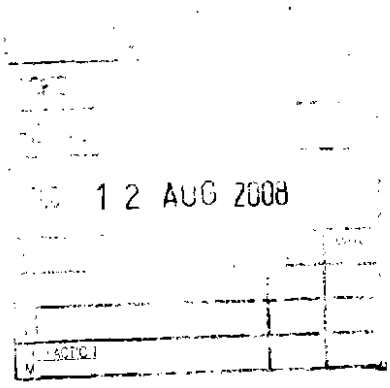
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5th August 2008

ACOUSTIC CONSULTANTS

ACOUSTIC ASSESSMENT AT UNIT 7, THE QUADRANGLE, MANCHESTER.



architectural
environmental
occupational
industrial
noise control at source
project management
planning
legal services
expert witness

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1.0 SUMMARY

At the request of ADC Architects an assessment of the noise transfer of all aspects of noise from the proposed café bar at Unit 7, The Quadrangle, Manchester has been undertaken. This assessment has been conducted to meet various Noise Rating curves, typical of living spaces in urban areas.

Our assessment has considered the following factors:-

- Internal noise transfer through the floor and flanking elements.
- Internal noise breakout to the above apartments
- External plant noise breakout to the above apartments.

Our assessments have been considered in light of BS4142, BS8233 and also in light of NR35 contours in order to control any excessive tonal or low frequency behaviour. The resulting assessments indicate that the proposed design will be suitable for development.

Report Prepared by: **Report Checked by:**

2.0 BRIEF

PDA Ltd was commissioned by ADC Architects to undertake an assessment of the acoustic properties of the proposed internal wall and floor construction.

Details of the brief are given below:

A) Travel to the site in Manchester and undertake a noise survey to establish the ambient noise climate in the vicinity of the site. Measurements will be made during the likely opening hours of the proposed development. Measurements will be undertaken between 10:00 to 14:00 at the nearest noise sensitive residence.

Measurements shall be made in accordance with the provisions of BS 7445 "Description and Measurement of Environmental Noise". The measurements will include dB(A) and octave bands in terms of L_{eq}, L_{max} and L_N values.

B) PDA will undertake a noise modelling exercise to determine the likely noise emission from the ground floor café in. This noise model will take into account noise transfer through the external building envelope and through internal floors. This level will be compared with the background noise measurements taken in Part A). The calculated internal noise level will be compared with local authority requirements. Where these requirements have been exceeded we will prepare a scheme of remedial measures to reduce noise emission.

C) PDA will undertake a noise modeling exercise based on available data on the proposed plant and equipment to determine the contribution at the nearest noise sensitive receiver. This level will be compared with the background noise measurements taken in Part A) and will be assessed in accordance with the requirements of the local authority. Should the results of the noise model indicate unfavourable noise levels PDA will prepare a scheme of remedial measures to reduce noise propagation to the nearest residential receiver.

D) We will prepare a full consultant's report detailing descriptions of the noise models, the results and any conclusions with respect to necessary noise control. The report will also include contact details of relevant noise control equipment supplier/installers.

3.0 NOISE SURVEY DETAILS

3.1 Site Description

The proposed café bar is located in the city centre of Manchester. Surrounding the site are existing shops and bar venues. On the floors above the proposed development contains a number of existing residential flats.

It is intended that the existing ground floor restaurant area is to be converted into a café bar. It is not intended that loud amplified entertainment noise is to be installed within the bar area. Any music will be limited to background levels.

3.2 Survey Times and Dates

The ambient noise measurements were made on the 4th July 2008, with all measurements being made by Mr. Liam Kavaney of PDA Ltd.

3.3 Equipment Used

Throughout the survey the following equipment was used:

Table 1. Measurement equipment

Type	Description	Serial No.
CEL 593 C100	Sound Level Meter	3/0511878
CEL 284/2	Sound Level Calibrator	4/02021914

The CEL 593 sound level meter is a precision grade 1 (as per BS EN 60651: 1994 and IEC 651) computing sound level meter capable of operating as an integrating sound level meter complying with BS EN 60204: 1994 (IEC 804). The meter was set to linear and fast response. The microphone was of the 'free field' type. The meter was calibrated directly before any measurement took place and immediately afterwards and no significant drift was observed.

3.4 Weather

4th July 2008

Temperature:	15°C
Wind Speed:	0 - 1
Wind Direction:	NW
Cloud Cover:	50%

3.5 Measurement Positions & Procedure

Background Measurements were conducted at appropriate locations around the proposed development, in order to establish existing noise levels incident on residential facades.

The microphone was mounted 1.5m above ground and at least 3.5m from any reflecting surface. A range statistical noise indicators were measured, including octave band L_{Aeq}, L_{A10} and L_{A90}. Measurements were set up to log every 15 minutes during the day. As the planned hours of operation of the café bar are between 0700-1900 hours, no measurements were made outside this time period.

4.0 TERMS OF REFERENCE

Assessing the noise impact from the proposed development is subject to three assessment methods detailed below:-

- Assessment of plant/industrial noise in accordance with BS4142
- Noise break out from within the proposed development via open doors
- Noise transfer through the floor and flanking elements.

The following sections detail the procedures to be used in each assessment.

4.1 BS 4142: Rating of Industrial Noise Affecting Mixed Residential and Industrial Areas.

In order to assess the impact of the noise generated by proposed site at the nearest residential receivers, British Standard 4142 shall be used.

BS 4142 : 1997 remains the only objective standard for assessing the likelihood of annoyance and consequent complaints that may be attributable to the operation of a noise source.

Briefly the standard may be thought of as procedures for the determination of:

a) External noise levels 'from factories, industrial premises, fixed installations and sources of an industrial nature in commercial premises and

b) The background noise level, this being measured in the absence of any noise from the premises in question.

