Acoustic Consultancy Report

96152/3/1/3

External Plant Assessment

Report Prepared For

G.D.M. Pts.
High Holborn House
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Checked By

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Contents

i) Executive Summary

New mechanical plant is to be installed at High Holborn House, WC1V 6BX.

LCP has been commissioned by GDM Partnership to carry out an acoustic environment survey and to use the obtained data to assess the potential noise impact of the plant installation on surrounding noise sensitive receptors.

The design criterion is as follows:

Day:	46 dB $L_{Aeq,\,T}$ at 30m, Sandland Street;
Night:	43 dB $L_{Aeq,\,T}$ at 30m, Sandland Street;
Commercial:	55 dB $L_{Aeq,\,T}$ at 12m, Hand Court.

The design as proposed and assessed will achieve the required criteria provided the mitigation detailed in section 5 of this report is implemented; the calculated rating levels are as follows:

Day:	33 dB $L_{Aeq,\,T}$ at 30m, Sandland Street;
Night:	33 dB $L_{Aeq,\,T}$ at 30m, Sandland Street;
Commercial:	45 dB $L_{Aeq,\,T}$ at 12m, Hand Court.

This report concludes that the design criteria can be achieved.

ii) Document History

Issue	Date	Issue Details	Issued By	Checked By
1	27/08/19	Initial Issue	JT	RM

1 Introduction

New mechanical plant is to be installed at High Holborn House, WC1V 6BX

LCP has been commissioned by GDM Partnership to carry out an acoustic environment survey and to use the obtained data to assess the potential noise impact of the plant installation on surrounding noise sensitive receptors.

The report details recommendations for necessary noise mitigation where necessary.

The guidance contained in this report is given on the basis that the operational period of the plant may potentially be continuous between 05:00 and 23:00.

2 Survey

2.1 Site Description

The site layout together with the measurement position is shown in the drawing contained within Appendix A.

2.2 Receiver Location

The site was surveyed to determine the location of the most affected receiver.

The nearest residential receiver to the plant area is 30m to the north of the site. The nearest commercial is 12m to the west of the site. This is shown in the site plan in Appendix A.

2.3 Local Noise Climate

The predominant local noise sources were existing plant on both the roof and at ground level along Hand Court in addition to road traffic along High Holborn.

2.4 Measurements

The noise monitoring took place from the 20th to the 21st August 2019. The measurement period was considered sufficient to establish the lowest background sound levels corresponding to the operational period of the plant.

The weather conditions monitored during the survey are shown in the following table.

Table 1: Weather Conditions at Measurement Location

Weather	Value
Average Wind Speed	4m/s
Wind Direction	NE
Cloud Cover	30%
Max. Temperature	20°C
Min. Temperature	9°C
Precipitation	None

2.5 Measurement Results

The measured statistical broad-band sound pressure levels are shown within Appendix B. The lowest background sound level(s) obtained being as follows:

Table 2: lowest background sound levels, dB re $2x10^{-5}$ Pa

Measurement Position	$L_{A90,\ 15\ mins}$ Day*	$L_{A90,\ 15\ mins}$ Night*
MP1	46	43

* Day, Evening and Night periods are defined as between 07:00 - 23.00 and 23:00 - 07:00 respectively.

3 Evaluation of Design Criteria

3.1 Residential Design Criterion

3.1.1 BS4142:2014

BS4142:2014 states that the significance of sound of an industrial and/or commercial nature depends upon both the margin by which the rating level of the specific sound source exceeds the background sound level and the context in which the sound occurs.

Table 3: BS4142 assessment based upon rating level

Difference between background noise and rating levels	Assessment
+ 10 dB	Indication of a significant adverse impact
+ 5 dB	Indication of an adverse impact
0 dB	Indication of low impact

Certain acoustic features can increase the significance of impact. The specific sound level should be corrected if a tone, impulse or other acoustic feature is expected to be present.

Table 4: Corrections for acoustic features, subjective method

Acoustic Feature	Correction, dB		
	Just Perceptible	Clearly Perceptible	Highly Perceptible
Tonality	2	4	6
Impulsivity	3	6	9
Other Characteristics	3		
Intermittency	3		

Typically the acoustic feature correction would not be expected to exceed 10dB.

Where the level of uncertainty could affect the conclusion, take reasonably practicable steps to reduce the level of uncertainty.

3.1.2 World Health Organisation Night Noise Guidelines for Europe (2009)

The WHO's document 'Night Noise Guidelines for Europe (NNG) states the following:

"*…it is recommended that the population should not be exposed to night noise levels greater than 40 dB of* $L_{night,\ outside}$ *during the part of the night when most people are in bed*."

