Project: J 02900R1
Noise Impact Assessment:
51 Red Lion Street, Camden

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

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Client: Fairly Square

Prepared by: D. M. Thomas

Signed:

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Acoustic Consultant

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1.0 BACKGROUND

1.1 Planning permission is sought for a kitchen extraction system at 51 Red Lion Street, London; the system comprises of an extraction fan, filtration system, duct bends and attenuator options. The external duct system (exhausting above roof level) is overlooked by a number of residential (noise sensitive) windows[1].

1.2 The development location falls under the jurisdiction of The London Borough of Camden (LBC); LBC has specific requirements for applications of this nature.

See Section 2.0 - ASSESSMENT CRITERIA

1.3 The proposed operational hours are until 23:00 hours; Sound Planning has evaluated noise impact until 02:00 hours and 24 hours in case of a future 'extended hours' application.

1.4 The nearest noise sensitive windows to external extraction duct are shown in APPENDIX 2 & 3.

1.5 The existing ambient noise comprises of road traffic noise and other commercial (kitchen/restaurants) in the localised area.

1.6 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.

1.6.1 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.

1.6.2 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)

[1] See APPENDIX 2 & APPENDIX 3.

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- 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[2,3]

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*.

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[3] Superseded by BS 4142: 2014.

2.3 British Standard 4142: 2014.[4]

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

[4] 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[5]

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.

[5] 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[6].

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}

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

2.6 British Standard 8233: 2014[7]

2.6.1 BS 8233: 2014 is the *Guidance on sound insulation and noise reduction for buildings – Code of practice*.

2.6.2 Indoor Ambient Noise Levels for Dwellings

Activity	Location	Design Range dB $L_{Aeq,T}$
Study and work requiring attention	Staff/meeting room, training room	35 - 45
	Executive Office	35 - 40

3.0 METHODOLOGY

3.1 Existing Noise Climate

Red Lion Street possesses a mixture of commercial/retail premises and residential dwellings (apartments/flats).

See APPENDIX 2 – Site Location/Plans

3.2 Background Noise Assessment

3.2.1 The microphone was positioned in a secure location representative of the nearest noise sensitive receiver windows (NSR) relative to the proposed external extraction duct. The existing external condenser units were switched off during the assessment period (24 hours).

See APPENDIX 3 – Site Photographs.

3.2.2 Ambient/background noise levels were measured continuously over the period 13:45 hours Thursday 6th April to 15:00 hours Friday 7th April, 2017.

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[7] Supersedes BS 8233: 1999.

3.2.3 The measurement period incorporates a full 24 hour period.

3.2.4 Measurements were undertaken in accordance with BS 7445[8] and BS 4142[9].

3.2.5 The Sound Level Meter (SLM) used for the assessment is Class 1 with real time octave band measurement capability; and compliant to IEC 61672[10].

3.2.6 The A-weighted L_{90}, L_{eq} and L_{max} descriptors were measured for 15 minute periods using the Fast (F) setting.

3.2.7 Meteoric conditions were dry with calm winds, and generally acceptable in accordance with BS 7445.

3.3 Instrumentation/Equipment

3.3.1 Equipment

Equipment	Make	Model	Class	Serial Number	UKAS Calibration
SLM	Norsonic	Nor140	1	1405819	U21376 (18/4/16)
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				

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

3.3.2 Field Calibration

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

UKAS calibration certificates are available on request.

3.3 Duct System Break-Out Calculations

3.3.1 All calculations will utilise the manufacturers' sound power level (SWL) data or calculated SWL based on the fan type, pressure and air volume[11].

3.3.2 The fan sound power level (SWL) will be attenuated by internal system (duct) losses and end reflection on reaching the exhaust termination[12].

3.3.3 Duct Break-Out[13] calculations will utilise the formula:

$SWL_{break\text{-}out} = SWL_{duct} – R + 10\log(S/A)$[14]

Where	*SWL*	*Sound Power Level*
	S	*Surface Area (Visible Duct)*
	A	*Cross Section*
	R	*Sound Reduction Index*

The term 'R' cannot give a greater break-out level than there is inside the duct. Therefore at low frequency the effective reduction is taken as 3dB.

3.3.4 The noise level at the nearest external noise sensitive receivers (NSR's) will be calculated using the formula:

$SPL_2 = SPL_1 – 20\log_r – 11 + DI$[15] [point source] and $SPL_2 = SPL_1 – 10\log_r – 11 + DI$ [line source].

Where 'r' = radius; SPL = Sound Pressure Level.

[11] Sound Research Laboratories: *Noise Control in Building Services*. Pergamon Press 1988.
[12] Sound Research Laboratories: *Noise Control in Building Services*. Pergamon Press 1988.
[13] See APPENDIX 6 – Calculation Tables.
[14] Sound Research Laboratories: *Noise Control in Building Services*. Pergamon Press 1988.
[15] DI = Directivity Index.

3.3.5 The directionality of the duct opening[16] relative to the receiver should also be considered; the approximate directivity attenuation can be found by comparing fd/c with the angle to the receiver[17].

3.3.6 Screening attenuation is based on Maekawa's formula (if required), where the expected insertion loss the barrier is the function of the Fresnel number $(2.\delta/\lambda)$[18].

