plant).

6.12 The lowest measured background noise was $L_{A90,15min}$ 34dB that occurred during the period between 03:30 and 04:15hrs on 5th November 2014. The calculated noise impact is 21dBA. The calculation exercise (Table 4) demonstrates that noise impact A meets the LPA criteria by 3dB.

Noise Impact A (Swimming pool ventilation system)

6.13 Throughout the calculation exercise, guidance and formula were extracted from the publication *"Noise Control in Building Services" (published by SRL)*.

6.14 The ductwork system attenuation was calculated by considering the attenuation of sound energy produced by each component of the ductwork system. As the swimming pool ventilation system has not yet been specified, an air handling unit from a similar project was utilised. This AHU featured in line attenuation on the atmosphere duct runs to reduce the in duct sound power level.

6.15 Noise leaving the ductwork system at the fresh air intake and exhaust air was propagated to the nearest noise sensitive façade using point source propagation. The calculation exercise (attached as Appendix C) provided the following noise impact:

	Octave Band Centre Frequency (Hz)								dBA
	63	125	250	500	1k	2k	4k	8k	
Pool fresh Air	6	6	6	6	6	8	7	6	14
Pool exhaust	6	6	6	6	8	11	9	6	16
Combined Level at nearest façade @ 14.9m	9	9	9	9	13	16	14	10	18

Table 5

6.16 In order to comply with the requirements of the LPA, any noise from the proposed installation of the mechanical plant should not exceed a level of 24 dBA (10dB below the lowest measured background noise over the operational hours of the plant).

6.17 The lowest measured background noise was $L_{A90,15min}$ 34dB that occurred during the period between 03:30 and 04:15hrs on 5th November 2014. The calculated noise impact is 18dBA. The calculation exercise (Table 4) demonstrates that noise impact A meets the LPA criteria by 6dB.

Noise Impact B

6.18 The noise impact at the rear of No.2 The Chestnuts will be a function of the noise egress from the plant room.

6.19 The calculation principles and data used in the prediction of Noise Impact A has been re-used in Table 6.

All plant room equipment	Octave Band Centre Frequency (Hz)								dBA
	63	125	250	500	1k	2k	4k	8k	
Groundfos Magna 3D	61	49	47	40	32	30	29	31	43
Water booster set	72	60	58	51	43	42	40	42	55
Plant vent fan	58	46	44	37	29	27	26	28	40
Weismann Vitobloc	78	66	64	57	49	47	46	48	60
TOTAL plant room noise level	79	67	65	58	50	48	47	49	61
Rw acoustic louvre	-4	-4	-6	-9	-12	-17	-11	-10	
Acoustic splitter/silencer	-5	-5	-5	-5	-5	-5	-5	-5	
Building edge diffraction	-10	-10	-10	-10	-10	-10	-10	-10	
Reverberant correction	3	3	3	3	3	3	3	3	
Distance attenuation (12m)	-22	-22	-22	-22	-22	-22	-22	-22	
Level at façade	35	23	19	9	0	0	0	0	15

Table 6

6.20 The lowest measured background noise was $L_{A90,15min}$ 34dB that occurred during the period between 03:30 and 04:15hrs on 5th November 2014. The calculated combined noise impact is 15dBA. The calculation exercise (Table 6) demonstrates that noise impact B meets the LPA criteria.

Noise Impact C

6.22 The noise impact at the rear of No.1 Firecrest Drive will be a function of the noise egress from the 5No. condensers mounted adjacent to the garden store. These condensers are located internally and the spaces are ventilated through acoustic louvres. It has been assumed the internal walls of this area containing the condenser units will be lined with an acoustic lining system.

6.23 In considering the propagation of noise from the mechanical plant within the garden undercroft, consideration was given to the following equation.

$L_{p2} = L_{p1} - R - 6$

Where L_{p1} is the sound pressure level on the source side of the plant room
L_{p2} is the sound pressure level close to the plant room on the outside
R is the sound reduction index of the acoustic louvre

6.24 The total attenuation was calculated by considering distance attenuation from the location of the louvre to the nearest noise sensitive façade. It was assumed the undercroft walls would be lined with an acoustic lining system to minimise reverberant sound created within the enclosed space.

6.25 The calculation principles and data used in the prediction of Noise Impact C has been re-used in Table 7.

Condensers in garden	Octave Band Centre Frequency (Hz)								dBA
	63	125	250	500	1k	2k	4k	8k	
Mitsubishi PUHZ-P100	57	56	55	49	50	46	42	32	54
Mitsubishi PUHZ-P140	69	58	52	53	51	49	43	38	56
4No. Mitsubishi PUHZ-P140	63	62	61	55	56	52	48	38	60
TOTAL noise from condensers	64	63	62	56	57	53	49	39	
Acoustic louvre	-4	-4	-6	-9	-12	-17	-11	-10	
Distance attenuation	-22	-22	-22	-22	-22	-22	-22	-22	
Level at façade	32	31	28	19	17	8	10	1	24

Table 7

6.26 The lowest measured background noise was $L_{A90,15min}$ 34dB that occurred during the period between 03:30 and 04:15hrs on 5th November 2014. The calculated noise impact is 24dBA. The calculation exercise (Table 7) demonstrates that noise impact C meets the LPA criteria.