Assessment

It is generally accepted that for the introduction of a noise source to be unnoticeable in the presence of the pre-existing background noise, all other factors being equal, it should have an 'A' weighted noise level that is at least 10 dB below the existing background noise level. The above philosophy forms the basis of the BS 4142 assessment procedure.

More specifically BS 4142 requires, where the noise source in question produces discernible tonal elements, e.g. 'whines, hisses, hums etc.' that 5 dB(A) is added to the noise level, be this measured or calculated. Again where the noise in question contains distinct impulsive elements e.g. 'bangs, clicks, clatters or thumps', or where the noise is irregular enough to attract attention, BS 4142 again requires the additional 5 dB(A). If the noise in question is in possession of both tonal and impulsive characteristics, only one 5 dB(A) adjustment is made.

From the above the rating level is established, this being the value that is compared with the background noise.

According to BS 4142 a rating Level of:

a) 10 dB(A) or more above the background is a positive indication that complaints, attributable to the operation of the noise source, are likely.

b) 5 dB(A) above the background is of marginal significance.

10 dB(A) below the background is a positive indication that complaints attributable to the operation of the noise source are unlikely.

4.2 BS8233:1999

The noise levels generated by internal noise breakout and internal noise transfer will be assessed to ensure that the internal noise environment will comply with the following criterion:

Table 2. BS8233 recommended indoor ambient noise levels

Criterion	Typical Situation	Design range $L_{Aeq,T}$	
		Good	Reasonable
Reasonable Resting/Sleeping Conditions	Living rooms	30	40
	Bedrooms	30	35

It should however be stressed that the above criterion relates to steady noise, in this case from road traffic etc., excluding unusual noise events departing from the typical noise character of the area.

Noise within the apartments from external activities will be assessed to not exceed the reasonable standard for both living rooms and bedrooms during the opening hours of the café.

4.3 Noise Rating (NR) Curves

Whilst the design criteria of BS8233 controls the overall level of noise entering a dwelling. It is desirable to also place a degree of control on the individual octave bands in order to keep dominant tonal or low frequency components from affecting ambient noise climates to an unsavoury degree.

NR curves provide a series of upper limits for each octave or third octave centre frequencies and can therefore provide a way of setting a suitable design target for the ingress of noise from the proposed development in to the residential spaces above.

It is generally accepted that the octave band limits of the NR35 curve represents an overall noise level equating to 40 dB(A), i.e the 'reasonable' resting criterion of BS8233 and so this shall be used throughout the assessment.

5.0 MEASURED RESULTS

Table 3 below shows the measured results of the L_{90} background data for the octave band frequencies 32Hz – 4 kHz.

Table 3. Measured Background Results

Date	Time Period	L_{90} Octave Band Centre Frequencies							
		32 Hz	63 Hz	125 Hz	500 Hz	1k Hz	2k Hz	4k Hz	A-weighted L_{A90}
4th July 2008	10:36 to 11:33	66	59	58	55	52	52	47	56
4th July 2008	11:39 to 14:39	67	58	58	55	52	52	47	56

5.1 Discussion of Background Noise

The background noise within the area was subjectively constant. The dominant source was from passing traffic on Oxford Road which included a high number of buses.

6.0 CAFÉ TO APARTMENT NOISE TRANSFER CALCULATION

6.1 Design Assumptions

Below is a list of assumptions made when conducting the noise transfer from the bar area to the room above:

- Assessment and specification of the acoustic performance of the building envelope, has been undertaken based on achieving section 4 above.

- Information on the sound insulation properties of building element has either been taken from PDA in-house library of construction element sound insulation properties or by utilising Insul Sound insulation prediction software. Calculation of the noise transfer from the café bar area to the room above has been calculated using Bastian Building Acoustics Planning System.

- Calculations have been conducted to determine the noise breakout to the worst case apartment room on the first floor directly above the bar area.

- All wall and floor dimensions have been taken from supplied drawings for the café bar. An assumption has been made that the apartment above occupies the same floor space as that of the café bar. Should further information become available on this then PDA will be happy to adjust calculations accordingly.

- It is accepted that open windows provide approximately 10 to 15 dB of sound reduction to the internal spaces. For the purposes of this report, a mean value of 12.5dB has been assumed in all calculations.

- Noise data has been sourced from PDA in-house library of noise source data. The data was gathered within a wine bar house with approximately 10 to 15 people present and some background music. As a result, noise levels are likely to exceed those to be generated by the proposed café bar. The noise levels used within our calculations are as follows:

Table 4. Noise Source Data

Location	dB(A)	Octave Band Centre Frequency (Hz)							
		31	63	125	250	500	1k	2k	4k
Wine Bar	65	60	56	57	56	57	54	50	44

6.2 BS4142 Assessment

Table 5. BS4142 Assessment of plant noise

A weighted Specific Noise at façade	:	29 dB(A) L_{eq}
No Feature Correction Required	:	0 dB
Rating Level	:	29 dB
Background Noise Level *taken as a representative 'mean value' of measured L_{90} noise levels	:	56 dB(A) L_{90}*
Rating Level – Background Noise Level	:	-27 dB

Therefore the assessment is a positive indication that complaints attributable to the noise source are unlikely.

6.2.1 Discussion of Results

It can be seen from the above table that plant noise levels incident on the façade are 27dB below that of the prevailing background noise. As a result, it is unlikely that noise from them will be audible within dwellings.

6.3 Calculation of internal noise break out

We have considered the noise break out from an open door of the proposed development. Internal noise levels have been modelled to radiate from the whole of the door space, leading to a calculation of the sound power for that area. This sound power level is then used to determine internal noise levels within the apartment based on source to receiver distances and the attenuation for a partially open window.

