Noise Survey and
Façade Acoustic Design Strategy
Eskdale Drive, Jarrow

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1. Revision register

Version	Changes from previous version	Issued by	Date

2. Contents

3. Summary

3.1 This report has been prepared in support of a planning requirement for a residential development in Jarrow.

3.2 Requirements have been agreed with the Local Authority and require internal ambient noise levels to be below set limits.

3.3 Noise levels affecting the proposed development from road traffic have been measured and the façade noise impact calculated.

3.4 Calculated noise levels are used to determine the potential façade sound insulation treatments to meet the internal noise level requirements of the Local Planning Authority.

3.5 A set of minimum glazing and ventilation strategy options, interpreted from Approved Document F (AD-F), is proposed as shown in Table 1 and illustrated in Figure 1.

3.6 A limit of 28 dB(A) in bedrooms and living rooms is suggested for mechanical services noise.

<table>
<tr><th>Façade affected</th><th>Glazing / mm</th><th>Potential ventilation strategy</th></tr>
<tr><td></td><td>10-16-4
Double glazing</td><td rowspan="2">AD-F System 3, continuous mechanical extract (MEV), using of a single acoustic trickle vent such as TITON SF X V75 + C75

OR

AD-F System 4, mechanical supply and extract with heat recovery (MVHR). No vent is required.</td></tr>
<tr><td></td><td>4-16-4
Double glazing</td></tr>
<tr><td></td><td>4-16-4
Double glazing</td><td>AD-F System 3, continuous mechanical extract (MEV), using of a single trickle vent such as Greenwoods 4000L

OR

AD-F System 4, mechanical supply and extract with heat recovery (MVHR). No vent is required.</td></tr>
<tr><td></td><td>10-16-6.4
Laminate Double glazing</td><td rowspan="3">AD-F System 4, mechanical supply and extract with heat recovery (MVHR). No vent is permissible.</td></tr>
<tr><td></td><td>10-16-4
Double glazing</td></tr>
<tr><td></td><td>4-16-4
Double glazing</td></tr>
</table>

Table 1: Summary of minimum façade sound insulation treatment

Figure 1: Façade layout

4. Introduction

4.1 A residential development consisting of 106 plots is proposed at Eskdale Drive in Jarrow.

4.2 The site location is shown in Figure 2.

4.3 Apex Acoustics has been commissioned to undertake a noise survey and provide advice on the sound insulation of the façade to achieve the internal levels required by the Local Planning Authority.

4.4 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.

4.5 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.

4.6 Internal noise transmission and the sound insulation requirements of the Building Regulations are not considered in this report.

Figure 2: Site location outlined in red and measurement positions indicated by "1" and "2"

5. Guidance and agreed requirements

5.1 Noise criteria have been agreed with the Local Authority.

5.2 The National Planning Policy Framework (NPPF, 2012), Reference 1, sets out the Government's economic, environmental and social planning policies for England.

5.3 The NPPF is consistent with the Noise Policy Statement for England (NPSE), Reference 2.

5.4 The aims and further details of the NPPF and NPSE are discussed in Appendix 2.

5.5 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

5.6 Note 4 to Table 4 of BS 8233 states:

"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."

5.7 Due to heavy traffic on both roads, this is considered as continuous noise and maximums are therefore not considered in this assessment, as per WHO Guidelines discussed in Appendix 3.

5.8 The limits identified in BS 8233 are agreed as the criteria.

6. Noise sources and measurements

6.1 Measurements of the existing noise environment were made using the guidance of Calculation of Road Traffic Noise (CRTN), Reference 5.

6.2 Measurements were made during the day at the positions indicated in Figure 2. The positions are selected to be representative of both the A19 and the A194.

6.3 Measurements were made with the microphone located at 1.5 m above ground level, away from other reflecting surfaces, such that they are considered to be free field.

6.4 The equipment used is listed in Table 3.

Equipment	Model	Serial no.
Sound Level Meter	NTI XL2	A2A-09585-E0
Calibrator	Larson Davis CAL 200	12573

Table 3: Equipment used

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

6.6 Measurements were made on the 4th January 2017. The temperature was around 4°C; the average wind speed measured was 1 m/s at Position 1 and 5 m/s at Position 2.

6.7 The most significant noise sources affecting the proposed development were road traffic on A19 and A194.

6.8 An illustration of the measurements in progress in Position 1 is shown in Figure 3.

6.9 A sample of the time history of the $L_{Aeq, 1 sec}$ for each position are shown in Appendix 1.

Figure 3: Measurements in progress at Position 1

7. Results

7.1 The measured noise levels are shown in Table 4.

Position	Start time / hh:mm	$L_{Aeq,10mins}$ / dB	Octave Band Centre Frequency / Hz					
			125	250	500	1000	2000	4000
1	13:45	63	44	45	55	61	56	44
	14:00	64	44	47	56	62	57	44
	15:31	66	47	47	57	64	59	46
2	14:30	72	52	54	61	71	63	49
	15:10	71	52	54	60	69	63	49
	16:45	72	52	54	61	71	63	49

Table 4: Measured noise levels

7.2 The calculation method of the overall daytime noise level, $L_{Aeq,\ 16\ hr}$ and night-time noise level, $L_{Aeq,\ 8\ hr}$, from the measured data is described in Appendix 4, in accordance with CRTN and Transport Research Laboratory, Reference 6.

7.3 The measured values of the L_{A10} for three consecutive hours are shown in Table 5.

Time Period	Measured noise level, L_{A10} / dB	
	Position 1	Position 2
First hour	67	74
Second hour	67	73
Third hour	69	74

Table 5: Measured L_{A10} over three consecutive hours

7.4 The calculation of the daytime $L_{Aeq,\ 16\ hr}$ noise level is shown in Table 6.

Parameter	Level / dB	
	Position 1	Position 2
Arithmetic mean $L_{A10,3hr}$	67	74
$L_{A10,18hr}$	66	73
$L_{Aeq,16hr}$	64	71

Table 6: Calculation $L_{Aeq,16hr}$ from measured L_{A10}

7.5 The calculated daytime $L_{Aeq,\ 16\ hr}$ and night-time $L_{Aeq,\ 8\ hr}$ noise levels are shown in Table 7.

Parameter	Level / dB	
	Position 1	Position 2
Daytime, $L_{Aeq,\ 16\ hr}$	64	71
Night time, $L_{Aeq,\ 8\ hr}$	56	62

Table 7: Calculated and measured noise levels

8. Calculated noise impact

8.1 Sound transmission and propagation is modelled using proprietary software, CadnaA, Reference 7. This models sound propagation outdoors according to ISO 9613, Reference 8.

