10/0263/FULL

Acoustic Associates Sussex Ltd

Measurement of Existing Traffic Noise Levels & Assessment of Plant Machinery Noise

Site: **27 Chapel Road, Worthing**
Client: **Hardwick Hartley Partnership**

Report by: Pradeep Mistry BSc(Hons) MSc AMIOA
Revised by: Peter Attwood BSc(Hons) MSc MCIOB MIOA MIDiagE
Reference Number: MG/2250/05/12

Date: 09/05/2012

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1.0 Introduction and Executive Summary

1.1 Acoustics Associates Sussex Ltd has been appointed to:

- Assess the acoustic design of current site
- Measure existing traffic noise levels at 27 Chapel Road, Worthing
- Measure noise levels of existing plant machinery
- Compare noise level predictions with relevant standards/criteria
- Ensure that internal noise levels stated in WHO can be achieved within bedrooms and lounges

1.2 27 Chapel Road are currently offices, they are to be refurbished and converted into four one bedroom flats. Two flats are proposed on the first floor, while the remaining two flats are on separate floors. The ground floor is currently used as a restaurant and is proposed to continue to serve as a restaurant.

1.3 This report provides the results summary of measurements of existing traffic noise levels (L_{A10}) at one location taken overlooking Chapel Road, Worthing.

1.4 The background noise level (L_{A90}) measured along Chapel Road was 55 dB(A).

1.5 Noise from the kitchen extract plant is assessed and a sound attenuating enclosure is proposed which will reduce plant noise levels outside habitable room windows on the rear of the property.

1.6 It is proposed that a Mechanical Ventilation and Heat recovery (MVHR) System be installed to provide ventilation for the flats and improve their sustainability rating. This will also avoid the need for opening windows to achieve ventilation and thereby allow the full sound insulation properties of glazing to be achieved.

1.7 A secondary glazing unit is proposed for windows facing either onto Chapel Road or overlooking the extract system serving the ground floor kitchen.

1.8 The combination of the above measures is shown in the report to achieve the acceptability criteria set by the Local Authority, which are in turn based upon those set by the World Health Organisation (WHO) and BS8233: 1999: *Sound insulation and noise reduction for buildings – Code of Practice*

2.0 Context and Noise Criteria

2.1 Internal Noise Levels

The target internal levels are based on guidelines laid out by the World Health Organisation (WHO) and are as follows:

Room Type	Target Internal Level – $L_{eq,T}$ dB (A)
Living Room	35 (Daytime only)
Bedroom	30 (Night)

The target internal noise level for a bedroom during the night time corresponds to the threshold of sleep disturbance. Internal noise levels of 30dB (A) and above are likely to cause sleep disturbance.

The target internal noise level for bedrooms and living rooms during the day time for a reasonable standard is set to 35dB(A). When the internal noise levels exceed 35dB (A) speech intelligibility levels of the occupants will be reduced.

2.2 BS 8233:1999 - Sound Insulation and Noise Reduction for Buildings

BS8233:1999 states the following indoor ambient noise levels within spaces that are unoccupied as follows:

Criterion	Typical Situations	Design Range $L_{eq,T}$ dB (A)	
		Good	Reasonable
Reasonable resting/sleeping conditions	Living rooms	30	40
	Bedrooms	30	35

2.3 Local Environment Health External Criterion

The Local Council has stipulated that noise levels must broadly adhere to those specified in paragraphs 2.1 and 2.2.

3.0 Noise Survey Baseline Conditions and Results

3.1 Site: 27 Chapel Road, Worthing

3.2 Survey Engineer: Pradeep Mistry BSc (Hons) MSc AMIOA

3.3 Survey Date; 09/09/2010

3.4 Equipment used:

- Norsonic Nor118 Type 1, Integrating-averaging sound level meter
- Wind Shield
- Castle GA607 Class 1 Acoustic Calibrator
- Tripod

The meter was calibrated before commencing the noise measurements (@94dB). The calibration was re-checked at the end of the measurements to ensure that no calibration drift had occurred. After survey the calibration showed no significant drift (94dB)

3.5 Weather condition

- Dry
- Wind speed average less than $5ms^{-1}$

3.6 Free field Adjustment

All measurements were taken at 4.5m (approximately) from the ground level and 1m from the nearest façade. Taking in to account the microphone location it follows that all measurements at this location are façade level measurements and therefore a 3dB correction will be applied.