3.3.7 Noise mitigation calculations will utilise sound reduction indices or insertion loss data from the manufacturer's specification data sheets.

4.0 RESULTS

4.1 Lowest Background Noise Levels

Time Period (hours)	**Background Noise Level dB $L_{A90,\ 15mins}$**
Until 23:00 hours	45.8
Until 02:00 hours	40.6
24 hours	40.3

See APPENDIX 4 – Background Noise Levels for full results.

[16] The configuration of the duct termination is currently unknown e.g. cowl etc.
[17] f = frequency; d = duct opening (m); and c = speed of sound 344m/s. Reference: Watson et al. *The Little Red Book of Acoustics*. BTA 2007.
[18] Attenborough, K. et al. *Predicting Outdoor Sound*. Copyright Taylor & Francis Group 2007.

4.2 Mechanical Equipment - Sound Power Levels

Aerofoil 50JM/20/4/6/40[19]

4.2.1 Inlet[20]:

Sound Spectrum (Hz)							
63	**125**	**25**	**500**	**1k**	**2k**	**4k**	**8k**
79	81	78	77	75	71	68	62

4.2.2 Outlet:

Sound Spectrum (Hz)							
63	**125**	**25**	**500**	**1k**	**2k**	**4k**	**8k**
81	83	79	77	75	71	69	63

4.2.3 Break-Out[21]:

Sound Spectrum (Hz)							
63	**125**	**25**	**500**	**1k**	**2k**	**4k**	**8k**
71	65	57	54	50	43	47	39

[19] Flakt Woods - Technical Data Sheets.
[20] The inlet sound spectrum is relevant to internal noise levels and not external noise levels.
[21] The proposed location for the fan is inside the building; therefore break-out will not need to be considered.

4.3 Meteorological Conditions

Wind Speed/Direction	Variable < 1m/s
Likelihood of Temperature Inversion[22]	No - Relatively short distances – Little effect
Precipitation	0 mm
Fog	No
Wet Ground	No
Frozen Ground/Snow Coverage	No
Temperature	9 - 20 °C
Cloud Cover	Partial cloud cover

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

4.4 Levels of Uncertainty

Category	Notes
Complexity of Sound Source	Extract fan located internally within the extraction duct; the external duct will radiate internal fan noise. Airborne noise will break-out through the duct termination point above roof level.
Complexity of Acoustic Environment (Residual)	Road Traffic and Mechanical Equipment noise from other commercial premises.
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
Measurement Time Intervals	Continuous
Range of Times	Including 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 NOISE CALCULATIONS[23]

5.1 The duct break-out noise at the nearest noise sensitive window (1st floor window) has been calculated at:

5.1.1	No Attenuation	55dB(A)
5.1.2	Podded Attenuator (Flakt Woods)	49dB(A)
5.1.3	Splitter Attenuator 40%FA x 1800mm (L)	39dB(A)
5.1.4	Splitter Attenuator (as above) + Ductwrap[24]	29dB(A)

5.2 Exhaust Terminal noise at the nearest noise sensitive window (1st floor window) has been calculated at:

5.2.1	No Attenuation	30dB(A)
5.2.2	Podded Attenuator (Flakt Woods)	22dB(A)
5.1.3	Splitter Attenuator 40%FA x 1800mm (L)	11dB(A)

5.3 Acoustic features should be assumed as noise emitted could contain distinguishable, discrete continuous notes (*whine*, *hiss*, *screech*, *hums*) and/or distinct impulses (*bangs, clicks, clatters, thumps*)[25].

6.0 NOISE MITIGATION STRATEGY

6.1 In order to achieve a level of 10 dB(A) below background in accordance with Camden's UDP i.e. 40 – 10 = 30 dB(A) (or less), the system should include a 40% Free Area Splitter Attenuator and the external duct be wrapped in AcoustiShield L5 + DS4.

6.2 The splitter attenuator should be 600mm x 600mm x 1800mm to provide the necessary insertion loss whilst minimising resistance to 75Pa.

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23 See APPENDIX 5 for full calculation tables.
24 CMS – AcousticShield L5 + DS4.
25 BS 4142 – Paragraph 8: 'Rating Level', Page 6.

6.3 Sound Reduction/Insertion Losses

6.3.1 Splitter Attenuator (600mm x 600mm X 1800mm)

40%FA							
63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
5	13	25	40	45	45	38	24

6.3.2 Acoustic Ductwrap

CMS AcoustiShield					
125	**250**	**500**	**1k**	**2k**	**4k**
26	26	36	47	50	53

6.4 Installation Notes

6.2.1 Silencers (attenuators) should be fitted in duct as close as possible to the fan.

6.2.2 Acoustic ductwrap should be applied to all external extract ductwork.

6.5 Suppliers

Product	Supplier
Attenuators	Various (EMTEC, FLAKT WOODS)
Acoustic Ductwrap	CMS Acoustics

7.0 CONCLUSIONS

7.1 Sound Planning has carried out an evaluation of mechanical equipment break-out noise at the nearest noise sensitive receivers in accordance with BS 4142: 2014 and Camden's Replacement Unitary Development Plan.