3.1.3 World Health Organisation (WHO) Guidelines for Community Noise (1999)

The WHO's 'Guidelines for Community Noise' gives the following relevant noise criteria:

Table 5: Guideline values for community noise, from Guidelines for Community Noise (WHO, 1999)

Specific Environment	$L_{Aeq,\ T}$ dB	Time Base (hours)	L_{Amax}, fast dB
Outdoor living area (serious annoyance, daytime and evening)	55	16	-
Outdoor living area (moderate annoyance, daytime and evening)	50	16	-
Dwelling, indoors	35	16	-
Inside bedrooms	30	8	45
Outside bedrooms	45	8	60
Outdoors in parkland and conservation areas*	-	-	-

* Existing quiet outdoor areas should be preserved and the ratio of intruding noise to natural background sound should be kept low

The WHO's 'Guidelines for Community Noise' also gives the following general guidance on the expected sound insulation performance of a façade with a partly open window, it states that:

"*At night, sound pressure levels at the outside facades of the living spaces should not exceed 45 dB* L_{Aeq} *and 60 dB* L_{Amax}*, so that people may sleep with bedroom windows open. These values have been obtained by assuming that the noise reduction from outside to inside with the window partly open is 15 dB.*"

3.1.4 BS8233:2014

The criteria offered in BS8233 for residential buildings are largely based on the recommendations made in the Guidelines for Community Noise.

Using the general guidance from above, on the expected sound insulation performance of a façade with a partly open window, the criteria shown in the table below have been adapted from the criteria offered in table 4 of BS8233 in order to obtain acceptable external noise levels.

The noise levels shown should be treated as overall noise levels, i.e., the combination of all existing noise levels at the site, and noise levels from any proposed plant or activity.

Table 6: External ambient noise levels for dwellings, based on BS8233, dB re $2x10^{-5}$ Pa

Activity	Location	Time period	
		07:00 to 23:00	23:00 to 07:00
Resting	Living Room	50 $L_{Aeq,16\ hour}$	-
Dining	Dining Room/area	55 $L_{Aeq,\ 16\ hour}$	-
Sleeping (daytime resting)	Bedroom	50 $L_{Aeq,\ 16\ hour}$	45 $L_{Aeq,\ 8\ hour}$

In addition to the above criteria, BS8233 goes on to say:

"*For traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external noise level does not exceed 50* $L_{Aeq,\ T}$*, with an upper guideline value of 55 dB* $L_{Aeq,\ T}$ *which would be acceptable in nosier environments*."

The above criteria are in line with the recommendations made in WHO's 'Guidelines for Community Noise'.

3.1.5 Local Authority Requirements

The London Borough of Camden conditions state that the noise level from any fixed mechanical plant/activity shall not exceed 5 dB below the lowest measured background noise level at 1m externally to the nearest noise sensitive facade.

Where mechanical plant is tonal or intermittent, the design criterion must be reduced by a further 5 dB.

A noise sensitive development includes housing, schools, hospitals, offices, workshops and open spaces.

3.1.6 Recommended Residential Design Rating Level

On the basis of the above the recommended residential design rating level should therefore be:

Residential Design Rating Level
Lowest $L_{A90,\ 15\ mins}$ - 10 dB

3.2 Commercial Design Criterion (BS8233:2014)

External design criteria for non-residential buildings have been derived from BS8233:2014.

Using the general guidance from WHO, on the expected sound insulation performance of a façade with a partly open window, the criteria shown in the table below have been adapted from the criteria offered in tables 2 and 6 of BS8233 in order to obtain acceptable external noise levels.

The noise levels shown should be treated as overall noise levels, i.e., the combination of all existing noise levels at the site, and noise levels from any proposed plant or activity.

Table 7: External ambient noise levels for non-domestic buildings, based on BS8233, dB re $2x10^{-5}$ Pa

Activity	Location	Design Level $L_{Aeq, 16\ hr}$
Speech or telephone communications	Department store, cafeteria, canteen, kitchen	70
	Concourse, corridor, circulation space	70
Study and work requiring concentration	Library, gallery, museum	65
	Staff/meeting room, training room	60
	Executive office	55
	Open plan office	65
Listening	Place of worship, counselling, meditation, relaxation	50

3.2.1 Recommended Commercial Design Rating Level

On the basis of the above the recommended commercial design rating level should therefore be:

Commercial Design Rating level
$L_{Aeq,\ T}$ 55 dB

3.3 Design Rating Levels

The design levels to be adopted for this project are set out in the table below.

Table 8: Design rating levels, dB re $2x10^{-5}$ Pa

Receiver Premises	Approximate Distance (m)	Design Level (Day) $L_{Aeq, 12\ hr}$	Design Level (Night) $L_{Aeq, 8\ hr}$
Nearest Residential-Sandland Street	30	36	33
Nearest Commercial-Hand Court	12	55	-

4 Review of Current Design

4.1 Current Design

The proposed plant shall be located in a light well on the western façade of the building at basement level. The proposed mechanical plant consists of 1 x Mitsubishi PURY-P1100YSNW-A and 1x Systemair AHU (Unit no. 20).

The operational period of the plant may potentially be continuous between 05:00 and 23:00.

4.2 Calculated Results

Calculations of the predicted noise levels have been carried out with the appropriate corrections for geometric attenuation, barrier effect, reflective surfaces and multiple source addition.

The design rating levels to be adopted for this project, together with the predicted noise levels, are set out in the table below.

Table 9: Design and predicted rating levels, dB re $2x10^{-5}$ Pa

Receiver Premises	Approximate Distance (m)	Design Level (Day) $L_{Aeq,\ 16\ hr}$	Design Level (Night) $L_{Aeq,\ 8\ hr}$	Predicted Level $L_{Aeq,T}$
Nearest Residential- Sandland Street	30	36	33	38
Nearest Commercial- Hand Court	12	55	-	52

Plant noise level data used in this assessment are contained within Appendix C.

