

REPORT TITLE: ACOUSTIC REPORT FOR PROPOSED AIR SOURCE HEAT PUMPS TO SERVE
NEW RESIDENTIAL HOUSES AT 66 FITZJOHN'S AVENUE, LONDON NW3 5LT

REPORT REF: 19123-003 Revision A

Revision	Issue Date	Commentary
-	October 2019	Initial acoustic report for air conditioning units Mitsubishi model PUMY-P125
A	March 2020	Air conditioning units replaced by air source heat pumps Daikin model ERGA08DVA

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DATE: March 2020

CONTENTS

SUMMARY

1. INTRODUCTION
2. NOISE CRITERIA (*London Borough Of Camden Acoustic Requirements*)
3. NOISE SURVEY
4. NOISE FROM AIR SOURCE HEAT PUMPS
5. VIBRATION FROM AIR SOURCE HEAT PUMPS
6. SPECIFICATIONS FOR NOISE & VIBRATION TREATMENTS

Appendix A: Noise Survey Instrumentation

Appendix B: Site Location Plan & Proposed Layout Drawings

Appendix C: Background Noise Survey Results

Appendix D: Manufacturer Noise Data For Air Source Heat Pumps

Appendix E: Noise Model Calculation For Air Source Heat Pumps

Appendix F: Details For Noise Reduction Treatment

Appendix G: Details For Typically Suitable Proprietary Vibration Isolators

SUMMARY

- Philip Acoustics has been commissioned to assess noise and vibration from air source heat pumps proposed to be installed to serve two new residential houses at 66 Fitzjohn's Avenue, London NW3 5LT.
- The assessment is undertaken with reference to London Borough of Camden's planning consent acoustic requirements for mechanical services equipment (including items such as air source heat pumps) as contained in Policy A4: *Noise and Vibration* of Section 6: *Protecting Amenity* of Camden Local Plan (adopted June 2017).
- As part of the assessment a background noise survey has been carried out over a seven-day period including sample weekdays and a full weekend. The survey establishes existing background noise levels during operational times of the air source heat pumps, at a position representative of outside nearest neighbouring residential properties.
- Based on results of the background noise survey and noise model calculations using the proposed air source heat pump manufacturer's noise data, the overall noise level from the air source heat pumps (with noise reduction treatment fitted) is calculated to comply with London Borough of Camden's planning consent acoustic requirements for mechanical services equipment.
- The noise reduction treatment comprises acoustic louvre enclosure of the air source heat pumps. Specification details for the acoustic louvre enclosure are included in Section 6.1 of the report.
- Location of the air source heat pumps is at distance from, and not structurally linked to, neighbouring existing residential properties. Therefore, there will be no potential for any structure-borne vibration from the equipment to transfer to the neighbouring existing properties. Notwithstanding this, then as good practice and to anyhow mitigate possible vibration from the equipment to the new houses at 66 Fitzjohn's Avenue themselves, it is advised the air source heat pumps be installed on conventional proprietary vibration isolators. Specification details for typically suitable vibration isolators are provided in Section 6.2 of the report.

1. INTRODUCTION

Two external air source heat pumps are proposed to be installed to serve two new residential houses (i.e. one per property) currently under construction at 66 Fitzjohn's Avenue, London NW3 5LT.

The air source heat pumps are to be positioned within an acoustic louvre enclosure at roof level of the houses, to maximise distance to existing neighbouring residential properties.

As part of the planning application process for the air source heat pumps, the Local Planning Authority (London Borough of Camden) requires information in the form of an acoustic (noise & vibration assessment) report, in order to protect the amenity of residents in the vicinity with regard to possible noise and vibration disturbance from the pumps.

Philip Acoustics has therefore been commissioned to provide an acoustic assessment report for the proposed air source heat pumps. This report presents results of the assessment and includes:

- Noise criteria: London Borough of Camden planning consent acoustic requirements;
- Measurement survey of existing background noise levels;
- Calculation of air source heat pump noise levels;
- Consideration of vibration from the air source heat pumps;
- Specification for noise reduction treatments and/or vibration isolation as necessary to ensure compliance with the planning consent requirements of London Borough of Camden.

2. NOISE CRITERIA (*London Borough Of Camden Acoustic Requirements*)

Policy A4: *Noise and Vibration* from Section 6 – *Protecting Amenity* of the Camden Local Plan (adopted June 2017) covers in detail noise issues relating to a wide range of planning and noise pollution scenarios, including of proposed new mechanical services plant / equipment such as air source heat pumps.

Policy A4: *Noise and Vibration* is reproduced below:

Policy A4 Noise and vibration

The Council will seek to ensure that noise and vibration is controlled and managed.

Development should have regard to Camden's Noise and Vibration Thresholds (Appendix 3). We will not grant planning permission for:

- development likely to generate unacceptable noise and vibration impacts; or
- development sensitive to noise in locations which experience high levels of noise, unless appropriate attenuation measures can be provided and will not harm the continued operation of existing uses.

We will only grant permission for noise generating development, including any plant and machinery, if it can be operated without causing harm to amenity. We will also seek to minimise the impact on local amenity from deliveries and from the demolition and construction phases of development.

"Camden's Noise and Vibration Thresholds" referenced in Policy A4 as applicable for proposed new plant / equipment such as air source heat pumps are advised in Table C from section *Industrial and Commercial Noise Sources* of Appendix 3 to the Camden Local Plan document as reproduced below:

Table C: Noise levels applicable to proposed industrial and commercial developments (including plant and machinery)

Existing Noise sensitive receptor	Assessment Location	Design Period	LOAEL (Green)	LOAEL to SOAEL (Amber)	SOAL (Red)
Dwellings**	Garden used for main amenity (free field) and Outside living or dining or bedroom window (façade)	Day	'Rating level' 10dB* below background	'Rating level' between 9dB below and 5dB above background	'Rating level' greater than 5dB above background
Dwellings**	Outside bedroom window (façade)	Night	'Rating level' 10dB* below background and no events exceeding 57dBL _{max}	'Rating level' between 9dB below and 5dB above background or noise events between 57dB and 88dB L _{Amax}	'Rating level' greater than 5dB above background and/or events exceeding 88dBL _{Amax}

Supporting notes to Table C and as relevant for the proposed air source heat pumps in this instance include:

- A Rating Level ($L_{A,T,r}$ dB) of 10dB below the background noise (15dB if tonal components are present) should be considered the design criterion, the Rating Level established as per the provisions of BS4142:2014;
- The periods in Table C correspond to 7am to 11pm for the day & 11pm to 7am for the night;
- For smaller equipment such as air source heat pumps where achievement of the Rating Level may not afford protection, the Council will generally also require NR35 or below. To be achieved (in terms of $L_{eq,5mins}$ dB octave band levels) 1m externally from the façade of premises located in a quiet background area.

Full title of the referenced British Standard is BS4142:2014 “*Methods for rating and assessing industrial and commercial sound*”. Note that as an aid to clarity and to be consistent with wording / guidance of “*Camden’s Noise and Vibration Thresholds*” referenced in Policy A4, this report retains use of the more familiar term “*noise*” throughout as opposed to the replacement term “*sound*” of BS4142:2014.

It is the author’s experience of undertaking many surveys and assessments of noise from air source heat pumps and similar equipment in similar scenarios and contexts to that as at 66 Fitzjohn’s Avenue, that compliance with London Borough of Camden’s policy requirements would mean noise from the proposed new air source heat pumps is not generally audible / disturbing or of impact to people inside or outside neighbouring residential dwellings.

Additional clarification points relevant to the assessment and noise criteria are provided below:

Air Source Heat Pumps Operating Mode

The noise criteria are cautiously/robustly applied for the air source heat pumps operating at standard duty (i.e. full normal 100% capacity), potentially over a complete 24-hour period (i.e. including during the middle of the night). In practice it is expected the air source heat pumps would operate at a reduced capacity (and thus with reduced noise output over standard duty) for much of the time including during the late evening and night period. Manufacturer noise data for the air source heat pumps is provided in Section 4 of this report.

Rating Noise Level

The noise criteria are applied in terms of a noise Rating Level $L_{A,T}$ dB and thus with any correction for tonal characteristics noise applied as necessary to the air source heat pump noise at the assessment position as per the BS4142:2014 assessment methodology.

Assessment Positions

As per Camden’s policy requirements, day and night period (as relevant) noise criteria for the air source heat pumps are applied for two separate assessment positions; to directly outside nearest windows, also to within nearest garden areas (external amenity space), of neighbouring existing residential properties to location of the pumps.

