lcp Lee Cunningham Partnership

Acoustic Consultancy Report

76869/3/1/2
External Plant Assessment

Report Prepared For

WSH Restaurants Investments Ltd
74 Charlotte Street
28 April 2016

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Contents

i) Executive Summary

New mechanical plant is to be installed at 74 Charlotte Street, in London. LCP has been commissioned 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:

39 dB $L_{Aeq,\,T}$ at 10m, 11 Charlotte Mews.

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:

39 dB $L_{Aeq,\,T}$ at 10m, 11 Charlotte Mews.

This report concludes that the design criteria can be achieved.

ii) Document History

Issue	Date	Issue Details	Issued By	Checked By
1	28th April 2016	Initial Issue	JN	MB

1 Introduction

New mechanical plant is to be installed at 74 Charlotte Street, in London. LCP has been commissioned 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 10:00 and 00:30 Mondays to Saturdays and between 12:00 and 00:00 Sundays, Bank and Public holidays.

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 receiver with direct line of sight to the plant area is approximately 10m to the north east of the site at 11 Charlotte Mews.

2.3 Local Noise Climate

The predominant local noise sources were road traffic and pedestrians. Construction works were being carried out between approximately 08:00 – 13:00 on site, as shown in the graph in Appendix B. The measurement data during this time frame has not been used in establishing the representative background sound level/

2.4 Measurements

The noise monitoring took place on 04/03/2015. 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	W
Cloud Cover	50%
Max. Temperature	8°C
Min. Temperature	6°C
Precipitation	Sat 5th: Light Rain 10:00 - 11:30, 14:00 – 15:00, 16:00 – 16:30. Sun 6th: Occasional Light Rain Showers 12:00 – 16:00

2.5 Measurement Results

The measured statistical broad-band sound pressure levels are shown within Appendix B. The representative background sound level(s) during the operational hours of the plant are shown in the following table. The results shown do not include any influence from any construction works being carried out on site.

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

Measurement Position	Saturday 10:00 – 00:30 $L_{A90, 15 mins}$	Sunday 12:00 – 00:00 $L_{A90, 15 mins}$
MP1	53	49

3 Evaluation of Design Criteria

3.1 Residential Design Criterion

3.1.1 Local Authority Requirements

Local Authority Conditions state that:

Noise levels at a point 1m 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 (or any part of it) is 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 10 dB(A) below the LA90, expressed in dB(A).

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

Receiver Premises	Approximate Distance (m)	Design Level 10:00 – 00:30 $L_{Aeq, T}$
11 Charlotte Mews	10	39

4 Review of Current Design

4.1 Current Design

One condenser, one supply air handling unit and one kitchen extract fan will be located on the second floor terrace plant area. Three condensers will be located on the 4th floor roof.

The plant will operate between 10:00 and 00:30 Mondays to Saturdays and between 12:00 and 00:00 Sundays, Bank and Public holidays.

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

Receiver Premises	Approx. Distance (m)	Design Level 10:00 – 00:30 $L_{Aeq, T}$	Predicted Level $L_{Aeq,T}$
11 Charlotte Mews	10	39	66

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, one of the following mitigation is recommended to reduce noise levels to acceptable levels.

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

5.1 Second Floor Plant Area Screening

The proposed plant louvered plant area wall will require an acoustic louvre with the minimum sound reduction loss provided in the following table. The louvre will need to have a minimum height that matches the highest item of plant.

Table 5: Required acoustic louvre sound reduction performance, dB

	Octave Band Centre Frequency (Hz)								R_w
	63	125	250	500	1k	2k	4k	8k	
SH300*	7	7	10	17	29	30	27	21	22

* data taken from Caice

The problems of air flow, pressure drop etc, applicable to the equipment will all need to be taken into account by the design engineer/manufacturer of the louvre.

