

Acoustic Consultancy Report

92107/3/1/4

External Plant Assessment

Report Prepared For

Gsm Ltd
Iceland Broad Street Mall
11 April 2019

Report Author

A handwritten signature in black ink, appearing to read 'S. Shapley', with a long horizontal stroke extending to the left.

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i) Executive Summary

New mechanical plant is to be installed at the Iceland Food store development at Unit 4 Broad Street Mall, Reading.

LCP has been commissioned by Iceland Foods to use the obtained data to assess the potential noise impact of the plant installation on surrounding noise sensitive receptors.

The recommended residential design criterion is as follows:

Day: 44 dB $L_{Aeq, T}$; elevations facing Oxford Road;
Night: 32 dB $L_{Aeq, T}$; elevations facing Oxford Road;
Day: 39 dB $L_{Aeq, T}$; elevations facing Queens Walk;
Night: 31 dB $L_{Aeq, T}$; elevations facing Queens Walk;
Day: 38 dB $L_{Aeq, T}$; residential block A Broad Street Mall;
Night: 31 dB $L_{Aeq, T}$; residential block A Broad Street Mall;
Day: 36 dB $L_{Aeq, T}$; residential block B Broad Street Mall;
Night: 31 dB $L_{Aeq, T}$; residential block B Broad Street Mall;
Day: 38 dB $L_{Aeq, T}$; residential block E Broad Street Mall;
Night: 31 dB $L_{Aeq, T}$; residential block E Broad Street Mall.

The design will achieve the recommended rating level, the report concludes that:

The calculated levels achieve the criteria set out in Hoare Lea's Acoustic Planning Condition 8 Report

ii) Document History

Issue	Date	Issue Details	Issued By
1	10 th December 2018	Initial Issue	SS
2	11 th April 2019	Additional Receivers Added	SS

1 Introduction

New mechanical plant is to be installed at the Iceland Food store development at Unit 4 Broad Street Mall, Reading.

LCP has been commissioned by Iceland Foods to assess the potential noise impact of the plant installation on surrounding noise sensitive receptors.

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

2 Evaluation of Design Criteria

2.1 Hoare Lea's Argos Corner Planning Condition 8 Report

Hoare Lea were appointed to provide acoustic advice for the commercial properties within Broad Street Mall.

In section 5.2 of Hoare Lea's Argos Corner Planning Condition 8 Report ref REP-1010530-LR-20181016 their report states the following regarding noise criteria for mechanical plant to be installed at Broad Street Mall:

"Based on the criteria set out in Section 3 and the survey results, the cumulative maximum sound pressure levels for fixed plant, equipment and machinery associated with each tenant plant scheme shall not exceed the levels presented in Table 1 at 1 m from the nearest noise sensitive premises."

The criteria stated in table 1 of Hoare Lea's Planning Condition 8 Report is as follows:

Table 1: Representative background sound levels, dB re 2×10^{-5} Pa

Location	Design Level Day (07:00 – 23:00) $L_{Aeq, 15 \text{ mins}}$	Design Level Night (23:00 – 07:00) $L_{Aeq, 15 \text{ mins}}$
Elevations facing Oxford Road	44	32
Elevations facing Queens Walk	39	31

2.2 Additional Receivers

Additional Residential Receivers have been notified since the Hoare Lea Report.

The following table includes both Hoare Lea's criteria and the proposed residential blocks to be built on top of the Broad Street Mall complex.

Table 2: Representative background sound levels, dB re 2×10^{-5} Pa

Location	Design Level Day (07:00 – 23:00) $L_{Aeq, 15 \text{ mins}}$	Design Level Night (23:00 – 07:00) $L_{Aeq, 15 \text{ mins}}$
Elevations facing Oxford Road	44	32
Elevations facing Queens Walk	39	31
Residential block A Broad Street Mall	44	32
Residential block B Broad Street Mall	44	32
Residential block E Broad Street Mall	44	32

3 Review of Plant Installation

The proposed plant is located on the roof and within the carpark entrance. All the plant has the potential to run over a 24-hour period. The plant located within the carpark entrance is contained within the basement of the building, there are no nearby noise sensitive premises who are affected by the plant. Due to the remote location of the plant, it has been excluded from the calculations.

The plant located on the roof has a direct line of sight between the nearest noise sensitive premise on Oxford Road, located 34m away from the nearest unit. A 9-story commercial building is in between the roof plant area and the nearest noise sensitive premise on Queens Walk, this can be seen in the site plan in Appendix A.

Both the Mitsubishi PURY-P450YNW condensers are to operate in Low-Noise Mode during closing hours of the store.

