Cole Jarman

Highgate Centre for Mental Health

Plant Noise Assessment

Report 18/0627/R1

Highgate Centre for Mental Health

Plant Noise Assessment

Report 18/0627/R1

FDE Architects

25 Rectory Lane
London
E17 3BG

Revision	Description	Date	Prepared	Approved
0	1st Issue	19 December 2018	Adam Sharpe	Neil Jarman

Cole Jarman Limited Reg. in England and Wales No. 7102436
An RSK Company
Registered Office Spring Lodge, 172 Chester Road, Helsby WA6 0AR
www.colejarman.com info@colejarman.com

Head Office +44 (0)1932 829007
John Cree House, 24b High Street, Addlestone, Surrey, United Kingdom KT15 1TN
Manchester 0161 470 8888 | Fourways House, 57 Hilton Street, Manchester M1 2EJ
Bristol 0117 287 2633 | The Old School, Stillhouse Lane, Bristol BS3 4EB

Table of Contents

Attachments

End of Section

Plant Noise Assessment

1 Introduction

1.1 An extension to the Highgate Centre for Mental Health is proposed. As part of this extension, it will be necessary to install new mechanical services plant.

1.2 Cole Jarman have been appointed to undertake an on-site background noise survey in order to inform the assessment of the noise emissions from the mechanical services scheme, this to form part of the extension's planning application.

1.3 The report details the results of the background noise survey, in addition to the findings of the evaluation of noise emissions from the proposed plant to the nearest noise sensitive areas. Where necessary, mitigation measures have been set out with performance requirements for the various elements specified.

2 Site Description

2.1 The site, located at Dartmouth Park Hill, Highgate, London N19 5NX is currently occupied by the car park and grounds of the Highgate Centre for Mental Health. The current centre premises is formed of a large, irregularly shaped complex comprised of a mixture of two and three storey clinic buildings, accessible from Dartmouth Park Road to the east.

2.2 The area situated between the site extents and Dartmouth Park Hill to the east is occupied by the large three-storey Highgate Wing of The Whittington Hospital, beyond which is the small residential Holbrook Close and the main Whittington Hospital grounds. To the north of Holbrook Close lies St Joseph's RC Primary School, which sits between Dartmouth Park Hill and Highgate Hill.

2.3 The area to the south of the site beyond existing clinic buildings is occupied by Lulot Gardens, a crescent of four-storey residential flats.

2.4 The site is surrounded by Highgate Cemetery and Waterlow Park to the north and west respectively.

2.5 The site sits within the jurisdiction of the London Borough of Camden.

3 Background Noise Survey

3.1 **Methodology**

3.1.1 An unattended noise survey was undertaken at the site commencing at 1045 hours on Tuesday 4 December, concluding at 0945 hours on Thursday 6 December 2018.

3.1.2 Measurements of background noise levels were taken from a free-field position in line to the east of the Centre's entrance building, roughly four metres above local ground level. This has been illustrated in attached site plan 18/0627/SP1.

3.1.3 This position was selected to quantify background noise levels representative of those at the nearest noise sensitive receivers external to the Centre's demise at the Whittington Hospital Highgate Wing to the east.

3.1.4 Measurements of the L_{Aeq}, L_{Amax} and L_{A90} indices were recorded over consecutive 15-minute periods for the duration of the survey using the equipment listed within table T1 (see attached Glossary of Acoustic Terms for an explanation of the noise units used).

Item	Manufacturer	Type
Sound Level Analyser	Norsonic	140
Acoustic Calibrator	Norsonic	1251
Weatherproof windshield	Norsonic	1212

T1 Equipment used during unattended noise survey.

3.1.5 The microphone was fitted within a weatherproof enclosure, and the sound level meter calibrated before and after the survey in order to confirm an acceptable level of accuracy.

3.1.6 The weather conditions when setting up the noise monitoring equipment were cold, sunny and still with dry roads. When collecting the equipment, the weather was overcast and cool with dry roads and some breeze. These conditions are deemed acceptable and are not considered to have affected the measurement results.

3.2 Results

3.2.1 The results of the noise measurements are presented in attached time history graph 18/0627/TH01.

3.2.2 The noise climate perceived onsite was comprised of playground noise from the nearby St Joseph's Primary School to the northeast, with elevated noise levels during vehicular activity entering/departing the site. In addition, there was some ground work noted to be taking place to the south during set up of the survey.

3.2.3 The minimum background noise levels recorded during the day and night time measurement hours during the survey duration are set out in table T2 below:

Location	Minimum Background Noise Level, dB(A)	
	Daytime (0700-2300 only)	Night time (24-hour)
MP1 – East of Centre entrance building	39	36

T2 Lowest measured background noise levels, L_{A90}.

4 Plant Noise Limits

4.1 The site falls under the jurisdiction of the London Borough of Camden.

4.2 Policy A4 of the London Borough of Camden's *Local Plan 2017* relates specifically to noise:

We will only grant permission for noise generating development, including any plant and machinery, if it can be operated without causing harm to amenity.

Planning conditions will be imposed to require that plant and equipment which may be a source of noise is kept working efficiently and within the required noise limits and time restrictions.

Conditions may also be imposed to ensure that attenuation measures are kept in place and are effective throughout the life of the development.

4.3 With regard to noise from new mechanical services plant, Appendix 3 of the Local Plan sets out the following:

A relevant standard or guidance document should be referenced when determining values for LOAEL and SOAEL for non-anonymous noise. Where appropriate and within the scope of the document it is expected that British Standard 4142:2014 'Methods for rating and assessing industrial and commercial sound' (BS 4142) will be used. For such cases a 'Rating Level' of 10 dB below background (15dB if tonal components are present) should be considered as the design criterion).

4.4 Section 11(1) of BS4142 states however:

Where background sound levels and rating levels are low, absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night.

