



Land at East Street, Reading

Façade noise impact assessment

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Revision B



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Prepared for

Studios Development (Reading) Ltd

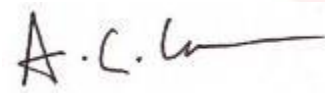
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2 Summary

- 2.1 This report has been prepared in support of a Planning Application for a residential development at Land at East Street, Reading.
- 2.2 Noise levels affecting the proposed development from road traffic and commercial premises have been measured during the day and night, and the façade noise impact calculated.
- 2.3 Measured noise levels are used to determine the potential façade sound insulation treatments to meet the internal noise level requirements of current guidance and good practice.
- 2.4 A set of minimum glazing and ventilation strategy options, interpreted from Approved Document F (AD-F), is proposed as shown in Table 1.

Façade affected	Glazing Performance	Vent Performance (1 vent per room)	Potential ventilation strategy
Northern	26 dB R _w + C _{tr} e.g. 6/12/6 Double glazing	38 dB D _{n,e,w} e.g. RW Simon Acoustic EHAS	AD-F System 3, continuous mechanical extract (MEV), relying on a single trickle vent for make-up air
		Not required	AD-F System 4, mechanical supply and extract with heat recovery (MVHR)
All other	26 dB R _w + C _{tr} e.g. 6/12/6 Double glazing	34 dB D _{n,e,w} e.g. Greenwood 4000L	AD-F System 3, continuous mechanical extract (MEV), relying on a single trickle vent for make-up air
		Not required	AD-F System 4, mechanical supply and extract with heat recovery (MVHR)

Table 1: Summary of minimum façade sound insulation treatment

- 2.5 Background noise levels have been measured at a location considered representative of the nearest noise sensitive location.
- 2.6 It is proposed that, when assessed according to the methodology in BS 4142 noise from mechanical services be limited to a rating level such that the noise impact does not give rise to a Significant Observed Adverse Effect Level.

3 Introduction

- 3.1 A residential development consisting of a 4 – storey student residential accommodation building has been proposed at Land off East Street, Reading.
- 3.2 The site location is shown in Figure 1.
- 3.3 Apex Acoustics has been commissioned to use previously measured noise survey data and provide advice on the sound insulation of the façade to achieve the internal levels required by the Local Planning Authority.
- 3.4 The purpose of this report is to identify the usual acoustic design parameters of the Local Environmental Health Department, and the manner in which internal noise levels may be achieved in practice.
- 3.5 The current background noise levels at the noise sensitive locations nearest to the proposed development site will also be determined and used to define noise limits for fixed plant associated with the development.
- 3.6 The nearest noise sensitive locations are considered to be the residential properties on Bourne-Stevens Close.
- 3.7 This assessment is based on measurements of road traffic noise and other noise sources, room and window dimensions on the architects’ plans, assumptions about room conditions, with glazing and ventilation strategy options proposed in this report.
- 3.8 Internal noise transmission and the sound insulation requirements of the Building Regulations are not considered in this report.