Full calculation data can be found at the rear of this report, the results however, are summarised in the table below:

Table 6. Internal noise breakout assessment

Location	dB(A)	Octave Band Centre Frequency (Hz)							
		31	63	125	250	500	1k	2k	4k
Internal Noise Breakout within 1st Floor Apartment	36	37	34	34	33	34	31	27	21
NR35 Upper Limits	N/A	79	63	52	45	37	35	32	30
Assessment Verdict	Noise Levels are not in excess of NR35								

6.3.1 Discussion of Results

It can be seen from the above table that noise levels generated by that of people talking and low level music will not exceed NR35 within the 1st floor apartment or above. The NR curve satisfying the calculated internal noise levels is that of NR32.

As can also be seen from the above table. The internal noise levels will readily satisfy the 'reasonable' resting criterion on BS8233, as detailed in Table 2.

6.4 Calculation of internal noise transfer via the floor and flanking elements

Full calculation data can be found at the rear of this report, the results however, are summarised in the table below:

Table 7. Internal noise transfer via the floor and flanking elements assessment

Location	dB(A)	Octave Band Centre Frequency (Hz)							
		31	63	125	250	500	1k	2k	4k
Internal Noise Breakout within 1st Floor Apartment	27	39	36	38	29	25	19	8	-2
NR35 Upper Limits	N/A	79	63	52	45	37	35	32	30
Assessment Verdict	Noise Levels are not in excess of NR35								

6.4.1 Discussion of Results

It can be seen from the above table that the resultant transfer of noise through the floor and flanking elements from the proposed development is significantly less than the noise criteria of NR35. The NR curve satisfying the calculated internal noise levels is that of NR22.

As can also be seen from the above table. The internal noise levels will clearly satisfy the 'reasonable' resting criterion on BS8233, as detailed in Table 2.

7.0 DISCUSSION AND ADDITIONAL FACTORS

The calculations within this report have been based on manufacturer data, selecting noise levels attributable to plant working at the maximum capacity. It should be noted that this is unlikely to happen during all times and that any noise generated by the units have been calculated to be in excess of 10 dB below that of background noise levels.

With regards to the floor construction, our calculations have been based only on the performance of the single concrete slab. As such, no suspended ceiling tile has been included, as the type of which has not been made available. However, the inclusion of any reasonable ceiling tile will further improve the sound insulation performance of the floor system and will generally offer a desirable degree of control of reverberant noise within the café bar. Controlling the reverberant noise will reduce the degree of noise breakout from the bar, leading to further improvements in the noise control of the development.

8.0 CONCLUSION

At the request of ADC Architects an assessment of the noise transfer of all aspects of noise from the proposed café bar at Unit 7, The Quadrangle, Manchester has been undertaken. This assessment has been conducted to meet various Noise Rating curves, typical of living spaces in urban areas.

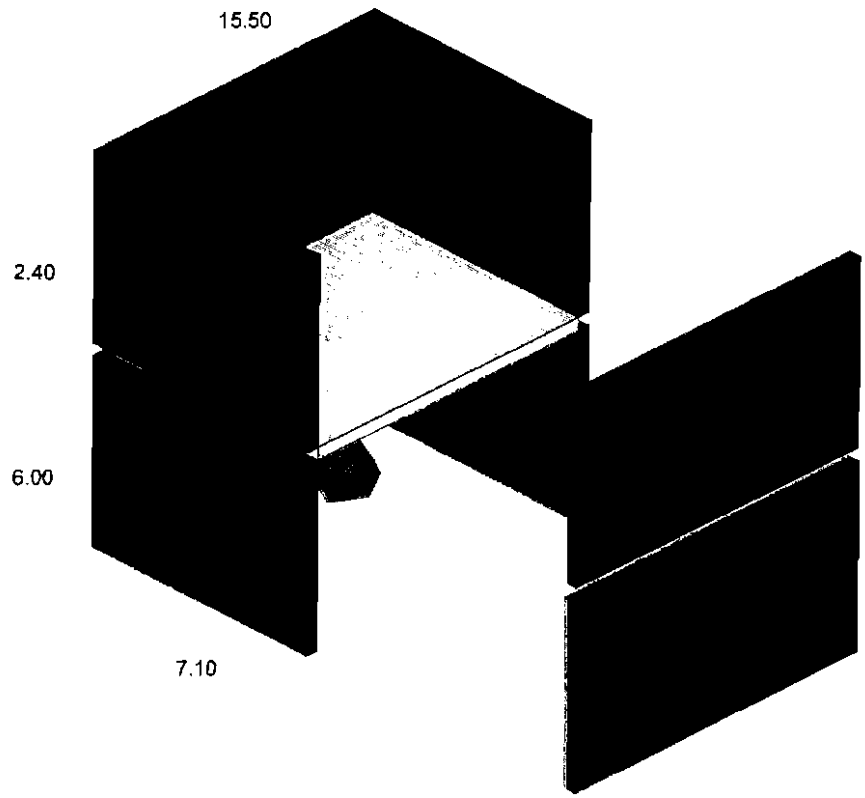
Our assessment has considered the following factors

- Internal noise transfer through the floor and flanking elements.
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- External plant noise breakout to the above apartments.

Our assessments have been considered in light of BS4142, BS8233 and also in light of NR35 contours in order to control any excessive tonal or low frequency behaviour. The resulting assessments indicate that the proposed design will be suitable for development.