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

Table 3: Predicted and design noise levels, dB re 2×10^{-5} Pa

Receiver Premises	Design Level Day (07:00 – 23:00) $L_{Aeq, 15 \text{ mins}}$	Design Level Night (23:00 – 07:00) $L_{Aeq, 15 \text{ mins}}$	Predicted Level Day (07:00 – 23:00) $L_{Aeq, T}$	Predicted Level Night (23:00 – 07:00) $L_{Aeq, T}$
Elevations facing Oxford Road	44	32	38	30
Elevations facing Queens Walk	39	31	22	18
Residential block A Broad Street Mall	39	31	38	31
Residential block B Broad Street Mall	39	31	36	31
Residential block E Broad Street Mall	39	31	38	31

4 Conclusion

Calculations have been carried out to determine the noise levels at the nearest receiver premises.

The calculations meet the criteria set out in Hoare Lea's Acoustic Planning Condition 8 Report.

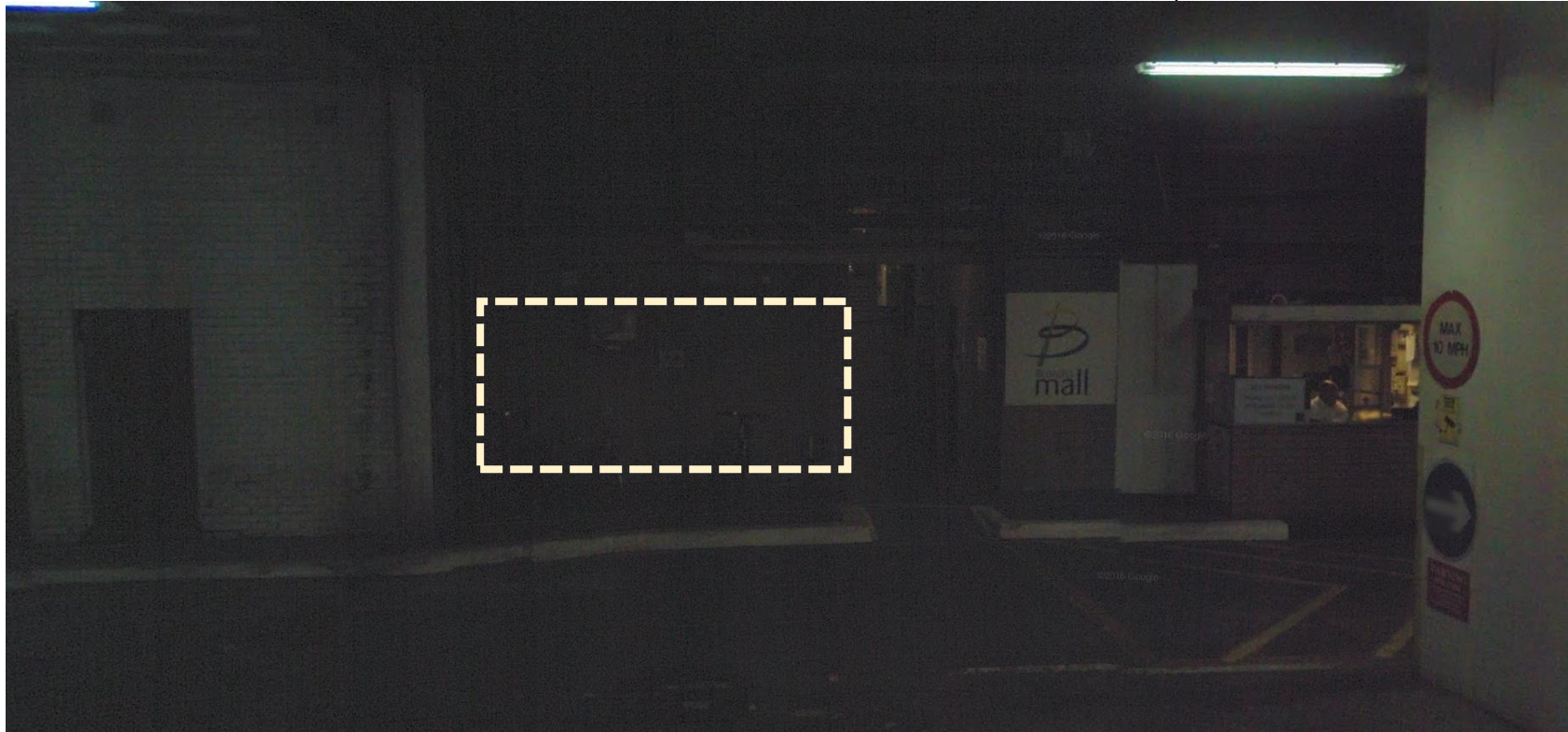
It is therefore recommended that planning permission in respect of the plant installation shall be given.

Appendix A: Site Plan



Appendix B: Photographs

Plant location of Searle the MSA132 & Mitsubishi PUHZ-ZRP50VKA2 condensers contained within the carpark entrance



Appendix C: Plant Data

Plant noise data used in the preceding assessment follow.

