hepworth acoustics

THE LORE OF THE LAND, FITZROVIA

PLANT NOISE IMPACT ASSESSMENT

On behalf of:

The Fat Boy Pub Co.

Report No P18-171-R01v7
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PLANT NOISE IMPACT ASSESSMENT

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The Fat Boy Pub Co.

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1.0 INTRODUCTION

1.1 Hepworth Acoustics Ltd was commissioned by The Fat Boy Pub Co. to carry out a noise impact assessment of the proposed new mechanical equipment to be installed at The Lore of the Land public house (formerly The Lukin), 4 Conway Street, Fitzrovia, London W1T 6BB.

1.2 The assessment has been commissioned in connection with the planning application for the proposed development. The aim of this report is to assess whether the existing and proposed new equipment will meet suitable limits for noise, and to make recommendations for noise mitigation where required.

1.3 The site is bounded by Conway Street to the south west. To the south east is Rebecca Hossack Art Gallery. The other buildings in the vicinity include offices and private residences. The most affected noise-sensitive premises, to the best of our knowledge, are the flats in County House. We have also taken into consideration the residences on Conway Street and Maple Street, the rear windows of which overlook The Lore of the Land and the location of the existing and proposed equipment. Other residences are further away so will be less affected. A location plan is shown in Figure 1.

1.4 The three existing condensers on the first-floor flat roof to the rear of the premises are proposed to be replaced with new, quieter, models and relocated to the third-floor flat roof. One new condenser is proposed to be added, serving the cellar. The new cellar condenser can operate intermittently at any time, according to demand. The three condensers being relocated are for air-conditioning so can potentially operate during the premise's opening hours, but will not be used outside of these times.

1.5 There will be also be new kitchen extract and supply fans installed within the existing pitched roof void. The new inlet louvre is on the rear wall of the premises, and the new outlet (extract) comes through the new office window and discharges a minimum of 1 metre above eaves level on the north-east side of the roof. This is expected to operate from around 10:00 to 23:00 daily.

1.6 The existing kitchen ventilation system and two heat dumps to the rear of the premises will remain in situ. We have been explicitly requested by Camden Council to exclude the noise impact of the existing kitchen extract from this assessment. For assessment purposes, we have assumed for a cautious approach that the heat dumps can switch on at any time, although in practice they are unlikely to operate at night.

1.7 This assessment is based on drawing 3175/35, Revision L, from Pembrook Design, dated 2nd November 2018.

1.8 The various noise units and indices referred to in this report are described in Appendix I. All noise levels mentioned have been rounded to the nearest decibel, as fractions of decibels are imperceptible.

2.0 ACOUSTIC DESIGN CRITERIA

Camden Council

2.1 Camden Council has the following guidance in *Camden Planning Guidance: Amenity*, dated March 2018:

> *Developments proposing plant, ventilation, air extraction or conditioning equipment and flues will need to provide the system's technical specifications to the Council accompanying any acoustic report. 'BS4142 Method for rating Industrial and Commercial Sound'* [SIC] *contains guidance and standards which should also be considered within the acoustic report.*

2.2 The following additional guidance is included for industrial and commercial noise sources in *Appendix 3: Noise Thresholds* of the *Camden Local Plan 2017:*

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

2.3 BS 4142: 2014 '*Methods for rating and assessing industrial and commercial sound*' provides methods for rating and assessing sound of an industrial and/or commercial nature.

2.4 BS 4142 requires the 'rating' noise level for the operation to be compared with the background (L_{A90}) noise level in the absence of the operational noise being assessed.

2.5 The 'rating' level is derived based on the 'specific' L_{Aeq} noise level attributable to the operation with an '*acoustic feature*' penalty added for any noise sources which give rise to tonal, impulsive, intermittent, or other characteristics readily distinctive against the residual acoustic environment.

2.6 In the context of this development, we consider the guidance in BS 4142: 2014 to be appropriate so this will be adopted, along with Camden Council's 'Rating Level' criteria stated above.