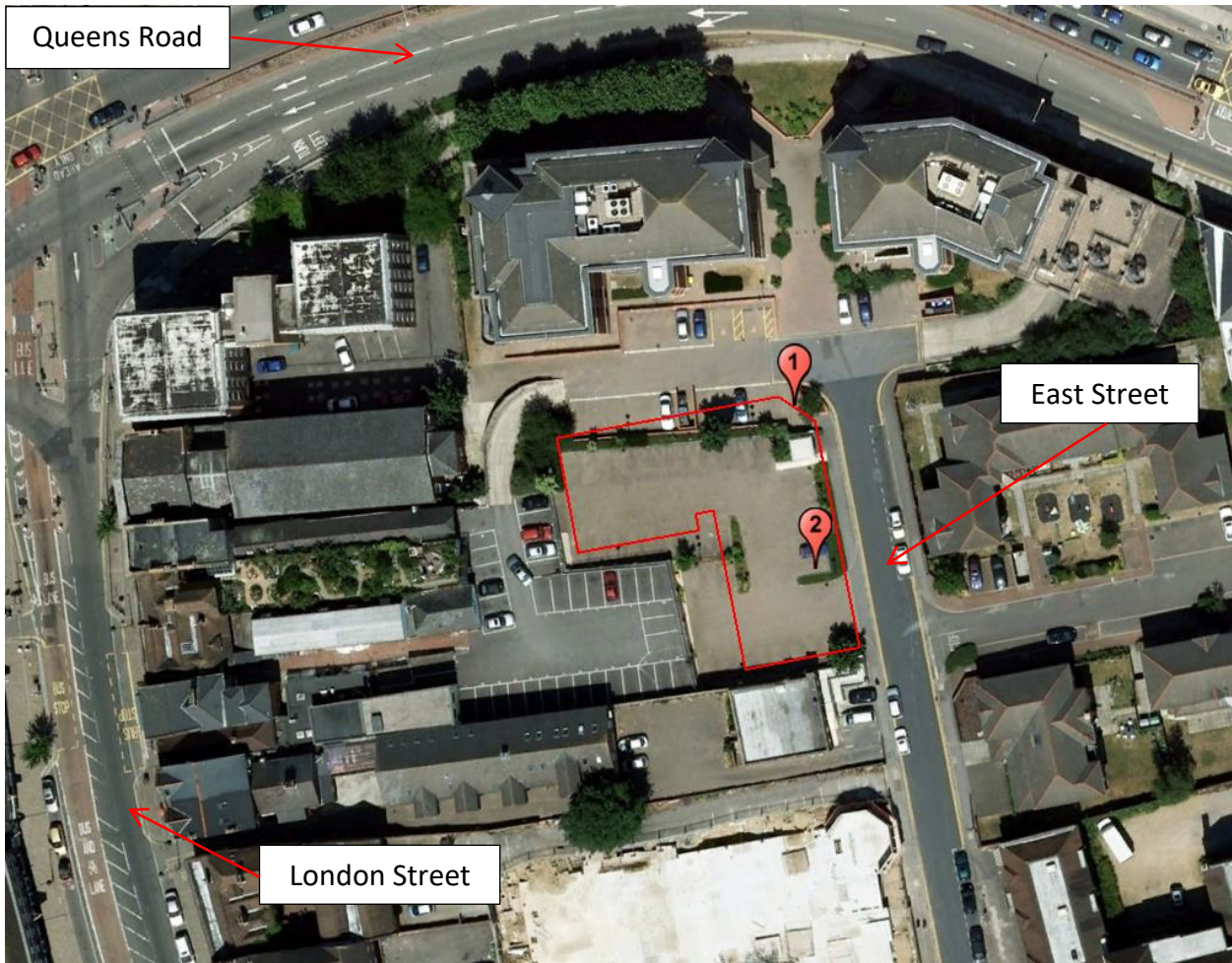


Figure 1: Site location, approximate building location outlined in red, measurement positions indicated by markers

4 Guidance and acceptable levels

- 4.1 The National Planning Policy Framework (NPPF, 2018), Reference 1, sets out the Government’s planning policies for England and how these should be applied. It provides a framework within which locally-prepared plans for housing and other development can be produced.
- 4.2 The Noise Policy Statement for England (NPSE) set out the long term vision of Government noise policy, “Promote good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development”, Reference 2.
- 4.3 The aims and further details of the NPPF and NPSE are discussed in Appendix 1.
- 4.4 Adverse impact may occur if the noise level exceeds certain limits in either the outdoor amenity areas or inside habitable rooms.
- 4.5 WHO guidance and BS 8233 define guideline upper limits for noise to achieve good sleep and desired sound environment in outdoor amenity spaces.
- 4.6 Table 4 of BS 8233, Reference 3, defines guideline upper limits for internal ambient noise levels in dwellings for steady external noise sources, as shown in Table 2.

Activity	Location	Guideline upper limit, L _{Aeq, T} / dB	
		07:00 to 23:00	23:00 to 07:00
Resting	Living rooms	35	-
Dining	Dining room/area	40	-
Sleeping (daytime resting)	Bedroom	35	30

Table 2: Guideline indoor ambient noise levels defined in BS 8233

- 4.7 Note 4 to Table 4 of BS 8233 states:
- 4.8 “Regular individual noise events (for example, scheduled aircraft or passing trains) can cause sleep disturbance. A guideline value may be set in terms of SEL or L_{Amax}, F, depending on the character and number of events per night. Sporadic noise events could require separate values.”

4.9 However, due to the relatively low activity on the surrounding roads and from other noise sources during the night-time period, individual events are considered. As such, maximum levels are considered in this assessment. Therefore the World Health Organisation (WHO), Reference 4, guidance on sleep disturbance is considered appropriate, as discussed in Appendix 2.

4.10 Section 3.4 of the WHO guidelines states:

“For a good sleep, it is believed that indoor sound pressure levels should not exceed approximately 45 dB LA_{max} more than 10 – 15 times per night.”

4.11 The above guidance is adopted to assess the impact on internal levels within proposed bedrooms during the night time period, 23:00 to 07:00 hours.

4.12 The typical criteria for the internal noise levels from general external sources adopted by the Local Environmental Health Department are consistent with these values, and presented in Table 3.

Situation	Proposed upper limits / dB	
	L _{Aeq, T}	L _{AFmax}
Living rooms and Bedrooms, daytime	35	-
Bedrooms, night time	30	45

Table 3: Proposed internal noise level requirements

5 Potential commercial noise sources

5.1 It is understood that there are commercial premises in the vicinity of the proposed residential development identified as:

1. RISC
2. Shehnai
3. South Street Arts Centre

5.2 The 3 no. identified commercial premises are shown in Figure 2 and are discussed in turn below.

5.3 RISC

5.4 It is understood that the RISC (Reading International Solidarity Centre) café and venue hosts live music events typically during evening periods.

5.5 RISC fronts on to London Street / A327.

5.6 It is understood that there is an entrance to the site from the east / rear of the premises.

5.7 It is proposed to measure and assess noise from this venue from live music or other observed operations or activities.

5.8 Shehnai

5.9 It is understood that the facilities at Shehnai are regularly used for weddings which are likely to include amplified music.