See Section 3.0 - METHODOLOGY

7.2 The proposed extraction system without noise mitigation exceeds noise limits expressed within The London Borough of Camden's Unitary Development Plan (UDP).

See Section 5.0 - NOISE CALCULATIONS

7.3 A splitter attenuator (adjoining the selected fan) coupled with ductwrap (all external) as specified in the NOISE MITIGATION section <u>will</u> achieve an acceptable noise level at the nearest noise sensitive receivers (windows).[26]

See Section 5.0 - NOISE CALCULATIONS

7.4 The proposed noise mitigation measures result in noise levels at the nearest noise sensitive receivers which meet Camden's UDP for all hours of the day/night; extended hours could be applied for using the findings of this acoustic report.

See Section 6.0 - NOISE MITIGATION STRATEGY

[26] Achieves target noise levels for 24 hour operation if required in the future.

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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.

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

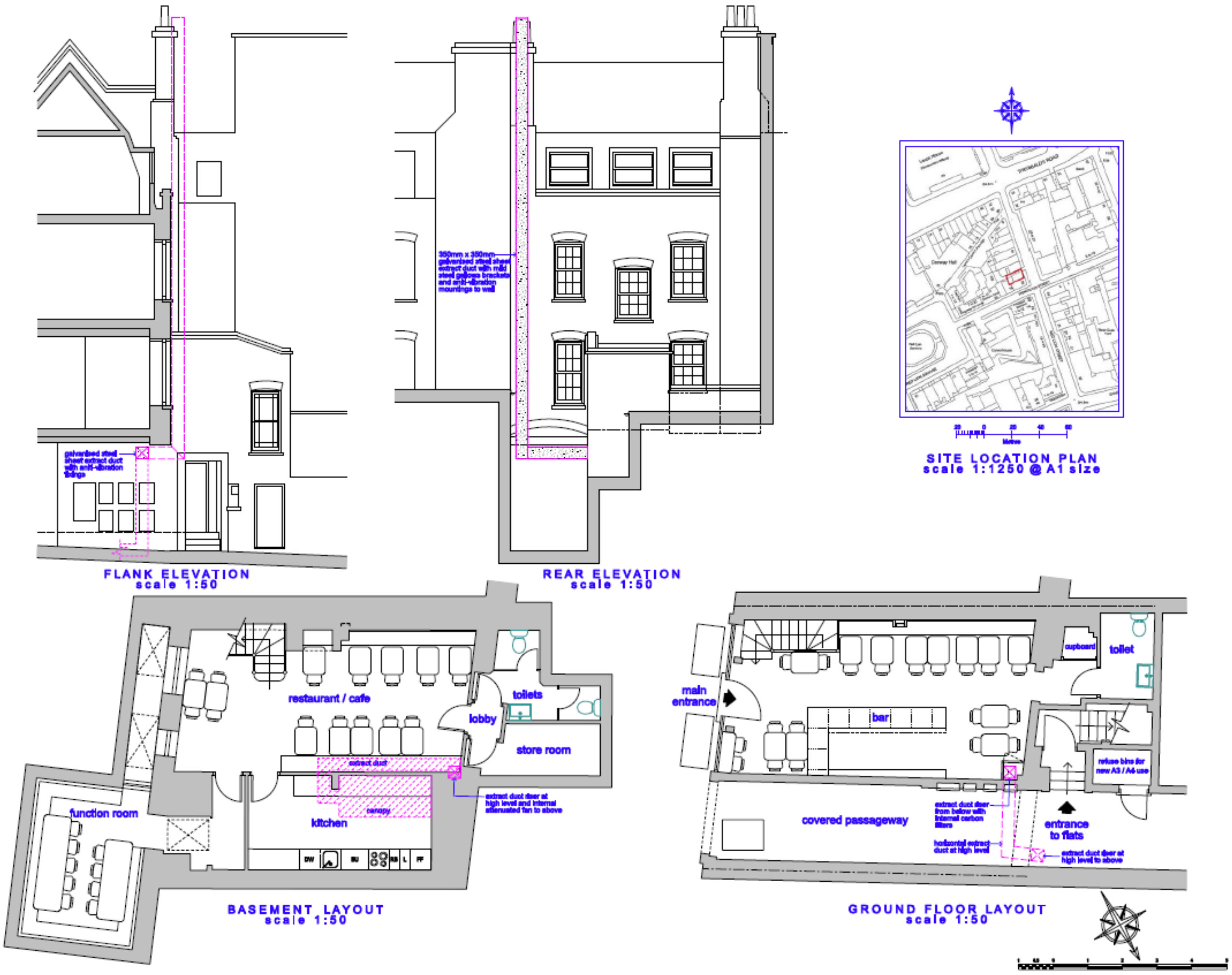
Site Location/Plans

51 Red Lion Street

Google Earth Screenshot

Site Location/Plans

Mechanical Equipment Layout



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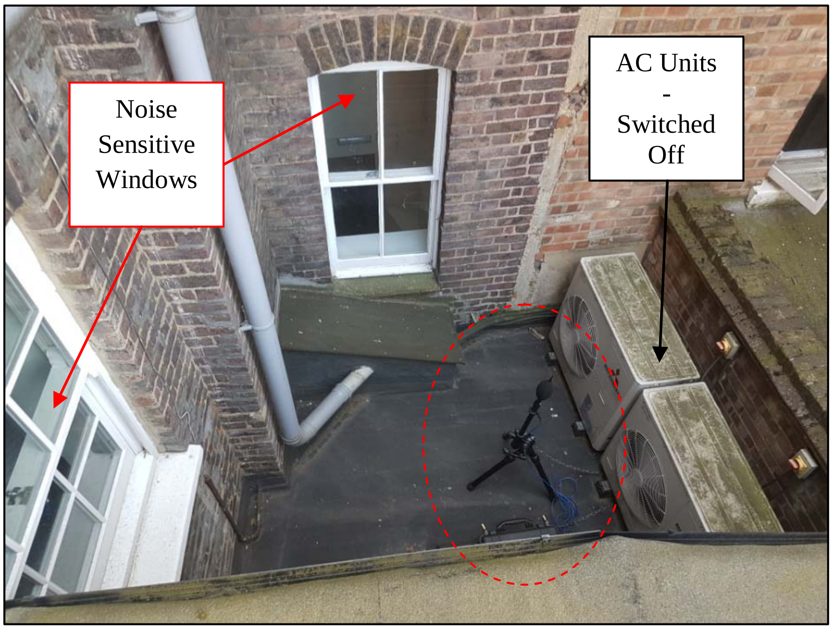
APPENDIX 3

Site Photographs



Microphone Position - Rear Elevation

Rear Elevation

APPENDIX 4

Background Noise Measurements

File	Date	Time	L_{Aeq}	L_{AFmax}	L_{AFmin}	L_{AF50}	L_{AF90}