2.7 Camden's Development Policy 28 (Noise and Vibration) recommends that noise levels from plant and machinery at 1 metre external to a sensitive façade should be < 5 dB(A) below background noise levels, or < 10 dB(A) below if the noise has a distinguishable discrete continuous note or distinct impulses.

3.0 ENVIRONMENTAL NOISE SURVEY

Survey Details and Results

3.1 Environmental noise measurements were carried out at the site at Location 1 marked on Figure 1, which is on the third-storey flat roof to the rear of the premises.

3.2 The description and measurement of environmental noise has been carried out in accordance with the guidance in BS 7445 *Description and measurement of environmental noise*, as stipulated in the *Camden Local Plan 2017*.

3.3 Noise measurements were taken between 19:45 on Tuesday 17th April and 14:45 on Thursday 19th April 2018.

3.4 The weather conditions throughout the noise survey were dry and overcast, with wind speeds below 5 m/s. Wind was from the south and east. Temperatures were between 10°C and 18°C. These were considered suitable conditions for the survey.

3.5 The noise measurements were taken in 'free-field' conditions with the microphone at approximately 1.5 metres above the level of the third storey flat roof. Measurements were taken in 15-minute samples for the duration of the survey.

3.6 The results of the noise survey are detailed in Appendix II in graphical form. The measured noise levels are summarised in Table 1.

Table 1: Background Noise Levels Summary (dBA)

Location	Daytime (07:00 to 23:00)		Night-time (23:00 to 07:00)	
	Lowest $L_{A90,15mins}$	Modal $L_{A90,15mins}$	Lowest $L_{A90,15mins}$	Modal $L_{A90,15mins}$
1	48	55	44	46

3.7 The lowest measured noise level for the time period when the kitchen ventilation system, heat dumps, and condensers will be operating together (10:00 to 23:00) was 48 dB $L_{A90,15mins}$. The lowest measured noise level for the time period when the heat dumps and condenser only will be operating (23:00 to 10:00) was 44 dB $L_{A90,15mins}$.

Noise Sources

3.8 The dominant noise source during the day was noise from the existing mechanical plant located to the rear of the premises. The influence of the noise from the existing kitchen extract fan is noticeable between 10:00 and 21:00 in the chart in Appendix II.

3.9 When the kitchen extract fan was not running, local road traffic became the dominant noise source.

Sound Level Meter Details

3.10 The continuous noise monitoring was carried out using a Rion NL-31 Type 1 sound level meter (serial no. 01120844).

3.11 The calibration level of the meter was checked before and after the survey with a Brüel & Kjær Type 4231 sound calibrator (serial no. 2412667). No significant calibration deviation was observed.

4.0 ASSESSMENT

Equipment Noise Data

4.1 The manufacturer's sound power level data by octave band of the proposed new equipment is shown in Table 2a. The measured sound pressure levels of the existing equipment are shown in Table 2b.

Table 2a: Proposed Equipment Octave Band Sound Power Level Data, dB L_w

Equipment	Type	Octave Band Centre Frequency (Hz)							
		63	125	250	500	1k	2k	4k	8k
Condenser A	Daikin RZASG100MV1	58	58	66	67	66	63	59	51
Condenser B	Daikin RZASG100MV1	58	58	66	67	66	63	59	51
Condenser C	Daikin RZASG125MV1	60	60	64	66	67	62	58	51
Cellar Condenser	TeCool E050H	58	56	62	62	62	60	55	50
New Kitchen Extract	Systemair MUBT 062 560 EC outlet	67	69	73	75	74	71	66	59
	Systemair MUBT 062 560 EC surroundings	50	51	56	58	57	54	49	42
New Kitchen Supply	Systemair MUBT 062 560 EC inlet	65	67	71	73	72	69	64	57
	Systemair MUBT 062 560 EC surroundings	50	51	56	58	57	54	49	42

Table 2b: Existing Equipment Octave Band Sound Pressure Level Data, dB L_p

Equipment	Type	Octave Band Centre Frequency (Hz)							
		63	125	250	500	1k	2k	4k	8k
Heat Dump 1	Cornelius 12 Watt @ 5 m	35	37	37	39	44	42	35	31
Heat Dump 2	Cornelius 12 Watt @ 5 m	35	37	37	39	44	42	35	31