4.5 We would normally consider 30 dBA as representing a low background level; Considering this point, as the day and night time background noise levels in table T2 are only 9 and 6 dB(A) above 30dB(A) respectively, we would recommend a plant noise emission limit of 30dB(A), so

as to set a pragmatic and achievable limit. This limit should apply 1m from the facade of the adjacent Whittington Hospital building

4.6 Noise should not have any tonal or intermittent character that would otherwise attract attention to it, otherwise a 5dBA penalty to apply.

4.7 To put the recommended limit of 30dB(A) in context, allowing for a typical loss of 12dB(A) from a partially open window would result in noise levels below 20dB(A) inside any residences exposed to this level of external plant noise.

4.8 Internal noise levels below 20dB(A) are more than 10dB(A) below the guideline level of $L_{Aeq,8h}$ 30dB suggested in BS8233:2014[1], as being appropriate or bedrooms to provide suitable conditions for sleeping.

4.9 Based on the results of our background noise survey set out within table T2, in addition to the guidance set out above, we recommend that the following plant emission limits are to apply at the nearest noise sensitive premises:

Location	**Noise Emission Limit, dB**
	24-hour
All noise sensitive receivers	30

T3 Plant noise emission limits at the nearest noise sensitive properties.

4.10 These limits are to apply to all plant items running simultaneously in the representative time periods, when running at design duty and are to apply at 1m from the outside of nearby residential windows. Any plant with a tonal component or other distinctive feature out of character with the existing environment would be subject to a further 5dB penalty.

5 Plant Noise Assessment

5.1 Proposed Installation

5.1.1 The proposed internal and external units ducted to atmosphere are as follows:

- CU01: Mitsubishi PUHZ-HW-140VHA2;
- CU02: Mitsubishi PUHZ-HW-140VHA2;
- CU03: Mitsubishi PURY-P300YNW-A;
- CU04: Mitsubishi PUHZ-PUZ-ZM60VHA;

[1] British Standard 8233:2014 - Guidance and sound insulation and noise reduction for buildings

- CU05 Mitsubishi PUHZ-ZM35VKA;
- CU06 Mitsubishi PUHZ-ZM35VKA;

- Dirty Extract: VES CAT0545-1/P/EE/LB/CPSC/SP;

- MVHR1: Mitsubishi Electric LGH-100RVX-E;
- MVHR2: Mitsubishi Electric LGH-100RVX-E;
- MVHR3: Mitsubishi Electric LGH-100RVX-E.

5.1.2 The condensing units are to be located externally within the area between the new building's western façade and the eastern façade of the centre's existing entrance building. The Dirty Extract is to be located within the lobby area, discharging to atmosphere through a louvered termination on the building's eastern façade, while the MVHR units are to be located within the Nurse Triage/Assessment Area, and are to discharge through louvres on the western and southern façades, in addition to a louvre through the building's plant room.

5.1.3 In-duct silencers manufactured by *Environmental Equipment Corporation Ltd.* have been specified for the MVHR and Dirty Extract units located within the building. The expected insertion loss performance of these have been set out in table T4 and factored in to our calculations.

Code	Location	Insertion Loss at Octave Band Centre Frequency (Hz)							
		63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
ATT01	MVHR1 Exhaust	4	6	10	16	21	23	17	11
ATT02	MVHR1 Fresh Air	4	6	10	16	21	23	17	11
ATT07	Dirty Extract Exhaust Air	4	7	9	11	15	18	14	8
ATT10	MVHR2 Exhaust	4	6	10	16	21	23	17	11
ATT11	MVHR2 Fresh Air	4	6	10	16	21	23	17	11
ATT14	MVHR3 Exhaust	4	6	10	16	21	23	17	11
ATT15	MVHR3 Fresh Air	4	6	10	16	21	23	17	11

T4 Specified silencer insertion losses.

5.1.4 As the units are to serve residential elements within the building, there will be no strict operating hours for the plant, with the units used on an ad-hoc basis. As a result of this, the 24-hour night time plant limits will apply.

5.2 Methodology

5.2.1 Our assessment has used manufacturer's noise data for each plant item as shown in the attached schedule 18/0627/PNS1. The noise data suggests that no tonality correction need be applied.

5.2.2 The nearest noise-sensitive receiver to the proposed plant installation is described below and illustrated on the attached site plan 18/0627/SP1.

- AP1: Second floor room on western façade of The Whittington Hospital's Highgate Wing.

5.2.3 The noise levels generated by all mechanical services elements have been calculated by correcting the plant noise levels for distance and radiation losses, façade reflections and screening where appropriate.

5.2.4 Details of our calculations are set out on attached sheets 18/0627/CS1-CS13.

5.3 Results

5.3.1 The results of our assessment indicate that no further mitigation of plant noise emissions will be required in order to meet the London Borough of Camden's noise emission limits.

5.3.2 The rating noise levels calculated as per the installation specified in section 5.1 above are shown in table T5.

Assessment Position	**Rating Noise Level, dB(A)** *(Limit)*
AP1 – 2F room on western façade of The Whittington Hospital's Highgate Wing	19 *(30)*

T5 Plant noise emission levels at assessment positions.

6 Conclusions

6.1 An extension to the Highgate Centre for Mental Health is proposed. As part of this extension, it will be necessary to install new mechanical services plant.

6.2 Noise mitigation measures have been recommended on the basis of a subsequent assessment of the proposed units and it has been shown that the limits would be met at all times.

End of Section

Glossary of Acoustic Terms

L_{Aeq}:

The notional steady sound level (in dB) which over a stated period of time, would have the same A-weighted acoustic energy as the A-weighted fluctuating noise measurement over that period. Values are sometimes written using the alternative expression dB(A) L_{eq}.

L_{Amax}:

The maximum A-weighted sound pressure level recorded over the period stated. L_{Amax} is sometimes used in assessing environmental noise when occasional loud noises occur, which may have little effect on the L_{Aeq} noise level. Unless described otherwise, L_{Amax} is measured using the "fast" sound level meter response.

