

Acoustic Assessment of Mechanical Services Equipment at Bubbledogs, 70 Charlotte Street, London

Report Reference: 130103-002F

Date: July 2014

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Site Address: Bubbledogs
 70 Charlotte Street
 London

Client: Firstplan
 25 Floral Street
 London
 WC2E 9DS

Report Reference: 130103-002

Revision: A: First issue
 B: Condensers relocated
 C: Kitchen extract duct revised
 D: Air conditioning condensers relocated
 E: Planning drawings updated
 F: Planning drawings updated

Author: Rob Cant MIOA

Date: July 2014

This report has been prepared by ACA Acoustics Limited (ACA) with all reasonable skill, care and diligence in accordance with generally accepted acoustic consultancy principles and taking account of the services and terms agreed between ACA and our client. Any information provided by third-parties and referred to herein may not have been checked or verified by ACA unless expressly stated otherwise. This report is confidential to the client and ACA accepts no responsibility whatsoever to third parties unless formally agreed by ACA. Any such party relies upon the report at their own risk.

CONTENTS

CONTENTS.....	2
0. SUMMARY.....	3
1. INTRODUCTION	4
2. LONDON BOROUGH OF CAMDEN COUNCIL PLANNING CONSENT ACOUSTIC REQUIREMENTS.....	5
3. REVIEW OF SITE LOCATION & DEVELOPMENT PROPOSALS.....	6
4. NOISE SURVEY	7
4.1 Noise Measurement and Assessment Procedure.....	7
4.2 Instrumentation.....	7
4.3 Noise Measurement Results.....	8
5. NOISE FROM MECHANICAL SERVICES EQUIPMENT	9
6. RECOMMENDATIONS FOR NOISE & VIBRATION CONTROL TREATMENTS	11
6.1 Duct-Mounted Silencers.....	11
6.2 Fan Casing Acoustic Enclosures	12
6.3 Acoustically Double-Skinned Ductwork	13
6.4 Air Conditioning Condenser Acoustic Enclosure.....	13
6.5 Vibration.....	13
APPENDIX A.....	A1
APPENDIX B.....	B1
APPENDIX C.....	C1
APPENDIX D.....	D1

0. SUMMARY

- ACA Acoustics Limited has been commissioned by Firstplan on behalf of the client to assess noise emissions from ventilation and air conditioning systems installed at Bubbledogs, 70 Charlotte Street, London.
- The assessment is required in order to provide evidence that noise emissions from the new mechanical equipment complies with London Borough of Camden Council's acoustic requirements along with other relevant British Standards and guidance documents. London Borough of Camden Council's requirement, applicable at this site, is that noise from the new equipment shall be designed to 10dBA below the prevailing background level at 1m outside windows of the nearest affected noise-sensitive property.
- A noise survey has previously been carried out in the vicinity by Philip Acoustics Limited to establish existing background noise levels. Manufacturer's noise data has been obtained for the new equipment.
- Lowest background noise levels to the rear façade are measured at LAF90 44dBA during opening hours of the restaurant. Background noise levels are relatively constant and primarily due to existing non-associated mechanical services equipment within the area and traffic on local routes, albeit local traffic is screened from the measurement location by the existing buildings. Based on results of the noise survey and London Borough of Camden Council's planning consent requirement, the overall noise limit for the equipment operating during opening hours of the restaurant to outside nearest noise-sensitive windows is set at ≤ 34 dBA.
- Based on calculations using manufacturer's noise data, the overall noise level from the proposed equipment is ≤ 34 dBA outside the nearest noise-sensitive windows. This achieves London Borough of Camden Council's planning consent requirements. Noise from the proposed equipment should not be detrimental to the amenity of any residential occupiers in the vicinity.
- The assessment includes benefit of noise control treatments to the proposed equipment. Details of suitable noise and vibration control treatments are included in this report.

1. INTRODUCTION

Various mechanical services equipment items associated with ventilation and air conditioning are installed at a commercial property at Bubbledogs, 70 Charlotte Street, London.

The Planning Department of London Borough of Camden Council requires information in the form of an acoustic report regarding noise and vibration from the new equipment. The report is required to demonstrate that the new equipment will comply with London Borough of Camden Council's noise and vibration requirements applicable for mechanical services equipment affecting nearby noise-sensitive properties along with other relevant British Standards and guidance documents.

ACA Acoustics Limited has been commissioned by Firstplan on behalf of the client to carry out an assessment of noise and vibration from the new equipment and where necessary, make recommendation to reduce noise and vibration levels from the equipment to comply with planning requirements.

This report presents results of the noise and vibration surveys and assessment and includes:

- Review of London Borough of Camden Council's noise requirements;
- Confirmation of existing background noise levels;
- Calculation of equipment noise levels;
- Review of any noise/vibration control treatments necessary to the equipment to ensure compliance with the requirements of London Borough of Camden Council.

2. LONDON BOROUGH OF CAMDEN COUNCIL PLANNING CONSENT ACOUSTIC REQUIREMENTS

London Borough of Camden Council's policies relating to noise from new mechanical services equipment are contained within the Council's Local Development Framework; Policy DP28.

In Summary, London Borough of Camden's noise conditions are:

Noise level from plant and machinery at which planning permission will not be granted:

<i>Noise at 1m external to a sensitive façade;</i>	<i>5dBA < LA90</i>
<i>Noise that has a distinguishable discrete continuous note (whine, hiss, screech, hum) at 1m external to a sensitive façade;</i>	<i>10dBA < LA90</i>
<i>Noise that has distinct impulses (bangs, clicks, clatters, thumps) at 1m external to a sensitive façade;</i>	<i>10dBA < LA90</i>
<i>Noise at 1m external to sensitive façade where LA90 > 60dB</i>	<i>55dB LAeq</i>

Table 1: London Borough of Camden Council noise related planning conditions

Each of the above is applicable over a period of 60 minutes and measured at 1m external to noise-sensitive facades (typically nearest residential windows).

The author considers that the type of equipment proposed do not normally include a significant tonal element and would typically be considered "broadband". However air conditioning condensers have the potential to operate on an intermittent basis, as required by the load on the system. Therefore for the purposes of this report, the more onerous noise condition of 10dBA below the existing background noise is used for the assessment in this report.

3. REVIEW OF SITE LOCATION & DEVELOPMENT PROPOSALS

The development site is at Bubbledogs, 70 Charlotte Street, London, close to the junction of Charlotte Street and Goodge Street.

Planning permission is sought for installation of various new mechanical services equipment items associated with ventilation and air conditioning for a new restaurant. Supply and extract fans serving the restaurant kitchen along with associated ductwork and ancillary items have been installed to the flat roof areas at the rear of the site. Three new air conditioning condensers are also installed on the lower flat roof.

The three air conditioning condensers are to be relocated to the rear wall of the property on the upper flat roof area.

The nearest noise sensitive facades to the equipment are identified as.

- Rear upper windows of residential properties along Charlotte Mews which is to the rear of the site. Nearest of these windows is approximately 3-4m from the supply fan discharge.
- Rear windows of possible residential flats on upper floor levels of 66 and 68 Charlotte Street. Nearest of these windows is approximately 5m from the kitchen extract fan location and approximately 1-2m from the proposed air conditioning condenser location.

4. NOISE SURVEY

In order to assess noise from the mechanical services equipment in accordance with London Borough of Camden Council's requirements it is necessary to establish representative background noise levels at the nearest noise-sensitive properties.

A noise survey has previously been carried out within the vicinity of the site by Philip Acoustics Limited. Details of the background noise survey carried out by Philip Acoustics Limited are provided below.

Note that although equipment is already installed, it was not possible to run each equipment item individually, nor possible to measure at 1m outside windows of closest residential properties at the rear façade of Charlotte Street. Therefore assessment has been carried out based on measured background noise levels and manufacturer's data for the equipment.

