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Project: J 02237R1
ASHP Noise Impact Assessment:
5-7 Lancaster Grove

Consultants: Sound Planning Ltd
48 Windermere Way
Farnham
Surrey
GU9 0DE

Client: Optic Realm

Prepared by: D. M. Thomas

Signed:

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Acoustic Consultant

Dated: Tuesday 21st July, 2015

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1.0 BACKGROUND

1.1 Planning permission is sought for the installation of external AC units to the rear garden of 5-7 Lancaster Grove.

See APPENDIX 2 – Site Location

1.2 The location falls under the jurisdiction of the London Borough of Camden; a noise impact assessment should be carried out in accordance with their Unitary Development Plan (UDP).

1.3 The proposed external AC units are Daikin Altherma Flex EMRQ10 Units (2 number) and will be located to the rear of the back garden area.

See APPENDIX 3 - Site Plans

1.4 The external AC units' position will be 17 metres away from the nearest noise sensitive window (residential).

1.5 Sound Planning has been retained to evaluate potential noise impact on the nearest noise sensitive receivers using appropriate methodologies and assessment criteria and design a suitable noise mitigation strategy

1.5.1 Participating Acoustic Consultant

Dan Thomas is a Member of the Institute of Acoustics (M.I.O.A) having attained appropriate qualifications in acoustics and experience within the workplace.

1.5.2 Qualifications

Dan has been working within the noise and vibration industry for ten years and has attained the following qualifications within the field of acoustics:

- Institute of Acoustics (IOA) Diploma
- Post Graduate Diploma in Applied Acoustics and Noise Control (University of Surrey)
- Masters Degree in Applied Acoustics and Noise Control (University of Surrey)

2.0 ASSESSMENT CRITERIA

2.1 Noise emissions from mechanical plant should be assessed in accordance with the requirements of the Local Planning Authority; and relevant national standards:

2.2 BS 4142: 1997[1,2]

2.2.1 Noise from industrial sources radiated to residential areas is usually assessed against British Standard BS 4142: 1997, *`Method for rating industrial noise affecting mixed residential and industrial areas'*. This standard describes a method for assessing whether the `specific noise' from an industrial source is likely to give rise to complaints from residents of the adjacent dwellings.

2.2.2 The `specific noise' levels are determined outside dwellings. The specific noise level is determined for reference time periods of 1 hour for the *daytime* (07:00 to 23:00) and 5 minutes for the *night time* (23:00 to 07:00). Tonal or impulsive characteristics of a noise are likely to increase the scope for complaints and this taken into account by adding +5dB to the specific noise source level to obtain the `Rating Level'. BS 4142: 1997 requires that the Rating Level of a noise is compared with the existing background noise: ($L_{A90,\ T}$).

2.2.3 Guidance given in the standard states that if the difference between the Rating Level and the background noise ($L_{A90,\ T}$) is +5dB, it would be considered as being of *marginal significance*. This is usually taken as being an acceptable situation, as it is a reasonable compromise between the requirements of commerce and the amenity of residents.

2.2.4 A difference of around +10dB or more indicates that *complaints are likely*. Most Local Authorities use a difference of +10dB as the point at which they will take action against the organisation producing the noise.

2.2.5 If the Rating Level is more than 10dB <u>below</u> the background noise this is a positive indication that *complaints are unlikely*.

[1] British Standard 4142: 1997 – *Method for rating industrial noise affecting mixed residential and industrial areas*. © BSI 1997. ISBN 0 580 28300 3.
[2] Superseded by BS 4142: 2014.

2.3 British Standard 4142: 2014.[3]

2.3.1 BS 4142: 2014 – Scope

This British Standard describes methods for rating and assessing sound of an industrial and/or commercial nature, which includes:

a) sound from industrial and manufacturing processes;

b) sound from fixed installations which comprise mechanical and electrical plant and equipment;

c) sound from the loading and unloading of goods and materials at industrial and/or commercial premises; and

d) sound from mobile plant and vehicles that is an intrinsic part of the overall sound emanating from premises or processes, such as that from forklift trucks, or that from train or ship movements on or around an industrial and/or commercial site.

The methods described in this British Standard use outdoor sound levels to assess the likely effects of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident.

This standard is applicable to the determination of the following levels at outdoor locations:

a) rating levels for sources of sound of an industrial and/or commercial nature and

b) ambient, background and residual sound levels, for the purposes of:

- investigating complaints;
- assessing sound from proposed, new, modified or additional source(s) of sound of an industrial and/or commercial nature; and

[3] British Standard 4142: 2014 – Methods for rating and assessing industrial and commercial sound.

- assessing sound at proposed new dwellings or premises used for residential purposes.

2.3.2 BS 4142: 2014 – Assessment of Impacts

The significance of sound of an industrial and/or commercial nature depends upon both the margin by which the rating level of the specific sound source exceeds the background sound level and the context in which the sound occurs.

Evaluation of Adverse Impact

- Typically, the greater this difference, the greater the magnitude of the impact.

- A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.

- A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.

- 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.

Adverse impacts include, but are not limited to, annoyance and sleep disturbance. Not all adverse impacts will lead to complaints and not every complaint is proof of an adverse impact.

2.4 Noise Measurement Protocol - British Standard 7445-1: 2003[4]

2.4.1 The methods and procedures described in BS 7445 are intended to be applicable to sounds from all sources, individually and in combination, which contribute to the total noise at a site.

[4] Description and measurement of environmental noise. Part 1 – Guide to quantities and procedures.

2.4.2 The aim of the BS 7445 series is to provide authorities with material for the description of noise in community environments. Based on the principles described in this standard, acceptable limits of noise can be specified and compliance with these limits can be controlled.