L_{A10} & L_{A90}:

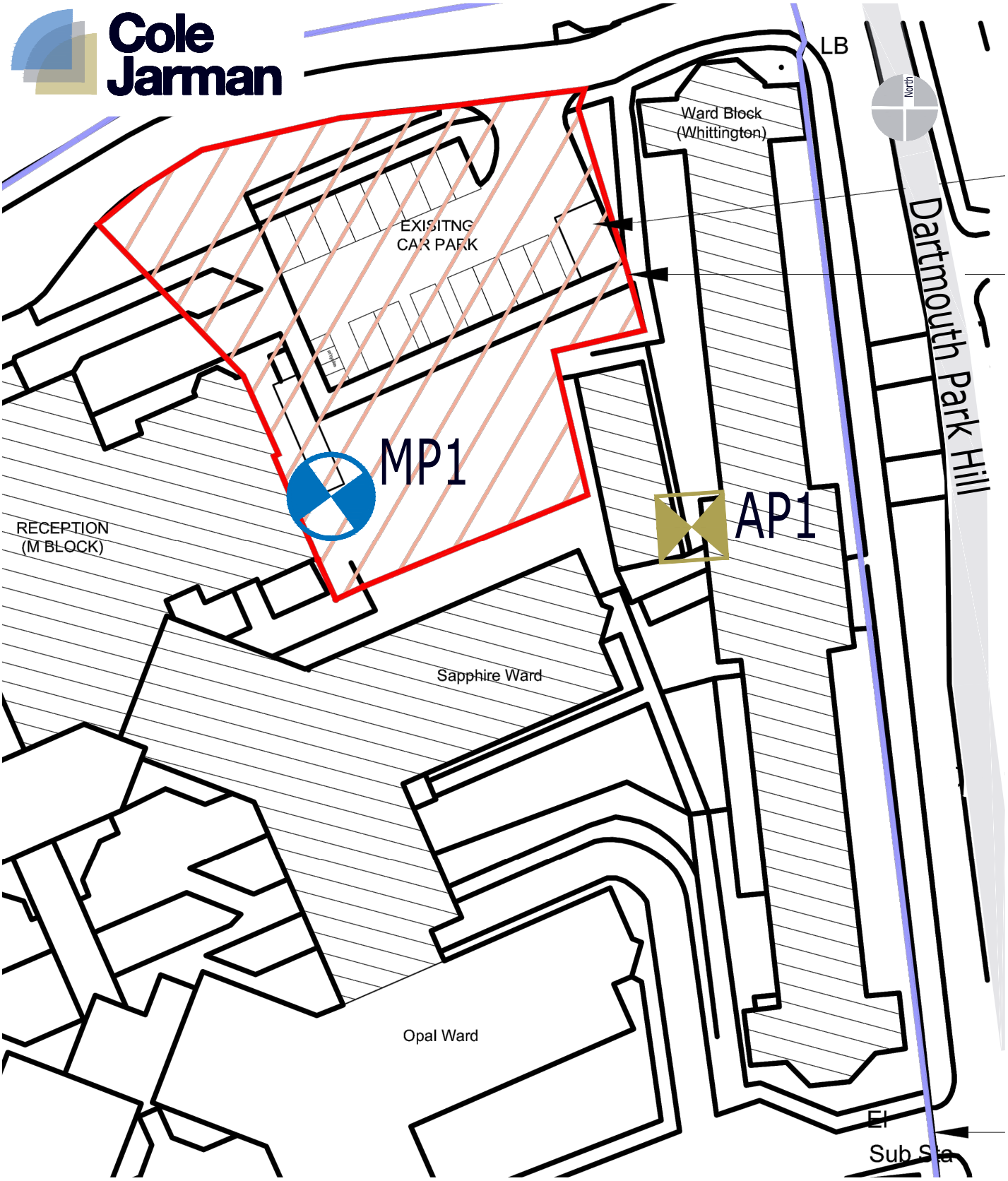
If non-steady noise is to be described, it is necessary to know both its level and degree of fluctuation. The L_{An} indices are used for this purpose. The term refers to the A-weighted level (in dB) exceeded for n% of the time specified. L_{A10} is the level exceeded for 10% of the time and as such gives an indication of the upper limit of fluctuating noise. Similarly L_{A90} gives an indication of the lower levels of fluctuating noise. It is often used to define the background noise.

L_{A10} is commonly used to describe traffic noise. Values of dB L_{An} are sometimes written using the alternative expression dB(A) L_n.

L_{AX}, L_{AE} or SEL

The single event noise exposure level which, when maintained for 1 second, contains the same quantity of sound energy as the actual time varying level of one noise event. L_{AX} values for contributing noise sources can be considered as individual building blocks in the construction of a calculated value of L_{Aeq} for the total noise. The L_{AX} term can sometimes be referred to as Exposure Level (L_{AE}) or Single Event Level (SEL).

End of Section



Title: Site plan illustrating unattended measurement and assessment positions

Figure 18/0627/SP1

Project: Highgate Centre for Mental Health

Date: December 2018 Revision: -

Scale: Not to scale

Cole Jarman Limited
t +44 (0)1932 829007 f +44 (0)1932 829003

John Cree House, 24B High Street, Addlestone, Surrey KT15 1TN
e info@colejarman.com w www.colejarman.com