2	6/4/2017	13:45	53.8	60.1	51.2	53.3	52.4
3	6/4/2017	14:00	53.7	65.7	51.1	53.1	52.3
4	6/4/2017	14:15	54	65.1	51.4	53.6	52.7
5	6/4/2017	14:30	57.2	75.6	51.4	53.4	52.6
6	6/4/2017	14:45	57.6	76.5	51.3	53.5	52.6
7	6/4/2017	15:00	53.7	72.6	51.2	53.2	52.4
8	6/4/2017	15:15	53.9	70.9	45	53.2	48.1
9	6/4/2017	15:30	51.5	66.2	44.9	48.4	46.8
10	6/4/2017	15:45	49.8	63.9	45.2	48.5	46.8
11	6/4/2017	16:00	48.3	62.9	44.6	47.4	46.3
12	6/4/2017	16:15	49.3	64.5	44.9	48.1	46.7
13	6/4/2017	16:30	48.2	60.3	44.6	47.5	46.3
14	6/4/2017	16:45	47.7	60.7	44.5	47	45.8
15	6/4/2017	17:00	49	69.1	44.3	47.1	46.1
16	6/4/2017	17:15	50.5	72	44.5	48	46.3
17	6/4/2017	17:30	52.2	76.3	45.2	49.7	46.9
18	6/4/2017	17:45	51	63.6	48.2	50.6	49.7
19	6/4/2017	18:00	51.3	62.2	48.4	50.6	49.8
20	6/4/2017	18:15	51.6	65.3	48.4	50.8	49.8
21	6/4/2017	18:30	52.7	57.3	49.2	52.8	50.6
22	6/4/2017	18:45	54	68	51.8	53.8	53
23	6/4/2017	19:00	55	71.1	51.8	54.1	53.2
24	6/4/2017	19:15	54.8	67.5	52.2	54.1	53.3
25	6/4/2017	19:30	55.3	72.3	52.3	54.1	53.4
26	6/4/2017	19:45	54.1	60.9	51.9	53.9	53.2
27	6/4/2017	20:00	54.7	74.2	51.7	53.6	52.8
28	6/4/2017	20:15	54.7	69.8	51.7	53.6	52.9
29	6/4/2017	20:30	55	72.5	51.7	53.7	52.9
30	6/4/2017	20:45	53.7	61.8	51.8	53.6	53
31	6/4/2017	21:00	55.1	72.2	51.7	54	53.3
32	6/4/2017	21:15	54.1	65.6	52.2	53.8	53.3
33	6/4/2017	21:30	55.5	71.2	52.3	54.2	53.5
34	6/4/2017	21:45	57.3	76.7	52.2	54.2	53.3
35	6/4/2017	22:00	54.1	64.3	52	53.9	53.3
36	6/4/2017	22:15	54.5	70.2	52.1	54	53.3

