MACH RESIDENTIAL

8 SMART'S PLACE, COVENT GARDEN

Noise Impact Assessment

David Kohn Architects Ltd

MACH RESIDENTIAL

8 SMART'S PLACE, COVENT GARDEN

Noise Impact Assessment

David Kohn Architects Ltd

Revision	Description	Author	Checked by	Issued by	Issue Date
00	First Issue	RP	SH	RP	09/10/2018

.

MACH Acoustics Ltd
3rd Floor 4 York Court
Upper York Street
Bristol
BS2 8QF

Eagle House
163 City Road
London
EC1V 1NR

t: 0117 944 1388
e: info@machacoustics.com
w: www.machacoustics.com

Consultants	AR	Andrew Rickard	andrew@machacoustics.com
	CB	Claire Bye	claire@machacoustics.com
	CJ	Chris Jones	chris@machacoustics.com
	JC	Josh Childs	josh@machacoustics.com
	KE	Kyle Edwards	kyle@machacoustics.com
	MR	Max Reynolds	max@machacoustics.com
	OS	Oscar Pope	oscar@machacoustics.com
	PS	Patrick Shuttleworth	patrick@machacoustics.com
	PJ	Phil Jordan	phil@machacoustics.com
	RP	Rory Peliza	rory@machacoustics.com
	SH	Stefan Hannan	stefan@machacoustics.com
	SD	Steffan Davies	steffan.d@machacoustics.com
	YW	Hsuan-Yang Wang	yang@machacoustics.com
	ZN	Ze Nunes	ze@machacoustics.com
	ZV	Zoe Vernon	zoe@machacoustics.com
Finance	TT	Tracy Toal	tracy@machacoustics.com
	ZG	Zheng Ge	zheng@machacoustics.com

TABLE OF CONTENTS

1.0 INTRODUCTION

MACH Residential has been appointed by David Kohn Architects Ltd to undertake an environmental noise assessment for the proposed MVHR system and ASHP units at 8 Smart's Place, Covent Garden. Proposals are for an MVRH system with inlet and outlet on façade and an additional five ASHP units on the roof.

The purpose of the assessment is to determine the noise level of the proposed plant in relation to the existing ambient background noise level representative of the worst affected dwellings to the proposed development. To establish a worst case for background noise levels during the 24-hour period, noise monitoring was undertaken between 13:37 on 05/04/16 and 12:05 on 06/04/16.

2.0 SITE DESCRIPTION

The location of the proposed site is green, the nearest residential receiver is green and the nearest commercial property is blue, as indicated in Figure 2-1. An assessment has been made to the worst affected residential and commercial receptors.

