Re-assessment of the Sound Insulation of the Proposed New Residential Dwelling at 11 Ballroyd Lane, Longwood, Huddersfield

Report Prepared for:

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1.0 Summary

Planning permission is being sought to permit the construction of a new four bedroom house on land adjacent to number 11 Ballroyd Lane in Huddersfield. A previous assessment of the existing noise climate and an evaluation of the internal noise levels, resulting from external noise break-in, was produced in September 2016. This report identified suitable sound insulation measures that could be employed to produce an internal noise climate that complied with the selected internal design guidance, with respect to external noise break-in.

Since the issuing of the September 2016 report the Local Planning Authority (Kirklees MBC) and their consultees within Environmental Health expressed concerns relating to the internal layout of the proposed house and the arrangement of external amenity space. As a consequence the original design layout and orientation of the proposed house considered in the earlier, September 2016 report, have been revised to take account of these comments. Reflecting these changes this report contains a re-assessment of the new proposal with respect to examining the effect that the existing noise climate may have on the proposed dwelling. This report will, where appropriate, utilise elements from the original report issued in September 2016 and where necessary new elements will be included to account for any changes resulting from the revised proposal. With reference to the re-use of the original existing noise climate measured levels, this was agreed with Kirklees MBC's Environmental Health Department.

The ambient noise surveys indicated that the overall noise climate in the vicinity of the proposed house on Ballroyd Lane was primarily influenced by the emission of noise from the nearby Wooltex factory. Additional noise contributions were made by the rustling of leaves on the nearby trees, traffic on Dale Street and Ballroyd Lane itself, the passage of trains, intermittent overflying aircraft and some noise from the nearby residential premises.

Combining the measured noise levels obtained from the surveys with the sound insulation provided by the proposed building envelope, it can be seen that the calculated internal noise levels comply with the design targets with respect to the L_{Aeq}, L_{A1} and L_{Amax} parameters contained within both the Kirklees MBC guidance document and British Standard BS8233:2014. As a consequence, it is suggested that the sound insulation provided by the building envelope components, highlighted in this report, will be sufficient to control the 'break-in' of external noise to the proposed house without the need for any additional sound attenuation measures. In addition it is suggested that the noise climate in the principal amenity space, to the front of the proposed house, would comply with the design target of 55dB L_{Aeq}. Consequently it is suggested that the existing noise climate in the vicinity of the proposed new house at 11 Ballroyd Lane should not be regarded as an impediment to the development of the proposed dwelling.

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2.0 Introduction

Planning permission is being sought to permit the construction of a new four bedroom house on land adjacent to number 11 Ballroyd Lane in Huddersfield. A previous assessment of the existing noise climate and an evaluation of the internal noise levels resulting from external noise break-in to the proposed house was produced in September 2016. This report identified suitable sound insulation measures that could be employed to produce an internal noise climate that complied with the selected internal design guidance, with respect to external noise break-in.

Since the issuing of the September 2016 report the Local Planning Authority (Kirklees MBC) and their consultees within Environmental Health expressed concerns relating to the internal layout of the proposed house and the arrangement of external amenity space. As a consequence the original design layout and orientation of the proposed house have been revised to take account of these comments. Reflecting these changes this report contains a re-assessment of the new proposal with respect to examining the effect that the existing noise climate may have on the proposed dwelling. This report will, where appropriate, utilise elements from the original report issued in September 2016 and where necessary new elements will be included to account for the revised proposal. With reference to re-use of the original existing noise climate data, this was agreed with Kirklees MBC's Environmental Health Department.

3.0 Site Description

The proposed house would be located to the south eastern end of the existing parcel of land adjacent to number 11 Ballroyd Lane (figure 1 and photograph 1 overleaf). The parcel of land is currently used by Mr. J. P. Wadsworth to store vehicles and some equipment associated with his construction business. To the north, north east and west of the proposed house are the existing residential dwellings on Ballroyd Lane, including a new house currently under construction (photographs 2 and 3 overleaf). To the south of the proposed house is the Wooltex facility with Dale Street beyond (photograph 4 overleaf).

Photograph 1. Proposed development site adjacent to 11 Ballroyd Lane



Photograph 1. Existing parcel of land adjacent to number 11 Ballroyd Lane



Photograph 2. Existing residential properties on Ballroyd Lane



Photograph 3. Existing residential properties on Ballroyd Lane (to the north west of the proposed site)



Photograph 4. Wooltex facility to the south of the proposed development site



4.0 Assessment Criteria

As planning permission is currently being sought no formal planning conditions relating to the acoustic conditions to be met within the proposed house currently exist. As a consequence the potential effect of the existing noise climate on the proposed dwelling will be assessed with reference to the guidance contained within the "Noise Design Advice" issued by Kirklees MBC in 2007 and BS 8233: 2014 "Guidance on sound insulation and noise reduction for buildings".

4.1 Kirklees MBC "Noise Design Advice"

This document was issued by Kirklees MBC's Environmental Services Pollution and Noise Control department in May 2007. The document provides guidance relating to desirable acoustic conditions in a variety of situations, however with reference to the proposed dwelling the appropriate criteria are as detailed in table 1 overleaf.

Table 1. Proposed Design Criteria, Kirklees MBC "Noise Design Advice".

Room/area	**dB $L_{Aeq\ 16hour}$** (0700 – 2300 hours)	**dB $L_{Aeq\ 8\ hour}$** (2300 – 0700 hours)	**dB $L_{A1\ 15minutes}$** (2300 – 0700 hours)	**dB L_{Amax}** (2300 – 0700 hours)
Living rooms Studies	35 35	- -	- -	- -
Gardens	55	-	-	-
Bedrooms	-	30	45	55

In addition to the guidance contained in the table above the internal noise climate within the proposed house will also be considered with reference to the guidance contained within BS 8233:2014 “Guidance on sound insulation and noise reduction for buildings”.

4.2 BS 8233:2014

BS 8233:2014 draws together research and best practice relating to building design, providing guidance to facilitate the development of buildings that have internal noise environments that are consistent with and appropriate for their intended use. The British Standard highlights methods for the control of noise from a number of sources including external noise and building services etc., as well as evaluating the effect that noise from these sources may have on the acoustics of the internal spaces.

With reference to the design guidance relating to the internal noise climate of residential dwellings, BS 8233:2014 summarises this guidance within table 4 of section 7.7.2. The main elements of this guidance is reproduced in table 1 below.

