

Acoustic Associates Sussex Ltd

BS4142:2014-A1:2019 Noise Assessment.

Site: **Caffe Grey, 26 Felpham Road, Felpham.**

Client: **Caffe Grey Limited**

Report by: Scott Castle BSc (Hons) CEnvH, MCIEH PGDip: Acoustics MIOA

Date: 04/03/2022

Project: J3336

Issue 1



Sound Insulation Testing - Acoustic Design of Buildings - BS4142 - PPG24 - Schools Acoustics BB93 -
Vibration - Expert Witness Testimony - Noise at Work - Air Tightness Testing - Auditorium Acoustics

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1 Introduction

Acoustic Associates have been appointed to undertake an acoustic assessment to support a planning application for a change of use. Specifically, the application site seeks planning permission to change from retail to a café/restaurant which includes a new kitchen flue.

Standards and guidance referenced for this assessment include:

- ISO9613 (Attenuation of sound during propagation outdoors) 1996
- BS4142:2014-A1:2019- Methods for rating and assessing industrial and commercial sound
- BS8233 (Sound insulation and noise reduction for buildings) 2014
- Noise and vibration control for building services systems CIBSE Guide B4: 2016
- Fläkt Woods Practical Guide to Noise Control (2005)
- BS EN ISO 140-4:1998: Field measurements of airborne sound insulation between rooms
- Approved Document E: Resistance to the Passage of Sound (2003 edition incorporating 2015 amendments).

Background sound pressure levels were measured with a class 1 sound level meter over a number of days (including a weekend) at a position representative of the nearest residential receptor.

The background sound pressure levels were reviewed and calculated as being 45dB $L_{A90,15\text{minutes}}$ for the period of 08:00 hours to 22:00 hours when the flue is proposed to be in operation.

The Rating Level or $L_{Ar,Tr}$ for the nearest residential window is only marginally above the measured background sound pressure levels by 0.7dB which is not likely to be noticeable and therefore does not require any mitigation measures.

Sound insulation testing was also carried out to ensure that the resident in the flat above at 26A Felpham Road remains protected from internally generated patron noise. The $D_{nTw} + C_{tr}$ results of the tests were a minimum of 5dB(A) above the requirements of Approved Document E.

An assessment indicated that the concrete floor/ceiling partition provides good sound insulation properties and based on full capacity of the caffè, noise ingress will be below a reduced BS8233:2014 threshold to account for sounds which may have character, ie people noise.

Based on the assessment undertaken, planning permission should not be withheld on noise grounds.

2 Context, Noise Criteria & Noise Assessment Methodology

2.1 Context and Planning Context

The application site is seen in Figure 1 below located at 26 Felpham Road, Felpham. The front of the premises is orientated West towards Felpham Road. A planning application is currently awaiting determination by Arun District Council (FP/15/22/PL).



Figure 1. Site Location

To the front of the premises are a number of 1 hour parking bays. Commercial premises are located either side of the site. A dog grooming parlour is located to the immediate North, and an alleyway to the south. A physio studio is located at 24 Felpham Road.

To accommodate the change of use, a kitchen extract is proposed which requires planning permission and an assessment against BS4142:2014-A1:2019. As seen in Figure 2 below, the extract is proposed on the Northern elevation. This layout shows good acoustic design as this facade already is exposed to increased sound pressure levels due to passing road traffic noise.

