Acoustic Consultancy Report

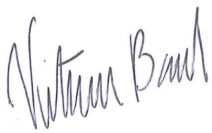
95819/3/1/5

External Plant Assessment

Report Prepared For

Hitek Consultants Ltd
Soas Uol Research Block
11 March 2020

Report Author



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Contents

i) Executive Summary 2
ii) Document History 2
1 Introduction 3
2 Survey 3
2.1 Site Description 3
2.2 Receiver Location 3
2.3 Local Noise Climate 3
2.4 Measurements 3
2.5 Measurement Results 4
3 Evaluation of Design Criteria 4
3.1 Residential Design Criterion 4
3.1.1 BS4142:2014 4
3.1.2 World Health Organisation Night Noise Guidelines for Europe (2009) 5
3.1.3 World Health Organisation (WHO) Guidelines for Community Noise (1999) 5
3.1.4 BS8233:2014 5
3.1.5 Local Authority Requirements 6
3.1.6 Recommended Residential Design Rating Level 6
3.2 Design Rating Levels 6
4 Review of Current Design 7
4.1 Current Design 7
4.2 Calculated Results 7
5 Noise Mitigation Option 7
5.1 Noise Mitigation Scheme 7
5.2 Mitigated Results 9
6 Conclusion 9
Appendix A: Site Plan 10
Appendix B: Measurement Data 11
Appendix C: Plant Location 12
Appendix D: Plant Data 13
Appendix E: Calculations 14
Appendix F: Glossary 15

i) Executive Summary

New mechanical plant is to be installed at SOAS University of London, in London.

LCP has been commissioned by Hitek Consultants Ltd 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:	50 dB $L_{Aeq,T}$ at 7m, nearest SOAS classroom window;
Day:	45 dB $L_{Aeq,T}$ at 119m, nearest residential window;
Evening:	48 dB $L_{Aeq,T}$ at 119m, nearest residential window;
Night:	48 dB $L_{Aeq,T}$ at 119m, nearest residential window.

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:	50 dB $L_{Aeq,T}$ at 7m, nearest SOAS classroom window;
Day:	33 dB $L_{Aeq,T}$ at 119m, nearest residential window;
Evening:	33 dB $L_{Aeq,T}$ at 119m, nearest residential window;
Night:	33 dB $L_{Aeq,T}$ at 119m, nearest residential window.

This report concludes that the design criteria can be achieved.

ii) Document History

Issue	Date	Issue Details	Issued By	Checked By
1	11th March 2020	Initial Issue	VB	MB

1 Introduction

New mechanical plant is to be installed at SOAS University of London, in London.

LCP has been commissioned by Hitek Consultants Ltd 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 in this report is on the basis that the mechanical plant will be consistently operating over a 24 hour period.

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 along Malet Street, approximately 119m to the south-west of the site. The plant area is surrounded by SOAS classrooms which are serviced by the mechanical plant. The nearest classroom window is approximately 7m to the west of the proposed plant area. This is shown in the site plan in Appendix A.

2.3 Local Noise Climate

The predominant local noise sources were existing mechanical plant in the vicinity and road traffic noise from local road networks.

2.4 Measurements

The noise monitoring took place on 12th February 2020 to the 13th February 2020. The measurement period was considered sufficient to establish the representative 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	1m/s
Wind Direction	East
Cloud Cover	50%
Max. Temperature	8°C
Min. Temperature	1°C
Precipitation	None

2.5 Measurement Results

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

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

Measurement Position	$L_{A90,\ 15\ mins}$ Day*	$L_{A90,\ 15\ mins}$ Evening*	$L_{A90,\ 15\ mins}$ Night*
MP1	55	58	58

* Day, Evening and Night periods are defined as between 07:00 - 19.00, 19.00 - 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)

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 published "*Camden Development Policies 2010 – 2025*", Section 3 of which provides the following table.