8.2 The parameters used, source of data and details are described in Table 8.

Parameter	Source	Details
Model dimensions	Google Earth	British Transverse Mercator coordinates
Site location and layout	Architects drawings	Architects drawings, References 13, 14
Topography – within site	Site observations, Google Street view and Topography survey from client	Topography survey, Reference 20
Topography – Outside of site	Site observations and Google Street view	Modelled with changes in topography
Building heights – proposed buildings	Drawings	Architects drawings, References 13, 14
Building heights – outside of site	Site observations and Google Street view	3 m per storey + 2 m roof (residential properties)
Receptor positions	Site observations and Google Street view	On the NSSL façade closest to the source at a height of 4 m to represent first floor window height
Building and barrier absorption coefficient	ISO 9613-2	0.21 to represent a reflection loss of 1 dB
G, Ground factor	ISO 9613-2	Hard ground, G = 0
Max. order of reflections	Apex Acoustics	Three

Table 8: Modelling parameters and assumptions

8.3 Using the calculated daytime noise levels to ascribe sound power levels to the surrounding roads, the noise impact at the proposed building façade is calculated.

8.4 A plan view of the model with the graphical results at 4 m above the ground during the day is shown in Figure 5, and during the night in Figure 6. A 3D view of the noise model is shown in Figure 4.