5.2 Attenuators

Attenuators are required to the AHU intake and Kitchen EF exhaust. The required attenuator insertion losses are shown in the following table. Indicative attenuator sizes to achieve the required performance are also shown as a guide only.

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.

The fan terminals, in addition to the attenuators, will also need to be located behind the acoustic louvered plant screen wall, this will need to be taken into account and careful design will be required to ensure adequate airflow.

Table 6: Required attenuator insertion losses, dB

Plant	Attenuator Dimensions (LxWxH)	Octave Band Centre Frequency (Hz)							
		63	125	250	500	1k	2k	4k	8k
AHU intake	1100x450x1200	3	7	13	23	28	17	8	5
KEF exhaust	1175x450x2400	9	12	24	50	48	30	18	12

5.3 Fourth Floor Plant Area Screening

The fourth floor plant will require screening, either with a solid acoustic panel screen or alternatively with an acoustic louvre with the minimum sound reduction loss provided in the following table. The screen/louvre will need to have a minimum height that matches the highest item of plant.

Table 7: Required acoustic louvre sound reduction performance, dB

	Octave Band Centre Frequency (Hz)								R_w
	63	125	250	500	1k	2k	4k	8k	
SH300*	7	7	10	17	29	30	27	21	22

* data taken from Caice

The problems of air flow, pressure drop etc, applicable to the equipment will all need to be taken into account by the design engineer/manufacturer of the louvre.

5.4 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 8: Design and predicted rating levels, dB re $2x10^{-5}$ Pa

Receiver Premises	Approx. Distance (m)	Design Level 10:00 – 00:30 $L_{Aeq, T}$	Predicted Level $L_{Aeq,T}$
11 Charlotte Mews	10	39	39