Table E: Noise levels from plant and machinery at which planning permission will not be granted

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	5dB(A) <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	10dB(A) <LA90
Noise that has distinct impulses (bangs, clicks, clatters, thumps) at 1 metre external to a sensitive façade.	Day, evening and night	0000-2400	10dB(A) <LA90
Noise at 1 metre external to sensitive façade where LA90>60dB	Day, evening and night	0000-2400	55dBL_{Aeq}

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
Representative $L_{A90,\ 15\ mins}$ - 10 dB

3.2 Design Rating Levels

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

Table 7: Design rating levels, dB re $2x10^{-5}$ Pa

Receiver Premises	**Approximate Distance (m)**	**Design Level (Day) $L_{Aeq,\ 12\ hr}$**	**Design Level (Evening) $L_{Aeq,\ 4\ hr}$**	**Design Level (Night) $L_{Aeq,\ 8\ hr}$**
Nearest residential window	119	45	48	48
1m from nearest classroom window	7	50	-	-

4 Review of Current Design

4.1 Current Design

The proposed plant shall comprise of one chiller and one air handling unit (AHU) to be located externally on the existing flat roof. The proposed location of the plant has been provided in Appendix D.

The guidance in this report is on the basis that the mechanical plant will be consistently operating over a 24 hour period.

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

Receiver Premises	Approximate Distance (m)	Design Level (Day) $L_{Aeq,\ 12\ hr}$	Design Level (Evening) $L_{Aeq,\ 4\ hr}$	Design Level (Night) $L_{Aeq,\ 8\ hr}$	Predicted Level $L_{Aeq,T}$
Nearest residential window	119	45	48	48	43
1m from nearest classroom window	7	50	-	-	62

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

5 Noise Mitigation Option

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 a suitable noise mitigation scheme by means of attenuators installed on the AHU fresh air in and discharge. The advised acoustic insertion loss have been provided in the table below.

Table 9: Advised attenuator insertion losses, dB

Plant	Location	Octave Band Centre Frequency (Hz)							
		63	125	250	500	1k	2k	4k	8k
AHU – Fresh air in	Primary	2	3	7	8	6	5	5	3

Plant	Location	Octave Band Centre Frequency (Hz)							
		63	125	250	500	1k	2k	4k	8k
AHU – Discharge	Primary	2	3	7	8	6	5	5	3
	Secondary	2	3	7	8	6	5	5	3

* data taken from Caice.

In addition, an open top screen should surround the chiller with a minimum height of 200mm above the unit. The advised acoustic performance of the acoustic screen is provided in the table below.

Table 10: Advised screen acoustic performance, dB

	Octave Band Centre Frequency (Hz)							
	63	125	250	500	1k	2k	4k	8k
Screen	6	11	17	23	26	20	28	28

* data based on 13mm plywood board.

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.

Should this option be implemented, the design of the mitigation will need the services of a noise control company specialising in bespoke solutions to non-standard situations.

Such a company would visit the site, and attempt to arrive at an economic solution, taking into account all the parameters of this particular situation.

The problems of air flow, pressure drop etc, applicable to this equipment will all need to be taken into account.

Such a company is:

Company	Address	Telephone	Email/Web
Caice	Riverside House 3 Winnersh Fields Winnersh Wokingham RG41 5QS	0118 918 6470	enquiries@caice.co.uk www.caice.co.uk

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)** $L_{Aeq,\ 12\ hr}$	**Design Level (Evening)** $L_{Aeq,\ 4\ hr}$	**Design Level (Night)** $L_{Aeq,\ 8\ hr}$	**Predicted Level** $L_{Aeq,T}$
Nearest residential window	119	45	48	48	33
1m from nearest classroom window	7	50	-	-	50

Calculations are shown within Appendix E.

