Sound Insulation Scheme

Project No: PA266

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1. Summary

A noise assessment has been undertaken for the proposed extension of The Leek Veterinary Clinic at 80 Broad Street. The assessment considers noise transmission through the shared ceiling partition into the apartment above, and through the partition wall to the adjoining residential dwelling at 76 Broad Street.

The primary noise sources associated with the veterinary clinic are the barking of dogs and a surgical dental kit with a compressor. Representative noise data and manufacturer information have been used to predict likely internal noise levels during operational hours.

The existing ceiling was acoustically modelled and was found to be inadequate, with resultant noise levels exceeding the target criteria by 2.2 dB. An enhanced specification has therefore been provided. The existing wall partition was found to provide sufficient insulation. A specification for the wall surrounding the stairwell has also been provided to ensure the stairwell does not act as a flanking path for sound toward the first-floor dwelling.

With the recommended alterations in place the target criteria stipulated by Staffordshire Moorlands Council would be met, ensuring the amenity of residents is not compromised.

2. Criteria

The following criteria have been stipulated by Staffordshire Moorlands Council.

Noise levels within adjoining residential dwellings are not to exceed:

- 35 dB L_{Aeq} in bedrooms (07:00 – 23:00)
- 30 dB L_{Aeq} in bedrooms (23:00 – 07:00)
- 40 dB L_{Aeq} in living areas (07:00 – 23:00)

The first-floor residential dwelling is understood to be a studio-type apartment and therefore bedroom levels must be maintained. The adjoining residential dwelling to the east is assumed only to have living areas on ground floor. No night-time operation is proposed by the veterinary clinic.

The target noise levels for the assessment are therefore as follows:

- 35 dB L_{Aeq} within first-floor apartment
- 40 dB L_{Aeq} within ground floor adjoining dwelling

3. Source Noise Levels

3.1. Noise Sources Under Investigation

Following liaison with the client it has been determined that the following noise sources will be present within the veterinary centre:

- Surgical drill used for dental surgery
- Barking of dogs – this can typically occur when dogs regain consciousness after being under anaesthetic.

3.2. Assumed Noise Levels

3.2.1. Dog Barks

Noise levels of dogs can vary greatly with breed, however on average a noise level of 100 dB is reported [1], with frequency characteristics shown in Figure 1 below.

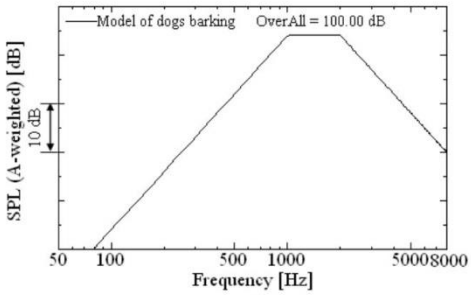


Figure 1: Frequency characteristics of a dog barking

To obtain frequency band noise levels, the reference curve above is increased until the sum of all octave bands reaches 100 dBA. The resultant octave band noise levels are shown in Table 1 below.

Table 1: Octave Band Noise Levels of a Single Dog Bark

1/1 Octave Frequency Band, Hz	63	125	250	500	1000	2000	4000	Total dB(A)
Reference Curve, dB(A)	N/A	-40	-23	-10	0	0	-13	-
Normalised to 100 dB(A)	N/A	56.7	73.7	86.7	96.7	96.7	83.7	**100**

Because the sound of dogs barking would occur in intermittent bursts rather than continuously, it is necessary to apply an on-time correction to the noise levels in order to estimate the L_{Aeq} noise level over a given period of time.

For the assessment, continuous dog barking is considered to occur for 60 seconds out of each hour. If a single bark lasts 1 second, the assessment therefore considers a worst-case scenario of 60 individual barks each hour. An $L_{Aeq,1hour}$ of 82.3 dB is derived below:

$$L_2 = L_1 + 10Log(\frac{T_1}{T_2})$$

$$82.3\ dB\ L_{Aeq} = 100 + 10Log(\frac{1}{60})$$

This correction is applied to all octave bands. The resultant spectra is shown in Table 2 below.