6.27 For the purposes of assessing the noise output from the condensers, it has been assumed that their primary use would be the comfort cooling of the house. In the event that the condenser units would be required to provide a role as a secondary heating source to supplement the primary heating system, it is recommended that a double banked acoustic louvre (Gilberts Series 27) is utilised. This increased acoustic performance will offset the small increase in noise when the condensers operate in heating mode.

7. CONCLUSION AND MITIGATION MEASURES

7.1 The foregoing assessment indicates that the proposed installation of mechanical plant will meet the requirements imposed by the LPA as set out in the Local Development Framework 2010-2025 Section DP28 (Table E). Further mitigation measures other than those detailed in this design report will not be required.

7.2 In order to meet the requirements the following mitigation measures will need to be incorporated:

(a) The swimming pool AHU within this document features in line attenuation on atmosphere supply and exhaust ducts.

(b) The water booster set is located within an acoustic enclosure.

(c) Acoustic louvres located in the basement plant room are based on Gilberts Series 15 louvres. Alternative manufacturers' data should be checked to ensure it meets the same level of attenuation as indicated.

(d) The basement plant room walls should be lined with an acoustic wall lining product.

(e) Acoustic louvres located in the garden area are also based on Gilberts Series 15 louvres (in the event the condensers are also used as a secondary heating source, the louvres should be uprated to Series 27). The garden undercroft area where the units are located should be lined with acoustic wall lining panels.

7.3 It is recommended that plant and machinery within the plant room is mounted on anti-vibration mounts to minimise the transmission of structure borne sound to other parts of the building.

7.4 It is anticipated that the M & E scheme will change during detailed design stage. During this stage the acoustic attenuation required will be revisited to ensure that compliance with the LPA criteria is met.