CALCULATIONS

Room View



Worksheet-Table

		Sending Room		Junctio	Receiving Room		DnT,w + C		L'n,w	
M	t	Basic Element	Additional La	Type-N	Basic Element	Additional La	dB	%	dB	%
X	d	concrete floor (2400 kg/m³) 160 m					44.9	67		
X	f1	lightweight concrete (1400 kg/m³)		2	lightweight concrete (1400 kg/m³)		57.5	4		
X	f2	lightweight concrete (1400 kg/m³)		2	lightweight concrete (1400 kg/m³)		57.5	4		
X	f3	lightweight concrete (1400 kg/m³)		2	lightweight concrete (1400 kg/m³)		52.2	13		
X	f4	lightweight concrete (1400 kg/m³)		2	lightweight concrete (1400 kg/m³)		52.2	13		
						Total:	43.2	100		

Elements / Constructions

tau	Room	Element	Construction
d	SR	monolithic floor	concrete floor (2400 kg/m³) 160 mm
f1	SR	monolithic wall	lightweight concrete (1400 kg/m³) 100 mm
f1	RR	monolithic wall	lightweight concrete (1400 kg/m³) 100 mm
f2	SR	monolithic wall	lightweight concrete (1400 kg/m³) 100 mm
f2	RR	monolithic wall	lightweight concrete (1400 kg/m³) 100 mm
f3	SR	monolithic wall	lightweight concrete (1400 kg/m³) 100 mm
f3	RR	monolithic wall	lightweight concrete (1400 kg/m³) 100 mm
f4	SR	monolithic wall	lightweight concrete (1400 kg/m³) 100 mm
f4	RR	monolithic wall	lightweight concrete (1400 kg/m³) 100 mm

Geometry Data

Volume sending room (m³): 660.30
Volume receiving room (m³): 264.12

t	Room	Basic Element	a	b	S	lij
			(m)	(m)	(m²)	(m)
d		concrete floor (2400 kg/m³) 160 mm	15.50	7.10	110.05	
f1	SR	lightweight concrete (1400 kg/m³) 100 mm	6.00	7.10	42.60	7.10
f1	RR	lightweight concrete (1400 kg/m³) 100 mm	2.40	7.10	17.04	7.10
f2	SR	lightweight concrete (1400 kg/m³) 100 mm	6.00	7.10	42.60	7.10
f2	RR	lightweight concrete (1400 kg/m³) 100 mm	2.40	7.10	17.04	7.10
f3	SR	lightweight concrete (1400 kg/m³) 100 mm	6.00	15.50	93.00	15.50
f3	RR	lightweight concrete (1400 kg/m³) 100 mm	2.40	15.50	37.20	15.50
f4	SR	lightweight concrete (1400 kg/m³) 100 mm	6.00	15.50	93.00	15.50
f4	RR	lightweight concrete (1400 kg/m³) 100 mm	2.40	15.50	37.20	15.50

Input Data Elements

tau	Roor	X	50	63	80	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	Xw
d	SR	R	29.8	28.5	27.8	28.7	37.2	40.1	42.3	44.6	46.9	49.3	51.7	54.2	56.7	59.3	61.9	64.3	66.0	67.6	69.3	71.1	71.2	55
d	SR	Lr	59.6	61.5	64.1	64.9	65.9	66.4	66.8	67.2	67.6	68.0	68.4	68.7	69.0	69.4	69.7	69.9	70.1	70.4	70.6	70.8	71.0	76
f1	SR	R	30.5	31.3	32.1	32.8	33.3	33.5	33.0	30.9	31.6	31.7	38.8	41.3	43.9	46.6	49.0	50.8	52.6	54.5	56.3	58.2	60.1	43
f1	RR	R	30.5	31.3	32.1	32.8	33.3	33.5	33.0	30.9	31.6	31.7	38.8	41.3	43.9	46.6	49.0	50.8	52.6	54.5	56.3	58.2	60.1	43
f2	SR	R	30.5	31.3	32.1	32.8	33.3	33.5	33.0	30.9	31.6	31.7	38.8	41.3	43.9	46.6	49.0	50.8	52.6	54.5	56.3	58.2	60.1	43
f2	RR	R	30.5	31.3	32.1	32.8	33.3	33.5	33.0	30.9	31.6	31.7	38.8	41.3	43.9	46.6	49.0	50.8	52.6	54.5	56.3	58.2	60.1	43
f3	SR	R	30.5	31.3	32.1	32.8	33.3	33.5	33.0	30.9	31.6	31.7	38.8	41.3	43.9	46.6	49.0	50.8	52.6	54.5	56.3	58.2	60.1	43
f3	RR	R	30.5	31.3	32.1	32.8	33.3	33.5	33.0	30.9	31.6	31.7	38.8	41.3	43.9	46.6	49.0	50.8	52.6	54.5	56.3	58.2	60.1	43
f4	SR	R	30.5	31.3	32.1	32.8	33.3	33.5	33.0	30.9	31.6	31.7	38.8	41.3	43.9	46.6	49.0	50.8	52.6	54.5	56.3	58.2	60.1	43
f4	RR	R	30.5	31.3	32.1	32.8	33.3	33.5	33.0	30.9	31.6	31.7	38.8	41.3	43.9	46.6	49.0	50.8	52.6	54.5	56.3	58.2	60.1	43