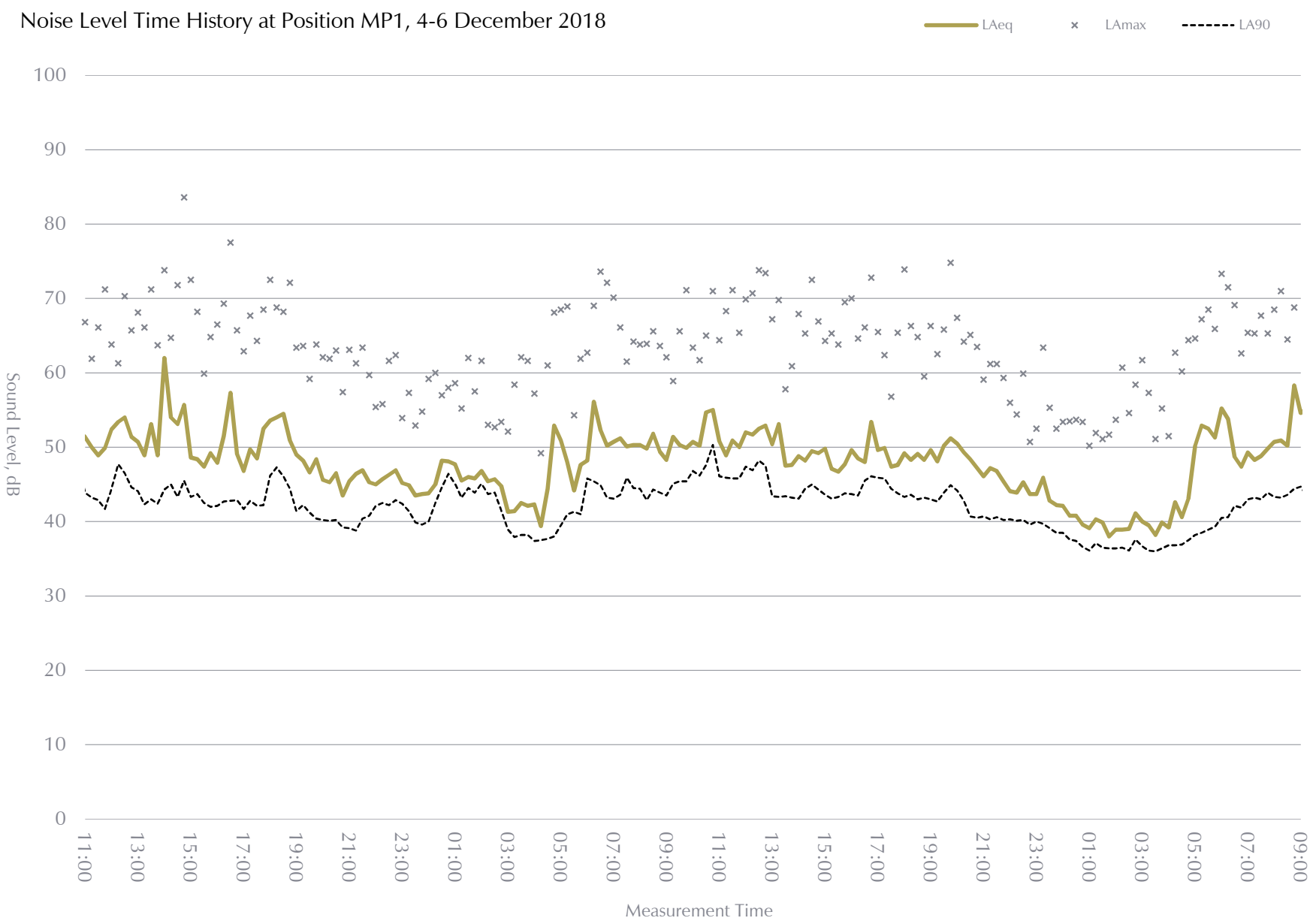


Figure 18/0627/TH01

Schedule of Plant and Air Handling Equipment Sound Levels, dB

Reference	Description	Data[1] Source	Noise Level Type	Noise Levels (dB)							
				63	125	250	500	1k	2k	4k	8k
CU01	External condensing unit 01	Man	Sound Pressure, Lp @ 1m	65	55	52	51	48	43	37	30
CU02	External condensing unit 02	Man	Sound Pressure, Lp @ 1m	65	55	52	51	48	43	37	30
CU03	External condensing unit 03	Man	Sound Pressure, Lp @ 1m	76	63	63	60	45	50	45	40
CU04	External condensing unit 04	Man	Sound Pressure, Lp @ 1m	53	52	53	44	43	39	33	27
CU05	External condensing unit 05	Man	Sound Pressure, Lp @ 1m	58	51	45	44	40	37	32	31
CU06	External condensing unit 06	Man	Sound Pressure, Lp @ 1m	58	51	45	44	40	37	32	31
DE01	Dirty Extract fan ducted to atmosphere through east facade	Man	Sound Power, Lw	70	62	56	51	44	46	41	44
MVHR1 Exhaust	MVHR 1 exhaust discharging through plant room	Man	Sound Power, Lw	72	72	68	69	62	62	63	52
MVHR1 FA	MVHR 1 fresh air through west facade	Man	Sound Power, Lw	72	72	68	69	62	62	63	52
MVHR2 Exhaust	MVHR 2 exhaust discharging through west facade	Man	Sound Power, Lw	72	72	68	69	62	62	63	52
MVHR2 FA	MVHR 2 fresh air through west facade	Man	Sound Power, Lw	72	72	68	69	62	62	63	52
MVHR3 Exhaust	MVHR 3 exhaust discharging through west facade	Man	Sound Power, Lw	72	72	68	69	62	62	63	52

Reference	Description	Data Source	Noise Level Type	Noise Levels (dB)							
				63	125	250	500	1k	2k	4k	8k
MVHR3 FA	MVHR 3 fresh air through south facade	Man	Sound Power, Lw	72	72	68	69	62	62	63	52

Notes

1 - Man refers to data supplied by the equipment manufacturer or supplier, Emp refers to data calculated using empirical formulae, and Meas refers to data measured by Cole Jarman

CU01 to AP1

		Octave Band Centre Frequency (Hz)								
		63	125	250	500	1k	2k	4k	8k	
Noise Source										
Noise Source - CU01										
Sound Pressure Levels @ 1m		**65**	**55**	**52**	**51**	**48**	**43**	**37**	**30**	**53dBA**
Full Conformal Area										
Distance (m)	1									
Type - Semi-anechoic										
		14	*14*	*14*	*14*	*14*	*14*	*14*	*14*	
Silencer										
Silencer - None										
		0	*0*	*0*	*0*	*0*	*0*	*0*	*0*	
Point Source Radiation Loss										
Radiation - Eighthspherical										
		-2	*-2*	*-2*	*-2*	*-2*	*-2*	*-2*	*-2*	
Point Source Distance Loss										
End Distance (m)	34									
		-31	*-31*	*-31*	*-31*	*-31*	*-31*	*-31*	*-31*	
Maekawa Screening Loss										
Path Difference (m)	0.873									
		-10	*-12*	*-15*	*-17*	*-20*	*-20*	*-20*	*-20*	
Facade Reflection										
Reflection (dB)	2.5									
		2	*2*	*2*	*2*	*2*	*2*	*2*	*2*	
External Receiver										
External Receiver - AP1										
Sound Pressure, Lp		**39**	**27**	**21**	**18**	**12**	**7**	**1**	**-6**	**20dBA**