Table 1. Indoor ambient noise levels for dwellings (reproduced from table 4 of BS8233:2014)

Activity	**Location**	**0700 to 2300**	**2300 to 0700**
Resting	Living room	35dB $L_{Aeq,\ 16\ hour}$	-
Dining	Dining room/area	40dB $L_{Aeq,\ 16\ hour}$	-
Sleeping (daytime resting)	Bedroom	35dB $L_{Aeq,\ 16\ hour}$	30dB $L_{Aeq,\ 8\ hour}$

Although the 2014 version of BS 8233 contains comprehensive guidance relating to desirable internal noise levels within habitable spaces in terms of the L_{Aeq} values over the day and night time periods, it does not contain an L_{Amax} standard for bedrooms at night. As a result reference will be made to the guidance contained within the earlier 1999 version of BS 8233. The L_{Amax} guidance from the 1999 version of BS8233 specifies a separate ‘reasonable’ standard in bedrooms at night, from individual noise events. To achieve this ‘reasonable’ standard BS 8233:1999 states in footnote (a) to table 5 that, "individual noise events (measured with the fast time-weighting) should not normally exceed 45 dB L_{Amax}". The 45dB L_{Amax} criterion is often considered as a stringent criterion particularly with respect to urban and sub-urban environments.

In addition to the internal noise design guidance, BS 8233:2014 also provides guidance on the external noise environment. In this situation BS8233:2014, at paragraph 7.7.3.2, states the following: “*For traditional external areas that are used for amenity space,*

such as gardens and patios, it is desirable that the external noise climate does not exceed 50dB $L_{Aeq,T}$ with an upper guideline value of 55dB $L_{Aeq,T}$ which would be acceptable in noisier environments".

With reference to the subsequent assessments of the likely internal noise climate within the proposed house, all evaluations will be undertaken with respect to guidance contained within both of the above documents. Despite this and with reference to both the versions of BS 8233, it must be remembered that the advice contained within these documents is design guidance and the suggested levels are *desirable*. It does not represent a set of rigid criteria, below which a development 'passes' and above which a development 'fails'. For instance, with windows open, there can be very few developments outside the quietest of areas where the internal levels would not exceed at least some of the various criteria.

5.0 Survey Details

5.1 Survey Times and Personnel

The noise surveys, to evaluate the existing noise climate in the vicinity of the proposed new house at 11 Ballroyd Lane, were undertaken between 1600 - 1900 hours on the 23rd September 2016 and between 2300 - 0100 hours on the 23rd - 24th September 2016.

All measurements were fully attended for the duration and the surveys and were conducted by Mr. R Smith of Druk Limited.

5.2 Weather

Throughout the ambient noise surveys the weather conditions were as follows:

Afternoon, 23rd September

All surfaces were dry, cloud cover was approximately 50%, the temperature was 15°C, the wind speed was approximately 0.4m/s and the barometric pressure was 1005mb.

Night time, 23rd - 24th September

All surfaces were dry, cloud cover was approximately 50%, the temperature was 13°C, the wind speed was approximately 0.4m/s and the barometric pressure was 1003mb.

5.3 Equipment

All the noise surveys and measurements were conducted using the equipment detailed in the table 2 overleaf.

The sound level meter was field calibrated before, after and during the surveys as necessary, during which time no significant deviation in the calibrated level was observed.

Table 2. Equipment used during the ambient noise survey

Equipment description	Manufacturer	Model number	Serial number
Sound level meter	Norsonic AS	Nor 140	1402738
Microphone pre-amplifier	Norsonic AS	Nor 1209	12075
Microphone	Norsonic AS	Nor 1225	72843
Acoustic calibrator	Norsonic AS	Nor 1251	31522

5.4 Measurement Procedure

An initial walk-over survey of the development site suggested that the noise climate in the vicinity of the proposed new dwelling was very consistent. Consequently a single measurement position to the south of the proposed site was adopted and this is detailed on figure 2 overleaf. In this position the measurement location was approximately in line with what would be the rear elevation of the proposed house.

The sound level meter was tripod mounted such that the microphone was approximately 1.3 metres above ground level and at least 3 metres from any potentially reflecting surface. During both the day and night time surveys the measurement time interval was 15 minutes and all measurements were made with the 'fast' time weighting engaged.

6.0 Noise Survey Results

The noise climate in the vicinity of 11 Ballroyd Lane was regarded as being an essentially sub-urban environment with some mixed commercial enterprises in the vicinity. The following paragraphs contain brief subjective descriptions of the noise sources noted during the survey periods.

6.1 Qualitative Assessment: Afternoon Period

During the afternoon period the principal contributor to the ambient noise climate was the emission of noise from the rear weaving shed of the Wooltex works. Throughout this period the emission of noise from this source remained very constant whilst the noise itself was broadband in character with no discernible tones. Additional noise sources included the sound of the leaves on the tress surrounding the proposed development site rustling in the breeze, road traffic on Dale Street and Ballroyd Lane, birdsong, the sound of trains on the viaduct to the south east of the proposed site and the sound of intermittent aircraft overflights.

6.2 Qualitative Assessment: Night time Period

As was the case during the afternoon period the principal contributor to the existing noise climate was the emission of noise from the rear weaving shed of the Wooltex facility. Again this noise source remained very constant whilst the noise itself was broadband in character with no discernible tones. Additional noise sources included the sound of the leaves on the tress surrounding the proposed development site rustling in

the breeze, intermittent road traffic on Dale Street and Ballroyd Lane and the infrequent passage of trains on the viaduct to the south east of the proposed site.

6.3 Basic Results

The measured noise levels from the measurement position are presented in tables 3 and 4 below and overleaf. All data have been rounded to the nearest whole decibel and full data are presented in tabular form in Appendix 1.