4.2 Based on our experience of this type of equipment and the data in Tables 2a and 2b, we do not expect the equipment to feature tonal or impulsive characteristics readily distinctive against the residual acoustic environment. Therefore, the Rating Level ($L_{Aeq,15min}$) is required not to exceed 10 dB(A) below the minimum external $L_{A90,15min}$ background noise during the proposed hours of operation at the nearest noise sensitive properties in accordance with the guidance in Appendix 3 of the *Camden Local Plan 2017*.

Daytime

4.3 The assessment predicting the noise emission level to compare to the corresponding background noise level for the equipment at 1 metre outside the window of the nearest residence is summarised in Table 3. This shows that with no mitigation measures the overall emission levels will be 12 dB(A) above background noise levels during the kitchen extract fans' proposed operating hours (i.e. 10.00 to 23.00

daily). During this time, all equipment is assumed to be operating in order to consider the worst-case scenario. The detailed calculation is in Appendix III.

Table 3: Total Predicted Noise Levels at Nearest Residential Window Without Mitigation

Description	dB(A)
Resultant condensers and heat dumps emission level at 1 metre from nearest residence window (dB $L_{Aeq,15mins}$)	57
Resultant new kitchen ventilation emission level at 1 metre from nearest residence window (dB $L_{Aeq,15mins}$)	57
Total emission level at 1 metre from nearest residence window without mitigation (dB $L_{Aeq,15mins}$)	60
Lowest measured background noise level, 10.00 to 23.00 (dB $L_{A90,15mins}$)	48
Comparison ($L_{Aeq,15mins}$ – $L_{A90,15mins}$)	+12

4.4 As can be seen from Table 3, the emissions level without noise mitigation is calculated to be 12 dB(A) above the background noise level 1 metre outside the window of the most-affected noise-sensitive premises. Noise mitigation measures will therefore be required.

4.5 To mitigate noise from the new kitchen ventilation system, we recommend duct attenuators to be installed on the atmosphere side of the new kitchen supply and extract fans. The duct attenuators should be selected with the insertion loss values shown in Table 4a.

Table 4a: Duct Attenuator Minimum Insertion Loss Values (dB)

Description	Octave Band Centre Frequency (Hz)							
	63	125	250	500	1k	2k	4k	8k
Insertion loss	1	7	15	30	33	22	17	14

4.6 To reduce the noise impact of the condensers, we recommend installing a 1.5 metre high solid timber screen around the condensers, along the edge of the third-floor flat roof. The screen is to be imperforate (no gaps), sealed at the base, and with surface mass no less than 10 kg/m^2. Proprietary acoustic screening is recommended. Note that the purpose of this screen is to attenuate noise from the condensers, not for the kitchen ventilation systems. The noise from the kitchen ventilation systems is addressed with the measures described in Paragraphs 4.5 to 4.7.

4.7 The barrier calculation parameters for the noise attenuation of the proposed screen are shown in Appendix III. The attenuation is calculated based on the guidance in BS 5228-1: 2009 + A1: 2014 and the Fresnel-Kirchhoff theory.

4.8 In addition to the screen described above, we recommend acoustic enclosures for the condensers. The existing heat dumps will also require acoustic enclosures. Each enclosure should have the minimum sound reduction performance shown in Table 5. A suitable product would be the 'Panther Box' produced by Noise Solutions Ltd, for example, or approved equal.

Table 5: Condenser and Heat Dump Enclosure Minimum Sound Reduction Values (dB)

Description	Octave Band Centre Frequency (Hz)							
	63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
Sound reduction	11	11	21	21	26	32	33	29

4.9 With the above measures, the rating level of the equipment is predicted to be reduced by 27 dB(A) to 36 dB $L_{Aeq,15mins}$, which brings the total emission level at 1 metre outside the nearest window down to 12 dB(A) below the lowest measured background noise level between 10.00 and 23.00 as shown in Table 6. This will therefore be compliant with the Local Authority's criteria. The detailed calculations including the effect of the noise mitigation measures are shown in Appendix III.