4.1 Noise Measurement and Assessment Procedure

The proposed equipment will serve a commercial property. As the equipment is to serve a commercial property it will have the potential to operate during the operating hours of the property, as required by the occupants, typically taken to be to midnight latest.

The background noise measurement position was selected to the flat roof at the rear of the building, using a microphone extension cable and telescopic boom arrangement such that they are representative of 1m outside of the nearest residential windows.

The site was considered secure and therefore an unmanned noise survey was carried out over a three-day period between 19th May and 21st May 2010. In addition to the overall dBA values, manual samples of L90 dB octave band background noise were also recorded.

The location of the proposed equipment is shown on drawings in Appendix A.

4.2 Instrumentation

The following equipment was used during the noise survey; the sound level meter was calibrated before and after the survey measurements:

Equipment	Serial Number
Logging Noise Measurements: Rion sound level meter type NL-31 Class 1 complete with weatherproof and lockable outdoor environmental kit	00431030
Short-term Octave Band Noise Measurements: Bruel & Kjaer sound level meter type 2260 c/w microphone type 4189	2311656
Bruel & Kjaer calibrator type 4231 (UKAS Certified)	02326801
Microphone extension cable and telescopic boom arrangements	-

Table 2: Equipment used

4.3 Noise Measurement Results

Complete results of the noise survey are provided in graphical form in Appendix B. The lowest measured background noise level during operational times of the equipment was LA90 44dB. The values recorded by Philip Acoustics Limited are used as basis for acoustic design such that noise from the equipment is $\leq 34\text{dBA}$ outside nearest noise-sensitive windows ($\geq 10\text{dBA}$ below the lowest recorded values). Summary of measured noise levels are provided in Table 3 below.

LA90 Operating Times	LA90 Night-Time 00:00 – 11:00	London Borough of Camden Noise Limit
44dB	42dB	$\leq 34\text{dBA}$

Table 3: Summary noise survey results and London Borough of Camden noise limit

The limit to achieve London Borough of Camden Council's requirement for equipment operating during opening hours of the restaurant is 34dBA; this is 10dBA below the lowest background noise level. At this level the equipment noise will not increase the background noise and will not be disturbing or detrimental to the amenity of nearby occupants.

5. NOISE FROM MECHANICAL SERVICES EQUIPMENT

The planning application includes installation of a new kitchen extract fan, kitchen supply fan and three air conditioning condensers along with associated ductwork, pipework and ancillaries.

Noise levels from the new equipment can be determined from manufacturer's noise data. The manufacturer's data for the supply and extract fans is in terms of octave band sound power level spectra. Data for the condensers is in terms of dBA sound power levels; representative octave band spectra have been used in the calculations, based on measurements of similar equipment undertaken by the author. Summary of noise from the proposed equipment is shown in Table 4 below.

Description	dBA	Octave Band Centre Frequency – Hz (dB)							
		63	125	250	500	1k	2k	4k	8k
Extract Fan – Systemair MUB 062 630D4-K2 IE2		101	93	90	86	82	78	73	68
Supply Fan – Systemair MUB 062 630D4-A2		100	92	89	85	81	77	72	67
Mitsubishi PUHZ-RP60VHA	Lp = 48 at 1m								
Mitsubishi SUZ-KA71VA2	LP = 55 at 1m								

Table 4: Equipment noise levels

To calculate the noise contribution from the supply and extract fans a computer noise model has been used. The model is based on the calculation methods for ducted mechanical services equipment set out in the Chartered Institute of Building Services Engineers' CIBSE Guide B5 *"Noise and vibration control for HVAC"* and takes account of losses within the ductwork system, end reflection at the terminal, distance between the terminal and noise-sensitive windows, acoustic screening and acoustic directivity.

To calculate the noise contributions from the new condensers a computer noise model has been used in accordance with procedures set out in ISO9613-2:1996. The model takes account of distance between equipment and noise-sensitive windows, acoustic directivity, acoustic reflections and acoustic screening.

Calculations include benefit of various noise and vibration control treatments; details of suitable mitigation measures are included in Section 6 of this report.

The overall calculated noise level from the equipment to outside the nearest noise-sensitive windows compared with the planning requirement is shown in Table 5 on the following page. Summary print-outs from the calculation models are included in Appendix C.

Description	Calculated Equipment Noise Levels	Camden Council Noise Limit
All equipment operating	34dBA	≤ 34dBA

Table 5: Calculated equipment noise at nearest noise-sensitive windows

Table 5 shows that the overall noise level from the equipment is at least 10dBA below the lowest measured background noise and achieves London Borough of Camden Council's planning consent requirements.

Resultant noise from the equipment will not be disturbing or detrimental to the amenity of nearby existing occupants. Details of suitable noise control treatments are included in Section 6 of this report.

6. RECOMMENDATIONS FOR NOISE & VIBRATION CONTROL TREATMENTS

To achieve the noise limit requirement of London Borough of Camden Council it is necessary to install duct-mounted silencers to the atmospheric side of the fans, acoustic enclosures to the fan casings and an acoustic enclosure around the air conditioning condensers.

The equipment is directly structurally linked to non-associated residential dwellings and therefore it is considered that structure-borne noise and vibration may transmit to these properties. As such it is recommended that the equipment is isolated from the structure on high-deflection anti-vibration mounts and that flexible connections are used between the fans and adjoining ductwork.

Note that considerations of non-acoustic aspects such as structural, visual, airflow and construction materials are outside the scope of ACA Acoustics Limited and should be considered by others accordingly.

Alternative methods of attenuation to those detailed below may be acceptable. Full details of any alternative scheme, including working drawings and expected attenuation should be submitted and approved prior to manufacture.

6.1 Duct-Mounted Silencers

To achieve the noise limit requirement of London Borough of Camden Council it is necessary to install silencers to the atmospheric connection of the supply and extract fans.

Minimum dynamic insertion loss at the design duty along with description of typical silencer to achieve the specified performance is shown in Table 6.

Description	Octave Band Centre Frequency – Hz (IL – dB)								Comments
	63	125	250	500	1k	2k	4k	8k	
FA Inlet	15	26	39	53	55	55	46	32	Nominal 1800mm long rectangular silencer
Exhaust	12	21	28	40	48	33	24	15	Nominal 1800mm long rectangular silencer

Table 6: Silencer minimum insertion loss performance

To reduce breakout noise from the ducted systems it is recommended that the silencers are installed as close to the fan as practically possible within spatial limitations on site and are manufactured with double-skinned casings.

It is anticipated that the silencers installed by Allaway Acoustics Limited will achieve the above specification and no further noise-control treatments are required to the atmospheric side of the ventilation systems.

Silencers have also been installed to the roomside of the systems; this will control breakout noise from the subsequent ductwork.

6.2 Fan Casing Acoustic Enclosures

To reduce noise breakout from the fan casings to nearby residential properties it will be necessary to install acoustic enclosures to both supply and extract fan units.

The acoustic enclosures shall be formed from acoustic panels. Specification for suitable acoustic panels is shown below:

- Outer casing formed from plain sheet steel minimum 1.0mm thickness;
- Inner casing (facing fans) formed from perforated sheet steel;
- Panels containing a fibrous sound absorbent infill that is non-shedding, non-combustible, non-hygroscopic and chemically inert. This infill shall be faced with glass cloth to prevent fibre migration;
- Infill density minimum 45kg.m^{-3} . Infill thickness minimum 50mm;

The enclosures shall be installed such that the fan casing and flexible connections both sides are located within the enclosures.

