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ACOUSTICS PLUS

Proposed Mechanical Plant Installation

30 Oval Road, London, NW1 7DE

Environmental Noise Assessment

February 2010

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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 The Association of Noise Consultants (ANC) and the author is an associate member of The Institute of Acoustics (IOA.

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

1.3 The proposed installation will consist of a number of items of mechanical plant that will be located in a basement plant room and designated plant areas on the roof.

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 potential noise impact upon the surrounding neighbourhood.

1.5 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 30 Oval Road, London, NW1.

2.2 The site is currently under construction but will consist of a mixed use development comprising 70 1, 2 and 3 bedroom apartments located over five levels together with ground floor and basement commercial space. The site is located in a mixed residential and commercial area. The site is bounded to the south by the Grand Union Canal which is overlooked by residential premises located on Jamestown Road (see Figure 14). There are also residential premises located to the north on Gilbeys Yard (see Figure 7). These premises are located approximately 20-30m from the boundary of the site.

2.3 The site and its surroundings can be seen in Figures 1 to 15.

2.4 It is understood the outline design can be divided into the following categories:

(a) Roof mounted plant located above 4th floor level (see Figure 16);

(b) Basement mounted plant.

(c) Ground floor substation

2.5 From discussions with the Ardmore Group, the list of plant will be as follows

Roof mounted plant

- *3No. Outdoor condenser Mitsubishi PUMY-P100VHM – serving residential*
- *2No. Outdoor condenser Mitsubishi PUMY-P125VHM – serving residential*
- *1No. Outdoor condenser Mitsubishi PUHY-P350VHM – serving residential*
- *1No. Outdoor condenser Mitsubishi PUHY-P400VHM – serving residential*

Basement mounted plant

- *Pressurization Kit/Water Booster*
- *HA pump*
- *PH pump*
- *Gas boiler pump*
- *Bio boiler pump*
- *Gas boiler*
- *Bio mass boiler*

Ground floor substation

- *2No. ES135-1 500kVA transformers*

2.6 It is understood that the roof mounted plant will be located in two designated plant areas which will be surrounded on all sides (but open to the top) by a proprietary barrier system.

2.7 The nearest noise sensitive façade to the roof mounted plant will be the 4th or 5th floor of the site. These façades will not have line of sight with the plant. Other residential façades that may be affected are located on Jamestown Road overlooking the canal and on Gilbeys Yard.

2.8 The nearest noise sensitive façade to the mechanical plant located in the basement that will be utilised for servicing the residential apartments located above and is to discharge on the northern façade is Gilbeys Yard.

2.9 The nearest noise sensitive façade to the transformers located in the ground floor substation is located directly above and is to discharge via louvred doors on the northern façade

2.10 Information in regard of the noise level from the specified mechanical plant to be located on the roof has been provided by Mitsubishi HVAC (copy of the data sheets is provided in Appendix A). The units are itemised below:

(a) 3No. Mitsubishi PUMY-P100VHM @ 51dBA @ 1m (per unit [heating])

(b) 2No. Mitsubishi PUMY-P125VHM @ 52dBA @ 1m (per unit [heating])

(c) 1No. Mitsubishi PUHY-P350VHM @ 60dBA @ 1m (per unit [heating])

(d) 1No. Mitsubishi PUHY-P400VHM @ 61dBA @ 1m (per unit [heating])

2.11 Information in regard of the noise level from the specified mechanical plant to be located in the basement plant room has been provided by Ardmore Group and is assumed to be measured at 1m. The units are itemised below:

a)	*Pressurization Kit/Water Booster*		*57dBA*
b)	*HA Pump*	*max*	*70dBA*
c)	*PH Pump*		*60dBA*
d)	*Gas Boiler pump*	*max*	*70dBA*
e)	*Bio Boiler pump*	*max*	*70dBA*
f)	*Gas Boiler*		*65dBA*
g)	*Bio Boiler*		*75dBA*

2.12 Information in regard of the noise level from the mechanical plant to be located within the ground floor substation has been provided by Ardmore Group. The units are itemised below:

(a) 2No. ES135-1 500KVA @ 53dBA @ 0.3m (per unit)

3. NOISE OUTLINE

3.1 In order to produce an environmental noise assessment, consideration must be given to 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 façade. Measurements were obtained at ground floor level on the site. Measurements obtained during the daytime period were dominated by demolition and construction noise and are therefore not reported. It is considered that night time background noise levels obtained on the site are reflective of background noise levels experienced at the adjacent noise sensitive façades.

3.3 The particulars of the measurement exercise are recorded below:

Date:	18th – 19th September 2008
Start Time:	15:12 hrs
Location:	ground floor, site side of hoarding, next to Gilbeys Yard
Weather:	no wind, no precipitation

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

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

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

3.6 For the sake of clarity, the lowest measured background noise over the anticipated operational hours of the mechanical plant is highlighted. As the roof mounted condenser units and the mechanical plant in the basement will be utilised for servicing residential premises, it is anticipated that the operational hours will be on a demand basis during any given 24hr period.

3.7 Information regarding the noise levels not to be exceeded by the mechanical plant was provided by the LPA (London Borough of Camden). The following conditions apply:

10 Prior to the installation of the equipment, sound data for the emergency chiller unit, the proposed plant in the basement level, and the sub-station on the ground floor shall be submitted for approval. In addition to the sound data, the following information for the plant and equipment detailed above shall be submitted for approval:

- Details of the proposed acoustic enclosure and sound barriers to be installed;
- Barrier calculations detailing the level of attenuation which can be achieved;

The emergency chiller unit, the proposed plant in the basement level, and the sub-station on the ground floor shall be provided with acoustic isolation and sound attenuation in accordance with the scheme approved by the Council before it is brought into operation. The acoustic isolation shall thereafter be permanently retained, and maintained in effective order, such that it continues to comply with Council noise standards as detailed in condition 5 below.