Figures

17 Branch Hill, London, NW3

Figure 1

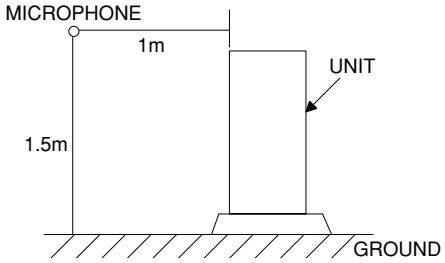
Figure 2

Figure 3

Figure 4

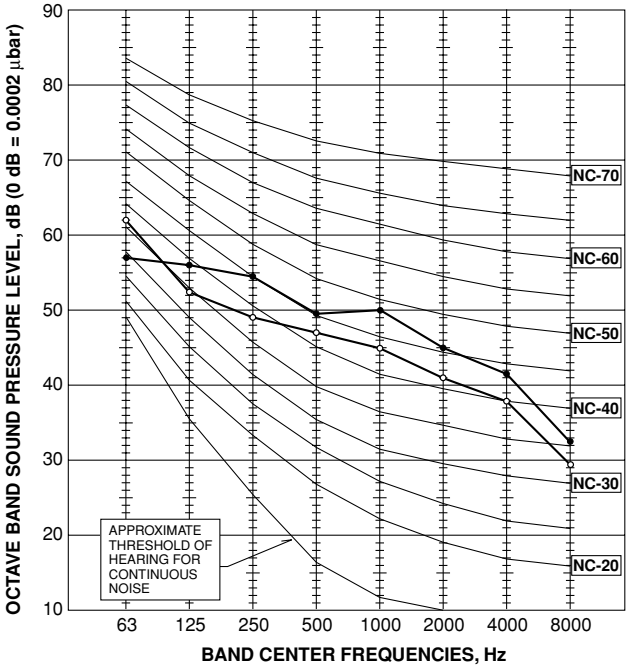
Figure 5

Appendix A



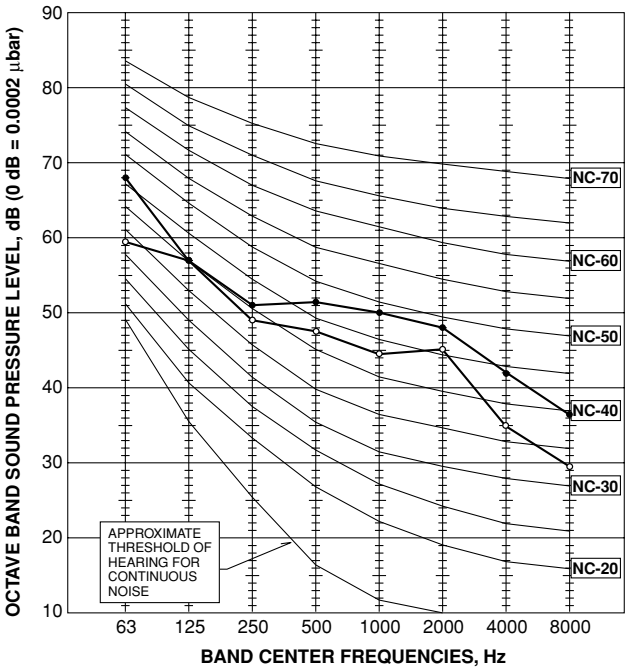
PUHZ-P100VHA2

MODE	SPL(dB)	LINE
COOLING	50	○—○
HEATING	54	●—●



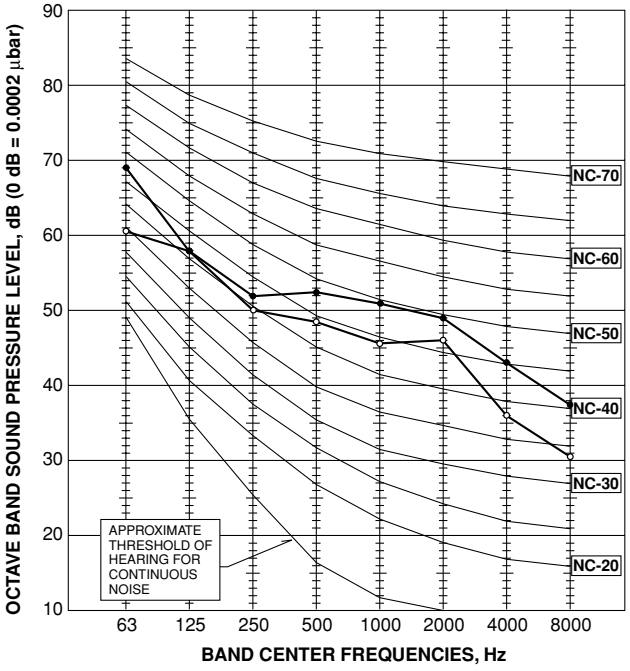
PUHZ-P125VHA2

MODE	SPL(dB)	LINE
COOLING	51	○—○
HEATING	55	●—●



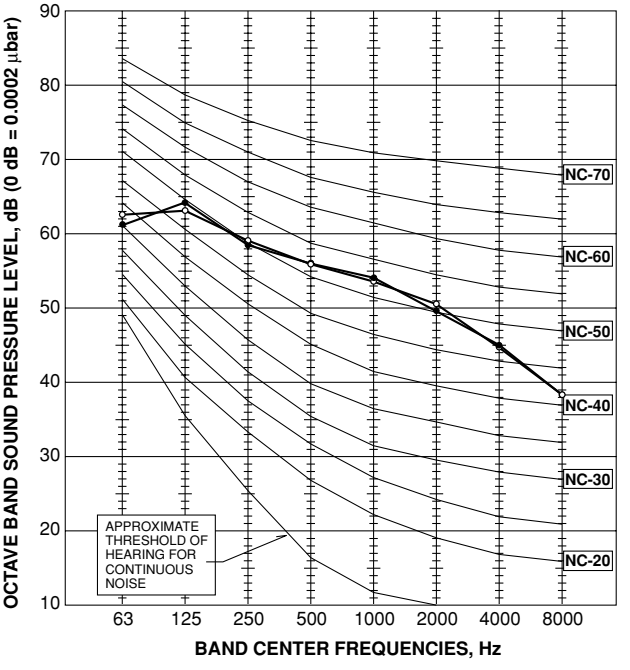
PUHZ-P140VHA2

MODE	SPL(dB)	LINE
COOLING	52	○—○
HEATING	56	●—●



PUHZ-P200YHA
PUHZ-P250YHA

MODE	SPL(dB)	LINE
COOLING	59	○—○
HEATING	59	●—●



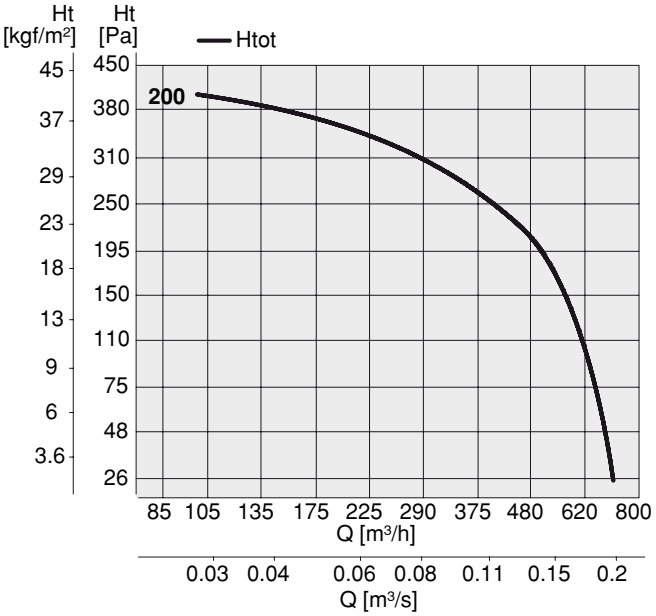
Frequenza 50Hz – Temperatura dell'aria 15°C – Pressione barometrica 760 mm Hg – Peso specifico dell'aria 1,22 Kg/m3
Frequency 50Hz – Air temperature 15°C – Barometric pressure 760 mm Hg – Air specific weight 1,22 Kg/m3

Lp: livello di pressione sonora rilevato a 1,50 m - ***Lp:*** *sound pression level measured at 1,50 m*

MINI-BOX 200

Tipo Type	Modello Model	U	rpm	Pm (kW)	In (A)	IP/CL	REG.
MINI-BOX	200	M	2550	0,12	0,54	44/F	RVN