The enclosures when installed shall provide the following minimum sound reduction index (R):

Description	Octave Band Centre Frequency – Hz (IL – dB)							
	63	125	250	500	1k	2k	4k	8k
Acoustic Panel	13	17	24	30	38	39	41	39

Table 7: Acoustic panel minimum Rw performance

Panels shall provide the following minimum sound absorption when assessed in accordance with BS EN ISO 354:2003:

Description	Octave Band Centre Frequency – Hz (α)							
	63	125	250	500	1k	2k	4k	8k
Acoustic Panel	0.10	0.25	0.65	1.00	1.00	1.00	0.95	0.90

Table 8: Acoustic panel minimum sound absorption coefficient

6.3 Acoustically Double-Skinned Ductwork

During the author's visit to site, noise breakout from the ductwork and transformation sections between the fan units and silencers both sides was clearly audible.

It is recommended that the ductwork sections are replaced with acoustically double-skinned construction. Sound insulation performance of the ductwork shall be as shown in Table 7 above.

6.4 Air Conditioning Condenser Acoustic Enclosure

The air conditioning condensers are to be relocated to the rear wall overlooking the upper flat roof area. To reduce noise from the air conditioning condensers to adjacent noise-sensitive windows it will be necessary to install an acoustic enclosure around the units.

The acoustic enclosure shall be formed from acoustic panels to the sides, providing acoustic screening to the adjacent windows and with 150mm deep acoustic louvres to the front face providing ventilation to the units.

Specification for suitable acoustic panels is as shown in Section 6.2 above. Specification of suitable acoustic louvres is typically:

- Louvres formed from plain sheet steel minimum 1.0mm thickness;
- Louvres shall have a series of horizontal blades contained within a four-sided external frame;
- Louvre blades have lower faces of perforated sheet metal, containing a fibrous sound absorbent infill that is non-shedding, non-combustible, non-hygroscopic and chemically inert.

The louvres when installed shall provide the following minimum insertion loss (IL):

Description	Octave Band Centre Frequency – Hz (IL – dB)							
	63	125	250	500	1k	2k	4k	8k
Acoustic Louvre	4	4	5	8	12	16	15	13

Table 9: Acoustic louvre minimum insertion loss performance

6.5 Vibration

As the proposed equipment is directly structurally connected to residential properties, to control structure-borne noise to these properties it is recommended that the equipment is installed on vibration isolators.

The supply and extract fans are installed on vibration isolators and include flexible connections to adjoining ductwork both sides. No further vibration isolation treatments are required to these units.

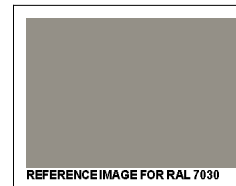
The air conditioning condensers should be installed on rubber or neoprene turret type vibration isolators providing a deflection of not less than 8mm at the working load.

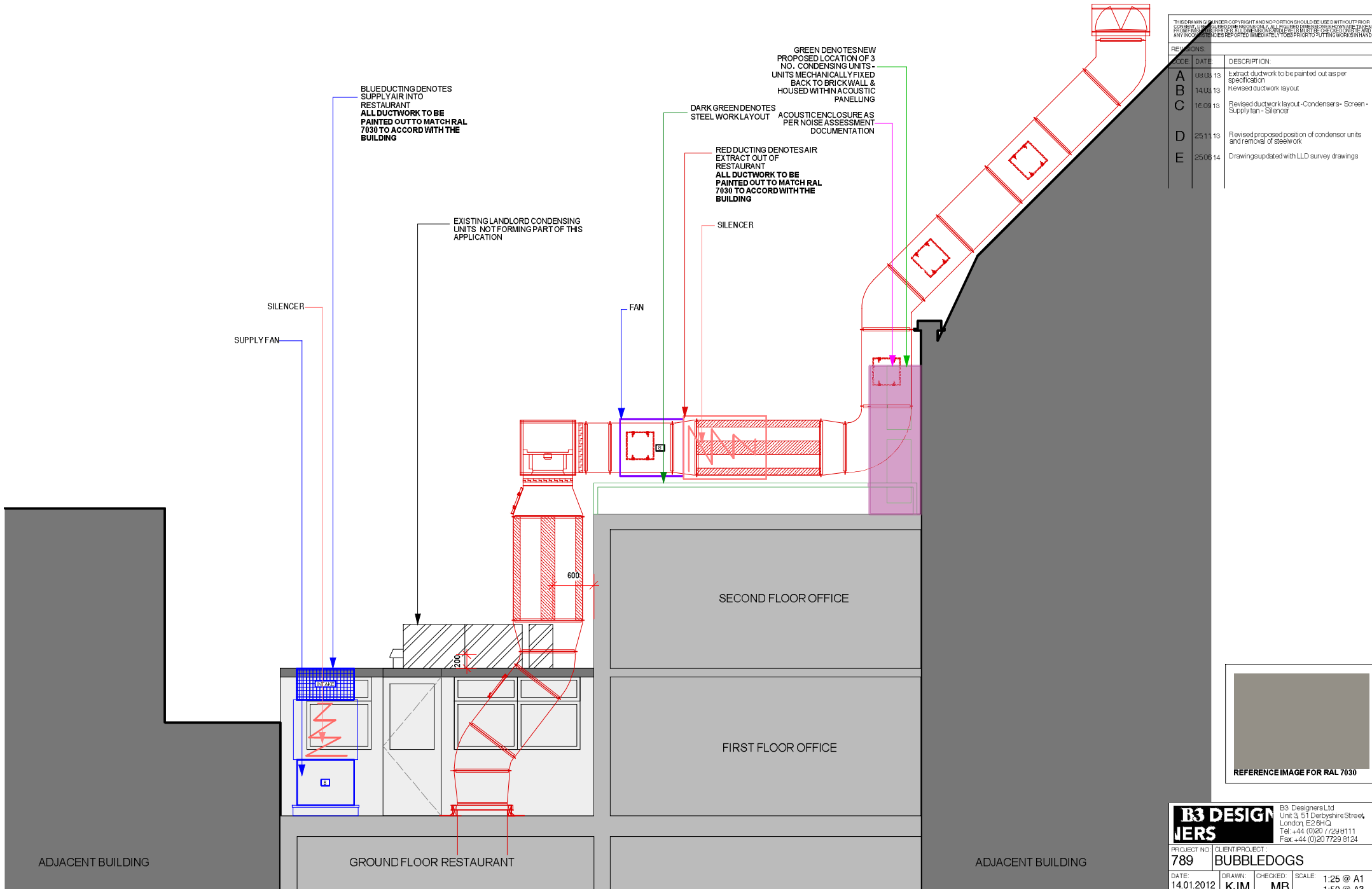
The noise and vibration control treatments proposed have been based on Allaway Acoustics Limited's standard range; contact Chris Williams, Tel: 01992 550825.