3.7 Microphone Positions

- Front Façade (Chapel Road)
  The meter was placed within the proposed lounge on the Chapel Road façade with the microphone on an extension lead. The microphone was positioned using an extension pole 1 metre outside a 1st floor window which overlooked Chapel Road.

- Rear Façade
  Measurements were taken from the rear of the property outside a window on the 2nd floor. This position was chosen as access via other windows and doors were either nailed shut or keys were unobtainable for the rear door. Microphone was approximately 3m from the extract fan.

3.8 Supplementary Noise Survey; 2nd May 2012

A further measurement of noise levels from the extract fan and associated ductwork was undertaken on 2nd May 2012 to confirm casing breakout noise levels for the fan. The purpose of this later exercise was to allow accurate prediction of the attenuation effects of a proposed noise enclosure for the fan unit.

The supplementary survey was conducted by Peter Attwood BSc(Hons) MSc MCIOB MIOA MIDiagE

3.9 Measurement Details/Results - Front Façade

Road noise was measured between 11:55 – 13:55 hrs. At the time of the survey all of the existing plant machinery was switched off and the restaurant was closed. The measurement results can be found in the table below:

Measurement Type	Measurement Time	Measurement Duration	L_{A90} dB (A)	L_{A10} dB(A)
Road Noise	11:55	1 Hour	55	67
Road Noise	12:55	1 Hour	55	67
Road Noise	13:55	1 Hour	54	69

Figure 1 – Noise Measurement Table

For completeness the background noise levels were also measured and are stated in the table above. Background noise level, $L(A)_{90,T}$ is the A-weighted sound pressure level of the residual noise at the assessment position that is exceeded for 90 % of a given time interval, T.

3.10 Measurement Details/Results - Rear Façade – 09/09/2010

Three 5 minute measurements were made outside the rear façade of the building. During the measurements the kitchen extract system was operating. For the three measurements the noise level emitted from the extract was fairly constant. The worst case measurement results can be found in the table below:

Measurement Type	Measurement Time	Measurement Duration	L_{A90} dB(A)	L_{Aeq} dB(A)
Extract Fan @ 3m	16:19	5 Mins	60.9	61.4

3.11 Measurement Results - Rear Façade – 02/05/2012

Measurement Type	Measurement Time	Measurement Duration	L_{A90} dB(A)	L_{Aeq} dB(A)
Extract Fan @ 1m	13:13	5 Mins	69.8	70.3

4.0 Calculation of External Noise Levels (Front Façade)

4.1 Calculation of Road Traffic Noise (CRTN) – Shortened form Measurement Method/Result

Road traffic noise was measured for three consecutive hours between 11:55 and 13:55 on the 09/09/2010. The calculation of road traffic (CRTN) shortened form measurement method (Section III, Para 43) was used to calculate the free field L_{10} 18 Hour:

Using L_{10} (3 Hour) as the arithmetic mean of the three consecutive values of hourly L_{10}, the current value of L_{10} (18 Hour) can be calculated from the following (The measured façade level was 68 dB(A), this requires a 3dB correction due to the effects of façade reflections, to convert façade levels to free-field levels):

Therefore 68dB – 3dB = 65 dB(A) (Free-field)

L_{10} (18 Hour) = L_{10} (3 Hour) – 1 dB

L_{10} (18 Hour) = 65dB – 1dB = 64 dB(A) (Free-field)

PPG24 States that the L_{Aeq} 16 Hour is approximately 2dB less then the L_{10} (18 Hour).

Therefore - Free Field L_{Aeq}, 16 Hours = 62 dB(A)

4.2 Club/Pub bar noise

There are a number of pubs and bars along Chapel Road. The lounges in the proposed flats overlook Chapel Road which are subject to noise during the night. It is unlikely noise emanating from people that leave the pubs/bars at night will have a significant effect on noise levels within bedrooms as they are located at the rear of each flat.