Reason: To safeguard the amenities of the adjoining premises and the area generally in accordance with the requirements of policies SD6 SD7B, SD8 and Appendix 1of the London Borough of Camden Replacement Unitary Development Plan 2006.

11 Noise levels at a point 1 metre external to sensitive facades shall be at least 5dB(A) less than the existing background measurement (LA90), expressed in dB(A) when all plant/equipment are in operation unless the plant/equipment hereby permitted will have a noise that has a distinguishable, discrete continuous note (whine, hiss, screech, hum) and/or if there are distinct impulses (bangs, clicks, clatters, thumps), then the noise levels from that piece of plant/equipment at any sensitive façade shall be at least 10dB(A) below the LA90, expressed in dB(A).

Reason: To safeguard the amenities of the adjoining premises and the area generally in accordance with the requirements of policies SD6, SD7B, SD8 and Appendix 1 of the London Borough of Camden Replacement Unitary Development Plan 2006.

4. EQUIPMENT

4.1 All measurements were obtained using the following equipment:

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

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

5. CALCULATIONS

5.1 The following noise impacts were considered:

(a) the egress of noise from the roof mounted plantroom to nearest noise sensitive façade;

(b) the egress of noise from the basement plantroom to the nearest noise sensitive façade.

(c) the egress of noise from the ground floor substation to the nearest noise sensitive façade.

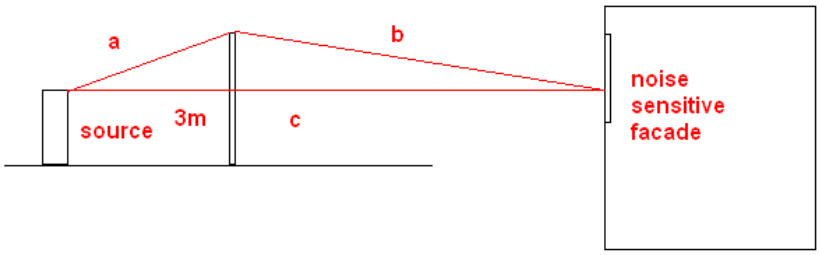
Noise impact (a)

5.2 Given the proposed location of the condensing units, the egress of noise from the condensing units over the barrier to the nearest noise sensitive façade was considered.

5.3 The height of the barrier is critical in determining the sound reduction available. In this instance and given the height of the condensers, the barrier height should be a minimum of 3.0 metres.

5.4 The calculation can be shown as follows. Using the Maekawa method to approximate the attenuation provided by a thin rigid barrier between the source of sound and the noise sensitive façade the following formula was utilised-

$$E_b = 10 \text{ Log } [3+ 40 (\delta/\lambda)]$$



$$\delta = a + b - c$$

5.5 λ = Velocity (330m/s) / frequency (Hz)

	Octave Band Centre Frequency (Hz)								dBA
	63	125	250	500	1k	2k	4k	8k	
Wavelength	5.24	2.64	1.32	0.66	0.33	0.17	0.08	0.04	

Table 1

5.6 Assuming a worst case scenario and a minimal increase in path length, the attenuation afforded by a barrier of this type can be approximated as follows:

	Octave Band Centre Frequency (Hz)								dBA
	63	125	250	500	1k	2k	4k	8k	
Barrier attenuation	5	6	7	8	10	12	14	17	

Table 2

5.7 In considering the propagation of noise from the roof mounted plant, consideration was given to point source propagation over 20m with additional attenuation provided by the barrier as shown in Table 2.

5.8 The total noise output from the roof mounted condensers was calculated as:

Make & Model	Octave Band Centre Frequency (Hz)								dBA
	63	125	250	500	1k	2k	4k	8k	
3No. PUMY-P100VHM	62	58	55	54	51	46	40	53	57
2No. PUMY-P125VHM	63	57	54	53	50	45	39	42	55
1No. PUHY-P350VHM	69	70	64	61	57	57	60	56	60
1No. PUHY-P400VHM	68	69	61	59	55	51	49	43	61
TOTAL	70	70	63	62	58	55	55	55	65

Table 3

5.9 The predicted noise level from the roof mounted condensers at the nearest noise sensitive façade was calculated as follows:

	Octave Band Centre Frequency (Hz)								dBA
	63	125	250	500	1k	2k	4k	8k	
All condensers	70	70	63	62	58	55	55	55	65
Distance attenuation	-26	-26	-26	-26	-26	-26	-26	-26	
Barrier attenuation	-5	-6	-7	-8	-10	-12	-14	-17	
Predicted façade level	39	38	30	28	22	17	15	12	29

Table 4

5.10 The lowest measured background noise level during the relevant period was 44dB L_{A90} that occurred during a number of 15 minute periods between 00:12 and 03:12 on 19th September 2008.

5.11 In order to comply with the requirements of the LPA, any noise from the proposed installation should not exceed a level of 34 dBA (10 dB below the lowest measured background noise over the anticipated operational hours of the plant – any 24hour period) at the nearest noise sensitive façade. The predicted façade level was 29dBA.