5.10 During the site noise monitoring visit it was not possible to ascertain if there was a function at this venue.

5.11 It is estimated that Shehnai is approximately 100 m from the nearest point of the proposed development site.

5.12 It is understood that there are several residential properties on South Street between Shehnai and the proposed development site, the nearest being approximately 40 m from Shehnai.

5.13 It is considered that should noise from operations and activities be of a level whereby the future residents of the proposed development site were to be

adversely affected, the noise level at the existing residential properties on South Street would be significantly higher, potentially between 6 dB to 18 dB, depending on the nature of the sources and shielding afforded by the buildings between the venue and the proposed development site, resulting in a much higher noise level, and greater nuisance, at the existing residential properties on South Street.

5.14 Hence, it is considered that further assessment of noise impact from activities and operations from Shehnai on the proposed residential development is not required.

5.15 South Street Arts Centre

5.16 It is understood that South Street Arts Centre holds events including amplified live music, plays and comedy.

5.17 During the site noise monitoring visit there were no events at the venue.

5.18 It is considered that South Street Arts Centre is approximately 35 m from the closest part of the proposed development.

5.19 It is understood that there are several residential properties on East Street and Bourne-Stevens Close nearby to South Street Arts Centre, the nearest being approximately 10 m from South Street Arts Centre.

5.20 It is considered that should noise from operations and activities be of a level whereby the future residents of the proposed development site were to be adversely affected, the noise level at the existing residential properties on East Street and Bourne-Stevens Close would be significantly higher, potentially between 6 dB to 15 dB, depending on the nature of the sources and shielding afforded by the buildings between the venue and the proposed development site, resulting in a much higher noise level, and greater nuisance, at the existing residential properties on East Street and Bourne-Stevens Close.

5.21 Hence, it is considered that further assessment of noise impact from activities and operations from South Street Arts Centre on the proposed residential development is not required.

6 Noise sources and measurements

6.1 Measurements of the existing noise environment were made using the guidance of BS 7445, Reference 5.

6.2 Measurements were made during the day and night at position 2, and during the daytime only at position 1; the measurement positions are indicated in Figure 1.

6.3 Measurements at position 1 were made with the microphone located at approximately 1.5 m above ground level, between 17:27 hours and 17:42 hours on the 21st September 2016

6.4 Measurements were made at position 1 to capture noise from Queens Road / A 329.

6.5 Measurements at position 2 were made with the microphone located at approximately 3.5 m above ground level, between 16:27 hours on the 21st September 2016 and 10:59 hours on the 22nd September 2016.

6.6 Measurements were made at position 2 to determine the general noise environment and noise events associated with RISC occurring during night-time hours.

6.7 Audio recordings were made at position 2 so that noise events could be identified.

6.8 The equipment used is listed in Table 4.

Equipment	Model	Serial no.
Sound Level Meter	Norsonics 140	1403423
Calibrator	Norsonics 1251	32198
Sound Level Meter	XL2	A2A-05832-E0
Calibrator	Larson Davis CAL 200	9462

Table 4: Equipment used

6.9 Both meters and calibrators have calibration certificates traceable to national standards.

6.10 During the setup of measurement positions 1 and 2, the wind speed measured was between 1.2 and 1.8 m/s; cloud cover was approximately 80 %.

6.11 The most significant noise source affecting the proposed development during the daytime was road traffic.

6.12 Other noise sources included pedestrians passing.

6.13 Live music event at RISC

6.14 During the evening of 21st September 2016 a live music event occurred at RISC.

6.15 Apex Acoustics personnel attended the eastern side of the venue at 22:00 hours.

6.16 No music or other noise associated with RISC was audible and no measurements were deemed necessary.

6.17 Results

6.18 The measured noise levels are shown in Table 5.

Position	Start time / hh:mm	Period T / hh:mm	dB L _{Aeq,T}	dB L _{Aeq,T} Octave Band Centre Frequency / Hz					
				125	250	500	1k	2k	4k
1	17:27	00:15	55	43	46	47	52	48	41
2	16:27	06:15	55	42	45	47	51	47	41
	23:00	07:59	49	34	39	42	46	41	32
	07:00	04:16	56	42	47	48	52	49	44

Table 5: Measured A-weighted noise levels

6.19 Further to analysis of the measured noise levels and audio recordings, a single noise event was identified as being attributable to one of the identified commercial operations.

6.20 The identified noise event was a bottle bin being emptied at 23:44 hours.

6.21 The measured level at position 2 for this event and the other highest measured L_{AFmax} events are shown in Table 6.

6.22 Where the commercial noise from bottle bins being emptied are the most significant L_{AFmax} affecting any portion of the proposed building façade, it is proposed to use this event in the façade noise break-in calculations.

Event	Time / hh:mm	dB L _{AFmax}	dB L _{AFmax} Octave Band Centre Frequency / Hz					
			125	250	500	1k	2k	4k
Bottle Bins	23:44	66	44	50	52	55	61	62
Car	23:37	74	54	57	63	67	72	61
Car	00:17	71	48	53	65	65	66	59
People	06:58	69	54	59	61	65	61	57
People	06:58	67	50	59	59	64	60	55
People	23:29	67	46	51	63	63	62	52
Moped	06:39	67	56	65	63	62	54	40
Moped	06:57	66	57	55	55	60	59	56
People	23:34	65	45	50	61	60	59	48

Table 6: Measured A-weighted maximum noise levels

6.23 The WHO guidance implies that potentially it may be acceptable to exceed the proposed L_{AFmax} internal limit by 10 – 15 times during the night-time period.