Calculations are shown within Appendix D.

5 Noise Mitigation

As the plant installation has been assessed to be over the required criteria at the surrounding noise sensitive receptors, the following option shall be applied in order that noise emissions are reduced to acceptable levels.

Should the plant installation be redesigned after consideration of the mitigation option, the installation shall be re-assessed to ensure compliance to the specification has been achieved.

5.1 Noise Mitigation Scheme

The suggested mitigation measure is the introduction of attenuators which are to be installed on the inlet and exhaust of the AHU. Typical performance of the attenuators required is shown I the table below:

Table 10: typical atmosphere side attenuator performance, dB

	Octave Band Centre Frequency (Hz)							
	63	125	250	500	1k	2k	4k	8k
AHU Exhaust Air*	3	7	11	21	22	14	9	5

AHU Outdoor Air *	3	7	11	21	22	14	9	5

*data taken from Caice

The manufacturer/supplier of any attenuators shall ensure that the air volumes through all attenuators and the configurations of the attenuators will not create regenerated noise. Alternative configurations may have to be selected.

It is recommended that all attenuator performances are verified by test data in accordance with ISO 7235.

It is important to note that as the criteria is a single figure dB(A) value, the performance of any enclosure, screen or attenuator at each individual frequency can vary from those shown above and still meet the single figure dB(A) value.

5.2 Mitigated Results

The design rating levels to be adopted for this project, together with the predicted noise levels inclusive of the mitigation detailed in Section 5, are set out in the table below.

Table 11: Design and predicted mitigated rating levels, dB re $2x10^{-5}$ Pa

Receiver Premises	**Approximate Distance (m)**	**Design Level (Day)** $L_{Aeq,\ 16\ hr}$	**Design Level (Night)** $L_{Aeq,\ 8\ hr}$	**Predicted Level** $L_{Aeq,T}$
Nearest Residential- Sandland Street	30	36	33	33
Nearest Commercial- Hand Court	12	55	-	45

Plant noise level data used in this assessment are contained within Appendix C.

Calculations are shown within Appendix D.