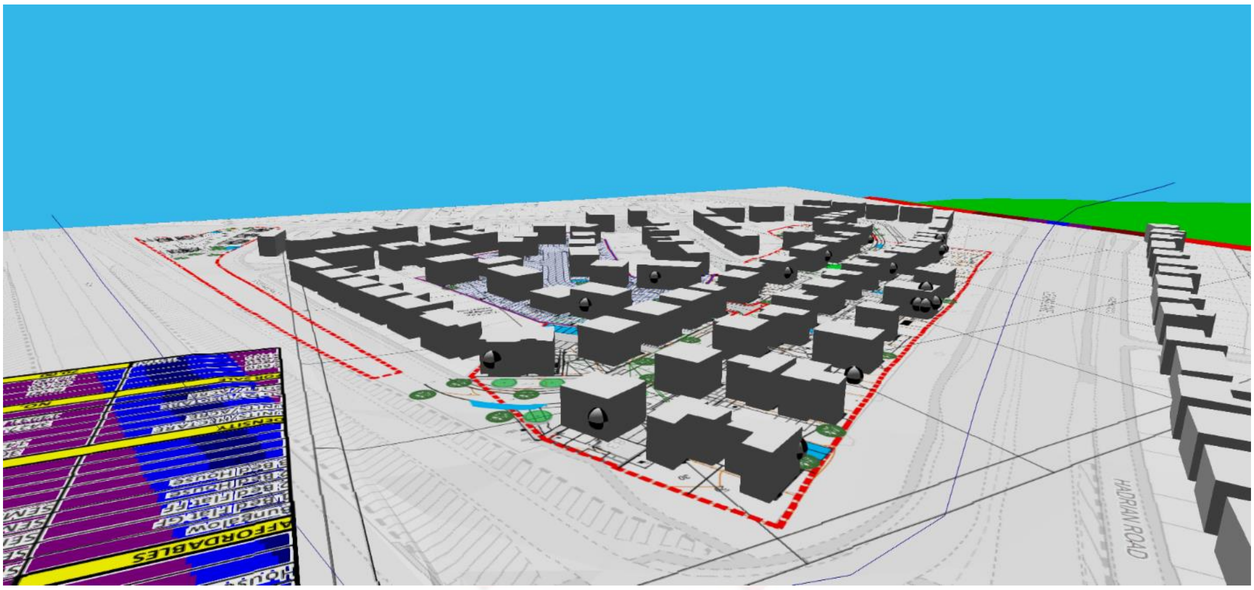

Figure 4: 3D view of model

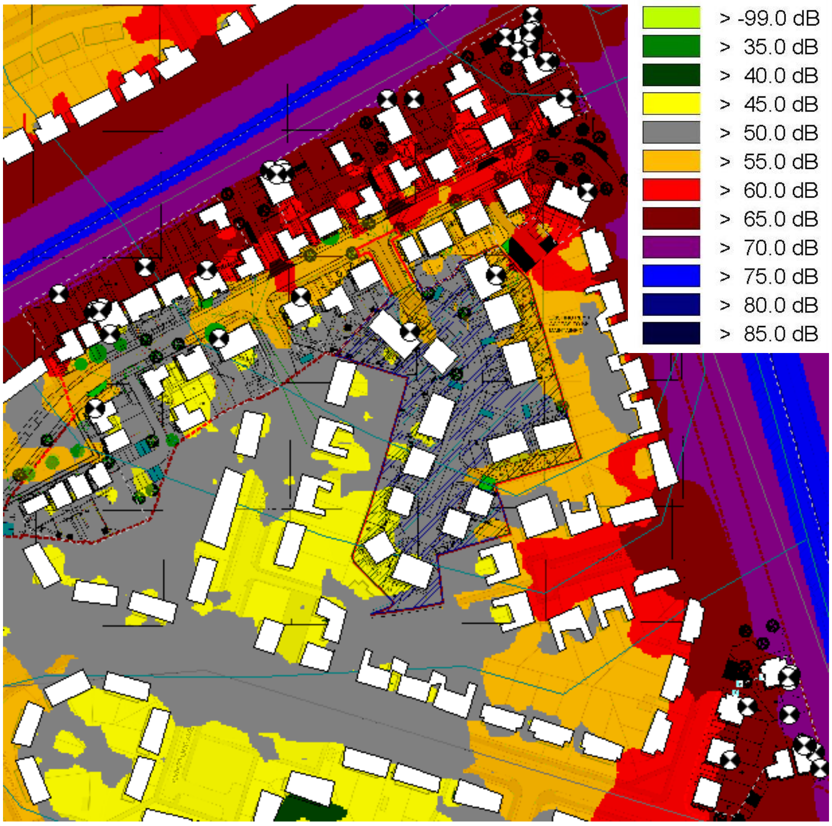

Figure 5: Plan view showing noise contours during the day at 4 m

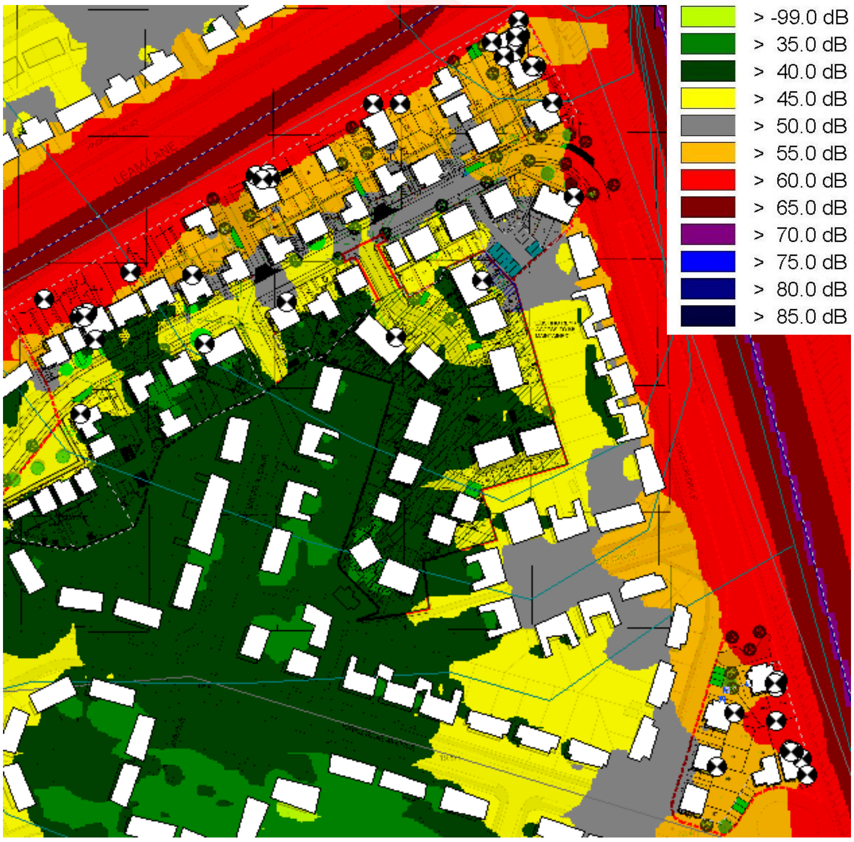

Figure 6: Plan view showing noise contours during the night at 4 m

9. Mitigation measure – Garden

9.1 Due to the proximity of the site from busy roads, external noise levels within gardens are shown for indication.

9.2 BS 8233 advises on external noise level limits in private garden and states as follow:

For traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external noise level does not exceed 50 dB $L_{Aeq, T}$, with an upper guideline value of 55 dB $L_{Aeq, T}$ which would be acceptable in noisier environments. However, it is also recognized that these guideline values are not achievable in all circumstances where development might be desirable. In higher noise areas, such as city centres or urban areas adjoining the strategic transport network, a compromise between elevated noise levels and other factors, such as the convenience of living in these locations or making efficient use of land resources to ensure developments needs can be met, might be warranted. In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited.

9.3 **Without barriers**

9.4 The closest gardens from the road are exposed to external noise levels above the upper limit set by BS 8233 of 55 dB $L_{Aeq, T}$.as shown in Figure 7.

9.5 **With barriers**

9.6 Barriers of 1.8 m height are calculated to ensure external levels to be under 60 dB $L_{Aeq, T}$ in the outskirt plots. This is considered to be the levels that can be achieved practically.

9.7 In most cases, the upper limit set by BS 8233 of 55 dB $L_{Aeq, T}$ is achieved.

9.8 Locations of the barriers are shown in cyan in Figure 8.

9.9 To be effective in practice, the barrier should have no cracks or gaps, be continuous to the ground, and have a surface density ≥ 10 kg/m^2 such as a timber fence or brick wall.

9.10 If barriers are installed, this may lower the required glazing specifications.

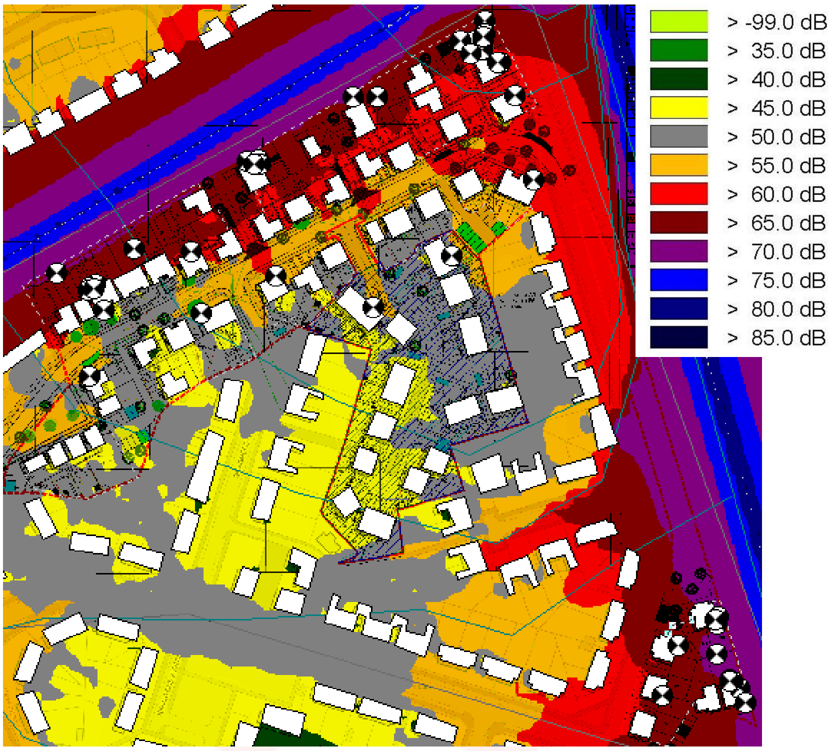

Figure 7: Plan view showing sound contours at 1.5 m in daytime without mitigation.

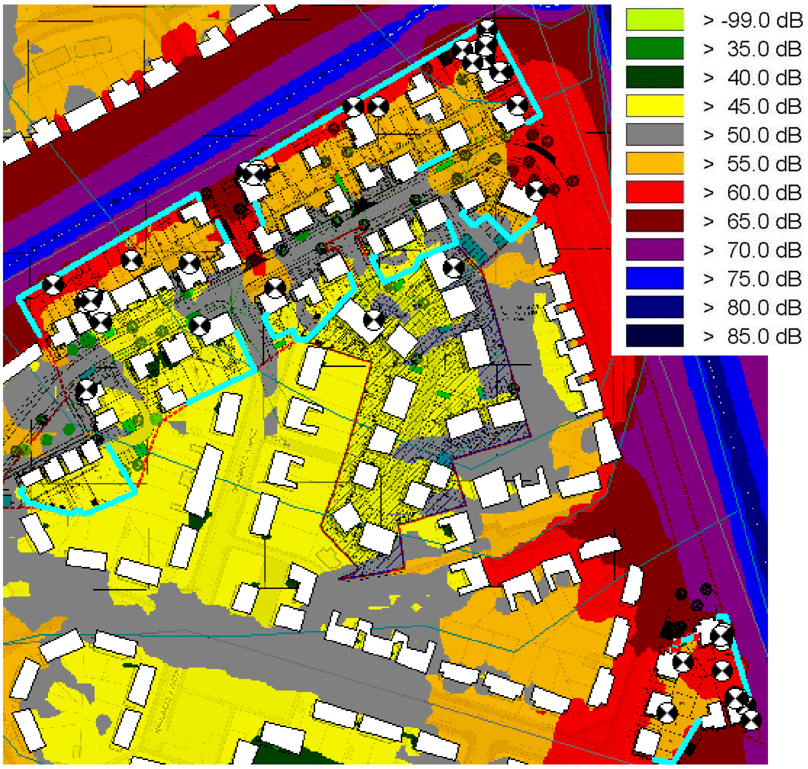

Figure 8: Plan view showing sound contours at 1.5 m in daytime with mitigation.
1.8 m height barrier in cyan

10. Facade noise calculations

10.1 The calculation method for façade sound insulation is in accordance with BS 8233 and the principles of BS EN 12354-3, Reference 9, as described in Appendix 5. It is detailed in the Apex method, Reference 10.