6.24 In this instance for those building façades less affected by the bottle bin noise, it is proposed to use the highest L_{AFmax} event associated with people talking in the calculations, as this is a noise source which is considered to be more annoying than other transport related noise sources.

6.25 This would be the 3rd highest L_{AFmax} event overall for any such affected façades.

6.26 The measured background noise levels are shown in Table 7.

Date	Time / hh:mm	dB L _{AFmax}
21/09/16	17:00	49
	18:00	49
	19:00	48
	20:00	48
	21:00	46
	22:00	46
	23:00	44
22/09/16	00:00	42
	01:00	40
	02:00	39
	03:00	40
	04:00	41
	05:00	42
	06:00	46
	07:00	50
	08:00	51
	09:00	49
	10:00	50

Table 7: Measured background noise levels

7 Calculated noise impact

7.1 As the measurements were taken at the position of the proposed façade, they are taken to be representative of the likely noise levels affecting the building once constructed.

7.2 This is a prudent assumption, as the proposed building, once constructed, will act as a noise barrier to some of the road traffic noise currently affecting the measurement position. However, the difference is likely to be small, and using the measured data directly represents a prudent practice.

7.3 It is considered that the bottle bin emptying noise event most likely occurred at the rear of RISC.

7.4 The potential noise level at the façade of the nearest bedroom proposed within the building may be calculated using the following equation:

$$L_{pfac} = L_{pmeas} + 20 \times \log(r_1/r_2)$$

Where:

L_{pfac} is the free-field sound pressure level incident on the building façade

L_{pmeas} is the measured sound pressure level at position 2

r₁ is the distance from the source to the measurement position

r₂ is the distance from the source to the building façade

7.5 The estimated distances between source, receiver and façade positions are shown in Table 8; the calculated sound pressure level incident on the building western end of the northern façade are shown in Table 9.

Location	Distance / m
RISC to measurement position 2 (r ₁)	48
RISC to closest point of proposed building facade	12

Table 8: Estimated distances

Position	dB L _{AFmax}
North-western point of proposed building façade	78

Table 9: Calculated A-weighted maximum bottle bin noise levels at building façade

- 7.6 It is considered that the rooms to the southern and eastern façades will be screened from the bottle bin noise source by the building itself, and this noise will therefore be sufficiently attenuated such that it is no longer the significant L_{AFmax} event.

8 Façade noise calculations

- 8.1 The calculation method for façade sound insulation is in accordance with BS 8233 and the principles of BS EN 12354-3, Reference 6, as described in Appendix 3 and detailed in the Apex Method, Reference 7.
- 8.2 **Ventilation strategy**
- 8.3 The proposed development will be required to meet Part F of the Building Regulations, with regard to ventilation provision, as described in Approved Document F (AD-F), Reference 8.
- 8.4 For AD-F System 1, Background ventilators and intermittent extract fans, the quantity of trickle vents required is typically not feasible acoustically.
- 8.5 Therefore in this case it has been assumed AD-F System 3, Continuous mechanical extract (MEV), is to be used. This is considered in the calculation by the use of a single through-frame acoustic slot vent, RW Simon Acoustic EHAS and Greenwoods 4000L, with manufacturer's data for the element normalised level difference, D_{n,e}, References 10 and 11. Other vents may also be assessed for suitability.
- 8.6 It is noted in Table 5.2C of AD-F that if the building design air permeability is greater than 5.0 m³/m².hr, then building leakage may be relied upon for make up air and no background ventilators are necessary.
- 8.7 However, as described in para. 5.10 of AD-F, this strategy relies upon the as-built air permeability being greater than 3.0 m³/m².hr. If this is not the case, alternative means of compliance with AD-F would be required.
- 8.8 Should AD-F System 4, Continuous mechanical supply and extract with heat recovery (MVHR), be implemented, trickle vents are not required.
- 8.9 It should be emphasised that the above is not intended to constitute a ventilation strategy design, which is the responsibility of the mechanical engineers. Assumptions regarding the ventilation strategy are required in order to carry out the acoustic assessment.
- 8.10 Once the ventilation strategy is established, if the details vary from those described above, the proposed details should be reassessed for acoustic performance.

8.11 Reverberation time

8.12 From ISO 16283, Reference 9, the reverberation time is typically 0.5 seconds across the relevant frequency range for a furnished living room. This value is used for both living rooms and bedrooms.

8.13 Dimensions and unit descriptions

8.14 The room and window dimensions are taken from the architect's plans and elevations, Reference 12.

8.15 Glazing

8.16 The acoustic performance of the proposed glazing listed in the summary table is taken from Pilkington Glass, Reference 13.

8.17 Opening windows may be acceptable to provide purge ventilation; all opening lights should be well fitted with compressible seals.