Figure 2. Approximate location of the measurement position

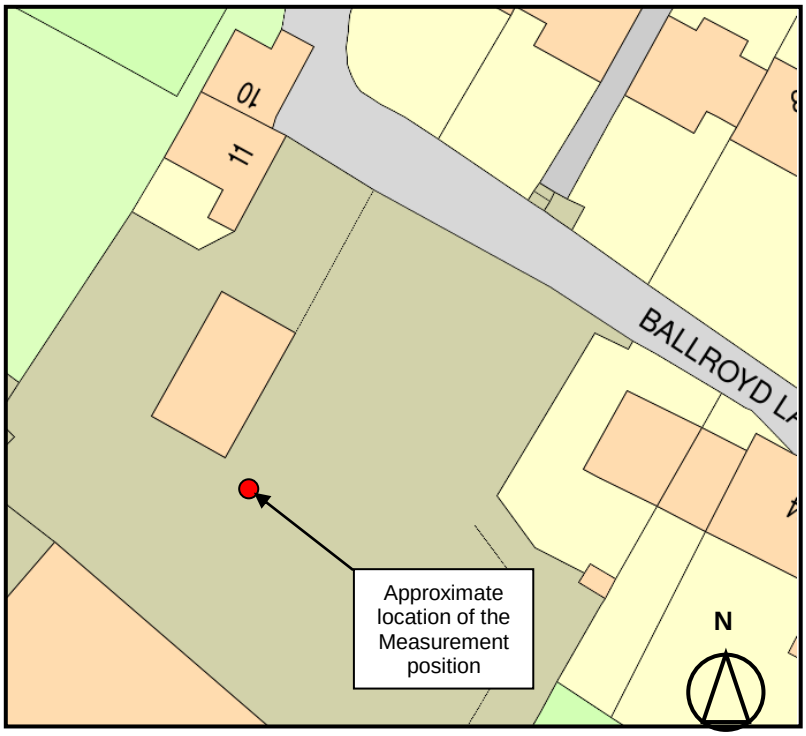


Table 3. Existing ambient noise levels, afternoon/evening, 11 Ballroyd Lane

Start time	dB L_{Aeq}, (15 minutes)	dB L_{Amax}, (15 minutes)	dB L_{A1} (15minutes)	dB L_{A90}, (15 minutes)
1600	54	74	55	52
1615	54	61	55	53
1630	53	61	55	52
1645	54	65	55	52
1700	54	69	55	52
1715	53	71	55	52
1730	54	71	55	52
1745	53	67	55	50

Table 3, continued. Existing ambient noise levels, afternoon/evening, 11 Ballroyd Lane

Start time	dB L_{Aeq}, (15 minutes)	dB L_{Amax}, (15 minutes)	dB L_{A1} (15minutes)	dB L_{A90}, (15 minutes)
1800	53	67	55	50
1815	51	64	53	50
1830	52	66	53	50
1845	53	68	55	51
Standard deviation	0.85	3.78	0.78	1.16

Table 4. Existing ambient noise levels, night time, 11 Ballroyd Lane

Start time	dB L_{Aeq}, (15 minutes)	dB L_{Amax}, (15 minutes)	dB L_{A1} (15minutes)	dB L_{A90}, (15 minutes)
2300	51	67	55	49
2315	51	62	55	49
2330	51	62	57	49
2345	51	60	55	49
0000	52	72	56	50
0015	51	60	55	49
0030	51	60	54	49
0045	50	60	55	49
Standard deviation	0.41	4.45	0.74	0.27

As can be seen from the tables 3 and 4 the noise climate, in terms of the L_{Aeq}, L_{A10}, L_{A1} and L_{A90} parameters, remained steady throughout the survey periods. This fact suggests that the local noise climate was principally affected by a relatively dominant and constant noise source. In this case the emission of noise from the Wooltex facility represented such a source. With reference to the L_{Amax} levels, these demonstrate a greater degree of variability and were largely a consequence of cars travelling along Ballroyd Lane.

7.0 Noise Transmission Calculations

Using the measured ambient noise levels from the afternoon and night-time measurement periods, calculations have been performed to assess the likely internal noise levels within the proposed new house. All the assessments have been conducted with reference to the design guidance detailed in section 4.0 above.

The subsequent assessment of the potential internal noise levels within the proposed house have been undertaken using the highest measured levels from the noise surveys and these levels are detailed in table 5 below. Consequently the following assessments may be regarded as worst case situations which are unlikely to persist for all but short periods of time.

The sound insulation provided by a building envelope is calculated from the sound insulation provided by the various façade elements, such as the glazing, external walls etc., and the areas they cover. In the majority of cases it is the glazing that can be considered as the 'weak' link acoustically, therefore increasing the sound insulation of the glazing will improve the overall sound insulation of the façade. The result of the calculations is a composite sound insulation value for the whole façade.

Table 5. Highest measured noise levels, 11 Ballroyd Lane

OBCF, Hz*	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**Overall, dB(A)**
Daytime, L_{Aeq}, (1600 - 1615 hours)	63	60	57	50	49	44	37	31	**54**
Night time, $L_{Aeq,}$ (0000 - 0015 hours)	60	59	55	46	45	42	40	35	**52**
Night time, $L_{A1.}$ (2300 - 2315 hours)	63	61	57	51	53	48	44	40	**57**
Night time, $L_{Amax.}$ (0000 - 0015 hours)	67	64	62	64	70	64	58	56	**72**

The assessments contained within the subsequent sections of this re-assessment report have been undertaken according to drawings JW01 and JW02 issued in April 2017 by the scheme architect, Mr. C. West of Slaithwaite, Huddersfield. These drawings are reproduced in Appendix 2. To facilitate the calculations to be made the following assumptions have been employed:

- The reverberation times within the habitable rooms will be 0.5 seconds.
- The floor to ceiling height will be approximately 2.3 metres.
- The external wall will be cavity masonry with a thermally insulated cavity.

7.1 Construction Specification

The building envelope constructional details described below and overleaf have been assumed for the purposes of the subsequent calculations.

External Walls

The external walls will be of cavity masonry construction around 300mm thick and will comprise: an external brick leaf, a 75 - 100mm cavity filled with thermal insulation and a 100mm thick concrete block inner leaf lined with one layer of 12.5mm plasterboard on adhesive dabs. Test results for a similar construction suggest that external walls of this type should provide an overall sound insulation of around R_w 52dB, with the octave band sound insulation values being as detailed in table 6 overleaf.

Table 6. External Wall**,** Octave Band Sound Insulation Values

OBCF, Hz*	125	250	500	1k	2k	4k	Overall, R_w dB(A)
Sound Insulation, dB	38	42	51	59	63	63	52

* Octave Band Centre Frequency

Glazing

The glazing will comprise sealed units with a nominal specification of 4mm pane - 16/20mm cavity - 4mm pane, mounted in PVCu frames. Laboratory test data obtained from Pilkington indicates that such a system should provide an overall sound insulation value of 31dB R_w. The octave band sound insulation values for the glazing system are as detailed in table 7 below.