2.4.3 BS 7445 does not specify limits for environmental noise.

2.5 Camden Replacement Unitary Development Plan (UDP)

2.5.1 *The Council will only grant planning permission for plant or machinery, including ventilation or air handling equipment, if it can be operated without causing a loss to local amenity and does not exceed the thresholds set out in Appendix 1 - Noise and Vibration (Table E).*

2.5.2 Noise levels from plant and machinery at which planning permission will not be granted[5].

Noise description and location of measurement	**Period**	**Time (hours)**	**Noise Level**
Noise at 1 metre external to a sensitive façade	Day, evening and night	0000 - 2400	5dB(A) < L_{A90}
Noise that has a distinguishable discrete continuous note (whine, hiss, screech, hum) at 1 metre external to a sensitive façade	Day, evening and night	0000 - 2400	10dB(A) < L_{A90}
Noise that has distinct impulses (bangs, clicks, clatters, thumps) at 1 metre external to a sensitive façade	Day, evening and night	0000 - 2400	10dB(A) < L_{A90}
Noise at 1 metre external to a sensitive façade where L_{A90} > 60dB	Day, evening and night	0000 - 2400	55dB L_{Aeq}

[5] Camden Replacement Unitary Development Plan. Appendix 1 – Noise and Vibration Thresholds.

3.0 METHODOLOGY

3.1 Existing Noise Climate

5-7 Lancaster Grove is situated in a residential environment, with houses to the North, East, South and West.

See APPENDIX 2 – Site Location

3.2 Background Noise Assessment

3.2.1 An extended background noise assessment was conducted over the period: 14:15 hours, Wednesday 8th July – 15:00 hours, Thursday 9th July, 2015.

3.2.3 The air source heat pump is for residential purposes and can be operational at any time during a given 24 hour period.

3.2.4 The microphone was located as close as possible to the nearest noise sensitive windows whilst being > 3.5 metres away from any reflective façades (walls etc).

See APPENDIX 4 – Site Photographs

3.2.5 Measurements were undertaken in accordance with BS 7445[6] and BS 4142[7].

3.2.6 The Sound Level Meter (SLM) used for the assessment is Class 1 with real time octave band measurement capability; and compliant to IEC 61672[8].

3.2.6 The A-weighted L_{90}, L_{eq} and L_{max} descriptors were measured every 15 minutes using the Fast (F) setting, and logged periodically over the extended measurement period.

3.3 Noise levels at the nearest noise sensitive façade (windows) will be calculated using the manufacturers' sound pressure level (SPL) data corrected for distance, directivity and screening effects.

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[6] British Standard 7445-1: 2003 – *Description and measurement of environmental noise.* © BSI 1997. ISBN 0 580 19736 0.
[7] British Standard 4142: 1997 – *Method for rating industrial noise affecting mixed residential and industrial areas*. © BSI 1997. ISBN 0 580 28300 3.
[8] International Standard IEC 61672-1: 2002. Electroacoustics – Sound level meters – Part 1: Specifications.

See CRITERIA ASSESSMENT section 5.0.

3.4 Distance corrections will be applied in accordance with BS 7445 and BS 4142. The resultant sound pressure level (L_p) will be compared to the measured background noise level in accordance with the requirements of BS 4142.

3.5 Instrumentation/Equipment

3.5.1 Equipment

Equipment	Make	Model	Class	Serial Number	UKAS Calibration
SLM	Norsonic	Nor140	1	1405819	U15573 (25/2/14)
Field Calibrator	Casella	CEL 110/1	1	077948	U18561 (16/4/15)
Environmental Tripod					
Wind/Weather Shield					
Laser Measurer	Leica	Disto A5		1073750838	
Digital Camera	Samsung				

3.5.2 Field Calibration

A field calibration was conducted for the SLM microphone; no deviation was detected (1kHz).

3.5.3 UKAS Calibration

UKAS calibration certificates are available on request.

4.0 RESULTS

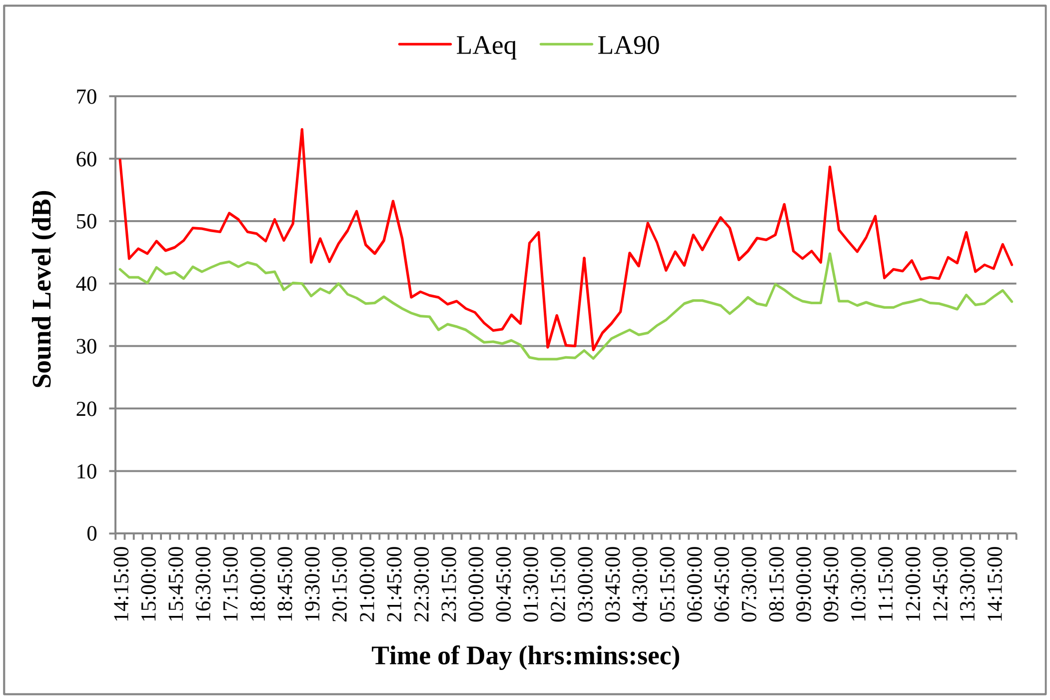
4.1 Background Noise Levels

4.1.1 Table – Lowest Background Noise Levels

Time Period (Hours)	Description	Lowest Background Noise Level dB $L_{A90,\ 15mins}$	Time Period Occurred
07:00 – 23:00	Daytime	35	22:30 – 23:00 07:00 – 07:15
23:00 – 07:00	Night Time	28	01:30 – 03:00

See APPENDIX 6 – Background Noise Levels for full results.