37	6/4/2017	22:30	53.5	59.3	51.6	53.4	52.8
38	6/4/2017	22:45	53.9	66.3	51.7	53.5	52.8
39	6/4/2017	23:00	48.9	65.6	43.3	47.8	45.4
40	6/4/2017	23:15	52.8	65.2	42.8	47.9	45.3
41	6/4/2017	23:30	46.5	66	40.5	45.5	43.3
42	6/4/2017	23:45	45.7	65.3	39.4	44.7	42.1
43	7/4/2017	0:00	52.5	74.3	39.4	44.6	41.8
44	7/4/2017	0:15	44.6	54.8	39.6	44.4	42.2
45	7/4/2017	0:30	45	58.9	37.1	44	41.2
46	7/4/2017	0:45	43.5	53.4	37.1	43	40.8
47	7/4/2017	1:00	48.8	71.3	38	43.8	41.2
48	7/4/2017	1:15	44.1	52.5	36.7	43.6	40.7
49	7/4/2017	1:30	43.8	52.6	37	43.4	40.9
50	7/4/2017	1:45	43.7	55	35.5	43.1	40.6
51	7/4/2017	2:00	44	56	38.2	43.3	40.8
52	7/4/2017	2:15	43.7	58.9	38.2	43.3	40.6
53	7/4/2017	2:30	43.4	54.1	38	42.9	40.6
54	7/4/2017	2:45	43.7	55.8	37.3	43	41
55	7/4/2017	3:00	43.7	56.7	37.8	42.7	40.3
56	7/4/2017	3:15	51.5	71.9	37.6	42.9	40.4
57	7/4/2017	3:30	43.4	53.3	38.7	42.7	40.6
58	7/4/2017	3:45	44.3	56.6	37.2	43.7	40.6
59	7/4/2017	4:00	43.8	51.8	37.9	43.3	40.7
60	7/4/2017	4:15	48.3	61.7	38.6	44.3	41.1
61	7/4/2017	4:30	45.1	57.2	38.6	43.2	41.1
62	7/4/2017	4:45	46.5	60.3	38.9	44	41.1
63	7/4/2017	5:00	45.8	56.7	38.8	44.4	41.6
64	7/4/2017	5:15	46.6	59.1	40	44.3	42
65	7/4/2017	5:30	45.1	59.8	39.9	44.1	42.3
66	7/4/2017	5:45	48.7	59.7	40.3	46.5	42.7
67	7/4/2017	6:00	48.3	59.9	40.7	45.5	43
68	7/4/2017	6:15	48.1	61	41.1	46.1	43.4
69	7/4/2017	6:30	48	59.4	41.4	46.1	43.5
70	7/4/2017	6:45	46.4	59.1	41.1	45.7	43.6
71	7/4/2017	7:00	46.8	55.1	42	46.4	44.2
72	7/4/2017	7:15	48.6	62.5	42	46.7	45.1
73	7/4/2017	7:30	47.3	64.8	41.9	46.3	44.3
74	7/4/2017	7:45	51.7	72.7	43.7	47.2	45.5
75	7/4/2017	8:00	54.4	77	43.9	47.3	45.8
76	7/4/2017	8:15	47.2	55.5	42.5	46.9	45.3
77	7/4/2017	8:30	48.6	63.4	43.8	47.3	45.9
78	7/4/2017	8:45	47.8	61.1	43.7	47.3	45.7

79	7/4/2017	9:00	49.8	70.5	43.2	46.9	45.3
80	7/4/2017	9:15	48.8	68.2	43.6	46.8	45.4
81	7/4/2017	9:30	47.2	59.9	43	46.8	45.2
82	7/4/2017	9:45	49	63.6	43.3	47.4	45.7
83	7/4/2017	10:00	48.4	63.7	43	47.2	45.3
84	7/4/2017	10:15	52.9	71.3	43.1	47.2	45.4
85	7/4/2017	10:30	51.2	72.7	43.4	47.8	45.5
86	7/4/2017	10:45	51.2	65.1	44.8	48.7	46.8
87	7/4/2017	11:00	54.8	58.7	52.4	54.7	53.6
88	7/4/2017	11:15	57.4	77.2	52.2	54.5	53.7
89	7/4/2017	11:30	56.9	79.6	52.3	54.2	53.5
90	7/4/2017	11:45	54.3	62	52.3	54.2	53.5
91	7/4/2017	12:00	55	68.7	52.4	54.2	53.6
92	7/4/2017	12:15	54.7	70.9	51.7	54	53.2
93	7/4/2017	12:30	54.3	67.7	52.2	54	53.3
94	7/4/2017	12:45	53.7	64	51.5	53.5	52.8
95	7/4/2017	13:00	53.5	59.4	51.5	53.4	52.7
96	7/4/2017	13:15	53.6	58.5	51.7	53.6	52.9
97	7/4/2017	13:30	54	59.3	52	53.8	53.1
98	7/4/2017	13:45	53.8	62	51.6	53.6	52.9
99	7/4/2017	14:00	53.9	60.4	51.7	53.7	53
100	7/4/2017	14:15	54	60.9	52.2	54	53.3
101	7/4/2017	14:30	54.8	76.6	51.9	54	53.3
102	7/4/2017	14:45	62.3	79.5	53.2	54.9	53.9

APPENDIX 5

Calculation Tables[27]