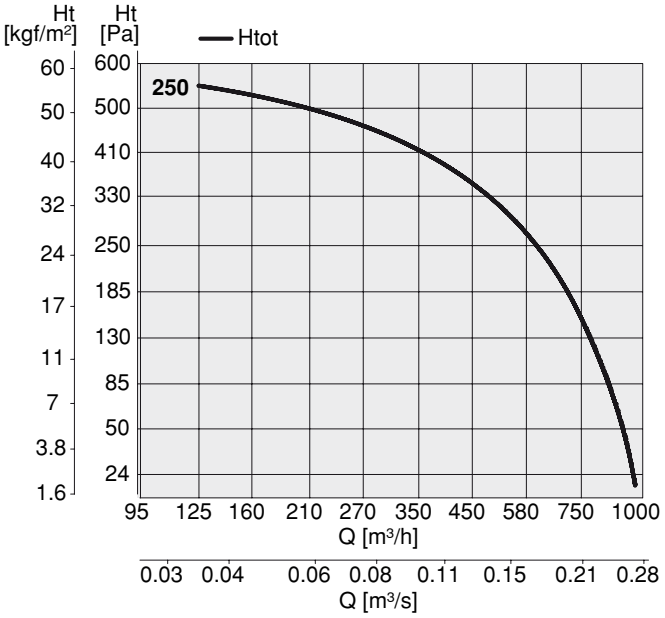
Tipo Type	Modello Model	Lp dB(A)	Lw dB(A) Hz - Lw in bande di frequenza								
			Tot.	63	125	250	500	1k	2k	4k	8k
MINI-BOX	200	36	50	23	35	40	47	46	42	34	24



MINI-BOX 250

Tipo Type	Modello Model	U	rpm	Pm (kW)	In (A)	IP/CL	REG.
MINI-BOX	250	M	2550	0,19	0,83	44/F	RVN o RVM

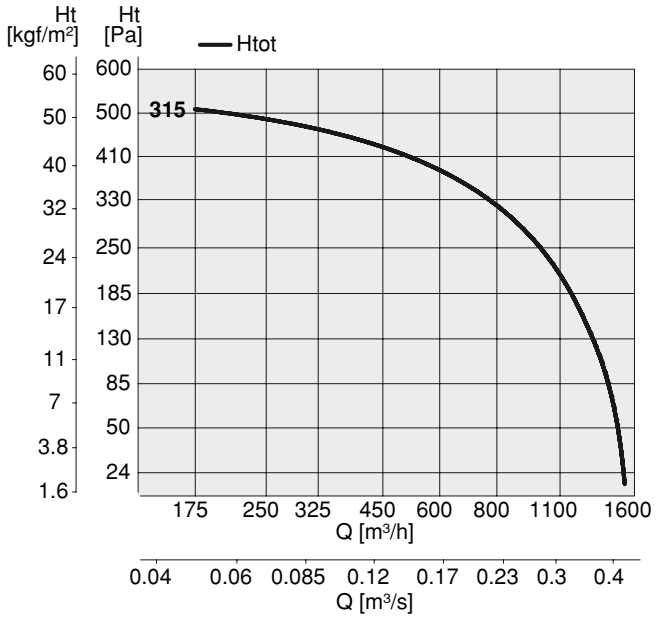
Tipo Type	Modello Model	Lp dB(A)	Lw dB(A) Hz - Lw in bande di frequenza								
			Tot.	63	125	250	500	1k	2k	4k	8k
MINI-BOX	250	39	53	25	37	43	49	48	44	36	26



MINI-BOX 315

Tipo Type	Modello Model	U	rpm	Pm (kW)	In (A)	IP/CL	REG.
MINI-BOX	3115	M	2630	0,31	1,35	44/F	RVM

Tipo Type	Modello Model	Lp dB(A)	Lw dB(A) Hz - Lw in bande di frequenza								
			Tot.	63	125	250	500	1k	2k	4k	8k
MINI-BOX	315	41	55	27	39	45	51	50	46	38	28