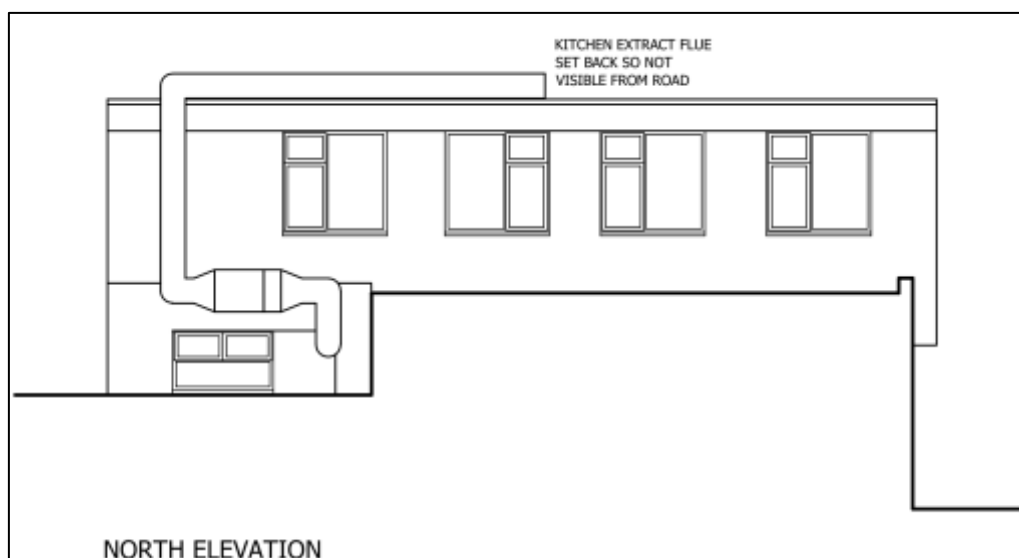


Figure 2. Proposed Extraction Location - Northern Facade

Whilst the applicant in their design and access statement had indicated the use of bi-fold doors, this has no longer been pursued due to the space that these can take up when open.

Given the proximity of the residential flat above, an assessment of noise break in/emissions from the restaurant is also warranted as part of the scope and this has been reflected in the concerns raised by Environmental Health as technical consultees to the application.

It is relevant to note that the local authority (Arun District Council) has already issued a premises licence under the Licensing Act 2003 dated 29th October 2021.

2.2 Site Soundscape

The soundscape is dominated by road traffic noise from Felpham Road which runs North to South at the front of the premises and vehicles coming and going from the temporary parking bays to the front.

2.3 Nearest Residential Receptor Location

The nearest residential receptor is 26A Felpham Road, which is the two-bedroom flat above the premises.

2.4 Proposed Hours of Operation

The proposed hours for the business are Sunday to Wednesday 08:00 to 16:00 hours and Thursday, Friday and Saturday, 08:00 to 16:00 hours and then 18:00 to 23:00 hours. Liaison with the client suggests that the kitchen extract would likely be operational between these hours and would terminate at latest 22:00 hours. The sound from the flue would likely be continuous.

2.5 External Plant

As stated, the plant in question is a flue serving the kitchen extraction system located on the Northern elevation. This is a circular 400mm diameter flue being installed which rises vertically to the flat roof at first floor level, and is then angled parallel with the flat roof. No hats or cowls are proposed at the termination point.

The motor/fan unit and the attenuators are proposed to be inside the property.

2.6 Target Noise Level - Planning Noise Advice Document Sussex (PNADS), March 2021

The Sussex Planning Noise Advice Document dated March 2021, which Arun Council are signed up to, describes that the Rating Level or $L_{A_{r,Tr}}$ should not exceed measured background sound pressure levels.

“3.2.1 The rating level of the industrial or commercial sound source should, where practicable, achieve a level no greater than the representative background sound, when measured in accordance with BS 4142:2014 + A1: 2019.”

2.7 BS4142: 2014: Methods for rating and assessing industrial and commercial sound

This document provides a means of assessing the impact of industrial or commercial sound upon nearby noise-sensitive receptors, including residential properties.

It does this by comparing the Rating Level of the noise from the industrial or commercial source with the pre-existent L_{90} background noise level affecting the same noise-sensitive premises. The Standard provides guidance that:

- a) Typically, the greater the difference, the greater the magnitude of the impact.
- b) A difference of around +10dB or more is likely to be an indication of a significant adverse impact, depending on the context.
- c) A difference of around +5dB is likely to be an indication of an adverse impact, depending on the context.
- d) 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 noise level, this is an indication of the specific sound source having a low impact, depending on the context.

3 Methodology and Approach

To ensure that sufficient information is presented to accompany the planning application, the following approach was applied:

1. Visit the commercial premises and measure background sound levels as close as possible to the nearest residential receptor.
2. Extract information from the measured dataset which shows the representative background sound pressure levels for periods when the flue will operate
3. Duct calculations will be undertaken to determine the noise levels arising from the flue.
4. A BS4142:2014-A1:2019 assessment will then be carried out using the worst case predicted results.
5. Context and uncertainty will be discussed in line with BS4142:2014-A1:2019
6. Given the proximity of the residential demise above, a vertical airborne sound insulation test is also proposed to determine the baseline performance of the separating partition. This will guide what, if any additional works might be necessary to protect the upstairs occupants.

4 Background Sound Survey Baseline Conditions & Results

A background noise survey was carried out between the 25th February 2022 and 28th February 2022 to assess the background sound pressure levels at the site and more specifically at the closest location to the upstairs residents. Given the proximity of the adjacent wall, the measured sound pressure levels are considered to be façade levels and will not require any later correction.