Table 6: Total Predicted Noise Levels at Nearest Residential Window with Mitigation

Description	dB(A)
Resultant condensers and heat dumps emission level at 1 metre from nearest residence window (dB $L_{Aeq,15mins}$)	33
Resultant new kitchen ventilation emission level at 1 metre from nearest residence window (dB $L_{Aeq,15mins}$)	34
Total emission level at 1 metre from nearest residence window with mitigation (dB $L_{Aeq,15mins}$)	36
Lowest measured background noise level, 10.00 to 23.00 (dB $L_{A90,15mins}$)	48
Comparison ($L_{Aeq,15mins}$ – $L_{A90,15mins}$)	-12

Night-time and Early Morning

4.10 When the kitchen ventilation systems are not operating and hence the condensers and heat dumps are operating alone, the predicted noise levels with mitigation are shown in Table 7. This is for the unlikely scenario that all heat dumps and condensers are operating simultaneously, in order to consider the worst case.

Table 7: Predicted Heat Dump and Condenser Noise at Nearest Residential Window with Mitigation

Description	dB(A)
Resultant total condenser and heat dump emissions level at 1 metre from nearest residence window (dB $L_{Aeq,15mins}$)	32
Lowest measured background noise level, 23.00 to 10.00 (dB $L_{A90,15mins}$)	44
Comparison ($L_{Aeq,15mins}$ – $L_{A90,15mins}$)	-12

4.11 This shows that with the proposed mitigation measures, the total combined condenser and heat dump rating levels will be 12 dB(A) below the lowest measured background noise levels at 1 metre from the nearest residence window. This is therefore compliant with the Local Authority's noise requirements.

4.12 We recommend that all mechanical equipment is mounted on suitable vibration isolation mounts to control structure-borne noise. All vibration isolators should be specified to achieved isolation efficiency of 0.95 at 125 Hz. Ductwork and pipework should be connected to mechanical equipment using flexible connectors.

5.0 CONCLUSION

5.1 The Fat Boy Pub Co. appointed Hepworth Acoustics to assess the impact of noise on the neighbouring noise-sensitive premises from the existing condensers and the proposed new equipment to be installed at The Lore of the Land, 4 Conway Street, Fitzrovia, London W1T 6BB. The noise impact of the existing kitchen extract equipment has been excluded at the direct request of Camden Council.

5.2 A noise survey has been undertaken at the site and the background noise levels have been determined in accordance with the requirements of the *Camden Local Plan 2017*.

5.3 Using the noise data for the proposed equipment and the existing condensers, the levels for the noise emissions at the nearest noise-sensitive premises has been predicted using the guidance in BS 4142: 2014. Suitable noise mitigation measures have been recommended to allow compliance with the noise requirements of the Local Authority.

Figure 1 – Location Plan

Appendix I: Noise Units & Indices

Sound and the decibel

A sound wave is a small fluctuation of atmospheric pressure. The human ear responds to these variations in pressure, producing the sensation of hearing. The ear can detect a very wide range of pressure variations. In order to cope with this wide range of pressure variations, a logarithmic scale is used to convert the values into manageable numbers. Although it might seem unusual to use a logarithmic scale to measure a physical phenomenon, it has been found that human hearing also responds to sound in an approximately logarithmic fashion. The dB (decibel) is the logarithmic unit used to describe sound (or noise) levels. The usual range of sound pressure levels is from 0 dB (threshold of hearing) to 120 dB (threshold of pain).

Due to the logarithmic nature of decibels, when two noises of the same level are combined together, the total noise level is (under normal circumstances) 3 dB(A) higher than each of the individual noise levels e.g. 60 dB(A) plus 60 dB(A) = 63 dB(A). In terms of perceived 'loudness', a 3 dB(A) variation in noise level is a relatively small (but nevertheless just noticeable) change. An increase in noise level of 10 dB(A) generally corresponds to a doubling of perceived loudness. Likewise, a reduction in noise level of 10 dB(A) generally corresponds to a halving of perceived loudness.