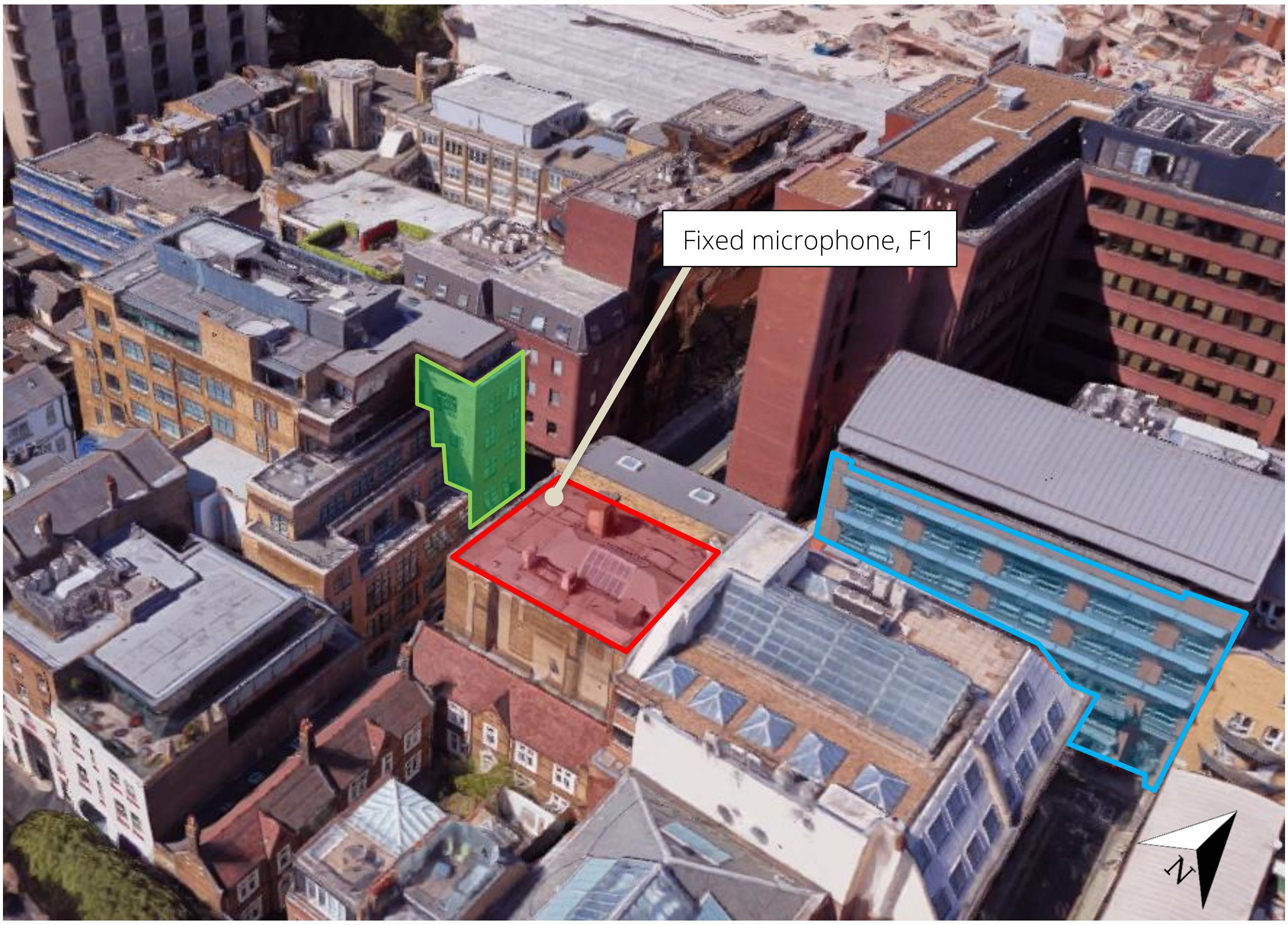


Figure 2-1: Shows the site location (red), the worst affected residents (green) and the worst affected commercial properties (blue).

2.1 Environmental Noise Sources

The following are seen to constitute primary contributors to background noise levels on site;

- The surrounding roads including; Smart's Place, Stukley Street and Macklin Street.
- There are also a number of plant units which can be heard within the surrounding area.

2.2 Noise Sensitive Receptors

The nearest noise sensitive receptors are indicated in green and blue in Figure 2-1, and are as follows;

- There are a number of residential properties on Smart's Place approximately 15 m away from the ASHUs
- There are also a number of commercial properties, approximately 15 meters away from the ASHUs
- The worst affected residents to the MVHR exhaust and supply is the proposed development.

The proposed development has a number of skylights which MACH has suggested should not be openable. As these windows are not openable, they have not been considered within the BS4142 assessment, however a break in calculation from the ASHPs has been undertaken to ensure that internal ambient noise levels according to BS8233 are adhered to.

2.3 Noise Source Locations

The proposed plant locations are highlighted in Figure 2-2. MACH has been informed that there are a number of ventilation units above the fire escape stairs which are to be used to provide ventilation to the stairs in the event of a fire. As these units are unlikely to be used often, they have not been taken into account when assessing the plant units to BS4142.