4.1 Background and Existing Noise Survey Details

Survey(s) carried out by	Scott Castle BSc(Hons) Env Health, MCIEH CEnvH PGDip Acoustics MIOA
Equipment Used	Norsonic 118- Class 1 Sound Level Meter – Serial No. 31540 (Unattended)
Equipment Used	Castle Acoustic Calibrator – Serial No. 041173
Location	SZ94850/99540 - Pole Mounted at 2.7m above rear ground floor level
Duration	25 th February 2022 to 28 th February 2022

Table 1. Survey Equipment

The sound level meter was calibrated before and after commencing the noise measurements (@114dB with no drift). All measurements were taken with the time base set to 15-minute interval periods. The unattended sound level meter position can be seen below in Figure 3.



Figure 3. Survey Location

4.2 Representative Background Sound Levels

The survey monitoring position was chosen to represent an “area” background sound level representative to the site. BS4142 states the following on page 11 (Note 1):

To obtain a representative background sound level a series of either sequential or disaggregated measurements ought to be carried out for the period(s) of interest, possibly on more than one occasion. A representative level ought to account for the range of background sound levels and ought not automatically to be assumed to be either the minimum/modal value.

Modal occurrences for background sound levels have been used for the $L_{A90, 15\text{minute}}$ periods for the daytime period between 08:00 and 22:00 hours when the flue serving Caffè Grey would likely be in operation.

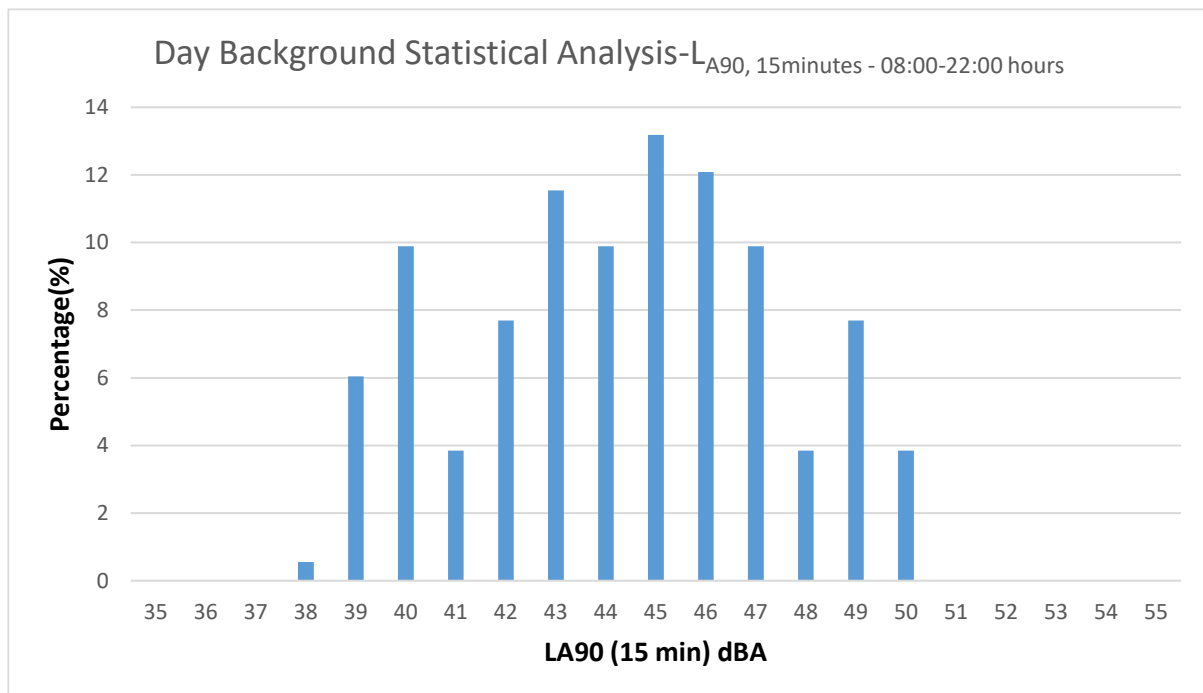


Figure 4. Daytime Measured Background Sound Pressure Levels - $L_{A90,15\text{minutes}}$ – 08:00 to 22:00 hours

The representative background sound pressure level would therefore be 45dB $L_{A90,15\text{ minutes}}$ for the entire period, ie 08:00 to 22:00 hours.