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

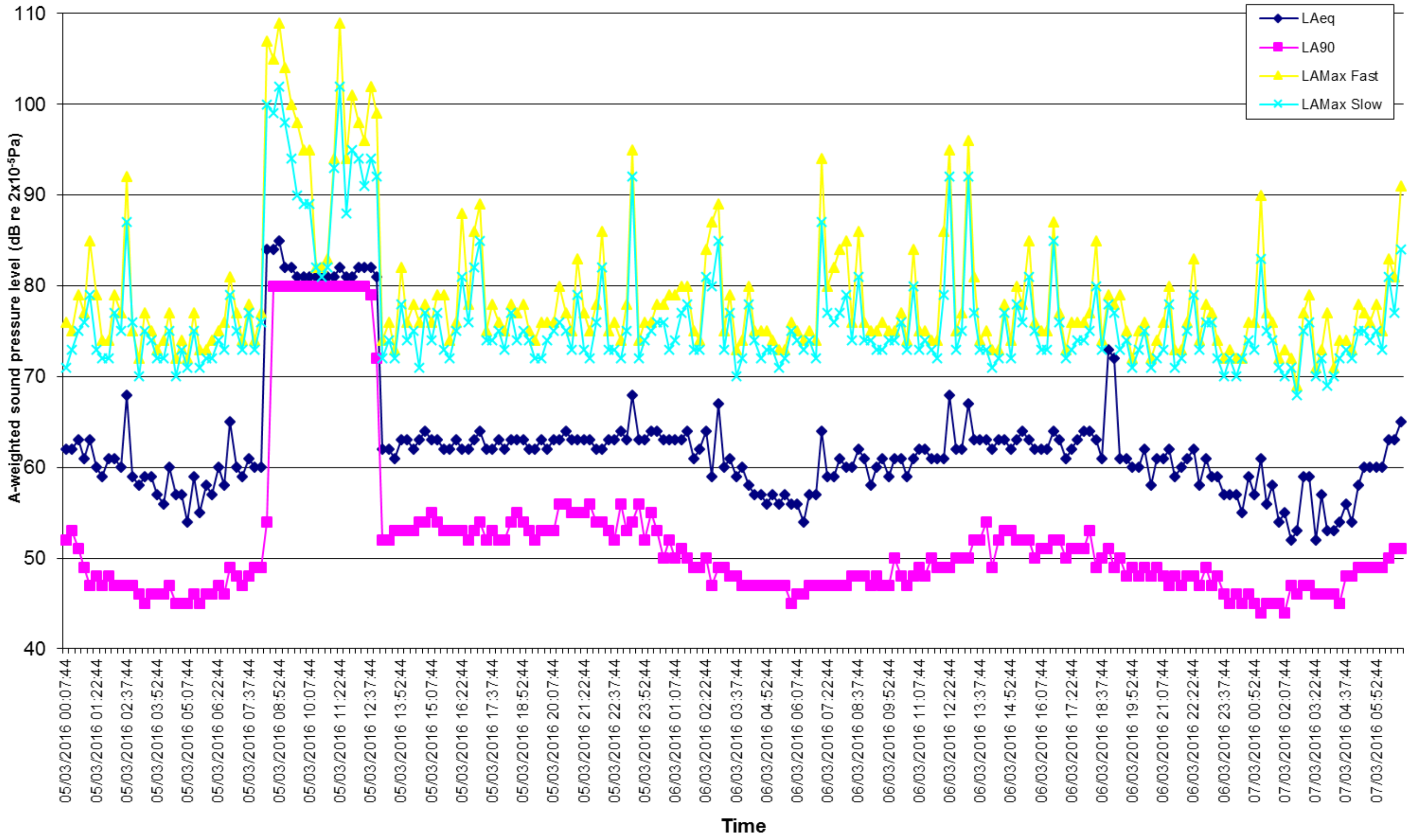
6 Conclusion

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: 11258
- Svantek pre-amplifier SV12L S/N: 13111 with GRAS microphone capsule 40AE S/N: 86548

Calibration checks were made prior to and after completion of measurements using a Svantek SV30A calibrator, S/N: 2343436 complying with Class 1 specification of BS EN 60942:2003, calibration level 94.0 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 9: 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 Intake	63	74	75	69	67	59	54	54	72
AHU Case Radiated	57	67	57	48	47	41	39	38	55
KEF Exhaust	84	88	92	92	88	84	79	75	93
KEF Case Radiated	69	68	65	59	50	41	30	27	60

Table 10: Manufacturer's plant sound pressure data, dB re 2×10^{-5} Pa

Plant	Distance (m)	Octave Band Centre Frequency (Hz)								L_{PA}
		63	125	250	500	1k	2k	4k	8k	
AHU Condenser*	10	21	20	21	18	14	10	5	3	20
RYYQ18T Condenser	1	66	65	66	63	59	55	50	43	65
RYYQ20T Condenser	1	65	65	66	64	60	56	52	45	66

* The sound pressure spectrum for this unit has been estimated based upon the manufacturer's single figure broadband value.

Appendix D: Calculations

Calculation without 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
1	AHU FAI		63	74	75	69	67	59	54	54	72	72	10.0	-28	44	1	0	None
2	AHU Breakout		57	67	57	48	47	41	37	38	55	55	10.0	-28	27	1	0	None
3	EF Exhaust		84	88	92	92	88	84	79	75	93	93	10.0	-28	65	1	0	None
4	EF Breakout		69	68	65	59	50	41	30	27	60	60	10.0	-28	32	1	0	None
5	AHU Condenser	10.00	21	20	21	18	14	10	5	3	20	48	10.0	-28	20	1	0	None
6	RYYQ18T Condenser	1.00	66	65	66	63	59	55	50	43	65	73	27.0	-37	36	1	0	None
7	RYYQ20T Condensers	1.00	65	65	66	64	60	56	52	45	66	74	27.0	-37	37	2	3	None