4.1.2 Graph – Existing Noise Levels



4.2 Air Source Heat Pump

Manufacturer	Model	Sound Pressure Level dB $L_{PA\ @1m}$		Number of Units
		Heating	Cooling	
Daikin	EMRQ10	58	/	2

4.3 Meteorological Conditions

Wind Speed/Direction	WNW - 1-3m/s
Likelihood of Temperature Inversion[9]	No - Relatively short distances – Little effect
Precipitation	No
Fog	No
Wet Ground	No
Frozen Ground/Snow Coverage	No
Temperature	11 - 20°C
Cloud Cover	Clear

[9] i.e. Calm night with little cloud cover.

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4.4 Levels of Uncertainty

Category	Notes
Complexity of Sound Source	Supply Air (rear) Exhaust Air – Roof Mounted Fan
Complexity of Acoustic Environment (Residual)	Varying traffic flows
Level of Residual Sound (including Specific)	n/a
Measurement Locations	Representative of nearest noise sensitive receivers
Distance Between Sound Source & Measurement Position	n/a
Number of Measurements Taken	24 hours (15 min periods)
Measurement Time Intervals	Continuous
Range of Times	Representative of quietest likely times of proposed operation
Range of Suitable Weather Conditions	1 measurement period – Suitable weather conditions
Measurement Method/Practitioners	1 measurement period (Dan Thomas)
Level of Rounding	Rounded to nearest DP; 0.5 rounded up
Instrumentation	Type 1 SLM (suitable)

5.0 CRITERIA ASSESSMENT

5.1 Noise Sensitive Receiver (Residential Windows) – See APPENDIX 2 – Site Location

Daikin Altherma Flex EMRQ10	58 dB(A) @ 1m [heating mode]
Number of units	2 Units
Sound Pressure Level Correction	58 + 10 log(2)
	= 61 dB(A) @ 1m
Directivity Index	+ 3 dB[10]
	= 64 dB(A) @ 1m
Distance to NSR (14m)	64 – 20 log (17/1)
Level at NSR Window	39 dB(A)
Acoustic Feature	YES
Lowest Background Noise Level	28 dB L_{A90}
Target Level (Camden)	28 – 10
	= 18 dB(A)
Excess over Target Level	+21 dB (39 - 18)
Noise Mitigation Required	**21 dB**

[10] AC units located over hard reflective surface (hemi-spherical).

6.0 NOISE MITIGATION STRATEGY

6.1 Noise Control Requirements

6.1.1 The predicted noise level for 2 Daikin EMRQ10 external units is 39 dB L_{Aeq} at the nearest (and most noise sensitive) noise sensitive window.

6.1.2 The target noise level is 10 dB below the reference background level of 28 dB L_{A90}; therefore a minimum 21 dB noise reduction is required.

6.1.3 In order to achieve a 21 dB noise reduction the external ASHP units should be fully enclosed within an acoustic enclosure.

6.1.4 The enclosure should facilitate required air flow as well as achieve the requisite noise reduction (insertion loss).

6.2 QuietBox VE (2 Units)

6.2.1 Components

- Acoustic Louvres 300mm (D)
- Acoustic Panels (100mm thick Rockwool 45kg/m^3)
- 50mm Acoustic Panel Septums
- Roof Mounted Attenuator

See APPENDIX 7 for further specification details.

6.2.2 Enclosure Dimensions

TBC

6.3 Noise Reduction

6.3.1 The Acoustic Enclosures have been designed to meet the target level of 10 dB below background at the nearest noise sensitive windows.

6.3.2 See APPENDIX 7 for predicted noise level calculations.

7.0 CONCLUSIONS

7.1 Sound Planning has carried out an environmental noise assessment in accordance with BS 7445: 2003 and BS 4142: 2014.

See Section 3.0 - METHODOLOGY

7.2 A 24 hour background noise assessment provided a reference background noise level of 28 dB $L_{A90,\ 15mins}$ (to 1DP).

See Section 4.0 - RESULTS

7.3 The predicted noise level for 2 Daikin EMRQ10 external units is 39 dB L_{Aeq} at the nearest (and most noise sensitive) noise sensitive window.

7.4 The target noise level is 10 dB below the reference background level of 28 dB L_{A90}; therefore a minimum 21 dB noise reduction is required.

See Section 5.0 - CRITERIA ASSESSMENT

7.5 Noise Mitigation Measures

7.5.1 In order to meet the target noise criteria at the nearest noise sensitive window the external AC units should be fully enclosed within an acoustic enclosure.

7.5.2 Section 6.0 – NOISE MITIGATION STRATEGY for enclosure specification details.

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APPENDIX 1

Glossary of Acoustic Terms

The Decibel, dB

The unit used to describe the magnitude of sound is the decibel (dB) and the quantity measured is the sound pressure level. The decibel scale is logarithmic and it ascribes equal values to proportional changes in sound pressure, which is a characteristic of the ear. Use of a logarithmic scale has the added advantage that it compresses the very wide range of sound pressures to which the ear may typically be exposed to a more manageable range of numbers. The threshold of hearing occurs at approximately 0 dB (which corresponds to a reference sound pressure of 2 x 10^{-5} pascals) and the threshold of pain is around 120 dB. The sound energy radiated by a source can also be expressed in decibels. The sound power is a measure of the total sound energy radiated by a source per second, in watts. The sound power level, L_w is expressed in decibels, referenced to 10^{-12} watts.