5 Duct Calculations

The ductwork is 0.8g galvanised steel and circular with a 400mm diameter. The motor unit for the fan to drive air through the ductwork is a system air AR 400E4-L Sileo Axial Fan.

The induct sound power levels provided by the client's duct work installer are detailed below in Figure 5.

Sound power level	Acoustic filter	63	125	250	500	1k	2k	4k	8k	Total
Inlet	dB(A)	44	54	59	60	64	63	59	51	69
Outlet	dB(A)	43	55	60	61	65	64	58	49	70

Figure 5. In Duct Sound Power Levels

It is relevant to note that the motor unit is to be housed inside the property and has two silencers proposed, one on the inlet to the fan (ie room side) and one in the outlet of the fan (environmental side). All attenuators are located within the building to minimise the external impact.

The silencers are two 400mm diameter, 600mm long and are circular straight silencers. For the purposes of the duct work calculation only one atmospheric attenuator is present.



Figure 6. Inline Fan/Motor Unit and Silencers

Ød_{nom} [mm]	l_{nom} [mm]	63	125	250	500	1k	2k	4k	8k	Ødy	l	m
400	300	0	1	2	3	3	2	3	1	508	300	12,0
400	600	0	2	4	8	10	5	4	4	508	600	16,0
400	900	0	2	5	12	16	7	5	6	508	900	22,0
400	1200	0	2	7	16	20	9	6	7	508	1200	32,0

Figure 7. Silencer Details for 400mm Diameter and 600mm Length

Given that the sound pressure within the flue will be approximately the same in the external sections of the duct, due to the attenuators fitted internally (inside the premises), it may be treated as the same sound source for the closest window to the flue and the closest window to the termination point.

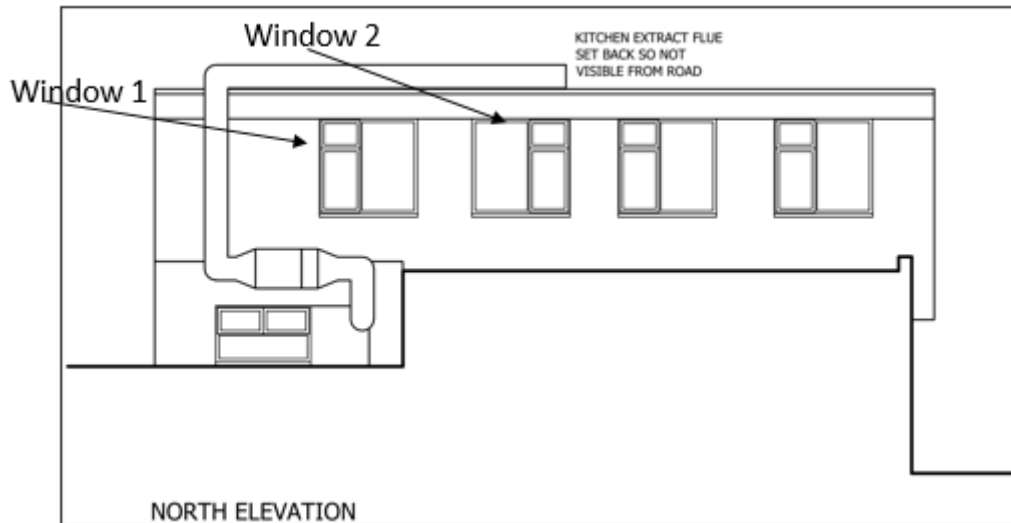


Figure 8. Illustration to detail reception points

The sum total at the 1st window from both duct breakout as well as the termination point will be 45.7 dB $L_{Aeq,T}$. This is comprised as 45.7dB $L_{Aeq,T}$ from the ductwork and 23dB $L_{Aeq,T}$ from the termination point.

The sum total at the 2nd window from both duct breakout as well as the termination point will be 39.9 dB $L_{Aeq,T}$.

The detailed calculations can be seen in Appendix A.

6 BS4142:2014-A1:2019 Assessment

A BS4142:2014-A1:2019 assessment has been carried out of the worst-case window of 26A, as the flat above the property.