APPENDIX A

Layout Drawings of the Development

REVISIONS:		
CODE	DATE	DESCRIPTION
A	08/03/13	Extract ductwork to be painted out as per specification
B	14/03/13	Revised ductwork layout
C	16/08/13	Revised ductwork layout- Condensers and screen
D	25/11/13	Revised proposed position of condensor units and removal of steelwork
E	25/06/14	Drawings updated with LLD survey drawings

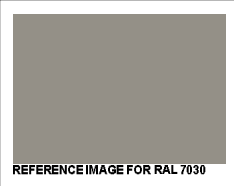




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REVISIONS:		
CODE	DATE	DESCRIPTION
A	08.03.13	Extract ductwork to be painted out as per specification
B	14.04.13	Revised ductwork layout
C	16.06.13	Revised ductwork layout - Condensers - Screen - Supply fan - Silencer
D	25.11.13	Revised proposed position of condenser units and removal of steelwork
E	25.05.14	Drawings updated with LLD survey drawings



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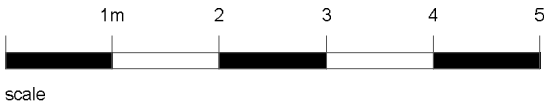
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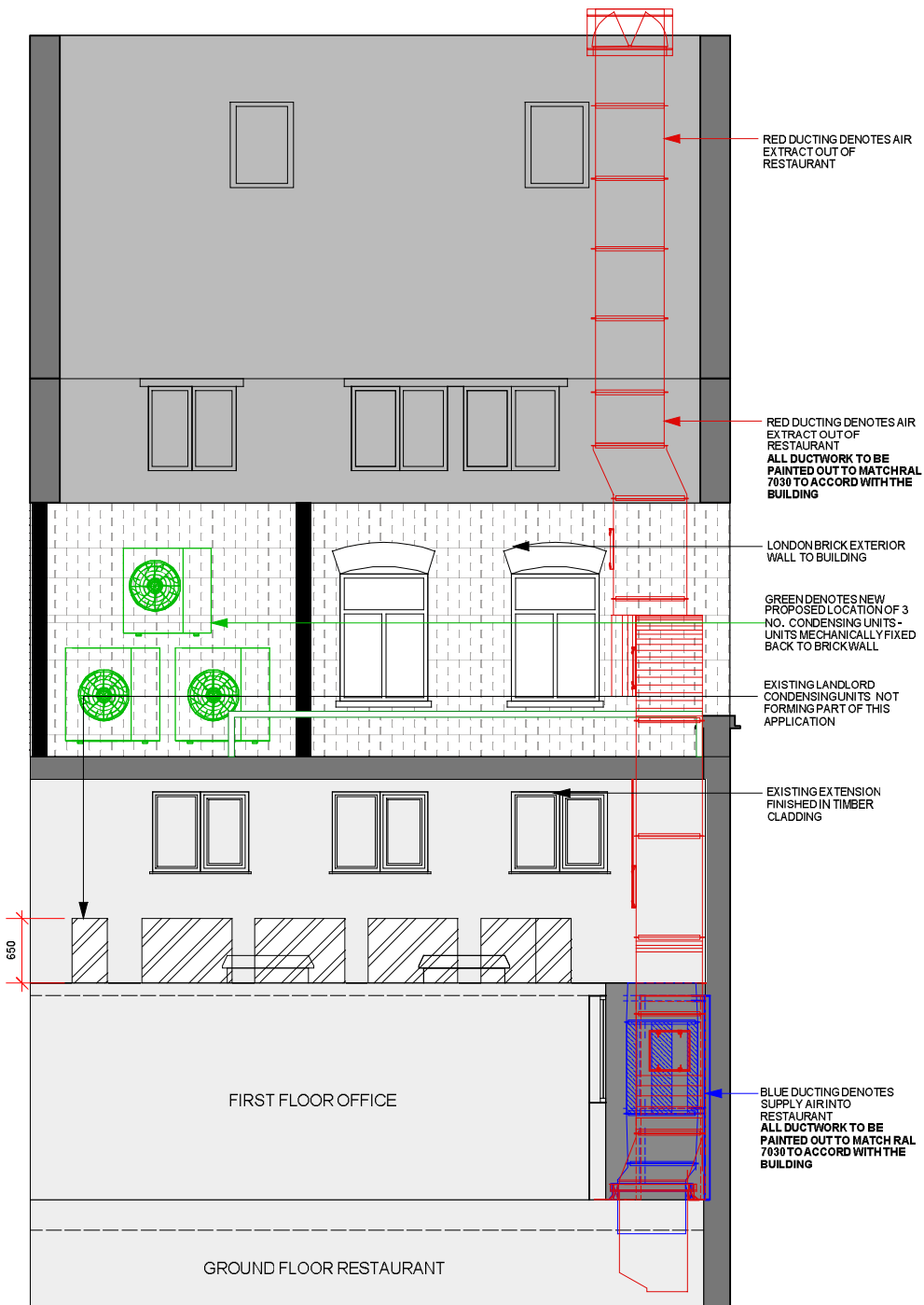
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1:50 @ A3

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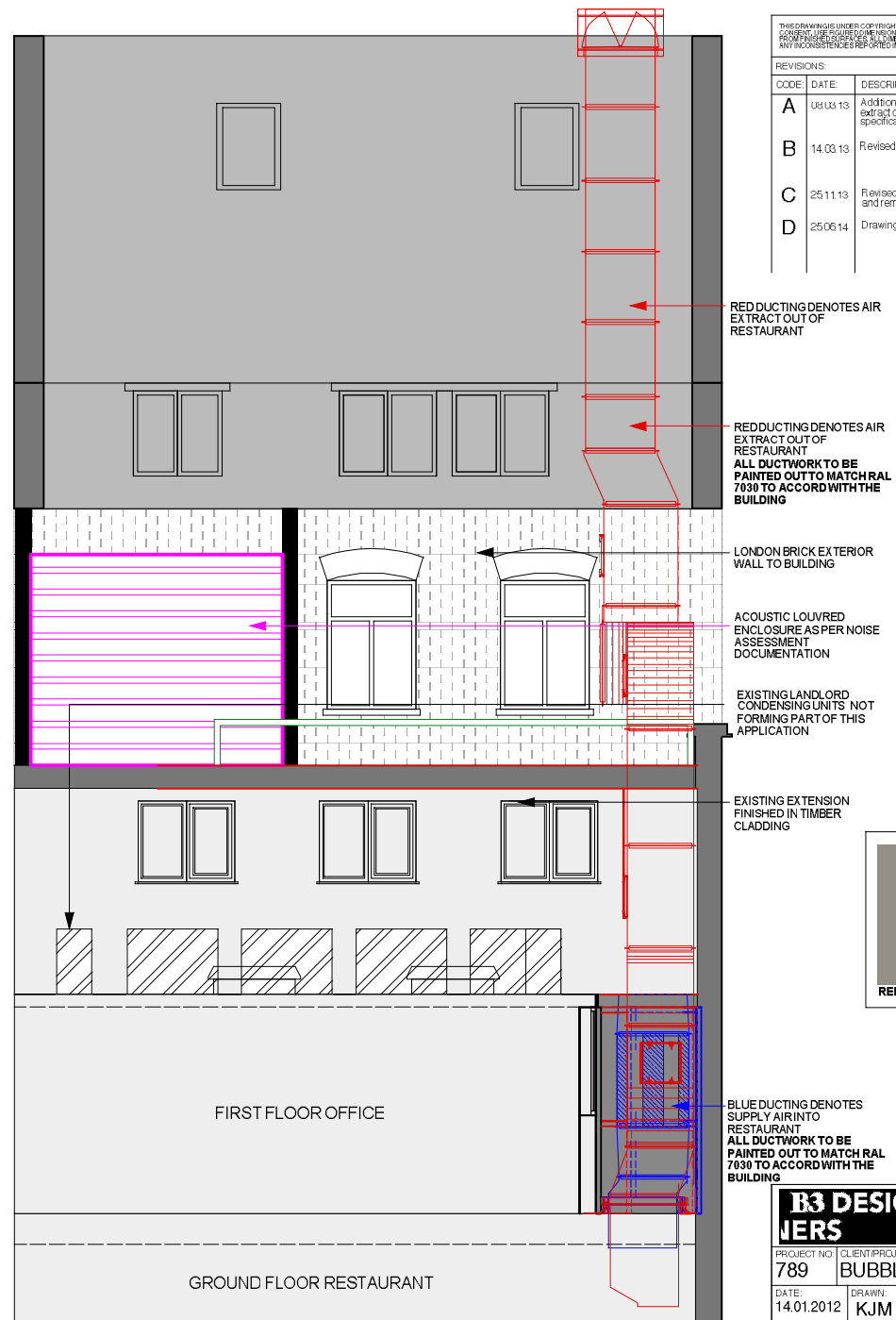
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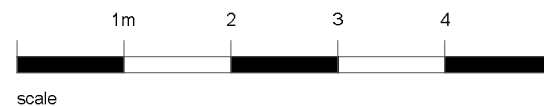