10.2 **Ventilation strategy**

10.3 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 11.

10.4 For AD-F System 1, Background ventilators and intermittent extract fans, the quantity of trickle vents required is not typically feasible acoustically.

10.5 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 standard or acoustic slot vent, e.g. Titon SF X V75 / SFSA C75 or Greenwoods 4000L, with manufacturer's data for the element normalised level difference, $D_{n,e}$. Other vents may also be assessed for suitability.

10.6 Should AD-F System 4, Continuous mechanical supply and extract with heat recovery (MVHR), be implemented, trickle vents are not required.

10.7 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.

10.8 Once the ventilation strategy is established, if the details vary from those described above, the proposed details should be reassessed for acoustic performance.

10.9 **Reverberation time**

10.10 From ISO 16283-1, Reference 12, 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.

10.11 **Dimensions and unit descriptions**

10.12 The room and window dimensions are taken from the architect's plans and elevations, Reference 13 and 14.

10.13 **Glazing**

10.14 The acoustic performance of the proposed glazing listed in the summary table is taken from Pilkington, Reference 15.

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

10.16 **Façade construction details**

10.17 The construction details were advised by the architects.

10.18 It is understood the wall for the house to be a double skin 100 mm brick and aerated blockwork with 100 mm fully filled cavity and plasterboard on the inside.

10.19 For the affordable house the brick layer is replaced by a 90 mm layer of medium density blockwork.

10.20 The roof is proposed to be concrete roofing tiles on 25 mm battens, 400 mm insulation within the trusses and a plasterboard on the underside.

10.21 This is considered into the calculations.

10.22 **Rooms most exposed to noise ingress**

10.23 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.

10.24 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.

10.25 As night time levels are more than 5 dB lower than the daytime levels, the calculation are not reported as the daytime is the limiting factor.

10.26 A summary of the calculated internal levels is shown in Table 9.

Dwelling description	Calculated internal level / dB	Full calculation
	Daytime	
Plot 1 - HT6, Bedroom 2	23	Table 10
Plot 10 – HT3, Bedroom 3	32	Table 11
Plot 11 – HT6, Bedroom 4	30	Table 12
Plot 12 – HT6, Bedroom 4	29	Table 13
Plot 30 – HT6, Bedroom 4	32	Table 14
Plot 44 – 2B4P (Affordable), Bedroom 1	29	Table 15
Plot 86 – HT2, Bedroom 1	29	Table 16
Plot 91 – HT6, Bedroom 4	25	Table 17
Plot 102 – HT3, Bedroom 1	29	Table 18
Plot 102 – HT3, Bedroom 2	31	Table 19
Plot 105 – HT6, Bedroom 4	32	Table 20
Plot 106 – HT6, Bedroom 4	29	Table 21

Table 9: Summary of calculated worst case internal noise levels

11. Noise aspects of mechanical services design

11.1 The potential for noise issues from mechanical services is discussed in Appendix 6.

11.2 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 16.

11.3 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 17.

11.4 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.

11.5 Measurements of mechanical services noise should be made in accordance with the Association of Noise Consultants Guidelines, Reference 18.

12. Conclusion

12.1 Noise levels affecting the proposed development have been measured and the highest noise impact calculated.

12.2 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.

13. References

1. National Planning Policy Framework, Department for Communities and Local Government, March 2012.
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 Bergland, Thomas Lindvall, Dietrich H Schwela, World Health Organisation, 1999.
5. Calculation of Road Traffic Noise, Department of Transport, 1988.
6. Transport Research Laboratory / Defra, Method for converting the UK road traffic noise index $L_{A10,\ 18\ hr}$ to the EU noise indices for noise mapping, 2006.
7. CadnaA environmental noise modelling software, version 2017, Datakustik GmbH.
8. ISO 9613: Acoustics - Attenuation of sound during propagation outdoors
9. 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.
10. 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
11. Approved Document F 2010 Edition, The Building Regulations 2000.
12. BS EN ISO 16283-1: 2014. Acoustics – Field measurement of sound insulation in buildings and of building elements – Part 1: Airborne sound insulation.
13. Plan B Housing Drawings. Project no. N81-2404, Drawings 3B5P, 2B-4P, HT 1_01, Bung NF

14. IDPartnership Northern Drawings. Project No. N81:0000 drawing no. HT6-01, LP-01

15. Pilkington Glass technical data sheet

16. 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

17. 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

18. ANC Guidelines: Noise Measurement in Buildings, Part 1: Noise from Building Services, Association of Noise Consultants, 2011

19. Noise from domestic ventilation systems, Apex Acoustics, poster presentation at the Institute of Acoustics Conference 2014, download from www.apexacoustics.co.uk