Caffè Grey - Daytime - 08:00-22:00 hours			
Results	Measurement Parameter		Relevant Clause
Specific sound level	$L_{Aeq(T)}$	45.7	7.3.4
On time corrected value	Not Applicable	0	
Acoustic feature correction	Not Applicable	0	9.2
Rating level	$L_{A,r,Tr}$	45.7	9.2
Background sound level	$L_{A90(T)}$	45	8
Excess of rating level over background sound level		0.7	11
Assessment indicates a	Marginally Above Background and Possible Adverse Effect - Depending on Context		11
Uncertainty of the assessment	Discussed		10

Figure 9. BS4142:2014-A1:2019 Assessment

The outcome of the assessment details that the noise impact of the flue is likely to be marginally above (ie 0.7dB) the measured background sound pressure levels. An impact of less than 0.7dB above measured background is not likely to be noticeable and mitigation measures are not deemed necessary.

Context is always relevant when considering an assessment outcome. The flue operates during the daytime hours only and as new equipment it is not likely to be tonal. The noisier elements of the flue are the motor/fan unit and these have been deliberately housed internally inside the restaurant. It is relevant to note that only the worst-case window has been considered using BS4142:2014, as window 2 was already at least 5dB below the measured background.

It is however recommended that regular inspection, maintenance and servicing occurs to ensure that the unit remains in optimal performance.

7 Sound Insulation Testing – Ground floor to First Floor

The building is concrete frame with a concrete floor, 6-8 inches thick, with a 6-8 inch void and subsequent plasterboard finish in the café area.

On 13th January 2022, an Approved Document E sound insulation test was carried to determine the performance of the separating partition between the commercial and residential demise above. A vertical airborne test was carried out from the larger space (ie the ground floor café element) to the bedroom and lounge room areas representing habitable spaces of 26A above.

The testing process followed the guidance of BS EN ISO 140-4:1998. This involves exciting the ground floor café area with very high sound pressure levels (105dB(A)) using pink noise and then testing in the rooms above, testing without the sound source present (background) and then reverberation times being undertaken in the two receive rooms (Bedroom and Lounge)

The results of the sound insulation testing were as follows:

- Café to Bedroom = 50dB $D_{nTw} + C_{tr}$
- Café to Lounge Area = 48dB $D_{nTw} + C_{tr}$

It should be noted these results are 5dB better than the Approved Document E $D_{nTw} + C_{tr}$ requirements for conversions.

8 Predicted Internal Sound Pressure Levels (Generated in Caffe Grey)

8.1 People Noise

As a café/restaurant, background music is proposed and in addition to this people noise will be generated inside the premises. The table layout is already known from the site set up, so it is fair to assume at least one individual customer/patron talking from each table, as clearly not all customers would speak at the same time.

Table A.1 of BS: 9921:2003 states that a normal human voice is 60dB(A) at 1m and a raised human voice level is 66dB(A) at 1m. It is likely that due to alcohol consumption, some of patrons may be talking with raised voices, however it would be unrepresentative to expect everyone in the premises would be talking at a raised level.

Therefore, for the following calculation, half of the individuals talking will be projected to be speaking at a raised level and half at a normal level.

It should be remembered that this represents a robust scenario with the premises at full capacity. From the current table layout, it is estimated that there could be 29 persons sat and as discussed, not all individuals would speak at once and it would be an over estimate to use 3 people speaking in a table of six, when at most, two might be speaking with the remainder of the table listening.

It is therefore estimated that of 13 persons (including staff) speaking, 6 would be at a normal level and 6 at an increased vocal effort.

$$60 + 10 \log(7) = 68.5 \text{ dB}$$

$$66 + 10 \log(6) = 73.8 \text{ dB}$$

$$\text{Combined people noise} = 10 \log(10^{6.85} + 10 \log 10^{7.38}) = 74.9 \text{ dB(A)}$$

8.2 Background Music/Noise Level

For a setting such as Caffè Grey, background music would not normally exceed 70dB(A) measured at 1m, otherwise patrons would likely complain about speech intelligibility and not being able to hear one another.

8.3 Combined Internal Noise Level inside Café Grey

The background music (70dB(A)) and the people noise (74.9dB(A)) are therefore logarithmically combined to determine the overall internal noise level. This is calculated as $10 \log(10^{7.0} + 10^{7.49}) = 76.1 \text{ dB(A)}$ and presents a robust scenario of full capacity.

8.4 Noise Break In to 26A Felpham Road (Flat Above)

The purpose of the sound insulation testing was to determine the sound insulation performance of the current concrete separation between the ground floor commercial premises and the residential demise above. Importantly, an assessment of how much sound is likely to enter the residential flat above is required. This was an area of concern flagged by Environmental Health.