The ear is not equally sensitive to sound at all frequencies. It is less sensitive to sound at low and very high frequencies, compared with the frequencies in between. Therefore, when measuring a sound made up of different frequencies, it is often useful to 'weight' each frequency appropriately, so that the measurement correlates better with what a person would actually hear. This is usually achieved by using an electronic filter called the 'A' weighting, which is built into sound level meters. Noise levels measured using the 'A' weighting are denoted dB(A) or dBA.

Frequency and Hertz (Hz)

As well as the loudness of a sound, the frequency content of a sound is also very important. Frequency is a measure of the rate of fluctuation of a sound wave. The unit used is cycles per second, or hertz (Hz). Sometimes large frequency values are written as kiloHertz (kHz), where 1 kHz = 1000 Hz.

Young people with normal hearing can hear frequencies in the range 20 Hz to 20 kHz. However, the upper frequency limit gradually reduces as a person gets older.

Glossary of Terms

When a noise level is constant and does not fluctuate, it can be described adequately by measuring the dB(A) level. However, when the noise level varies with time, the measured dB(A) level will vary as well. In this case it is therefore not possible to represent the noise climate with a simple dB(A) value. In order to describe noise where the level is continuously varying, a number of other indices can be used. The indices used in this report are described below.

$L_{Aeq,T}$ This is the A–weighted 'equivalent continuous noise level' which is an average of the total sound energy measured over a specified time period, T. In other words, L_{Aeq} is the level of a continuous noise which has the same total (A–weighted) energy as the real fluctuating noise, measured over the same time period. It is increasingly being used as the preferred parameter for all forms of environmental noise.

L_p This is the sound pressure level of a sound source, in decibels, which is 20 times the logarithm to the base 10 of the ratio of sound pressure radiated by the source to a reference pressure. The reference pressure is 20 micropascals (2×10^{-5} Pa). Sound Pressure is the difference between the pressure caused by a sound wave and the ambient pressure of the medium the sound wave is passing through.

L_W This is the sound power level of a sound source, in decibels, which is 10 times the logarithm to the base 10 of the ratio of sound power radiated by the source to a reference power. The reference power is 1 picowatt (1×10^{-12} watt). The sound power level is the fundamental measure of the total sound energy radiated by a source per unit time.

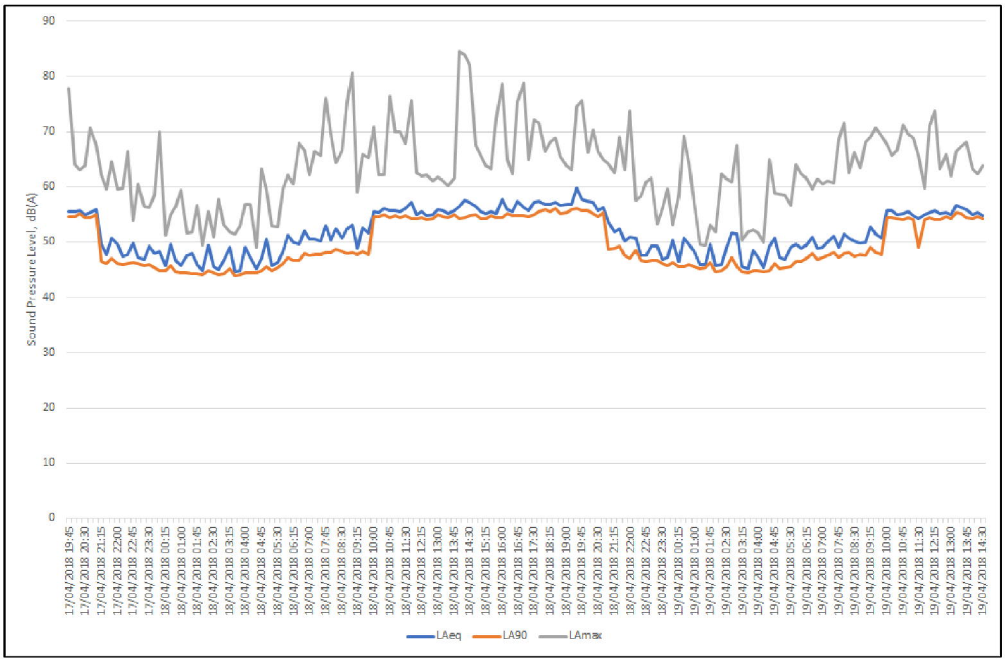
$L_{A90,T}$ This is the A–weighted noise level exceeded for 90% of the time period, T. L_{A90} is used as a measure of background noise.