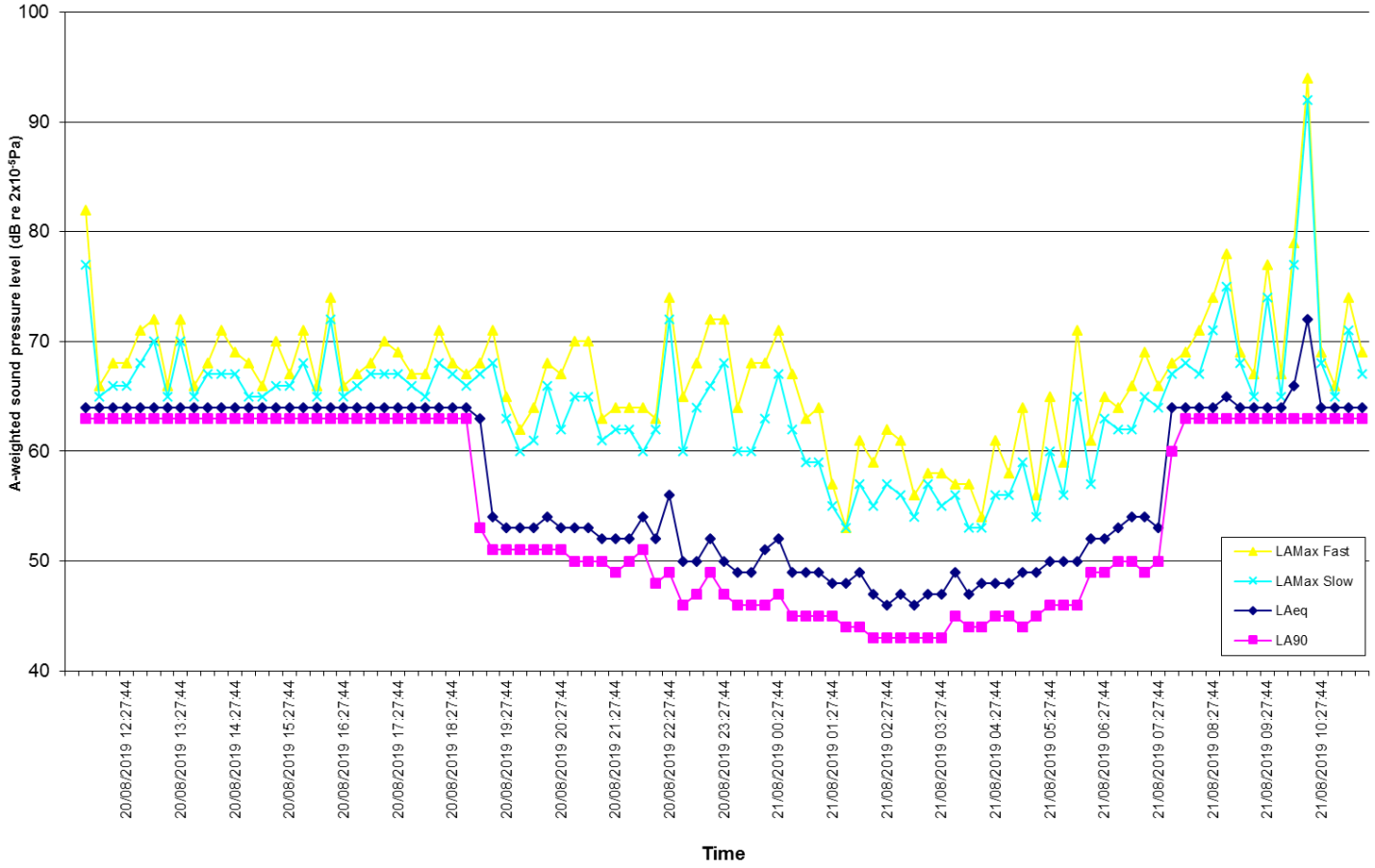
6 Conclusion

An environmental noise survey has been undertaken in order to establish the representative background sound levels local to the site generally in accordance with the method contained within BS4142: 2014.

Calculations have been carried out to determine the noise levels at the nearest receiver premises. The calculations show that with the implementation the noise mitigation measures detailed in section 5 of this report the design criteria will be met.

Appendix A: Site Plan

Appendix B: Measurement Data



Sound pressure level measurements were obtained using the following instrumentation complying with the Class 1 specification of BS EN 61672:2003

- Svantek 959 Sound Level Meter S/N: 11205
- Svantek pre-amplifier SV12L S/N: 13245 with GRAS microphone capsule 40AE S/N: 75181

Calibration checks were made prior to and after completion of measurements using a Svantek SV30A calibrator, S/N: 10893 complying with Class 1 specification of BS EN 60942:2003, calibration level 114.0 dB @ 1.0 kHz. All acoustic instrumentation carried current manufacturer's certificates of conformance.

Appendix C: Plant Data

Plant noise data used in the preceding assessment follow.

Table 12: Manufacturer's plant sound power data, dB re 10^{-12} W

Plant	Octave Band Centre Frequency (Hz)								L_{WA}
	63	125	250	500	1k	2k	4k	8k	
AHU Outdoor	65	65	73	67	62	52	47	44	69
AHU Exhaust	73	74	82	82	83	73	71	69	85
AHU Breakout	66	62	60	58	60	48	44	32	62

Table 13: Manufacturer's plant sound pressure data, dB re $2x10^{-5}$ Pa

Plant	Distance (m)	Octave Band Centre Frequency (Hz)								L_{PA}
		63	125	250	500	1k	2k	4k	8k	
PURY-P1100YSNW-A	1m	82	72	72	68	62	59	55	51	69

Appendix D: Calculations

Nearest Residential Receiver: No Mitigation

Ref.	plant	Ref.dist.	Sound Level (Lp/Lw) 63	125	250	500	1k	2k	4k	8k	dB(A)	Lw dB(A)	Reciever Distance (m)	dB(A)	Lp	No. off	dB	Angular Directionality	63	125	250	500	1k	2k	4k	8k	Reflections	dB	Façade correction	dB	Duct Losses (input negative values) 63	125	250	500	1k	2k	4k	8k	Additional Attenuation 63	125	250	500	1k	2k	4k	8k
1	PURY-P1100YSNW-A	1.00	82	72	72	68	62	59	55	51	69	77	30.0	-38	40	1	0	None	0	0	0	0	0	0	0	0	2	6	Yes	3																
2	AHU Outdoor		65	65	73	67	62	52	47	44	69	69	30.0	-38	31	1	0	None	0	0	0	0	0	0	0	0	2	6	Yes	3	-6	-2	0	0	0	0	0	0								
3	AHU Exhaust		73	74	82	82	83	73	71	69	85	85	30.0	-38	48	1	0	None	0	0	0	0	0	0	0	0	2	6	Yes	3	-6	-2	0	0	0	0	0	0								
4	AHU Breakout		66	62	60	58	60	48	44	32	62	62	30.0	-38	25	1	0	None	0	0	0	0	0	0	0	0	2	6	Yes	3																

Ref.	plant	Receiver Lp 63	125	250	500	1k	2k	4k	8k	dB(A)
1	PURY-P1100YSNW-A	61	51	51	47	41	38	34	30	49
2	AHU Outdoor	36	36	44	38	33	23	18	15	40
3	AHU Exhaust	44	45	53	53	54	44	42	40	57
4	AHU Breakout	37	33	31	29	31	19	15	3	34
	Total	**63**	**53**	**57**	**55**	**56**	**46**	**44**	**42**	**59**

Barrier Path Difference Loss: Source height	Receiver height	Barrier height	Source to barrier distance	Barrier to receiver distance	Calculated path difference	63	125	250	500	1000	2000	4000	8000
1.0	11.0	6.0	5.0	25.0	0.94	-10	-12	-15	-18	-21	-24	-24	-24
1.0	11.0	6.0	3.0	27.0	1.67	-12	-14	-17	-20	-23	-24	-24	-24
1.0	11.0	6.0	3.0	27.0	1.67	-12	-14	-17	-20	-23	-24	-24	-24
1.0	11.0	6.0	3.0	27.0	1.67	-12	-14	-17	-20	-23	-24	-24	-24