Noise impact (b)

5.12 Given the proposed location of the items of mechanical plant within the basement plantroom, the egress of noise from the plantroom to the nearest noise sensitive façades on Gilbey's Yard was considered.

5.13 From information obtained from the mechanical engineers appointed on this project, it is considered that potential noise egress from the plantroom will be via the associated ductwork between the plantroom to the points of discharge on the northern façade at ground floor level. The two rectangular ductwork runs servicing the plantroom are shown in diagram 1 below:

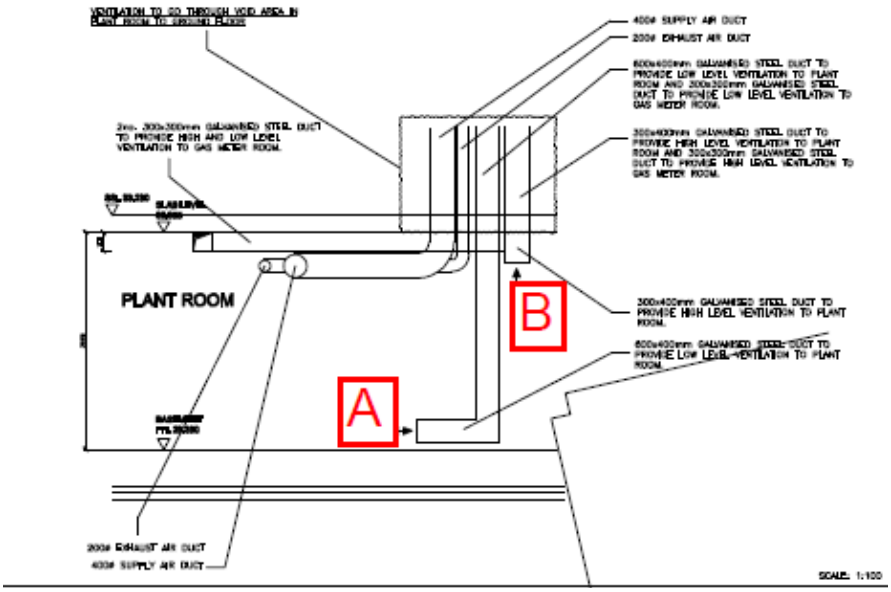


Diagram1

5.14 The route of the ductwork from the plantroom to the points of discharge on the northern façade are shown in diagram 2 below:

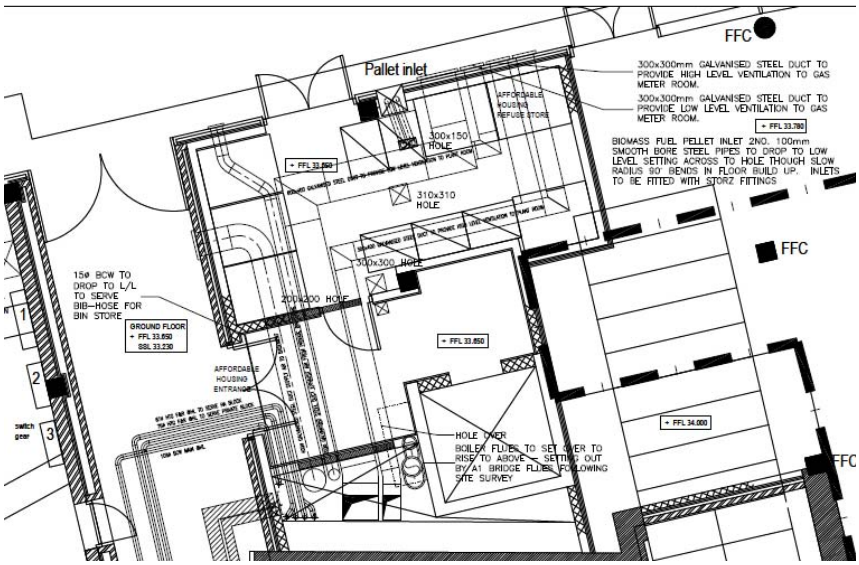


Diagram 2

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

5.16 The total direct sound output (L_{pd}) from the basement plant was calculated as:

Make & Model	dBA @ 1m(assumed)
Pressurization Kit/Water Booster	57
HA pump	70
PH pump	60
Gas boiler pump	70
Bio boiler pump	70
Gas boiler	65
Bio mass boiler	75
TOTAL L_{pd}	**78**

Table 5

5.17 In order to calculate the total sound pressure level, consideration was given to the reverberant contribution that the plantroom would afford. For the purposes of this report, a correction of +6dB was added to the direct sound pressure levels.

5.18 In order to calculate the effective sound power level (L_w) entering the associated ductwork the following correction can be applied:

$$L_w = L_p + 10\text{Log } S - 6\text{dB}$$

Where,

L_p = reverberant sound pressure level in the plantroom (dB)

S = area of aperture (m^2)

Ductwork servicing plantroom	Area of aperture (m^2)
(A) 600x400mm low level ventilation	0.24
(B) 300x400mm high level ventilation	0.12

Table 6

5.19 The effective sound power levels (L_w) are as follows:

Ductwork run	Effective sound power levels (L_w)
(A) 600x400mm low level ventilation	70
(B) 300x400mm high level ventilation	67

Table 7

5.20 The ductwork system attenuation was calculated by considering the attenuation of sound energy produced by each component of the ductwork system.

5.21 The calculation exercise (attached as Appendix C) provided results of the attenuation provided at 1kHz for the ductwork system (the reduction at 1kHz was considered in the absence of octave band data for the items of mechanical plant).