Table 2: On-time Corrected Noise Levels for Barking of Dogs

1/1 Octave Frequency Band, Hz	63	125	250	500	1000	2000	4000	Total
On-time Corrected Noise Levels, dBA	N/A	38.9	55.9	68.9	78.9	78.9	65.9	**82.3**
On-time Corrected Noise Levels, dBZ	N/A	55.0	64.5	72.1	78.9	77.7	64.9	**82.0**

3.2.2. Surgical Equipment

The equipment to be used is a *VETair Mobile Dental Unit & Scaler Kit*. Manufacturer specifications are shown below:

Technical Specifications:

- Dimensions: 78x57x43cm HWD
- Weight: 52kg
- Power: 40v AC, 50/60hz, 3.6 Amp, 500W
- Compressor Output: 78LPM Displacement
- Volume: 55 dB(A)
- Reservoir Capacity: 15 Litres

Source: http://www.burtonsveterinary.com/

It is unknown whether the quoted noise level of 55dB(A) describes Sound Power Level or Sound Pressure Level and the frequency content of the sound is not given. In order to ensure the assessment accounts for a worst-case scenario, 55 dB L_{pA} at 1m is assumed to be generated in each Octave Band from 63Hz – 4kHz. The assumed spectra is shown below:

Table 3: Assumed Noise Levels of Surgical Equipment

1/1 Octave Frequency Band, Hz	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**
Surgical Equipment Noise Level	55.0	55.0	55.0	55.0	55.0	55.0	55.0

No on-time correction is applied to the surgical equipment as it assumed that it could be in use for long periods of time.

3.2.3. Total Internal Noise Level

The total, unweighted, internal noise levels in the extended area of the veterinary centre are shown below:

Table 4: Total Unweighted Internal Noise Levels

1/1 Octave Frequency Band, Hz	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**
Dog Barking, dB L_{eq}	-	55.0	64.5	72.1	78.9	77.7	64.9
Surgical Equipment Noise Level, dB L_{eq}	55.0	55.0	55.0	55.0	55.0	55.0	55.0
TOTAL, dB L_{eq}	55.0	58.0	65.0	72.2	78.9	77.7	65.3

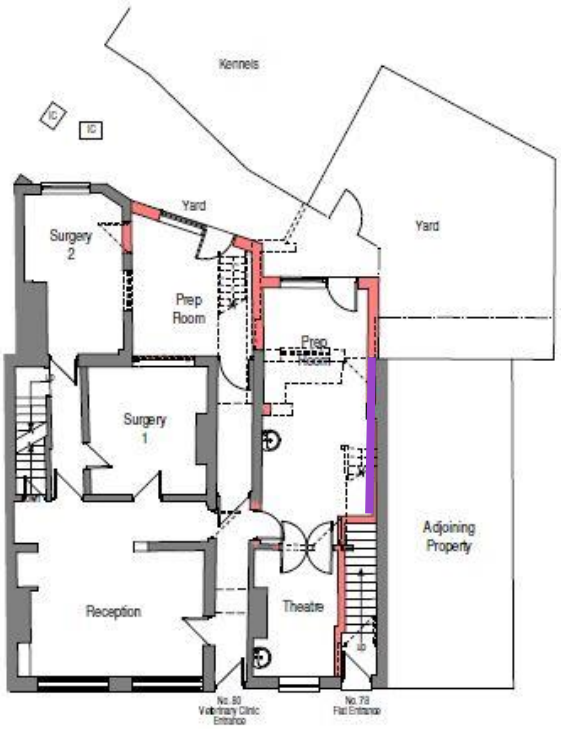
4. Noise Ingress to Residential

4.1. Existing Building Insulation

The existing construction details of the building are shown in Table 5 below:

Table 5: Existing Partition Details

Partition	Approx. Shared Area, m^2	Existing Construction Details
Wall Partition to Ground Floor Adjoining Dwelling	8.8	Half-brick wall of minimum 70mm thickness
Ceiling Partition to First Floor Dwelling	14	190mm partition 22mm Floorboards, timber joists and plasterboard to underside



Ground Floor Plan

First Floor Plan

4.2. Noise Levels within Adjoining Dwellings

With no further sound insulation added, the noise levels shown in Table 6 below would be achieved within the adjoining dwellings:

Table 6: Noise Levels with Existing Insulation

Zone	Noise Level Achieved, dB $L_{Aeq,1hr}$	Criteria, dB L_{Aeq}	Difference
Ground Floor Living Room	38.9	40	-1.1
First-Floor Studio	37.2	35	+2.2

It is demonstrated that the target criteria is exceeded by 2.2 dB within the first-floor apartment. Mitigation is therefore required and is detailed in **Section 5**.