Background Noise Level

The noise criteria are applied as “worse case”, cautiously/robustly based on the representative lowest existing background noise level for the times over 24 hours as relevant for the assessment position, based on results of a seven-day background noise survey including sample weekdays and a full weekend (see Section 3 of the report).

Table A from section *Vibration* of Appendix 3 to the Camden Local Plan document provides vibration level thresholds. The thresholds are applicable for a wide range of vibration sources such as railways, roads, leisure & entertainment premises as well as plant/machinery (so including such as air source heat pumps), as affecting (i.e. occurring inside) various types of property including residential dwellings. The vibration level thresholds are in terms of Vibration Dose Values (VDVs) and for dwellings with separate level thresholds applicable for the day and night period.

Location for the air source heat pumps is at distance from, and not structurally linked/connected to, any neighbouring existing residential properties. Thus, there is no potential for structure-borne vibration from the pumps to transfer to the neighbouring residential properties and by default Camden’s vibration level thresholds will be complied with.

3. NOISE SURVEY

To assess noise from the air source heat pumps against London Borough Of Camden's planning consent noise requirements it is necessary to establish background noise levels representative of at the assessment positions. Details of the background noise survey carried out are provided in Sections 3.1 to 3.3.

3.1 Survey Instrumentation

Details of the noise survey instrumentation used are provided in Appendix A. The sound level meter was calibration verified before and after the survey measurements using the UKAS certified calibrator.

3.2 Survey Details & Procedure

Although the proposed air source heat pumps would likely only tend to operate during the daytime and evening periods, as they are to serve residential properties then they will potentially operate at any time over 24 hours. Therefore, the survey was carried out over at least a full 24-hour period to obtain background noise levels during the entire range of possible times of operation.

The background noise survey was carried out over a seven-day period from Wednesday 04 September 2019 through Tuesday 10 September 2019 to include sample weekdays and also a full weekend. The weather included dry and calm / light wind (i.e. suitable survey conditions) during majority of the day and night periods of the survey.

Measurements of background noise were recorded continually in terms of consecutive 15-minute samples of overall equivalent free-field $L_{A90,T}$ dB values ($T=15$ minutes) for the entire survey duration.

Location of the air source heat pumps at roof level of the new houses, plus nearest neighbouring existing residential properties, are indicated on a site location plan and proposed layout plan drawings in Appendix B.

The nearest windows and garden areas (external amenity space) are of the neighbouring residential properties at 64 Fitzjohn's Avenue (to front elevation of the development site) and 12 Akenside Road (to rear elevation of the development site). Other neighbouring residential properties are more distant and/or more screened from the air source heat pumps proposed location.

Straight line distance between the air source heat pumps proposed location and nearest windows (64 Fitzjohn's Avenue) is circa 12m, and to within the nearest external amenity space (rear garden area of 12 Akenside Road) is also circa 12m.

The background noise survey measurement position was externally at equivalent first floor window level selected centrally to the southern boundary of the development site, achieved using a telescopic pole and microphone extension cable arrangement from ground level. The background noise survey position is indicated on the site location plan in Appendix B.

The survey position was selected as best practicable representative of outside the nearest existing residential properties and at the southern boundary of the development site as "worse-case"; being more screened by existing buildings from noise of passing traffic along Fitzjohn's Avenue.

Note the noise survey was at an elevated position (equivalent first floor windows level) for reasons that majority of the external ground floor area of the development site is currently excavated (for basement construction works) and also partially occupied by the contractor's temporary building structures (site offices & toilets etc.) shielding some of the ground floor external area so non-representative. Plus also positions at 1.2m to 1.5m above ground level and adjacent to the nearest neighbouring residential properties would be non-compliant with the guidance of BS4142 (being less than 3.5m from vertical reflecting surfaces – walls, fences & other structures), and also because the main potential for adverse noise impact (disturbance) from the proposed air source heat pumps is considered to be during the late evening and night to upper floor level bedrooms of the neighbouring residential properties.

3.3 Survey Observations & Results

Background noise levels are relatively low and predominantly due to underlying noise from passing traffic on the adjacent Fitzjohn's Avenue plus road traffic generally in the wider area. Background noise levels are low principally because the development site and nearest parts of the neighbouring existing residential properties (to the site) are screened by existing building structures from traffic on Fitzjohn's Avenue.

Background noise fluctuates during the day and into the evening, then gradually reduces during the late evening and into the night (lowest between circa 2am to 4am), before then increasing again in the morning as traffic increases. This diurnal noise profile is normal for this location with underlying noise from traffic on surrounding roads.

A graph showing full raw data background noise level measurements over the seven-day survey period is provided in Appendix C.

Summary of the representative lowest measured $L_{A90,T}$ background noise levels and associated air source heat pump noise limits based on London Borough of Camden's noise requirements (as detailed in Section 2 of this report) are shown in Table 1.

The background noise levels and limits are split into two separate time period values such that noise from the air source heat pumps to outside nearest windows and to garden areas (external amenity space) of the neighbouring residential properties is assessed using the representative lowest background noise during times as relevant for both assessment positions.

Air Source Heat Pump Operating Mode	Assessment Position & Relevant Times	Measured Representative Lowest Background Noise Level $L_{A90,15min}$	Air Source Heat Pump Noise Limit (Rating Level)
Pumps operating standard duty (full 100% duty)	To garden areas (external amenity space) of neighbouring properties Assessment time range: 7am to 11pm	36dB (occurs during the late evening up to circa 11pm)	$L_{A,T} \leq 26\text{dBA}$ (10dB below background) $L_{A,T} \leq 21\text{dBA}$ (15dB below background, applicable if pumps have tonal components)
	To outside nearest windows of neighbouring properties Assessment time range: Over 24 hours	32dB (occurs during middle of the night circa 2am to 4am)	$L_{A,T} \leq 22\text{dBA}$ (10dB below background) $L_{A,T} \leq 17\text{dBA}$ (15dB below background, applicable if pumps have tonal components)

Table 1: Measured representative lowest background noise and associated noise limits

4. NOISE FROM AIR SOURCE HEAT PUMPS

The proposed air source heat pumps are Daikin model ERGA08DVA. Manufacturer's noise data for the air source heat pumps is provided in Appendix D.

The manufacturer data is for the pumps operating at standard (i.e. full normal 100%) duty for cooling and heating mode. The noise data is in terms of free-field overall dBA and linear octave band dB sound pressure levels at 1m distance in front of the air source heat pumps.

Note that the noise assessment in this report is cautiously/robustly carried out with the air source heat pumps operating at standard (100%) duty in cooling mode as being "worse-case" with slightly higher noise output (by overall 1dBA) than for heating mode.

Summary of noise output from the air source heat pumps including octave band values operating at standard (100%) duty in cooling mode is shown in Table 2.

Description	Overall dBA	Octave Band Centre Frequency (Hz) (Linear dB)							
		63	125	250	500	1k	2k	4k	8k
Daikin model ERGA08DVA Cooling mode (standard / full 100% duty)	50	52	54	52	49	44	38	32	23

Table 2: Air source heat pump noise data (cooling mode); free-field sound pressure levels at 1m

Manufacturer noise data for the Daikin model ERGA08DVA indicates the air source heat pumps generate a typically broadband type noise without very strong or clearly perceptible tonal elements. This correlates with experience of the author in measuring noise levels from as-installed same make and similar type/size model air source heat pumps.

Notwithstanding this, with the acoustic enclosure noise reduction treatment applied (see Section 6.1 of the report), any residual tonal components will tend to be suppressed and noise from the air source heat pumps to neighbouring residential properties will be substantially below the lowest background noise. Therefore, the noise criterion 10dB below background of London Borough of Camden's planning consent noise requirement is applied.

To calculate the noise contribution from the air source heat pumps to the assessment positions outside nearest windows and to garden areas (external amenity space) of the neighbouring residential properties a spreadsheet-based noise model has been used. The model takes account of the distance between the air source heat pumps and the assessment positions, acoustic directivity, acoustic reflections and natural line of sight acoustic screening.

The noise model calculation also takes account of acoustic louvre enclosure noise reduction treatment applied to the air source heat pumps as specified in Section 6.1 of this report.

Noise model calculation details are provided in Appendix E.

The overall calculated noise Rating Level from the proposed air source heat pumps to outside nearest windows and to garden areas (external amenity space) of the neighbouring residential properties compared with London Borough of Camden's noise requirement is shown in Table 3.

Noise from the air source heat pumps to outside windows of neighbouring properties and/or other external amenity spaces that are more distant from, or more significantly screened from, location of the air source heat pumps will be lower.