20. Three60 mapping's drawings, Tarran Dorran Jarrow, Project No. KM/TD/001

14. Appendix 1: Time histories

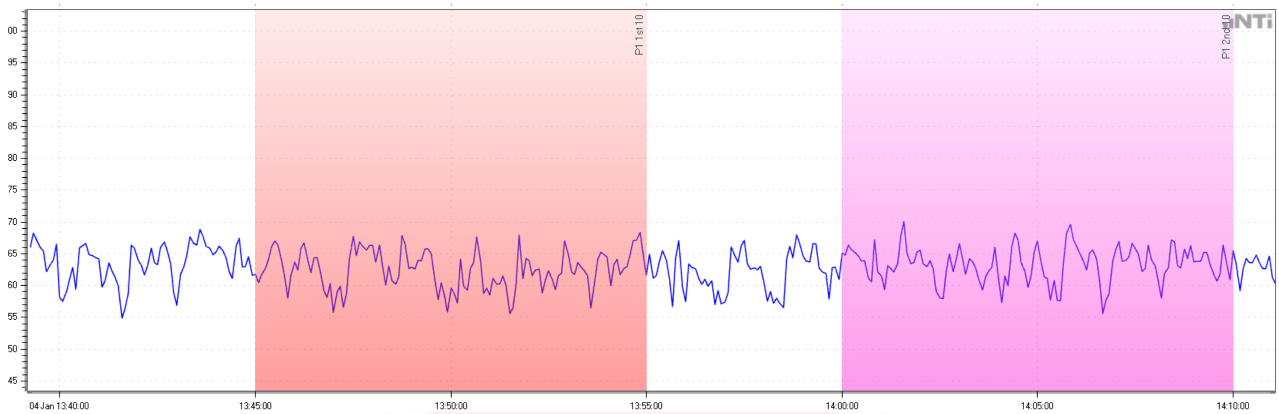

Figure 9: $L_{Aeq,\,1\,sec}$ between 13:39 and 14:11 hrs at Position 1

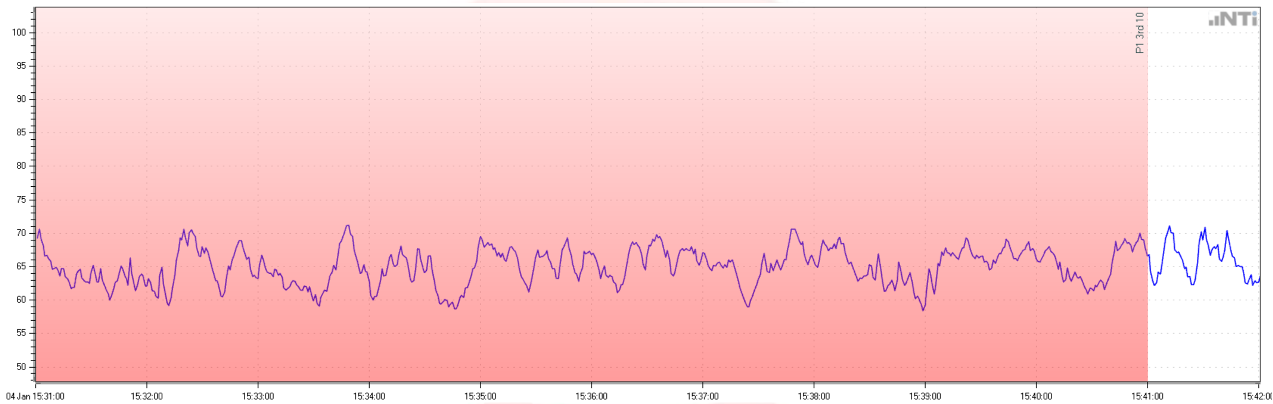

Figure 10: $L_{Aeq,\,1\,sec}$ between 15:31 and 15:42 hrs at Position 1

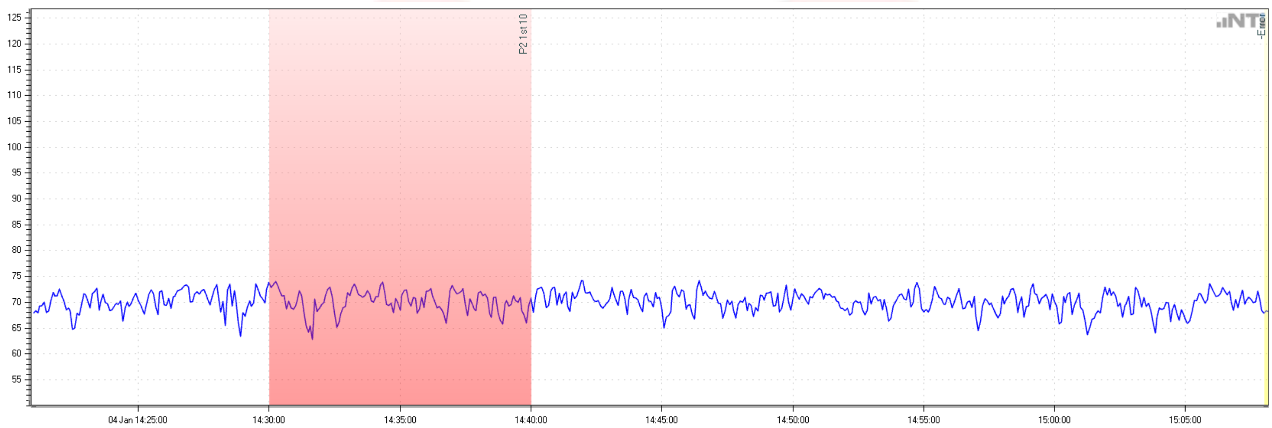

Figure 11: $L_{Aeq,\,1\,sec}$ between 14:20 and 15:08 hrs at Position 2

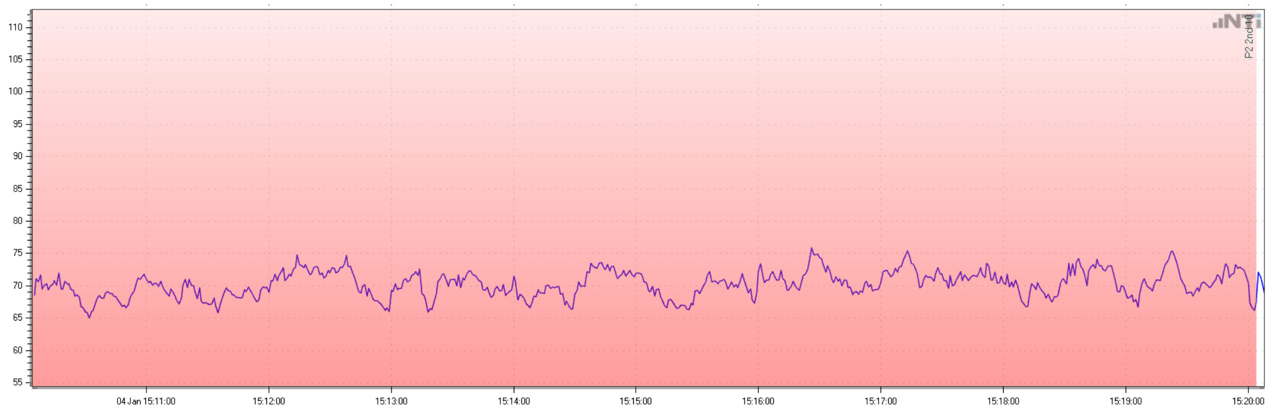

Figure 12: $L_{Aeq, 1\ sec}$ between 15:10 and 15:20 hrs at Position 2

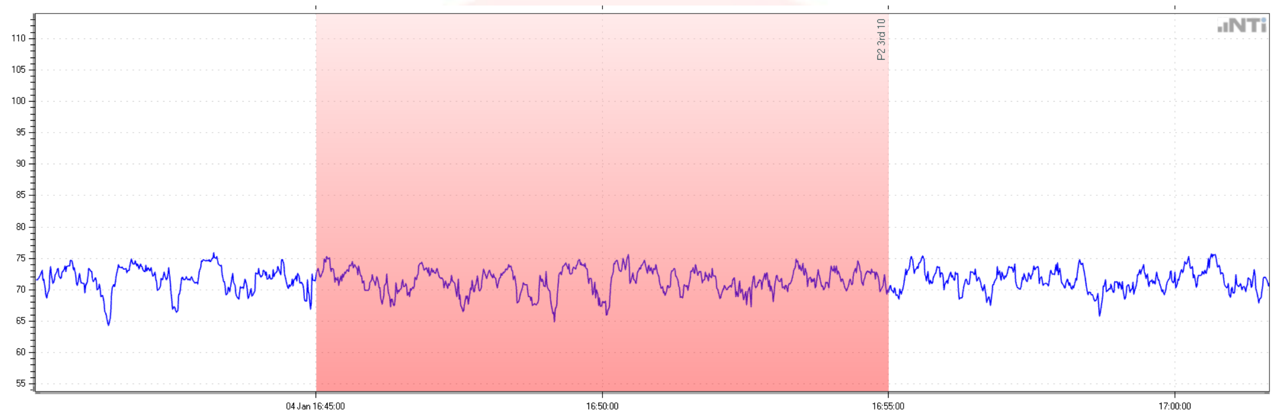

Figure 13: $L_{Aeq, 1\ sec}$ between 16:40 and 17:01 hrs at Position 2

15. Appendix 2: Current policy and guidance

15.1 **National Planning Policy Framework (NPPF)**

15.2 The National Planning Policy Framework (NPPF, 2012) sets out the Government's economic, environmental and social planning policies for England and "these policies articulate the Government's vision of sustainable development". In respect of noise, Paragraph 123 of the NPPF states the following:

"Planning policies and decisions should aim to:

- avoid noise from giving rise to significant adverse impacts on health and quality of life as a result of new development
- mitigate and reduce to a minimum other adverse impacts on health and quality of life arising from noise from new development, including through the use of conditions,
- recognise that development will often create some noise and existing businesses wanting to develop in continuance of their business should not have unreasonable restriction put on them because of changes in nearby land uses since they were established; and
- identify and protect areas of tranquillity which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason."