Structural Reverb. Time, lab (s)

tau	Roor	50	63	80	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
d	SR	0.892	0.763	0.623	0.552	0.530	0.466	0.409	0.357	0.311	0.270	0.233	0.201	0.172	0.147	0.126	0.107	0.090	0.076	0.064	0.053	0.044
f1	SR	1.434	1.207	1.011	0.843	0.699	0.575	0.469	0.374	0.269	0.234	0.197	0.165	0.139	0.115	0.094	0.077	0.062	0.051	0.041	0.033	0.027
f1	RR	1.434	1.207	1.011	0.843	0.699	0.575	0.469	0.374	0.269	0.234	0.197	0.165	0.139	0.115	0.094	0.077	0.062	0.051	0.041	0.033	0.027
f2	SR	1.434	1.207	1.011	0.843	0.699	0.575	0.469	0.374	0.269	0.234	0.197	0.165	0.139	0.115	0.094	0.077	0.062	0.051	0.041	0.033	0.027
f2	RR	1.434	1.207	1.011	0.843	0.699	0.575	0.469	0.374	0.269	0.234	0.197	0.165	0.139	0.115	0.094	0.077	0.062	0.051	0.041	0.033	0.027
f3	SR	1.434	1.207	1.011	0.843	0.699	0.575	0.469	0.374	0.269	0.234	0.197	0.165	0.139	0.115	0.094	0.077	0.062	0.051	0.041	0.033	0.027
f3	RR	1.434	1.207	1.011	0.843	0.699	0.575	0.469	0.374	0.269	0.234	0.197	0.165	0.139	0.115	0.094	0.077	0.062	0.051	0.041	0.033	0.027
f4	SR	1.434	1.207	1.011	0.843	0.699	0.575	0.469	0.374	0.269	0.234	0.197	0.165	0.139	0.115	0.094	0.077	0.062	0.051	0.041	0.033	0.027
f4	RR	1.434	1.207	1.011	0.843	0.699	0.575	0.469	0.374	0.269	0.234	0.197	0.165	0.139	0.115	0.094	0.077	0.062	0.051	0.041	0.033	0.027

Structural Reverb. Time, situ (s)

tau	Roor	50	63	80	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
d	SR	0.632	0.552	0.475	0.392	0.360	0.319	0.282	0.249	0.219	0.192	0.168	0.146	0.127	0.110	0.094	0.081	0.069	0.059	0.050	0.043	0.036
f1	SR	1.085	0.925	0.786	0.665	0.560	0.470	0.391	0.322	0.252	0.190	0.166	0.144	0.122	0.102	0.084	0.069	0.057	0.046	0.038	0.031	0.025
f1	RR	0.849	0.731	0.627	0.535	0.455	0.385	0.323	0.267	0.204	0.178	0.152	0.129	0.109	0.092	0.077	0.064	0.052	0.043	0.035	0.029	0.024
f2	SR	1.085	0.925	0.786	0.665	0.560	0.470	0.391	0.322	0.252	0.190	0.166	0.144	0.122	0.102	0.084	0.069	0.057	0.046	0.038	0.031	0.025
f2	RR	0.849	0.731	0.627	0.535	0.455	0.385	0.323	0.267	0.204	0.178	0.152	0.129	0.109	0.092	0.077	0.064	0.052	0.043	0.035	0.029	0.024
f3	SR	1.432	1.204	1.008	0.841	0.699	0.578	0.476	0.387	0.301	0.212	0.187	0.162	0.136	0.113	0.093	0.076	0.062	0.050	0.040	0.033	0.026
f3	RR	1.050	0.896	0.762	0.645	0.543	0.455	0.379	0.310	0.235	0.197	0.167	0.143	0.121	0.101	0.084	0.069	0.056	0.046	0.038	0.031	0.025
f4	SR	1.432	1.204	1.008	0.841	0.699	0.578	0.476	0.387	0.301	0.212	0.187	0.162	0.136	0.113	0.093	0.076	0.062	0.050	0.040	0.033	0.026
f4	RR	1.050	0.896	0.762	0.645	0.543	0.455	0.379	0.310	0.235	0.197	0.167	0.143	0.121	0.101	0.084	0.069	0.056	0.046	0.038	0.031	0.025

In-Situ-Data Elements

tau	Roof	X	50	63	80	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	Xw
d	SR	R	31.3	29.9	29.0	30.2	38.9	41.7	43.9	46.2	48.4	50.8	53.1	55.6	58.0	60.6	63.1	65.5	67.1	68.7	70.3	72.1	72.1	56
d	SR	Lr	58.1	60.1	62.9	63.4	64.2	64.8	65.2	65.6	66.1	66.5	67.0	67.3	67.7	68.1	68.5	68.7	69.0	69.3	69.6	69.8	70.1	75
f1	SR	R	31.7	32.5	33.2	33.8	34.3	34.4	33.8	31.5	31.9	32.6	39.5	41.9	44.5	47.1	49.5	51.2	53.0	54.9	56.6	58.5	60.4	43
f1	RR	R	32.8	33.5	34.2	34.8	35.2	35.2	34.6	32.4	32.8	32.9	39.9	42.4	44.9	47.6	49.9	51.6	53.4	55.2	56.9	58.8	60.6	44
f2	SR	R	31.7	32.5	33.2	33.8	34.3	34.4	33.8	31.5	31.9	32.6	39.5	41.9	44.5	47.1	49.5	51.2	53.0	54.9	56.6	58.5	60.4	43
f2	RR	R	32.8	33.5	34.2	34.8	35.2	35.2	34.6	32.4	32.8	32.9	39.9	42.4	44.9	47.6	49.9	51.6	53.4	55.2	56.9	58.8	60.6	44
f3	SR	R	30.5	31.3	32.1	32.8	33.3	33.5	32.9	30.7	31.1	32.1	39.0	41.4	44.0	46.7	49.1	50.9	52.7	54.6	56.3	58.2	60.1	43
f3	RR	R	31.9	32.6	33.3	34.0	34.4	34.5	33.9	31.7	32.2	32.5	39.5	41.9	44.5	47.2	49.5	51.3	53.0	54.9	56.7	58.5	60.4	43
f4	SR	R	30.5	31.3	32.1	32.8	33.3	33.5	32.9	30.7	31.1	32.1	39.0	41.4	44.0	46.7	49.1	50.9	52.7	54.6	56.3	58.2	60.1	43
f4	RR	R	31.9	32.6	33.3	34.0	34.4	34.5	33.9	31.7	32.2	32.5	39.5	41.9	44.5	47.2	49.5	51.3	53.0	54.9	56.7	58.5	60.4	43