Appendix II: Noise Survey Results

Location 1

Equipment:	Rion NL-31 'Type 1' sound level meter (serial no. 01120844) with tripod and windshield
Weather:	Dry, wind speed below 5 m/s

All measured sound pressure levels in dB re 20 µPa.



Appendix III: Noise Calculations

Without noise mitigation

Description	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**dB(A)**	**Comments**
Kitchen Outlet Lw	67	69	73	75	74	71	66	59		Manufacturer's data
Duct attenuator	0	0	0	0	0	0	0	0		
Duct losses	0	0	0	0	0	0	0	0		Negligible
Outlet area	2	2	2	2	2	2	2	2		
End reflections	-4	-1	0	0	0	0	0	0		Woods Practical Guide to Noise Control, Fig 5.7
Outlet directivity	1	1	1	0.5	-0.5	-2	-15	-15		SRL Noise Control in Building Services, Fig 11.2
Distance attenuation	-28	-28	-28	-28	-28	-28	-28	-28		10
Receiver façade correction	3	3	3	3	3	3	3	3		
Resulting SPL from duct outlet	41	46	51	53	51	46	28	21	54	
Kitchen Inlet Lw	65	67	71	73	72	69	64	57		Manufacturer's data
Duct attenuator	0	0	0	0	0	0	0	0		
Duct losses	0	0	0	0	0	0	0	0		Negligible
Outlet area	2	2	2	2	2	2	2	2		
End reflections	-4	-1	0	0	0	0	0	0		Woods Practical Guide to Noise Control, Fig 5.7
Outlet directivity	1.5	1.5	1.5	1.5	1	1	0	0		SRL Noise Control in Building Services, Fig 11.2
Distance attenuation	-28	-28	-28	-28	-28	-28	-28	-28		10
Receiver façade correction	3	3	3	3	3	3	3	3		
Resulting SPL from duct inlet	40	45	50	52	50	47	41	34	54	
Kitchen supply fan case breakout Lw	50	51	56	58	57	54	49	42		Manufacturer's data
Kitchen extract fan case breakout Lw	50	51	56	58	57	54	49	42		Manufacturer's data
Total kitchen fan case breakout Lw	53	54	59	61	60	57	52	45		
Roof attenuation	-7	-11	-16	-23	-23	-24	-24	-27		Measured data for tiled slate roof
Distance attenuation	-30	-30	-30	-30	-30	-30	-30	-30		12
Receiver façade correction	3	3	3	3	3	3	3	3		
Resulting SPL from case breakout	19	16	16	11	10	6	1	-9	15	
Total kitchen ventilation SPL	**43**	**48**	**53**	**55**	**53**	**50**	**41**	**34**	**57**	
Condenser A Lw	76	73	72	69	61	56	59	53		Manufacturer's data
Distance attenuation	-26	-26	-26	-26	-26	-26	-26	-26		8
Barrier attenuation	-5	-5	-6	-6	-8	-9	-12	-14		
Reflecting plane behind condensers	3	3	3	3	3	3	3	3		
Receiver façade correction	3	3	3	3	3	3	3	3		
Condenser A Resultant SPL	51	48	46	43	33	27	27	19	43	
Condenser B Lw	76	73	72	69	61	56	59	53		Manufacturer's data
Distance attenuation	-27	-27	-27	-27	-27	-27	-27	-27		9
Barrier attenuation	-5	-5	-6	-6	-8	-9	-12	-14		
Reflecting plane behind condensers	3	3	3	3	3	3	3	3		
Receiver façade correction	3	3	3	3	3	3	3	3		
Condenser B Resultant SPL	50	47	45	42	32	26	26	18	42	
Condenser C Lw	73	72	71	71	64	57	59	54		Manufacturer's data
Distance attenuation	-28	-28	-28	-28	-28	-28	-28	-28		10
Barrier attenuation	-5	-5	-6	-6	-8	-9	-12	-14		
Reflecting plane behind condensers	3	3	3	3	3	3	3	3		
Receiver façade correction	3	3	3	3	3	3	3	3		
Condenser C Resultant SPL	46	45	43	43	34	26	25	18	42	
Cellar Condenser Lw	58	56	62	62	62	60	55	50		Manufacturer's data
Distance attenuation	-26	-26	-26	-26	-26	-26	-26	-26		8
Barrier attenuation	-5	-5	-6	-6	-8	-9	-12	-14		
Reflecting plane behind condensers	3	3	3	3	3	3	3	3		
Receiver façade correction	3	3	3	3	3	3	3	3		
Cellar Condenser Resultant SPL	33	31	36	36	34	31	23	16	38	
Existing Heat Dump Lp	35	37	37	39	44	42	35	31		SPL @ 5 metres
2no. units	38	40	40	42	47	45	38	34		
Reflecting plane behind heat dumps	3	3	3	3	3	3	3	3		
Receiver façade correction	3	3	3	3	3	3	3	3		
Heat Dumps Resultant SPL	44	46	46	48	53	51	44	40	57	
Resulting SPL from condensers & heat dumps	**55**	**53**	**51**	**51**	**53**	**51**	**44**	**40**	**57**	
Overall resulting SPL	***55***	***54***	***55***	***56***	***56***	***53***	***46***	***41***	***60***	