With 76.1dB(A) generated internally inside the café, a test sound source which used speech, laughter as well as background music data was used to replicate the spectral frequency at 76.1dB(A) inside the café.

The Dnt values obtained from the sound testing were then applied to determine how much sound would enter the residential flat above (24A).

The calculations are shown in Figure 10 below and indicate 26dB(A) inside the bedroom and 27dB(A) rounded for the lounge area.

Café to Bedroom						Café to Lounge					
Frequency Hz	Adjusted music spectrum (-13dB)	Dnt	Linear level in NSR	A weighting	A weighted level in NSR	Frequency Hz	Adjusted music spectrum (-13dB)	Dnt	Linear level in NSR	A weighting	A weighted level in NSR
50	61.7	33.2	28.5	-30.2	-1.7	50	61.7	36.1	25.6	-30.2	-4.6
63	60.3	42.4	17.9	-26.2	-8.3	63	60.3	35.9	24.4	-26.2	-1.8
80	63.1	36.9	26.2	-22.5	3.7	80	63.1	35.2	27.9	-22.5	5.4
100	66.0	40.4	25.6	-19.1	6.5	100	66.0	35.2	30.8	-19.1	11.7
125	62.5	42	20.5	-16.1	4.4	125	62.5	40.8	21.7	-16.1	5.6
160	65.9	40.2	25.7	-13.4	12.3	160	65.9	37.7	28.2	-13.4	14.8
200	67.9	43.2	24.7	-10.9	13.8	200	67.9	43	24.9	-10.9	14.0
250	68.9	43	25.9	-8.6	17.3	250	68.9	42.2	26.7	-8.6	18.1
315	70.0	43.4	26.6	-6.6	20.0	315	70.0	44.3	25.7	-6.6	19.1
400	69.3	47.8	21.5	-4.8	16.7	400	69.3	46.7	22.6	-4.8	17.8
500	71.6	49.5	22.1	-3.2	18.9	500	71.6	49.1	22.5	-3.2	19.3
630	71.8	53.3	18.5	-1.9	16.6	630	71.8	51.3	20.5	-1.9	18.6
800	68.4	55.3	13.1	-0.8	12.3	800	68.4	53.8	14.6	-0.8	13.8
1000	62.3	56.9	5.4	0	5.4	1000	62.3	57.7	4.6	0	4.6
1250	61.7	58.6	3.1	0.6	3.7	1250	61.7	60.5	1.2	0.6	1.8
1600	61.5	59.3	2.2	1	3.2	1600	61.5	63.9	-2.4	1	-1.4
2000	63.4	60.9	2.5	1.2	3.7	2000	63.4	65.3	-1.9	1.2	-0.7
2500	62.4	65	-2.6	1.3	-1.3	2500	62.4	67.3	-4.9	1.3	-3.6
3150	58.8	68.9	-10.1	1.2	-8.9	3150	58.8	71.3	-12.5	1.2	-11.3
4000	53.5	72.8	-19.3	1	-18.3	4000	53.5	73.7	-20.2	1	-19.2
5000	52.0	75.2	-23.2	0.6	-22.6	5000	52.0	76.2	-24.2	0.6	-23.6
Broadband A weighted level in NSR					26.0	Broadband A weighted level in NSR					26.7

Figure 10. Assessment of Predicted Noise Ingress to 26A Felpham Road

Whilst BS8233:2014 Table 4 values provide for daytime noise levels of 35dB $L_{Aeq,16 \text{ hour}}$ internally, these relate to continuous and anonymous sounds, without character. Given the changeable pitch, intermittency and range of human speech and laughter etc, it is relevant to consider a lower noise level internally to protect the residential apartment and therefore 30dB $L_{Aeq,16 \text{ hour}}$ is relevant for the daytime period when the café premises will be open.

The measured sound insulation performance shows that the predicted internal noise levels inside the habitable rooms of 26A Felpham Road are below the reduced criterion for daytime values ie 30dB $L_{Aeq, 16 \text{ hour}}$.

9 Mitigation Measures

Mitigation measures are not deemed necessary based on the outcome of the assessment of both noise ingress and ductwork. However, it is recommended that the duct work be fixed to the walls uses appropriate antivibration mounts to prevent structure borne noise becoming a concern.

10 Uncertainty

The sound level meter used in the site survey work and sound testing was calibrated before and after the survey in situ, without any significant drift having occurred, to ensure that the information and data being obtained was representative and that the sound level meter was operating correctly.

Background sound pressure levels have been measured over a number of days and deliberately included a weekend to properly understand the soundscape.