A typical sound pressure level of 1 person shouting is 80 dB(A) at 1m (BB93 Page 53 Figure 4.3).

Predicted SPL at nearest noise sensitive window = SPL at reference position – 20Log(r2/r1)

r2 = Distance between the person and proposed 1st floor lounge window (5m)

r1 = Reference distance from person shouting, i.e 1m

SPL at nearest noise sensitive window = SPL at measurement position – 20Log(5/1)

80 – 20log (5/1)

80 – 14 = 66 dB(A)

SPL at nearest noise sensitive window = 66 dB(A)

The calculation predicted that the free field noise level 1m from the nearest façade will be: 66 dB(A) outside the proposed 1st floor lounge window. The façade level will be 66 + 3 = 69 dB(A).

4.3 Summary

An open window will attenuate external noise levels by approximately 15dB(A). The existing sash windows will have an approximate Rw of 29 dB(A). and an Existing Rtra of 26 dB(A). Therefore the predicted noise levels are such that mitigation measures will be required as the noise criteria stated in section 2 will not be achieved even with the windows closed. Mitigation measures are discussed in detail in section 6.

5.0 Calculation of External Noise Levels (Rear Façade)

The ground floor is currently occupied by a restaurant which has a kitchen extract fan installed which runs along a roof at the rear of the property at first floor level. The proposed drawings show that the nearest affected residential property will be Flat 1 of 27 Chapel Road, Worthing.

The original measurement was taken from the rear of the property outside a window on the 2nd floor. This position was chosen as access via other windows and doors was not possible, these being either nailed shut or keys were unobtainable for the rear door.

Three sets of readings were taken and the worst-case measurement results can be found in the table below:

Measurement Type	Measurement Time	Measurement Duration	L_{A90} dB(A)	L_{Aeq} dB(A)
Extract Fan	16:19	5 Mins	60.9	61.4

To calculate the worst case external noise level a distance correction is required.

5.1 Worst Case External Noise Level (due to plant noise)

Noise level at 3m (approximately) from kitchen extract duct = 61 dB(A)

SPL at nearest noise sensitive window = SPL at measurement position – 20Log(r2/r1)

r2 = Distance between the kitchen extract fan and nearest noise sensitive window (1m)

r1 = Distance between measurement position and kitchen extract fan (3m)

SPL at nearest noise sensitive window = SPL at measurement position – 20Log(1/3)

SPL at nearest noise sensitive window = 71 dB(A)

5.2 Summary

An open window will attenuate external noise levels by approximately 15dB(A). The existing sash windows will have an approximate Rw of 29 dB(A). Therefore the predicted noise levels are such that mitigation measures will be required as the noise criteria stated in section 2 will not be achieved even with the windows closed. Mitigation measures are discussed in detail in the next section.

6.0 Summary of Proposed Noise Mitigation Measures

6.1 Glazing

Because the sound insulation of a window (and other components of the building envelope) varies with the frequency (or pitch) of the sound, the overall noise reduction provided by a window will depend, among other factors, on the spectrum of the external noise.

The construction of the facades will not be altered during the conversion and the current build of the external facade is blockwork. Calculations show that natural ventilation (opened windows) cannot be an option as the noise criteria will not be achieved.

6.2 Proposed Glazing

It is recommended that secondary sash windows are installed to the proposed lounges facing Chapel Road. These should be mounted in a separate frame from that for the existing glazing, with a void depth between the two sets of panes of 100mm. The secondary panes should be of thickness at least 30% greater than the primary glazing. A check should be made on the thickness of the glass used in the primary glazing to facilitate this, e.g. if the primary panes are of 4mm thickness then the secondary panes should be 6mm thick (probably of laminated glass for security and safety).

The reveals of the window opening should be lined with acoustically absorbent material. Cut-down acoustic ceiling tiles are frequently used for this purpose. Alternatively, the linings could be of self-coloured soft fibreboard or of perforated board with a mineral fibre layer beneath. The provision of absorbent linings in the reveals will benefit the overall attenuation performance by around 3dB, compared to the non-lined case.