789 - ELEVATION BB
SCALE 1:50 @ A3



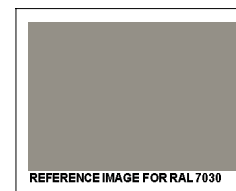
789 - ELEVATION CC
SCALE 1:50 @ A3



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REVISIONS:

CODE	DATE	DESCRIPTION
A	08.03.13	Additional fenestration detail to rear elevation & extract ductwork to be painted out as per specification
B	14.03.13	Revised ductwork layout
C	25.11.13	Revised proposed position of condensor units and removal of steelwork
D	25.06.14	Drawings updated with LLD survey drawings

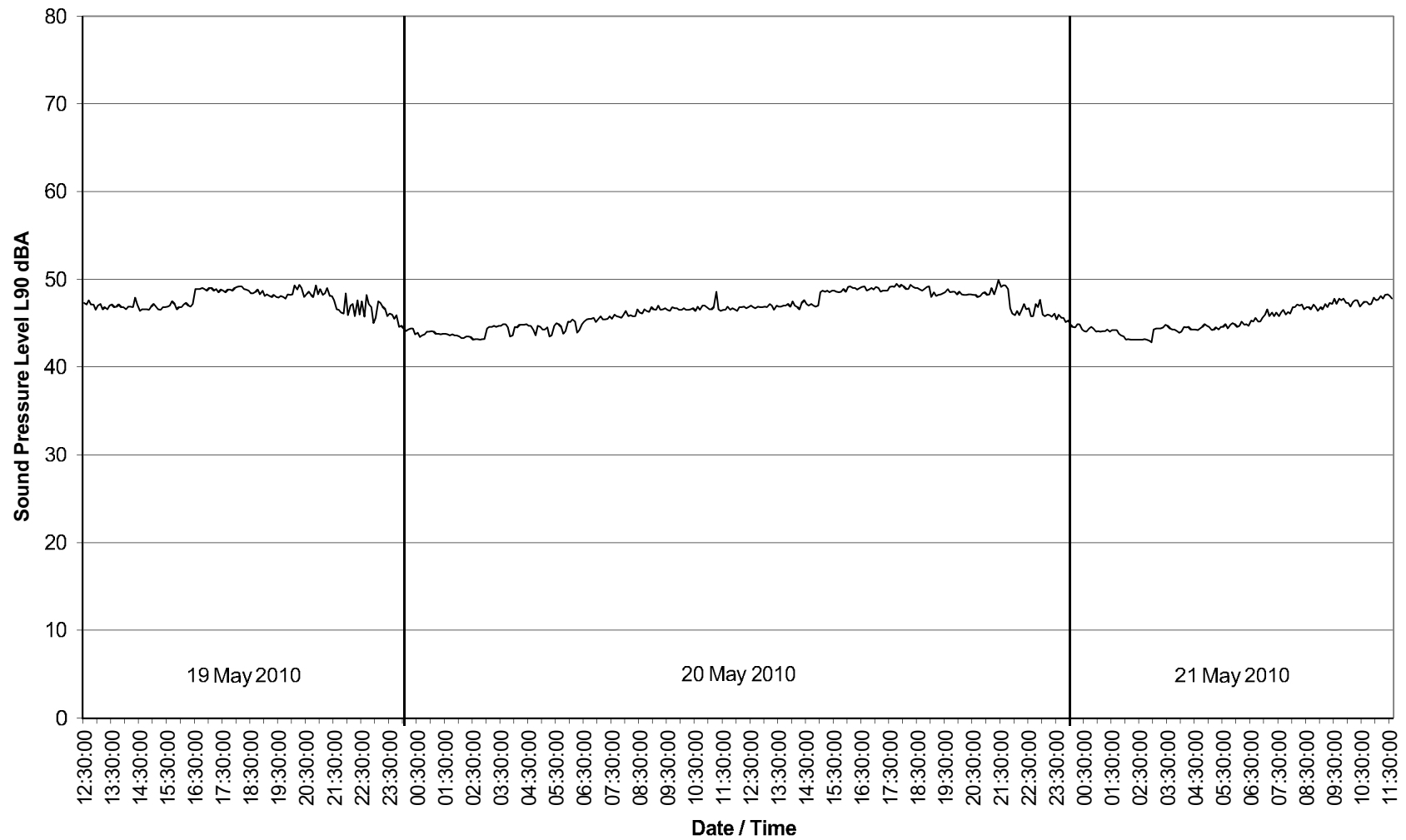


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APPENDIX B

Noise Survey Results

EXISTING BACKGROUND NOISE OVER COMPLETE MEASUREMENT PERIOD AT POSITION REPRESENTATIVE OF
OUTSIDE NEAREST RESIDENTIAL WINDOWS TO REAR OF 70 CHARLOTTE STREET, LONDON W1T 4QJ



APPENDIX C

Acoustic Calculations



Project Information

Project: Bubbledogs, 70 Charlotte Street, London
Client: Firstplan
Reference: 130103
Date: 13/01/2013

Ductwork System Calculation (Atmospheric Side)

System Reference: Kitchen Extract

Description				Octave Band Centre Frequency - Hz (dB)								Notes
				63	125	250	500	1k	2k	4k	8k	
Fan Lw	Model: MUB 062 630D4-K2 IE2			101	93	90	86	82	78	73	68	
	Airflow: 1.95 m ³ .s ⁻¹											
		Duct Size (mm) W x H										
Unlined Rectangular Duct		720	720	0.432	0.288	0.216	0.072	0.072	0.072	0.072	0.072	
Length (m): 0.72												
Radius Bend		650	800	1	2	3	3	3	3	3	3	
Silencer		1200	800	12	21	28	40	48	33	24	15	Allaway Acoustics silencer nominally 1800mm long
Radius Bend		720	720	1	2	3	3	3	3	3	3	
Radius Bend		720	720	1	2	3	3	3	3	3	3	
Unlined Rectangular Duct		720	720	3	2	1.5	0.5	0.5	0.5	0.5	0.5	
Length (m): 5												
Radius Bend		720	720	1	2	3	3	3	3	3	3	
End Reflection		720	720	5.7	2.4	0.8	0.2	0.1	0	0	0	

Directivity	Freefield		0	0	0	0	0	0	0	0	0
Distance to Listener	5 m		25	25	25	25	25	25	25	25	25
Screening			0	0	0	0	0	0	0	0	0

Calculated Lp at Receiver: 26.4 dBA 50.868 34.312 22.484 8.228 -3.672 7.428 11.428 15.428



Project Information

Project: Bubbledogs, 70 Charlotte Street, London
Client: Firstplan
Reference: 130103
Date: 18/01/2013

Ductwork System Calculation (Atmospheric Side)

System Reference: Kitchen Supply

Description		Octave Band Centre Frequency - Hz (dB)										Notes
		63	125	250	500	1k	2k	4k	8k			
Fan Lw	Model: MUB 062 630D4-A2	100	92	89	85	81	77	72	67			
	Airflow: 1.95 m³.s ⁻¹											
	Duct Size (mm) W x H											
Silencer	1000 700	15	26	39	53	55	55	46	32	Allaway Acoustics silencer nominally 1800mm long		
Silencer	1000 1000	2	2	2	2	4	4	4	6	Panel Filter		
End Reflection	1000 1000	3.9	1.5	0.5	0.1	0	0	0	0			