5. Mitigation

5.1. Sound Insulation Scheme

Recommended partition specifications are shown in Table 7. A specification for the wall surrounding the stairwell has also been included which will ensure the stairwell does not act as a flanking path for sound travelling toward the first-floor dwelling.

Table 7: Enhanced Specifications

Partition	Enhanced Specification
Ceiling Partition to First-Floor Residential	• Existing Floorboards • Existing Cavity with new 100mm Rockwool Insulation (minimum density 48kg/m^3) • 1 x 12.5mm SoundBloc • 1 x 12.5mm Plasterboard
Existing Ground Floor Brick Wall	No Enhancements Necessary
Wall Surrounding Stairwell	• 100mm Timber Stud Wall with 60mm fibreglass in cavity and single layer 12.5mm plasterboard on both sides. **Note**: a concrete block wall of 100mm thickness would also provide adequate sound insulation.

5.2. Mitigated Noise Levels within Adjoining Dwellings

With the recommended specifications in place, the noise levels shown in Table 8 would be achieved. Full calculations are shown in **Appendix A**.

Table 8: Noise Levels with Enhanced Insulation

Zone	**Noise Level Achieved, dB $L_{Aeq,1hr}$**	**Criteria, dB L_{Aeq}**	**Difference**
Ground Floor Living Room	38.9	40	-1.1
First-Floor Studio	32.2	35	-2.8
In Stairwell	34.6	40	-5.4

It is demonstrated that the recommended enhancements would ensure the target criteria were met in all cases.

Appendix A – Noise Ingress Calculations

The following noise break-out formula is used to predict noise egress from one space to another (Watson, et al, in *The Little Red Book of Acoustics*, 3rd Edition, p111):

$$L_{ext} = L_{int} - SRI + 10\log(S/A), \text{ dB}$$

- *L_{ext}: The noise level at the NSR;*
- *L_{int}: The noise level within the Veterinary Centre;*
- *-SRI: The sound reduction of the wall partitions;*
- *S: The surface area of the partition shared with the receiving room;*
- *A: The equivalent absorptive area within the room;*

Noise Ingress to First-Floor Residential (With Enhanced Specification)

	63	125	250	500	1k	2k	4k
Source	55.0	58.0	65.0	72.2	78.9	77.7	65.3
R1 Ceiling	15.0	19.0	38.0	45.0	49.0	53.0	57.0
R2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
R3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Comp R	-15.0	-19.0	-38.0	-45.0	-49.0	-53.0	-57.0
Breakin	39.4	38.4	26.4	26.6	29.3	24.1	7.7
A-Weighting	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0
	13.2	22.3	17.8	23.4	29.3	25.3	8.7

Breakout Sum LA	32.2

S1 Ceiling	14		
S2	0	Noise Source dBZ	82.1
S3	0		
S Total	14		
S Facing NSR	14		
Absorptive Area	16.1		

Noise Ingress to Ground Floor Residential (With Existing Wall to be Unchanged)

	63	125	250	500	1k	2k	4k
Source	55.0	58.0	65.0	72.2	78.9	77.7	65.3
R1 Wall	32.0	36.0	37.0	32.0	40.0	48.0	55.0
R2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
R3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Comp R	-32.0	-36.0	-37.0	-32.0	-40.0	-48.0	-55.0
Breakin	20.4	19.4	25.4	37.6	36.3	27.1	7.7
A-Weighting	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0
	-5.8	3.3	16.8	34.4	36.3	28.3	8.7

Breakout Sum LA	38.9

S1 Ceiling	8.8		
S2	0	Noise Source dBZ	82.1
S3	0		
S Total	8.8		
S Facing NSR	8.8		
Absorptive Area	16.0		

Noise Ingress to Stairwell with Recommended Specification

	63	125	250	500	1k	2k	4k
Source	55.0	58.0	65.0	72.2	78.9	77.7	65.3
R1 Wall	14.0	13.0	28.0	39.0	46.0	51.0	44.0
R2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
R3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Comp R	-14.0	-13.0	-28.0	-39.0	-46.0	-51.0	-44.0
Breakin	38.4	42.4	34.4	30.6	30.3	24.1	18.7
A-Weighting	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0
	12.2	26.3	25.8	27.4	30.3	25.3	19.7

Breakout Sum LA	34.6

S1 Ceiling	6.6		
S2	0	Noise Source dBZ	82.1
S3	0		
S Total	6.6		
S Facing NSR	6.6		
Absorptive Area	12.0		