Air Source Heat Pump Operating Mode	Assessment Position & Relevant Times	Air Source Heat Pump Overall Noise Level (Rating Level)	Noise Limit	Comment
Pumps operating cooling mode standard duty (full 100% duty)	To garden areas (<i>external amenity space</i>) of neighbouring properties Assessment time range: 7am to 11pm	16dB	$L_{A,Ti} \leq 26\text{dBA}$	Complies
	To outside nearest windows of neighbouring properties Assessment time range: Over 24 hours	21dB	$L_{A,Ti} \leq 22\text{dBA}$	Complies

Table 3: Noise from proposed air source heat pumps to assessment positions

Table 3 shows that noise from the air source heat pumps with the specified acoustic louvre enclosure noise reduction treatment (see Section 6.1), complies with the noise limit criteria as per London Borough of Camden's requirements.

At this level, noise from the air source heat pumps will be significantly below existing lowest background noise levels and be subjectively very low such that it would not be expected to give rise to any noise impact or disturbance affecting the amenity of residential neighbours.

Additionally, it is important to note the noise model calculation and associated assessment is cautious/robust and in practice noise from the proposed air source heat pumps will be further below the background noise and noise limit requirement to neighbouring residential properties for the following reasons:

- The calculation is with both air source heat pumps operating simultaneously at standard full (100%) duty cooling mode; at all times over 24 hours including throughout the entire night period, this is extremely unlikely to occur for majority of the time;
- The calculation allows no acoustic directivity benefit; even though the air source heat pumps' orientation means they do not face directly towards the nearest neighbouring residential properties;
- The noise limit used for the windows assessment position is very cautiously based on the representative lowest measured background noise level over 24 hours (i.e. including middle of the night), over several days. Background noise for the majority of the time, including during the middle of the night on some days is higher than the lowest value used for the assessment, and correspondingly for these times air source heat pump noise would be further below the background noise and associated noise limits applicable to these times based on the background noise occurring during these times.

In addition to the assessment as detailed on the previous page and in Table 3, noise from air source heat pumps to outside nearest windows of the neighbouring residential properties is also assessed against London Borough of Camden's NR value noise limit requirement (NR35) as detailed in Table 4:

Description	NR Value	Octave Band Centre Frequency (Hz) ($L_{eq,5mins}$ dB)							
		63	125	250	500	1k	2k	4k	8k
London Borough of Camden NR value limit	≤NR35	≤63	≤52	≤45	≤39	≤35	≤32	≤30	≤29
Noise from air source heat pumps (<i>full 100% duty</i>) Daikin model ERGA08DVA to outside nearest windows of neighbouring properties	NR15	30	29	25	19	10	3	-	-
Excess of pumps' noise on NR limit (<i>no excess</i>)	-	-	-	-	-	-	-	-	-

Table 4: Noise from proposed air source heat pumps; NR value assessment

Table 4 shows that noise from the air source heat pumps with the specified acoustic louvre enclosure noise reduction treatment (see Section 6.1), readily complies with the NR value noise limit criterion as per London Borough of Camden's requirements.

This additional NR value limit assessment confirms noise from the proposed new air source heat pumps will be significantly / subjectively very low and not expected to give rise to any noise impact or disturbance affecting the amenity of residential neighbours.

5. VIBRATION FROM AIR SOURCE HEAT PUMPS

Proposed location of the air source heat pumps is at distance from, and not structurally linked / attached to neighbouring existing residential buildings. Thus, there will be no potential for any structure-borne vibration from the pumps to transfer to the neighbouring existing properties.

Notwithstanding this, then as good practice and to anyhow mitigate possible vibration from the air source heat pumps to the new houses at 66 Fitzjohn's Avenue themselves, it is advised the pumps be installed on conventional proprietary vibration isolators.

Specification details for typically suitable vibration isolators are provided in Section 6.2 of the report

6. SPECIFICATIONS FOR NOISE & VIBRATION TREATMENTS

This report is based on the proposed air source heat pumps Daikin model ERGA08DVA as detailed in Section 4. If during installation or as part of future possible equipment replacement, an alternative make and/or model of air source heat pump or similar equipment is selected, then it is important that noise levels for the alternative equipment be checked by Philip Acoustics or another acoustic consultant to ensure the treatments specified below remain valid and noise emissions remain compliant with London Borough Of Camden's noise requirements.

6.1 Noise

To ensure compliance with London Borough of Camden's noise requirements it is recommended the air source heat pumps be located within an acoustic louvre enclosure as indicated on the roof plan layout drawing in Appendix F.

Note that Philip Acoustics can only advise on acoustic (noise and vibration) issues and therefore professional advice from others may need to be sought to confirm aspects of the acoustic louvre enclosure with regard to non-acoustic issues such as visual appearance, structural loading, maintenance access and airflow ventilation.

Use of an absorptive acoustic louvre enclosure is a normal / standard method of noise reduction treatment for singular or small quantity and domestic type external air source heat pumps and similar equipment in this scenario, and in non-technical terms essentially forms a "soundproof" box over and around the equipment. The acoustic louvre enclosure is required to reduce noise levels of the air source heat pumps in overall terms by at least 10dBA.

Although outside of the scope for this acoustic (noise assessment) report, the use of an acoustic louvre enclosure will also have the benefit of visually screening the air source heat pumps.

A typical acoustic enclosure would have acoustic louvres to the front (and sides or top) to permit airflow to/from the air source heat pumps and with the remaining non-acoustic louvre parts of the enclosure's outer structure being formed by normal/standard type proprietary 25mm to 50mm thick acoustic panels, being solid one side (minimum 20swg sheet steel) and perforated the other (typically perforated 22swg sheet steel) with 25mm to 50mm thick acoustic grade mineral wool absorptive lining. The perforated (absorptive) side of the enclosure panels need to face inwards towards the air source heat pumps.

Proprietary 25mm to 50mm thick acoustic panels as the specification details above are available as standard from most acoustic hardware suppliers.

The acoustic panel parts of the enclosure can be painted or over-clad externally to whatever specification / material as required for visual reasons.

The recommended minimum performance requirement for the enclosure acoustic louvres is shown in Table 5. As normal for noise reduction treatments, the performance specification is for different amounts in different frequency bands, but with requirement to achieve an overall noise reduction of at least 10dBA.

Description	Octave Band Centre Frequency (Hz)								Comments
	63	125	250	500	1k	2k	4k	8k	
Acoustic Louvre Insertion Loss dB	3	6	8	11	15	16	13	12	Suitable acoustic louvre would be typically 300mm depth

Table 5: Acoustic louvre performance specification (typical for nominal 300mm depth acoustic louvres)

The Table 5 acoustic louvre specification is based on using a proprietary nominal 300mm depth type acoustic louvre as available from most acoustic hardware suppliers.

Technical data sheets for three example suitable 300mm depth acoustic louvres (suppliers Allaway Acoustics, Kingfisher and McKenzie Martin) are provided in Appendix F.

Note that different acoustic suppliers have slightly differing performance data for their 300mm depth acoustic louvres. Therefore, some supplier data may indicate slight variation in performance as compared with the octave band specification data in Table 5, however this is recommended acceptable providing the acoustic louvres are 300mm depth type.

It is anticipated the acoustic louvres forming the enclosure will need to be demountable to enable maintenance access to the air source heat pumps. This would be achieved typically by using easy release acoustic louvered access panels (as opposed to acoustic louvre doors which are more costly and unnecessary for this relatively small size enclosure). All cable and pipe entry points into and out of the enclosure to the pumps should be sealed airtight.

6.2 Vibration

As detailed in Section 5, it is advised as good practice that the air source heat pumps be installed using conventional proprietary vibration isolator mountings.

Appropriate proprietary vibration isolators for the air source heat pumps in this scenario (at roof level) would be rubber or neoprene turret type, with static deflection nominally $\geq 5\text{mm}$ under the weight / loading of the pumps. Normally four vibration isolators are required per pump, one to each corner mounting position.

Two example suppliers and details of their typically suitable vibration isolators are provided below, the suppliers are not listed in any order of preference and other suppliers will be able to provide equivalent vibration isolators. A copy of each of the supplier's relevant data sheets is provided in Appendix G.

EMTEC: www.emtecproducts.co.uk Vibration isolator Type RD-1

Typical suitable vibration isolators of this supplier for the Daikin model ERGA08DVA air source heat pump of nominal gross weight 60kg (pump + refrigerant charge), are Type RD-1 colour code Blue (max load per isolator 15.8kg).