Spectral data was also obtained from the plant manufacturers to ensure that the ductwork calculations were as accurate as possible.

Environmental Health comments as Technical Consultees to the planning process were also reviewed and from this, site measurements were taken to ensure that the resident of 26A above remains protected from unwanted sound. Liaison with the upstairs resident of 26A meant that such testing could be carried out rather than reliance on modelling or suggested performance which further reduced uncertainty.

The BS4142:2014 assessment was also made for a worst-case assessment at Window 2. In reality, the closer the windows to Felpham Road, the higher the contribution of sound from passing traffic.

11 Conclusion

Background sound pressure levels were measured with a class 1 sound level meter over a number of days (including a weekend) at a position representative of the nearest residential receptor.

The background sound pressure levels were reviewed and calculated as being 45dB $L_{A90,15\text{minutes}}$ for the period of 08:00 hours to 22:00 hours when the flue is proposed to be in operation.

The Rating Level or $L_{A_{r,Tr}}$ for the nearest residential window is only marginally above the measured background sound pressure levels by 0.7dB which is not likely to be noticeable and therefore does not require any mitigation measures.

Sound insulation testing was also carried out to ensure that the resident in the flat above at 26A Felpham Road remains protected from internally generated patron noise. The $D_{nTw} + C_{tr}$ results of the tests were a minimum of 5dB(A) above the requirements of Approved Document E.

An assessment indicated that the concrete floor/ceiling partition provides good sound insulation properties and based on full capacity of the caffè, noise ingress will be below a reduced BS8233:2014 threshold to account for sounds which may have character, ie people noise.

Based on the assessment undertaken, planning permission should not be withheld on noise grounds.

12 Appendix A – Duct Calculations

		63	125	250	500	1000	2000	4000	8000		distance to reception = r	
Enter Fan sound power (linear) or chose fan type:												
Fan outlet		43	55	60	61	65	64	58	49		r=	0.7
Silencer details		19952.62	316227.8	1000000	1258925	3162278	2511886	630957.3	79432.82	69.5		
Silencers		0	2	4	8	10	5	4	4			
Insertion loss per bend < 900 diamter circular duct width(mm) x Frequency(khz)		25.2	50	100	200	400	800	1600	3200		TABLE 4.24	
Number of bends	5	1	1	2	3	3	3	3	3		TABLE 4.24 Calc	
Insertion Loss all bends		5	5	10	15	15	15	15	15		TABLE 4.23	
Diameter	400											
Insertion loss per bend < 900 diamter circular duct		0.03	0.03	0.03	0.03	0.06	0.06	0.06	0.06		TABLE 4.19 cbse	
number of metres duct run	12.5											
Insertion loss for duct length		0.375	0.375	0.375	0.375	0.75	0.75	0.75	0.75			
Termination reflections		13	9	5	4	0	0	0	0		TABLE 4.26	
SWL radiated from discharge		24.6	38.6	40.6	33.6	39.3	43.3	38.3	29.3			
Directivity		3	3	3	3	3	3	3	3			
Radiating Free space Hih level discharge at dist r	SPL	17	31	33	26	31	35	30	21			
Barrier Calcs		0.0	0.0	0.0	11.02496	13.86028	16.78038	19.74486	22.73207			
A w		0	0	0	0	0	0	0	0			
A-Weighted SPL		20	34	36	18	20	22	14	2		Total SPL	
		93.82183	2356.698	3735.115	58.85837	111.886	143.4717	22.92544	1.450764		38.14529	
											6524.227	
Vert section												
Insertion loss per bend < 900 diamter circular duct		0.03	0.03	0.03	0.03	0.06	0.06	0.06	0.06			
Number of bends	2	1	1	2	3	3	3	3	3			
Insertion Loss all bends		2	2	4	6	6	6	6	6		W	0.4
Directivity											L	12.5
Insertion loss per m of duct		0.03	0.03	0.03	0.03	0.06	0.06	0.06	0.06		H	0.4
number of metres duct run	2.7											
Insertion loss for duct length		0.081	0.081	0.081	0.081	0.162	0.162	0.162	0.162			
		3.147097	3.147097	3.147097	3.147097	3.147097	3.147097	3.147097	3.147097			
Sw/Sd		2.064	2.064	2.064	2.064	2.064	2.064	2.064	2.064			
Lw Duct (SWLo)		40.919	50.919	51.919	46.919	48.838	52.838	47.838	38.838			
Duct SRI (R)		3	8	14	20	26	32	38	40			
swlb = swld-R+10log(Sw/Sd)	Lw breakout (SWLa)	41.1	46.1	41.1	30.1	26.0	24.0	13.0	2.0			
swlb never greater than swld-3	SWLa - 3	37.919	47.919	48.919	43.919	45.838	49.838	44.838	35.838			
Pick SWLa or SWLo -3 which ever is lower		37.9	46.1	41.1	30.1	26.0	24.0	13.0	0.0		Total SPL	
											35.25	
		25	33	28	17	13	11	0	-13		3349.655	
barrier		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		Duct distance to recpetor	1.7
Aw		0	0	0	0	0	0	0	0			
		25	33	28	17	13	11	0	-13			
		339.627	2216.725	700.99	55.68162	21.75764	13.72814	1.090465	0.054841			