15.3 **Noise Policy Statement for England (NPSE)**

15.4 The NPPF is consistent with the Noise Policy Statement for England which 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."

15.5 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

15.6 Together, the first two aims of the NPPF and 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."

15.7 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.

16. Appendix 3: WHO Community Noise Guideline values

16.1 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.

16.2 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.

16.3 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.

16.4 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.

16.5 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).

16.6 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.

16.7 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.

17. Appendix 4: Calculation of daytime and night-time levels

17.1 **Calculation of $L_{A10, 18hr}$ using CRTN shortened measurement procedure**

17.2 The shortened measurement procedure outlined in CRTN, paragraph 43 can be used to calculate the $L_{A10,18hr}$ from measurements of the L_{A10} made over any 3 consecutive hours between 10:00 and 17:00. The measured values are shown in Table 5.

17.3 For the shortened measurement procedure, the arithmetic mean of the three noise levels shown is taken and the $L_{A10,18hr}$ calculated from the $L_{A10,3hr}$ as shown in the equation below:

$$L_{A10,18hr} = L_{A10,3hr} - 1 \text{ dB}$$

17.4 **Calculation of $L_{Aeq, 16hr}$ from the $L_{A10, 18hr}$**

17.5 BS 8233 states that for road traffic noise the $L_{Aeq,16hr}$ can be calculated from the $L_{A10,18hr}$ as shown in the equation below:

$$L_{Aeq,16hr} = L_{A10,18hr} - 2 \text{ dB}$$

17.6 The $L_{Aeq,16hr}$ is calculated as shown in Table 6.

17.7 The TRL use the following equations to determine day ($L_{Aeq, 8 hr}$), evening ($L_{Aeq, 4 hr}$) and night-time ($L_{Aeq, 8 hr}$) noise levels from the equations below for different road types.

17.8 For non-motorway roads:

$$L_{night} = 0.90 \times L_{A10,18hr} - 3.77 \text{ dB}$$

18. Appendix 5: Calculation of façade noise ingress

18.1 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.

18.2 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.

18.3 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.

18.4 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.

Plot 1

Bedroom 2	
Volume, V /m³	33.8
Window area, S /m²	2.2
Wall area, S /m²	9.5
Reverberation Time, T /s	0.5
Number of vents required	1

Octave centre frequency	**dB(A)**	**125 Hz**	**250 Hz**	**500 Hz**	**1 kHz**	**2 kHz**
Daytime freefield noise, L_{1in} / dB(A) Leq	**51**	**34**	**34**	**41**	**50**	**44**
4/16/4 double glazing, R / dB		24	20	25	35	38
Equation 1, L_2 / dB(A) Leq	**16**	6	10	12	11	2
100 mm brick, 100 mm filled cavity, 100 mm aerated blockwork		44	39	43	54	64
Equation 2, L_2 / dB(A) Leq	**4**	-8	-3	1	-2	-18
Greenwoods 4000 L trickle vent, Dn,e / dB		39	36	34	31	34
Equation 3, L_2 / dB(A) Leq	**22**	-2	1	10	21	12
Combined noise through all building elements / dB(A) Leq	**23**					

Table 10: Calculations for Plot 1 – HT6, Bedroom 2

Plot 10

Bedroom 3	
Volume, V /m³	16.8
Window area, S /m²	1.4
Wall area, S /m²	4.3
Reverberation Time, T /s	0.5
Number of vents required	1

Octave centre frequency	**dB(A)**	**125 Hz**	**250 Hz**	**500 Hz**	**1 kHz**	**2 kHz**
Daytime freefield noise, L_{1in} / dB(A) Leq	**64**	**44**	**45**	**55**	**62**	**58**
4/16/4 double glazing, R / dB		24	20	25	35	38
Equation 1, L_2 / dB(A) Leq	**30**	17	22	27	24	17
100 mm brick, 100 mm filled cavity, 100 mm aerated blockwork		44	39	43	54	64
Equation 2, L_2 / dB(A) Leq	**16**	2	8	14	10	-4
TITON SF X V75 + C75 vent, Dn,e / dB		37	37	36	47	49
Equation 3, L_2 / dB(A) Leq	**27**	13	14	25	21	14
Combined noise through all building elements / dB(A) Leq	**32**					

Table 11: Calculations for Plot 10 – HT3, Bedroom 3

Plot 11

Bedroom 4	
Volume, V /m^3	17.7
Window area, S /m^2	2.2
Wall area, S /m^2	13.7
Reverberation Time, T /s	0.5
Number of vents required	1

Octave centre frequency	**dB(A)**	**125 Hz**	**250 Hz**	**500 Hz**	**1 kHz**	**2 kHz**
Daytime freefield noise, L_{1in} / dB(A) Leq	**64**	**44**	**45**	**55**	**62**	**57**
10/16/4 double glazing, R / dB		25	22	33	40	43
Equation 1, L_2 / dB(A) Leq	**27**	18	22	21	21	13
100 mm brick, 100 mm filled cavity, 100 mm aerated blockwork		44	39	43	54	64
Equation 2, L_2 / dB(A) Leq	**21**	7	13	19	15	0
TITON SF X V75 + C75 vent, Dn,e / dB		37	37	36	47	49
Equation 3, L_2 / dB(A) Leq	**27**	13	14	25	21	14
Combined noise through all building elements / dB(A) Leq	**30**					

Table 12: Calculations for Plot 11 – HT6, Bedroom 4

Plot 12

Bedroom 4	Façade 1	Façade 2
Volume, V /m^3	17.7	
Window area, S /m^2	1.1	1.1
Wall area, S /m^2	4.2	6.7
Reverberation Time, T /s	0.5	
Number of vents required	0	
Roof area	12.6	