Ref.	plant	63	125	250	500	1k	2k	4k	8k	Façade correction	dB
1	AHU FAI	0	0	0	0	0	0	0	0	Yes	3
2	AHU Breakout	0	0	0	0	0	0	0	0	Yes	3
3	EF Exhaust	0	0	0	0	0	0	0	0	Yes	3
4	EF Breakout	0	0	0	0	0	0	0	0	Yes	3
5	AHU Condenser	0	0	0	0	0	0	0	0	Yes	3
6	RYYQ18T Condenser	0	0	0	0	0	0	0	0	Yes	3
7	RYYQ20T Condensers	0	0	0	0	0	0	0	0	Yes	3

Ref.	plant	Duct Losses 63	125	250	500	1k	2k	4k	8k	Additional Attenuation 63	125	250	500	1k	2k	4k	8k
1	AHU FAI																
2	AHU Breakout																
3	EF Exhaust	-6	-2	0	0	0	0	0	0								
4	EF Breakout																
5	AHU Condenser																
6	RYYQ18T Condenser																
7	RYYQ20T Condensers																

Ref.	plant	Receiver Lp 63	125	250	500	1k	2k	4k	8k	dB(A)
1	AHU FAI	38	49	50	44	42	34	29	29	47
2	AHU Breakout	32	42	32	23	22	16	12	13	30
3	EF Exhaust	59	63	67	67	63	59	54	50	68
4	EF Breakout	44	43	40	34	25	16	5	2	35
5	AHU Condenser	24	23	24	21	17	13	8	6	23
6	RYYQ18T Condenser	40	39	40	37	33	29	24	17	39
7	RYYQ20T Condensers	42	42	43	41	37	33	29	22	43
Total		**59**	**63**	**67**	**67**	**63**	**59**	**54**	**50**	**68**

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
12.0	9.0	12.0	1.5	8.5	0.07	-5	-6	-7	-9	-11	-13	-16	-19
12.0	9.0	12.0	1.5	8.5	0.07	-5	-6	-7	-9	-11	-13	-16	-19
12.0	9.0	12.0	1.5	8.5	0.07	-5	-6	-7	-9	-11	-13	-16	-19
12.0	9.0	12.0	1.5	8.5	0.07	-5	-6	-7	-9	-11	-13	-16	-19
12.0	9.0	12.0	1.5	8.5	0.07	-5	-6	-7	-9	-11	-13	-16	-19
20.0	9.0		1.5	25.5	-17.94	0	0	0	0	0	0	0	0
20.0	9.0		1.5	25.5	-17.94	0	0	0	0	0	0	0	0

Criteria NR	63	125	250	500	1k	2k	4k	8k	dB(A)
30	59	48	40	34	30	27	25	23	39

Barrier SRI	63	125	250	500	1k	2k	4k	8k
Manual								
Weather Louvre	1	2	2	2	3	3	4	7

Ref.	Plant	Excess 63	125	250	500	1k	2k	4k	8k	dB(A)
1	AHU FAI	-21	1	10	10	12	7	4	6	8
2	AHU Breakout	-27	-6	-8	-11	-8	-11	-13	-10	-9
3	EF Exhaust	0	15	27	33	33	32	29	27	29
4	EF Breakout	-15	-5	0	0	-5	-11	-20	-21	-4
5	AHU Condenser	-35	-25	-16	-13	-13	-14	-17	-17	-16
6	RYYQ18T Condenser	-19	-9	0	3	3	2	0	-6	0
7	RYYQ20T Condensers	-17	-6	3	7	7	6	5	-1	4
Total		0	15	27	33	33	32	29	27	29

Barrier Deration								
AHU FAI	6	6	6	8	8	10	12	12
AHU Breakout	6	6	6	8	8	10	12	12
EF Exhaust	6	6	6	8	8	10	12	12
EF Breakout	6	6	6	8	8	10	12	12
AHU Condenser	6	6	6	8	8	10	12	12
RYYQ18T Condenser	3	2	2	2	2	2	1	1
RYYQ20T Condensers	3	2	2	2	2	2	1	1