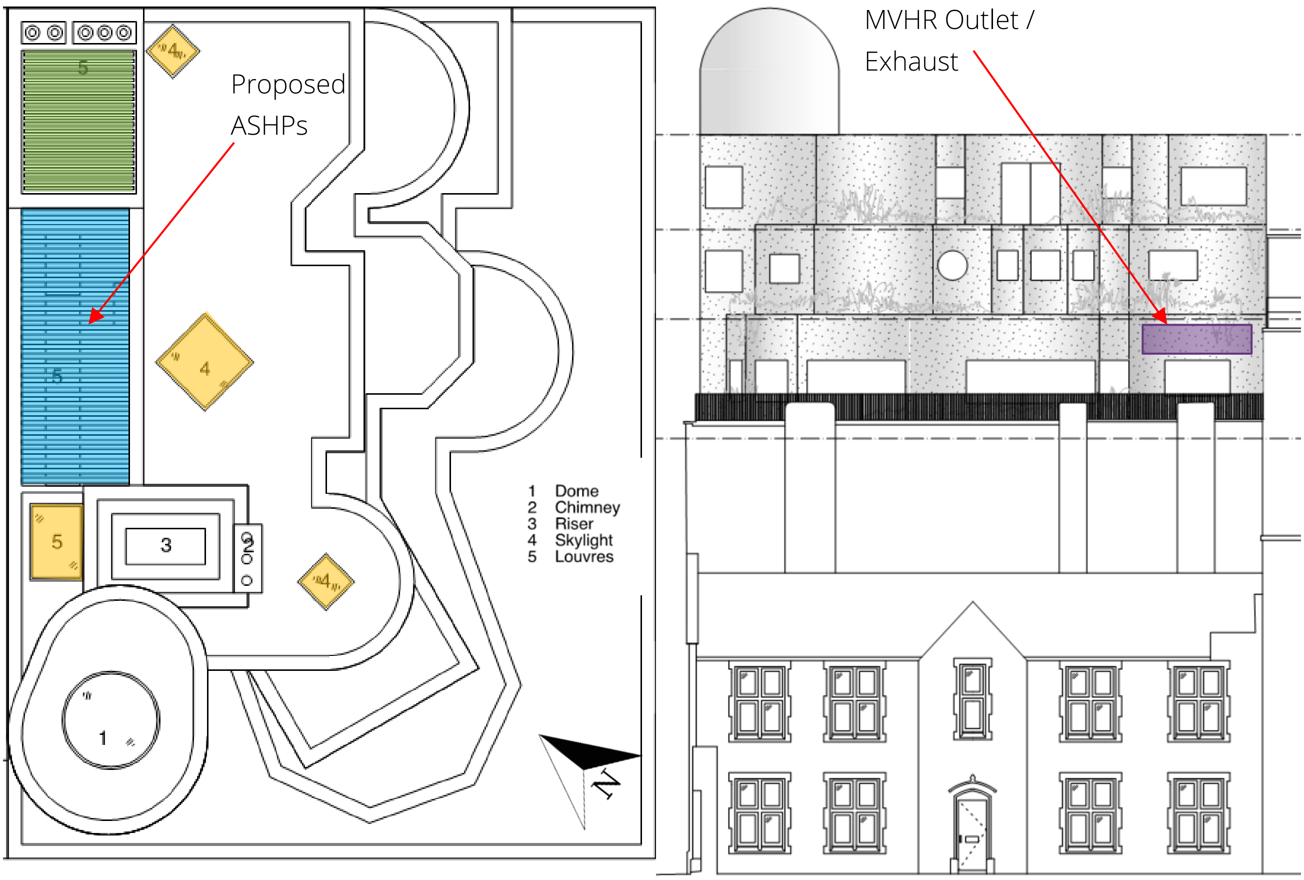


Figure 2-2: Proposed Source Locations, ASHP units (highlighted in blue) emergency ventilation units (green), skylight windows (yellow) and MVHR outlet / exhaust (purple).

3.0 ENVIRONMENTAL NOISE SURVEY

3.1 Methodology

In order to establish existing background noise levels on site, continuous 5–minute samples of the acoustic parameters $L_{Aeq, T}$, $L_{A90\ T}$, and $L_{Amax,T}$ were measured across a 24 hour period. This period has been selected to account for a worst case of background noise levels at the nearest noise sensitive receptors.

The noise assessment serves to evaluate the noise from the proposed plant at the nearest existing residential and commercial properties. Therefore, the measurement location has been chosen to be representative of background noise levels on Stuckeley Street and Smarts Place.

The fixed measurement location (F) is illustrated in Figure 2-1. To establish a worst case for background noise levels during the 24-hour period, monitoring was undertaken between 13:37 on 05/04/16 and 12:05 on 06/04/16.

3.2 Measurement Equipment

The measurement equipment illustrated in Table 3.1 was used during the survey, all equipment complies with BS EN 60942:2003 i.e. a class 1 device.

Name	Serial Number	Last Calibrated	Certificate number	Calibration Due
Norsonic Precision Sound Analyser Type 118 STI	30562	May-18	28586	May-20
Norsonic Type 1206 Pre-amplifier	30249	May-18	28586	May-20
GRAS 40AF Microphone	114670	May-18	28586	May-20

Table 3.1: Measurement Equipment Calibration

3.3 Weather Conditions

The following climate conditions were recorded for the site:

Wind: Less than 5 m/s.
Humidity: The weather was clear.
Temperature: 7 $_{o}$C.

The above weather conditions are suitable for the measurement of environmental noise in accordance with BS7445 *Description and Measurement of Environmental Noise.*

4.0 RESULTS

4.1 Fixed Measurement Results

The following graph presents the background noise levels recorded over the measurement period at the fixed location (F). The complete set of measurement data is available on request.