Directivity	Plane	3	3	3	3	3	3	3	3
Distance to Listener	4 m	23	23	23	23	23	23	23	23
Screening		5	8	11	13	15	16	18	20

Calculated Lp at Receiver:	28.4 dBA	54.1	34.5	16.5	-3.1	-13	-18	-16	-11
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Project Information

Project: Bubbledogs, 70 Charlotte Street, London
 Client: Firstplan
 Reference: 130103
 Date: 22/11/2013



ISO 9613-2:1996 ENVIRONMENTAL NOISE PROPAGATION CALCULATION

Calculation Model: A/C Condenser

Description			Octave Band Centre Frequency - Hz (dB)								Notes
			63	125	250	500	1k	2k	4k	8k	
Source Lw	Type:	Mitsubishi SUZ-KA71VA2	61	63	62	60	58	54	47	41	Manufacturer's data; Lp 55dBA at 1m
	Source:	Manufacturer's Data 63 dBA									
Directivity Correction (Dc)			1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	
	Source Height	0.8 m									
	Receiver Height	0.8 m									
	Distance	1.485 m									
	Directivity Index	0									
Geometrical Divergence (Adiv) - 1.485m			14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	
Atmospheric Absorption (Aatm)			0	0	0	0	0	0	0.1	0.2	
	Temperature	15 °C									
	Relative Humidity	50 %									
Ground Effect (Agr)			-3	-3	-3	-3	-3	-3	-3	-3	
	Source Height	0.8 m									
	Receiver Height	0.8 m									
	Source Ground	Hard Ground - G = 0									
	Receiver Ground	Hard Ground - G = 0									
	Middle Ground	Hard Ground - G = 0									
Screening (Abar)			4.4	9	11	13.5	16.2	19.1	20	20	No line-of-sight to closest noise-sensitive windows through acoustic screen
	Source to Barrier	0.6 m									
	Barrier to Receiver	1.4 m									
	Parallel Distance	0.823 m									
Miscellaneous (Amisc)			0	0	0	0	0	0	0	0	
Reflections (Lw,im + A)			29.4	31.4	30.4	28.3	26.3	22.1	14.5	6	
Calculated Lp at Receiver:			39.2 dBA	47	44.5	41.6	37.4	33.1	26.9	19.1	12.3
Attenuation			4	4	5	8	12	16	15	13	150mm acoustic louvre
Attenuated Lp at Receiver:			32 dBA	43	40.5	36.6	29.4	21.1	10.9	4.1	0

Project Information

Project: Bubbledogs, 70 Charlotte Street, London
 Client: Firstplan
 Reference: 130103
 Date: 22/11/2013



ISO 9613-2:1996 ENVIRONMENTAL NOISE PROPAGATION CALCULATION

Calculation Model: A/C Condenser

Description			Octave Band Centre Frequency - Hz (dB)								Notes
			63	125	250	500	1k	2k	4k	8k	
Source Lw	Type: Mitsubishi SUZ-KA71VA2		61	63	62	60	58	54	47	41	Manufacturer's data; Lp 55dBA at 1m
	Source: Manufacturer's Data	63 dBA									
Directivity Correction (Dc)			2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	
	Source Height	0.8 m									
	Receiver Height	0.8 m									
	Distance	2.567 m									
	Directivity Index	0									
Geometrical Divergence (Adiv) - 2.567m			19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	
Atmospheric Absorption (Aatm)			0	0	0	0	0	0	0.1	0.3	
	Temperature	15 °C									
	Relative Humidity	50 %									
Ground Effect (Agr)			-3	-3	-3	-3	-3	-3	-3	-3	
	Source Height	0.8 m									
	Receiver Height	0.8 m									
	Source Ground	Hard Ground - G = 0									
	Receiver Ground	Hard Ground - G = 0									
	Middle Ground	Hard Ground - G = 0									
Screening (Abar)			3.9	8.2	10.2	12.5	15.1	17.9	20	20	No line-of-sight to closest noise-sensitive windows through acoustic screen
	Source to Barrier	1.6 m									
	Barrier to Receiver	1.4 m									
	Parallel Distance	0.823 m									
Miscellaneous (Amisc)			0	0	0	0	0	0	0	0	
Reflections (Lw,im + A)			30.1	32.1	31.1	29	27	22.8	15.2	6.7	
Calculated Lp at Receiver:	36.8 dBA		43.5	41.5	38.8	35	31.2	25.6	17.3	9.8	
Attenuation			4	4	5	8	12	16	15	13	150mm acoustic louvre
Attenuated Lp at Receiver:	29 dBA		39.5	37.5	33.8	27	19.2	9.6	2.3	0	

APPENDIX D

Typical Noise & Vibration Control Treatments

DATA SHEET **A02E**

RECTANGULAR ATTENUATOR

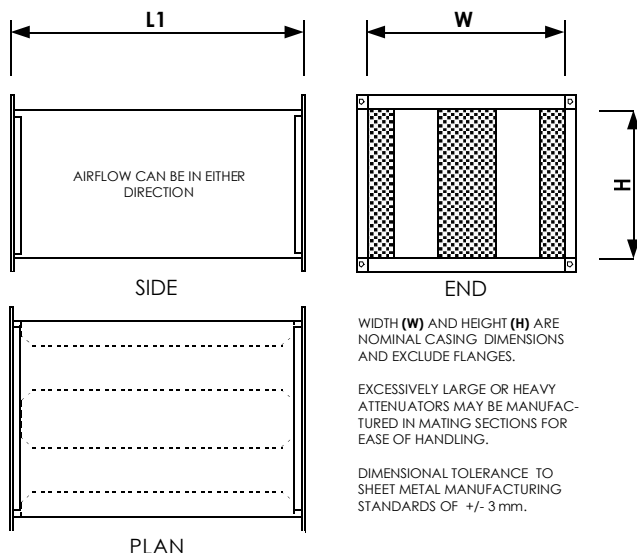
MODEL **SP**

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DIMENSIONS



SPECIFICATION

ATTENUATORS ARE CONSTRUCTED TO DW144 SPECIFICATION FOR MEDIUM PRESSURE DUCTWORK.

CASES ARE FORMED FROM PRE-GALVANISED STEEL OF THE SPECIFIED GAUGE, BUT IN NO INSTANCE LESS THAN 0.8 mm. CASE SEAMS ARE LOCK FORMED AND MASTIC SEALED.

CASES ARE STIFFENED AND FITTED WITH PROPRIETARY FLANGES.

SOUND ABSORBENT ELEMENTS ARE ARRANGED WITHIN THE CASING TO FORM A SERIES OF CENTRAL SPLITTERS AND SIDE LININGS. SPLITTER FRAMES ARE FORMED FROM PRE-GALVANISED STEEL, AND CONTAIN A FIBROUS INFILL THAT IS NON-SHEDDING, NON-COMBUSTIBLE, NON-HYGROSCOPIC AND CHEMICALLY INERT. THE INFILL IS FACED WITH GLASS CLOTH AND PRE-GALVANISED PERFORATED STEEL.

SPLITTER ELEMENTS HAVE AERODYNAMIC FAIRINGS ON AIR ENTRY AND AIR EXIT END OF ATTENUATOR.

NOTES

THIS DATA SHEET IS TO BE READ IN CONJUNCTION WITH THE EQUIPMENT SCHEDULE.

EXCESSIVELY LARGE OR HEAVY ATTENUATORS MAY BE MANUFACTURED IN MATING SECTIONS FOR EASE OF HANDLING.

ATTENUATORS WILL BE SUPPLIED WITHOUT SUPPORT STEELWORK, BRACKETS, FIXINGS, GASKET, MASTIC OR OTHER SUCH ITEMS, UNLESS OTHERWISE STATED.