Table 7. Glazing, octave band sound insulation; 4mm – 16/20mm – 4mm glazing

OBCF, Hz*	125	250	500	1k	2k	4k	Overall, R_w dB(A)
Sound Insulation, dB	24	20	25	35	38	35	31

* Octave Band Centre Frequency

Ventilation

It has been assumed that background ventilation in compliance with the requirements of Approved Document F will be provided by window frame mounted ventilators, with local mechanical extract ventilation being provided in areas of high humidity. The calculations will be performed assuming the use of a Greenwood 4000S frame ventilators. Laboratory test data indicates that this ventilator will provide a sound insulation value of 33dB $D_{n,e,w}$ respectively in its open position. The octave band sound insulation values, rounded to the nearest whole decibel, for the ventilators are as detailed in table 8 below:

Table 8. Greenwood window frame mounted ventilators, sound insulation values

OBCF, Hz*	125	250	500	1k	2k	4k	Overall, $D_{n,e,w}$ dB
Greenwood 4000S	36	37	34	30	33	37	33

* Octave Band Centre Frequency

Despite this it is worth remembering that many local planning authorities are now requiring some form of ventilation strategy that facilitates the rapid ventilation of the internal spaces without necessitating the opening of windows. This is particularly the case where developments are planned within city centres or other higher noise environments. The intention is to provide occupants in higher noise environments with a choice of whether to ventilate the internal spaces by opening the windows or not. The implicit assumption is that ventilating the internal spaces by opening windows will inevitably permit the ingress of external noise.

With reference to the proposed dwelling Kirklees MBC's Environmental Health Department did express concerns relating to the ventilation of the proposed dwelling

façades that will face the Wooltex UK weaving shed. These concerns related primarily to the fact that in those rooms facing the Wooltex works, opening the windows in the warmer months of the year would permit the ingress of higher levels of external noise. Although the design of the proposed dwelling has been amended to minimise the number of habitable rooms on the rear elevation, by providing buffer areas in the form of the kitchen and en-suite bathroom, it is inevitable that two of the proposed bedrooms will have one façade facing the Wooltex works.

With respect to Kirklees MBC's Environmnetal Health Department's concerns, one way to address the compromise that exists between adequately ventilating the internal spaces whilst ensuring the continuity of the façade sound insulation, would be to consider the provision of mechanical ventilation to the bedrooms on the rear elevation of the proposed house. Where mechanical ventilation is to be provided it would be prudent to locate the intake and exhaust terminations of such systems on the quieter façade of the building facing Ballroyd Lane. Where this is not possible the exhaust and inlet terminations could be provided with suitable attenuators to minimise the ingress of external noise. Where duct attenuators are to be provided is it not uncommon to specify that they achieve similar sound insulation values to that provided by the windows and this would be recommended in this case. It would be prudent to engage an M & E contractor to undertake suitable assessments to evaluate the likely noise levels at the internal terminations resulting from losses through the attenuators, ductwork, end reflections etc.

The above comments accord with the advice given in note 5 to paragraph 7.7.2 of BS8233:2014, which states the following: "If relying on closed windows to meet the guide values, there needs to be an appropriate alternative ventilation that does not compromise the facade insulation or the resulting noise level". It would however be prudent to discuss the ventilation requirements for the flats with the Local Planning Authority at the earliest possible opportunity.

Roof

The second floor accommodation within the proposed house is located within the roof space, consequently the roof construction will have a bearing on the sound insulation of the bedroom in the roof. As a consequence the following notional roof construction has been used in the calculations: roof tiles on 38 x 25mm battens with a sarking felt layer beneath. 100m PIR insulation will be fitted between the 150mm deep rafters. The structure will be under drawn with one layer of 12.5mm wallboard. Laboratory test data indicates that this roof structure will provide a sound insulation value of around 40dB R_w. The octave band sound insulation values for the notional roof structure are as detailed in Table 9 below:

Table 9. Typical roof construction, sound insulation values

OBCF, Hz*	**125**	**250**	**500**	**1k**	**2k**	**4k**	**Overall, R_w dB(A)**
Ceiling comprising one layer of 12.5mm wallboard	27	33	38	43	42	50	40

* Octave Band Centre Frequency

7.2 Calculation Results

For the purposes of the calculations the highest measured noise levels detailed in table 5 above were used. The results of the break-in noise calculations are presented, with reference to the design guidance contained within the Kirklees MBC "Noise Design Advice" document and BS 8233:2014, in tables 10 and 11 below. With respect to the presentation of the results in compliance with the BS 8233:2014 guidance, the calculations relating to the night time L_{Aeq} and L_{Amax} results are presented in the same columns with the L_{Amax} results being contained in brackets. Full data are available in Appendix 3.

Table 10. Calculated internal noise levels, proposed house, 11 Ballroyd Lane - Kirklees Environmental Services Pollution and Noise Control “Noise Design Advice” document guidance levels

Location	Design target, dB L_{Aeq}	Calculated level, dB L_{Aeq}	Design target, dB L_{A1}	Calculated level, dB L_{A1}	Design target, dB L_{Amax}	Calculated level, dB L_{Amax}
Kitchen/dining room	35	**29***	-	**-**	-	**-**
Living room	35	**30***	-	**-**	-	**-**
Master bedroom	30	**26****	45	**30**	55	**45**
Front bedroom	30	**25****	45	**30**	55	**45**
Rear bedroom	30	**25****	45	**30**	55	**45**
Attic bedroom	30	**26****	45	**30**	55	**44**

* dB $L_{Aeq\ 16hour}$ equivalent
** dB $L_{Aeq\ 8hour}$ equivalent

Table 11. Calculated internal noise levels, proposed house, 11 Ballroyd Lane – BS 8233:2014 guidance levels

Location	Design target, daytime, dB L_{Aeq}	Calculated level, daytime, dB L_{Aeq}	Design target, night time, dB L_{Aeq}	Calculated levels, night time, dB L_{Aeq} and L_{Amax}
Kitchen/dining room	35	**29**	30 (45)	-
Living room	35	**30**	30 (45)	-
Master bedroom	35	**28**	30 (45)	**26 (45)**
Front bedroom	35	**28**	30 (45)	**25 (45)**
Rear bedroom	35	**28**	30 (45)	**25 (45)**
Attic bedroom	35	**34**	30 (45)	**26 (44)**