5.22 In considering the propagation of noise from the basement plantroom ductwork discharge points, consideration was given to point source propagation over a distance of 20m.

5.23 Utilising the following formula $10Log_{10}$ $(4x\pi r^2)$ to determine the distance attenuation minus the ductwork attenuation provided, the noise levels at the nearest noise sensitive façade have been calculated as follows;

Ductwork system	Level at nearest noise sensitive façade (L_w – ductwork attenuation – distance)
Ductwork A	38
Ductwork B	35
TOTAL	**40**

Table 8

5.24 The lowest measured background noise level during the relevant period was 44dB L_{A90} that occurred during a number of 15 minute periods between 00:12 and 03:12 on 19th September 2008.

5.25 In order to comply with the requirements of the LPA, any noise from the installation of the mechanical plant within the basement plantroom should not exceed a level of 39 dBA (5 dB below the lowest measured background noise over the proposed operational hours of the installation).

Noise impact (c)

5.26 Given the proposed location of the transformers within the ground floor substation, the egress of noise from the substation to the nearest noise sensitive façade located above was considered.

5.27 In considering the propagation of noise from the substation, consideration was given to the following equation.

$SPL_2 = SPL_1 – R – 6$

Where SPL_1 is the sound pressure level on the source side of the door

SPL_2 is the sound pressure level close to the door on the outside

R is the sound reduction index of the separating acoustic louvred door

5.28 The sound reduction of the acoustic louvre was extracted from proprietary manufacturer's data.

Louvre type	Octave Band Centre Frequency (Hz)								dBA
	63	125	250	500	1k	2k	4k	8k	
Single bank	4	5	8	11	16	18	14	12	

Table 9

5.29 The noise level of the transformers was increased by 6dB to account for the reverberant nature of the floor, walls and ceiling of the substation. The noise level outside of the acoustic louvred door was propagated to the nearest noise sensitive façade using point source propagation over 2m. The calculation can be shown as follows:

	Octave Band Centre Frequency (Hz)								dBA
	63	125	250	500	1k	2k	4k	8k	
1 x ES135-1 transformer @300mm	60	55	52	51	48	44	33	19	53
2 x ES135-1 transformers@1m	58	53	50	49	46	42	31	17	51
Rw louvre door	4	5	8	11	16	18	14	12	
Distance attenuation	6	6	6	6	6	6	6	6	
Reverberant correction	6	6	6	6	6	6	6	6	
Façade level	48	42	36	32	24	18	11	-1	33

Table 10

5.30 The lowest measured background noise level during the relevant period was 44dB L_{A90} that occurred during a number of 15 minute periods between 00:12 and 03:12 on 19th September 2008.

5.31 In order to comply with the requirements of the LPA, any noise from the installation of the transformers within the ground floor substation should not exceed a level of 34 dBA (10 dB below the lowest measured background noise over the proposed operational hours of the installation).

6. CONCLUSION & MITIGATION MEASURES

6.1 The foregoing assessment indicates that the proposed plant installation located on the roof will meet the requirements imposed by the LPA.

6.2 The foregoing assessment indicates that the proposed plant installation located in the basement plantroom does not currently meet the requirements imposed by the LPA. However, Ardmore Construction will implement either of the necessary remedial measures detailed below in paragraph 6.4 in order to comply with the requirements imposed by the LPA.

6.3 The foregoing assessment indicates that the proposed plant installation located in the ground floor substation will meet the requirements imposed by the LPA subject to the type of louvre to be installed within the door is an acoustic louvre with sound reduction figures that at least match those stated in Table 9. Alternatively, the noise impact could be measured to determine if the noise egress from the substation can be shown to be 10dB below the lowest measured background noise of 44dB L_{A90} that occurred during a number of 15 minute periods between 00:12 and 03:12 on 19th September 2008.

6.4 In order to meet the requirements imposed by the LPA regarding the proposed plant installation located in the basement plantroom, consideration should be given to the following:

(a) installation of a single bank of acoustic louvred panels at the duct openings of Duct run A on the northern façade. The sound reduction index of a single bank of acoustic louvres can be expected to provide at least 10dB attenuation and the performance data from such a set of louvres available from Caice Acoustic Air Movement Ltd is reproduced below.

Performance

Acoustic and aerodynamic performance data for AS and AA acoustic louvres is given below.

	Octave Band Sound Reduction Index (dB)							
	63	125	250	500	1k	2k	4k	8k
Single bank	4	5	8	11	16	18	14	12
Double bank	6	8	12	18	24	26	20	18

(b) Or, installation of proprietary silencers on the duct opening of duct run A within the plantroom.