Christie & Grey: www.christiegrey.com Vibration isolator Type RM

Typical suitable vibration isolators of this supplier for the Daikin model ERGA08DVA air source heat pump of nominal gross weight 60kg (pump + refrigerant charge), are Type RM 19.100.Y.F colour code Yellow (max load per isolator 28kg).

A P P E N D I X A

Noise Survey Instrumentation

Site: 66 Fitzjohn's Avenue, London NW3 5LT

Report: 19123-003 Revision A Appendix A (page 1 of 1)

Date: March 2020

NOISE SURVEY INSTRUMENTATION

Six Day Background Noise Survey Wednesday 04 September 2019 – Monday 09 September 2019:

- Rion sound level meter type NL-31 Class 1 serial number 00773045 (in locked & tamperproof environmental case) plus Rion preamplifier type NH-21 serial number 25056 with Rion microphone type UC-53A serial number 313002 and Rion microphone extension cable type EC-04A, Rion outdoor microphone windshield type WS-10 and tripod / extension boom arrangement;
- Bruel & Kjaer calibrator type 4231 serial number 2454786 (UKAS certified);
- Speedtech Instruments Skymaster model SM-28 serial number 19370 (for sample weather conditions data during attended parts of survey).

A P P E N D I X B

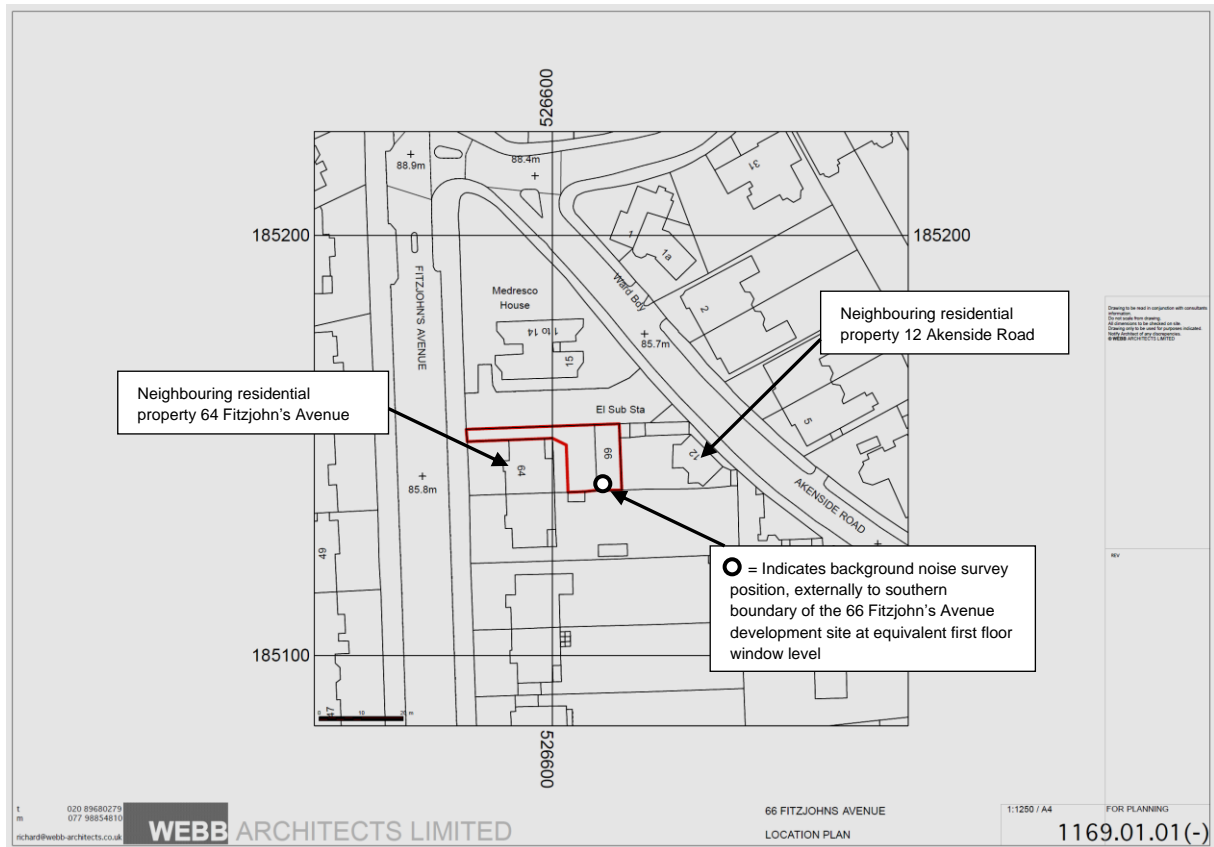
Site Location Plan & Proposed Layout Drawings

Site: 66 Fitzjohn's Avenue, London NW3 5LT

Report: 19123-003 Revision A Appendix B (page 1 of 2)

Date: March 2020

SITE LOCATION PLAN

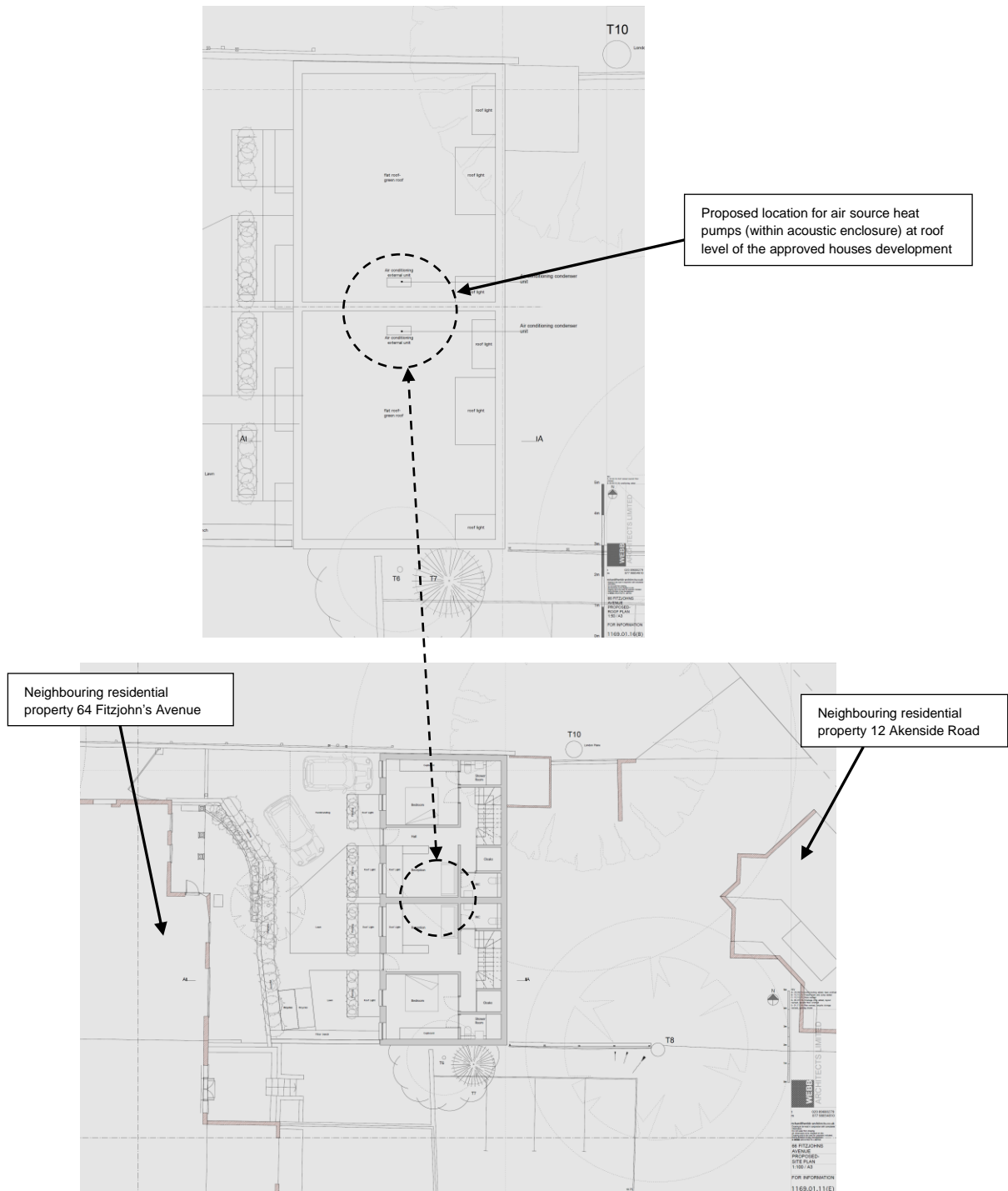


Site: 66 Fitzjohn's Avenue, London NW3 5LT

Report: 19123-003 Revision A Appendix B (page 2 of 2)