ATTENUATOR SEAMS AND JOINTS WILL BE FACTORY SEALED, HOWEVER, THE FLANGE CONNECTION SEAL, INCLUDING THE FLANGE CORNERS, IS THE RESPONSIBILITY OF THE INSTALLER.

THE PRESSURE LOSS STATED ON THE EQUIPMENT SCHEDULE IS DERIVED FROM TESTS CARRIED OUT IN ACCORDANCE WITH ISO 7235.

DIMENSIONAL TOLERANCE TO SHEET METAL MANUFACTURING STANDARDS OF ± 3 mm.

WEIGHT

WEIGHTS ARE GIVEN ON THE EQUIPMENT SCHEDULE.

CODE

THE ATTENUATOR CODE DEFINES THE SPLITTER AND AIRWAY DIMENSIONS AND IS GIVEN ON THE EQUIPMENT SCHEDULE.

SUFFIX

THE SUFFIX DEFINES ADDITIONAL FEATURES OR SPECIAL CONSTRUCTIONAL DETAILS.

G - GALVANISED STEEL CONSTRUCTION.

S - STAINLESS STEEL CONSTRUCTION.

U - UPVC/GRP CONSTRUCTION TO DW154 SPECIFICATION (SEPARATE DRAWING)

H1 - 2 HOUR/300°C CONSTRUCTION.

H2 - FIRE DUCT CONSTRUCTION (FINAL TREATMENT BY SPECIALIST CONTRACTOR)

C - CHLORINATED RUBBER PAINT TO INSIDE SURFACES.

J - SPLITTERS ARRANGED HORIZONTALLY.

L - SPLITTERS ONLY (REFER TO DATA SHEET A10 FOR DETAILS).

D - DOUBLE SKIN CASING.

M1 - MELINEX LINED INFILL.

M2 - MELINEX ENCAPSULATED INFILL.

X - SPECIAL CONSTRUCTION, REFER TO EQUIPMENT SCHEDULE FOR DETAILS.

FLANGE DETAILS

ATTENUATORS ARE FITTED WITH PROPRIETARY FLANGES AS FOLLOWS:

GREATEST DIMENSION (W or H)	FLANGE
0 - 1000 mm	DOBY 20
1001 - 1250 mm	DOBY 30
1251 and above	DOBY 40

NOTE: IT IS THE INSTALLERS RESPONSIBILITY TO PROVIDE THE FLANGE SEAL TO THE CONNECTING DUCT, INCLUDING THE FLANGE CORNERS.

STANDARD SIZES

THERE ARE NO STANDARD SIZES. ALL ATTENUATORS ARE MADE TO ORDER.

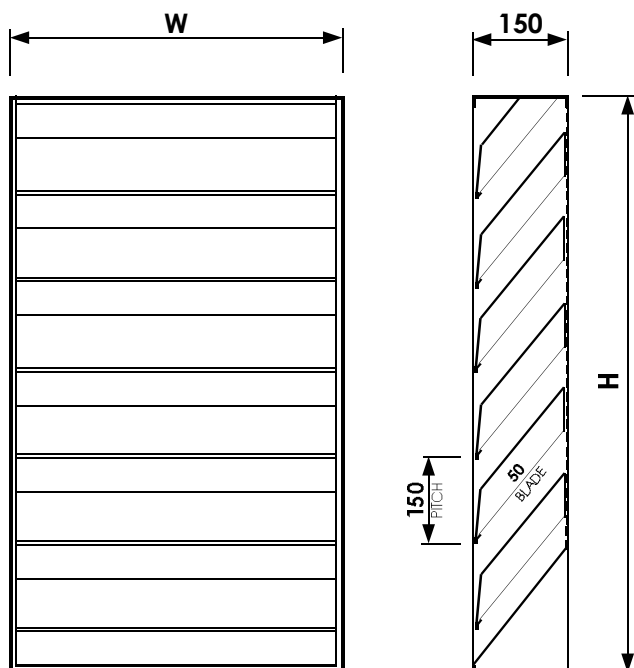
DATA SHEET **L60D** ACOUSTIC LOUVRE MODEL **AL1515**

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DIMENSIONS



SPECIFICATION

LOUVRES ARE CONSTRUCTED FROM FOLDED SHEET METAL AND HAVE A SERIES OF HORIZONTAL BLADES CONTAINED WITHIN A FOUR SIDED EXTERNAL FRAME.

THE MATERIAL OF CONSTRUCTION MAY BE PRE-GALVANISED STEEL (SUFFIX G) OR ALUMINIUM (SUFFIX A).

LOUVRE BLADES HAVE LOWER FACES OF PERFORATED SHEET METAL, CONTAINING A FIBROUS SOUND ABSORBENT INFILL THAT IS NON-SHEDDING, NON-COMBUSTIBLE, NON-HYGROSCOPIC AND CHEMICALLY INERT. THE INFILL IS FACED WITH GLASS CLOTH TO MINIMISE FIBRE MIGRATION.

GALVANISED BIRD SCREENS ARE FITTED AS STANDARD.

CASING SIDES ARE PROVIDED WITH 10mm DIA HOLES FOR FIXING ADJACENT SECTIONS TOGETHER, OR FIXING THE LOUVRE INTO THE BUILDERSWORK OPENING.

LOUVRES ARE SUPPLIED SELF FINISH AS STANDARD OR WITH AN OPTIONAL POLYESTER POWDER FINISH (SUFFIX P).

NOTES

THIS DATA SHEET IS TO BE READ IN CONJUNCTION WITH THE EQUIPMENT SCHEDULE.

WIDTH (**W**) AND HEIGHT (**H**) DIMENSIONS GIVEN ON THE EQUIPMENT SCHEDULE ARE AS MANUFACTURED. ADEQUATE CLEARANCE MUST BE ALLOWED WHEN CONSTRUCTING THE BUILDERSWORK OPENING, A MINIMUM OF 10 mm IS RECOMMENDED.

LOUVRES WILL BE SUPPLIED WITHOUT SUPPORT STEELWORK, CLEATS, BRACKETS, FIXINGS, FLASHING, MASTIC, OR OTHER SUCH ITEMS, UNLESS OTHERWISE STATED.

EXCESSIVELY LARGE OR HEAVY LOUVRES MAY BE MANUFACTURED IN MATING SECTIONS FOR EASE OF HANDLING.

LOUVRES ARE MANUFACTURED TO STANDARD SHEET METAL TOLERANCES OF +/- 3 mm.

STANDARD SIZES

THERE ARE NO STANDARD SIZES. ALL LOUVRES ARE MADE TO ORDER.

SUFFIX

THE SUFFIX DEFINES ADDITIONAL FEATURES OR SPECIAL CONSTRUCTIONAL DETAILS

- A** ALUMINIUM CONSTRUCTION.
- G** GALVANISED STEEL CONSTRUCTION.
- P** POLYESTER POWDER COAT.
- X** SPECIAL CONSTRUCTION - REFER TO EQUIPMENT SCHEDULE FOR DETAILS.

WEIGHT

LOUVRE WEIGHTS ARE GIVEN ON THE EQUIPMENT SCHEDULE. APPROXIMATELY:

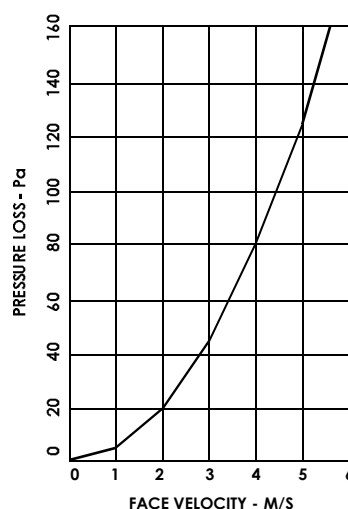
28kg/M² GALVANISED CONSTRUCTION
20kg/M² ALUMINIUM CONSTRUCTION

ACOUSTIC PERFORMANCE

SOUND REDUCTION INDEX B.S. 2750/3-1980 (ISO 140/3 -1978)

63	125	250	500	1000	2000	4000	8000	Hz
4	4	5	8	12	16	15	13	dB

PRESSURE LOSS



DATA SHEET **E70c**

ACOUSTIC ENCLOSURE PANEL

MODEL **CP50/UF**

IMPORTANT : THIS IS NOT A STAND ALONE DOCUMENT AND UNLESS REFERRED TO IN A DATED AND CERTIFIED EQUIPMENT SCHEDULE IS SUBJECT TO REVISION WITHOUT NOTICE.