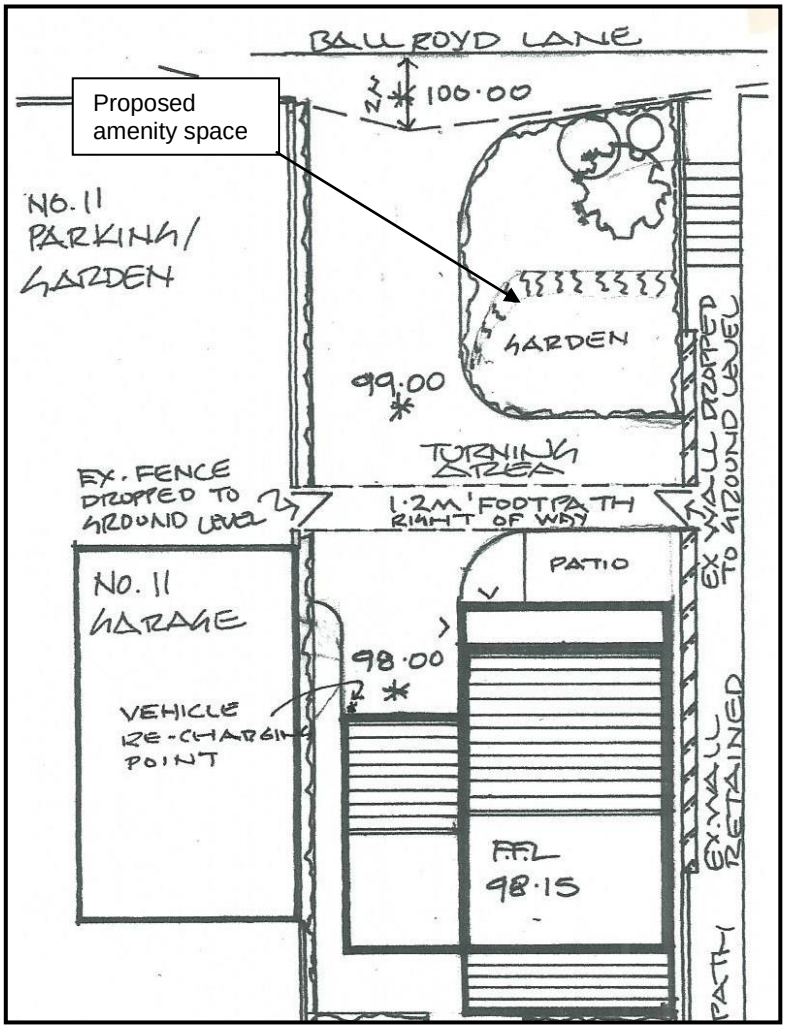
As can be seen from tables 10 and 11 the calculated internal noise levels resulting from external noise break-in do not exceed either sets of design guidance contained within section 4 above. As such it is suggested that the sound insulation of the building

envelope components detailed above, including the specified passive ventilation option, would be sufficient to limit the ingress of external noise to the interior of the proposed house without the need for any additional sound attenuation measures to be implemented.

7.3 External Amenity Area

With reference to the external amenity area appurtenant to the proposed house, this will comprise the garden area to the front of the house as detailed in Figure 3 below. With reference to the likely effect that the existing noise climate may have on this area, the following assumption has been made: the measured noise levels obtained from the afternoon period will be the most appropriate with reference to this evaluation.
The obtained noise levels from the afternoon survey indicate that at no time did the measured noise levels exceed 54dB $L_{Aeq\ (15\ mins)}$. As such it is suggested that based on the obtained measurements, the 'upper guideline' value of 55 dB L_{Aeq} stated within BS 8233:2014 would not be exceeded. In addition, as the principal contributor to the existing noise climate is the noise emitted from the nearby Wooltex works, the erection of the proposed house would be expected to provide a degree of acoustic shielding to the garden area. With this in mind it is anticipated that the resulting noise levels in the garden, incorporating the shielding effect of the house, would be below the lower 50 dB L_{Aeq} guide value detailed in BS8233:2014.

Figure 3. Architects sketch of the layout of the proposed house showing the external amenity space.



8.0 Conclusion

The ambient noise surveys have indicated that the overall noise climate in the vicinity of the proposed house at 11 Ballroyd Lane is primarily influenced by the emission of noise from the nearby Wooltex factory, with additional contributions made by the rustling of leaves on the nearby trees, traffic on Dale Street and Ballroyd Lane itself, the passage of trains, intermittent overflying aircraft and some noise from the nearby residential premises.

Combining the measured noise levels obtained from the surveys with the sound insulation provided by the building envelope, it has been demonstrated that the calculated internal noise levels would comply with the adopted design guidance values. With reference to the external amenity space for the proposed house, the front garden, the measured levels relating to the existing noise climate are such that it is suggested that the design guide values for the external amenity areas would not be breached. As a consequence it is suggested that the existing noise climate in the vicinity of the proposed new house at 11 Ballroyd Lane should not be regarded as an impediment to the construction of the house.

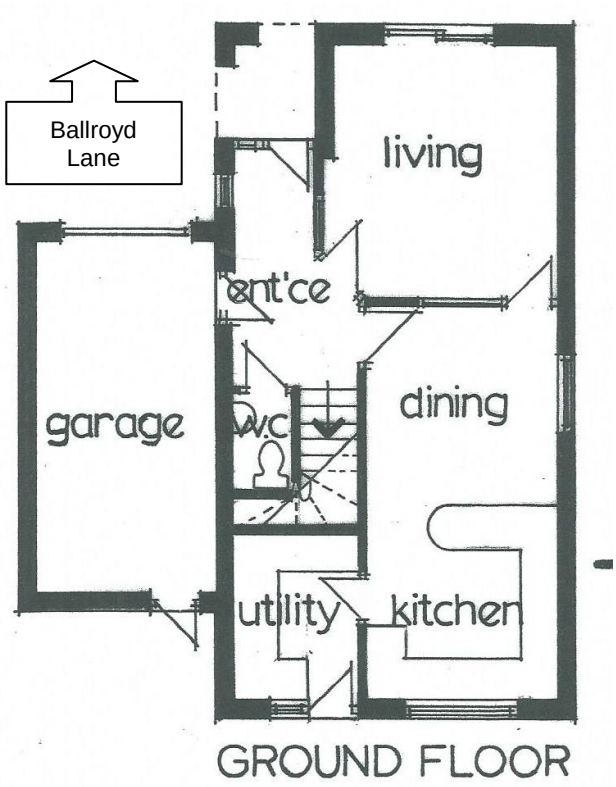
Appendix 1: Ambient noise survey results.