Date: March 2020

PROPOSED LAYOUT PLAN DRAWINGS (showing air source heat pumps roof level location)



A P P E N D I X C

Background Noise Survey Results

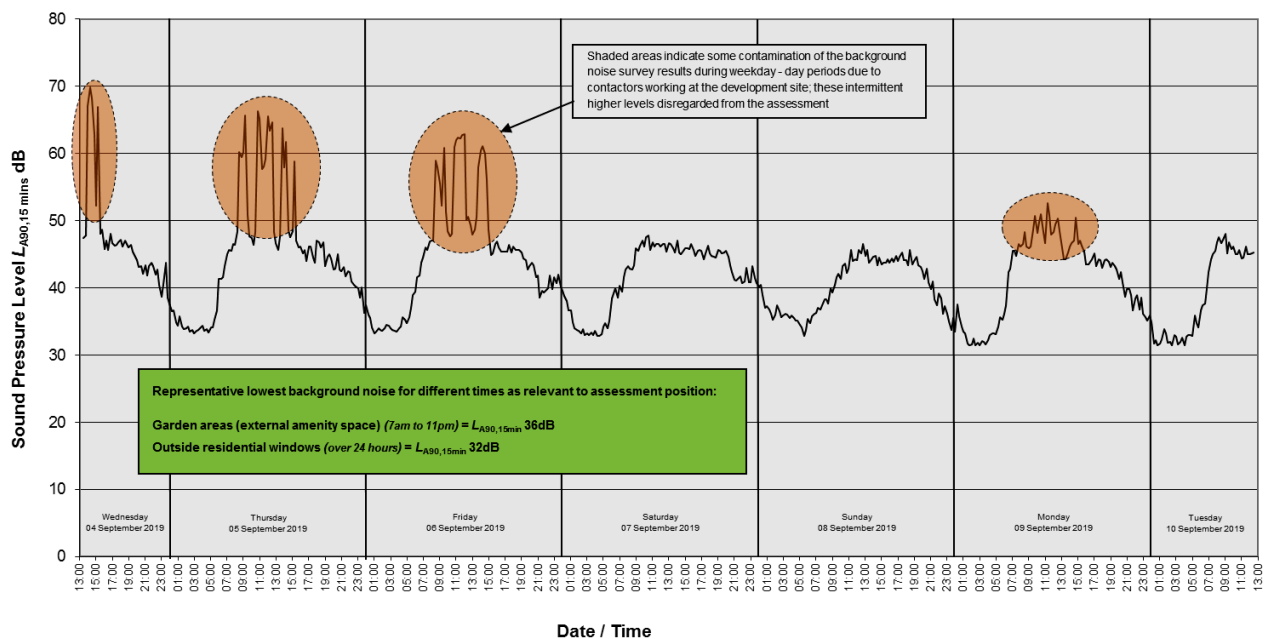
Site: 66 Fitzjohn's Avenue, London NW3 5LT

Report: 19123-003 Revision A Appendix C (page 1 of 1)

Date: March 2020

BACKGROUND NOISE SURVEY RESULTS

Raw Data Seven-Day Background Noise Survey Results



A P P E N D I X D

Manufacturer Noise Data For Air Source Heat Pumps

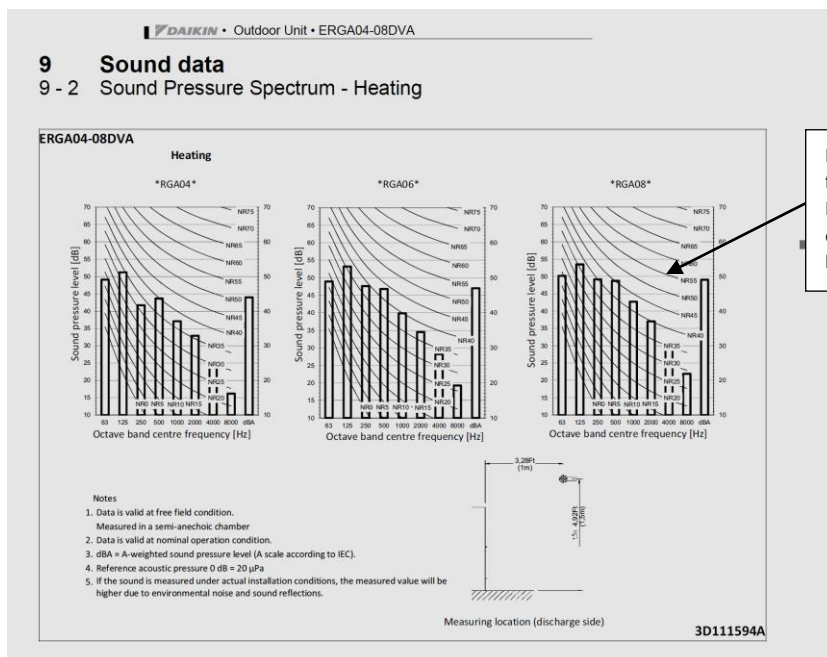
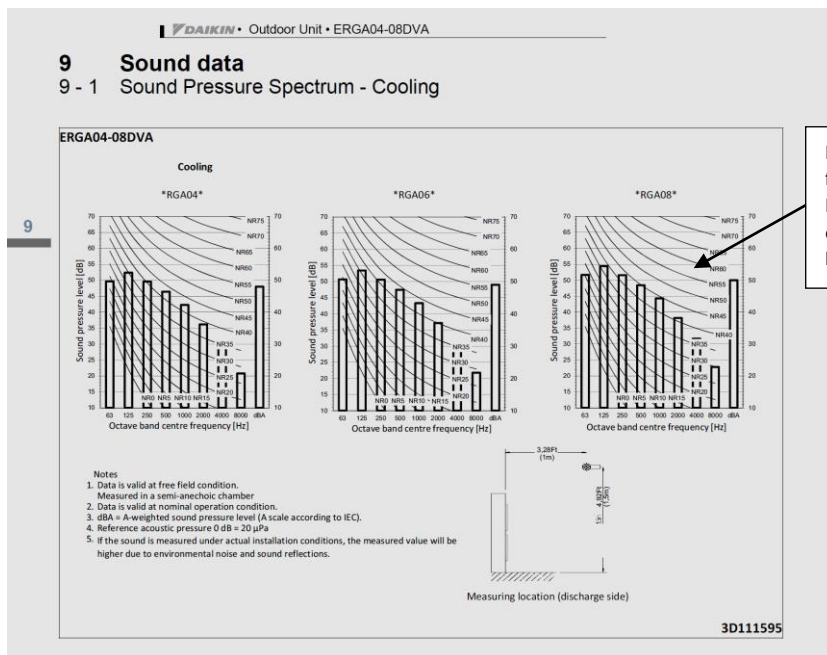
Site: 66 Fitzjohn's Avenue, London NW3 5LT

Report: 19123-003 Revision A Appendix D (page 1 of 1)

Date: March 2020

MANUFACTURER NOISE DATA FOR AIR SOURCE HEAT PUMPS

Daikin model ERGA08DVA



APPENDIX E

Noise Model Calculation For Air Source Heat Pumps

Site: 66 Fitzjohn's Avenue, London NW3 5LT

Report: 19123-003 Revision A Appendix E (page 1 of 2)

Date: March 2020

NOISE MODEL CALCULATION FOR AIR SOURCE HEAT PUMPS

Assessment Position: Garden areas (external amenity space) of neighbouring residential properties

Noise Condition: 2 x Daikin air source heat pumps model ERGA08DVA operating full (100%) duty cooling mode

Noise Mitigation: Air source heat pumps in acoustic louvre enclosure (see Section 6.1 Report 19123-003 Revision A)

Equipment & Description	Overall dBA	Lin dB at Octave Band Centre Frequency Hz							
		63	125	250	500	1k	2k	4k	8k
AIR SOURCE HEAT PUMP: 2 X Daikin model ERGA08DVA									
Sound pressure level data at 1m (free-field); L_p dB for pump units operating 100% duty cooling mode	50	52	54	52	49	44	38	32	23
Quantity; 3dB quantity correction applicable for 2 x same model air source heat pumps		3	3	3	3	3	3	3	3
Noise Mitigation; pump units positioned within acoustic enclosure (300mm type acoustic louvres)		-3	-6	-8	-11	-15	-16	-13	-12
Distance; ≈ 12 m from pump units to external amenity space (garden areas) assessment position		-22	-22	-22	-22	-22	-22	-22	-22
Screening; partial line of sight screening correction applicable, cautiously limit screening to -5dB		-5	-5	-5	-5	-5	-5	-5	-5
Directivity; cautiously nil directivity correction applied		0	0	0	0	0	0	0	0
Reflections; pump units at flat roof level in equivalent free-field conditions; nil correction applicable		0	0	0	0	0	0	0	0
Contribution at assessment position	16	25	24	20	14	5	-2	-5	-13
Cumulative contribution all sources at assessment position	16	25	24	20	14	5	-2	-5	-13

The overall noise level at the assessment position from the air source heat pumps operating is 16dBA.