6.3 Ventilation System

It is understood that heat recovery ventilation units are to be fitted to all apartments within the development. The correct heat recovery system will enable fresh air to be supplied to habitable rooms. The MVHR System proposed is the Vent-Axia HR250 Heat Recovery System.

For the apartments situated on the front façade the heat recovery system will have the outlet terminals positioned on the roof. Additional noise can enter the outlet and radiate within the flats; if the outlets are positioned away from the road, noise levels entering the outlet will not have a significant effect in habitable rooms.

The use of such an MVHR System (Mechanical Ventilation and Heat Recovery) will allow the full sound attenuation properties of the closed windows to be obtained, while ensuring adequate ventilation for residents.

6.4 Commercial Kitchen Extract System

In order to reduce the noise levels emitted by the extract fan (casing breakout levels), affecting the closest residential window, it is proposed to build an acoustic enclosure around the extract fan unit. Details of the proposed construction of the enclosure are included in the appendix to this document. It is anticipated that the installation of the enclosure will reduce noise levels from the casing breakout and associated ductwork by around 20dB outside the residential window.

This would reduce casing breakout and duct noise levels to around 51dB(A) externally to the bedroom window. With an MVHR System and secondary glazing in place, it is anticipated that internal noise levels in the bedroom resulting from the operation of the extract system will be 20dB(A) or less.

7.0 Calculation of internal Noise Levels

7. 1 BS8233 Calculation (Rigorous)

Calculations have been carried out for both the proposed lounge and bedroom (worst case) using the BS8233 rigorous calculations of noise break in. The rigorous noise break in calculation method used is shown in appendix 1. The calculation was completed, in each case, by adjusting the frequency spectra to match the measured/predicted levels detailed in sections 4.1 & 5.1. The calculation has been completed assuming secondary sash windows are provided as follows:

- Secondary sash glazing would consist of 6mm glass at least 100mm from existing glazing. Acoustic seals should be fitted to the secondary sash and existing. Acoustically-absorbent linings should be provided to the window reveals between the primary and secondary glazing.

It also assumes the installation of an MVHR System to enable ventilation of residential units to be achieved without the need to open windows.

7.2 Internal Noise Level Lounge (front façade)

The calculation shows that with an external façade traffic noise level of 65dB(A) and 6/100/4 glazing providing R_{TRA} 37dB(A) (source: Pilkington Glass), the daytime internal noise level for a typical first floor lounge would be approximately 28 dB(A). This noise level meets the criterion as stated in the WHO guidelines for a lounge (max 35dB(A) and also satisfies the "Good" BS8233 maximum noise level criterion.

7.3 Internal Noise Level Rear Facade

With the MVHR System and secondary glazing in place and the acoustic enclosure installed around the extract fan unit, the calculation shows that the internal noise level for the first floor lounge or bedroom will be less than 20dB(A). This noise level achieves the WHO noise criteria for the avoidance of sleep disturbance. It also achieves the BS8233 'Good' rating for both bedrooms and lounges.

7.4 Internal Noise Level Due to People Shouting

With the Vent-Axia MVHR System and secondary glazing in place, the internal noise level would approximate to the external noise level predicted in section 4.2 minus the attenuation provided by the windows. According to Pilkington Glass, the 6/100/4 secondary glazing specification will provide Rw 46dB. Therefore the internal level, with a predicted external façade level of 69dB(A), would be approximately 23dB(A). This shows that the WHO target noise level would be achieved as well as the BS8233 'Good' rating.

8.0 Conclusion

8.1 Road Traffic Noise

Calculations show that noise level criteria within lounges and bedrooms will be met with the proposals for sound attenuation measures that have been made. This is based on installing 6mm secondary sash glazing (to create 6_100_4 configuration) and the Vent-Axia HR250 Mechanical Ventilation and Heat Recovery (MVHR) System.