Vitobloc 200

Natural gas

Specification

Type		EM-5/13	EM-20/39	EM-50/81	EM-70/115	EM-140/207	EM-199/263	EM-199/293	EM-238/363	EM-363/498	EM-401/549
Electrical efficiency	%	27.2	32.2	34.5	34.3	36.5	37.0	36.0	35.7	37.8	38.1
Thermal efficiency	%	66.8	62.7	55.9	56.4	53.9	52.6	53.0	54.4	51.9	54.6
Total efficiency	%	94	94.9	90.3	90.7	90.4	89.6	89.0	90.1	89.7	92.7
Power index to AGFW FW308		0.41	0.51	0.62	0.61	0.68	0.76	0.68	0.66	0.73	0.73
Primary energy factor ENEV 2007 f_{PE}		0.7	0.7	0.74	0.74	0.74	0.74	0.73	0.73	0.71	0.71
Primary energy savings PEE acc. to CHP Directive	%	23.37	26.6	25.0	25.2	24.6	23.6	25.0	25.5	24.6	26.9
Permiss. heating water flow temperature	°C	80	80	90	90	90	85	85	90	85	85
Permiss. heating water return temperature	°C	60	60	70	70	70	65	65	70	65	65
Engine manufacturer		Toyota	Toyota	MAN	MAN	MAN	MAN	MAN	MAN	MAN	MAN
Number/arrangement of cylinders		3/in line	4/in line	4/in line	6/in line	6/in line	6/in line	6/in line	12/V	12/V	12/V
Process		Lambda =1*2	Lambda =1*2	Lambda =1*2	Lambda =1*2	Lambda =1*2 mix.cool*3	Lean burn turbo with mix.cool*4	Lean burn turbo with	Lambda =1*2 mix.cool*4	Lean burn turbo with mix.cool*3	Lean burn turbo with
Length **Width** **Height**	mm mm mm	1320 700 350	1 920 840 1 305	2 800 860 1 700	2 800 860 1 700	3 400 900 1 700	3 580 1 600 2 000	3 580 1 600 2 000	4 450 1 600 1 985	3 980 1 600 2 000	3 980 1 600 2 000
Weight (empty)	kg	350	900	2 000	2 100	3 420	4 800	4 800	5 300	6 300	6 300
Weight in operation	kg	450	1 000	2 200	2 300	3 620	5 300	5 300	5 800	6 800	6 800
Flue gas connection*5	Ø mm	50	50	80	80	100	150	150	150	200	200
Machine sound pressure level*6	dB(A)	66	66	62	72	74	81	81	77	81	81
Extractor fan sound pressure level*6	dB(A)	63	63	53	62	71	79	79	78	79	79
Flue gas sound pressure level*7	dB(A)	47	46	41	47	57	75	75	72	74	74
Inner room length min.	mm	3 260	4 140	5 240	5 240	6 040	6 600	6 600	7 450	7 000	7 000
Inner room width min.	mm	2 470	2 490	2 500	2 500	2 540	3 850	3 850	4 650	4 650	4 650
Inner room height min.	mm	2 000	2 000	2 800	2 800	2 800	3 500	3 500	3 500	3 500	3 500
Min. space needed for access to control panel	mm	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000
Min. space needed for access to connections	mm	1 200	1 200	1 400	1 400	1 600	2 000	2 000	2 000	2 000	2 000
Min. space needed on each side	mm	800	800	800	800	800	1 100	1 100	1 500	1 500	1 500

**1 Max. efficiency at flow/return temperatures of 50/35°C (condensing technology); with higher flow/return temperatures, reducing heating output.*

**2 Engines with three-way catalyst and operation with air ratios of Lambda = 1.*

**3 Engines with lean mixture combustion, mixture heating and external mixture cooling.*

**4 Engines with lean mixture combustion, mixture heating and internal mixture cooling.*

**5 Use approved flue system type. Connection withstands ulsation pressure up to 5 000 Pa.*

**6 Sound pressure level at 1 m distance in the open to DIN 45 635, measured with silencer hood and fan, exhaust air noise 1 m downstream of duct.*

**7 Sound pressure level at 1 m distance in the open to DIN 45 635, measured with the silencer (accessory).*

EM-5 module available from 2013.

Heatstar
Energy Technology Systems

Installation Services

Heatstar Project Ref:	P6725	11-Mar-2014
Project Title:		
System specified :	**Andromeda EC** **500** Super Plus	
Mains Electricity:	3 ph-Neutral-Earth 400v / 50 Hz Protected supply 1 ph-Neutral-Earth 230v / 50 Hz Protected supply	or
Supply rating :	Three phase: 6 Amps/phase. Single phase 14 Amps.	or
F.L. Running current :	Three phase: 3 Amps/phase. Single phase 5 Amps.	or
Protection required :	RCD (30mA) / Short circuit (MCB) / local isolator switch.	
Other wiring available :	Volt free switch contact to request LTHW demand.	

Air Flow Rating:	Supply/Return Air Flow:	1,000 M³/Hr.
	Max. External Res.:	150 Pa
	Exhaust/Fresh Air Flow:	44 M³/Hr.
	Max. External Res.:	30 Pa

Linear Sound Power *Lw dB :*

Frequency Hz	Return air	Supply air	Fresh air	Exhaust air
63	67.9	65.1	32.8	33.8
125	69.1	66.2	33.1	34.8
250	66.9	64.1	31.9	33.8
500	67.9	65.1	32.2	34.5
1000	65.1	62.3	30.8	33.1
2000	66.9	64.1	31.7	34.1
4000	64.3	61.5	30.5	32.7
8000	55.4	52.6	26.2	28.0

Condensate Water Drain:

Max. rate of flow :	4.1	L/Hr.
Pipe connection :	22	mm PVC / compression
Trapping required :	100	mm Minimum height 'P' trap.

L.T.H.W. Supply: (From Fuel Boiler)

Rated Flow / Rtn temp :	(Closed circuit Flow/return)		70 / 50 °C
Supply output rating :	15	kW /	51,000 BTUs
Flow rate required :	0.18	L/Sec @	6.8 kPa Internal Res.
Pump size for flow :	(Or equivalent duty model)		UPS 15-60
Connection size / type:	28	mm Copper / Compression	
Other requirements :			**Automatic by-pass valve.**

Pool Water Supply:

Connection size / type:	1.5	Inch PVC / Couplers on balanced by-pass.	
Flow rate required :	1.5	L/Sec @	0.4 kPa Internal Res.