Table 4: Manufacturers Plant Sound Data, dB

Plant	Data Type	Octave Band Centre Frequency (Hz)								L _A
		63	125	250	500	1k	2k	4k	8k	
Woods 560 Axial Fan	Lw	83	88	77	71	68	66	58	74	78
KD121 Scroll Condenser	Lp at 10m	21	21	20	23	26	26	24	21	32
Mitsubishi PURY-P450YNW	Lp at 1m	74	64	67	65	60	55	50	46	65

Appendix D: Calculations

Noise sensitive premises along Oxford Road - Daytime

Ref.	plant	Ref.dist.	Sound Level (Lp/Lw)								Lw dB(A)	Receiver Distance (m)	dB(A)	Lp	No. off	dB	Angular Directionality									Reflections	dB	Bend Loss & End Reflection							
			63	125	250	500	1k	2k	4k	8k	dB(A)							63	125	250	500	1k	2k	4k	8k			63	125	250	500	1k	2k	4k	8k
1	Woods 560 Axial Fan		83	88	77	71	68	66	58	74	78	78	34.0	-39	39	1	0	90(-6dB)	-6	-6	-6	-6	-6	-6	-6	1	3	-8	-3	-2	-2	-3	-3	-3	-3
2	KD121 Scroll Condenser	10	21	21	20	23	26	26	24	21	32	60	36.5	-39	20	1	0	None	0	0	0	0	0	0	0	1	3								
3	Mitsubishi PURY-P450YNW	1	74	64	67	65	60	55	50	46	65	73	38.0	-40	34	2	3	None	0	0	0	0	0	0	0	1	3								

Ref.	plant	Receiver Lp								Lw dB(A)
		63	125	250	500	1k	2k	4k	8k	
1	Woods 560 Axial Fan	41	46	35	29	26	24	16	32	36
2	KD121 Scroll Condenser	13	13	12	15	18	18	16	13	23
3	Mitsubishi PURY-P450YNW	48	38	41	39	34	29	24	20	40
	Safety	3	3	3	3	3	3	3	3	
	Total	52	50	45	42	38	34	28	36	45

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
0.8	2.5	2.4	13.5	20.5	0.05	-5	-6	-7	-8	-10
0.7	2.5	2.4	16.0	20.5	0.05	-5	-6	-6	-8	-9
1.9	2.5	2.4	17.5	20.5	0.00	-5	-5	-5	-5	-6

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

Barrier Deration										
Woods 560 Axial F	0	0	0	0	0	0	0	0	0	
KD121 Scroll Cond	0	0	0	0	0	0	0	0	0	
Mitsubishi PURY-F	0	0	0	0	0	0	0	0	0	

Net barrier loss										
Woods 560 Axial F	-5	-6	-7	-8	-10	-12	-14	-17		
KD121 Scroll Cond	-5	-6	-6	-8	-9	-12	-14	-17		
Mitsubishi PURY-F	-5	-5	-5	-5	-5	-6	-7	-8		

Noise sensitive premises along Oxford Road - Night-time

Ref.	plant	Ref.dist.	Sound Level (Lp/Lw)								Lw dB(A)	Receiver Distance (m)	dB(A)	Lp	No. off	dB	Angular Directionality									Reflections	dB	Bend Loss & End Reflection							
			63	125	250	500	1k	2k	4k	8k	dB(A)							63	125	250	500	1k	2k	4k	8k			63	125	250	500	1k	2k	4k	8k
1	Woods 560 Axial Fan		83	88	77	71	68	66	58	74	78	78	34.0	-39	39	1	0	90(-6dB)	-6	-6	-6	-6	-6	-6	-6	1	3	-8	-3	-2	-2	-3	-3	-3	-3
2	KD121 Scroll Condenser	10	21	21	20	23	26	26	24	21	32	60	36.5	-39	20	1	0	None	0	0	0	0	0	0	0	1	3								
3	Mitsubishi PURY-P450YNW LNM	1	65	57	52	50	48	44	40	44	53	61	38.0	-40	21	2	3	None	0	0	0	0	0	0	0	1	3								

Ref.	plant	Receiver Lp								Lw dB(A)
		63	125	250	500	1k	2k	4k	8k	
1	Woods 560 Axial Fan	41	46	35	29	26	24	16	32	36
2	KD121 Scroll Condenser	13	13	12	15	18	18	16	13	23
3	Mitsubishi PURY-P450YNW LNM	39	31	26	24	22	18	14	18	27
	Safety	3	3	3	3	3	3	3	3	
	Total	46	50	39	34	31	29	23	36	40

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
0.8	2.5	2.4	13.5	20.5	0.05	-5	-6	-7	-8	-10
0.7	2.5	2.4	16.0	20.5	0.05	-5	-6	-6	-8	-9
1.9	2.5	2.4	17.5	20.5	0.00	-5	-5	-5	-5	-6

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

Barrier Deration										
Woods 560 Axial F	0	0	0	0	0	0	0	0	0	
KD121 Scroll Cond	0	0	0	0	0	0	0	0	0	
Mitsubishi PURY-F	0	0	0	0	0	0	0	0	0	