Criteria NR	63	125	250	500	1k	2k	4k	8k	dB(A)
23	54	42	33	27	23	20	17	16	33

Barrier SRI		63	125	250	500	1k	2k	4k	8k	Rw
	Manual									0
	Unknown	100	100	100	100	100	100	100	100	101

Ref.	Plant	Excess 63	125	250	500	1k	2k	4k	8k	dB(A)
1	PURY-P1100YSNW-A	8	9	18	20	18	19	16	14	16
2	AHU Outdoor	-17	-6	11	11	10	4	1	0	7
3	AHU Exhaust	-9	3	20	26	31	25	25	25	24
4	AHU Breakout	-16	-9	-2	2	8	0	-2	-12	1
	Total	9	11	23	28	33	27	27	26	26

Barrier Deration		63	125	250	500	1k	2k	4k	8k
	PURY-P1100YSNW	0	0	0	0	0	0	0	0
	AHU Outdoor	0	0	0	0	0	0	0	0
	AHU Exhaust	0	0	0	0	0	0	0	0
	AHU Breakout	0	0	0	0	0	0	0	0

Ref.	Plant	Mitigated Receiver Lp 63	125	250	500	1k	2k	4k	8k	dB(A)
1	PURY-P1100YSNW-A	51	39	36	29	20	15	10	6	32
2	AHU Outdoor	19	20	27	18	10	-1	-6	-9	21
3	AHU Exhaust	27	29	36	33	31	20	18	16	35
4	AHU Breakout	26	19	14	9	8	-5	-9	-21	13
	Total	**52**	**40**	**40**	**36**	**33**	**23**	**20**	**18**	**38**

Net barrier loss		63	125	250	500	1k	2k	4k	8k
	PURY-P1100YSNW	-10	-12	-15	-18	-21	-24	-24	-24
	AHU Outdoor	-12	-14	-17	-20	-23	-24	-24	-24
	AHU Exhaust	-12	-14	-17	-20	-23	-24	-24	-24
	AHU Breakout	-12	-14	-17	-20	-23	-24	-24	-24

Nearest Commercial Receiver: No Mitigation

Ref.	plant	Ref.dist.	Sound Level (Lp/Lw) 63	125	250	500	1k	2k	4k	8k	dB(A)	Lw dB(A)	Reciever Distance (m)	dB(A)	Lp	No. off	dB	Angular Directionality	63	125	250	500	1k	2k	4k	8k	Reflections	dB	Façade correction	dB	Duct Losses (input negative values) 63	125	250	500	1k	2k	4k	8k	Additional Attenuation 63	125	250	500	1k	2k	4k	8k
1	PURY-P1100YSNW-A	1.00	82	72	72	68	62	59	55	51	69	77	12.0	-30	48	1	0	None	0	0	0	0	0	0	0	0	2	6	Yes	3																
2	AHU Outdoor		65	65	73	67	62	52	47	44	69	69	12.0	-30	39	1	0	None	0	0	0	0	0	0	0	0	2	6	Yes	3	-6	-2	0	0	0	0	0	0								
3	AHU Exhaust		73	74	82	82	83	73	71	69	85	85	12.0	-30	56	1	0	None	0	0	0	0	0	0	0	0	2	6	Yes	3	-6	-2	0	0	0	0	0	0								
4	AHU Breakout		66	62	60	58	60	48	44	32	62	62	12.0	-30	32	1	0	None	0	0	0	0	0	0	0	0	2	6	Yes	3																

Ref.	plant	Receiver Lp 63	125	250	500	1k	2k	4k	8k	dB(A)
1	PURY-P1100YSNW-A	69	59	59	55	49	46	42	38	57
2	AHU Outdoor	44	44	52	46	41	31	26	23	48
3	AHU Exhaust	52	53	61	61	62	52	50	48	65
4	AHU Breakout	45	41	39	37	39	27	23	11	41
	Total	**71**	**61**	**65**	**63**	**64**	**54**	**52**	**50**	**67**

Barrier Path Difference Loss: Source height	Receiver height	Barrier height	Source to barrier distance	Barrier to receiver distance	Calculated path difference	63	125	250	500	1000	2000	4000	8000
1.0	9.0	3.0	1.0	11.0	0.34	-7	-9	-11	-14	-16	-19	-22	-24
1.0	9.0	3.0	1.0	11.0	0.34	-7	-9	-11	-14	-16	-19	-22	-24
1.0	9.0	3.0	1.0	11.0	0.34	-7	-9	-11	-14	-16	-19	-22	-24
1.0	9.0	3.0	1.0	11.0	0.34	-7	-9	-11	-14	-16	-19	-22	-24

Criteria NR	63	125	250	500	1k	2k	4k	8k	dB(A)
47	73	63	56	51	47	44	42	40	55

Barrier SRI		63	125	250	500	1k	2k	4k	8k	Rw
	Manual									0
	Unknown	100	100	100	100	100	100	100	100	101