Refrigerant Data : 1.2 kG of R407C : Hermetically sealed. E&OE

Appendix B

Background noise measurements obtained at 17 Branch Hill, London

File	Date	Duration	LAeq	LAFmax	LAFmin	LAF,90
NOR140_8183105_141104_0002.NBF	(2014/11/04 14:00:00.00)	(0:14:59.0)	54	77	40	46
NOR140_8183105_141104_0003.NBF	(2014/11/04 14:15:00.00)	(0:14:59.0)	52	69	35	46
NOR140_8183105_141104_0004.NBF	(2014/11/04 14:30:00.00)	(0:14:59.0)	50	63	38	45
NOR140_8183105_141104_0005.NBF	(2014/11/04 14:45:00.00)	(0:14:59.0)	53	79	39	47
NOR140_8183105_141104_0006.NBF	(2014/11/04 15:00:00.00)	(0:14:59.0)	51	65	37	46
NOR140_8183105_141104_0007.NBF	(2014/11/04 15:15:00.00)	(0:14:59.0)	51	61	41	46
NOR140_8183105_141104_0008.NBF	(2014/11/04 15:30:00.00)	(0:14:59.0)	52	72	39	46
NOR140_8183105_141104_0009.NBF	(2014/11/04 15:45:00.00)	(0:14:59.0)	53	72	39	46
NOR140_8183105_141104_0010.NBF	(2014/11/04 16:00:00.00)	(0:14:59.0)	50	61	37	46
NOR140_8183105_141104_0011.NBF	(2014/11/04 16:15:00.00)	(0:14:59.0)	51	68	40	46
NOR140_8183105_141104_0012.NBF	(2014/11/04 16:30:00.00)	(0:14:59.0)	53	70	42	48
NOR140_8183105_141104_0013.NBF	(2014/11/04 16:45:00.00)	(0:14:59.0)	55	74	47	51
NOR140_8183105_141104_0014.NBF	(2014/11/04 17:00:00.00)	(0:14:59.0)	56	67	48	53
NOR140_8183105_141104_0015.NBF	(2014/11/04 17:15:00.00)	(0:14:59.0)	56	69	51	53
NOR140_8183105_141104_0016.NBF	(2014/11/04 17:30:00.00)	(0:14:59.0)	55	65	49	52
NOR140_8183105_141104_0017.NBF	(2014/11/04 17:45:00.00)	(0:14:59.0)	57	71	49	53
NOR140_8183105_141104_0018.NBF	(2014/11/04 18:00:00.00)	(0:14:59.0)	58	77	49	54
NOR140_8183105_141104_0019.NBF	(2014/11/04 18:15:00.00)	(0:14:59.0)	60	83	49	54
NOR140_8183105_141104_0020.NBF	(2014/11/04 18:30:00.00)	(0:14:59.0)	60	76	45	52
NOR140_8183105_141104_0021.NBF	(2014/11/04 18:45:00.00)	(0:14:59.0)	56	73	47	51
NOR140_8183105_141104_0022.NBF	(2014/11/04 19:00:00.00)	(0:14:59.0)	57	69	47	52
NOR140_8183105_141104_0023.NBF	(2014/11/04 19:15:00.00)	(0:14:59.0)	55	71	47	51
NOR140_8183105_141104_0024.NBF	(2014/11/04 19:30:00.00)	(0:14:59.0)	56	68	43	50
NOR140_8183105_141104_0025.NBF	(2014/11/04 19:45:00.00)	(0:14:59.0)	53	65	44	49
NOR140_8183105_141104_0026.NBF	(2014/11/04 20:00:00.00)	(0:14:59.0)	59	87	41	49
NOR140_8183105_141104_0027.NBF	(2014/11/04 20:15:00.00)	(0:14:59.0)	58	81	44	50
NOR140_8183105_141104_0028.NBF	(2014/11/04 20:30:00.00)	(0:14:59.0)	56	73	43	48
NOR140_8183105_141104_0029.NBF	(2014/11/04 20:45:00.00)	(0:14:59.0)	55	70	43	48
NOR140_8183105_141104_0030.NBF	(2014/11/04 21:00:00.00)	(0:14:59.0)	52	67	41	46
NOR140_8183105_141104_0031.NBF	(2014/11/04 21:15:00.00)	(0:14:59.0)	52	64	43	47
NOR140_8183105_141104_0032.NBF	(2014/11/04 21:30:00.00)	(0:14:59.0)	55	75	45	48
NOR140_8183105_141104_0033.NBF	(2014/11/04 21:45:00.00)	(0:14:59.0)	53	64	44	48
NOR140_8183105_141104_0034.NBF	(2014/11/04 22:00:00.00)	(0:14:59.0)	51	63	45	48
NOR140_8183105_141104_0035.NBF	(2014/11/04 22:15:00.00)	(0:14:59.0)	50	61	42	46
NOR140_8183105_141104_0036.NBF	(2014/11/04 22:30:00.00)	(0:14:59.0)	50	64	39	43
NOR140_8183105_141104_0037.NBF	(2014/11/04 22:45:00.00)	(0:14:59.0)	50	66	39	44
NOR140_8183105_141104_0038.NBF	(2014/11/04 23:00:00.00)	(0:14:59.0)	49	65	38	43
NOR140_8183105_141104_0039.NBF	(2014/11/04 23:15:00.00)	(0:14:59.0)	50	62	38	43
NOR140_8183105_141104_0040.NBF	(2014/11/04 23:30:00.00)	(0:14:59.0)	50	69	38	44
NOR140_8183105_141104_0041.NBF	(2014/11/04 23:45:00.00)	(0:14:59.0)	50	61	39	44
NOR140_8183105_141105_0001.NBF	(2014/11/05 00:00:00.00)	(0:14:59.0)	51	71	39	42
NOR140_8183105_141105_0002.NBF	(2014/11/05 00:15:00.00)	(0:14:59.0)	47	60	37	40
NOR140_8183105_141105_0003.NBF	(2014/11/05 00:30:00.00)	(0:14:59.0)	47	60	37	40
NOR140_8183105_141105_0004.NBF	(2014/11/05 00:45:00.00)	(0:14:59.0)	47	61	35	39
NOR140_8183105_141105_0005.NBF	(2014/11/05 01:00:00.00)	(0:14:59.0)	47	69	34	36
NOR140_8183105_141105_0006.NBF	(2014/11/05 01:15:00.00)	(0:14:59.0)	49	67	34	37