Net barrier loss										
Woods 560 Axial F	-5	-6	-7	-8	-10	-12	-14	-17		
KD121 Scroll Cond	-5	-6	-6	-8	-9	-12	-14	-17		
Mitsubishi PURY-F	-5	-5	-5	-5	-5	-6	-7	-8		

Residential block A Broad Street Mall – Daytime

Residential Block A Broad Street Main Daytime

Ref.	plant	Ref.dist.	Sound Level (Lp/Lw)								Lw dB(A)	Reciever Distance (m)	dB(A)	Lp	No. off	dB	Angular Directionality	63	125	250	500	1k	2k	4k	8k	Reflections	dB	Bend Loss & End Reflection							
			63	125	250	500	1k	2k	4k	8k								63	125	250	500	1k	2k	4k	8k										
1	Woods 560 Axial Fan		83	88	77	71	68	66	58	74	78	78	73.0	-45	33	1	0	90(-6dB)	-6	-6	-6	-6	-6	-6	-6	-6	1	3	-8	-3	-2	-2	-3	-3	-3
2	KD121 Scroll Condenser	10	21	21	20	23	26	26	24	21	32	60	75.0	-46	14	1	0	None	0	0	0	0	0	0	0	0	1	3							
3	Mitsubishi PURY-P450YNW	1	74	64	67	65	60	55	50	46	65	73	77.0	-46	28	2	3	None	0	0	0	0	0	0	0	0	1	3							

Ref.	plant	Receiver Lp								dB(A)
		63	125	250	500	1k	2k	4k	8k	
1	Woods 560 Axial Fan	35	40	29	23	20	18	10	26	30
2	KD121 Scroll Condenser	6	6	5	8	11	11	9	6	17
3	Mitsubishi PURY-P450YNW	42	32	35	33	28	23	18	14	34
Safety		3	3	3	3	3	3	3	3	3
Total		46	43	39	36	32	28	22	29	38

Criteria	NR	63	125	250	500	1k	2k	4k	8k	dB(A)
		35	63	52	45	39	35	32	30	28

Ref.	Plant	Excess								dB(A)
		63	125	250	500	1k	2k	4k	8k	
1	Woods 560 Axial Fan	-28	-13	-16	-16	-15	-14	-20	-2	-14
2	KD121 Scroll Condenser	-57	-46	-39	-30	-24	-21	-20	-22	-27
3	Mitsubishi PURY-P450YNW	-21	-20	-10	-6	-7	-9	-12	-14	-10
Total		-18	-9	-6	-3	-3	-4	-8	1	-6

Ref.	Plant	Mitigated Receiver Lp								dB(A)
		63	125	250	500	1k	2k	4k	8k	
1	Woods 560 Axial Fan	27	37	27	21	17	15	7	23	27
2	KD121 Scroll Condenser	6	6	5	8	11	11	9	6	17
3	Mitsubishi PURY-P450YNW	42	32	35	33	28	23	18	14	34
Safety		3	3	3	3	3	3	3	3	3
Total		45	41	38	36	31	27	22	26	38

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

Barrier Deration		Woods 560 Axial F	63	125	250	500	1k	2k	4k	8k
		KD121 Scroll Cond	0	0	0	0	0	0	0	0
		Mitsubishi PURY-P	0	0	0	0	0	0	0	0

Net barrier loss		Woods 560 Axial F	63	125	250	500	1k	2k	4k	8k
		KD121 Scroll Cond	0	0	0	0	0	0	0	0
		Mitsubishi PURY-P	0	0	0	0	0	0	0	0

Residential block A Broad Street Mall - Night-time

Residential Block A Broad Street Main Right Time

Ref.	plant	Ref.dist.	Sound Level (Lp/Lw)								Lw dB(A)	Receiver Distance (m)	dB(A)	Lp	No. off	dB	Angular Directionality	63	125	250	500	1k	2k	4k	8k	Reflections	dB	Bend Loss & End Reflection								
			63	125	250	500	1k	2k	4k	8k								63	125	250	500	1k	2k	4k	8k											
1	Woods 560 Axial Fan		83	88	77	71	68	66	58	74	78	78	73.0	-45	33	1	0	90(-6dB)	-6	-6	-6	-6	-6	-6	-6	-6	1	3	-8	-3	-2	-2	-3	-3	-3	-3
2	KD121 Scroll Condenser	10	21	21	20	23	26	26	24	21	32	60	75.0	-46	14	1	0	None	0	0	0	0	0	0	0	0	1	3								
3	Mitsubishi PURY-P450YNW LNM	1	65	57	52	50	48	44	40	44	53	61	77.0	-46	15	2	3	None	0	0	0	0	0	0	0	0	1	3								