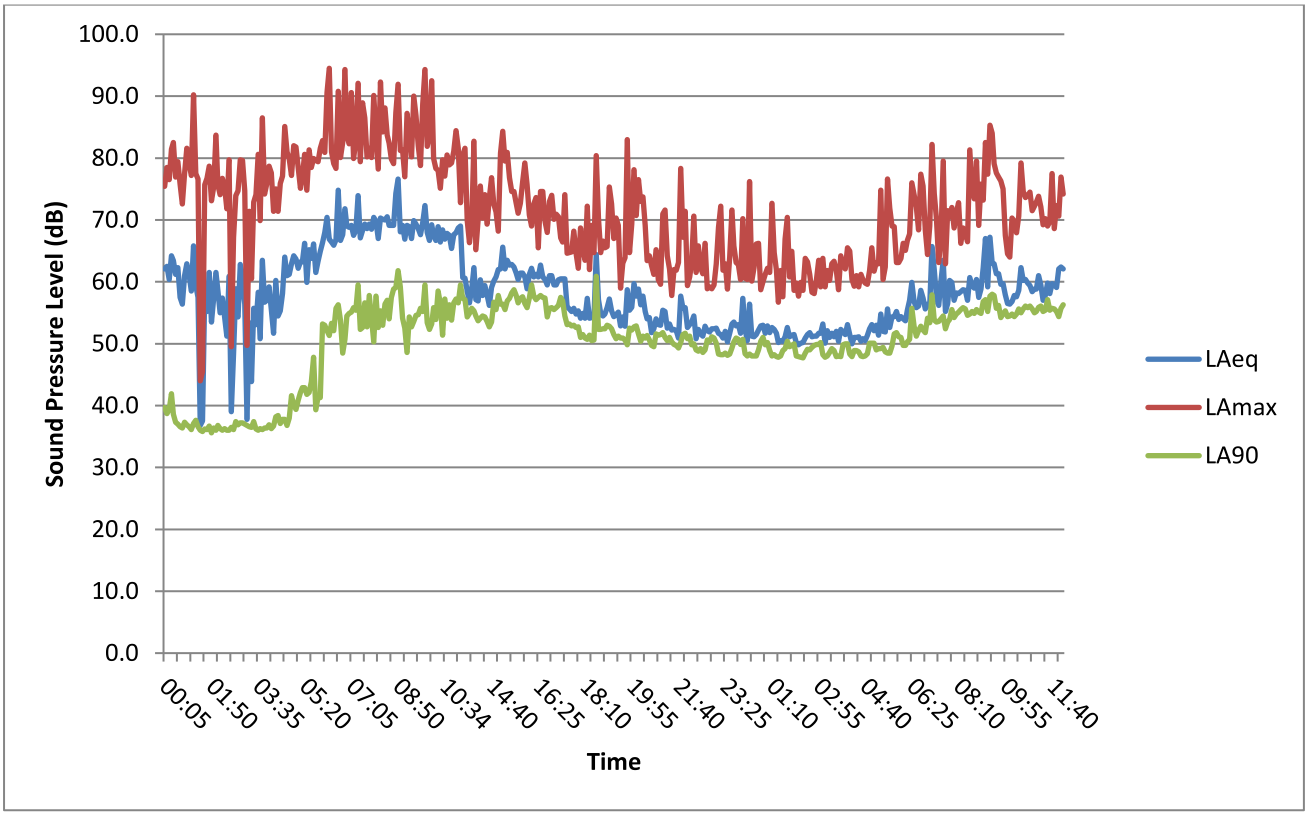


Figure 4-1: Fixed Measurement Graph (F1), L_{Aeq}, L_{Amax}, L_{A90}

4.2 Summary of Fixed Location Measurements – Background Noise

BS4142: 2014 states that '*in using the background sound level in the method for rating and assessing industrial and commercial sound it is important to ensure that values are reliable and suitably represent both the particular circumstances and periods of interest. For this purpose, the objective is not simply to ascertain a lowest measured background sound level, but rather to quantify what is typical during particular time periods.'* BS4142 further states that '*a representative level ought to account for the range of background sound levels and ought not automatically to be assumed to be either minimum or modal value'.* Hence BS4142 does not provide a black and white method of obtaining the assessment level for background noise.

For the purposes of assessment, MACH have derived the modal L_{A90} occurring during the operational hours of the noise source. Table 4.1 provides the background noise levels which will form the basis of assessment.

Time Interval	Assessment L_{A90} (dB)
Day (07:00 - 23:00)	56
Night (23:00 - 07:00)	48

Table 4.1: Assessment Background Noise Levels.

5.0 NOISE BREAK-OUT ASSESSMENT

5.1 Rating Level Target

The local council have asked that the sound pressure level at the worst affected noise sensitive receiver is at least 10 dB below the background level. Therefore, the target level is shown in Table 5.1 below.

Measurement Period	Background Noise Level dB L_{A90}	Noise Rating Level Design Criteria	Plant Noise Rating Level Limit dB $L_{Aeq,T}$
Day (07:00-23:00)	56	-10 dB	46 dB
Night (23:00-07:00)	48	-10 dB	38 dB

Table 5.1: Noise Rating Level Limits.

6.0 PLANT NOISE ASSESSMENT

6.1 Noise Sources

The following noise levels have formed the basis of assessment.

Source	Specification / Manufacturer	Sound Power dB L_{Aeq}, Octave Band Centre Frequencies, Hz							dB(A)
		63	125	250	500	1000	2000	4000	
MVHR Unit (Exhaust)	MRXBOXAB-ECO4 / Nuaire	61	56	56	63	53	48	40	61
MVHR Unit (Supply)		64	65	66	77	66	64	58	75
ASHP (Heating and Cooling)	REYQ10T / Daikin	81*	81	78	78	74	69	64	79
ASHP (Hot Water)**	Existing Unit	54	59	55	44	36	45	65	66

Table 6.1: Noise Source – Representative Noise Levels.

* manufacturer data for this ASHP unit was not available from the manufacturer at 63 Hz. Therefore, MACH have assumed this to be the same value as that of the unit at 125 Hz.
**The sound power level of this unit has been measured on site.

As stated in Section 2.3, there are a number of ventilation units above the fire escape stairs which are to be used in the event of an emergency. BS8233 states that for internal ambient noise levels within residential properties "it is normal to exclude occasional events, such as fireworks night or New Year's Eve". It is likely that the emergency ventilation units will be used less than once a year these units do not need to be considered.

Manufacturer data can be found in Appendix C.

6.2 Attenuation Requirements

Without the provision of attenuation to the proposed noise source, noise emissions will not meet the required rating level target stated in Table 5.1. In order to meet the required rating level target, the following attenuation will be required.

Sources requiring attenuation	Insertion Loss, Octave Band Centre Frequencies, Hz						
	63	125	250	500	1000	2000	4000
MVHR Unit (Exhaust)	-	13	23	38	33	33	28
MVHR Unit (Supply)	-	8	13	23	18	13	13
ASHP (Heating and Cooling)	10	20	20	25	25	20	15
ASHP (Hot Water)	-	-	-	-	-	5	15

Table 6.2: Required Attenuator Insertion Loss for each unit.

Table 6.2 above provides the minimum insertion loss required in each octave band, for the affected elements of the noise source.

There are a number of plant units to be mounted on the roof of the proposed dwelling. Therefore, to avoid any vibration being transferred from the units to the roof, and then reradiated into the dwelling, It is important that any units placed on roof should be mounted on the appropriate vibration mounts as supplied by the manufacturer.

6.3 Break-In Calculation

The ASHP units on the roof of Smart's Place are close to the skylights as highlighted in yellow in Figure 2-2. These windows should not be openable windows. As these windows cannot be opened they have not been assessed according to the BS4142 criteria, however, MACH have completed a break in assessment to predict the necessary sound insulation properties of the roof, glazing and ventilation elements required in order to achieve the internal ambient noise levels stated in BS8233.