Octave centre frequency	**dB(A)**	**125 Hz**	**250 Hz**	**500 Hz**	**1 kHz**	**2 kHz**
1-West, Daytime freefield noise, L_{1in} / dB(A) Leq	**66**	**46**	**48**	**58**	**64**	**60**
10/16/4 double glazing, R / dB		25	22	33	40	43
Equation 1, L_2 / dB(A) Leq	**26**	17	21	20	20	13
100 mm brick, 100 mm filled cavity, 100 mm aerated blockwork		44	39	43	54	64
Equation 2, L_2 / dB(A) Leq	**19**	4	10	16	12	-2
2-South, Daytime freefield noise, L1in / dB(A) Leq	**61**	**40**	**42**	**52**	**59**	**55**
10/16/4 double glazing, R / dB		25	22	33	40	43
Equation 1, L_2 / dB(A) Leq	**21**	11	15	15	15	7
100 mm brick, 100 mm filled cavity, 100 mm aerated blockwork		44	39	43	54	64
Equation 2, L_2 / dB(A) Leq	**15**	0	6	13	9	-6
3-Roof, Daytime freefield noise, L1in / dB(A) Leq	**59**	**42**	**42**	**51**	**58**	**52**
Roof tiles, 1 m void filled with 400 mm quilt on 12.5 wallboard		36	41	46	50	45
Equation 1, L_2 / dB(A) Leq	**19**	12	8	11	14	13
Combined noise through all building elements / dB(A) Leq	**29**					

Table 13: Calculations for Plot 12 – HT6, Bedroom 3

Plot 30

Bedroom 4	Façade 1	Façade 2
Volume, V /m³	17.7	
Window area, S /m²	1.1	1.1
Wall area, S /m²	4.2	9.5
Reverberation Time, T /s	0.5	
Number of vents required	0	
Roof area	7.3	

Octave centre frequency	dB(A)	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz
1-North, Daytime freefield noise, L_{1in} / dB(A) Leq	**68**	**49**	**51**	**58**	**67**	**60**
10/16/4 double glazing, R / dB		25	22	33	40	43
Equation 1, L_2 / dB(A) Leq	**29**	20	25	20	23	13
100 mm brick, 100 mm filled cavity, 100 mm aerated blockwork		44	39	43	54	64
Equation 2, L_2 / dB(A) Leq	**20**	7	14	16	15	-2
2-east, Daytime freefield noise, L1in / dB(A) Leq	**67**	**48**	**50**	**57**	**66**	**59**
10/16/4 double glazing, R / dB		25	22	33	40	43
Equation 1, L_2 / dB(A) Leq	**27**	19	24	20	22	12
100 mm brick, 100 mm filled cavity, 100 mm aerated blockwork		44	39	43	54	64
Equation 2, L_2 / dB(A) Leq	**23**	9	16	19	17	1
3-Roof, Daytime freefield noise, L1in / dB(A) Leq	**62**	**43**	**44**	**51**	**61**	**54**
Roof tiles, 1 m void filled with 400 mm quilt on 12.5 wallboard		36	41	46	50	45
Equation 1, L_2 / dB(A) Leq	**19**	11	7	9	15	13
Combined noise through all building elements / dB(A) Leq	**32**					

Table 14: Calculations for Plot 30 – HT6, Bedroom 4

Plot 44

Bedroom 2	
Volume, V /m^3	36.7
Window area, S /m^2	2.8
Wall area, S /m^2	9.6
Reverberation Time, T /s	0.5
Number of vents required	1

Octave centre frequency	**dB(A)**	**125 Hz**	**250 Hz**	**500 Hz**	**1 kHz**	**2 kHz**
Daytime freefield noise, L_{1in} / dB(A) Leq	**58**	**40**	**41**	**46**	**56**	**50**
4/16/4 double glazing, R / dB		24	20	25	35	38
Equation 1, L_2 / dB(A) Leq	**23**	13	18	18	18	8
100 mm brick, 100 mm filled cavity, 100 mm aerated blockwork		44	39	43	54	64
Equation 2, L_2 / dB(A) Leq	**10**	-2	4	5	4	-12
Greenwoods 4000 L trickle vent, Dn,e / dB		39	36	34	31	34
Equation 3, L_2 / dB(A) Leq	**28**	4	8	14	27	18
Combined noise through all building elements / dB(A) Leq	**29**					

Table 15: Calculations for Plot 44 – 2B4P (Affordable), Bedroom 2

Plot 86

Bedroom 1	
Volume, V /m^3	26.1
Window area, S /m^2	2.7
Wall area, S /m^2	6.2
Reverberation Time, T /s	0.5
Number of vents required	1

Octave centre frequency	**dB(A)**	**125 Hz**	**250 Hz**	**500 Hz**	**1 kHz**	**2 kHz**
Daytime freefield noise, L_{1in} / dB(A) Leq	**56**	**37**	**37**	**47**	**54**	**49**
4/16/4 double glazing, R / dB		24	20	25	35	38
Equation 1, L_2 / dB(A) Leq	**23**	11	15	20	17	9
100 mm brick, 100 mm filled cavity, 100 mm aerated blockwork		44	39	43	54	64
Equation 2, L_2 / dB(A) Leq	**8**	-5	0	5	2	-13
Greenwoods 4000 L trickle vent, Dn,e / dB		39	36	34	31	34
Equation 3, L_2 / dB(A) Leq	**27**	2	5	16	26	19
Combined noise through all building elements / dB(A) Leq	**29**					

Table 16: Calculations for Plot 86 – HT2, Bedroom 1

Plot 91

Bedroom 4	
Volume, V /m³	17.7
Window area, S /m²	2.2
Wall area, S /m²	13.7
Reverberation Time, T /s	0.5
Number of vents required	1

Octave centre frequency	**dB(A)**	**125 Hz**	**250 Hz**	**500 Hz**	**1 kHz**	**2 kHz**
Daytime freefield noise, L_{1in} / dB(A) Leq	**51**	34	34	42	49	44
4/16/4 double glazing, R / dB		24	20	25	35	38
Equation 1, L_2 / dB(A) Leq	**19**	9	13	16	13	5
100 mm brick, 100 mm filled cavity, 100 mm aerated blockwork		44	39	43	54	64
Equation 2, L_2 / dB(A) Leq	**9**	-3	2	6	2	-13
Greenwoods 4000 L trickle vent, Dn,e / dB		39	36	34	31	34
Equation 3, L_2 / dB(A) Leq	**24**	1	4	13	23	15
Combined noise through all building elements / dB(A) Leq	**25**					

Table 17: Calculations for Plot 91 – HT6, Bedroom 4

Plot 102

Bedroom 1	
Volume, V /m³	36.0
Window area, S /m²	2.7
Wall area, S /m²	9.5
Reverberation Time, T /s	0.5
Number of vents required	1

Octave centre frequency	**dB(A)**	**125 Hz**	**250 Hz**	**500 Hz**	**1 kHz**	**2 kHz**
Daytime freefield noise, L_{1in} / dB(A) Leq	**63**	**44**	**46**	**52**	**62**	**54**
4/16/4 double glazing, R / dB		24	20	25	35	38
Equation 1, L_2 / dB(A) Leq	**28**	16	22	23	23	13
100 mm brick, 100 mm filled cavity, 100 mm aerated blockwork		44	39	43	54	64
Equation 2, L_2 / dB(A) Leq	**15**	2	9	11	10	-8
TITON SF X V75 + C75 vent, Dn,e / dB		37	37	36	47	49
Equation 3, L_2 / dB(A) Leq	**21**	9	11	18	17	7
Combined noise through all building elements / dB(A) Leq	**29**					