		63	125	250	500	1000	2000	4000	8000		distance to reception = r	
Enter Fan sound power (linear) or chose fan type:												
Fan outlet		43	55	60	61	65	64	58	49		r=	2.47
Silencer details		19952.62	316227.8	1000000	1258925	3162278	2511886	630957.3	79432.82	69.5		
Silencers		0	2	4	8	10	5	4	4			
Insertion loss per bend < 900 diameter circular duct width(mm) x Frequency(khz)		25.2	50	100	200	400	800	1600	3200		TABLE 4.24	
Number of bends	5	1	1	2	3	3	3	3	3		TABLE 4.24 Calc	
Insertion Loss all bends		5	5	10	15	15	15	15	15		TABLE 4.23	
Diameter	400											
Insertion loss per bend < 900 diameter circular duct		0.03	0.03	0.03	0.03	0.06	0.06	0.06	0.06		TABLE 4.19 cbse	
number of metres duct run	12.5											
insertion loss for duct length		0.375	0.375	0.375	0.375	0.75	0.75	0.75	0.75			
Termination reflections		13	9	5	4	0	0	0	0		TABLE 4.26	
SWL radiated from discharge		24.6	38.6	40.6	33.6	39.3	43.3	38.3	29.3			
Directivity		3	3	3	3	3	3	3	3			
Radiating Free space Hih level discharge at dist r	SPL	6	20	22	15	20	24	19	10			
Barrier Calcs		0.0	0.0	26.39906	24.71909	26.1164	26.89239	25.89862	23.19983			
A w		0	0	0	0	0	0	0	0			
A-Weighted SPL		9	23	-2	-7	-3	1	-4	-10		Total SPL	
		7.535396	189.2806	0.687385	0.201928	0.534523	1.122968	0.446421	0.104622		23.00843	
											199.9138	
Vert section												
Insertion loss per bend < 900 diameter circular duct		0.03	0.03	0.03	0.03	0.06	0.06	0.06	0.06			
Number of bends	2	1	1	2	3	3	3	3	3			
Insertion Loss all bends		2	2	4	6	6	6	6	6		W	0.4
Directivity											L	12.5
Insertion loss per m of duct		0.03	0.03	0.03	0.03	0.06	0.06	0.06	0.06		H	0.4
number of metres duct run	2.7											
insertion loss for duct length		0.081	0.081	0.081	0.081	0.162	0.162	0.162	0.162			
											5 Sd (cross se	
											10.32 Sw Surface	
		3.147097	3.147097	3.147097	3.147097	3.147097	3.147097	3.147097	3.147097			
Sw/Sd		2.064	2.064	2.064	2.064	2.064	2.064	2.064	2.064			
Lw Duct (SWLo)		40.919	50.919	51.919	46.919	48.838	52.838	47.838	38.838			
Duct SRI (R)		3	8	14	20	26	32	38	40			
swlb = swld-R+10log(Sw/Sd)	Lw breakout (SWLa)	41.1	46.1	41.1	30.1	26.0	24.0	13.0	2.0			
swlb never greater than swld-3	SWLa - 3	37.919	47.919	48.919	43.919	45.838	49.838	44.838	35.838			
Pick SWLa or SWLo - 3 which ever is lower		37.9	46.1	41.1	43.9	26.0	24.0	13.0	0.0		Total SPL	
											45.71679	
											37297.48	
barrier		34	43	38	40	22	20	9	-4		Duct distance to recpetor	0.6
Aw		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
		0	0	0	0	0	0	0	0			
		34	43	38	40	22	20	9	-4			
		2726.45	17795.38	5627.392	10854.19	174.6655	110.2065	8.754013	0.440248			