CU02 to AP1

		Octave Band Centre Frequency (Hz)								
		63	125	250	500	1k	2k	4k	8k	
Noise Source										
Noise Source - CU02										
Sound Pressure Levels @ 1m		**65**	**55**	**52**	**51**	**48**	**43**	**37**	**30**	**53dBA**
Full Conformal Area										
Distance (m)	1									
Type - Semi-anechoic										
		14	*14*	*14*	*14*	*14*	*14*	*14*	*14*	
Silencer										
Silencer - None										
		0	*0*	*0*	*0*	*0*	*0*	*0*	*0*	
Point Source Radiation Loss										
Radiation - Quarterspherical										
		-5	*-5*	*-5*	*-5*	*-5*	*-5*	*-5*	*-5*	
Point Source Distance Loss										
End Distance (m)	34									
		-31	*-31*	*-31*	*-31*	*-31*	*-31*	*-31*	*-31*	
Maekawa Screening Loss										
Path Difference (m)	0.873									
		-10	*-12*	*-15*	*-17*	*-20*	*-20*	*-20*	*-20*	
Facade Reflection										
Reflection (dB)	2.5									
		2	*2*	*2*	*2*	*2*	*2*	*2*	*2*	
External Receiver										
External Receiver - AP1										
Sound Pressure, Lp		**36**	**24**	**18**	**15**	**9**	**4**	**-2**	**-9**	**17dBA**

CU03 to AP1

		Octave Band Centre Frequency (Hz)								
		63	125	250	500	1k	2k	4k	8k	
Noise Source										
Noise Source - CU03										
Sound Pressure Levels @ 1m		**76**	**63**	**63**	**60**	**45**	**50**	**45**	**40**	**60dBA**
Full Conformal Area										
Distance (m)	1									
Type - Semi-anechoic										
		15	*15*	*15*	*15*	*15*	*15*	*15*	*15*	
Silencer										
Silencer - None										
		0	*0*	*0*	*0*	*0*	*0*	*0*	*0*	
Point Source Radiation Loss										
Radiation - Quarterspherical										
		-5	*-5*	*-5*	*-5*	*-5*	*-5*	*-5*	*-5*	
Point Source Distance Loss										
End Distance (m)	33									
		-30	*-30*	*-30*	*-30*	*-30*	*-30*	*-30*	*-30*	
Maekawa Screening Loss										
Path Difference (m)	0.665									
		-9	*-11*	*-14*	*-16*	*-19*	*-20*	*-20*	*-20*	
Facade Reflection										
Reflection (dB)	2.5									
		2	*2*	*2*	*2*	*2*	*2*	*2*	*2*	
External Receiver										
External Receiver - AP1										
Sound Pressure, Lp		**49**	**34**	**31**	**26**	**8**	**12**	**7**	**2**	**28dBA**

Calculation Sheet 18/0627/CS4

CU04 to AP1

		Octave Band Centre Frequency (Hz)								
		63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	
Noise Source										
Noise Source - CU04										
Sound Pressure Levels @ 1m		**53**	**52**	**53**	**44**	**43**	**39**	**33**	**27**	**49dBA**
Full Conformal Area										
Distance (m)	1									
Type - Semi-anechoic										
		13	*13*	*13*	*13*	*13*	*13*	*13*	*13*	
Silencer										
Silencer - None										
		0	*0*	*0*	*0*	*0*	*0*	*0*	*0*	
Point Source Radiation Loss										
Radiation - Quarterspherical										
		-5	*-5*	*-5*	*-5*	*-5*	*-5*	*-5*	*-5*	
Point Source Distance Loss										
End Distance (m)	32									
		-30	*-30*	*-30*	*-30*	*-30*	*-30*	*-30*	*-30*	
Maekawa Screening Loss										
Path Difference (m)	1.288									
		-11	*-13*	*-16*	*-19*	*-20*	*-20*	*-20*	*-20*	
Facade Reflection										
Reflection (dB)	2.5									
		2	*2*	*2*	*2*	*2*	*2*	*2*	*2*	
External Receiver										
External Receiver - AP1										
Sound Pressure, Lp		**22**	**19**	**17**	**5**	**3**	**-1**	**-7**	**-13**	**12dBA**

CU05 to AP1

		Octave Band Centre Frequency (Hz)								
		63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	
Noise Source										
Noise Source - CU05										
Sound Pressure Levels @ 1m		**58**	**51**	**45**	**44**	**40**	**37**	**32**	**31**	**46dBA**
Full Conformal Area										
Distance (m)	1									
Type - Semi-anechoic										
		13	*13*	*13*	*13*	*13*	*13*	*13*	*13*	
Silencer										
Silencer - None										
		0	*0*	*0*	*0*	*0*	*0*	*0*	*0*	
Point Source Radiation Loss										
Radiation - Quarterspherical										
		-5	*-5*	*-5*	*-5*	*-5*	*-5*	*-5*	*-5*	
Point Source Distance Loss										
End Distance (m)	31									
		-30	*-30*	*-30*	*-30*	*-30*	*-30*	*-30*	*-30*	
Maekawa Screening Loss										
Path Difference (m)	1.517									
		-12	*-14*	*-17*	*-20*	*-20*	*-20*	*-20*	*-20*	
Facade Reflection										
Reflection (dB)	2.5									
		2	*2*	*2*	*2*	*2*	*2*	*2*	*2*	
External Receiver										
External Receiver - AP1										
Sound Pressure, Lp		**27**	**18**	**9**	**5**	**1**	**-2**	**-7**	**-8**	**9dBA**