Frequency, Hz

Frequency is analogous to musical pitch. It depends upon the rate of vibration of the air molecules that transmit the sound and is measure as the number of cycles per second or Hertz (Hz). The human ear is sensitive to sound in the range 20 Hz to 20,000 Hz (20 kHz). For acoustic engineering purposes, the frequency range is normally divided up into discrete bands. The most commonly used bands are octave bands, in which the upper limiting frequency for any band is twice the lower limiting frequency, and one-third octave bands, in which each octave band is divided into three. The bands are described by their centre frequency value and the ranges which are typically used for building acoustics purposes are 63 Hz to 4 kHz (octave bands) and 100 Hz to 3150 Hz (one-third octave bands).

Noise Rating

The Noise Rating (NR) system is a set of octave band sound pressure level curves used for specifying limiting values for building services noise. The Noise Criteria (NC) and Preferred Noise Criteria (PNC) systems are similar.

A-weighting

The sensitivity of the ear is frequency dependent. Sound level meters are fitted with a weighting network which approximates to this response and allows sound levels to be expressed as an overall single figure value, in dB(A).

Noise Descriptors

Where noise levels vary with time, it is necessary to express the results of a measurement over a period of time in statistical terms. Some commonly used descriptors follow.

$L_{Aeq, T}$ *The most widely applicable unit is the equivalent continuous A-weighted sound pressure level ($L_{Aeq, T}$). It is an energy average and is defined as the level of a notional sound which (over a defined period of time, T) would deliver the same A-weighted sound energy as the actual fluctuating sound.*

L_{AE} *Where the overall noise level over a given period is made up of individual noise events, the $L_{Aeq, T}$ can be predicted by measuring the noise of the individual noise events using the sound exposure level, L_{AE} (or SEL or L_{AX}). It is defined as the level that, if maintained constant for a period of one second, would deliver the same A-weighted sound energy as the actual noise event.*

L_{A1} *The level exceeded for 1% of the time is sometimes used to represent typical noise maxima.*

L_{A10} *The level exceeded for 10% of the time is often used to describe road traffic noise.*

L_{A90} *The level exceeded for 90% of the time is normally used to describe background noise.*

Sound Transmission Descriptors

D_{nT} Standardised level difference

$D_{nT, w}$ Weighted standardised level difference

L_1 The average sound pressure level in the source room

L_2 The average sound pressure level in the receiving room

T Reverberation time (receiving room)

T_0 Reference reverberation time = 0.5s

C_{tr} Adaption spectrum which takes account for low to medium speed road/rail/air traffic; disco music; and factory noise (medium to low frequency noise).

C Adaptation spectrum which takes account of domestic activities including speech, music, radio and television.

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Frequency Analysis

Octave Band	*A band of frequencies the upper limit of which is twice the lower limit. They are known by their centre frequency, e.g., 63, 125, 250, 500, 1000, 2000 Hz…*
One Third Octave	*The logarithmic frequency interval between a lower frequency f_2, when f_2/f_1 equals $2^{1/3}$ apart. Frequencies include: 100, 125, 160, 200, 250, 315, 400, 500, 630, 800, 1000Hz.*

Sound Transmission in the Open Air

Most sources of sound can be characterised as a single point in space. The sound energy radiated is proportional to the surface area of a sphere centred on the point. The area of a sphere is proportional to the square of the radius, so the sound energy is inversely proportional to the square of the radius. This is the inverse square law.

In decibel terms, every time the distance from a point source is doubled, the sound pressure level is reduced by 6 dB. Road traffic noise is a notable exception to this rule, as it approximates to a line source, which is represented by the line of the road. The sound energy radiated is inversely proportional to the area of a cylinder centred on the line. In decibel terms, every time the distance from a line source is doubled, the sound pressure level is reduced by 3 dB.

Factors Affecting Sound Transmission in the Open Air

Reflection

When sound waves encounter a hard surface, such as concrete, brickwork, glass, timber or plasterboard, it is reflected from it. As a result, the sound pressure level measured immediately in front of a building façade is approximately 3 dB higher than it would be in the absence of the façade.

Screening and Diffraction

If a solid screen is introduced between a source and receiver, interrupting the sound path, a reduction in sound level is experienced. This reduction is limited, however, by diffraction of the sound energy at the edges of the screen. Screens can provide valuable noise attenuation however. For example, a timber boarded fence built next to a motorway can reduce noise levels on the land beyond, typically by around 10 dB(A). The best results are obtained when a screen is situated close to the source or close to the receiver.

Meteorological Effects

Temperature and wind gradients affect noise transmission, especially over large distances. The wind effects range from increasing the level by typically 2 dB downwind, to reducing it by typically 10 dB upwind – or even more in extreme conditions. Temperature and wind gradient are variable and difficult to predict.