Ref.	plant	Receiver Lp								dB(A)
		63	125	250	500	1k	2k	4k	8k	
1	Woods 560 Axial Fan	35	40	29	23	20	18	10	26	30
2	KD121 Scroll Condenser	6	6	5	8	11	11	9	6	17
3	Mitsubishi PURY-P450YNW LNM	33	25	20	18	16	12	8	12	21
	Safety	3	3	3	3	3	3	3	3	3
	Total	40	43	32	27	25	23	17	29	33

Criteria										
NR	63	125	250	500	1k	2k	4k	8k	dB(A)	
22	53	41	32	26	22	19	16	15	32	

Ref.	Plant	Excess								dB(A)
		63	125	250	500	1k	2k	4k	8k	
1	Woods 560 Axial Fan	-18	-1	-4	-3	-2	-1	-7	11	-2
2	KD121 Scroll Condenser	-46	-35	-27	-18	-11	-7	-7	-8	-15
3	Mitsubishi PURY-P450YNW LNM	-20	-16	-12	-8	-6	-7	-9	-3	-11
	Total	-13	2	0	1	3	4	0	14	1

Ref.	Plant	Mitigated Receiver Lp								dB(A)
		63	125	250	500	1k	2k	4k	8k	
1	Woods 560 Axial Fan	27	37	27	21	17	15	7	23	27
2	KD121 Scroll Condenser	6	6	5	8	11	11	9	6	17
3	Mitsubishi PURY-P450YNW LNM	33	25	20	18	16	12	8	12	21
	Safety	3	3	3	3	3	3	3	3	3
	Total	37	40	31	26	23	21	16	26	31

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
0.8	3.0			73.0	-0.83	0	0	0	0	0	0	0	0
0.7	3.0			75.0	-0.68	0	0	0	0	0	0	0	0
1.9	3.0			77.0	-1.90	0	0	0	0	0	0	0	0

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

Barrier Deration		Woods 560 Axial F	63	125	250	500	1k	2k	4k	8k
		KD121 Scroll Cond	0	0	0	0	0	0	0	0
		Mitsubishi PURY-F	0	0	0	0	0	0	0	0

Net barrier loss		Woods 560 Axial F	63	125	250	500	1k	2k	4k	8k
		KD121 Scroll Cond	0	0	0	0	0	0	0	0
		Mitsubishi PURY-F	0	0	0	0	0	0	0	0



Residential block B Broad Street Mall – Daytime

Ref.	plant	Ref.dist.	Sound Level (Lp/Lw)										Lw dB(A)	Receiver Distance (m)	dB(A)	Lp	No. off	dB	Angular Directionality	63	125	250	500	1k	2k	4k	8k	Reflections	dB	Bend Loss & End Reflection							
			63	125	250	500	1k	2k	4k	8k	dB(A)	63																		125	250	500	1k	2k	4k	8k	63
1	Woods 560 Axial Fan		83	88	77	71	68	66	58	74	78	78	87.0	-47	31	1	0	45(-3dB)	-3	-3	-3	-3	-3	-3	-3	1	3	-8	-3	-2	-2	-3	-3	-3	-3		
2	KD121 Scroll Condenser	10	21	21	20	23	26	26	24	21	32	60	89.0	-47	13	1	0	None	0	0	0	0	0	0	0	1	3										
3	Mitsubishi PURY-P450YNW	1	74	64	67	65	60	55	50	46	65	73	91.0	-47	26	2	3	None	0	0	0	0	0	0	0	1	3										

Ref.	plant	Receiver Lp								dB(A)	Barrier Path Difference Loss:																						
		63	125	250	500	1k	2k	4k	8k		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	Woods 560 Axial Fan	36	41	30	24	21	19	11	27	31	0.8	3.0			87.0	-0.82	0	0	0	0	0	0	0	0	0								
2	KD121 Scroll Condenser	5	5	4	7	10	10	8	5	15	0.7	3.0			89.0	-0.68	0	0	0	0	0	0	0	0	0								
3	Mitsubishi PURY-P450YNW	40	30	33	31	26	21	16	12	32	1.9	3.0			91.0	-1.89	0	0	0	0	0	0	0	0	0								
Safety		3	3	3	3	3	3	3	3	3																							
Total		44	44	37	35	30	26	20	30	37																							

Criteria												
NR	63	125	250	500	1k	2k	4k	8k	dB(A)			
35	63	52	45	39	35	32	30	28	44			

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								dB(A)	Barrier Deration								
		63	125	250	500	1k	2k	4k	8k			Woods 560 Axial Fan	KD121 Scroll Cond	Mitsubishi PURY-P					
1	Woods 560 Axial Fan	-27	-12	-15	-15	-14	-13	-19	-1	-13	0	0	0	0	0	0	0	0	0
2	KD121 Scroll Condenser	-59	-48	-41	-32	-25	-23	-22	-24	-29	0	0	0	0	0	0	0	0	0
3	Mitsubishi PURY-P450YNW	-23	-22	-12	-8	-9	-11	-14	-16	-12	0	0	0	0	0	0	0	0	0
Total		-19	-8	-7	-4	-5	-6	-9	2	-7									