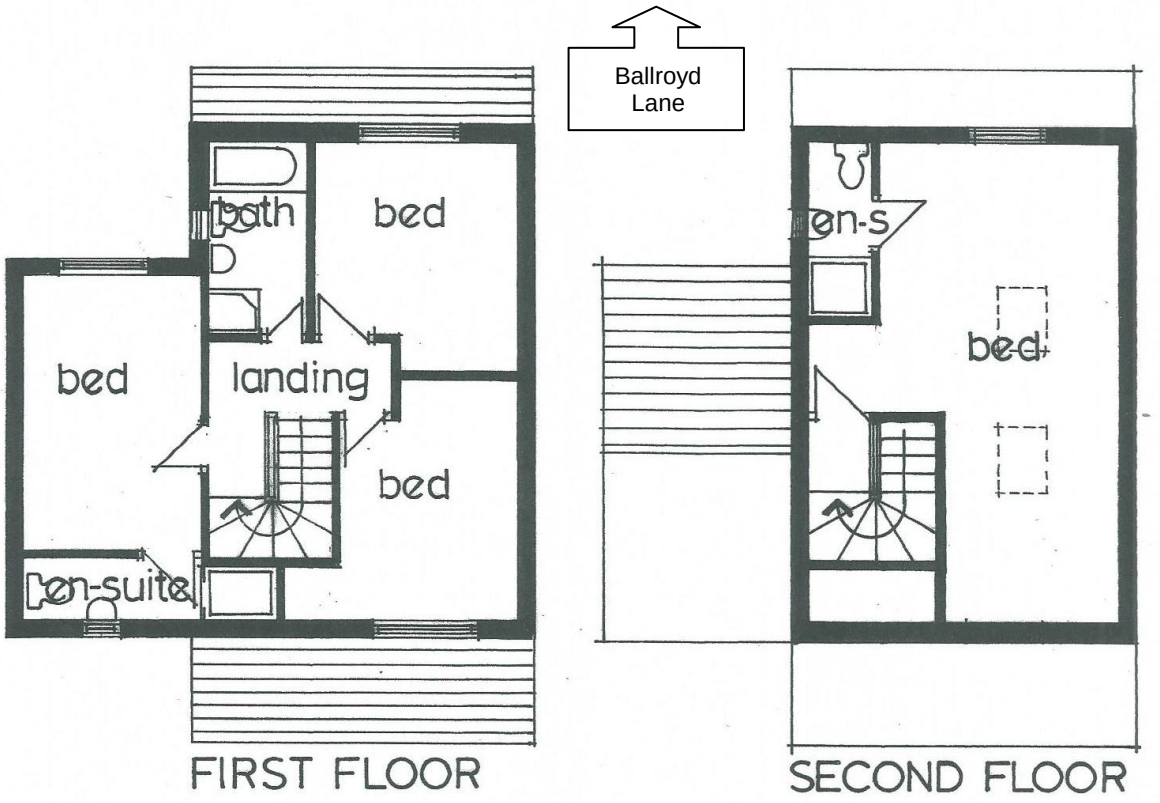
11 Ballroyd Lane												
Ambient noise survey												
23rd September 2016, daytime												
Octave Band Centre Frequency, Hz.		**dB(A)**	**31.5**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**16k**
1600												
L_{Aeq}		**54.2**	67.1	62.7	59.9	56.5	50.2	49.1	44.4	36.7	30.6	22.5
L_{max}		**73.6**	71.9	67.9	66.2	60.1	66.5	71.3	66.9	56.3	50.2	45.2
L_{10}		**55.3**	68.3	64.1	60.9	57.5	51.0	50.3	45.3	38.0	32.6	24.7
L_{90}		**52.4**	65.5	61.1	58.6	55.2	49.0	46.6	42.0	33.6	24.2	14.4
1615												
L_{Aeq}		**53.9**	66.4	62.9	59.7	56.7	50.2	48.2	43.4	35.4	28.7	25.1
L_{max}		**61.4**	71.7	71.4	63.5	61.8	56.0	54.7	53.3	48.9	53.0	55.0
L_{10}		**55.0**	67.8	64.3	60.7	57.8	51.1	49.6	44.7	37.0	30.6	21.7
L_{90}		**52.5**	64.5	60.9	58.6	55.3	49.0	46.8	42.2	33.5	23.6	13.7
1630												
L_{Aeq}		**53.5**	66.3	62.6	59.9	56.2	49.9	47.8	42.9	35.3	27.8	18.8
L_{max}		**61.2**	72.5	71.4	66.6	61.7	54.9	53.0	51.0	55.2	47.5	39.7
L_{10}		**54.7**	67.9	64.0	61.0	57.2	50.9	49.4	43.9	36.7	30.7	22.0
L_{90}		**52.2**	64.4	60.6	58.6	54.9	48.8	46.4	41.7	33.2	23.3	13.7
1645												
L_{Aeq}		**53.8**	67.8	63.2	59.7	56.7	50.1	47.8	43.5	38.4	27.6	18.0
L_{max}		**65.4**	72.1	67.1	63.8	61.6	62.1	56.3	58.5	59.2	42.8	34.8
L_{10}		**54.7**	69.0	64.4	60.8	57.8	51.1	48.9	43.8	36.6	30.0	20.5
L_{90}		**52.3**	66.3	61.8	58.4	55.3	48.6	46.5	41.9	33.5	24.0	14.3
1700												
L_{Aeq}		**53.8**	67.6	63.4	60.3	56.7	49.9	47.8	43.3	37.2	31.4	22.7
L_{max}		**69.5**	76.1	73.6	70.9	62.1	58.5	67.9	60.7	51.4	42.5	38.3
L_{10}		**55.0**	69.0	64.6	61.4	57.9	50.9	49.2	44.5	39.5	34.4	26.2
L_{90}		**52.3**	65.6	61.6	58.3	55.3	48.7	46.3	41.8	33.5	24.0	14.2
1715												
L_{Aeq}		**53.2**	66.8	62.9	60.2	56.3	49.6	47.0	42.3	34.9	28.0	19.7
L_{max}		**71.0**	75.8	80.8	82.8	75.1	66.0	57.2	55.3	49.5	48.0	45.8
L_{10}		**55.0**	69.3	64.8	61.0	57.8	51.1	49.4	44.3	37.9	32.1	23.2
L_{90}		**52.4**	65.7	61.7	58.1	55.3	48.8	46.6	42.1	33.5	23.3	13.5
1730												
L_{Aeq}		**53.6**	67.6	63.4	59.4	56.7	50.1	47.6	43.0	35.2	27.3	18.8
L_{max}		**70.9**	73.7	74.5	68.0	72.0	65.2	65.7	64.3	58.8	48.9	41.7
L_{10}		**54.8**	69.2	64.7	60.4	57.8	51.0	49.1	44.0	36.2	29.6	20.7
L_{90}		**52.1**	65.6	61.7	58.0	55.3	48.6	46.1	41.6	33.0	22.7	13.2
1745												
L_{Aeq}		**53.1**	66.1	62.3	59.2	56.4	49.8	46.9	41.4	37.6	29.4	19.8
L_{max}		**67.0**	75.5	74.0	68.8	68.9	65.5	59.9	54.1	56.4	49.2	43.0
L_{10}		**55.0**	68.7	64.6	60.6	57.7	51.5	49.3	43.8	39.4	32.5	22.7
L_{90}		**50.3**	62.5	58.4	57.5	54.4	46.7	43.4	37.4	29.9	20.9	13.1