APPENDIX 2

Site Location

5-7 Lancaster Grove

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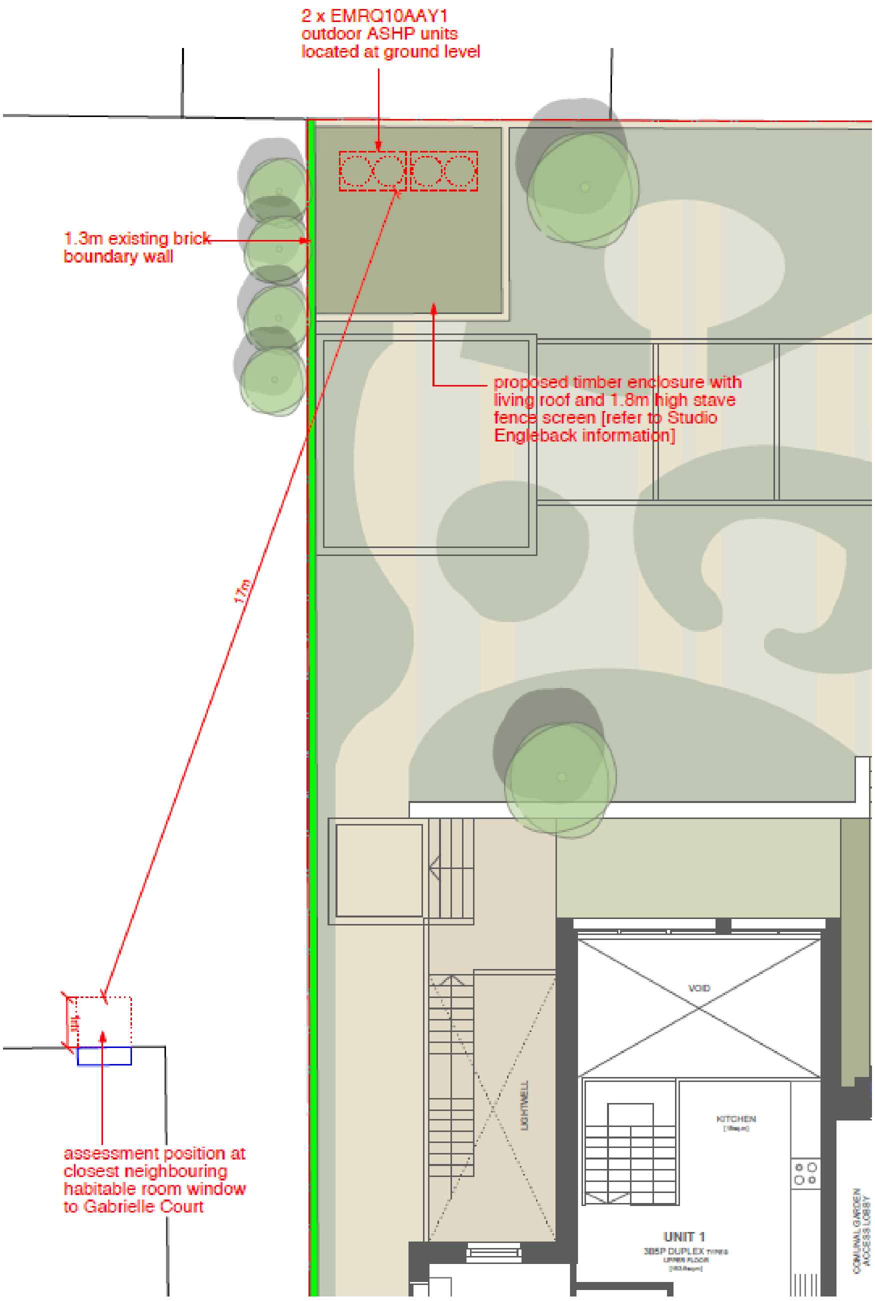
APPENDIX 3

Site Plans

External AC Unit Location



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APPENDIX 4

Site Photographs

Back Garden Area

Back Garden Area

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APPENDIX 5

AC Equipment

External ASHP Units

Features

The ultimate heating solution for residential and commercial applications based on air to water heat pump technology

Customised to meet your building's needs: up to 10 indoor units can be connected to 1 outdoor unit

- Low energy bills and low CO2 emissions
- Easy installation and maintenance
- Integrated heat recovery system

AC Equipment

2 Specifications

2-1 Technical Specifications				EMRQ8A	EMRQ10A	EMRQ12A	EMRQ14A	EMRQ16A
Heating capacity	Nom.		kW	22.4 (1)	28 (1)	33.6 (1)	39.2 (1)	44.8 (1)
Cooling capacity	Nom.		kW	20 (2)	25 (2)	30 (2)	35 (2)	40 (2)
Casing	Colour			Daikin White				
	Material			Painted galvanized steel plate				
Dimensions	Unit	Height	mm	1,680				
		Width	mm	1,300				
		Depth	mm	765				
	Packed unit	Height	mm	1,885				
		Width	mm	1,425				
		Depth	mm	860				
Weight	Unit		kg	331			339	
	Packed unit		kg	339			347	
Packing	Material			Cardboard / Wood / EPS	Cardboard / Wood / EPS	Cardboard / Wood / EPS	Cardboard / Wood / EPS	Cardboard / Wood / EPS
	Weight		kg	8				
Heat exchanger	Type			Cross fin coil				
Fan	Type			Propeller fan				
	Quantity			2				
	Discharge direction			Vertical				
Fan motor	Quantity			2				
	Drive			Direct drive				
	Output		W	350			750	
	Starting method			Soft start				
[illegible]	[illegible]			[illegible]				
	Cooling	Max.	[illegible]	[illegible]				
Refrigerant	Type			R-410A				
	Charge		kg	10.3	10.6	10.8	11.1	
	Control			Expansion valve (electronic type)				
Refrigerant oil	Type			Daphne FVC68D				
Piping connections	Liquid	Quantity		1				
		Type		Braze connection				
		OD	mm	9.52		12.7		
	Suction	Quantity		1				
		Type		Braze connection				
		OD	mm	19.1	22.2	28.6		
	High and low pressure gas	Quantity		1				
		Type		Braze connection				
		OD	mm	15.9	19.1		22.2	
	Piping length	System Equivalent	m	120				
	Additional refrigerant charge		kg/m	See installation manual				
	Total piping length	System Actual	m	300				
	Level difference	OU - IU Total	m	40				
		IU - IU Max.	m	15 (7)				
	High pressure side	Design pressure	bar	40				
Sound power level	Heating	Nom.	dBA	78		80	83	84
Sound pressure level	Heating	Nom.	dBA	58		60	62	63
Defrost method				Deicer				
Safety devices	Item	01		HPS				
		02		Fan driver overload protector				
		03		Inverter overload protector				
		04		Overcurrent relay				