Background noise measurements obtained at 17 Branch Hill, London

File	Date	Duration	LAeq	LAFmax	LAFmin	LAF,90
NOR140_8183105_141105_0007.NBF	(2014/11/05 01:30:00.00)	(0:14:59.0)	45	61	34	35
NOR140_8183105_141105_0008.NBF	(2014/11/05 01:45:00.00)	(0:14:59.0)	43	58	33	35
NOR140_8183105_141105_0009.NBF	(2014/11/05 02:00:00.00)	(0:14:59.0)	42	60	34	35
NOR140_8183105_141105_0010.NBF	(2014/11/05 02:15:00.00)	(0:14:59.0)	41	58	34	35
NOR140_8183105_141105_0011.NBF	(2014/11/05 02:30:00.00)	(0:14:59.0)	45	68	34	36
NOR140_8183105_141105_0012.NBF	(2014/11/05 02:45:00.00)	(0:14:59.0)	45	59	33	35
NOR140_8183105_141105_0013.NBF	(2014/11/05 03:00:00.00)	(0:14:59.0)	40	54	33	35
NOR140_8183105_141105_0014.NBF	(2014/11/05 03:15:00.00)	(0:14:59.0)	41	57	33	35
NOR140_8183105_141105_0015.NBF	(2014/11/05 03:30:00.00)	(0:14:59.0)	41	55	33	34
NOR140_8183105_141105_0016.NBF	(2014/11/05 03:45:00.00)	(0:14:59.0)	40	54	33	35
NOR140_8183105_141105_0017.NBF	(2014/11/05 04:00:00.00)	(0:14:59.0)	45	67	33	34
NOR140_8183105_141105_0018.NBF	(2014/11/05 04:15:00.00)	(0:14:59.0)	44	64	33	35
NOR140_8183105_141105_0019.NBF	(2014/11/05 04:30:00.00)	(0:14:59.0)	40	57	33	35
NOR140_8183105_141105_0020.NBF	(2014/11/05 04:45:00.00)	(0:14:59.0)	41	57	33	35
NOR140_8183105_141105_0021.NBF	(2014/11/05 05:00:00.00)	(0:14:59.0)	40	53	34	36
NOR140_8183105_141105_0022.NBF	(2014/11/05 05:15:00.00)	(0:14:59.0)	41	60	34	36
NOR140_8183105_141105_0023.NBF	(2014/11/05 05:30:00.00)	(0:14:59.0)	46	67	34	38
NOR140_8183105_141105_0024.NBF	(2014/11/05 05:45:00.00)	(0:14:59.0)	45	57	36	37
NOR140_8183105_141105_0025.NBF	(2014/11/05 06:00:00.00)	(0:14:59.0)	44	56	36	38
NOR140_8183105_141105_0026.NBF	(2014/11/05 06:15:00.00)	(0:14:59.0)	45	58	36	38
NOR140_8183105_141105_0027.NBF	(2014/11/05 06:30:00.00)	(0:14:59.0)	46	63	37	39
NOR140_8183105_141105_0028.NBF	(2014/11/05 06:45:00.00)	(0:14:59.0)	50	65	38	40
NOR140_8183105_141105_0029.NBF	(2014/11/05 07:00:00.00)	(0:14:59.0)	49	65	39	42
NOR140_8183105_141105_0030.NBF	(2014/11/05 07:15:00.00)	(0:14:59.0)	52	65	41	45
NOR140_8183105_141105_0031.NBF	(2014/11/05 07:30:00.00)	(0:14:59.0)	57	77	42	45
NOR140_8183105_141105_0032.NBF	(2014/11/05 07:45:00.00)	(0:14:59.0)	53	66	43	47
NOR140_8183105_141105_0033.NBF	(2014/11/05 08:00:00.00)	(0:14:59.0)	52	64	43	47
NOR140_8183105_141105_0034.NBF	(2014/11/05 08:15:00.00)	(0:14:59.0)	53	67	43	48
NOR140_8183105_141105_0035.NBF	(2014/11/05 08:30:00.00)	(0:14:59.0)	52	66	45	49
NOR140_8183105_141105_0036.NBF	(2014/11/05 08:45:00.00)	(0:14:59.0)	53	72	45	48
NOR140_8183105_141105_0037.NBF	(2014/11/05 09:00:00.00)	(0:14:59.0)	54	71	45	49
NOR140_8183105_141105_0038.NBF	(2014/11/05 09:15:00.00)	(0:14:59.0)	53	66	46	49
NOR140_8183105_141105_0039.NBF	(2014/11/05 09:30:00.00)	(0:14:59.0)	53	65	46	49
NOR140_8183105_141105_0040.NBF	(2014/11/05 09:45:00.00)	(0:14:59.0)	59	84	45	49
NOR140_8183105_141105_0041.NBF	(2014/11/05 10:00:00.00)	(0:14:59.0)	54	72	46	49
NOR140_8183105_141105_0042.NBF	(2014/11/05 10:15:00.00)	(0:14:59.0)	54	66	45	49
NOR140_8183105_141105_0043.NBF	(2014/11/05 10:30:00.00)	(0:14:59.0)	55	70	45	49
NOR140_8183105_141105_0044.NBF	(2014/11/05 10:45:00.00)	(0:14:59.0)	55	72	46	50
NOR140_8183105_141105_0045.NBF	(2014/11/05 11:00:00.00)	(0:14:59.0)	56	73	46	50
NOR140_8183105_141105_0046.NBF	(2014/11/05 11:15:00.00)	(0:14:59.0)	55	72	44	49
NOR140_8183105_141105_0047.NBF	(2014/11/05 11:30:00.00)	(0:14:59.0)	54	73	46	50
NOR140_8183105_141105_0048.NBF	(2014/11/05 11:45:00.00)	(0:14:59.0)	55	69	43	49
NOR140_8183105_141105_0049.NBF	(2014/11/05 12:00:01.00)	(0:14:58.0)	53	68	43	48
NOR140_8183105_141105_0050.NBF	(2014/11/05 12:15:00.00)	(0:14:59.0)	58	83	43	48
NOR140_8183105_141105_0051.NBF	(2014/11/05 12:30:00.00)	(0:14:59.0)	53	67	42	48
NOR140_8183105_141105_0052.NBF	(2014/11/05 12:45:00.00)	(0:14:59.0)	55	74	45	48
NOR140_8183105_141105_0053.NBF	(2014/11/05 13:00:00.00)	(0:2:45.0)	73	98	47	51