SPECIFICATION

THE ACOUSTIC ENCLOSURE PANEL COMPRISES A COMBINATION OF SOUND ABSORBENT MATERIALS AND HIGH MASS BARRIERS CONTAINED WITHIN A METAL CASING HAVING AN PLAIN OUTER AND PERFORATED INNER FACE, OFFERING EXCELLENT SOUND REDUCTION AND ABSORPTION PROPERTIES.

PANELS ARE CONSTRUCTED FROM GALVANISED STEEL (SUFFIX **G**), ZINTEC (SUFFIX **Z**), PLASTIC COATED STEEL (SUFFIX **L**) OR ALUMINIUM (SUFFIX **A**).

THE OUTER CASING IS FORMED FROM PLAIN SHEET METAL AND INSIDE FACE FROM PERFORATED METAL.

PANELS CONTAIN A FIBROUS SOUND ABSORBENT INFILL THAT IS NON-SHEDDING, NON-COMBUSTIBLE, NON-HYGROSCOPIC AND CHEMICALLY INERT. THE INFILL IS FACED WITH GLASS CLOTH TO PREVENT FIBRE MIGRATION.

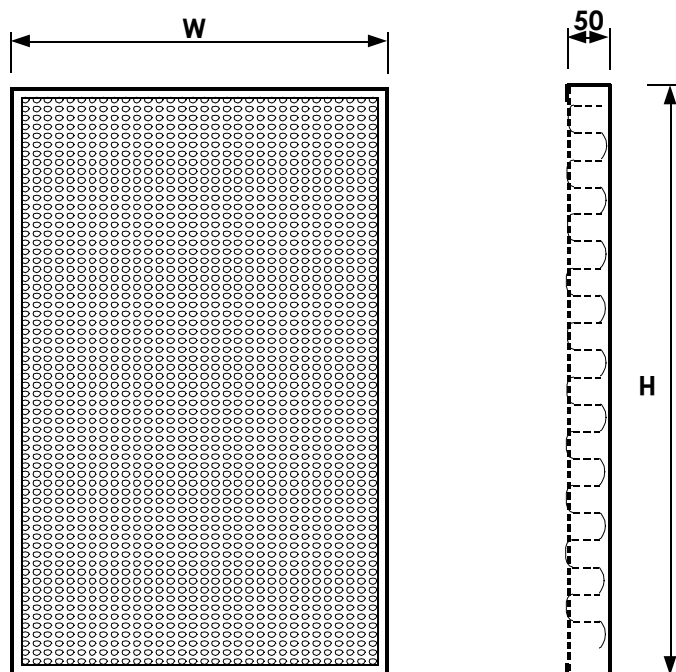
INFILL DENSITY- 45kg/m3.

INFILL THICKNESS -50mm.

THE CASING CAN BE SUPPLIED WITH A PERIMETER FLANGE FOR FIXING ADJACENT SECTIONS TOGETHER, FIXING THE PANELS INTO THE BUILDERSWORK OPENING OR FIXING INTO THE FRAMEWORK OF AN ACOUSTIC ENCLOSURE (OPTION **F**).

POLYESTER POWDER FINISH AVAILABLE (SUFFIX **P**)

DIMENSIONS



NOTES

THIS DATA SHEET IS TO BE READ IN CONJUNCTION WITH THE EQUIPMENT SCHEDULE

PANELS WILL BE SUPPLIED WITHOUT SUPPORT STEELWORK, BRACKETS, FIXINGS OR MASTIC UNLESS OTHERWISE STATED.

PANELS MORE THAN 1800 WIDE OR 2500 HIGH MAY BE MANUFACTURED IN SECTIONS FOR ON SITE ASSEMBLY.

SUFFIX

A - ALUMINIUM SUBSTRATE

G - GALVANISED STEEL SUBSTRATE

Z - ZINTEC SUBSTRATE

L - PLASTIC COATED STEEL

P - STOVED POLYESTER POWDER COAT

F - PERIPHERAL FIXING FRAME

SP - SPECIAL CONSTRUCTION, REFER TO EQUIPMENT SCHEDULE FOR DETAILS.

FEATURES

ARCHITECTURAL/INDUSTRIAL APPLICATION

ALL METAL CONSTRUCTION

HIGH SECURITY

HIGH ACOUSTIC RATING

HIGH SOUND ABSORPTION

INTERNAL/EXTERNAL USE

OPTIONAL POLYESTER FINISH

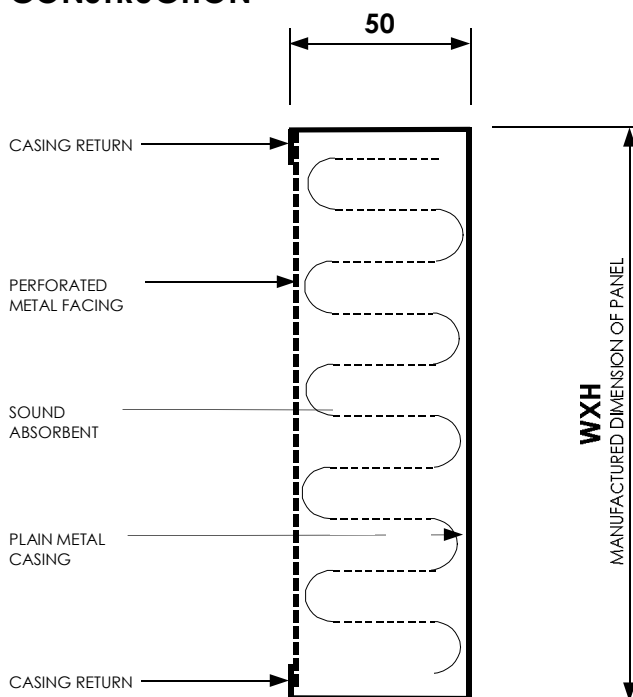
OPTIONAL FIXING FLANGES



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CONSTRUCTION



ACOUSTIC PERFORMANCE

SOUND REDUCTION INDEX B.S.2750/3-1980

63	125	250	500	1000	2000	4000	8000	HZ
13	17	24	30	38	39	41	39	dB

SOUND ABSORPTION B.S.3638 -1987

63	125	250	500	1000	2000	4000	8000	HZ
.10	.25	.65	1.00	1.00	1.00	.95	.90	-

WEIGHT

ACTUAL PANEL WEIGHTS ARE GIVEN ON THE EQUIPMENT SCHEDULE.
APPROXIMATE WEIGHT:
20kg/M² GALVANISED

BUILDERSWORK

THE **W** AND **H** DIMENSIONS GIVEN ON THE CERTIFIED EQUIPMENT SCHEDULE ARE AS MANUFACTURED.

ADEQUATE CLEARANCE MUST BE ALLOWED WHEN CONSTRUCTING THE BUILDERSWORK OPENING, MIN 10mm IS RECOMMENDED.

STANDARD SIZES

THERE ARE NO STANDARD SIZES.

PANELS ARE MANUFACTURED TO ORDER.