6 Conclusion

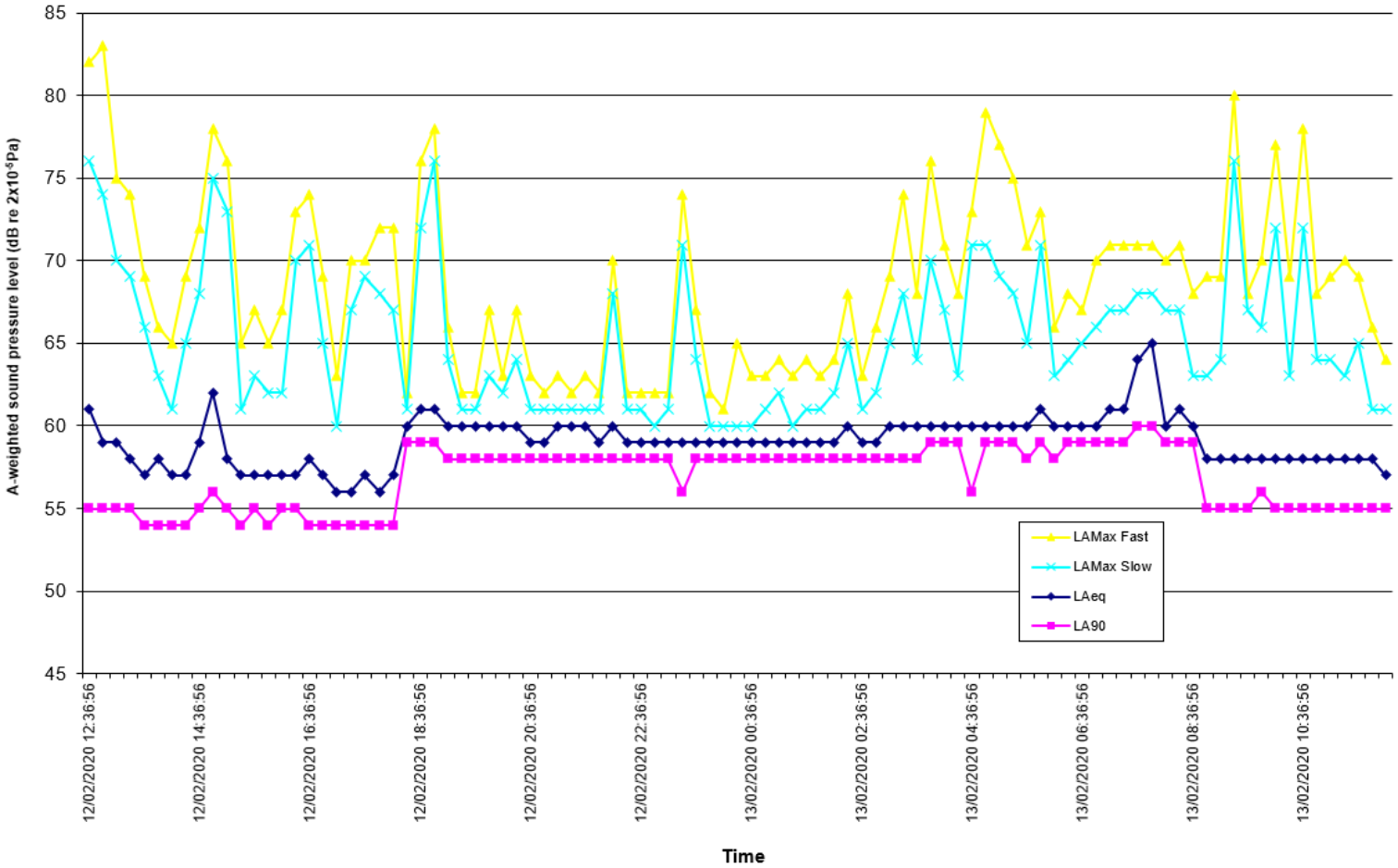
An environmental noise survey has been undertaken in order to establish the representative background sound levels local to the site generally in accordance with the method contained within BS4142: 2014.

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

Approximate measurement position (Latitude & Longitude) 51°31'19.97"N, 0° 7'45.01"W.