Ref.	Plant	Excess 63	125	250	500	1k	2k	4k	8k	dB(A)
1	PURY-P1100YSNW-A	-3	-4	3	4	2	2	0	-2	2
2	AHU Outdoor	-28	-18	-3	-4	-6	-13	-16	-17	-7
3	AHU Exhaust	-20	-9	6	11	15	8	8	8	10
4	AHU Breakout	-27	-21	-16	-13	-8	-17	-19	-29	-13
	Total	-2	-2	9	13	17	10	10	9	12

Barrier Deration		63	125	250	500	1k	2k	4k	8k
	PURY-P1100YSNW	0	0	0	0	0	0	0	0
	AHU Outdoor	0	0	0	0	0	0	0	0
	AHU Exhaust	0	0	0	0	0	0	0	0
	AHU Breakout	0	0	0	0	0	0	0	0

Ref.	Plant	Mitigated Receiver Lp 63	125	250	500	1k	2k	4k	8k	dB(A)
1	PURY-P1100YSNW-A	62	50	48	41	33	27	20	14	44
2	AHU Outdoor	31	33	41	33	25	12	4	-1	35
3	AHU Exhaust	39	42	50	48	46	33	28	24	49
4	AHU Breakout	38	32	28	24	23	8	1	-13	27
	Total	**63**	**52**	**54**	**50**	**47**	**35**	**30**	**26**	**52**

Net barrier loss		63	125	250	500	1k	2k	4k	8k
	PURY-P1100YSNW	-7	-9	-11	-14	-16	-19	-22	-24
	AHU Outdoor	-7	-9	-11	-14	-16	-19	-22	-24
	AHU Exhaust	-7	-9	-11	-14	-16	-19	-22	-24
	AHU Breakout	-7	-9	-11	-14	-16	-19	-22	-24

Nearest Residential Receiver: With Mitigation

Ref.	plant	Ref.dist.	Sound Level (Lp/Lw) 63	125	250	500	1k	2k	4k	8k	dB(A)	Lw dB(A)
1	PURY-P1100YSNW-A	1.00	82	72	72	68	62	59	55	51	69	77
2	AHU Outdoor		65	65	73	67	62	52	47	44	69	69
3	AHU Exhaust		73	74	82	82	83	73	71	69	85	85
4	AHU Breakout		66	62	60	58	60	48	44	32	62	62

Reciever Distance (m)	dB(A)	Lp	No. off	dB	Angular Directionality	63	125	250	500	1k	2k	4k	8k
30.0	-38	40	1	0	None	0	0	0	0	0	0	0	0
30.0	-38	31	1	0	None	0	0	0	0	0	0	0	0
30.0	-38	48	1	0	None	0	0	0	0	0	0	0	0
30.0	-38	25	1	0	None	0	0	0	0	0	0	0	0

Reflections	dB	Façade correction	dB
2	6	Yes	3
2	6	Yes	3
2	6	Yes	3
2	6	Yes	3

Duct Losses (input negative values) 63	125	250	500	1k	2k	4k	8k
-6	-2	0	0	0	0	0	0
-6	-2	0	0	0	0	0	0

Additional Attenuation 63	125	250	500	1k	2k	4k	8k
3	7	11	21	22	14	9	5
3	7	11	21	22	14	9	5

Ref.	plant	Receiver Lp 63	125	250	500	1k	2k	4k	8k	dB(A)
1	PURY-P1100YSNW-A	61	51	51	47	41	38	34	30	49
2	AHU Outdoor	36	36	44	38	33	23	18	15	40
3	AHU Exhaust	44	45	53	53	54	44	42	40	57
4	AHU Breakout	37	33	31	29	31	19	15	3	34
	Total	**63**	**53**	**57**	**55**	**56**	**46**	**44**	**42**	**59**

Barrier Path Difference Loss: Source height	Receiver height	Barrier height	Source to barrier distance	Barrier to receiver distance	Calculated path difference	63	125	250	500	1000	2000	4000	8000
1.0	11.0	6.0	5.0	25.0	0.94	-10	-12	-15	-18	-21	-24	-24	-24
1.0	11.0	6.0	3.0	27.0	1.67	-12	-14	-17	-20	-23	-24	-24	-24
1.0	11.0	6.0	3.0	27.0	1.67	-12	-14	-17	-20	-23	-24	-24	-24
1.0	11.0	6.0	3.0	27.0	1.67	-12	-14	-17	-20	-23	-24	-24	-24

Criteria NR	63	125	250	500	1k	2k	4k	8k	dB(A)
23	54	42	33	27	23	20	17	16	33

Barrier SRI		63	125	250	500	1k	2k	4k	8k	Rw
	Manual									0
	Unknown	100	100	100	100	100	100	100	100	101

Ref.	Plant	Excess 63	125	250	500	1k	2k	4k	8k	dB(A)
1	PURY-P1100YSNW-A	8	9	18	20	18	19	16	14	16
2	AHU Outdoor	-17	-6	11	11	10	4	1	0	7
3	AHU Exhaust	-9	3	20	26	31	25	25	25	24
4	AHU Breakout	-16	-9	-2	2	8	0	-2	-12	1
	Total	9	11	23	28	33	27	27	26	26