Table 18: Calculations for Plot 102 – HT3, Bedroom 1

Plot 102

Bedroom 2	Façade 1	Façade 2
Volume, V /m³	26.2	
Window area, S /m²	1.4	1.4
Wall area, S /m²	5.0	8.6
Reverberation Time, T /s	0.5	
Number of vents required	1	
Roof area	12.6	

Octave centre frequency	**dB(A)**	**125 Hz**	**250 Hz**	**500 Hz**	**1 kHz**	**2 kHz**
1-East, Daytime freefield noise, L_{1in} / dB(A) Leq	**66**	**47**	**48**	**55**	**65**	**58**
10/16/4 double glazing, R / dB		25	22	33	40	43
Equation 1, L_2 / dB(A) Leq	**25**	17	21	17	20	10
100 mm brick, 100 mm filled cavity, 100 mm aerated blockwork		44	39	43	54	64
Equation 2, L_2 / dB(A) Leq	**16**	3	10	12	12	-5
TITON SF X V75 + C75 vent, Dn,e / dB		37	37	36	47	49
Equation 3, L_2 / dB(A) Leq	**26**	13	15	22	22	13
2-North, Daytime freefield noise, L1in / dB(A) Leq	**66**	**47**	**49**	**55**	**65**	**57**
10/16/4 double glazing, R / dB		25	22	33	40	43
Equation 1, L_2 / dB(A) Leq	**26**	17	22	17	20	9
100 mm brick, 100 mm filled cavity, 100 mm aerated blockwork		44	39	43	54	64
Equation 2, L_2 / dB(A) Leq	**19**	6	13	15	14	-4
3-Roof, Daytime freefield noise, L1in / dB(A) Leq	**59**	**41**	**42**	**48**	**58**	**51**
Roof tiles, 1 m void filled with 400 mm quilt on 12.5 wallboard		36	41	46	50	45
Equation 1, L_2 / dB(A) Leq	**17**	10	6	7	13	10
Combined noise through all building elements / dB(A) Leq	**31**					

Table 19: Calculations for Plot 102 – HT3, Bedroom 2

Plot 105

Bedroom 4	Façade 1	Façade 2
Volume, V /m³	17.7	
Window area, S /m²	1.1	1.08
Wall area, S /m²	4.2	9.48
Reverberation Time, T /s	0.5	
Number of vents required	0	
Roof area	7.3	

Octave centre frequency	**dB(A)**	**125 Hz**	**250 Hz**	**500 Hz**	**1 kHz**	**2 kHz**
1-North, Daytime freefield noise, L_{1in} / dB(A) Leq	**69**	**50**	**52**	**58**	**68**	**60**
10/16/6.4 PVB		27	29	36	41	42
Equation 1, L_2 / dB(A) Leq	**26**	18	18	17	22	14
100 mm brick, 100 mm filled cavity, 100 mm aerated blockwork		44	39	43	54	64
Equation 2, L_2 / dB(A) Leq	**20**	7	14	16	15	-2
2-East, Daytime freefield noise, L1in / dB(A) Leq	**71**	**51**	**54**	**60**	**70**	**62**
10/16/6.4 PVB		27	29	36	41	42
Equation 1, L_2 / dB(A) Leq	**28**	20	20	19	24	16
100 mm brick, 100 mm filled cavity, 100 mm aerated blockwork		44	39	43	54	64
Equation 2, L_2 / dB(A) Leq	**26**	12	20	22	21	4
3-Roof, Daytime freefield noise, L1in / dB(A) Leq	**63**	**46**	**47**	**53**	**62**	**54**
Roof tiles, 1 m void filled with 400 mm quilt on 12.5 wallboard		36	41	46	50	45
Equation 1, L_2 / dB(A) Leq	**21**	14	10	11	16	14
Combined noise through all building elements / dB(A) Leq	**32**					

Table 20: Calculations for Plot 105 – HT6, Bedroom 4

Plot 106

Bedroom 4	Façade 1	Façade 2
Volume, V /m^3	17.7	
Window area, S /m^2	1.1	1.08
Wall area, S /m^2	4.2	9.48
Reverberation Time, T /s	0.5	
Number of vents required	0	
Roof area	7.3	

Octave centre frequency	**dB(A)**	**125 Hz**	**250 Hz**	**500 Hz**	**1 kHz**	**2 kHz**
1-North, Daytime freefield noise, L_{1in} / dB(A) Leq	**67**	**47**	**50**	**56**	**66**	**59**
10/16/4 double glazing, R / dB		25	22	33	40	43
Equation 1, L_2 / dB(A) Leq	**27**	18	24	19	22	12
100 mm brick, 100 mm filled cavity, 100 mm aerated blockwork		44	39	43	54	64
Equation 2, L_2 / dB(A) Leq	**19**	5	12	14	14	-4
2-West, Daytime freefield noise, L1in / dB(A) Leq	**62**	**40**	**45**	**51**	**61**	**53**
10/16/4 double glazing, R / dB		25	22	33	40	43
Equation 1, L_2 / dB(A) Leq	**22**	11	18	14	16	6
100 mm brick, 100 mm filled cavity, 100 mm aerated blockwork		44	39	43	54	64
Equation 2, L_2 / dB(A) Leq	**17**	1	11	13	12	-5
3-Roof, Daytime freefield noise, L1in / dB(A) Leq	**60**	**43**	**44**	**50**	**59**	**51**
Roof tiles, 1 m void filled with 400 mm quilt on 12.5 wallboard		36	41	46	50	45
Equation 1, L_2 / dB(A) Leq	**18**	11	7	8	13	10
Combined noise through all building elements / dB(A) Leq	**29**					

Table 21: Calculations for Plot 106 – HT6, Bedroom 4

19. Appendix 6: Mechanical ventilation systems

19.1 **Noise from the MVHR unit**

19.2 Noise from mechanical ventilation systems is not currently controlled under the Building Regulations.

19.3 There is no formal requirement to associate any particular ventilation condition with any particular noise level limit.

19.4 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.

19.5 Problems with the dissociation of ventilation condition and noise level are discussed by Harvie-Clark and Siddall, Reference 17.

19.6 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 17.

19.7 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 16.

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

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

19.8 This European project of scientific collaboration associates noise levels with different classes of performance in its Table 5.4, as reproduced below.

19.9 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.

19.10 It is suggested that for reasonable conditions the values for at least Class C area adopted as the design target, ie 28 dB(A).

19.11 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.

19.12 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.

19.13 **Noise implications of other design issues**

19.14 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.

19.15 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.

19.16 Further guidance on issues with domestic mechanical services that can cause noise problems are identified in Noise from Domestic Ventilation Systems, Reference 19.

19.17 **Cross-talk between rooms**

19.18 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 $D_{ne,w} \geq 45$ dB.

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

19.20 **Purge ventilation and over heating**

19.21 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.

19.22 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.

19.23 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.