Within BS8233, the internal ambient noise levels at night are advised to be below 30 dB $L_{Aeq,8hr}$ this is seen to be suitable for sleeping at night. For this level to be achieved the following specifications for each façade element should be adhered to:

Description	Element	Units	125	250	500	1000	2000	4000
Skylight windows	Roof construction	R_w	34	39	40	45	50	55
	Glazing	R_w	29	39	49	52	55	63

Table 6.3: Minimum sound reduction indices (SRI) for façade elements

Note that the specifications are for guidance only. Similar systems to the ones used in calculations may achieve the same desired internal noise levels. All systems should be verified by the supplier against the sound reduction indices above.

Description	Element	Construction Description
Façade Elements	Roof	Construction to be confirmed
	Glazing	Double - 9.1 Phon /20/13.1 Phon

Table 6.4: Suggested façade elements.

The roof construction has not been included in the table above, as the construction is currently not decided on, however any system should achieve a similar sound insulation performance as those shown in Table 6.3. MACH would also advise that no trickle vents are installed on the skylights as these are a weak-point in terms of acoustics. With elements which achieve the sound reduction indices as noted in Table 6.3, the predicted resultant noise levels are:

		Sound Pressure Level dB, $L_{Aeq,T}$, Octave Band Centre Frequencies, Hz						
Element	Location	125	250	500	1000	2000	4000	dBA
Predicted internal noise levels from plant noise	Bedroom	32	23	17	9	6	4	20

Table 6.5: Shows the predicted internal noise levels within the bedroom, due to break through from plant noise.

It should be noted that the predicted internal noise level from the plant units is below the target for 30 dB within a bedroom at night, adequate for sleeping. This is to take into account the fact that breakthrough the façade from other noise sources will combine with breakthrough from the plant units. Therefore, the combination of the two noise sources is predicted to still achieve the internal noise levels set out in BS8233.

6.4 Assessment – BS 4142: 2014

Table 6.6 provides the calculated rating level at the nearest noise sensitive receptor. The specific noise level has been established through calculation as provided in Appendix B. The nearest noise sensitive receptors are indicated in Figure 2.1 and outlined in Section 2.2

This assessment assumes that the attenuation in Section 6.2 has been implemented in full.

An acoustic feature correction has not been applied, as the source is broadband in nature, and once attenuation has been applied, the specific noise level is low

Period	Location	Background Noise Level (L_{A90}, dB)	Specific Noise Level ($L_{Aeq\ 15\ MIN}$, dB)	Rating Level	Assessment Outcome
Day Time (07:00 – 23:00)	Worst affected Residential receivers	56	38	38	-18 dB
Day Time (07:00 – 23:00)	Worst affected Commercial Receivers	56	33	33	-23 dB
Night Time (23:00 – 07:00)	Worst affected Residential receivers	48	38	38	-10 dB
Night Time (23:00 – 07:00)	Worst affected Commercial Receivers	48	33	33	-15 dB

Table 6.6: BS4142: Assessment Outcome

As can been seen in Table 6.6 the rating level of the proposed noise source is compliant with the required rating level targets.

MACH have taken into account the worst-case scenario when the plant units are on continuously throughout the assessment period. Therefore, this assessment is seen to be very robust.

7.0 CONCLUSION

MACH Residential has been appointed by David Kohn Architects Ltd to undertake an environmental noise assessment for the proposed MVHR inlet/outlet and ASHP units at 8 Smart's Place, Covent Garden. Proposals are for a number of ASHP units to be placed on the roof, along with MVHR outlet and inlets to be on the façade of the building.

The assessment has indicated that the rating level of the proposed plant will be compliant with the provisions of BS 4142: 2014, with the inclusion of attenuation as outlined in Section 6.2. As such the assessment indicates that there will be a low risk of complaints.

APPENDIX A – BS4142 CRITERIA

BS 4142:2014 "Methods for rating and assessing industrial and commercial sound" describes a method of determining the level of noise of an industrial nature, together with the procedures for assessing whether the noise in question is likely to give rise to complaints from persons living in the vicinity. As such, an assessment to BS 4142 is typically called for within planning conditions. The likelihood of complaints in response to a noise depends on various factors. BS 4142 assesses the likelihood of complaints by considering the margin by which the noise in question exceeds the background noise level.

BS 4142 states that one should *'obtain an initial estimate of the impact of the specific sound by subtracting the measured background sound level from the rating level and consider the following:*

a) Typically, the greater this difference, the greater the magnitude of the impact.
b) A difference of around +10 dB or more is likely to be an indication of a <u>significant</u> adverse impact, depending on the context.
c) A difference of around + 5 dB is likely to be an indication of an adverse impact, depending on the context.
d) *The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context.*

The aforementioned rating level is based upon the specific noise level of the noise source in question. A correction should be applied to the specific noise level to obtain an increased rating level if *'a tone, impulse or other characteristic occurs, or is expected to be present, for new or modified sound sources.* To summarise, BS4142 section 9.2 advises the following in regards to corrections for acoustic characteristics:

- Tonality – *for sound ranging from not tonal to prominently tonal the Joint Nordic Method gives a correction of between 0 dB and +6 dB for tonality. Subjectively, this can be converted to a penalty of 2 dB for a tone which is just perceptible at the noise receptor, 4 dB where it is clearly perceptible, and 6 dB where it is highly perceptible.*
- Impulsivity – *A correction of up to +9 dB can be applied for sound that is highly impulsive, considering both the rapidity of the change in sound level and the overall change in sound level., Subjectively, this can be converted to a penalty of 3 dB for impulsivity which is just perceptible at the noise receptor, 6 dB where it is clearly perceptible, and 9 dB where it is highly perceptible.*
- Other sound characteristics – *Where the specific sound features characteristics that are neither tonal nor impulsive, though otherwise are readily distinctive against the residual acoustic environment, a penalty of 3 dB can be applied*
- Intermittency – *When the specific sound has identifiable on/off conditions, if the intermittency is readily distinctive against the residual acoustic environment, a penalty of 3 dB can be applied.*