With noise mitigation

Description	63	125	250	500	1k	2k	4k	8k	dB(A)	Comments
New Kitchen Outlet Lw	67	69	73	75	74	71	66	59		Manufacturer's data
Duct attenuator	-1	-7	-15	-30	-33	-22	-17	-14		
Duct losses	0	0	0	0	0	0	0	0		Negligible
Outlet area	2	2	2	2	2	2	2	2		
End reflections	-4	-1	0	0	0	0	0	0		Woods Practical Guide to Noise Control, Fig 5.7
Outlet directivity	1	1	1	0.5	-0.5	-2	-15	-15		SRL Noise Control in Building Services, Fig 11.2
Distance attenuation	-28	-28	-28	-28	-28	-28	-28	-28		10
Receiver façade correction	3	3	3	3	3	3	3	3		
Resulting SPL from duct outlet	40	39	36	23	18	24	11	7	31	
New Kitchen Inlet Lw	65	67	71	73	72	69	64	57		Manufacturer's data
Duct attenuator	-1	-7	-15	-30	-33	-22	-17	-14		
Duct losses	0	0	0	0	0	0	0	0		Negligible
Outlet area	2	2	2	2	2	2	2	2		
End reflections	-4	-1	0	0	0	0	0	0		Woods Practical Guide to Noise Control, Fig 5.7
Outlet directivity	1.5	1.5	1.5	1.5	1	1	0	0		SRL Noise Control in Building Services, Fig 11.2
Distance attenuation	-28	-28	-28	-28	-28	-28	-28	-28		10
Receiver façade correction	3	3	3	3	3	3	3	3		
Resulting SPL from duct inlet	39	38	35	22	17	25	24	20	32	
New Kitchen supply fan case breakout Lw	50	51	56	58	57	54	49	42		Manufacturer's data
New Kitchen extract fan case breakout Lw	50	51	56	58	57	54	49	42		Manufacturer's data
Total kitchen fan case breakout Lw	53	54	59	61	60	57	52	45		
Roof attenuation	-7	-11	-16	-23	-23	-24	-24	-27		Measured data for tiled slate roof
Distance attenuation	-30	-30	-30	-30	-30	-30	-30	-30		12
Receiver façade correction	3	3	3	3	3	3	3	3		
Resulting SPL from case breakout	19	16	16	11	10	6	1	-9	15	
Total new kitchen ventilation SPL	**42**	**41**	**38**	**25**	**21**	**28**	**24**	**20**	**34**	
Condenser A Lw	76	73	72	69	61	56	59	53		Manufacturer's data
Enclosure reduction	-11	-11	-21	-21	-26	-32	-33	-29		Manufacturer's data
Distance attenuation	-26	-26	-26	-26	-26	-26	-26	-26		8
Barrier attenuation	-6	-7	-9	-11	-13	-16	-19	-22		
Reflecting plane behind condensers	3	3	3	3	3	3	3	3		
Receiver façade correction	3	3	3	3	3	3	3	3		
Condenser A Resultant SPL	39	35	22	17	2	-12	-13	-18	22	