Appendix B – Insul™ Models

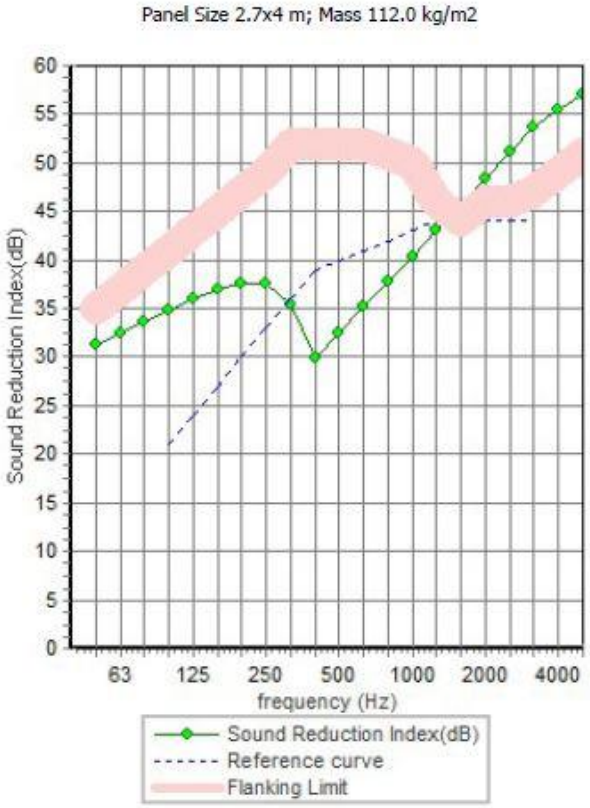
PARTITION WALL – EXISTING

Rw	40 dB
C	-1 dB
C_{tr}	-3 dB
D_{nTw}	42 dB [V:50m3] [A:11m2]

System description

Panel 1 : 1 x 70.0 mm Brick (ρ:1600 kg/m3,E:8.9GPa,η:0.01)

frequency (Hz)	R(dB)	R(dB)
50	31	
63	32	32
80	34	
100	35	
125	36	36
160	37	
200	38	
250	38	37
315	35	
400	30	
500	33	32
630	35	
800	38	
1000	40	40
1250	43	
1600	46	
2000	48	48
2500	51	
3150	54	
4000	55	55
5000	57	



PARTITION CEILING – EXISTING

Rw	41 dB
C	-4 dB
C_{tr}	-12 dB
D_{nTw}	43 dB

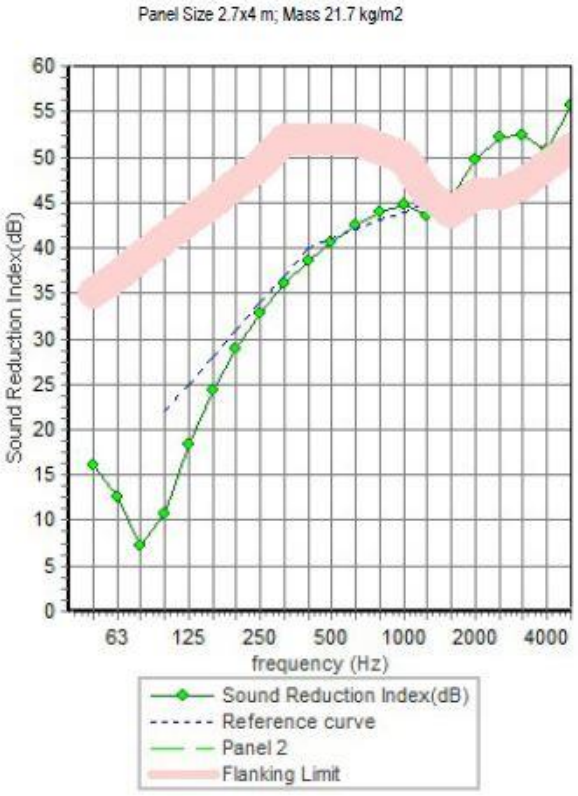
System description

Panel 1 : 1 x 22.0 mm Particle Board (ρ:660 kg/m3,E:2.7GPa,η:0.03)

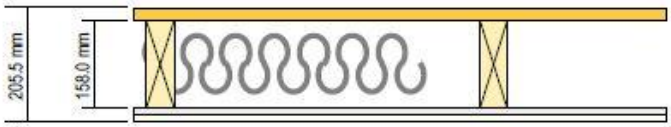
Cavity: Solid joist(timber or Twinaplate): Stud spacing 600 mm
Panel 2 + 1 x 10.0 mm mm Plasterboard (ρ:710 kg/m3,E:2GPa,η:0.01)