APPENDIX B – CALCULATIONS

BS8233 Facade Noise Break In Calculation		63	125	250	500	1000	2000	4000	dB(A)
Noise Level at Façade		70	61	57	52	48	48	49	**57**
Calculation of environmental noise break-in									
3dB Safety (Calculation of enviromental noise break-in)	3 dB	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
L2 = L0 - R + 10*log(S/A) + 3dB (Freefield version)									
Facade level type	Lff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Free field level									
Calculated A = 0.161V/RT									
Volume =	53 m3								
RT	0.8 s	0.8	0.8	0.8	0.8	0.8	0.8	0.8	
A (absorption in sabins)		10.6	10.6	10.6	10.6	10.6	10.6	10.6	
10*log(S/A)		3.2	3.2	3.2	3.2	3.2	3.2	3.2	
FAÇADE Elements									
Total Façade Area	**22.0 m2**								
Custom Roof Build Up	15 m2	0	34	39	40	45	50	55	
10Log((Si/Stot)10^(-R/10))		0	-36	-41	-42	-47	-52	-57	
Predicted noise level in building Lff+tl+10log(A0/A)+K		-99.0	31.0	22.9	16.6	7.6	2.6	-1.5	19.5
Double - 9.1 Phon /20/13.1 Phon	1 m2	0	29	39	49	52	55	63	
10Log((Si/Stot)10^(-R/10))		0	-42	-52	-62	-65	-68	-76	
Predicted noise level in building Lff+tl+10log(A0/A)+K		-99.0	24.2	11.1	-4.2	-11.2	-14.2	-21.3	9.4

		63	125	250	500	1000	2000	4000	dB(A)
Combined Noise Levels (1+2+3+4+5+6) - All Elements including Vents/Open Windows		**3.0**	**32**	**23**	**17**	**9**	**6**	**4**	**20**
Target	NR Difference	-62	-23	-24	-24	-29	-29	-29	**30**
	NR pass / fail	*Pass*	*Pass*	*Pass*	*Pass*	*Pass*	*Pass*	*Pass*	**Pass**

Table B.1: Shows the predicted noise break in through the roof, from the proposed mechanical plant units.

MACH ACOUSTICS	Octave Band Centre Frequencies, Hz							
	63	125	250	500	1000	2000	4000	dB(A)
SWL Radiating from ASHP (Existing	54	59	55	44	36	45	65	66.1
Louver / breakout losses	0	0	0	0	0	5	15	
Other losses (screening, etc)	0	0	0	0	0	0	0	
Radiation Directivity	2	(1-freespace, 2-hemispherical, 4-1/4sphere, 8-1/8sphere)						
@ Distance (m)	15							
SPL @ Residence	22	27	23	12	4	8	18	21.9
SWL Radiating from AHU1 (REYQ10T	81	81	78	78	74	69	64	79.0
Louver / breakout losses	10	20	20	25	25	20	15	
Other losses (screening, etc)	0	0	0	0	0	0	0	
Radiation Directivity	2	(1-freespace, 2-hemispherical, 4-1/4sphere, 8-1/8sphere)						
@ Distance (m)	15							
SPL @ Residence	39	29	26	21	17	17	17	25.7
SWL Radiating from AHU2 (REYQ10T	81	81	78	78	74	69	64	79.1
Louver / breakout losses	10	20	20	25	25	20	15	
Other losses (screening, etc)	0	0	0	0	0	0	0	
Radiation Directivity	2	(1-freespace, 2-hemispherical, 4-1/4sphere, 8-1/8sphere)						
@ Distance (m)	15							
SPL @ Residence	39	29	26	21	17	17	17	25.7
SWL Radiating from AHU3 (REYQ10T	81	81	78	78	74	69	64	79.1
Louver / breakout losses	10	20	20	25	25	20	15	
Other losses (screening, etc)	0	0	0	0	0	0	0	
Radiation Directivity	2	(1-freespace, 2-hemispherical, 4-1/4sphere, 8-1/8sphere)						
@ Distance (m)	15							
SPL @ Residence	39	29	26	21	17	17	17	25.7
SWL Radiating from AHU4 (REYQ10T	81	81	78	78	74	69	64	79.1
Louver / breakout losses	10	20	20	25	25	20	15	
Other losses (screening, etc)	0	0	0	0	0	0	0	
Radiation Directivity	2	(1-freespace, 2-hemispherical, 4-1/4sphere, 8-1/8sphere)						
@ Distance (m)	15							
SPL @ Residence	39	29	26	21	17	17	17	25.7
SWL Radiating from AHU5 (REYQ10T	81	81	78	78	74	69	64	79.1
Louver / breakout losses	10	20	20	25	25	20	15	
Other losses (screening, etc)	0	0	0	0	0	0	0	
Radiation Directivity	2	(1-freespace, 2-hemispherical, 4-1/4sphere, 8-1/8sphere)						
@ Distance (m)	15							
SPL @ Residence	39	29	26	21	17	17	17	25.7
Combined SPL	**47**	**37**	**34**	**29**	**25**	**25**	**26**	33