Noise generated by the air source heat pumps at the assessment position is substantially below the representative lowest background noise, plus the proposed Daikin model ERGA08DVA generates a broadband characteristic noise (i.e. no strong / dominant prevailing tonal components), and notwithstanding this the specified acoustic louvre enclosure noise reduction treatment will tend to suppress any residual (albeit non-expected) tonal or other noise characteristics of the equipment.

Therefore, and as per the assessment provisions of British Standard BS4142:2014, no tonal character correction is applied and the air source heat pumps noise Rating Level to the assessment position = $L_{A_r,Tr}$ 16dB.

Site: 66 Fitzjohn's Avenue, London NW3 5LT

Report: 19123-003 Revision A Appendix E (page 2 of 2)

Date: March 2020

NOISE MODEL CALCULATION FOR AIR SOURCE HEAT PUMPS

Assessment Position: Outside nearest windows of the neighbouring residential properties

Noise Condition: 2 x Daikin air source heat pumps model ERGA08DVA operating full (100%) duty cooling mode

Noise Mitigation: Air source heat pumps in acoustic louvre enclosure (see Section 6.1 Report 19123-003 Revision A)

Equipment & Description	Overall dBA	Lin dB at Octave Band Centre Frequency Hz							
		63	125	250	500	1k	2k	4k	8k
AIR SOURCE HEAT PUMP: 2 X Daikin model ERGA08DVA									
Sound pressure level data at 1m (free-field); L_p dB for pump units operating 100% duty cooling mode	50	52	54	52	49	44	38	32	23
Quantity; 3dB quantity correction applicable for 2 x same model air source heat pumps		3	3	3	3	3	3	3	3
Noise Mitigation; pump units positioned within acoustic enclosure (300mm type acoustic louvres)		-3	-6	-8	-11	-15	-16	-13	-12
Distance; ≈ 12 m from pump units to nearest windows assessment position		-22	-22	-22	-22	-22	-22	-22	-22
Screening; nil line of sight screening correction applicable (to upper floor windows)		0	0	0	0	0	0	0	0
Directivity; cautiously nil directivity correction applied		0	0	0	0	0	0	0	0
Reflections; pump units at flat roof level in equivalent free-field conditions; nil correction applicable		0	0	0	0	0	0	0	0
Contribution at assessment position	21	30	29	25	19	10	3	0	-8
Cumulative contribution all sources at assessment position	21	30	29	25	19	10	3	0	-8

The overall noise level at the assessment position from the air source heat pumps operating is 21dBA.

Noise generated by the air source heat pumps at the assessment position is substantially below the representative lowest background noise, plus the proposed Daikin model ERGA08DVA generates a broadband characteristic noise (i.e. no strong / dominant prevailing tonal components), and notwithstanding this the specified acoustic louvre enclosure noise reduction treatment will tend to suppress any residual (albeit non-expected) tonal or other noise characteristics of the equipment.

Therefore, and as per the assessment provisions of British Standard BS4142:2014, no tonal character correction is applied and the air source heat pumps noise Rating Level to the assessment position = $L_{A,r,Tr}$ 21dB.

APPENDIX F

Details For Noise Reduction Treatment

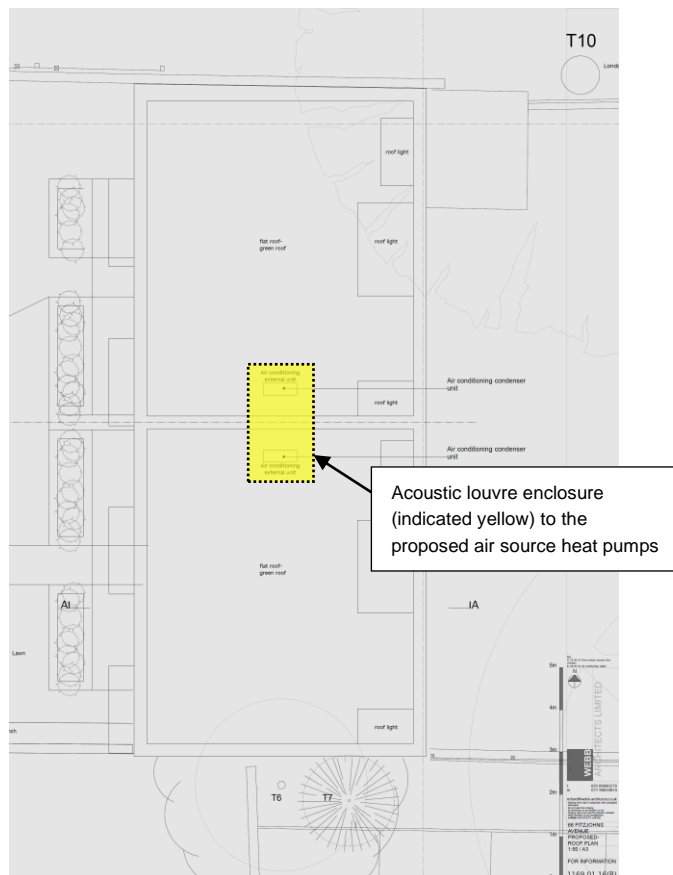
Site: 66 Fitzjohn's Avenue, London NW3 5LT

Report: 19123-003 Revision A Appendix F (page 1 of 4)

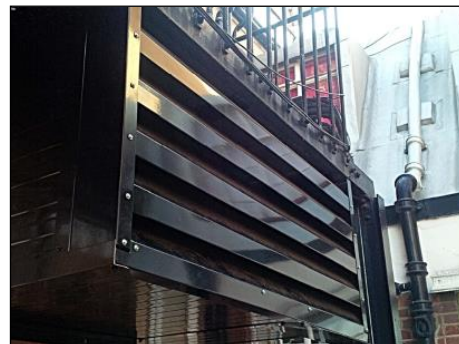
Date: March 2020

DETAILS FOR NOISE REDUCTION TREATMENT

Roof Plan Layout Drawing Indicating Air Source Heat Pumps Acoustic Enclosure (noise reduction treatment)



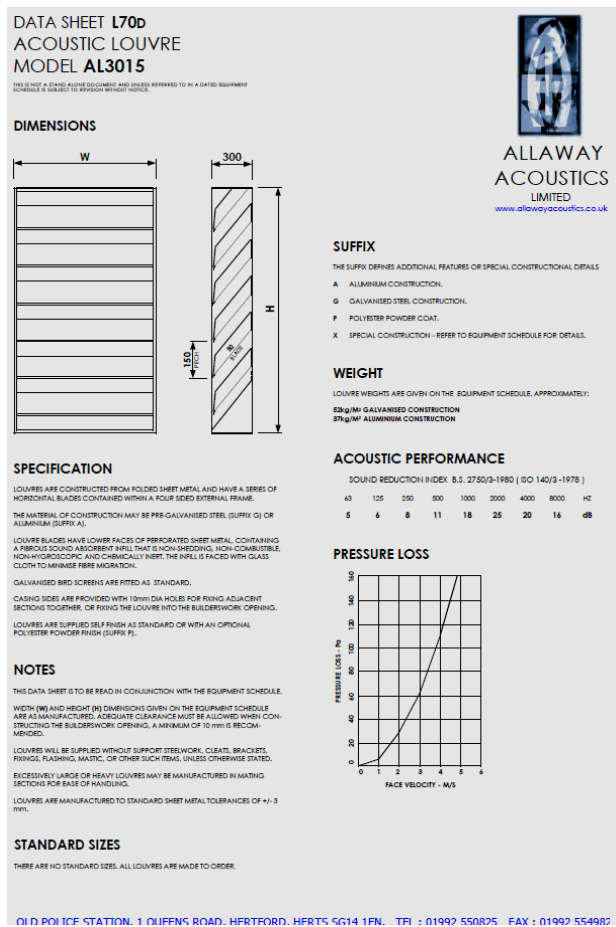
Photograph of a typical example acoustic louvre enclosure around an external domestic use air conditioning unit / air source heat pump serving a residential dwelling, this example enclosure is wall mounted with acoustic panel sides, top & bottom plus acoustic louvre to front. *This typical acoustic louvre enclosure was required to be painted black for planning reasons.*



Site: 66 Fitzjohn's Avenue, London NW3 5LT
Report: 19123-003 Revision A Appendix F (page 2 of 4)
Date: March 2020

DETAILS FOR NOISE REDUCTION TREATMENT

Data Sheet For Example 300mm Acoustic Louvre: Allaway Acoustics



Site: 66 Fitzjohn's Avenue, London NW3 5LT

Report: 19123-003 Revision A Appendix F (page 3 of 4)

Date: March 2020

DETAILS FOR NOISE REDUCTION TREATMENT

Data Sheet For Example 300mm Acoustic Louvre: Kingfisher



Kingfisher

KA ACOUSTIC LOUVRES

KA Acoustic Louvres
Acoustically treated louvres providing permanent ventilation combined with reduction of airborne sound transmission into or out of buildings. The louvres also provide weather protection, and are supplied as framed modular panels.