8.18 Rooms most exposed to noise ingress

8.19 Calculations are carried out for those rooms most exposed to noise ingress as the worst cases. If these have sufficient sound insulation to meet the internal level criteria, noise levels in less exposed but similarly protected rooms will be lower and therefore also comply with the Local Authority requirements.

8.20 The most exposed rooms are those with the largest ratio of window area to room volume, as well as those closest and most exposed to the noise sources.

8.21 Calculated noise impact

8.22 Façade noise calculations are carried out in octave bands between 125 Hz and 2 kHz since technical data from glazing and trickle vent manufacturers is typically not available outside of this range.

8.23 The measured $L_{Aeq,T}$ octave band spectra in this range have therefore been adjusted so that the single figure A-weighted noise level matches the measured level, which includes minor contributions from frequency bands outside of the calculation range.

8.24 The calculated spectra used in the façade noise calculations are shown in Table 10.

Parameter	dB(A)	Octave Band Centre Frequency / Hz				
		125	250	500	1k	2k
Daytime $L_{Aeq,T}$	55	43	46	48	51	48
Night time $L_{Aeq,T}$	49	34	39	42	46	41
Night time L_{AFmax} (bottle bins)	78	59	65	67	69	76
Night time L_{AFmax} (people)	69	54	59	61	65	61

Table 10: Corrected A-weighted external free-field noise levels used to calculate façade sound insulation

8.25 A summary of the calculated internal levels is shown in Table 11.

Dwelling description	Calculated internal level			Full calculation
	Daytime	Night time		
	dB L _{Aeq, 16hrs}	dB L _{Aeq, 8hrs}	dB L _{AFmax}	
Level 3, northern facade	26	19	45	Table 13
Level 3, north-western facade	28	21	41	Table 14

Table 11: Summary of calculated worst case internal noise levels

9 Noise aspects of mechanical services design

- 9.1 The potential for noise issues from mechanical services is discussed in Appendix 4.
- 9.2 An upper limit of 28 dB(A) in bedrooms and living rooms is suggested for mechanical services noise when ventilating at the minimum low rate in accordance with AD-F. This would be classified as a Class C environment according to the COST TU0901 collaboration programme, Reference 14.
- 9.3 The mechanical services noise limits are both to prevent the total noise from all sources exceeding the limits identified, and to prevent mechanical services noise causing annoyance that may result in occupants curtailing the operation of the ventilation system as described in Problems in Residential Design for Ventilation and Noise, Reference 15.
- 9.4 It is suggested that the specification includes a requirement for commissioning measurements of noise from the mechanical services, to ensure that the contractor pays sufficient attention to the design and construction requirements to meet this limit.
- 9.5 Measurements of mechanical services noise should be made in accordance with the Association of Noise Consultants Guidelines, Reference 17.

10 Potential fixed plant noise impact

- 10.1 It is proposed that, when assessed according to the methodology in BS 4142, Reference 16, noise from mechanical services be limited to a rating level such that the noise impact does not give rise to a SOAEL (as defined in the NPSE).
- 10.2 Based on the distribution and variation of measured background noise levels, $L_{A90, 1 \text{ hr}}$, the typical background levels shown in Table 12 are used in any future assessment of noise impact due to fixed plant associated with the development.

Period	Typical $L_{A90,1\text{hr}}$
Daytime	48
Night-time	40

Table 12: Typical background noise levels

11 Conclusion

- 11.1 Noise levels affecting the proposed development have been measured and the highest noise impact calculated.
- 11.2 On the basis of the measurements, assumptions and details in this report, it is calculated that the minimum façade sound insulation provision as shown in the summary table is required.
- 11.3 A single through-frame slot vent is calculated to adequately maintain the sound insulation of the façade.
- 11.4 It is suggested that a ventilation strategy of either continuous mechanical extract (MEV) or MVHR may be appropriate.
- 11.5 A noise limit of 28 dB(A) in bedrooms and living rooms is proposed for mechanical services noise when ventilating at the minimum low rate in accordance with AD-F; it is suggested that commissioning measurements are undertaken to demonstrate that this is achieved in practice.