Table B.2: Shows the predicted noise levels at the worst affected residential receivers due to noise from the ASHUs

MACH ACOUSTICS	Octave Band Centre Frequencies, Hz							
	63	125	250	500	1000	2000	4000	dB(A)
SWL Radiating from ASHP (Existing	54	59	55	44	36	45	65	66.1
Louver / breakout losses	0	0	0	0	0	5	15	
Other losses (screening, etc)	0	0	0	0	0	0	0	
Radiation Directivity	2	(1-freespace, 2-hemispherical, 4-1/4sphere, 8-1/8sphere)						
@ Distance (m)	1							
SPL @ Residence	46	51	47	36	28	32	42	45.4
SWL Radiating from AHU1 (REYQ10T	81	81	78	78	74	69	64	79.0
Louver / breakout losses	10	20	20	25	25	20	15	
Other losses (screening, etc)	0	0	0	0	0	0	0	
Radiation Directivity	2	(1-freespace, 2-hemispherical, 4-1/4sphere, 8-1/8sphere)						
@ Distance (m)	1							
SPL @ Residence	63	53	50	45	41	41	41	49.2
SWL Radiating from AHU2 (REYQ10T	81	81	78	78	74	69	64	79.1
Louver / breakout losses	10	20	20	25	25	20	15	
Other losses (screening, etc)	0	0	0	0	0	0	0	
Radiation Directivity	2	(1-freespace, 2-hemispherical, 4-1/4sphere, 8-1/8sphere)						
@ Distance (m)	1							
SPL @ Residence	63	53	50	45	41	41	41	49.2
SWL Radiating from AHU3 (REYQ10T	81	81	78	78	74	69	64	79.1
Louver / breakout losses	10	20	20	25	25	20	15	
Other losses (screening, etc)	0	0	0	0	0	0	0	
Radiation Directivity	2	(1-freespace, 2-hemispherical, 4-1/4sphere, 8-1/8sphere)						
@ Distance (m)	1							
SPL @ Residence	63	53	50	45	41	41	41	49.2
SWL Radiating from AHU4 (REYQ10T	81	81	78	78	74	69	64	79.1
Louver / breakout losses	10	20	20	25	25	20	15	
Other losses (screening, etc)	0	0	0	0	0	0	0	
Radiation Directivity	2	(1-freespace, 2-hemispherical, 4-1/4sphere, 8-1/8sphere)						
@ Distance (m)	1							
SPL @ Residence	63	53	50	45	41	41	41	49.2
SWL Radiating from AHU5 (REYQ10T	81	81	78	78	74	69	64	79.1
Louver / breakout losses	10	20	20	25	25	20	15	
Other losses (screening, etc)	0	0	0	0	0	0	0	
Radiation Directivity	2	(1-freespace, 2-hemispherical, 4-1/4sphere, 8-1/8sphere)						
@ Distance (m)	1							
SPL @ Residence	63	53	50	45	41	41	41	49.2
Combined SPL	**70**	**61**	**57**	**52**	**48**	**48**	**49**	57

Table B.3: Shows the predicted noise levels at skylights on the roof of Smarts Place due to noise from the ASHUs