Barrier Deration		63	125	250	500	1k	2k	4k	8k
	PURY-P1100YSNW	0	0	0	0	0	0	0	0
	AHU Outdoor	0	0	0	0	0	0	0	0
	AHU Exhaust	0	0	0	0	0	0	0	0
	AHU Breakout	0	0	0	0	0	0	0	0

Ref.	Plant	Mitigated Receiver Lp 63	125	250	500	1k	2k	4k	8k	dB(A)
1	PURY-P1100YSNW-A	51	39	36	29	20	15	10	6	32
2	AHU Outdoor	16	13	16	-3	-12	-15	-15	-14	8
3	AHU Exhaust	24	22	25	12	9	6	9	11	20
4	AHU Breakout	26	19	14	9	8	-5	-9	-21	13
	Total	**52**	**40**	**37**	**30**	**22**	**17**	**14**	**14**	**33**

Net barrier loss		63	125	250	500	1k	2k	4k	8k
	PURY-P1100YSNW	**-10**	**-12**	**-15**	**-18**	**-21**	**-24**	**-24**	**-24**
	AHU Outdoor	**-12**	**-14**	**-17**	**-20**	**-23**	**-24**	**-24**	**-24**
	AHU Exhaust	**-12**	**-14**	**-17**	**-20**	**-23**	**-24**	**-24**	**-24**
	AHU Breakout	**-12**	**-14**	**-17**	**-20**	**-23**	**-24**	**-24**	**-24**

Nearest Commercial Receiver: With Mitigation

Ref.	plant	Ref.dist.	Sound Level (Lp/Lw) 63	125	250	500	1k	2k	4k	8k	dB(A)	Lw dB(A)
1	PURY-P1100YSNW-A	1.00	82	72	72	68	62	59	55	51	69	77
2	AHU Outdoor		65	65	73	67	62	52	47	44	69	69
3	AHU Exhaust		73	74	82	82	83	73	71	69	85	85
4	AHU Breakout		66	62	60	58	60	48	44	32	62	62

Reciever Distance (m)	dB(A)	Lp	No. off	dB	Angular Directionality	63	125	250	500	1k	2k	4k	8k
12.0	-30	48	1	0	None	0	0	0	0	0	0	0	0
12.0	-30	39	1	0	None	0	0	0	0	0	0	0	0
12.0	-30	56	1	0	None	0	0	0	0	0	0	0	0
12.0	-30	32	1	0	None	0	0	0	0	0	0	0	0

Reflections	dB	Façade correction	dB
2	6	Yes	3
2	6	Yes	3
2	6	Yes	3
2	6	Yes	3

Duct Losses (input negative values) 63	125	250	500	1k	2k	4k	8k
-6	-2	0	0	0	0	0	0
-6	-2	0	0	0	0	0	0

Additional Attenuation 63	125	250	500	1k	2k	4k	8k
3	7	11	21	22	14	9	5
3	7	11	21	22	14	9	5

Ref.	plant	Receiver Lp 63	125	250	500	1k	2k	4k	8k	dB(A)
1	PURY-P1100YSNW-A	69	59	59	55	49	46	42	38	57
2	AHU Outdoor	44	44	52	46	41	31	26	23	48
3	AHU Exhaust	52	53	61	61	62	52	50	48	65
4	AHU Breakout	45	41	39	37	39	27	23	11	41
	Total	**71**	**61**	**65**	**63**	**64**	**54**	**52**	**50**	**67**

Barrier Path Difference Loss: Source height	Receiver height	Barrier height	Source to barrier distance	Barrier to receiver distance	Calculated path difference	63	125	250	500	1000	2000	4000	8000
1.0	9.0	3.0	1.0	11.0	0.34	-7	-9	-11	-14	-16	-19	-22	-24
1.0	9.0	3.0	1.0	11.0	0.34	-7	-9	-11	-14	-16	-19	-22	-24
1.0	9.0	3.0	1.0	11.0	0.34	-7	-9	-11	-14	-16	-19	-22	-24
1.0	9.0	3.0	1.0	11.0	0.34	-7	-9	-11	-14	-16	-19	-22	-24

Criteria NR	63	125	250	500	1k	2k	4k	8k	dB(A)
47	73	63	56	51	47	44	42	40	55

Barrier SRI		63	125	250	500	1k	2k	4k	8k	Rw
	Manual									0
	Unknown	100	100	100	100	100	100	100	100	101

Ref.	Plant	Excess 63	125	250	500	1k	2k	4k	8k	dB(A)
1	PURY-P1100YSNW-A	-3	-4	3	4	2	2	0	-2	2
2	AHU Outdoor	-28	-18	-3	-4	-6	-13	-16	-17	-7
3	AHU Exhaust	-20	-9	6	11	15	8	8	8	10
4	AHU Breakout	-27	-21	-16	-13	-8	-17	-19	-29	-13
	Total	-2	-2	9	13	17	10	10	9	12

Barrier Deration		63	125	250	500	1k	2k	4k	8k
	PURY-P1100YSNW	0	0	0	0	0	0	0	0
	AHU Outdoor	0	0	0	0	0	0	0	0
	AHU Exhaust	0	0	0	0	0	0	0	0
	AHU Breakout	0	0	0	0	0	0	0	0