Ref.	Plant	Mitigated Receiver Lp										dB(A)	Net barrier loss						
		63	125	250	500	1k	2k	4k	8k	24	28			Woods 560 Axial Fan	KD121 Scroll Cond	Mitsubishi PURY-P			
1	Woods 560 Axial Fan	28	38	28	22	18	16	8	24	28	0	0	0	0	0	0	0	0	0
2	KD121 Scroll Condenser	5	5	4	7	10	10	8	5	15	0	0	0	0	0	0	0	0	0
3	Mitsubishi PURY-P450YNW	40	30	33	31	26	21	16	12	32	0	0	0	0	0	0	0	0	0
Safety		3	3	3	3	3	3	3	3	3									
Total		43	41	37	34	29	26	20	27	36									

Residential block B Broad Street Mall - Night-time

Ref.	plant	Ref.dist.	Sound Level (Lp/Lw)								Lw dB(A)	Receiver Distance (m)	dB(A)	Lp	No. off	dB	Angular Directionality	63	125	250	500	1k	2k	4k	8k	Reflections	dB	Bend Loss & End Reflection							
			63	125	250	500	1k	2k	4k	8k																		dB(A)	63	125	250	500	1k	2k	4k
1	Woods 560 Axial Fan		83	88	77	71	68	66	58	74	78	78	87.0	-47	31	1	0	45(-3dB)	-3	-3	-3	-3	-3	-3	-3	1	3	-8	-3	-2	-2	-3	-3	-3	-3
2	KD121 Scroll Condenser	10	21	21	20	23	26	26	24	21	32	60	89.0	-47	13	1	0	None	0	0	0	0	0	0	0	1	3								
3	Mitsubishi PURY-P450YNW	1	65	57	52	50	48	44	40	44	53	61	91.0	-47	14	2	3	None	0	0	0	0	0	0	0	1	3								

Ref.	plant	Receiver Lp								dB(A)	Barrier Path Difference Loss:																						
		63	125	250	500	1k	2k	4k	8k		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	Woods 560 Axial Fan	36	41	30	24	21	19	11	27	31	0.8	3.0				87.0	-0.82	0	0	0	0	0	0	0	0								
2	KD121 Scroll Condenser	5	5	4	7	10	10	8	5	15	0.7	3.0				89.0	-0.68	0	0	0	0	0	0	0	0								
3	Mitsubishi PURY-P450YNW	31	23	18	16	14	10	6	10	19	1.9	3.0				91.0	-1.89	0	0	0	0	0	0	0	0								
Safety		3	3	3	3	3	3	3	3	3																							
Total		40	44	33	27	25	23	16	30	34																							

Criteria												
NR	63	125	250	500	1k	2k	4k	8k	dB(A)			
22	53	41	32	26	22	19	16	15	32			

Ref.	Plant	Excess								dB(A)	Barrier SRI	Manual Unknown	63	125	250	500	1k	2k	4k	8k	Rw
		63	125	250	500	1k	2k	4k	8k												
1	Woods 560 Axial Fan	-17	0	-3	-3	-1	0	-6	12	-1											0
2	KD121 Scroll Condenser	-48	-37	-29	-20	-12	-9	-9	-10	-17											101
3	Mitsubishi PURY-P450YNW	-22	-18	-14	-10	-8	-9	-11	-5	-13											
Total		-13	3	0	1	3	4	0	15	2											

Ref.	Plant	Mitigated Receiver Lp								dB(A)	Net barrier loss	Woods 560 Axial Fan	KD121 Scroll Condenser	Mitsubishi PURY-P450YNW
		63	125	250	500	1k	2k	4k	8k					
1	Woods 560 Axial Fan	28	38	28	22	18	16	8	24	28		0	0	0
2	KD121 Scroll Condenser	5	5	4	7	10	10	8	5	15		0	0	0
3	Mitsubishi PURY-P450YNW	31	23	18	16	14	10	6	10	19		0	0	0
Safety		3	3	3	3	3	3	3	3	3		0	0	0
Total		35	41	31	26	23	20	15	27	31		0	0	0

Residential block E Broad Street Mall – Daytime

Ref.	plant	Ref.dist.	Sound Level (Lp/Lw)										Lw dB(A)	Receiver Distance (m)	dB(A)	Lp	No. off	dB	Angular Directionality	63	125	250	500	1k	2k	4k	8k	Reflections	dB	Bend Loss & End Reflection							
			63	125	250	500	1k	2k	4k	8k	dB(A)	63																		125	250	500	1k	2k	4k	8k	
1	Woods 560 Axial Fan		83	88	77	71	68	66	58	74	78	78	79.0	-46	32	1	0	None	0	0	0	0	0	0	0	0	1	3	-8	-3	-2	-2	-3	-3	-3	-3	
2	KD121 Scroll Condenser	10	21	21	20	23	26	26	24	21	32	60	79.0	-46	14	1	0	None	0	0	0	0	0	0	0	0	1	3									
3	Mitsubishi PURY-P450YNW	1	74	64	67	65	60	55	50	46	65	73	79.0	-46	28	2	3	None	0	0	0	0	0	0	0	0	1	3									