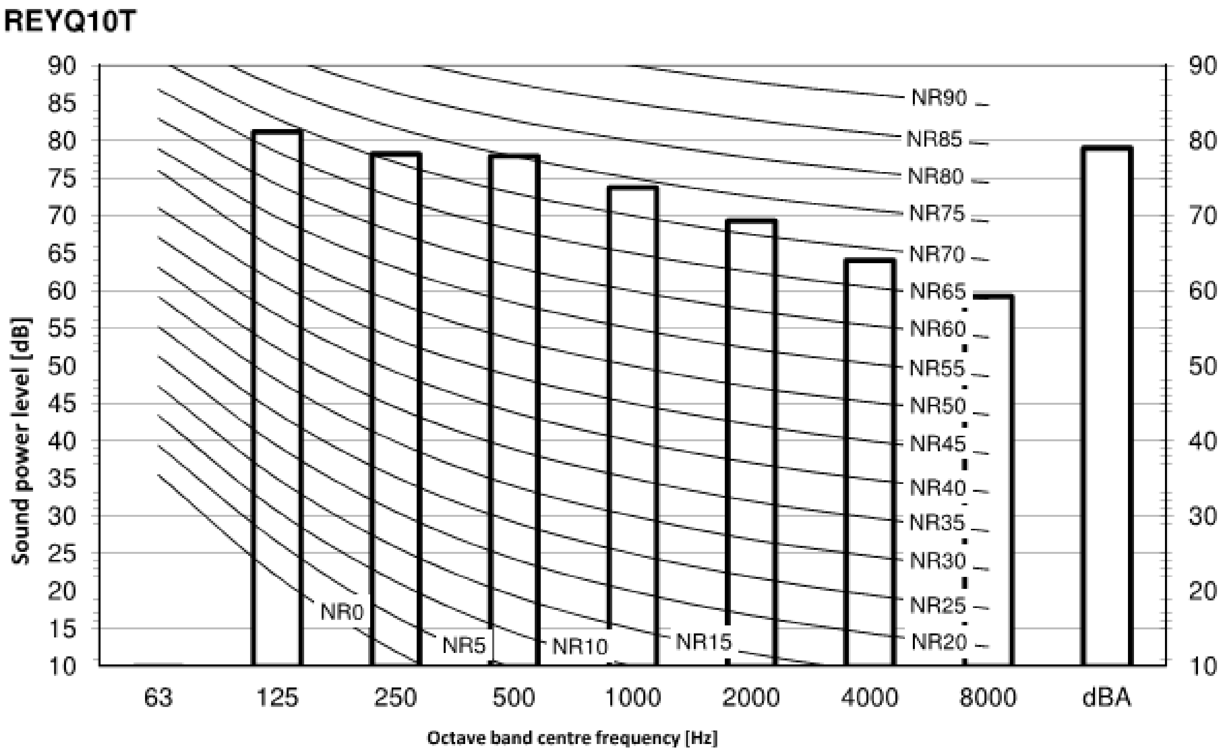
MACH ACOUSTICS	Octave Band Centre Frequencies, Hz							
	63	125	250	500	1000	2000	4000	dB(A)
SWL Radiating from ASHP (Existing	54	59	55	44	36	45	65	66.1
Louver / breakout losses	0	0	0	0	0	5	15	
Other losses (screening, etc)	0	0	0	0	0	0	0	
Radiation Directivity	2	(1-freespace, 2-hemispherical, 4-1/4sphere, 8-1/8sphere)						
@ Distance (m)	15							
SPL @ Residence	22	27	23	12	4	8	18	21.9
SWL Radiating from AHU1 (REYQ10T	81	81	78	78	74	69	64	79.0
Louver / breakout losses	10	20	20	25	25	20	15	
Other losses (screening, etc)	0	0	0	0	0	0	0	
Radiation Directivity	2	(1-freespace, 2-hemispherical, 4-1/4sphere, 8-1/8sphere)						
@ Distance (m)	15							
SPL @ Residence	39	29	26	21	17	17	17	25.7
SWL Radiating from AHU2 (REYQ10T	81	81	78	78	74	69	64	79.1
Louver / breakout losses	10	20	20	25	25	20	15	
Other losses (screening, etc)	0	0	0	0	0	0	0	
Radiation Directivity	2	(1-freespace, 2-hemispherical, 4-1/4sphere, 8-1/8sphere)						
@ Distance (m)	15							
SPL @ Residence	39	29	26	21	17	17	17	25.7
SWL Radiating from AHU3 (REYQ10T	81	81	78	78	74	69	64	79.1
Louver / breakout losses	10	20	20	25	25	20	15	
Other losses (screening, etc)	0	0	0	0	0	0	0	
Radiation Directivity	2	(1-freespace, 2-hemispherical, 4-1/4sphere, 8-1/8sphere)						
@ Distance (m)	15							
SPL @ Residence	39	29	26	21	17	17	17	25.7
SWL Radiating from AHU4 (REYQ10T	81	81	78	78	74	69	64	79.1
Louver / breakout losses	10	20	20	25	25	20	15	
Other losses (screening, etc)	0	0	0	0	0	0	0	
Radiation Directivity	2	(1-freespace, 2-hemispherical, 4-1/4sphere, 8-1/8sphere)						
@ Distance (m)	15							
SPL @ Residence	39	29	26	21	17	17	17	25.7
SWL Radiating from AHU5 (REYQ10T	81	81	78	78	74	69	64	79.1
Louver / breakout losses	10	20	20	25	25	20	15	
Other losses (screening, etc)	0	0	0	0	0	0	0	
Radiation Directivity	2	(1-freespace, 2-hemispherical, 4-1/4sphere, 8-1/8sphere)						
@ Distance (m)	15							
SPL @ Residence	39	29	26	21	17	17	17	25.7
Combined SPL	**47**	**37**	**34**	**29**	**25**	**25**	**26**	33

Table B.4: Shows the predicted noise levels at the worst affected commercial receivers due to noise from the ASHUs

MACH ACOUSTICS	Octave Band Centre Frequencies, Hz							
	63	125	250	500	1000	2000	4000	dB(A)
SWL Radiating from MVHR Inlet	61	56	56	63	53	48	40	61.2
Louver / breakout losses	0	8	13	23	18	13	13	
Other losses (screening, etc)	0	0	0	0	0	0	0	
Radiation Directivity	2	(1-freespace, 2-hemispherical, 4-1/4sphere, 8-1/8sphere)						
@ Distance (m)	1							
SPL @ Residence	53	40	35	32	27	27	19	35.0
SWL Radiating from MVHR Outlet	64	65	66	77	66	64	58	75.1
Louver / breakout losses	0	13	23	38	33	33	28	
Other losses (screening, etc)	0	0	0	0	0	0	0	
Radiation Directivity	2	(1-freespace, 2-hemispherical, 4-1/4sphere, 8-1/8sphere)						
@ Distance (m)	1							
SPL @ Residence	56	44	35	31	25	23	22	35.2
Combined SPL	**58**	**46**	**38**	**35**	**29**	**29**	**24**	**38**

Table B.5: Shows the predicted noise levels at the worst affected residential receivers due to noise from the MVHRs

APPENDIX C – MANUFACTURER DATA



	Maximum power consumption		Sound Power Levels dB re 1pW (Frequency Hz)								dBA @3m
Curve	(Watts)		63	125	250	500	1k	2k	4k	8k	
1	350	Open inlet	61	56	56	63	53	48	40	33	
		Open outlet	64	65	66	77	66	64	58	55	
		Breakout	66	63	61	62	49	41	34	26	43

Table C.1: Shows the manufacturer data for the ASHP (upper) and MVHR (lower)