Duct Break-Out Noise Calculation

OUTLET	Frequency (Hz)							
	125	**250**	**500**	**1k**	**2k**	**4k**	**Overall**	
Fan - 50JM/20/4/6/40	83	79	77	75	71	69	85.8	dB
ATTENUATOR	**-13**	**-25**	**-40**	**-45**	**-45**	**-38**		
Duct Run	2	2	2	2	2	2		
Duct Attenuation per m	0.66	0.49	0.33	0.23	0.23	0.23		
Duct Attenuation	-1.3	-1.0	-0.7	-0.5	-0.5	-0.5		
Duct Bend 90˚	0	-2	-8	-5	-3	-3		
Filter (Absolute/HEPA)	-5	-5	-5	-7	-8	-12		
Corrected SWL	63.7	46.0	23.3	17.5	14.5	15.5	63.8	
AcoustiShield L5 (CMS)	**-26**	**-26**	**-36**	**-47**	**-50**	**-53**		
ALLEN Formula								
Visible Perimeter (m)	0.35	0.35	0.35	0.35	0.35	0.35		
Length (m)	12	12	12	12	12	12		
Perimeter x Length (S)	4.2	4.2	4.2	4.2	4.2	4.2		
Duct Cross Section (m^2) (A)	0.12	0.12	0.12	0.12	0.12	0.12		
10log(S/A)	15.4	15.4	15.4	15.4	15.4	15.4		
Losses	-10.6	-10.6	-20.6	-31.6	-34.6	-37.6		
Minimum -3	-10.6	-10.6	-20.6	-31.6	-34.6	-37.6		
$L_{W(radiated)}$	53.1	35.5	2.8	-14.0	-20.0	-22.0		
Distance (m)	1	1	1	1	1	1		
DI	3	3	3	3	3	3		
Line Source Attenuation	-8	-8	-8	-8	-8	-8		
Attenuated Level	45.1	27.5	-5.2	-22.0	-28.0	-30.0	45.2	dB
A-Weighted	29.0	18.9	-8.4	-22.0	-26.8	-29.0	29.4	dB(A)
A-Weighting	-16.1	-8.6	-3.2	0	1.2	1		

[27] See APPENDIX 2 - Site Location/Plans for mechanical equipment layout.

Exhaust Terminal Noise Calculation

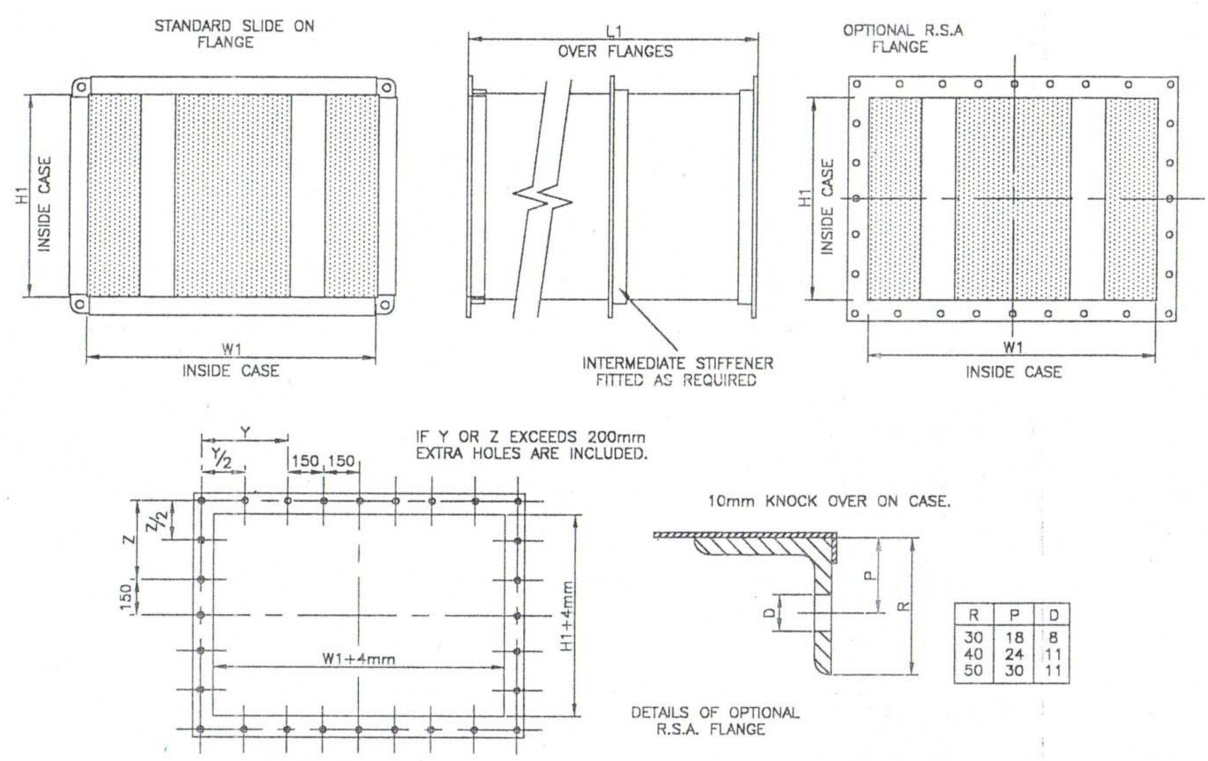
TERMINATION	Frequency (Hz)									
	63	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**Overall**	
50JM/20/4/6/40	81	83	79	77	75	71	69	63	87.1	dB
Duct Bend 90˚	0	0	-2	-8	-5	-3	-3	-3		
ATTENUATOR	**-5**	**-13**	**-25**	**-40**	**-45**	**-45**	**-38**	**-24**		
Filter (Absolute/HEPA)	-3	-5	-5	-5	-7	-8	-12	-10		
Corrected SWL	73.0	65.0	47.0	24.0	18.0	15.0	16.0	26.0	73.6	
Duct Length (m)	16	16	16	16	16	16	16	16		
Duct Loss per m	0.49	0.66	0.49	0.33	0.23	0.23	0.23	0.23		Ref SRL
Duct Attenuation	-7.8	-10.6	-7.8	-5.3	-3.7	-3.7	-3.7	-3.7		
End Reflection	-10	-6	-2	0	0	0	0	0.0		
f	63	125	250	500	1000	2000	4000	8000		
d	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35		
c	344	344	344	344	344	344	344	344		
fd/c	0.1	0.1	0.3	0.5	1.0	2.0	4.1	8.1		
Directivity 120˚	0	0	-5	-8	-13	-17	-22	-22.0		Ref Owen
Distance (m)	4	4	4	4	4	4	4	4		
Point Source Attenuation	-23	-23	-23	-23	-23	-23	-23	-23		DI = 0
Attenuated Level	32.1	25.4	9.1	-12.3	-21.7	-28.7	-32.7	-22.7	33.0	dB
A-Weighted	5.9	9.3	0.5	-15.5	-21.7	-27.5	-31.7	-23.8	11.3	dB(A)
A-Weighting	-26.2	-16.1	-8.6	-3.2	0	1.2	1	-1.1		