Figures

Proposed Location of Mechanical Plant and Surrounding Area


Figure 1


Figure 2


Figure 3


Figure 4


Figure 5


Figure 6


Figure 7


Figure 8

noise sensitive properties on Gilbeys Yard

Figure 9

Figure 10

Figure 11

Figure 12

Figure 13

Figure 14

noise sensitive properties (rear of Jamestown Road)

Figure 15

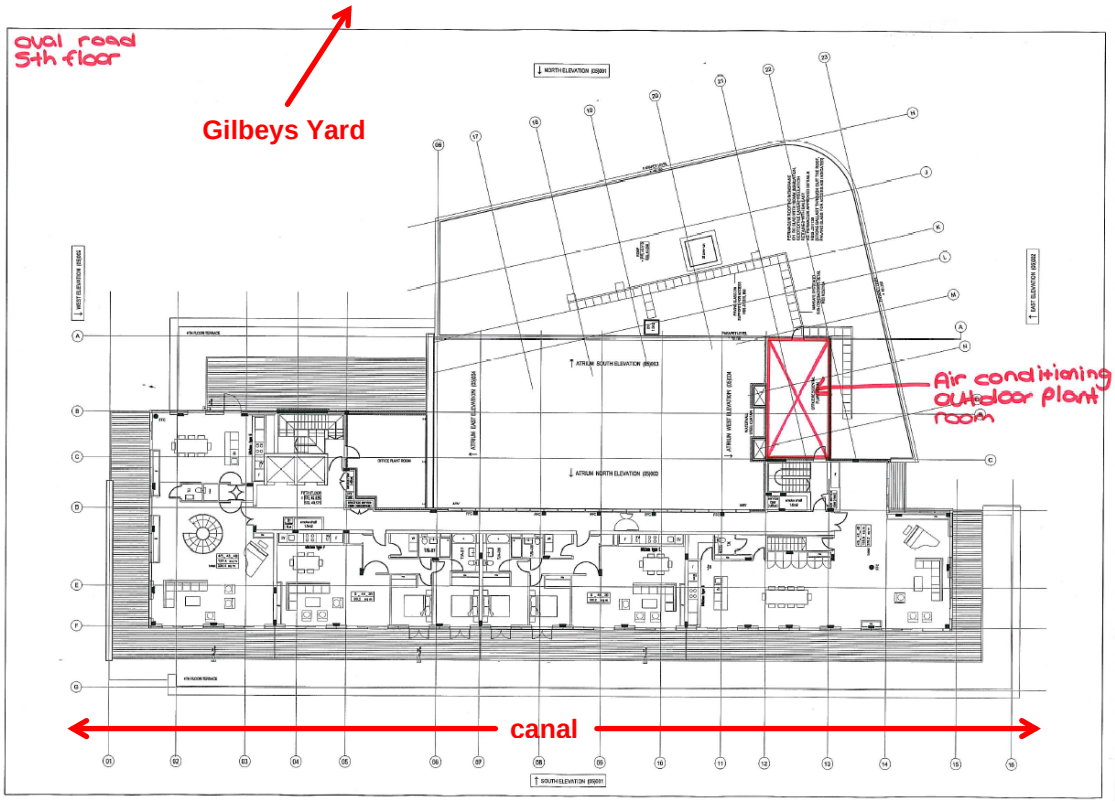

qual road
5th floor
Gilbeys Yard
Air conditioning
outdoor plant
room
canal

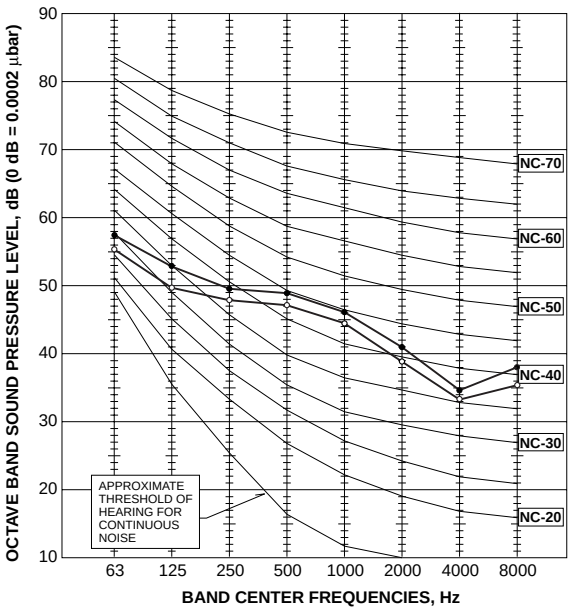
Figure 16

Appendix A

5-4. NOISE CRITERION CURVES

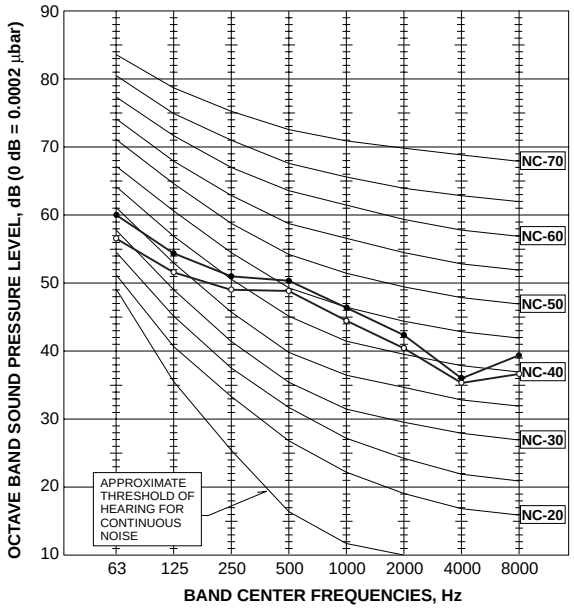
PUMY-P100VHM
PUMY-P100VHMA

MODE	SPL(dB)	LINE
COOLING	49	○—○
HEATING	51	●—●



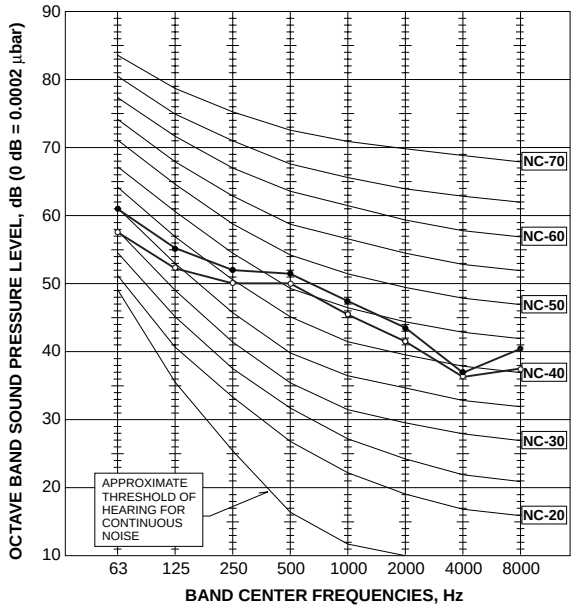
PUMY-P125VHM
PUMY-P125VHMA

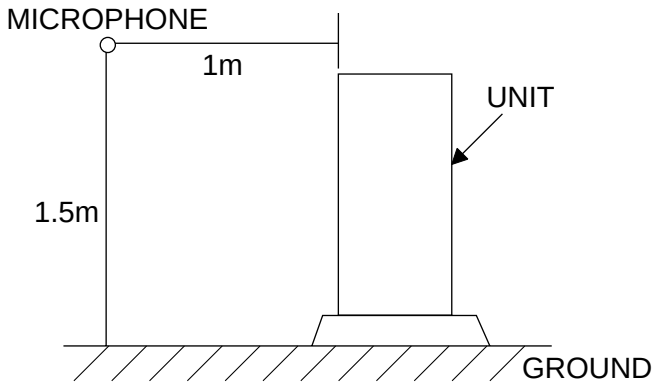
MODE	SPL(dB)	LINE