Appendix C

ACOUSTICS PLUS

CONTRACT TITLE: 17 Branch Hill, London, NW3
SOUND SOURCE: Swimming Pool Air Handling Unit (Fresh Air)
MAKE & TYPE: Heatstar Andromeda EC 500 Super Plus

					OCTAVE BAND CENTRE FREQUENCY (Hz)								
	OVERALL Lw				63	125	250	500	1k	2k	4k	8k	dBA
1													
2				UNIT Lw	33	33	32	32	31	32	31	26	38
3													
4	STRAIGHT DUCT												
5	LENGTH (m)		SIZE (mm)		0.82	0.66	0.33	0.16	0.16	0.16	0.16	0.16	
6	5.00		500 x 500		4.10	3.30	1.65	0.80	0.80	0.80	0.80	0.80	
7					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
8					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
9					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
10					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
11	BENDS & TAKE OFFS												
12	NO.	TYPE	SIZE (mm)				6	8	4	3	3	3	
13	1	90°	500 x 500		0.00	0.00	6.00	8.00	4.00	3.00	3.00	3.00	
14					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
15					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
16					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
17					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
18					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
19	OTHER ATTENUATION												
20													
21													
22													
23													
24	END REFLECTION SIZE (mm)												
25	500mm				9	4	1	0	0	0	0	0	
26													
27	**Lw LEAVING SYSTEM**				20	26	23	23	26	28	27	22	
28													
29	DISTANCE TO LISTENER (m)			14.9	-34	-34	-34	-34	-34	-34	-34	-34	
30	DIRECTIVITY OUTLET				4	5	6	7	8	9	9	9	
31	REVERBERANT CORRECTION				6	6	6	6	6	6	6	6	
32	**NOISE IMPACT**				6	6	6	6	6	8	7	6	14

ACOUSTICS PLUS

CONTRACT TITLE: 17 Branch Hill, London, NW3
SOUND SOURCE: Swimming Pool Air Handling Unit (Exhaust Air)
MAKE & TYPE: Heatstar Andromeda EC 500 Super Plus

					OCTAVE BAND CENTRE FREQUENCY (Hz)								
	OVERALL Lw				63	125	250	500	1k	2k	4k	8k	dBA
1													
2				UNIT Lw	34	35	34	35	33	34	33	28	40
3													
4	STRAIGHT DUCT												
5	LENGTH (m)		SIZE (mm)		0.82	0.66	0.33	0.16	0.16	0.16	0.16	0.16	
6	5.00		500 x 500		4.10	3.30	1.65	0.80	0.80	0.80	0.80	0.80	
7					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
8					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
9					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
10					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
11	BENDS & TAKE OFFS												
12	NO.	TYPE	SIZE (mm)				6	8	4	3	3	3	
13	1	90°	500 x 500		0.00	0.00	6.00	8.00	4.00	3.00	3.00	3.00	
14					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
15					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
16					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
17					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
18					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
19	OTHER ATTENUATION												
20													
21													
22													
23													
24	END REFLECTION SIZE (mm)												
25	500mm				9	4	1	0	0	0	0	0	
26													
27	**Lw LEAVING SYSTEM**				21	28	25	26	28	30	29	24	
28													
29	DISTANCE TO LISTENER (m)			14.9	-34	-34	-34	-34	-34	-34	-34	-34	
30	DIRECTIVITY OUTLET				4	5	6	7	8	9	9	9	
31	REVERBERANT CORRECTION				6	6	6	6	6	6	6	6	
32	**NOISE IMPACT**				6	6	6	6	8	11	9	6	16