Calculation Sheet 18/0627/CS6

CU06 to AP1

		Octave Band Centre Frequency (Hz)								
		63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	
Noise Source										
Noise Source - CU06										
Sound Pressure Levels @ 1m		**58**	**51**	**45**	**44**	**40**	**37**	**32**	**31**	**46dBA**
Full Conformal Area										
Distance (m)	1									
Type - Semi-anechoic										
		13	*13*	*13*	*13*	*13*	*13*	*13*	*13*	
Silencer										
Silencer - None										
		0	*0*	*0*	*0*	*0*	*0*	*0*	*0*	
Point Source Radiation Loss										
Radiation - Quarterspherical										
		-5	*-5*	*-5*	*-5*	*-5*	*-5*	*-5*	*-5*	
Point Source Distance Loss										
End Distance (m)	30									
		-30	*-30*	*-30*	*-30*	*-30*	*-30*	*-30*	*-30*	
Maekawa Screening Loss										
Path Difference (m)	1.501									
		-11	*-14*	*-17*	*-20*	*-20*	*-20*	*-20*	*-20*	
Facade Reflection										
Reflection (dB)	2.5									
		2	*3*	*2*	*2*	*2*	*2*	*2*	*2*	
External Receiver										
External Receiver - AP1										
Sound Pressure, Lp		**27**	**18**	**9**	**5**	**1**	**-2**	**-7**	**-8**	**9dBA**

DE01 to AP1

		Octave Band Centre Frequency (Hz)								
		63	125	250	500	1k	2k	4k	8k	
Noise Source										
Noise Source - DE01										
Sound Power Levels		**70**	**62**	**56**	**51**	**44**	**46**	**41**	**44**	**55dBA**
Silencer										
Silencer - ATT07										
		-4	*-7*	*-9*	*-11*	*-15*	*-18*	*-14*	*-8*	
Circular Unlined Duct Losses CJ										
Diameter (mm)	350									
Length (m)	13.5									
		-1	*-1*	*-1*	*-2*	*-3*	*-3*	*-3*	*-3*	
Bend Loss CJ										
Dimension (mm)	350									
No. of Bends (no.)	3									
Type - Radiussed Bend - With Vanes										
		0	*0*	*0*	*-3*	*-6*	*-9*	*-9*	*-9*	
End Reflection										
Width/Diameter (m)	1.3									
Length (m)	0.4									
Rec or Circ - Rectangular										
Free or Flush - Flush										
		-6	*-2*	*0*	*0*	*0*	*0*	*0*	*0*	
Point Source Radiation Loss										
Radiation - Hemispherical										
		-8	*-8*	*-8*	*-8*	*-8*	*-8*	*-8*	*-8*	

		Octave Band Centre Frequency (Hz)								
		63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	
External Grille Directivity										
Width (m)	1.3									
Height (m)	0.4									
Vertical (°)	25									
Horizontal (°)	35									
		2	*2*	*3*	*4*	*4*	*5*	*5*	*5*	
Point Source Distance Loss										
End Distance (m)	17									
		-25	*-25*	*-25*	*-25*	*-25*	*-25*	*-25*	*-25*	
Facade Reflection										
Reflection (dB)	2.5									
		2	*2*	*2*	*2*	*2*	*2*	*2*	*2*	
External Receiver										
External Receiver - AP1										
Sound Pressure, Lp		**30**	**24**	**19**	**8**	**-5**	**-9**	**-10**	**-1**	**14dBA**

MVHR1 Exhaust to AP1

		Octave Band Centre Frequency (Hz)								
		63	125	250	500	1k	2k	4k	8k	
Noise Source										
Noise Source - MVHR1 Exhaust										
Sound Power Levels		**72**	**72**	**68**	**69**	**62**	**62**	**63**	**52**	**71dBA**
Silencer										
Silencer - ATT01										
		-4	*-6*	*-10*	*-16*	*-21*	*-23*	*-17*	*-11*	
Rect Unlined Duct Losses CJ										
Width (mm)	250									
Height (mm)	200									
Length (m)	7									
		-3	*-4*	*-3*	*-2*	*-1*	*-1*	*-1*	*-1*	
Bend Loss CJ										
Dimension (mm)	200									
No. of Bends (no.)	1									
Type - Radiussed Bend - With Vanes										
		0	*0*	*0*	*0*	*-1*	*-2*	*-3*	*-3*	
End Reflection										
Width/Diameter (m)	0.8									
Length (m)	0.4									
Rec or Circ - Rectangular										
Free or Flush - Flush										
		-8	*-3*	*0*	*0*	*0*	*0*	*0*	*0*	
Point Source Radiation Loss										
Radiation - Hemispherical										
		-8	*-8*	*-8*	*-8*	*-8*	*-8*	*-8*	*-8*	

		Octave Band Centre Frequency (Hz)								
		63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	
External Grille Directivity										
Width (m)	0.8									
Height (m)	0.4									
Vertical (°)	10									
Horizontal (°)	60									
		0	*1*	*2*	*2*	*2*	*2*	*2*	*2*	
Point Source Distance Loss										
End Distance (m)	35									
		-31	*-31*	*-31*	*-31*	*-31*	*-31*	*-31*	*-31*	
Maekawa Screening Loss										
Path Difference (m)	3									
		-14	*-17*	*-20*	*-20*	*-20*	*-20*	*-20*	*-20*	
Facade Reflection										
Reflection (dB)	2.5									
		2	*2*	*2*	*2*	*2*	*2*	*2*	*2*	
External Receiver										
External Receiver - AP1										
Sound Pressure, Lp		**7**	**6**	**0**	**-4**	**-16**	**-19**	**-13**	**-18**	**-2dBA**