Ref.	Plant	Mitigated Receiver Lp 63	125	250	500	1k	2k	4k	8k	dB(A)
1	AHU FAI	39	49	49	43	39	31	25	22	45
2	AHU Breakout	33	42	31	22	19	13	8	6	29
3	EF Exhaust	54	61	66	66	60	56	50	43	66
4	EF Breakout	45	43	39	33	22	13	1	-5	35
5	AHU Condenser	25	23	23	20	14	10	4	-1	21
6	RYYQ18T Condenser	43	41	42	39	35	31	25	18	41
7	RYYQ20T Condensers	45	44	45	43	39	35	30	23	45
Total		**55**	**61**	**66**	**66**	**60**	**56**	**50**	**44**	**66**

Net barrier loss								
AHU FAI	**1**	**0**	**-1**	**-1**	**-3**	**-3**	**-4**	**-7**
AHU Breakout	**1**	**0**	**-1**	**-1**	**-3**	**-3**	**-4**	**-7**
EF Exhaust	**1**	**0**	**-1**	**-1**	**-3**	**-3**	**-4**	**-7**
EF Breakout	**1**	**0**	**-1**	**-1**	**-3**	**-3**	**-4**	**-7**
AHU Condenser	**1**	**0**	**-1**	**-1**	**-3**	**-3**	**-4**	**-7**
RYYQ18T Condenser	**3**	**2**	**2**	**2**	**2**	**2**	**1**	**1**
RYYQ20T Condensers	**3**	**2**	**2**	**2**	**2**	**2**	**1**	**1**

Calculation including 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
1	AHU FAI		63	74	75	69	67	59	54	54	72	72	10.0	-28	44	1	0	None
2	AHU Breakout		57	67	57	48	47	41	37	38	55	55	10.0	-28	27	1	0	None
3	EF Exhaust		84	88	92	92	88	84	79	75	93	93	10.0	-28	65	1	0	None
4	EF Breakout		69	68	65	59	50	41	30	27	60	60	10.0	-28	32	1	0	None
5	AHU Condenser	10.00	21	20	21	18	14	10	5	3	20	48	10.0	-28	20	1	0	None
6	RYYQ18T Condenser	1.00	66	65	66	63	59	55	50	43	65	73	27.0	-37	36	1	0	None
7	RYYQ20T Condensers	1.00	65	65	66	64	60	56	52	45	66	74	27.0	-37	37	2	3	None

Ref.	plant	63	125	250	500	1k	2k	4k	8k	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	AHU FAI	0	0	0	0	0	0	0	0	Yes	3									3	7	13	23	28	17	8	5
2	AHU Breakout	0	0	0	0	0	0	0	0	Yes	3																
3	EF Exhaust	0	0	0	0	0	0	0	0	Yes	3	-6	-2	0	0	0	0	0	0	9	12	24	50	48	30	18	12
4	EF Breakout	0	0	0	0	0	0	0	0	Yes	3																
5	AHU Condenser	0	0	0	0	0	0	0	0	Yes	3																
6	RYYQ18T Condenser	0	0	0	0	0	0	0	0	Yes	3																
7	RYYQ20T Condensers	0	0	0	0	0	0	0	0	Yes	3																

Ref.	plant	Receiver Lp 63	125	250	500	1k	2k	4k	8k	dB(A)
1	AHU FAI	38	49	50	44	42	34	29	29	47
2	AHU Breakout	32	42	32	23	22	16	12	13	30
3	EF Exhaust	59	63	67	67	63	59	54	50	68
4	EF Breakout	44	43	40	34	25	16	5	2	35
5	AHU Condenser	24	23	24	21	17	13	8	6	23
6	RYYQ18T Condenser	40	39	40	37	33	29	24	17	39
7	RYYQ20T Condensers	42	42	43	41	37	33	29	22	43
	Total	**60**	**64**	**68**	**68**	**64**	**60**	**55**	**51**	**69**