Appendix B: Measurement Data

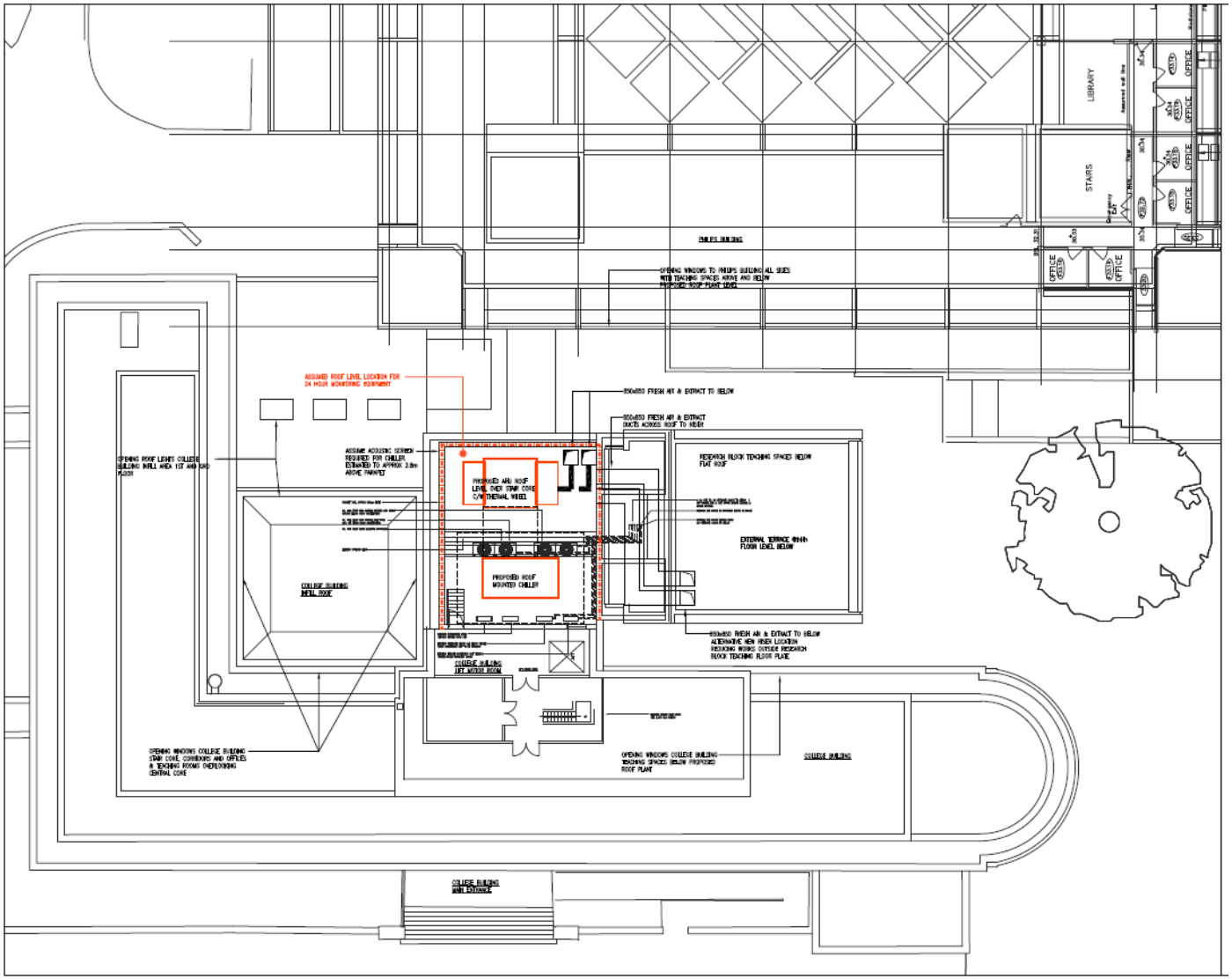


Sound pressure level measurements were obtained using the following instrumentation complying with the Class 1 specification of BS EN 61672:2003