COOLING	50	○—○
HEATING	52	●—●



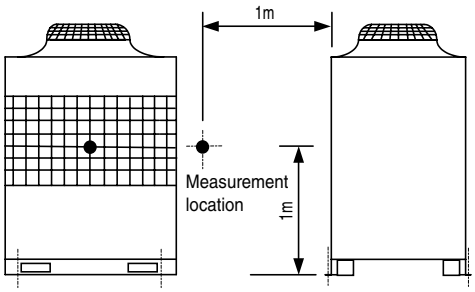
PUMY-P140VHM
PUMY-P140VHMA

MODE	SPL(dB)	LINE
COOLING	51	○—○
HEATING	53	●—●



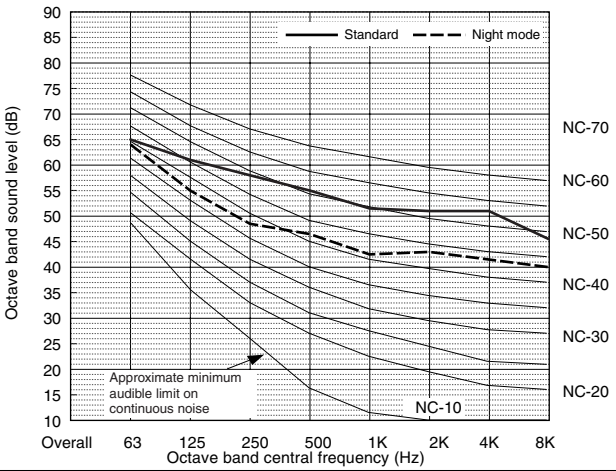


Measurement condition
PUY-P200,250,300,350YGM
PUHY-P200,250,300,350,400YGM



Sound level of PUHY, PUY-P300YGM-A(-BS)

Ref. : P300YGM-WYNB0-3618

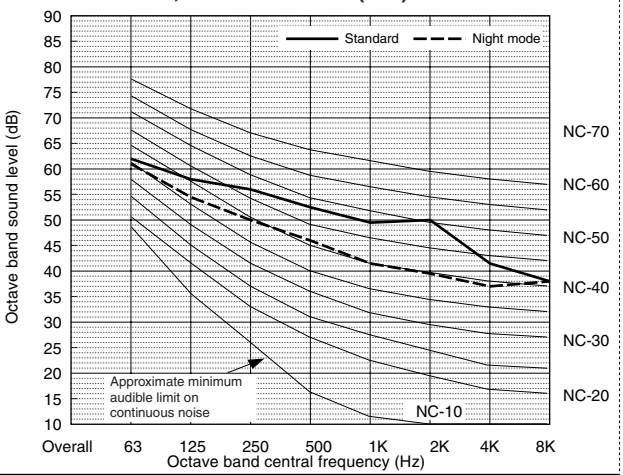


		63Hz	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz	dB(A)
Standard	50Hz	65	61	58	55	51.5	51	51	45.5	59
	60Hz	65	61	58	55	51.5	51	51	45.5	59
Night mode	50/60Hz	64	55	48.5	46.5	42.5	43	41.5	40	51

* When Night Mode is set, the A/C system's capacity is limited. The system could return to normal operation from Night Mode automatically in the case that the operation condition is severe.