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
12.0	9.0	12.0	1.5	8.5	0.07	-5	-6	-7	-9	-11	-13	-16	-19
12.0	9.0	12.0	1.5	8.5	0.07	-5	-6	-7	-9	-11	-13	-16	-19
12.0	9.0	12.0	1.5	8.5	0.07	-5	-6	-7	-9	-11	-13	-16	-19
12.0	9.0	12.0	1.5	8.5	0.07	-5	-6	-7	-9	-11	-13	-16	-19
12.0	9.0	12.0	1.5	8.5	0.07	-5	-6	-7	-9	-11	-13	-16	-19
20.0	9.0	20.0	1.5	25.5	0.12	-6	-7	-8	-10	-12	-15	-18	-21
20.0	9.0	20.0	1.5	25.5	0.12	-6	-7	-8	-10	-12	-15	-18	-21

Criteria

NR	63	125	250	500	1k	2k	4k	8k	dB(A)
30	59	48	40	34	30	27	25	23	39

Barrier SRI	63	125	250	500	1k	2k	4k	8k
Manual								
SH300	7	7	10	17	29	30	27	21

Ref.	Plant	Excess 63	125	250	500	1k	2k	4k	8k	dB(A)
1	AHU FAI	-21	1	10	10	12	7	4	6	8
2	AHU Breakout	-27	-6	-8	-11	-8	-11	-13	-10	-9
3	EF Exhaust	0	15	27	33	33	32	29	27	29
4	EF Breakout	-15	-5	0	0	-5	-11	-20	-21	-4
5	AHU Condenser	-35	-25	-16	-13	-13	-14	-17	-17	-16
6	RYYQ18T Condenser	-19	-9	0	3	3	2	0	-6	0
7	RYYQ20T Condensers	-17	-6	3	7	7	6	5	-1	4
	Total	1	16	28	34	34	33	30	28	30

Barrier Deration								
AHU FAI	2	3	2	1	0	0	0	2
AHU Breakout	2	3	2	1	0	0	0	2
EF Exhaust	2	3	2	1	0	0	0	2
EF Breakout	2	3	2	1	0	0	0	2
AHU Condenser	2	3	2	1	0	0	0	2
RYYQ18T Condenser	2	3	2	1	0	0	0	3
RYYQ20T Condensers	2	3	2	1	0	0	0	3

Ref.	Plant	Mitigated Receiver Lp 63	125	250	500	1k	2k	4k	8k	dB(A)
1	AHU FAI	32	39	32	13	3	4	5	7	26
2	AHU Breakout	29	39	27	15	11	3	-4	-4	25
3	EF Exhaust	41	46	38	9	4	16	20	21	33
4	EF Breakout	41	40	35	26	14	3	-11	-15	30
5	AHU Condenser	21	20	19	13	6	0	-8	-11	15
6	RYYQ18T Condenser	37	36	34	28	21	15	7	0	30
7	RYYQ20T Condensers	39	39	37	32	25	19	12	5	33
	Total	**47**	**50**	**44**	**36**	**28**	**23**	**22**	**23**	**39**

Net barrier loss								
AHU FAI	**-3**	**-3**	**-5**	**-8**	**-11**	**-13**	**-16**	**-17**
AHU Breakout	**-3**	**-3**	**-5**	**-8**	**-11**	**-13**	**-16**	**-17**
EF Exhaust	**-3**	**-3**	**-5**	**-8**	**-11**	**-13**	**-16**	**-17**
EF Breakout	**-3**	**-3**	**-5**	**-8**	**-11**	**-13**	**-16**	**-17**
AHU Condenser	**-3**	**-3**	**-5**	**-8**	**-11**	**-13**	**-16**	**-17**
RYYQ18T Condenser	**-4**	**-4**	**-6**	**-9**	**-12**	**-15**	**-18**	**-18**
RYYQ20T Condensers	**-4**	**-4**	**-6**	**-9**	**-12**	**-15**	**-18**	**-18**

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.