APPENDIX 6

Noise Mitigation Measures

Rectangular Attenuators

Cross-Section



OPTIONS:

Attenuator end connections:

- Rolled steel angle flanges (rectangular).
- Slide on Doby type flanges (rectangular).
- Spigot ends (both).
- End flanges that incorporate threaded inserts (circular).

Splitter orientation:

- Vertically mounted splitters (rectangular).
- Horizontally mounted splitters (rectangular).

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Noise Mitigation Measures

Rectangular Attenuators

Insertion Losses

37.5% FA, 120mm Airway, C=4.56								
Length	63	125	250	500	1K	2K	4K	8K
450	4	5	8	14	22	20	19	16
600	4	6	10	18	25	23	22	17
750	4	7	12	21	28	26	24	19
900	4	8	14	24	31	29	26	20
1200	5	10	18	30	38	35	31	23
1500	5	12	23	36	44	41	36	26
1800	5	14	27	42	45	45	40	29
2100	6	16	31	45	45	45	45	32
2400	6	18	35	45	45	45	45	35

40% FA, 133mm Airway, C=5.06								
Length	63	125	250	500	1K	2K	4K	8K
450	4	4	7	14	21	18	18	15
600	4	5	9	17	24	21	20	16
750	4	6	11	20	27	24	23	17
900	4	7	13	22	30	27	25	18
1200	5	9	17	28	37	34	29	20
1500	5	11	21	34	43	40	33	22
1800	5	13	25	40	45	45	38	24
2100	5	15	29	45	45	45	42	26
2400	5	17	33	45	45	45	45	28

42.5% FA, 148mm Airway, C=5.61								
Length	63	125	250	500	1K	2K	4K	8K
450	4	4	7	13	19	18	17	14
600	4	5	8	16	22	21	18	15
750	4	6	10	18	25	24	20	16
900	4	7	12	21	28	27	22	16
1200	4	8	16	27	35	32	26	18
1500	5	10	19	33	41	38	29	20
1800	5	12	23	38	45	44	33	21
2100	5	14	27	44	45	45	36	23
2400	5	16	30	45	45	45	40	24

45% FA, 164mm Airway, C=6.21								
Length	63	125	250	500	1K	2K	4K	8K
450	3	4	6	13	18	17	16	13
600	4	5	8	15	21	20	17	14
750	4	5	10	18	24	23	19	15
900	4	6	11	21	28	25	21	16
1200	4	8	15	26	34	31	24	17
1500	4	10	19	32	40	36	27	19
1800	5	11	22	37	45	41	31	20
2100	5	13	26	42	45	45	34	22
2400	5	15	29	45	45	45	37	23

47.5% FA, 181mm Airway, C=6.87								
Length	63	125	250	500	1K	2K	4K	8K
450	3	3	5	12	16	15	14	12
600	4	4	7	14	19	17	15	13
750	4	5	8	17	23	20	17	14
900	4	5	10	20	26	22	18	14
1200	4	7	14	25	32	27	21	16
1500	4	8	17	30	38	32	23	17
1800	4	10	21	35	44	38	26	18
2100	4	11	24	40	45	43	28	19
2400	4	13	27	45	45	45	31	20

50% FA, 200mm Airway, C=7.6								
Length	63	125	250	500	1K	2K	4K	8K
450	3	3	4	12	14	13	12	12
600	3	4	6	14	18	15	13	12
750	3	4	7	17	21	18	14	13
900	3	5	9	19	24	20	15	13
1200	4	6	12	24	30	25	17	14
1500	4	7	15	29	37	29	20	15
1800	4	9	18	34	43	34	22	16
2100	4	10	21	38	45	39	24	17
2400	4	11	24	43	45	43	26	18