Mass-air-mass resonant frequency =67 Hz

frequency (Hz)	R(dB)	R(dB)
50	16	
63	13	10
80	7	
100	11	
125	18	15
160	24	
200	29	
250	33	32
315	36	
400	39	
500	41	40
630	42	
800	44	
1000	45	44
1250	44	
1600	46	
2000	50	48
2500	52	
3150	52	
4000	51	53
5000	56	



PARTITION CEILING – ENHANCED SPECIFICATION



Rw	47 dB
C	-5 dB
C_{tr}	-13 dB
D_{nTw}	49 dB

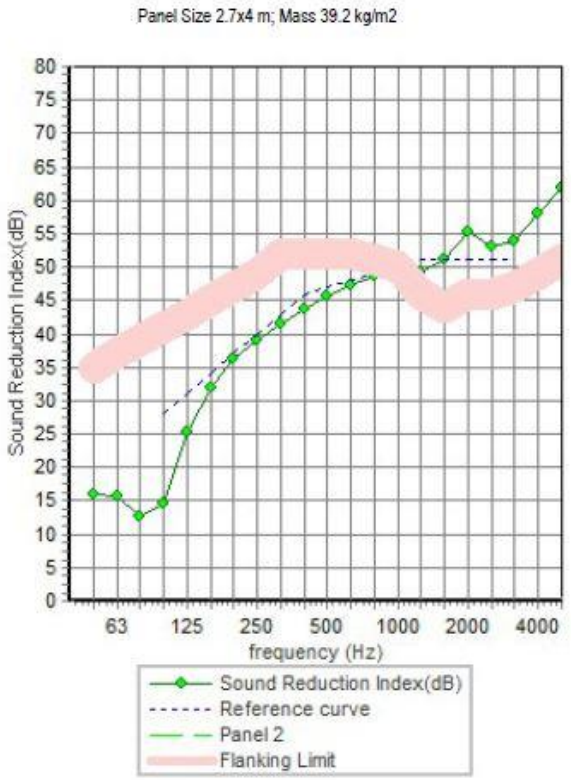
System description

Panel 1 : 1 x 22.0 mm Particle Board (ρ:660 kg/m3,E:2.7GPa,η:0.03)

Cavity: Solid joist(timber or Twinaplate): Stud spacing 600 mm , Infill Rockwool (48kg/m3) Thickness 100 mm (ρ:48 kg/m3, Rf:19400 Pa.s/m2)
Panel 2 + 1 x 12.5 mm Gyproc SoundBloc 12.5mm (ρ:848 kg/m3,E:3.8GPa,η:0.01) + 1 x 13.0 mm mm Plasterboard (ρ:710 kg/m3,E:2GPa,η:0.01)

Mass-air-mass resonant frequency =44 Hz

frequency (Hz)	R(dB)	R(dB)
50	16	
63	16	15
80	13	
100	15	
125	25	19
160	32	
200	36	
250	39	38
315	42	
400	44	
500	46	45
630	47	
800	49	
1000	50	49
1250	49	
1600	51	
2000	55	53
2500	53	
3150	54	
4000	58	57
5000	62	



STAIRWELL PARTITION WALL – SPECIFICATION

Rw	38 dB
C	-4 dB
C_{tr}	-11 dB
D_{nTw}	40 dB

System description

Panel 1 : 1 x 10.0 mm mm Plasterboard (ρ:710 kg/m3,E:2GPa,η:0.01)

Cavity: Timber stud: Stud spacing 600 mm , Infill Fibreglass (10kg/m3) Thickness 60 mm (ρ:10 kg/m3, Rf:4000 Pa.s/m2)
Panel 2 + 1 x 10.0 mm mm Plasterboard (ρ:710 kg/m3,E:2GPa,η:0.01)

Mass-air-mass resonant frequency =90 Hz

frequency (Hz)	R(dB)	R(dB)
50	14	
63	14	14
80	14	
100	10	
125	14	13
160	20	
200	25	
250	30	28
315	33	
400	37	
500	40	39
630	43	
800	45	
1000	47	46
1250	49	
1600	50	
2000	51	51
2500	51	
3150	49	
4000	41	44
5000	46