8. 2 Pub/Bar Noise

Noise levels were calculated based on people leaving nearby pubs/bars. It was calculated that noise levels were below the maximum criteria stated by WHO and BS8233. However it should also be noted that the current drawings show that there are only lounges on the front façade. The bedrooms for each flat are at the rear of the property, so noise levels from people shouting for example are likely to inaudible within bedrooms on the rear facade.

8.3 Plant Machinery Noise

Section 5 calculated that the noise level would be 71 dB(A) at the nearest residential window with no other sound attenuation measures in place. For this reason, proposals have been put forward for a sound attenuating enclosure for the external fan unit. Details of the enclosure are included in the appendix to this document and it is anticipated that such an enclosure will provide around 20dB attenuation of the noise from the fan casing and nearby ductwork. The Local Authority has stated that such an enclosure would be visually acceptable taking into account other facades on the rear of Chapel Road.

Additionally, it is proposed to install secondary glazing and an MVHR System. The fan and associated ductwork are also to be mounted on anti-vibration mounts.

The calculations, as detailed in section 7.3 show that the levels stated in BS8233 and WHO will be achieved as the internal noise level is predicted to be below 20 dB(A) within the worst case bedroom.

8.4 General Conclusion

The report demonstrates that if the mitigation measures detailed in section 6 are completed noise levels within rooms on the front façade will achieve the relevant criteria.

The same mitigation measures to windows on the front façade and the MVHR System will provide adequate attenuation of noise from revellers leaving pubs or clubs at night.

The proposals for secondary glazing, the MVHR System and the noise enclosure for the external fan unit will ensure that noise levels in the habitable rooms at the rear of the property all fall within the criteria for acceptability set by the WHO and BS8233.

It is therefore considered that the proposals put forward for sound attenuation measures ensure that the criteria set by the Local Authority will be satisfied and all Planning requirements with respect to noise fulfilled.

Glossary

Terminology and extracts from BS4142 (Method for rating industrial noise affecting mixed residential and industrial areas (1997)) have been used in this report. For clarity a definition of certain terms can be found below:

- **Specific noise level,** *L*Aeq,*Tr*
  The equivalent continuous A-weighted sound pressure level at the assessment position produced by the specific noise source over a given reference time interval.

- **Measurement time interval,** *T*m
  The total time over which measurements are taken. NOTE. This may consist of the sum of a number of non-contiguous, short term measurement time intervals.

- **Rating level,** *L*Ar,*Tr*
  The specific noise level plus any adjustment for the characteristic features of the noise.

- **Ambient noise**
  Totally encompassing sound in a given situation at a given time usually composed of sound from many sources near and far.

- **Residual noise**
  The ambient noise remaining at a given position in a given situation when the specific noise source is suppressed to a degree such that it does not contribute to the ambient noise.

- **Residual noise level,** *L*Aeq,*T*
  The equivalent continuous A-weighted sound pressure level of the residual noise.

- **Background noise level,** *L*A90,*T*
  The A-weighted sound pressure level of the residual noise at the assessment position that is exceeded for 90 % of a given time interval, *T*, measured using time weighting, *F*, and quoted to the nearest whole number of decibels

- **Noise Rating,** *NR*
  Noise rating (NR) is a graphical method for assigning a single number rating to a noise spectrum. It can be used to specify the maximum acceptable level in each octave band of a frequency spectrum, or to assess the acceptability of a noise spectrum for a particular application. The method was originally proposed for use in assessing environmental noise, but it is now used in the UK mainly for describing noise from mechanical ventilation systems in buildings".

Appendices

BS8233 Calculation for Front Facade

Enter Values

A_e	10
S_t	8.17
S_{wi}	1.79
S_w	6.38
S_r	12.35
S	20.52
Glazing Type	6_100_4
Roof Type	Tiles on Felt, Pitched Roof, Plasterboard Ceiling