Ref.	plant	Receiver Lp									
		63	125	250	500	1k	2k	4k	8k	dB(A)	
1	Woods 560 Axial Fan	40	45	34	28	25	23	15	31	35	
2	KD121 Scroll Condenser	6	6	5	8	11	11	9	6	17	
3	Mitsubishi PURY-P450YNW	42	32	35	33	28	23	18	14	34	
Safety		3	3	3	3	3	3	3	3		
Total		47	48	40	37	33	29	23	34	40	

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			
0.8	34.0	2.4	4.5	74.5	-0.01	-5	-5	-4	-4	-3	0	0	0			
0.7	34.0	2.4	4.5	74.5	0.00	-5	-5	-5	-5	-4	-4	-3	0			
1.9	34.0	2.4	4.5	74.5	-0.17	-2	0	0	0	0	0	0	0			

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

Ref.	Plant	Excess									
		63	125	250	500	1k	2k	4k	8k	dB(A)	
1	Woods 560 Axial Fan	-23	-7	-11	-11	-10	-9	-15	3	-9	
2	KD121 Scroll Condenser	-57	-46	-40	-31	-24	-21	-21	-22	-27	
3	Mitsubishi PURY-P450YNW	-22	-20	-10	-6	-7	-9	-12	-14	-10	
Total		-16	-4	-4	-2	-2	-3	-7	6	-3	

Ref.	Plant	Mitigated Receiver Lp									
		63	125	250	500	1k	2k	4k	8k	dB(A)	
1	Woods 560 Axial Fan	27	37	28	22	19	20	12	28	30	
2	KD121 Scroll Condenser	1	1	0	3	7	7	6	6	13	
3	Mitsubishi PURY-P450YNW	39	32	35	33	28	23	18	14	34	
Safety		3	3	3	3	3	3	3	3		
Total		42	42	38	36	31	28	22	31	38	

Net barrier loss		Woods 560 Axial F	-5	-5	-4	-4	-3	0	0	0	0
		KD121 Scroll Cond	-5	-5	-5	-5	-4	-4	-3	0	0
		Mitsubishi PURY-P	-2	0	0	0	0	0	0	0	0

Residential block E Broad Street Mall - Night-time

Ref.	plant	Ref.dist.	Sound Level (Lp/Lw)								Lw dB(A)	Receiver Distance (m)	dB(A)	Lp	No. off	dB	Angular Directionality	63	125	250	500	1k	2k	4k	8k	Reflections	dB	Bend Loss & End Reflection							
			63	125	250	500	1k	2k	4k	8k																		dB(A)	63	125	250	500	1k	2k	4k
1	Woods 560 Axial Fan		83	88	77	71	68	66	58	74	78	79.0	-46	32	1	0	None	0	0	0	0	0	0	0	0	1	3	-8	-3	-2	-2	-3	-3	-3	
2	KD121 Scroll Condenser	10	21	21	20	23	26	26	24	21	32	60	79.0	-46	14	1	0	None	0	0	0	0	0	0	0	0	1	3							
3	Mitsubishi PURY-P450YNW	1	65	57	52	50	48	44	40	44	53	61	79.0	-46	15	2	3	None	0	0	0	0	0	0	0	0	1	3							

Ref.	plant	Receiver Lp								dB(A)
		63	125	250	500	1k	2k	4k	8k	
1	Woods 560 Axial Fan	40	45	34	28	25	23	15	31	35
2	KD121 Scroll Condenser	6	6	5	8	11	11	9	6	17
3	Mitsubishi PURY-P450YNW	33	25	20	18	16	12	8	12	21
Safety		3	3	3	3	3	3	3	3	
Total		43	48	37	31	28	26	19	34	38

Criteria	NR	63	125	250	500	1k	2k	4k	8k	dB(A)
		22	53	41	32	26	22	19	16	15

Ref.	Plant	Excess								dB(A)
		63	125	250	500	1k	2k	4k	8k	
1	Woods 560 Axial Fan	-13	4	2	2	3	4	-1	16	3
2	KD121 Scroll Condenser	-47	-35	-27	-18	-11	-8	-7	-9	-15
3	Mitsubishi PURY-P450YNW	-20	-16	-12	-9	-6	-7	-9	-3	-11
Total		-10	6	4	5	6	7	3	19	6

Ref.	Plant	Mitigated Receiver Lp								dB(A)
		63	125	250	500	1k	2k	4k	8k	
1	Woods 560 Axial Fan	27	37	27	21	17	16	8	24	28
2	KD121 Scroll Condenser	1	1	0	2	4	2	-2	-7	8
3	Mitsubishi PURY-P450YNW	28	21	18	18	16	12	8	12	21
Safety		3	3	3	3	3	3	3	3	
Total		33	40	30	25	22	20	13	27	31