Ref.	Plant	Mitigated Receiver Lp 63	125	250	500	1k	2k	4k	8k	dB(A)
1	PURY-P1100YSNW-A	62	50	48	41	33	27	20	14	44
2	AHU Outdoor	28	26	30	12	3	-2	-5	-6	22
3	AHU Exhaust	36	35	39	27	24	19	19	19	33
4	AHU Breakout	38	32	28	24	23	8	1	-13	27
	Total	**63**	**51**	**49**	**42**	**35**	**29**	**24**	**22**	**45**

Net barrier loss		63	125	250	500	1k	2k	4k	8k
	PURY-P1100YSNW	**-7**	**-9**	**-11**	**-14**	**-16**	**-19**	**-22**	**-24**
	AHU Outdoor	**-7**	**-9**	**-11**	**-14**	**-16**	**-19**	**-22**	**-24**
	AHU Exhaust	**-7**	**-9**	**-11**	**-14**	**-16**	**-19**	**-22**	**-24**
	AHU Breakout	**-7**	**-9**	**-11**	**-14**	**-16**	**-19**	**-22**	**-24**

Appendix E: Glossary

The list below details the major acoustical terms and descriptors, with brief definitions:

'A' Weighting
Weighting applied to the level in each stated octave band by a specified amount, in order to better represent the response of the human ear. The letter 'A' will follow a descriptor, indicating the value has been 'A' weighted. An 'A' weighted noise level may also be written as dB(A).
Airborne Noise
Noise transmitted through air.
Ambient Noise
The total noise level including all 'normally experienced' noise sources.
dB or Decibel
Literally meaning 'a tenth of a bel', the bel being a unit devised by the Bell Laboratory and named after Alexander Graham Bell. A logarithmically based descriptor to compare a level to a reference level. Decibel arithmetic is not linear, due to the logarithmic base. For example:

30 dB + 30 dB ≠ 60 dB	30 dB + 30 dB = 33 dB

$D_{nTw}+C_{tr}$
The weighted, normalised difference in airborne noise levels measured in a source room (L1) and a receive room (L2) due to a separating partition.

D	Is simply L1 – L2.
D_{nT}	Is the normalisation of the measured level difference to the expected (in comparison to the measured) reverberation time in the receiving room.
D_{nTw}	Is the weighted and normalised level difference. This value is the result of applying a known octave band weighting curve to the measured result.
C_{tr}	Is a correction factor applied to the D_{nTw} to account for the known effects of particular types of noise, such as loud stereo music or traffic noise.

Frequency (Hz)
Measured in Hertz (after Heinrich Hertz), and represents the number of cycles per second of a sound or tone.
Insertion Loss, dB

The amount of sound reduction offered by an attenuator or louvre once placed in the path of a noise level.

$L_{A90, T}$

The ‘A’ weighted noise level exceeded for 90% of the time period T, described or measured. The ‘90’ can be substituted for any value between 1 and 99 to indicate the noise level exceeded for the corresponding percentage of time described or measured.

$L_{Aeq, T}$

The ‘A’ weighted ‘equivalent’ noise level, or the average noise level over the time period T, described or measured.

L_{Amax}

The ‘A’ weighted maximum measured noise level. Can be measured with a ‘slow’ (1 sec) or ‘fast’ (0.125 sec) time weighting.

L_{Amin}

The ‘A’ weighted minimum measured noise level.

NR

Noise Rating (NR) level. A frequency dependent system of noise level curves developed by the International Organisation for Standardisation (ISO). NR is used to categorise and determine the acceptable indoor environment in terms of hearing preservation, speech communication and annoyance in any given application as a single figure level. The US predominantly uses the Noise Criterion (NC) system.

Octave

The interval between a frequency in Hz (f) and either half or double that frequency (0.5f or 2f).

Pa

Pascals, the SI unit to describe pressure, after physicist Blaise Pascal.

Reverberation Time, T_{mf}, RT60, RT30 or RT20

The time taken in seconds for a sound to diminish within a room by 1,000 times its original level, corresponding to a drop in sound pressure of 60 dB. When taking field measurements and where background noise levels are high, the units RT20 or RT30 are used (measuring drops of 20 or 30 dB respectively). Sometimes given as a mid-frequency reverberation time, T_{mf} which is the average of reverberation time values at 500Hz, 1kHz and 2kHz.

R_w

The sound reduction value(s) of a constructional element such as a door, as measured in a laboratory, with a known octave band weighting curve applied to the result.

Sound Power Level

A noise level obtained by calculation from measurement data, given at the face of an item of plant or machinery. Referenced to 10^{-12} W or 1pW.

Sound Pressure Level

A noise level measured or given at a distance from a source or a number of sources. Referenced to $2x10^{-5}$ Pa.

Subjective Effect of Changes in Sound Pressure Level

The table below details the subjective effects of variations in sound pressures (adapted from Bies and Hansen).

Difference between background noise and rating levels	Increase in ambient noise level in 'real terms'	Change in apparent loudness
+ 10 dB	+ 10 dB	Twice as loud
+ 5 dB	+ 6 dB	Clearly noticeable
0 dB	+ 3 dB	Just perceptible
-10 dB	0 dB	No change

W

Watts, the SI unit to describe power, after engineer James Watt.