52.5% FA, 221mm Airway, C=8.39								
Length	63	125	250	500	1K	2K	4K	8K
450	3	3	4	11	13	12	11	11
600	3	4	5	13	16	14	12	11
750	3	4	7	16	19	16	13	12
900	3	5	8	18	22	18	14	12
1200	4	6	11	22	28	22	16	13
1500	4	7	14	27	34	27	18	14
1800	4	8	17	32	40	31	20	15
2100	4	9	20	36	45	35	22	16
2400	4	10	23	41	45	39	24	17

55% FA, 244mm Airway, C=9.28								
Length	63	125	250	500	1K	2K	4K	8K
450	3	3	4	10	12	11	11	10
600	3	4	5	12	14	13	11	10
750	3	4	7	15	17	15	12	11
900	3	5	8	17	20	17	13	11
1200	3	6	11	21	25	21	15	13
1500	4	7	14	25	31	25	17	14
1800	4	8	17	29	36	29	19	15
2100	4	9	20	34	42	33	20	16
2400	4	10	23	38	45	37	22	17

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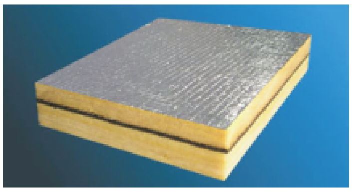
Noise Mitigation Measures

Acoustic Ductwrap

CMS acoustic SOLUTIONS

SuperLag Type AcoustiShield



Advantages

- *Available in sheet form.*
- *Flexible and easily cut.*
- *Easy to handle and install.*
- *Excellent acoustic performance.*
- *Single product wrap.*

Applications

CMS AcoustiShield acoustic lagging material is typically used for air conditioning ductwork, and pipe work that requires acoustic treatment.

Description

CMS AcoustiShield acoustic lagging material is a five part laminate incorporating an inner 25mm glass fibre spacer or isolating layer backed by woven glass tissue, a middle heavy mass barrier of lead or a polymeric acoustic barrier material with an outer 25mm glass fibre spacer with Class 'O' foil facing.

The heavy mass barrier is available with a surface weight of 5kg/m² for standard applications or high performance requirements, a 10kg/m² barrier is available.

Product designations are as follows:
L5 is with a 5kg/m² lead barrier.
L10 is with a 10kg/m² lead barrier.
P5 is with a 5kg/m² polymeric barrier.
P10 is with a 10kg/m² polymeric barrier.

Physical Information

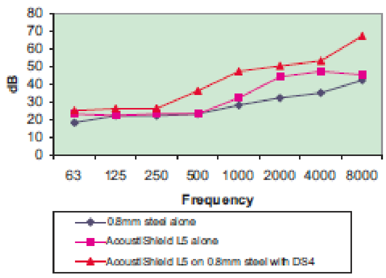
Standard sheet size:	2m x 1.2m x 50mm nominal
Density of spacer layers	23-25 kg/m³
Thermal Conductivity	0.036 w/m°k
Resistance	Non Hygroscopic
Fire retardance	Class 'O' with foil facing
Operating temperatures	150°C(max) -30°C (minimum)

Acoustic Performance

CMS AcoustiShield is a high performance material that has been acoustically tested to give the following Sound Reduction Index data.

AcoustiShield L5

Material / Frequency	125	250	500	1k	2k	4k
0.8mm steel	22	22	23	28	32	35
AcoustiShield L5	22	23	23	32	44	47
0.8mm steel + AcoustiShield L5 + DS4	26	26	36	47	50	53



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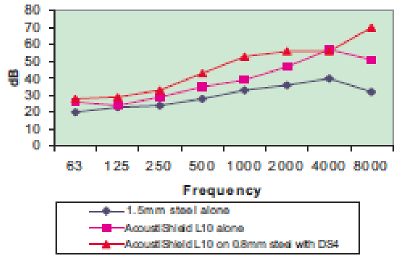
Noise Mitigation Measures

Acoustic Ductwrap

AcoustiShield L10

Material / Frequency	125	250	500	1k	2k	4k
1.5mm steel	23	24	28	33	36	40
AcoustiShield L10	24	29	35	39	47	57
1.5mm steel + AcoustiShield L10	29	33	43	53	56	56



Installation Guidelines

CMS AcoustiShield acoustic lagging material is easy to handle and simple to install to both rectangular and circular systems. When installing, all joints must be overlapped by a minimum of 25mm to maintain a consistent acoustic barrier. All joints should be sealed with aluminium foil tape.

For large sections of lagging, banding or pins and washers maybe required to support the CMS AcoustiShield in place and to maintain its acoustic integrity.

Installation Service

In addition to supply of this product CMS Acoustic Solutions offers a competitively-priced installation service anywhere in the UK. Use of our service ensures that installation is performed to the highest standards by tradesmen fully experienced in the specialist skills of fitting acoustic materials correctly. For further details contact our technical team on 01925 577711.

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