Junction Type

Flank	Junction	mi	mi_	M
f1	Type 2 (Rigid T-junction)	140	384	0.4
f2	Type 2 (Rigid T-junction)	140	384	0.4
f3	Type 2 (Rigid T-junction)	140	384	0.4
f4	Type 2 (Rigid T-junction)	140	384	0.4

Vibration Reduction Index Kij

Flan	Path	50	63	80	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
f1	Ff	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0
f1	Fd	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
f1	Df	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
f2	Ff	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0
f2	Fd	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
f2	Df	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
f3	Ff	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0
f3	Fd	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
f3	Df	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
f4	Ff	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0
f4	Fd	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
f4	Df	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8

Velocity Level Difference Dv,ij,situ

Flan	Path	50	63	80	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
f1	Ff	13.5	13.7	13.8	14.1	14.3	14.5	14.8	15.2	15.8	16.2	16.3	16.5	16.7	17.0	17.3	17.6	17.9	18.3	18.7	19.1	19.5
f1	Fd	12.0	12.2	12.3	12.6	12.7	12.8	13.0	13.2	13.5	13.9	14.0	14.1	14.2	14.5	14.7	14.9	15.2	15.5	15.8	16.1	16.4
f1	Df	10.6	10.7	10.8	11.1	11.1	11.2	11.4	11.6	12.0	12.0	12.2	12.3	12.5	12.7	12.9	13.1	13.4	13.7	14.0	14.2	14.6
f2	Ff	13.5	13.7	13.8	14.1	14.3	14.5	14.8	15.2	15.8	16.2	16.3	16.5	16.7	17.0	17.3	17.6	17.9	18.3	18.7	19.1	19.5
f2	Fd	12.0	12.2	12.3	12.6	12.7	12.8	13.0	13.2	13.5	13.9	14.0	14.1	14.2	14.5	14.7	14.9	15.2	15.5	15.8	16.1	16.4
f2	Df	10.6	10.7	10.8	11.1	11.1	11.2	11.4	11.6	12.0	12.0	12.2	12.3	12.5	12.7	12.9	13.1	13.4	13.7	14.0	14.2	14.6
f3	Ff	12.4	12.7	12.9	13.1	13.4	13.7	14.0	14.4	15.1	15.7	15.8	16.0	16.2	16.5	16.9	17.2	17.6	18.0	18.4	18.8	19.3
f3	Fd	9.7	9.9	10.1	10.4	10.5	10.6	10.9	11.1	11.4	11.9	12.0	12.1	12.3	12.5	12.8	13.0	13.3	13.6	14.0	14.3	14.6
f3	Df	8.4	8.5	8.7	9.0	9.1	9.2	9.4	9.6	10.0	10.1	10.3	10.4	10.6	10.8	11.0	11.2	11.5	11.8	12.1	12.4	12.8
f4	Ff	12.4	12.7	12.9	13.1	13.4	13.7	14.0	14.4	15.1	15.7	15.8	16.0	16.2	16.5	16.9	17.2	17.6	18.0	18.4	18.8	19.3
f4	Fd	9.7	9.9	10.1	10.4	10.5	10.6	10.9	11.1	11.4	11.9	12.0	12.1	12.3	12.5	12.8	13.0	13.3	13.6	14.0	14.3	14.6
f4	Df	8.4	8.5	8.7	9.0	9.1	9.2	9.4	9.6	10.0	10.1	10.3	10.4	10.6	10.8	11.0	11.2	11.5	11.8	12.1	12.4	12.8