1800												
L_{Aeq}		**53.0**	64.3	60.6	59.3	56.3	48.3	47.2	41.7	38.8	34.5	23.4
L_{max}		**67.2**	77.2	74.3	68.8	65.2	57.6	61.5	61.1	59.2	51.3	39.6
L_{10}		**54.8**	65.6	61.9	60.7	58.3	49.9	49.0	43.7	41.2	37.8	26.2
L_{90}		**49.9**	62.2	57.9	57.4	53.8	46.4	43.3	37.0	30.1	20.9	12.8
1815												
L_{Aeq}		**51.4**	64.8	60.9	58.7	54.4	47.7	45.3	39.5	34.2	30.6	21.9
L_{max}		**64.2**	77.3	70.3	65.4	59.6	56.6	59.1	57.6	56.2	50.9	41.7
L_{10}		**52.9**	66.2	62.4	59.8	55.5	49.0	47.3	41.1	36.4	32.9	23.7
L_{90}		**49.6**	62.9	58.8	57.5	53.1	46.3	42.9	37.2	29.2	19.5	12.4
1830												
L_{Aeq}		**51.8**	65.1	61.1	58.9	55.1	48.1	45.5	40.1	33.0	27.6	17.6
L_{max}		**65.8**	73.1	74.2	65.8	60.8	57.5	62.5	56.3	57.6	53.2	44.5
L_{10}		**53.0**	66.5	62.5	60.0	56.2	49.3	47.1	41.6	33.5	30.0	18.1
L_{90}		**50.0**	63.3	58.8	57.6	53.8	46.5	43.2	37.1	29.5	20.2	12.6
1845												
L_{Aeq}		**53.2**	66.0	61.9	59.1	56.1	49.6	47.5	42.8	36.1	27.5	18.1
L_{max}		**67.9**	79.8	69.6	65.3	65.3	63.7	63.2	60.6	57.5	52.1	40.0
L_{10}		**54.7**	67.9	63.4	60.3	57.5	51.0	49.3	44.5	35.3	27.5	18.6
L_{90}		**50.9**	63.6	59.8	57.7	54.3	47.2	44.8	39.4	30.7	20.7	12.6

11 Ballroyd Lane												
Ambient noise survey												
23rd - 24th September 2016, night time												
Octave Band Centre Frequency, Hz.		**dB(A)**	**31.5**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**16k**
2300												
L_{Aeq}		**51.0**	63.9	59.8	58.6	54.8	46.0	44.4	39.8	34.5	29.6	22.2
L_{max}		**67.4**	77.1	71.2	68.4	59.4	52.1	65.8	58.3	53.1	53.4	44.0
L_{A1}		**55.0**	66.3	62.8	60.6	57.2	48.0	50.0	45.5	43.6	39.0	32.0
L_{90}		**49.3**	62.2	58.0	57.4	53.1	45.1	42.6	37.6	30.1	20.9	13.5
2315												
L_{Aeq}		**50.8**	64.4	60.1	58.7	54.5	46.0	43.9	39.3	35.2	30.2	28.2
L_{max}		**61.9**	68.3	65.5	65.5	59.1	53.2	58.2	51.9	49.4	51.5	58.6
L_{A1}		**55.2**	66.8	62.8	61.1	57.1	50.4	50.2	44.4	42.2	37.8	36.3
L_{90}		**49.1**	62.6	58.3	57.3	53.0	44.9	42.1	37.1	29.8	21.2	15.0
2330												
L_{Aeq}		**51.1**	64.8	60.1	58.7	54.6	46.1	44.3	40.0	36.7	31.6	22.8
L_{max}		**61.7**	74.0	65.6	64.3	59.5	57.1	58.1	52.8	49.4	46.8	37.6
L_{A1}		**56.6**	67.4	62.8	60.7	56.9	51.3	52.6	47.6	43.8	39.7	31.5
L_{90}		**49.2**	62.9	58.3	57.5	53.1	44.8	42.1	37.4	31.2	23.5	14.7
2345												
L_{Aeq}		**51.0**	64.5	60.0	58.6	54.9	46.0	44.2	39.7	35.2	29.6	25.0
L_{max}		**59.9**	68.4	65.6	62.4	58.9	55.7	55.9	49.4	44.3	41.3	55.7
L_{A1}		**54.9**	67	62.9	60.6	57.1	50.7	49.8	44.5	40.7	37	30.5
L_{90}		**49.4**	62.7	58.2	57.5	53.5	44.8	42.5	37.2	30.0	21.5	13.5
0000												
L_{Aeq}		**51.8**	64.0	59.9	58.7	54.8	46.4	45.1	42.0	39.6	34.9	26.2
L_{max}		**71.9**	71.3	66.6	64.4	61.6	64.2	69.7	64.2	58.1	56.0	40.3
L_{A1}		**55.8**	66.6	63.0	61.1	57.0	49.0	49.7	46.9	46.6	43.2	36.0
L_{90}		**49.7**	62.3	58.0	57.4	53.5	45.2	42.8	38.7	33.1	26.2	16.6
0015												
L_{Aeq}		**51.1**	64.5	59.7	58.4	54.7	45.8	43.6	40.8	39.1	34.1	25.1
L_{max}		**59.8**	68.2	65.3	62.3	58.9	52.4	54.6	52.9	49.8	47.9	35.3
L_{A1}		**54.8**	66.9	62.4	60.4	56.9	48.5	47.8	46.3	45.5	41.2	33.0
L_{90}		**49.4**	62.9	57.9	57.3	53.2	44.8	42.2	38.0	33.6	26.6	16.5
0030												
L_{Aeq}		**50.6**	64.4	59.2	58.3	54.7	45.5	43.2	39.2	36.5	31.1	22.0
L_{max}		**60.0**	68.8	64.8	63.2	58.9	54.0	55.3	53.9	43.3	42.7	33.4
L_{A1}		**54.2**	66.9	62.0	60.4	56.8	49.7	48.4	43.3	42.2	37.4	28.7
L_{90}		**49.0**	62.6	57.4	57.1	53.4	44.4	41.6	36.9	30.8	23.1	14.4
0045												
L_{Aeq}		**50.4**	65.2	59.6	58.4	54.4	45.7	43.6	38.3	33.1	27.2	19.0
L_{max}		**60.2**	70.0	65.9	61.6	58.3	54.3	55.1	53.7	49.9	45.4	38.0
L_{A1}		**54.7**	68.4	62.6	60.3	56.7	50.4	50.3	43.3	38.3	33.4	27.0
L_{90}		**48.8**	63.2	57.8	57.2	53.0	44.5	41.3	36.5	29.9	21.2	13.3