Noise Spectrum

Frequency Dependent Variables	Frequency - 125	250	500	1000	2000	4000	
Incident Sound Pressure on Façade - $L_{eq,t}$	79.3	73	78.7	67	63.1	63	Adj. Plant Noise Spectrum (free
Trickle Vents - $D_{n,e}$	100	100	100	100	100	100	
Windows - R_{wi}	26	34	44	56	53	52	6_100_4
Wall - R_{ew}	40	44	45	51	56	56	Brick/Block wall (from BS8233)
Roof - R_r	100	100	100	100	100	100	Tiles on Felt, Pitched Roof, Plast
Effective Absorbtion Area - A	10.6	10.6	10.6	10.6	10.6	10.6	< clacs to be added

Broadband $L_{eq,t}$	28.67408

36.4 withtrickievent
28.6 With no tricke vent

Key

A_e	10 (m^2)
S_t	Total Facade Area (m^2)
S_{wi}	Window Area (m^2)
S_w	External Wall Area (m^2)
S_r	Ceiling Area (m^2)
S	Total Area from which sound enters the room (m^2)
$D_{n,e}$	Insulation of Trickle Vent (BS EN 20140-10)
R_{wi}	Sound Reduction of Window (Octave Band)
R_{ew}	Sound Reduction Index of External Wall (Octave Band)
R_r	Sound Reduction Index of Roof/Ceiling (Octave Band)
A	Equivalent Absorbtion Area of Rx Room

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BS8233 Calculation Details
(extract from BS8233: 1999)

6.7.2 *Typical design problem — More rigorous calculation*

6.7.2.1 *The calculation method*

The calculation method used here is based on the method given in EN 12354-3.

NOTE Measurement methods for the insulation of façade elements are given in BS EN ISO 140-5, a laboratory test method for the insulation of small elements, such as trickle ventilators, is given in BS EN 20140-10, and a laboratory test method for the insulation of other elements is given in BS EN ISO 140-3.

The following equation, which gives the equivalent sound pressure level in the room, $L_{eq,2}$, should be evaluated for each frequency band of interest:

$$L_{eq,2} = L_{eq,ff} + 10\log_{10}\left(\frac{A_0}{S}10^{\frac{D_{n,e}}{10}} + \frac{S_{wi}}{S}10^{\frac{R_{wi}}{10}} + \frac{S_{ew}}{S}10^{\frac{R_{ew}}{10}} + \frac{S_{rr}}{S}10^{\frac{R_{rr}}{10}}\right) + 10\log_{10}\left(\frac{S}{A}\right) + 3 \quad (1)$$

where

$L_{eq,ff}$ is the equivalent continuous sound pressure level outside the room elements under consideration;

NOTE It is the free-field sound level, measured or estimated at the intended position of the element under consideration. It is related to the level $L_{eq,1}$ measured within a few millimetres of the actual façade by the relation: $L_{eq,ff} = L_{eq,1} - 6$, and to the level $L_{eq,2M}$ measured 2 m away from the façade by the relation $L_{eq,ff} = L_{eq,1} - 3$.

A_0 is a reference absorption area of 10 m^2 and is independent of frequency;

S_f is the total façade area of the room in question in square metres (m^2);

S_{wi} is the area in square metres (m^2) of the windows of the room;

S_{ew} is the area in square metres (m^2) of the external wall of the room;

S_{rr} is the area in square metres (m^2) of the ceiling of the room;

S is the total area of elements through which sound enters the room in square metres (m^2), i.e. $S_f + S_{rr}$;

$D_{n,e}$ is the insulation of the trickle ventilator measured according to BS EN 20140-10;