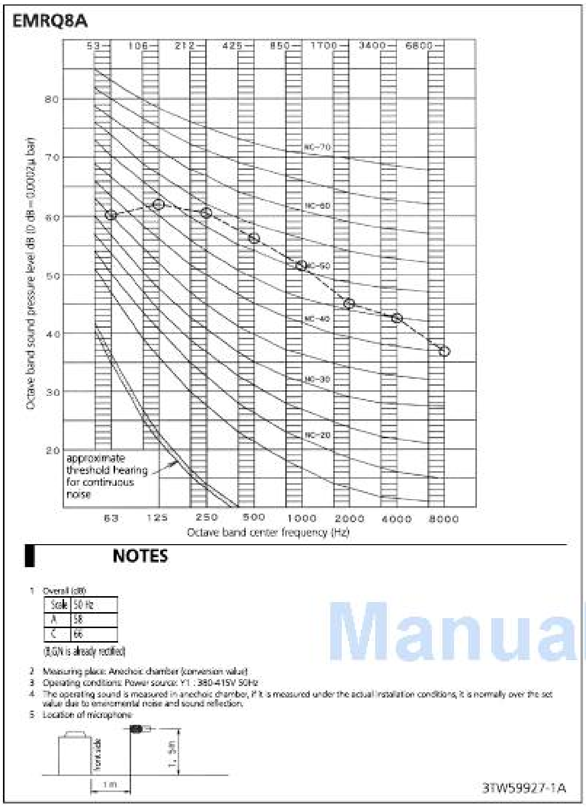
DAIKIN • Heating • Daikin Altherma flex type

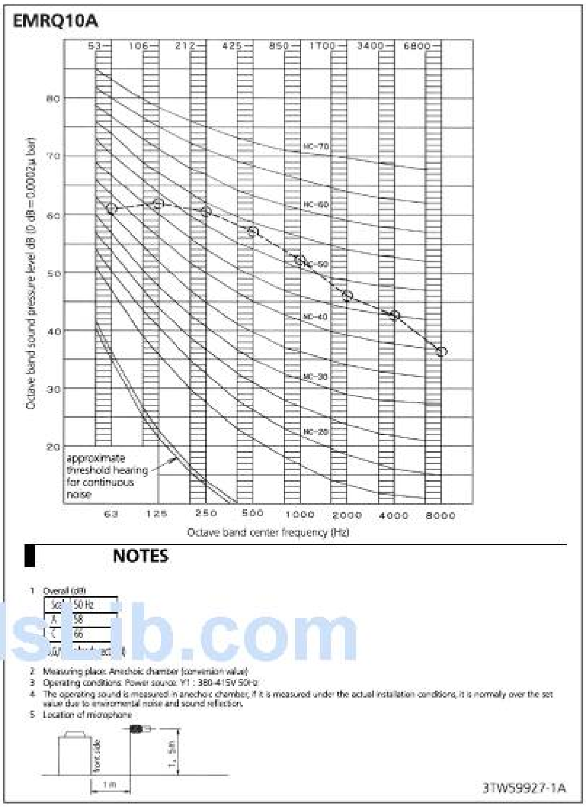
AC Equipment

Noise Spectrums

10 Sound data

10 - 2 Sound Pressure Spectrum





APPENDIX 6

Background Noise Measurements

Table

Date	Time	Duration	L_{Aeq}	L_{AFmax}	L_{AFmin}	$L_{AF,50}$	$L_{AF,90}$
08/07/2015	14:15:00	00:15:00	59.8	89	39	45.6	42.3
08/07/2015	14:30:00	00:15:00	44	55.3	38.8	43.2	41
08/07/2015	14:45:00	00:15:00	45.6	56.7	38.3	43.5	41
08/07/2015	15:00:00	00:15:00	44.8	58.2	37.8	42.8	40.1
08/07/2015	15:15:00	00:15:00	46.8	56.9	38.9	45.6	42.6
08/07/2015	15:30:00	00:15:00	45.3	62.1	39.1	44	41.5
08/07/2015	15:45:00	00:15:00	45.8	59.5	39.3	44.4	41.8
08/07/2015	16:00:00	00:15:00	46.9	65.3	37.4	43.7	40.8
08/07/2015	16:15:00	00:15:00	48.9	66.2	39.6	47	42.7
08/07/2015	16:30:00	00:15:00	48.8	63.6	39	46	41.9
08/07/2015	16:45:00	00:15:00	48.5	64.5	39.6	46.1	42.6
08/07/2015	17:00:00	00:15:00	48.3	61.2	39.8	46.7	43.2
08/07/2015	17:15:00	00:15:00	51.3	75.3	39.5	47.9	43.5
08/07/2015	17:30:00	00:15:00	50.3	67.3	37.8	46.9	42.7
08/07/2015	17:45:00	00:15:00	48.3	65.7	39.7	46.1	43.4
08/07/2015	18:00:00	00:15:00	48	64.5	40	45.9	43
08/07/2015	18:15:00	00:15:00	46.8	62.4	39	45.2	41.7
08/07/2015	18:30:00	00:15:00	50.3	78.6	38.5	44.9	41.9
08/07/2015	18:45:00	00:15:00	46.9	72	36.3	43	39
08/07/2015	19:00:00	00:15:00	49.6	78.6	37.7	43.7	40.1
08/07/2015	19:15:00	00:15:00	64.7	87.3	36.4	43.8	40
08/07/2015	19:30:00	00:15:00	43.4	63.6	35.1	41.2	38
08/07/2015	19:45:00	00:15:00	47.2	74	36	42.5	39.2
08/07/2015	20:00:00	00:15:00	43.5	61.8	36	41.7	38.5
08/07/2015	20:15:00	00:15:00	46.4	59.8	36.1	43.6	40
08/07/2015	20:30:00	00:15:00	48.5	75.4	36	41.2	38.3
08/07/2015	20:45:00	00:15:00	51.6	78.1	34.7	41.2	37.7
08/07/2015	21:00:00	00:15:00	46.2	64.8	33.3	40.5	36.8
08/07/2015	21:15:00	00:15:00	44.8	60.6	33.6	40.8	36.9
08/07/2015	21:30:00	00:15:00	46.9	76.9	35.2	41.1	37.9
08/07/2015	21:45:00	00:15:00	53.2	77.3	34.2	42.2	36.9
08/07/2015	22:00:00	00:15:00	47.2	73.9	33.3	40.4	36
08/07/2015	22:15:00	00:15:00	37.8	51.6	33.8	37	35.3