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		
0.8	34.0	2.4	4.0	75.0	0.00	-5	-5	-5	-5	-5	-5	-4	-4		
0.7	34.0	2.4	3.2	75.8	0.02	-5	-5	-5	-6	-7	-9	-11	-13		
1.9	34.0	2.4	2.6	76.4	-0.04	-4	-4	-2	0	0	0	0	0		

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

Barrier Deration		Woods 560 Axial F	0	0	0	0	0	0	0	0	0	0	0
		KD121 Scroll Cond	0	0	0	0	0	0	0	0	0	0	0
		Mitsubishi PURY-F	0	0	0	0	0	0	0	0	0	0	0

Net barrier loss		Woods 560 Axial F	-5	-5	-5	-5	-5	-5	-4	-4			
		KD121 Scroll Cond	-5	-5	-5	-6	-7	-9	-11	-13			
		Mitsubishi PURY-F	-4	-4	-2	0	0	0	0	0	0	0	0

Appendix E: Glossary

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

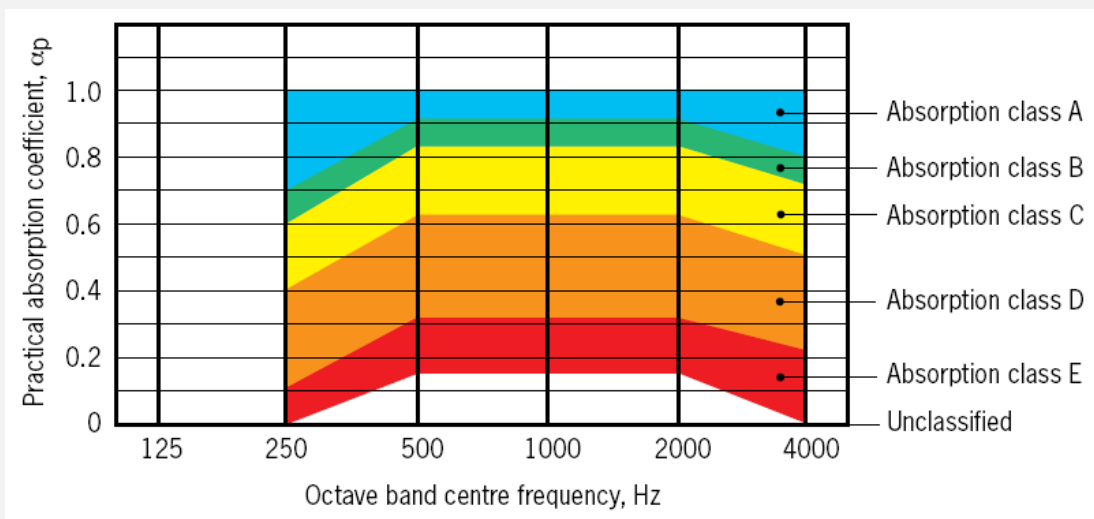
'A' Weighting

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).

Absorption Class

In order to categorise the absorptive effects of different elements (such as ceiling tiles), classes from A to E were derived, as per BS EN ISO 11654:1997. A class 'A' absorber would be very acoustically absorptive, a Class 'E' absorber would be less absorptive and more reflective. A product that is highly reflective may not be classified.

The chart shown below has been extracted from BB93, and demonstrates the characteristics of each class according to BS EN ISO 11654:1997.



Absorption Coefficient (α)

A value usually between 0 and 1 assigned to a material to indicate how acoustically absorptive it is. 0 indicates a material is entirely reflective (and therefore not absorptive), and 1 indicates a material is entirely absorptive (and therefore not reflective). Absorption coefficients are usually given for each octave band between 125Hz and 4kHz, or as an overall 'practical' coefficient.

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 $\neq$ 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.

Impact Noise

Re-radiated noise as a result of impact(s) on a solid medium, such as footfalls on floors. Measured in L'_{nTw} .

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.

L'_{nTw}

The weighted, normalised impact sound pressure level measured in a receive room below a source room.

L

Is the spatially averaged impact sound pressure level measured in a receive room.

L'_{nT}

Is the normalisation of the measured impact sound pressure level to the expected (in comparison to the measured) reverberation time in the receiving room.

L'_{nTw}

Is the weighted and normalised impact sound pressure level. This value is the result of applying a known octave band weighting curve to the measured result.

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 sound 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 2×10^{-5} Pa.

Speech Intelligibility, Speech Transmission Index (STI)

Speech intelligibility is the measure of how well a speaker's voice can be heard within a given space. Speech intelligibility within a room depends on a number of factors, including reverberation time and background noise.

The Speech Transmission Index or STI has emerged as the favoured method of describing speech intelligibility.

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.