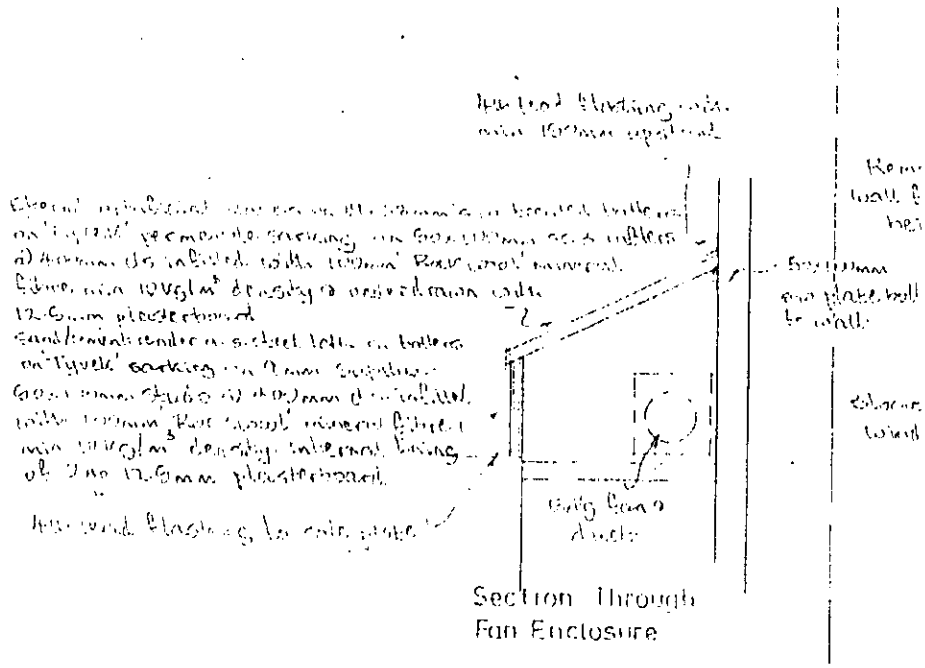
R_{wi} is the sound reduction index (octave band value) of the window (see annex C);

R_{ew} is the sound reduction index (octave band value) of the external wall (see annex C);

R_{rr} is the sound reduction index (octave band values) of the roof/ceiling (see annex C);

A is the equivalent absorption area of the receiving room being considered (see annex C).

Proposed Sound Attenuating Plant Enclosure



Section Through
Fan Enclosure

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Predicted performance of sound attenuation enclosure for plant:

Sound Insulation Prediction (v6.4.6)

INSUL

Program copyright Marshall Day Acoustics 2010

Acoustic Associates Sussex Ltd - Key No. 0379

Margin of error is generally within Rw +/- 3 dB

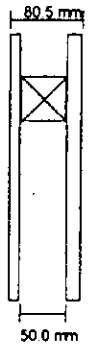
Job Name:

Notes:

Job No.: Page No.:

Date: 18 Apr 12 Initials:peterattwood

File Name: insul



Rw 36 dB
C -3 dB
Ctr -6 dB

System description

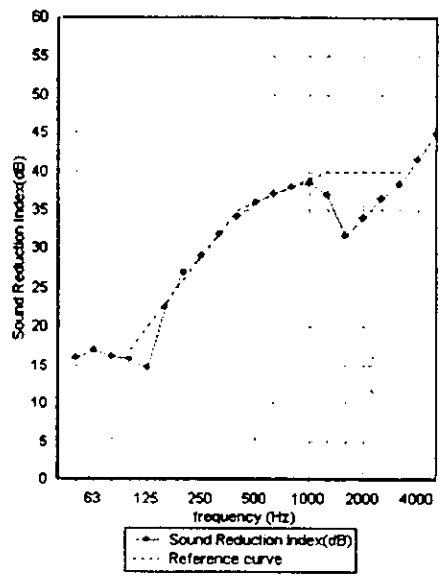
Panel 1 Outer layer: 1 x 12.5 mm Gyproc Wallboard 12.5mm (m=8.0 kg/m2, fc=3263 Hz, damping=0.01)

Cavity: Timber stud @ 400 mm , Infill Rockwool (33kg/m3) Thickness 50 mm
Panel 2 Inner layer: 1 x 18.0 mm Plywood (m=10.1 kg/m2, fc=1290 Hz, damping=0.01)

Mass-air-mass resonant frequency =127 Hz

Panel Size 2.7x4 m

frequency (Hz)	TL(dB)	TL(dB)
50	16	
63	17	16
80	16	
100	16	
125	15	17
160	23	
200	27	
250	29	29
315	32	
400	34	
500	36	36
630	37	
800	38	
1000	38	38
1250	37	
1600	32	
2000	34	34
2500	36	
3150	38	
4000	42	41
5000	45	



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