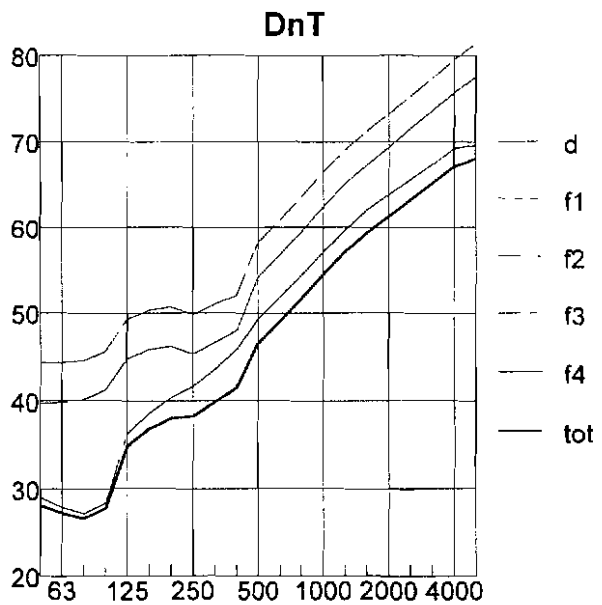
Sound Reduction per Path

Path	50	63	80	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	DnT,w +
Dd	30.2	28.8	27.8	29.0	37.7	40.6	42.8	45.0	47.3	49.6	52.0	54.4	56.9	59.4	62.0	64.3	66.0	67.5	69.2	70.9	71.0	46.4
1d	44.4	44.2	44.3	45.5	50.2	51.8	52.7	52.9	54.6	56.5	61.2	63.7	66.4	69.2	71.9	74.2	76.2	78.2	80.2	82.3	83.6	59.3
2d	44.4	44.2	44.3	45.5	50.2	51.8	52.7	52.9	54.6	56.5	61.2	63.7	66.4	69.2	71.9	74.2	76.2	78.2	80.2	82.3	83.6	59.3
3d	39.8	39.7	39.8	41.1	45.8	47.5	48.5	48.8	50.4	52.6	57.3	59.8	62.5	65.4	68.1	70.4	72.4	74.5	76.5	78.6	80.0	55.2
4d	39.8	39.7	39.8	41.1	45.8	47.5	48.5	48.8	50.4	52.6	57.3	59.8	62.5	65.4	68.1	70.4	72.4	74.5	76.5	78.6	80.0	55.2
d	29.0	27.9	27.1	28.4	36.2	38.7	40.4	41.7	43.6	45.8	49.4	51.8	54.4	57.1	59.7	62.0	63.8	65.6	67.3	69.2	69.6	44.9
11	50.7	51.6	52.5	53.3	54.0	54.3	54.0	52.1	53.1	53.9	61.0	63.6	66.3	69.3	71.9	74.0	76.1	78.3	80.4	82.7	85.0	59.9
D1	45.5	45.3	45.3	46.5	51.1	52.6	53.6	53.8	55.5	56.7	61.6	64.2	66.9	69.7	72.3	74.6	76.5	78.5	80.5	82.6	83.8	60.0
f1	44.4	44.4	44.5	45.7	49.3	50.4	50.8	49.8	51.1	52.1	58.3	60.9	63.6	66.5	69.1	71.3	73.3	75.4	77.5	79.6	81.3	57.5
22	50.7	51.6	52.5	53.3	54.0	54.3	54.0	52.1	53.1	53.9	61.0	63.6	66.3	69.3	71.9	74.0	76.1	78.3	80.4	82.7	85.0	59.9
D2	45.5	45.3	45.3	46.5	51.1	52.6	53.6	53.8	55.5	56.7	61.6	64.2	66.9	69.7	72.3	74.6	76.5	78.5	80.5	82.6	83.8	60.0
f2	44.4	44.4	44.5	45.7	49.3	50.4	50.8	49.8	51.1	52.1	58.3	60.9	63.6	66.5	69.1	71.3	73.3	75.4	77.5	79.6	81.3	57.5
33	45.2	46.2	47.2	48.1	48.9	49.3	49.0	47.2	48.3	49.6	56.7	59.2	62.0	65.0	67.8	69.9	72.0	74.3	76.5	78.8	81.1	55.4
D3	41.2	41.0	41.1	42.3	46.9	48.5	49.5	49.7	51.5	52.9	57.8	60.4	63.0	65.9	68.6	70.8	72.8	74.8	76.8	78.9	80.2	56.0
f3	39.7	39.8	40.1	41.3	44.8	45.9	46.2	45.3	46.6	47.9	54.2	56.8	59.5	62.4	65.1	67.3	69.4	71.5	73.6	75.8	77.6	52.2
44	45.2	46.2	47.2	48.1	48.9	49.3	49.0	47.2	48.3	49.6	56.7	59.2	62.0	65.0	67.8	69.9	72.0	74.3	76.5	78.8	81.1	55.4
D4	41.2	41.0	41.1	42.3	46.9	48.5	49.5	49.7	51.5	52.9	57.8	60.4	63.0	65.9	68.6	70.8	72.8	74.8	76.8	78.9	80.2	56.0
f4	39.7	39.8	40.1	41.3	44.8	45.9	46.2	45.3	46.6	47.9	54.2	56.8	59.5	62.4	65.1	67.3	69.4	71.5	73.6	75.8	77.6	52.2
tot	28.1	27.2	26.6	27.8	34.8	36.9	38.1	38.3	39.9	41.5	46.5	49.1	51.7	54.5	57.1	59.4	61.3	63.2	65.1	67.1	68.0	43.2

Airborne Sound per Element

tau	50	63	80	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	DnT,w +
d	29.0	27.9	27.1	28.4	36.2	38.7	40.4	41.7	43.6	45.8	49.4	51.8	54.4	57.1	59.7	62.0	63.8	65.6	67.3	69.2	69.6	44.9
f1	44.4	44.4	44.5	45.7	49.3	50.4	50.8	49.8	51.1	52.1	58.3	60.9	63.6	66.5	69.1	71.3	73.3	75.4	77.5	79.6	81.3	57.5
f2	44.4	44.4	44.5	45.7	49.3	50.4	50.8	49.8	51.1	52.1	58.3	60.9	63.6	66.5	69.1	71.3	73.3	75.4	77.5	79.6	81.3	57.5
f3	39.7	39.8	40.1	41.3	44.8	45.9	46.2	45.3	46.6	47.9	54.2	56.8	59.5	62.4	65.1	67.3	69.4	71.5	73.6	75.8	77.6	52.2
f4	39.7	39.8	40.1	41.3	44.8	45.9	46.2	45.3	46.6	47.9	54.2	56.8	59.5	62.4	65.1	67.3	69.4	71.5	73.6	75.8	77.6	52.2
tot	28.1	27.2	26.6	27.8	34.8	36.9	38.1	38.3	39.9	41.5	46.5	49.1	51.7	54.5	57.1	59.4	61.3	63.2	65.1	67.1	68.0	43.2

Resulting Diagram



Calculation of Internal Noise Breakout to Atmosphere and Receiver

Height of Door	2.4
Width of Door	1
Area of Door	2.4
Distance to Nearest Window	5
Attenuation of open window	12.5