Applications
Can be used to provide airborne sound attenuation at ducted fan inlets and discharge outlets in plant room walls or elsewhere. Also for general plant room ventilation with sound attenuation. Can be installed behind standard Kingfisher louvres or as an architectural feature of a building in themselves.

Composition
Standard louvre blades: galvanised steel sheet with no further applied finish. To special order: stainless steel, British Steel HP200 plastic coated steel sheet.

The acoustic medium is non-toxic mineral wool, density 45kg/m³, packed at 10% compression to eliminate voids, and held in position within the louvre blades by perforated galvanised steel sheet.

Accessories

Mitred corners where required, and a variety of edge trim and flashings to suit the installation.

Birdscreen guard: HDPE or expanded aluminium, hole size 15mm.

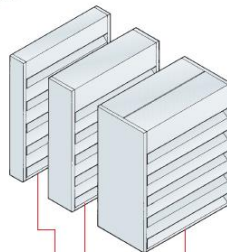
Insect guard: HDPE, hole size 4mm.

Single and double access doors also available with the same acoustic treatment.

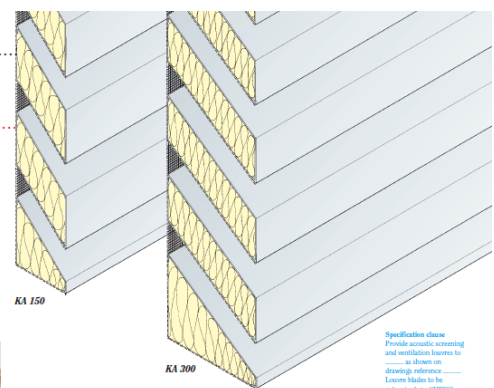
Size, shape
Blade centres and blade angle are fixed, to achieve the stated acoustic performance. Any practicable height or width of installation is possible. Maximum module size 2.5 x 2.5m.

Appearance
Standard finish: galvanised steel. Alternative finishes: polyester powder coating to BS 6496, oven-baked spray coating, HP 200 plastic coating (in a range of BS/RAL colours), stainless steel.

Maintenance
Periodic cleaning is required to maintain appearance for finished products.



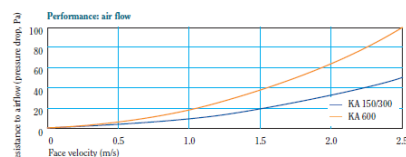
Blade type	KA 150	KA 300	KA 600
Overall depth	150mm	270mm	540mm
Free area	36%	37%	37%
Weight	28kg/m ²	50kg/m ²	100kg/m ²



Performance: acoustic
Airborne sound insulation independently measured by Sound Research Laboratories to BS 2750: Part 5.

Louvre type	Depth	Airborne sound reduction index (dB) at octave band mid frequency (Hz)							
		63	125	250	500	1000	2000	4000	8000
KA 150	150mm	2	3	4	8	13	11	9	8
KA 300	270mm	4	7	10	12	15	16	13	12
KA 600	540mm	6	8	12	21	32	33	26	24

Specification clause
Provide acoustic screening and ventilation louvres to — as shown on drawing reference — Louvre blades to be galvanised steel/HP200 plastic coated steel/ stainless steel*. Other applied finish to galvanised steel: polyester powder coating to BS 6496/oven-baked spray coating*. Colour: — Acoustic medium: non-toxic mineral wool, density 45kg/m³, packed at 10% compression to eliminate voids, and held in position within louvre blades by perforated galvanised steel sheet. Louvre type: KA 150/ KA 300/KA 600*. Accessories: (HDPE)/ aluminium* bird guard/ insect guard*. Louvres to be supplied by Kingfisher Louvre Systems Ltd, Plymouth, Devon, PL6 6NS. Email: info@kingfisherlouvers.com Tel: 01773 814101, Fax: 01773 814102. *Details as applicable.



Site: 66 Fitzjohn's Avenue, London NW3 5LT
Report: 19123-003 Revision A Appendix F (page 4 of 4)
Date: March 2020

DETAILS FOR NOISE REDUCTION TREATMENT

Data Sheet For Example 300mm Acoustic Louvre: McKenzie Martin

Acoustic Louvres

1



McKenzie Martin Ltd
 LOUVRE AND NATURAL VENTILATION SPECIALISTS



Acoustic Louvres

McKenzie Martin—Louvres and Natural Ventilation
 Eton Hill Works, Eton Hill Road, Radcliffe, Manchester, M26 2US

Www.McKenzieMartin.co.uk Sales@McKenzieMartin.co.uk Tel: 0161 723 2234



2

Acoustic Louvres

Available Features

- Various Shapes to Suit Requirements
- Concealed Mullions
- Box Frames, Flanges, Cills, Flashing
- Bird Fly Mesh
- Blanking Plates (Single Skin or Insulated)
- Integral Doors
- Terraces
- Double Multiple Banks

Available Finishes

- Natural Mill Finish
- Polyester Powder Coated to your choice of RAL
- British Steel Plastisol in a standard RAL colour

The System

Designed as an effective means of reducing sound transmittance whilst allowing weathered ventilation, McKenzie Martin Acoustic Louvres are suitable for vertical mounting into sidewall cladding or brickwork and may be installed singly, in horizontal runs or vertical tiers. The units are available in pitches of 100mm, 150mm and 300mm to suit.

Each model of louvre blade incorporates sound absorption material which is contained within a double layer of perforated mesh and provides sound reduction per the table below. The units are simple to install and maintain and may be used in conjunction with roof ventilators to provide an overall system of natural and/or fire ventilation. The louvres are made to measure and offered in a variety of materials and finishes to suit specific requirements.

Acoustic Performance

All units have been subjected to a series of controlled sound transmission tests to the specification shown in BS EN ISO 10140-2:2010. The results are shown in the tables below.

100mm Unit		150mm Unit		300mm Unit	
Octave Band Centre Frequency (Hz)	Sound Reduction Index (dB)	Octave Band Centre Frequency (Hz)	Sound Reduction Index (dB)	Octave Band Centre Frequency (Hz)	Sound Reduction Index (dB)
63	-0.9	63	2.1	63	3.0
125	4.6	125	6.7	125	6.7
250	4.2	250	4.8	250	9.3
500	6.0	500	7.4	500	13.4
1000	9.4	1000	13.2	1000	17.7
2000	17.2	2000	23.4	2000	20.4
4000	15.0	4000	20.8	4000	17.0
8000	13.4	8000	16.4	8000	14.7

Manufacturing Options

Top, bottom and side flanges may be formed to whatever mounting detail is required. For additional information please consult the separate form entitled detail for manufacture.

With flanged louvres the box depth can be manufactured to fit inside or outside the building line as required.

Where units are to be mounted in continuous horizontal runs joining plates are provided for weathering.

Nylon mesh or expanded aluminium mesh bird guards can be fitted internally if required.



McKenzie Martin—Louvres and Natural Ventilation

Eton Hill Works, Eton Hill Road, Radcliffe, Manchester, M26 2US

Tel: 0161 723 2234 Sales@McKenzieMartin.co.uk www.McKenzieMartin.co.uk

A P P E N D I X G

Details For Typically Suitable Proprietary Vibration Isolators

Site: 66 Fitzjohn's Avenue, London NW3 5LT

Report: 19123-003 Revision A Appendix G (page 1 of 2)

Date: March 2020

DETAILS FOR TYPICALLY SUITABLE PROPRIETARY VIBRATION ISOLATORS

Supplier: EMTEC



Effective Isolation for Floor Mounted Equipment

Series R & RD Neoprene Mountings are molded in colored oil-resistant neoprene. This unique color coding provides instant identification of loading capacity — simplifies stocking — prevents installation errors.