- 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 SV33 calibrator, S/N: 43066 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 Location



Appendix D: 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	
Chiller	62	64	70	77	82	80	75	73	86
AHU - Breakout	75	74	61	59	58	56	51	36	64
AHU - Fresh air in	78	74	76	66	59	54	49	46	70
AHU - Discharge	82	81	81	83	82	81	78	74	87

Appendix E: Calculations

Nearest residential window:

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	Chiller		62	64	70	77	82	80	75	73	86	86	119.0	-50	36	1	0	None	0	0	0	0	0	0	0	0		0	Yes	3															
2	AHU - Breakout		75	74	61	59	58	56	51	36	64	64	119.0	-50	15	1	0	None	0	0	0	0	0	0	0	0		0	Yes	3															
3	AHU - Fresh air in		78	74	76	66	59	54	49	46	70	70	119.0	-50	20	1	0	None	0	0	0	0	0	0	0	0		0	Yes	3	-8	-3	-1	0	0	0	0	0	2	3	7	8	6	5	5	3
4	AHU - Discharge		82	81	81	83	82	81	78	74	87	87	119.0	-50	38	1	0	None	0	0	0	0	0	0	0	0		0	Yes	3	-8	-3	-1	0	0	0	0	0	4	6	14	16	12	10	10	6

Ref.	plant	Receiver Lp 63	125	250	500	1k	2k	4k	8k	dB(A)
1	Chiller	15	17	24	31	36	33	28	26	39
2	AHU - Breakout	28	27	14	12	11	9	4	-11	18
3	AHU - Fresh air in	31	27	29	19	12	7	2	-1	23
4	AHU - Discharge	35	34	34	36	35	34	31	27	41
	Total	**38**	**36**	**36**	**38**	**39**	**37**	**33**	**30**	**43**

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
4.8	1.5	5	0.5	118.5	0.04	-5	-6	-6	-7	-9	-11	-14	-17
5.5	1.5			119.0	-5.44	0	0	0	0	0	0	0	0
5.5	1.5			119.0	-5.44	0	0	0	0	0	0	0	0
5.5	1.5			119.0	-5.44	0	0	0	0	0	0	0	0

Criteria NR	63	125	250	500	1k	2k	4k	8k	dB(A)
36	64	53	45	40	36	33	31	29	45

Barrier SRI	63	125	250	500	1k	2k	4k	8k	Rw
Manual									0
Typical 13mm Plywood Board	6	11	17	23	26	20	28	28	24

Ref.	Plant	Excess 63	125	250	500	1k	2k	4k	8k	dB(A)
1	Chiller	-49	-36	-22	-9	0	0	-3	-3	-6
2	AHU - Breakout	-35	-26	-31	-27	-25	-24	-26	-40	-27
3	AHU - Fresh air in	-32	-26	-16	-20	-24	-26	-28	-30	-21
4	AHU - Discharge	-28	-19	-11	-3	-1	1	1	-2	-4
	Total	-26	-17	-9	-2	3	4	2	1	-2

Barrier Deration		Chiller	3	1	0	0	0	1	0	0
		AHU - Breakout	1	0	0	0	0	0	0	0
		AHU - Fresh air in	1	0	0	0	0	0	0	0
		AHU - Discharge	1	0	0	0	0	0	0	0

Ref.	Plant	Mitigated Receiver Lp 63	125	250	500	1k	2k	4k	8k	dB(A)
1	Chiller	13	13	17	23	27	23	14	10	29
2	AHU - Breakout	28	27	14	12	11	9	4	-11	18
3	AHU - Fresh air in	21	21	21	11	6	2	-3	-4	16
4	AHU - Discharge	23	25	19	20	23	24	21	21	30
	Total	**30**	**30**	**25**	**25**	**28**	**27**	**22**	**22**	**33**

Net barrier loss		Chiller	-2	-5	-6	-7	-9	-10	-14	-17
		AHU - Breakout	0	0	0	0	0	0	0	0
		AHU - Fresh air in	0	0	0	0	0	0	0	0
		AHU - Discharge	0	0	0	0	0	0	0	0