	Frequency (Hz)								
	32	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**dB(A)**
Noise level in café bar	60	56	57	56	57	54	50	44	**65.0**
Sound Power of Open Door	64	60	61	59	61	58	53	47	
Noise level inside apartment	37	34	34	33	34	31	27	21	**dB(A)**
Aweighted	-2	8	18	24	31	31	28	22	**35.8**

										dB(A)
NR	32	77	61	50	42	35	32	29	27	**77.3**
		safe	safe	safe	safe	safe	safe	safe	safe	

Vent Type	BROADBAND dB(A)	Sound Power Level, Octave band mid frequency, dB 125	250	500	1000	2000	4000	8000	
Nuaire EST2		69	53	48	45	43	37	29	
	55	53	44	45	45	44	38	28	A-weighted values
VAM-FA	38								
Area (m2)	0.2108								
Distance to nearest window	5								
Noise level at window		125	250	500	1000	2000	4000	8000	
Nuaire EST2	41	39	30	31	31	30	24	14	
VAM-FA	24								
Open window attenuation	12.5								
Level inside apartment									
Nuaire EST2	29	28	18	18	19	18	12	1	
VAM-FA	12	7	-1	-1	0	-1	-7	-18	Noise levels have been based on Nuaire spectrum and adjusted to give correct broadband noise level
Combined Level	29	28	18	18	19	18	12	1	
A weighted	12	10	9	15	19	19	13	0	

	125	250	500	1000	2000	4000	8000
NR 21	40	32	24	21	18	15	14
	safe	safe	safe	safe	safe	safe	safe

DEFINITION OF ACOUSTIC TERMS

Definition of Acoustic Terms – (Architectural)

The decibel

This is the basic unit of noise, denoted dB.

A Weighting

This is a weighting process which simulates the human ear's different sensitivity at different frequencies. A weighting can be shown two typical ways, 50 dB(A) L_{eq} or 50 dB L_{Aeq}. Both mean the same thing. (See below for a definition of L_{eq}). The dB(A) level can be regarded as the overall level perceived by human beings.

L_{eq} and $L_{eq(s)}$

This is the equivalent continuous noise level which contains the same acoustic energy as the actual time-varying sound. In other words it is a kind of average noise level. It is denoted dB L_{eq} or, for A-weighted figures dB(A) L_{eq} or dB L_{Aeq}. It can also be expressed in terms of frequency analysis (see later). $L_{eq(s)}$ is the sample L_{eq} level.

L_n

This is the level exceeded for n% of the time. It is denoted dB L_n or, for A-weighted figures dB(A) L_n or dB L_{An}. It can be expressed in terms of frequency analysis (see later). L_{90} is the level exceeded for 90% of the time and is a measure of the lowest level typically reached. L_{10} is the level exceeded for 10% of the time and is the highest level typically reached. L_{50} is the level exceeded for 50% of the time and, mathematically, it is the median.

L_{max}

This is the maximum level reached during a measurement period. The "time constant", or the ability of the equipment to respond to impulses is usually expressed along with it, e.g. "Fast", "Slow", etc. It is denoted dB L_{max} or, for A-weighted figures dB(A) L_{max}. dB L_{Amax}, etc. It can also be expressed in terms of frequency analysis.

NR and NC Values

These are single-figure noise level values which take account of a noise's frequency content.

Reverberation Time

This is the most common way of expressing a room's basic acoustic character. It is the time taken for a steady noise to decay by 60 dB after its source has been abruptly cut off. It is denoted RT_{60} for most situations. RT_{20} and RT_{30} are also used but would normally be separately defined in the report body.

Frequency Analysis

Whereas dB(A) gives a very useful overall figure, it has its limitations in that it cannot be used to model or predict the effect of noise control and mitigation as this nearly always has radically different performance at different frequencies.

Frequency analysis expresses an overall noise level at each frequency or band of frequencies in the audible range. Octave band analysis divides the audible range into 10 bands from 31.5 Hz to 16 kHz and the noise level in each band can be expressed in any form e.g. L_{eq}, L_{90}, L_{max} etc. One third octave band analysis uses 30 bands.

Narrow band analysis takes the process to resolutions of less than 1 Hz. This is useful for identifying the existence of tones (whines, hums, etc.) and in pin-pointing the sources.

Definition of Acoustic Terms (Environmental)

The decibel

This is the basic unit of noise, denoted dB.

A Weighting

This is a weighting process which simulates the human ear's different sensitivity at different frequencies. A weighting can be shown two typical ways, 50 dB(A) L_{eq} or 50 dB L_{Aeq}. Both mean the same thing. (See below for a definition of L_{eq}). The dB(A) level can be regarded as the overall level perceived by human beings.

L_{eq} and $L_{eq(s)}$

This is the equivalent continuous noise level which contains the same acoustic energy as the actual time-varying sound. In other words it is a kind of average noise level. It is denoted dB L_{eq} or, for A-weighted figures dB(A) L_{eq} or dB L_{Aeq}. It can also be expressed in terms of frequency analysis (see later). $L_{eq(s)}$ is the sample L_{eq} level.

L_n

This is the level exceeded for n% of the time. It is denoted dB L_n or, for A-weighted figures dB(A) L_n or dB L_{An}. It can be expressed in terms of frequency analysis (see later). L_{90} is the level exceeded for 90% of the time and is a measure of the lowest level typically reached. L_{10} is the level exceeded for 10% of the time and is the highest level typically reached. L_{50} is the level exceeded for 50% of the time and, mathematically, it is the median.

L_{max}

This is the maximum level reached during a measurement period. The "time constant", or the ability of the equipment to respond to impulses is usually expressed along with it, e.g. "Fast", "Slow", etc. It is denoted dB L_{max} or, for A-weighted figures dB(A) L_{max}, dB L_{Amax}, etc. It can also be expressed in terms of frequency analysis.

Frequency Analysis

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