12 References

- 1 National Planning Policy Framework, Ministry of Housing, Communities & Local Government, July 2018.
- 2 Noise Policy Statement for England, Department for Environment, Food and Rural Affairs, March 2010.
- 3 BS 8233: 2014, Guidance on sound insulation and noise reduction for buildings.
- 4 Guidelines for Community Noise, Edited by Birgitta Berglund, Thomas Lindvall, Dietrich H Schwela, World Health Organisation, 1999.
- 5 BS 7445:2003, Description and measurement of environmental noise. Guide to quantities and procedures.
- 6 BS EN 12354-3:2000, Building Acoustics – Estimation of acoustic performance of buildings from the performance of elements – Part 3: Airborne sound insulation against outdoor sound.
- 7 Practical Acoustic Design – the Apex Method, Proceedings of the Institute of Acoustics Vol 36 Pt 3 2014. Full paper and Poster presentation at Institute of Acoustics Conference 2014, available to download from www.apexacoustics.co.uk
- 8 Approved Document F 2010 Edition, The Building Regulations 2000.
- 9 BS EN ISO 16283-1:2014 Acoustics – Field measurement of sound insulation in buildings and of building elements – Part 1: Airborne sound insulation.
- 10 Greenwood technical data sheet, October 2001
- 11 RW Simon Data Sheet, January 2013
- 12 Architects Drawings. 18053 001 Location Plan, 18053 050 B Proposed Level 0 Floor Plan, 16033 3011 Q Proposed Level 1 Floor Plan, 16033 3012 K Proposed Level 2 Floor Plan, 16033 3013 P Proposed Level 3 Floor Plan, 18053 4020 B Proposed Elevations, 18053 4021 B Proposed Elevations, 18053 4022 B Proposed Elevations, gdl architecture.
- 13 Pilkington Optiphon™ Laminated Glass for noise control, Pilkington, 8222 – June 2014
- 14 Integrating and Harmonizing Sound Insulation Aspects in Sustainable Urban Housing Constructions. Building acoustics throughout Europe Volume 1: Towards a common framework in building acoustics throughout Europe, COST Action TU0901, 2014, free download from <http://goo.gl/y6Xj3K>
- 15 Harvie-Clark, J. and Siddall, M. Problems in residential design for ventilation and noise, Proc. Institute of Acoustics 2013; 35 (1): 74-87, download from www.apexacoustics.co.uk
- 16 BS 4142: 2014, Method for rating and assessing industrial and commercial sound.
- 17 ANC Guidelines: Noise Measurement in Buildings, Part 1: Noise from Building Services, Association of Noise Consultants, 2011
- 18 Noise from domestic ventilation systems, Apex Acoustics, poster presentation at the Institute of Acoustics Conference 2014, download from www.apexacoustics.co.uk

13 Appendix 1: Current policy and guidance

13.1 National Planning Policy Framework (NPPF)

13.2 The National Planning Policy Framework (NPPF, 2018) sets out the Government's planning policies for England and how these should be applied. It provides a framework within which locally-prepared plans for housing and other development can be produced. In respect of noise, Paragraph 170, 180 and 182 of the NPPF states the following:

13.3 Paragraph 170:

"e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution..."

13.4 Paragraph 180:

"Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:

- a) mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life;
- b) identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason;
... "

13.5 Paragraph 182:

" Planning policies and decisions should ensure that new development can be integrated effectively with existing businesses and community facilities (such as places of worship, pubs, music venues and sports clubs). Existing businesses and facilities should not have unreasonable restrictions placed on them as a result of development permitted after they were established. Where the operation of an existing business or community facility could have a significant adverse effect on

new development (including changes of use) in its vicinity, the applicant (or 'agent of change') should be required to provide suitable mitigation before the development has been completed."

13.6 Noise Policy Statement for England (NPSE)

13.7 The Noise Policy Statement for England states three policy aims as follows:

"Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development:

- avoid significant adverse impacts on health and quality of life;
- mitigate and minimise adverse impacts on health and quality of life; and
- where possible, contribute to the improvement of health and quality of life."

13.8 The NPSE defines adverse noise impact as follows:

- No Observed Effect Level (NOEL)
This is the level below which no effect can be detected. In simple terms, below this level, there is no detectable effect on health and quality of life due to the noise.
- Lowest Observed Adverse Effect Level (LOAEL)
This is the level above which adverse effects on health and quality of life can be detected.
- Significant Observed Adverse Effect Level (SOAEL)
This is the level above which significant adverse effects on health and quality of life occur

13.9 The first two aims of the NPSE require that no significant adverse impact should occur and that, where a noise level which falls between a level which represents the lowest observable adverse effect and a level which represents a significant observed adverse effect, then according to the explanatory notes in the statement:

"... all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life whilst also taking into consideration the guiding principles of sustainable development. This does not mean that such effects cannot occur."

13.10 It is considered that meeting the internal ambient noise level limits given in BS 8233, which are in line with those given by the World Health Organisation, Reference 4, adequately achieve the first and second aims of the NPSE.

14 Appendix 2: WHO Community Noise Guideline values

14.1 Section 4.2.3 of WHO Community Noise Guideline Values discusses how electrophysiological and behavioural methods have demonstrated that both continuous and intermittent noise indoors lead to sleep disturbance.

14.2 The more intense the background noise, the more disturbing is its effect on sleep. Measurable effects on sleep start at background noise levels of about 30 dB L_{Aeq} . Physiological effects include changes in the pattern of sleep stages, especially a reduction in the proportion of REM sleep.

14.3 Subjective effects have also been identified, such as difficulty in falling asleep, perceived sleep quality, and adverse after-effects such as headache and tiredness. Sensitive groups mainly include elderly persons, shift workers and persons with physical or mental disorders.

14.4 Where noise is continuous, the equivalent sound pressure level should not exceed 30 dB(A) indoors, if negative effects on sleep are to be avoided. When the noise is composed of a large proportion of low-frequency sounds a still lower guideline value is recommended, because low frequency noise (e.g. from ventilation systems) can disturb rest and sleep even at low sound pressure levels. It should be noted that the adverse effect of noise partly depends on the nature of the source.