West Bottom - MVHR1 & 2 Fresh Air to AP1

		Octave Band Centre Frequency (Hz)								
		63	125	250	500	1k	2k	4k	8k	
West Bottom - MVHR1 & 2 Fresh Air										
West Bottom - MVHR1 & 2 Fresh Air - MVHR1 FA										
Sound Power Levels		**72**	**72**	**68**	**69**	**62**	**62**	**63**	**52**	**71dBA**
Silencer										
Silencer - ATT02										
		-4	*-6*	*-10*	*-16*	*-21*	*-23*	*-17*	*-11*	
Rect Unlined Duct Losses CJ										
Width (mm)	250									
Height (mm)	200									
Length (m)	11									
		-5	*-7*	*-5*	*-3*	*-2*	*-2*	*-2*	*-2*	
Bend Loss CJ										
Dimension (mm)	200									
No. of Bends (no.)	2									
Type - Radiussed Bend - With Vanes										
		0	*0*	*0*	*0*	*-2*	*-4*	*-6*	*-6*	
End Reflection										
Width/Diameter (m)	1.6									
Length (m)	0.4									
Rec or Circ - Rectangular										
Free or Flush - Flush										
		-5	*-1*	*0*	*0*	*0*	*0*	*0*	*0*	
Log Sum										
		4	*4*	*4*	*3*	*3*	*2*	*2*	*2*	

		Octave Band Centre Frequency (Hz)								
		63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	
Point Source Radiation Loss										
Radiation - Hemispherical										
		-8	*-8*	*-8*	*-8*	*-8*	*-8*	*-8*	*-8*	
External Grille Directivity										
Width (m)	1.6									
Height (m)	0.4									
Vertical (°)	15									
Horizontal (°)	160									
		0	*0*	*-2*	*-6*	*-8*	*-8*	*-8*	*-8*	
Point Source Distance Loss										
End Distance (m)	31									
		-30	*-30*	*-30*	*-30*	*-30*	*-30*	*-30*	*-30*	
Maekawa Screening Loss										
Path Difference (m)	1.7									
		-12	*-14*	*-17*	*-20*	*-20*	*-20*	*-20*	*-20*	
Facade Reflection										
Reflection (dB)	2.5									
		2	*2*	*2*	*2*	*2*	*2*	*2*	*2*	
External Receiver										
External Receiver - AP1										
Sound Pressure, Lp		**14**	**12**	**2**	**-8**	**-24**	**-28**	**-24**	**-28**	**-1dBA**

West top - MVHR2 & 3 Exhaust to AP1

		Octave Band Centre Frequency (Hz)								
		63	125	250	500	1k	2k	4k	8k	
West top - MVHR2 & 3 Exhaust										
West top - MVHR2 & 3 Exhaust - MVHR2 Exhaust										
Sound Power Levels		**72**	**72**	**68**	**69**	**62**	**62**	**63**	**52**	**71dBA**
Silencer										
Silencer - ATT10										
		-4	*-6*	*-10*	*-16*	*-21*	*-23*	*-17*	*-11*	
Rect Unlined Duct Losses CJ										
Width (mm)	250									
Height (mm)	200									
Length (m)	10									
		-4	*-6*	*-4*	*-3*	*-2*	*-2*	*-2*	*-2*	
Bend Loss CJ										
Dimension (mm)	200									
No. of Bends (no.)	3									
Type - Radiussed Bend - With Vanes										
		0	*0*	*0*	*0*	*-3*	*-6*	*-9*	*-9*	
End Reflection										
Width/Diameter (m)	1.6									
Length (m)	0.4									
Rec or Circ - Rectangular										
Free or Flush - Flush										
		-5	*-1*	*0*	*0*	*0*	*0*	*0*	*0*	
Log Sum										
		6	*3*	*2*	*3*	*3*	*3*	*3*	*3*	

		Octave Band Centre Frequency (Hz)								
		63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	
Point Source Radiation Loss										
Radiation - Hemispherical										
		-8	*-8*	*-8*	*-8*	*-8*	*-8*	*-8*	*-8*	
External Grille Directivity										
Width (m)	1.6									
Height (m)	0.4									
Vertical (°)	10									
Horizontal (°)	150									
		0	*0*	*-2*	*-6*	*-8*	*-8*	*-8*	*-8*	
Point Source Distance Loss										
End Distance (m)	33									
		-30	*-30*	*-30*	*-30*	*-30*	*-30*	*-30*	*-30*	
Maekawa Screening Loss										
Path Difference (m)	3									
		-14	*-17*	*-20*	*-20*	*-20*	*-20*	*-20*	*-20*	
Facade Reflection										
Reflection (dB)	2.5									
		2	*2*	*2*	*2*	*2*	*2*	*2*	*2*	
External Receiver										
External Receiver - AP1										
Sound Pressure, Lp		**14**	**9**	**-1**	**-9**	**-25**	**-30**	**-26**	**-31**	**-4dBA**

MVHR2 FA to AP1

		Octave Band Centre Frequency (Hz)								
		63	125	250	500	1k	2k	4k	8k	
Noise Source										
Noise Source - MVHR2 FA										
Sound Power Levels		**72**	**72**	**68**	**69**	**62**	**62**	**63**	**52**	**71dBA**
Silencer										
Silencer - ATT11										
		-4	*-6*	*-10*	*-16*	*-21*	*-23*	*-17*	*-11*	
Rect Unlined Duct Losses CJ										
Width (mm)	250									
Height (mm)	200									
Length (m)	8									
		-4	*-5*	*-4*	*-2*	*-2*	*-2*	*-2*	*-1*	
Bend Loss CJ										
Dimension (mm)	200									
No. of Bends (no.)	3									
Type - Radiussed Bend - With Vanes										
		0	*0*	*0*	*0*	*-3*	*-6*	*-9*	*-9*	
End Reflection										
Width/Diameter (m)	1.6									
Length (m)	0.4									
Rec or Circ - Rectangular										
Free or Flush - Flush										
		-5	*-1*	*0*	*0*	*0*	*0*	*0*	*0*	
Log Sum										
		2	*2*	*2*	*3*	*3*	*4*	*4*	*4*	