The VMC molding process embeds all metal parts in neoprene, preventing corrosion. Mountings can also be molded in other elastomers to meet special requirements.

Bulletin No. R12/93 (UK)

VMC KORFUND

Neoprene Mountings Series R/RD

Available in 4 sizes — 5 durometers

Load Range — 10 lbs. to 4,000 lbs.

Deflections to 1/4" with type R to 1/2" with type RD

Corrosion Proof

Molded in colored oil-resistant neoprene

5 colors for error free identification

Typical Applications

Air Handling Units Business Machines

Compressors Fans Instrument Panels

Machine Tools Pumps

Motor Generators Transformers

To Specify:

Neoprene mountings shall consist of a steel top plate and base plate completely embedded in coloured oil-resistant neoprene stock for easy identification of capacity. The mountings shall be Type R or RD, depending upon the required deflection of 1/4" to 1/2", as manufactured by VMC and as supplied by EMTEC Products Limited

TYPE R/RD



TYPE RP/RDP



Dimensions, In. (mm)

Type	1	2	3	4	5	6	7	8	9	10	11	12
R1	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 1/2"
RD1	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 1/2"
R2	2 1/2"	2 1/2"	2 1/2"	2 1/2"	2 1/2"	2 1/2"	2 1/2"	2 1/2"	2 1/2"	2 1/2"	2 1/2"	2 1/2"
RD2	2 1/2"	2 1/2"	2 1/2"	2 1/2"	2 1/2"	2 1/2"	2 1/2"	2 1/2"	2 1/2"	2 1/2"	2 1/2"	2 1/2"
R3	3 1/2"	3 1/2"	3 1/2"	3 1/2"	3 1/2"	3 1/2"	3 1/2"	3 1/2"	3 1/2"	3 1/2"	3 1/2"	3 1/2"
RD3	3 1/2"	3 1/2"	3 1/2"	3 1/2"	3 1/2"	3 1/2"	3 1/2"	3 1/2"	3 1/2"	3 1/2"	3 1/2"	3 1/2"
R4	4 1/2"	4 1/2"	4 1/2"	4 1/2"	4 1/2"	4 1/2"	4 1/2"	4 1/2"	4 1/2"	4 1/2"	4 1/2"	4 1/2"
RD4	4 1/2"	4 1/2"	4 1/2"	4 1/2"	4 1/2"	4 1/2"	4 1/2"	4 1/2"	4 1/2"	4 1/2"	4 1/2"	4 1/2"

* RD dimension applies to double deflection Type RD mountings only.

New design for Type R-4 and RD-4 neoprene mountings.





EMTEC Products Limited, Enterprise House, Blyth Road, Hayes, Middlesex UB3 1DD
Telephone: 0181 848 3031 Facsimile: 0181 573 3605



EMTEC Products Limited, Enterprise House, Blyth Road, Hayes, Middlesex UB3 1DD
Telephone: 0181 848 3031 Facsimile: 0181 573 3605



Type	Color Code	In.	Max. Load	Deflection	
				In.	mm
R1	BLUE	35	(15.8)	0.20	0.40
RD1	BLACK	45	(20.4)	0.20	0.40
R2	RED	75	(31.7)	0.25	0.50
RD2	GREEN	120	(54.4)	0.25	0.50
R3	BLUE	135	(61.3)	0.25	0.50
RD3	BLACK	170	(77.0)	0.25	0.50
R4	RED	240	(109.3)	0.25	0.50
RD4	GREEN	380	(172.5)	0.25	0.50
R5	BLUE	550	(248.3)	0.25	0.50
RD5	BLACK	750	(342.5)	0.25	0.50
R6	RED	925	(438.3)	0.25	0.50
RD6	GREEN	1100	(489.4)	0.25	0.50
R7	BLUE	1200	(581.3)	0.25	0.50
RD7	BLACK	1500	(721.3)	0.25	0.50
R8	RED	2200	(1081.3)	0.25	0.50
RD8	GREEN	3000	(1461.3)	0.25	0.50
R9	BLUE	4000	(1811.3)	0.25	0.50

Type R or RD IF BOLTING IS PREFERRED
Type R or RD mountings are furnished with a tapped hole in the center. This enables the equipment to be bolted securely to the mounting.

Type R or RD NO BOLTING REQUIRED
Type R or RD mountings may be used without bolting under machines having no lateral or severe vertical motion.

Type RP or RDP IF BOLT HOLE IS INACCESSIBLE
Type RP or RDP mountings may be used without bolting under machines having no lateral or severe vertical motion. Type RP or RDP mountings are furnished with a tapped hole in the center. This enables the equipment to be bolted securely to the mounting.

Site: 66 Fitzjohn's Avenue, London NW3 5LT

Report: 19123-003 Revision A Appendix G (page 2 of 2)


Date: March 2020

DETAILS FOR TYPICALLY SUITABLE PROPRIETARY VIBRATION ISOLATORS

Supplier: Christie & Grey

Rubber Turret Mountings

Type RM



Type RM Rubber Turret mountings are designed to provide superior attenuation of medium to high frequency vibration and noise emanating from a wide range of motor driven machines particularly axial and centrifugal fans.

High resilience rubber with low dynamic to static stiffness ratio ensures maximum efficiency, good creep performance and long service life.

DESIGN FEATURES

- Moulded in first grade natural rubber with integral steel base and upper fixing boss.
- Manufactured in three sizes, each available in three rubber compounds identified by a colour spot.
- Static deflections of up to 8 mm with loads from 5 kg to 400 kg.
- Upper fixing screw supplied as standard with optional height adjusters also available.

TYPICAL APPLICATIONS

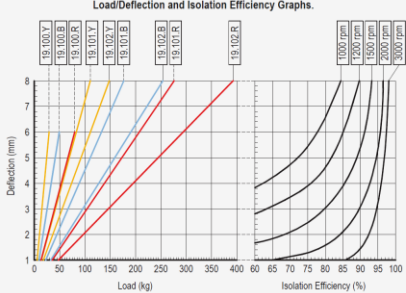
- Axial and Centrifugal Fans.
- Air Handling Units.
- Refrigeration Plant.
- Pumps.
- Rotary and Multi Cylinder Compressors.
- Floating Floors.
- Isolation of Sensitive Equipment.
- Test Rigs and Special Purpose Machines.

TYPE RM RUBBER TURRET MOUNTINGS

PART No.	COLOUR CODE	RATED LOAD (kg)	DEFLECTION AT RATED LOAD (mm)	DIMENSIONS (mm)												WT (kg) MAX
				A	B	C	D	E	F	G	H	J	K	L	M	
19.100.Y.F	YELLOW	25	6	80	57	45	9	12	32	5	41	M8 x 20	42	13	18	0.11
19.100.B.F	BLUE	50	8	95	71	60	9	14	45	5	56	M10 x 25	56	18	28	0.25
19.100.R.F	RED	80	8	150	115	86	11	22	70	6	82	M12 x 30	83	27	38	0.73
19.101.Y.F	YELLOW	110	8	150	115	86	11	22	70	6	82	M12 x 30	83	27	38	0.73
19.101.B.F	BLUE	180	8	150	115	86	11	22	70	6	82	M12 x 30	83	27	38	0.73
19.101.R.F	RED	280	8	150	115	86	11	22	70	6	82	M12 x 30	83	27	38	0.73
19.102.Y.F	YELLOW	150	8	150	115	86	11	22	70	6	82	M12 x 30	83	27	38	0.73
19.102.B.F	BLUE	260	8	150	115	86	11	22	70	6	82	M12 x 30	83	27	38	0.73
19.102.R.F	RED	400	8	150	115	86	11	22	70	6	82	M12 x 30	83	27	38	0.73

■ Above part number includes standard upper fixing screw size J, for height adjustable variant replace F with HA.

■ Maximum height adjustment available is 10 mm with HA variant.



Isolation efficiency is based on dynamic rather than static stiffness for accurate calculation of system performance.

Application Notes:
Rubber Turret mountings should not be used on machines exhibiting high out of balance forces or mobile applications without locking devices or independent restraints.

For full installation instructions please refer to our data sheet DS010.

For more detailed information and technical assistance please contact our Technical Department.

In the interests of continual development, the Company reserves the right to make modifications to these details without notice.

RD0001 - JUNE 2006 - Rev C

CHRISTIE & GREY Vibration & Shock Control

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