Sound level of PUHY, PUY-P200YGM-A(-BS)

Ref. : P200YGM-WYNB0-3616

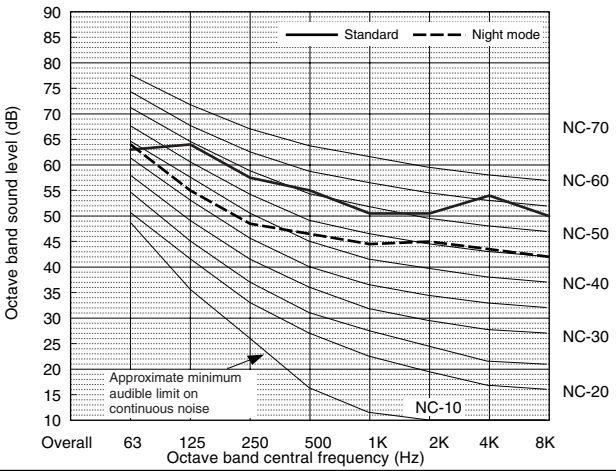


		63Hz	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz	dB(A)
Standard	50Hz	62	58	56	52.5	49.5	50	41.5	38	56
	60Hz	62	58	56	52.5	49.5	50	41.5	38	56
Night mode	50/60Hz	61	54.5	50	46	41.5	39.5	37	38	49

* When Night Mode is set, the A/C system's capacity is limited. The system could return to normal operation from Night Mode automatically in the case that the operation condition is severe.

Sound level of PUHY, PUY-P350YGM-A(-BS)

Ref. : P350YGM-WYNB0-3619

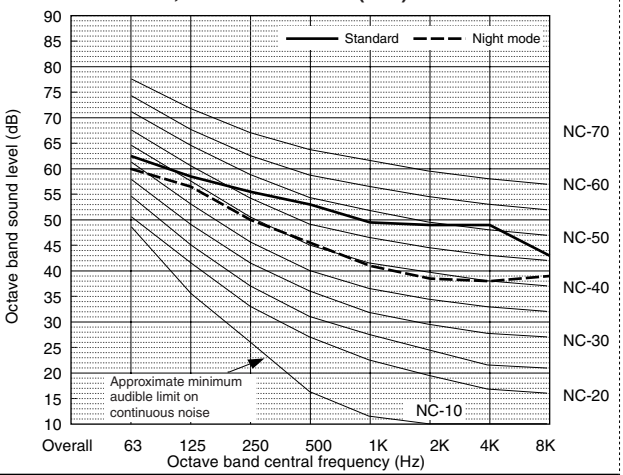


		63Hz	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz	dB(A)
Standard	50Hz	63	64	57.5	55	50.5	50.5	54	50	60
	60Hz	63	64	57.5	55	50.5	50.5	54	50	60
Night mode	50/60Hz	64	55	48.5	46.5	44.5	45	43.5	42	52

* When Night Mode is set, the A/C system's capacity is limited. The system could return to normal operation from Night Mode automatically in the case that the operation condition is severe.

Sound level of PUHY, PUY-P250YGM-A(-BS)

Ref. : P250YGM-WYNB0-3617

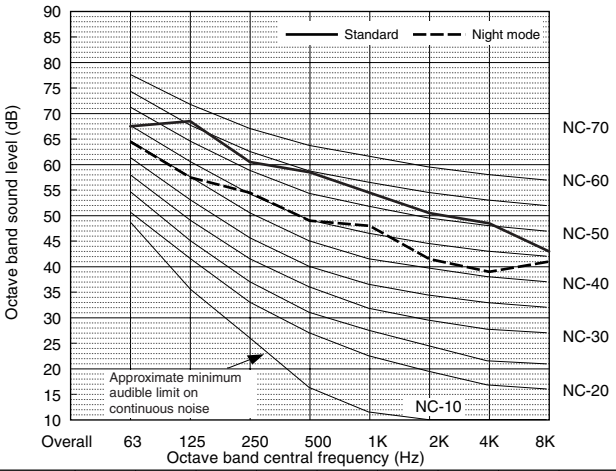


		63Hz	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz	dB(A)
Standard	50Hz	62.5	58.5	55.5	53	49.5	49	49	43	57
	60Hz	62.5	58.5	55.5	53	49.5	49	49	43	57
Night mode	50/60Hz	60	56.5	50	45.5	41	38.5	38	39	49

* When Night Mode is set, the A/C system's capacity is limited. The system could return to normal operation from Night Mode automatically in the case that the operation condition is severe.

Sound level of PUHY-P400YGM-A(-BS)

Ref. : P400YGM-WYNB0-3620



		63Hz	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz	dB(A)
Standard	50Hz	67.5	68.5	60.5	58.5	54.5	50.5	48.5	43	61
	60Hz	67.5	68.5	60.5	58.5	54.5	50.5	48.5	43	61
Night mode	50/60Hz	64.5	57.5	54.5	49	48	41.5	39	41	53

* When Night Mode is set, the A/C system's capacity is limited. The system could return to normal operation from Night Mode automatically in the case that the operation condition is severe.