		Octave Band Centre Frequency (Hz)								
		63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	
Point Source Radiation Loss										
Radiation - Hemispherical										
		-8	*-8*	*-8*	*-8*	*-8*	*-8*	*-8*	*-8*	
External Grille Directivity										
Width (m)	1.6									
Height (m)	0.4									
Vertical (°)	15									
Horizontal (°)	160									
		0	*0*	*-2*	*-6*	*-8*	*-8*	*-8*	*-8*	
Point Source Distance Loss										
End Distance (m)	31									
		-30	*-30*	*-30*	*-30*	*-30*	*-30*	*-30*	*-30*	
Maekawa Screening Loss										
Path Difference (m)	1.7									
		-12	*-14*	*-17*	*-20*	*-20*	*-20*	*-20*	*-20*	
Facade Reflection										
Reflection (dB)	2.5									
		2	*2*	*2*	*2*	*2*	*2*	*2*	*2*	
External Receiver										
External Receiver - AP1										
Sound Pressure, Lp		**14**	**12**	**2**	**-8**	**-24**	**-28**	**-24**	**-28**	**-1dBA**

Calculation Sheet 18/0627/CS12

MVHR3 Exhaust to AP1

		Octave Band Centre Frequency (Hz)								
		63	125	250	500	1k	2k	4k	8k	
Noise Source										
Noise Source - MVHR3 Exhaust										
Sound Power Levels		**72**	**72**	**68**	**69**	**62**	**62**	**63**	**52**	**71dBA**
Silencer										
Silencer - ATT14										
		-4	*-6*	*-10*	*-16*	*-21*	*-23*	*-17*	*-11*	
Rect Unlined Duct Losses CJ										
Width (mm)	250									
Height (mm)	200									
Length (m)	12.5									
		-6	*-8*	*-6*	*-4*	*-2*	*-2*	*-2*	*-2*	
Bend Loss CJ										
Dimension (mm)	200									
No. of Bends (no.)	3									
Type - Radiussed Bend - With Vanes										
		0	*0*	*0*	*0*	*-3*	*-6*	*-9*	*-9*	
End Reflection										
Width/Diameter (m)	1.6									
Length (m)	4									
Rec or Circ - Rectangular										
Free or Flush - Flush										
		0	*0*	*0*	*0*	*0*	*0*	*0*	*0*	
Log Sum										
		1	*3*	*4*	*3*	*3*	*3*	*3*	*3*	

		Octave Band Centre Frequency (Hz)								
		63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	
Point Source Radiation Loss										
Radiation - Hemispherical										
		-8	*-8*	*-8*	*-8*	*-8*	*-8*	*-8*	*-8*	
External Grille Directivity										
Width (m)	1.6									
Height (m)	0.4									
Vertical (°)	10									
Horizontal (°)	150									
		0	*0*	*-2*	*-6*	*-8*	*-8*	*-8*	*-8*	
Point Source Distance Loss										
End Distance (m)	33									
		-30	*-30*	*-30*	*-30*	*-30*	*-30*	*-30*	*-30*	
Maekawa Screening Loss										
Path Difference (m)	3									
		-14	*-17*	*-20*	*-20*	*-20*	*-20*	*-20*	*-20*	
Facade Reflection										
Reflection (dB)	2.5									
		2	*2*	*2*	*2*	*2*	*2*	*2*	*2*	
External Receiver										
External Receiver - AP1										
Sound Pressure, Lp		**14**	**9**	**-1**	**-9**	**-25**	**-30**	**-26**	**-31**	**-4dBA**

MVHR3 FA to AP1

		Octave Band Centre Frequency (Hz)								
		63	125	250	500	1k	2k	4k	8k	
Noise Source										
Noise Source - MVHR3 FA										
Sound Power Levels		**72**	**72**	**68**	**69**	**62**	**62**	**63**	**52**	**71dBA**
Silencer										
Silencer - ATT15										
		-4	*-6*	*-10*	*-16*	*-21*	*-23*	*-17*	*-11*	
Rect Unlined Duct Losses CJ										
Width (mm)	250									
Height (mm)	200									
Length (m)	7									
		-3	*-4*	*-3*	*-2*	*-1*	*-1*	*-1*	*-1*	
Bend Loss CJ										
Dimension (mm)	200									
No. of Bends (no.)	2									
Type - Radiussed Bend - With Vanes										
		0	*0*	*0*	*0*	*-2*	*-4*	*-6*	*-6*	
End Reflection										
Width/Diameter (m)	0.8									
Length (m)	0.4									
Rec or Circ - Rectangular										
Free or Flush - Flush										
		-8	*-3*	*0*	*0*	*0*	*0*	*0*	*0*	
Point Source Radiation Loss										
Radiation - Hemispherical										
		-8	*-8*	*-8*	*-8*	*-8*	*-8*	*-8*	*-8*	

		Octave Band Centre Frequency (Hz)								
		63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	
External Grille Directivity										
Width (m)	0.8									
Height (m)	0.4									
Vertical (°)	15									
Horizontal (°)	70									
		0	*1*	*2*	*2*	*2*	*2*	*1*	*2*	
Point Source Distance Loss										
End Distance (m)	26									
		-28	*-28*	*-28*	*-28*	*-28*	*-28*	*-28*	*-28*	
Facade Reflection										
Reflection (dB)	2.5									
		2	*2*	*2*	*2*	*2*	*2*	*2*	*2*	
External Receiver										
External Receiver - AP1										
Sound Pressure, Lp		**24**	**26**	**23**	**19**	**6**	**1**	**6**	**2**	**19dBA**

Cole Jarman Limited Reg. in England and Wales No. 7102436
An RSK Company

Registered Office Spring Lodge, 172 Chester Road, Helsby WA6 0AR
www.colejarman.com info@colejarman.com

Head Office +44 (0)1932 829007
John Cree House, 24b High Street, Addlestone, Surrey, United Kingdom KT15 1TN
Manchester 0161 470 8888 | Fourways House, 57 Hilton Street, Manchester M1 2EJ
Bristol 0117 287 2633 | The Old School, Stillhouse Lane, Bristol BS3 4EB