Nearest classroom window:

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	Chiller		62	64	70	77	82	80	75	73	86	86	7.0	-25	61	1	0	90(-6dB)	-6	-6	-6	-6	-6	-6	-6	-6		0	Yes	3															
2	AHU - Breakout		75	74	61	59	58	56	51	36	64	64	7.0	-25	39	1	0	90(-6dB)	-6	-6	-6	-6	-6	-6	-6	-6		0	Yes	3															
3	AHU - Fresh air in		78	74	76	66	59	54	49	46	70	70	7.0	-25	45	1	0	90(-6dB)	-6	-6	-6	-6	-6	-6	-6	-6		0	Yes	3	-8	-3	-1	0	0	0	0	0	2	3	7	8	6	5	5	3
4	AHU - Discharge		82	81	81	83	82	81	78	74	87	87	7.0	-25	62	1	0	90(-6dB)	-6	-6	-6	-6	-6	-6	-6	-6		0	Yes	3	-8	-3	-1	0	0	0	0	0	4	6	14	16	12	10	10	6

Ref.	plant	Receiver Lp 63	125	250	500	1k	2k	4k	8k	dB(A)
1	Chiller	34	36	42	49	54	52	47	45	58
2	AHU - Breakout	47	46	33	31	30	28	23	8	36
3	AHU - Fresh air in	50	46	48	38	31	26	21	18	42
4	AHU - Discharge	54	53	53	55	54	53	50	46	59
	Total	**56**	**55**	**55**	**56**	**57**	**55**	**52**	**49**	**62**

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
4.8	1.5	5	0.5	6.5	0.18	-6	-8	-9	-11	-14	-17	-19	-22
5.5	1.5			7.0	-4.60	0	0	0	0	0	0	0	0
5.5	1.5			7.0	-4.60	0	0	0	0	0	0	0	0
5.5	1.5			7.0	-4.60	0	0	0	0	0	0	0	0

Criteria NR	63	125	250	500	1k	2k	4k	8k	dB(A)
42	69	59	51	46	42	39	37	35	50

Barrier SRI	63	125	250	500	1k	2k	4k	8k	Rw
Manual									0
Typical 13mm Plywood Board	6	11	17	23	26	20	28	28	24

Ref.	Plant	Excess 63	125	250	500	1k	2k	4k	8k	dB(A)
1	Chiller	-35	-22	-9	4	12	12	10	10	7
2	AHU - Breakout	-22	-12	-18	-15	-12	-11	-14	-27	-14
3	AHU - Fresh air in	-19	-12	-3	-8	-11	-13	-16	-17	-8
4	AHU - Discharge	-15	-5	2	9	12	14	13	11	9
	Total	-13	-4	4	10	15	16	15	13	11

Barrier Deration		Chiller	3	2	1	0	0	2	1	1
		AHU - Breakout	1	0	0	0	0	0	0	0
		AHU - Fresh air in	1	0	0	0	0	0	0	0
		AHU - Discharge	1	0	0	0	0	0	0	0

Ref.	Plant	Mitigated Receiver Lp 63	125	250	500	1k	2k	4k	8k	dB(A)
1	Chiller	30	31	34	38	40	37	28	23	43
2	AHU - Breakout	47	46	33	31	30	28	23	8	36
3	AHU - Fresh air in	40	40	40	30	25	21	16	15	34
4	AHU - Discharge	42	44	38	39	42	43	40	40	48
	Total	**49**	**49**	**43**	**42**	**45**	**44**	**40**	**40**	**50**

Net barrier loss		Chiller	-3	-6	-8	-11	-14	-15	-18	-21
		AHU - Breakout	0	0	0	0	0	0	0	0
		AHU - Fresh air in	0	0	0	0	0	0	0	0
		AHU - Discharge	0	0	0	0	0	0	0	0

Appendix F: 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.