Appendix B

Background noise measurements obtained at 30 Oval Road, London, NW1

File	Date	Start	Filter	Detect	Time	units	Peak	Min	Max	Spl	Leq	L90
@OR026	18/09/2008	21:27'18	A	Fast	00:15'00	dB	88	46	75	47	57	49
@OR027	18/09/2008	21:42'18	A	Fast	00:15'00	dB	86	46	73	52	57	50
@OR028	18/09/2008	21:57'18	A	Fast	00:15'00	dB	85	47	75	53	58	50
@OR029	18/09/2008	22:12'18	A	Fast	00:15'00	dB	84	45	72	53	56	48
@OR030	18/09/2008	22:27'18	A	Fast	00:15'00	dB	88	46	76	52	58	50
@OR031	18/09/2008	22:42'18	A	Fast	00:15'00	dB	85	45	71	58	56	48
@OR032	18/09/2008	22:57'18	A	Fast	00:15'00	dB	83	43	70	53	55	46
@OR033	18/09/2008	23:12'18	A	Fast	00:15'00	dB	84	47	70	63	55	49
@OR034	18/09/2008	23:27'18	A	Fast	00:15'00	dB	90	42	66	50	54	45
@OR035	18/09/2008	23:42'18	A	Fast	00:15'00	dB	93	43	73	52	55	46
@OR036	18/09/2008	23:57'18	A	Fast	00:15'00	dB	91	44	73	59	54	46
@OR037	19/09/2008	00:12'18	A	Fast	00:15'00	dB	85	42	71	50	52	44
@OR038	19/09/2008	00:27'18	A	Fast	00:15'00	dB	78	44	66	55	52	47
@OR039	19/09/2008	00:42'18	A	Fast	00:15'00	dB	75	42	63	45	51	44
@OR040	19/09/2008	00:57'18	A	Fast	00:15'00	dB	76	42	63	58	51	44
@OR041	19/09/2008	01:12'18	A	Fast	00:15'00	dB	78	44	67	46	51	46
@OR042	19/09/2008	01:27'18	A	Fast	00:15'00	dB	81	42	67	50	52	44
@OR043	19/09/2008	01:42'18	A	Fast	00:15'00	dB	80	42	68	48	53	45
@OR044	19/09/2008	01:57'18	A	Fast	00:15'00	dB	76	44	65	58	51	46
@OR045	19/09/2008	02:12'18	A	Fast	00:15'00	dB	82	42	70	51	52	44
@OR046	19/09/2008	02:27'18	A	Fast	00:15'00	dB	74	43	62	54	50	46
@OR047	19/09/2008	02:42'18	A	Fast	00:15'00	dB	79	43	67	44	51	45
@OR048	19/09/2008	02:57'18	A	Fast	00:15'00	dB	81	43	68	49	51	44
@OR049	19/09/2008	03:12'18	A	Fast	00:15'00	dB	79	45	68	49	51	47
@OR050	19/09/2008	03:27'18	A	Fast	00:15'00	dB	78	43	66	46	51	45
@OR051	19/09/2008	03:42'18	A	Fast	00:15'00	dB	81	43	68	49	52	45
@OR052	19/09/2008	03:57'18	A	Fast	00:15'00	dB	81	45	69	53	53	47
@OR053	19/09/2008	04:12'18	A	Fast	00:15'00	dB	78	44	67	52	52	46
@OR054	19/09/2008	04:27'18	A	Fast	00:15'00	dB	82	45	70	49	54	48
@OR055	19/09/2008	04:42'18	A	Fast	00:15'00	dB	85	46	73	60	54	47
@OR056	19/09/2008	04:57'18	A	Fast	00:15'00	dB	84	46	72	54	56	48
@OR057	19/09/2008	05:12'18	A	Fast	00:15'00	dB	86	48	74	52	57	50
@OR058	19/09/2008	05:27'18	A	Fast	00:15'00	dB	85	48	74	59	57	50
@OR059	19/09/2008	05:42'18	A	Fast	00:15'00	dB	87	49	75	60	57	51

Appendix C

ACOUSTICS PLUS

CONTRACT TITLE: 30 Oval Road, London, NW1 7DE
SOUND SOURCE: Ductwork attenuation
MAKE & TYPE: Ductwork A

					OCTAVE BAND CENTRE FREQUENCY (Hz)								
OVERALL Lw				63	125	250	500	1k	2k	4k	8k	dBA	
1													
2			UNIT Lw	61	61	61	61	61	61	61	61	**68**	
3													
4	STRAIGHT DUCT - Rectangular unlined												
5	LENGTH (m)		SIZE (mm)	0.82	0.66	0.33	0.16	0.16	0.16	0.16	0.16		
6	13.00		600x400	10.66	8.58	4.29	2.08	2.08	2.08	2.08	2.08		
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)			5	8	4	3	3	3		
13	4	90º	600x400	0.00	0.00	20.00	32.00	16.00	12.00	12.00	12.00		
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	600x400			9	5	2	0	0	0	0	0		
26													
27	**Lw LEAVING SYSTEM**			41	47	35	27	43	47	47	47	**53**	**reduction at 1kHz** **18**
28													

ACOUSTICS PLUS

CONTRACT TITLE: 30 Oval Road, London, NW1 7DE
SOUND SOURCE: Ductwork attenuation
MAKE & TYPE: Ductwork B

				OCTAVE BAND CENTRE FREQUENCY (Hz)									
	OVERALL Lw			63	125	250	500	1k	2k	4k	8k	dBA	
1													
2			UNIT Lw	61	61	61	61	61	61	61	61	**68**	
3													
4	STRAIGHT DUCT - Rectangular unlined												
5	LENGTH (m)		SIZE (mm)	0.49	0.66	0.49	0.33	0.23	0.23	0.23	0.23		
6	11.00		300x400	5.39	7.26	5.39	3.63	2.53	2.53	2.53	2.53		
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)			2	8	5	3	3	3		
13	3	90º	300x400	0.00	0.00	6.00	24.00	15.00	9.00	9.00	9.00		
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	300x400			11	7	3	1	0	0	0	0		
26													
27	**Lw LEAVING SYSTEM**			45	47	47	32	43	49	49	49	**55**	**reduction at 1kHz** **18**