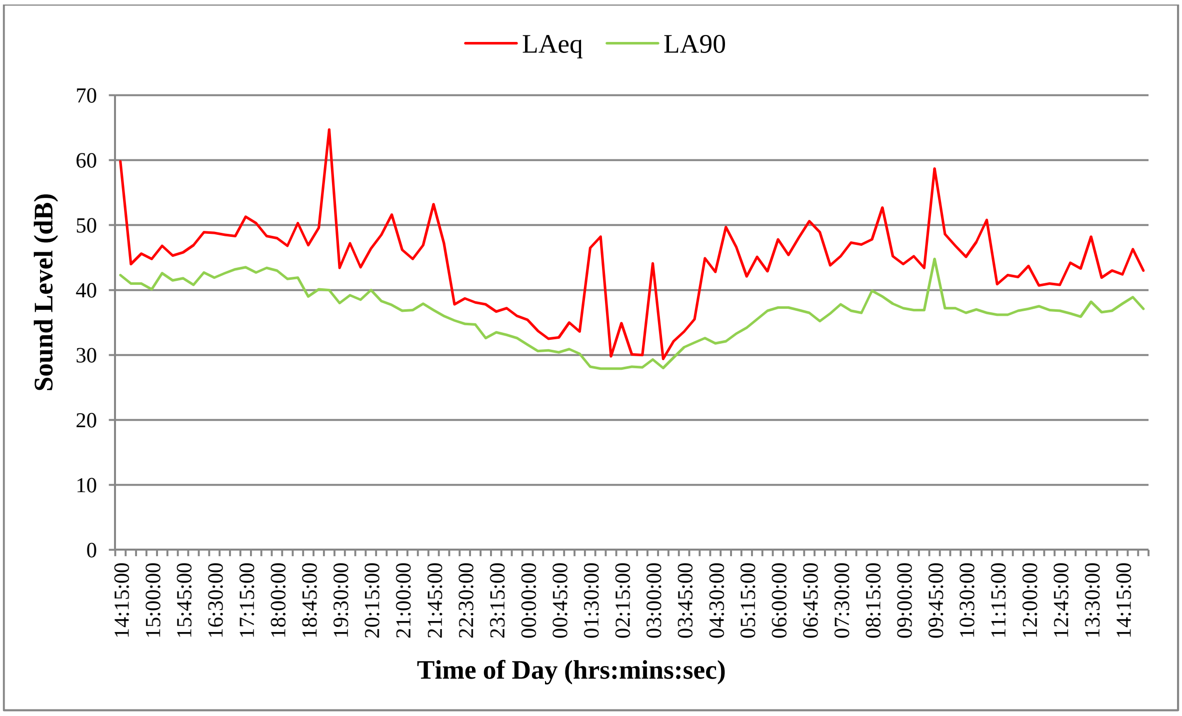
08/07/2015	22:30:00	00:15:00	38.7	60	33.2	37.1	34.8
08/07/2015	22:45:00	00:15:00	38.1	54.7	33	36.5	34.7
08/07/2015	23:00:00	00:15:00	37.8	63.7	30.7	34.6	32.6
08/07/2015	23:15:00	00:15:00	36.7	55.9	31.7	35.1	33.5
08/07/2015	23:30:00	00:15:00	37.2	55	31.5	35.6	33.1
08/07/2015	23:45:00	00:15:00	36	54	31	34	32.6
09/07/2015	00:00:00	00:15:00	35.4	49.3	30.2	33.6	31.6
09/07/2015	00:15:00	00:15:00	33.7	50.1	29.5	31.7	30.6
09/07/2015	00:30:00	00:15:00	32.5	46.2	29.3	31.9	30.7
09/07/2015	00:45:00	00:15:00	32.7	41.9	29	31.8	30.4
09/07/2015	01:00:00	00:15:00	35	60.5	29.5	33	30.9
09/07/2015	01:15:00	00:15:00	33.6	50	28.4	31.8	30.2
09/07/2015	01:30:00	00:15:00	46.5	66.4	26.8	29.7	28.2
09/07/2015	01:45:00	00:15:00	48.2	70.3	26.3	29.6	27.9
09/07/2015	02:00:00	00:15:00	29.8	42.3	26.3	29	27.9
09/07/2015	02:15:00	00:15:00	34.9	56.5	26.3	30.3	27.9
09/07/2015	02:30:00	00:15:00	30.1	44.6	26.9	29.4	28.2
09/07/2015	02:45:00	00:15:00	30	37.7	26.7	29.5	28.1
09/07/2015	03:00:00	00:15:00	44.1	78	27.6	30.8	29.3
09/07/2015	03:15:00	00:15:00	29.4	46.9	26.7	29	28
09/07/2015	03:30:00	00:15:00	32.1	48.8	27.9	30.9	29.6
09/07/2015	03:45:00	00:15:00	33.6	50.1	29.8	32.3	31.2
09/07/2015	04:00:00	00:15:00	35.5	50.4	30.5	33.8	31.9
09/07/2015	04:15:00	00:15:00	44.9	70.1	31.2	34.5	32.6
09/07/2015	04:30:00	00:15:00	42.8	59.4	29.2	35.8	31.8
09/07/2015	04:45:00	00:15:00	49.7	68	29.1	36.7	32.1
09/07/2015	05:00:00	00:15:00	46.6	69.2	31.4	37.5	33.3
09/07/2015	05:15:00	00:15:00	42.1	69.2	32.5	36.1	34.2
09/07/2015	05:30:00	00:15:00	45.1	68.4	33.7	37.6	35.5
09/07/2015	05:45:00	00:15:00	42.9	65.8	35	39.5	36.8
09/07/2015	06:00:00	00:15:00	47.8	71.5	35.3	40.7	37.3
09/07/2015	06:15:00	00:15:00	45.4	71.1	35.1	40	37.3
09/07/2015	06:30:00	00:15:00	48.1	66.5	35.2	39.6	36.9
09/07/2015	06:45:00	00:15:00	50.6	73.1	34.3	39.3	36.5
09/07/2015	07:00:00	00:15:00	48.9	78.4	32.8	38.1	35.2
09/07/2015	07:15:00	00:15:00	43.8	63.5	33.9	40.1	36.4
09/07/2015	07:30:00	00:15:00	45.2	61	36.3	41.1	37.8
09/07/2015	07:45:00	00:15:00	47.3	62.9	34.5	40.6	36.8
09/07/2015	08:00:00	00:15:00	47	64.4	34.6	40	36.5
09/07/2015	08:15:00	00:15:00	47.8	70	37.7	42.7	39.9
09/07/2015	08:30:00	00:15:00	52.7	68.3	36.3	41.5	39
09/07/2015	08:45:00	00:15:00	45.2	61.9	35.7	40.6	37.9