Condenser B Lw	76	73	72	69	61	56	59	53		Manufacturer's data
Enclosure reduction	-11	-11	-21	-21	-26	-32	-33	-29		Manufacturer's data
Distance attenuation	-27	-27	-27	-27	-27	-27	-27	-27		9
Barrier attenuation	-5	-5	-6	-6	-8	-9	-12	-14		
Reflecting plane behind condensers	3	3	3	3	3	3	3	3		
Receiver façade correction	3	3	3	3	3	3	3	3		
Condenser B Resultant SPL	39	36	24	21	6	-6	-7	-11	23	
Condenser C Lw	73	72	71	71	64	57	59	54		Manufacturer's data
Enclosure reduction	-11	-11	-21	-21	-26	-32	-33	-29		Manufacturer's data
Distance attenuation	-28	-28	-28	-28	-28	-28	-28	-28		10
Barrier attenuation	-5	-5	-6	-6	-7	-9	-11	-14		
Reflecting plane behind condensers	3	3	3	3	3	3	3	3		
Receiver façade correction	3	3	3	3	3	3	3	3		
Condenser C Resultant SPL	35	34	22	22	9	-6	-7	-11	22	
Cellar Condenser Lw	58	56	62	62	62	60	55	50		Manufacturer's data
Enclosure reduction	-11	-11	-21	-21	-26	-32	-33	-29		Manufacturer's data
Distance attenuation	-26	-26	-26	-26	-26	-26	-26	-26		8
Barrier attenuation	-6	-7	-8	-11	-12	-15	-18	-21		
Reflecting plane behind condensers	3	3	3	3	3	3	3	3		
Receiver façade correction	3	3	3	3	3	3	3	3		
Cellar Condenser Resultant SPL	21	18	13	10	4	-7	-16	-20	11	
Existing Heat Dump Lp	35	37	37	39	44	42	35	31	48	SPL @ 5 metres
Enclosure reduction	-11	-11	-21	-21	-26	-32	-33	-29		Manufacturer's data
2no. units	27	29	19	21	21	13	5	5		
Reflecting plane behind heat dumps	3	3	3	3	3	3	3	3		
Receiver façade correction	3	3	3	3	3	3	3	3		
Heat Dumps Resultant SPL	33	35	25	27	27	19	11	11	30	
Resulting SPL from condensers and heat dumps	**43**	**41**	**30**	**29**	**27**	**19**	**11**	**11**	**32**	
Overall resulting SPL	***46***	***44***	***39***	***31***	***28***	***28***	***24***	***21***	***36***	

Barrier calculation parameters

Barrier Attenuation Data	d (S-B)	d (B-R)	d (S-B-R)	d (SBR)	d (SR)	a	b	c	Path Diff
h Source = 7.6m (0.6m above roof level)									
h Receiver = 10.0m									
h Barrier = 1.5m									
Condenser A	1.1	8.1	9.1	9.6	9.4	1.4	8.2	9.4	0.2
Condenser B	2.4	7.4	9.8	10.1	10.1	2.5	7.6	10.1	0.0
Condenser C	2.7	8.1	10.7	11.0	11.0	2.8	8.2	11.0	0.0
Freezer Condenser	1.2	7.4	8.6	9.1	8.9	1.5	7.6	8.9	0.1