14.5 If the noise is not continuous, L_{Amax} or SEL are used to indicate the probability of noise induced awakenings. Effects have been observed at individual L_{Amax} exposures of 45 dB or less. Consequently, it is important to limit the number of noise events with a L_{Amax} exceeding 45 dB. Therefore, the guidelines should be based on a combination of values of 30 dB $L_{Aeq,8h}$ and 45 dB L_{Amax} . However, Section 3.4 of the WHO guidelines note that for a good sleep, it is believed that indoor sound pressure levels should not exceed approximately 45 dB L_{Amax} more than 10–15 times per night (Vallet & Vernet 1991).

14.6 To protect sensitive persons, a still lower guideline value would be preferred when the background level is low. Sleep disturbance from intermittent noise events

increases with the maximum noise level. Even if the total equivalent noise level is fairly low, a small number of noise events with a high maximum sound pressure level will affect sleep.

14.7 Therefore, to avoid sleep disturbance, guidelines for community noise should be expressed in terms of equivalent sound pressure levels, as well as L_{Amax} / SEL and the number of noise events. Measures reducing disturbance during the first part of the night are believed to be the most effective for reducing problems in falling asleep.

15 Appendix 3: Calculation of façade noise ingress

15.1 The noise level in a room due to sound penetrating a façade element may be calculated according to BS EN 12354-3 and BS 8233 from:

$$L_2 = L_{1,in} - R + 10 \times \log\left(\frac{S}{V}\right) + 10 \times \log(T) + 11$$

Equation 1.

Where:

- L_2 = noise level in room due to sound through façade portion of area S and mean sound reduction index R , dB
- $L_{1, in}$ = external free-field noise level at the position of the façade, dB.
- R = sound reduction index of portion, dB
- S = area of façade portion, m^2 .
- V = room volume, m^3
- T = reverberation time, s.

15.2 For small façade components, such as ventilators, the noise level in a room may be calculated according to the same standards as above from:

$$L_2 = L_{1,in} - D_{n,e} - 10 \times \log(V) + 10 \times \log(T) + 21$$

Equation 2.

Where:

- $D_{n,e}$ = element-normalised sound level difference of the ventilator.

Other components have the same meaning as above.

15.3 The sound reduction of the masonry portion of the facade is much higher than that of the glazing and ventilation provision. Therefore noise penetration through the masonry is disregarded as insignificant compared to noise penetration through the glazing and ventilation provision.

15.4 The noise penetration through the vents and the glazing is calculated as above and then combined in each frequency band to give an overall internal level from the

external sources by these routes. Calculations are carried out in five octave bands as indicated in BS 8233.

Level 3 North façade (balcony)	
Volume, V / m^3	50
Window area, S / m^2	3
Reverberation Time, T / s	0.5
Number of vents feasible	1

Daytime $L_{Aeq, 16 \text{ hr}}$ (dB)	dB(A)	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz
External free-field noise, L_{1in}	55	43	46	48	51	48
Glazing: 6/12/6 mm, R		20	19	29	38	36
Equation 1, $L_2(a)$	25	18	23	15	9	8
Vent: Acoustic EHAS, $D_{n,e}$		40	36	34	35	44
Equation 2, $L_2(b)$	20	3	11	15	17	5
Total noise through all elements, L_2	26					

Night-time $L_{Aeq, 8 \text{ hr}}$ (dB)	dB(A)	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz
External free-field noise, L_{1in}	49	34	39	42	46	41
Glazing: 6/12/6 mm, R		20	19	29	38	36
Equation 1, $L_2(a)$	18	10	16	9	4	1
Vent: Acoustic EHAS, $D_{n,e}$		40	36	34	35	44
Equation 2, $L_2(b)$	14	-5	4	9	12	-2
Total noise through all elements, L_2	19					

Night-time L_{AFmax} (dB)	dB(A)	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz
External free-field noise, L_{1in}	78	59	65	67	69	76
Glazing: 6/12/6 mm, R		20	19	29	38	36
Equation 1, $L_2(a)$	44	34	42	34	27	36
Vent: Acoustic EHAS, $D_{n,e}$		40	36	34	35	44
Equation 2, $L_2(b)$	39	19	30	34	35	33
Total noise through all elements, L_2	45					

Table 13: Calculations for Studio on northern façade

Level 3 North-west façade	
Volume, V / m^3	55
Window area, S / m^2	5
Reverberation Time, T / s	0.5
Number of vents feasible	1

Daytime $L_{\text{Aeq}, 16 \text{ hr}} \text{ (dB)}$	dB(A)	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz
External free-field noise, $L_{1\text{in}}$	55	43	46	48	51	48
Glazing: 6/12/6 mm, R		20	19	29	38	36
Equation 1, $L_2(a)$	27	20	25	17	11	10
Vent: 4000 L, $D_{n,e}$		39	36	34	31	34
Equation 2, $L_2(b)$	23	5	11	14	21	14
Total noise through all elements, L_2	28					

Night-time $L_{\text{Aeq}, 8 \text{ hr}} \text{ (dB)}$	dB(A)	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz
External free-field noise, $L_{1\text{in}}$	49	34	39	42	46	41
Glazing: 6/12/6 mm, R		20	19	29	38	36
Equation 1, $L_2(a)$	19	12	17	11	6	3
Vent: 4000 L, $D_{n,e}$		39	36	34	31	34
Equation 2, $L_2(b)$	17	-4	4	8	15	7
Total noise through all elements, L_2	21					