soundplanning

09/07/2015	09:00:00	00:15:00	44	61.6	33.9	40.3	37.2
09/07/2015	09:15:00	00:15:00	45.2	62.8	33.6	39.9	36.9
09/07/2015	09:30:00	00:15:00	43.4	62.9	34.3	40.7	36.9
09/07/2015	09:45:00	00:15:00	58.7	76.7	38.8	53.3	44.8
09/07/2015	10:00:00	00:15:00	48.6	68.5	34.2	42.4	37.2
09/07/2015	10:15:00	00:15:00	46.8	61.9	34.6	40.8	37.2
09/07/2015	10:30:00	00:15:00	45.1	67.9	34.5	39.1	36.5
09/07/2015	10:45:00	00:15:00	47.4	68.6	34.4	39.6	37
09/07/2015	11:00:00	00:15:00	50.8	67	33.9	40.4	36.5
09/07/2015	11:15:00	00:15:00	40.9	55	34.1	38.6	36.2
09/07/2015	11:30:00	00:15:00	42.3	57.1	33.5	39.2	36.2
09/07/2015	11:45:00	00:15:00	42	59.4	34.4	39.7	36.8
09/07/2015	12:00:00	00:15:00	43.7	64.2	34.1	39.7	37.1
09/07/2015	12:15:00	00:15:00	40.7	54.9	35.3	39.7	37.5
09/07/2015	12:30:00	00:15:00	41	54.8	34.6	39.3	36.9
09/07/2015	12:45:00	00:15:00	40.8	59.3	34.6	39.2	36.8
09/07/2015	13:00:00	00:15:00	44.2	64.1	34	40.5	36.4
09/07/2015	13:15:00	00:15:00	43.3	60.7	33.8	38.6	35.9
09/07/2015	13:30:00	00:15:00	48.2	66.1	34.2	42.4	38.2
09/07/2015	13:45:00	00:15:00	41.9	55.2	33.8	39.9	36.6
09/07/2015	14:00:00	00:15:00	43	59.3	34.5	39.3	36.8
09/07/2015	14:15:00	00:15:00	42.4	57	34.9	40.8	37.9
09/07/2015	14:30:00	00:15:00	46.3	63.7	35.2	42.3	38.9
09/07/2015	14:45:00	00:15:00	43	64.7	34.6	40.3	37.1

Background Noise Measurements

Graph



APPENDIX 7

Acoustic Enclosure

QuietBox VE

No Enclosure

QuietBox VE Enclosure

Acoustic Enclosures

QuietBox VE(B)

Bend Option

QuietBox VE(B)

Acoustic Enclosures

QuietBox VE

Insertion Loss Data[11]

Frequency v dB Reduction							
63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
-13	-16	-20	-21	-19	-21	-23	-24

[11] Field test results – Daikin ASHP.

Acoustic Enclosures

Enclosure Calculation

	Frequency (Hz)								Overall	
	63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**		
Daikin EMRQ10	60.5	61	59.5	56	50.5	46	43	36	66	dB
A-Weighted	34.3	44.9	50.9	52.8	50.5	47.2	44	34.9	58	dB(A)
2 Units	3	3	3	3	3	3	3	3		
QuietBox VE	-13	-16	-20	-21	-19	-21	-23	-24		
DI	3	3	3	3	3	3	3	3		
Distance Correction	-25	-25	-25	-25	-25	-25	-25	-25		
Attenuated Level	28.5	26.0	20.5	16.0	12.5	6.0	1.0	-7.0	31	dB
A-Weighted	2.3	9.9	11.9	12.8	12.5	7.2	2.0	-8.1	18	dB(A)