Night-time $L_{\text{AFmax}} \text{ (dB)}$	dB(A)	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz
External free-field noise, $L_{1\text{in}}$	69	54	59	61	65	61
Glazing: 6/12/6 mm, R		20	19	29	38	36
Equation 1, $L_2(a)$	40	32	38	30	25	23
Vent: 4000 L, $D_{n,e}$		39	36	34	31	34
Equation 2, $L_2(b)$	36	16	24	28	34	28
Total noise through all elements, L_2	41					

Table 14: Calculations for Studio on north-western facade

16 Appendix 4: Mechanical ventilation systems

16.1 Noise from the MVHR unit

- 16.2 Noise from mechanical ventilation systems is not currently controlled under the Building Regulations.
- 16.3 There is no formal requirement to associate any particular ventilation condition with any particular noise level limit.
- 16.4 There is guidance in Approved Document F (AD-F) that noise from mechanical services should not exceed 30 dB(A) in bedrooms and living rooms, and not exceed a limit of 35 dB(A) in kitchens, when ventilating at the minimum low rate according to AD-F.
- 16.5 Problems with the dissociation of ventilation condition and noise level are discussed by Harvie-Clark and Siddall, Reference 15.
- 16.6 On the basis of the literature review presented by Harvie-Clark and Siddall, it is suggested that these limits may cause annoyance to a significant proportion of people. Annoyance can result in occupants curtailing the operation of the ventilation system. Such action leads to inadequate ventilation resulting in poor air quality, which is well correlated with a range of adverse health effects, as described in Reference 15.
- 16.7 Tolerance to domestic mechanical ventilation system noise has not yet been investigated in the UK, and may well be culturally- dependent. However, it is suggested that appropriate noise level limits associated with the minimum low ventilation rate may be informed by COST Action TU0901, Reference 14.

Table 5.4. Sound levels in dwellings due to building service equipment.
Class limits.⁽¹⁾

Type of space and sources ⁽²⁾	Class A <i>L</i> _{eq} or <i>L</i> _{maxF} (dB)	Class B <i>L</i> _{eq} or <i>L</i> _{maxF} (dB)	Class C <i>L</i> _{eq} or <i>L</i> _{maxF} (dB)	Class D <i>L</i> _{eq} or <i>L</i> _{maxF} (dB)	Class E <i>L</i> _{eq} or <i>L</i> _{maxF} (dB)	Class F <i>L</i> _{eq} or <i>L</i> _{maxF} (dB)
In dwellings due to ventilation / heating / cooling installation <i>L</i> _{eq}	≤ 20	≤ 24	≤ 28	≤ 32	≤ 36	≤ 40

- 16.8 This European project of scientific collaboration associates noise levels with different classes of performance in its Table 5.4, as reproduced below.
- 16.9 This classification system is set to become an ISO Standard in approximately 2018, when the classification system is likely to be adopted into English Building Regulations.
- 16.10 It is suggested that for reasonable conditions the values for at least Class C area adopted as the design target, ie 28 dB(A).
- 16.11 It is suggested that the client include a requirement for commissioning measurements of MVHR noise to ensure that these levels are met in practice. Measurements should be made according to the Association of Noise Consultants Guidelines.
- 16.12 There is currently considered to be insufficient understanding of appropriate noise limits during the minimum high ventilation rate (boost condition), and therefore limits for this condition are not proposed.
- 16.13 Noise implications of other design issues
- 16.14 As well as ducted noise from the MVHR unit, there is potential for ventilation systems which are not well designed to develop a negative noise impact. For example, locating the unit on a light-weight wall, or in the loft directly over bedrooms may be inappropriate and lead to an adverse noise impact.
- 16.15 If the filters are not regularly changed, the fan may increase in effort to counteract the additional flow resistance, resulting in higher noise levels. The unit should therefore be in a place that facilitates its operation and maintenance.
- 16.16 Further guidance on issues with domestic mechanical services that can cause noise problems are identified in Noise from Domestic Ventilation Systems, Reference 18.
- 16.17 Cross-talk between rooms
- 16.18 Where there are ducts between rooms, there is potential for noise transmission between them; this is generally undesirable for the residents, but is not currently regulated. It is suggested that the level of cross-talk between rooms is limited such that *D*_{ne,w} ≥ 45 dB.

16.19 Distribution systems that utilise single ducts from a plenum to each vent typically overcome the requirement for cross-talk attenuators.

16.20 Purge ventilation and over heating

16.21 Overheating has traditionally been controlled by the use of purge ventilation; over heating is not controlled under the Building Regulations, and there is no universally accepted definition.

16.22 In locations with an unfavourable external noise environment, utilising open windows to provide purge ventilation during the night time is unlikely to be compatible with undisturbed sleep, and is therefore undesirable.

16.23 As a means of sufficient ventilation for air quality purposes that is compatible with maintaining the façade sound insulation is proposed in this report, it is suggested that the designers give sufficient attention to preventing overheating such that purge ventilation is not required during the night time period.