Appendix 2. Revised proposed house layout, 11 Ballroyd Lane





Appendix 3. Break-in Noise Calculations

Proposed house at 11 Ballroyd Lane, Longwood - amended layout June 2017

Break-in Noise Calculations

L_{Aeq} Assessment, daytime

Proposed house

Kitchen/dining room, rear elevation

	* Octave Band Centre Frequency, Hz		dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{Aeq}		54	67	63	60	57	50	49	44	37	31	23
B	Exposed façade, m^2	7		8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5
C	Volume of receiving room, m^3	55.2											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-12.6	-12.6	-12.6	-12.6	-12.6	-12.6	-12.6	-12.6	-12.6	-12.6
F	Composite SRI			20.9	25.9	30.9	27.5	32.6	42.6	45.6	42.6	47.6	52.5
G	A + B + E - F		18	42.1	32.7	24.9	24.9	13.5	2.4	-5.3	-10.0	-21.1	-34.1
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		21	45.1	35.7	27.9	27.9	16.5	5.4	-2.3	-7.0	-18.1	-31.1
K	Number of ventilators	1											
L	Ventilator $D_{n,e}$				31	36	37	34	30	33	38	43	
M	$L_{Aeq} - D_{n,e} + 10*\log(10) - B + 3$				36.2	28.4	24.0	20.7	23.6	15.9	3.2	-7.9	
N	Internal room noise level, vent open		27		39.0	31.2	29.4	22.1	23.7	16.0	3.6	-7.5	

Glazing: *4mm, 16/20mm, 4mm*

Ventilator type: *Greenwood 4000S*

Proposed house

Kitchen/dining room, gable

	* Octave Band Centre Frequency, Hz		dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{Aeq}		54	67	63	60	57	50	49	44	37	31	23
B	Exposed façade, m^2	14.8		11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.7
C	Volume of receiving room, m^3	55.2											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-12.6	-12.6	-12.6	-12.6	-12.6	-12.6	-12.6	-12.6	-12.6	-12.6
F	Composite SRI			25.8	30.8	35.8	34.8	40.2	50.0	53.1	50.4	55.4	59.8
G	A + B + E - F		15	40.4	31.0	23.2	20.9	9.1	-1.7	-9.5	-14.5	-25.6	-38.1
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		18	43.4	34.0	26.2	23.9	12.1	1.3	-6.5	-11.5	-22.6	-35.1
K	Number of ventilators	1											
L	Ventilator $D_{n,e}$				31	36	37	34	30	33	38	43	
M	$L_{Aeq} - D_{n,e} + 10*\log(10) - B + 3$				33.0	25.2	20.8	17.5	20.4	12.7	0.0	-11.1	
N	Internal room noise level, vent open		24		36.6	28.8	25.6	18.6	20.5	12.7	0.3	-10.8	

Glazing: *4mm, 16/20mm, 4mm*

Ventilator type: *Greenwood 4000S*

Combined noise level, dB(A)	29

Proposed house

Living room - gable

	* Octave Band Centre Frequency, Hz		dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{Aeq}		54	67	63	60	57	50	49	44	37	31	23
B	Exposed façade, m^2	9.6		9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8
C	Volume of receiving room, m^3	33											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-10.3	-10.3	-10.3	-10.3	-10.3	-10.3	-10.3	-10.3	-10.3	-10.3
F	Composite SRI			28.0	33.0	38.0	42.0	50.0	58.0	62.0	62.0	67.0	67.0
G	A + B + E - F		10	38.6	29.2	21.4	14.0	-0.3	-9.4	-18.1	-25.8	-36.9	-45.0
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		13	41.6	32.2	24.4	17.0	2.7	-6.4	-15.1	-22.8	-33.9	-42.0

Glazing: *4mm, 16/20mm, 4mm*

Ventilator type: *Greenwood 4000S*

Proposed house

Living room - front elevation

* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{Aeq}		54	67	63	60	57	50	49	44	37	31	23
B	Exposed façade, m^2	8.5		9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3
C	Volume of receiving room, m^3	33											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-10.3	-10.3	-10.3	-10.3	-10.3	-10.3	-10.3	-10.3	-10.3	-10.3
F	Composite SRI			17.8	22.8	27.8	24.1	29.1	39.1	42.1	39.1	44.1	49.1
G	A + B + E - F		25	48.2	38.8	31.0	31.4	20.1	9.0	1.3	-3.4	-14.5	-27.6
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		28	51.2	41.8	34.0	34.4	23.1	12.0	4.3	-0.4	-11.5	-24.6
K	Number of ventilators	1											
L	Ventilator $D_{n,e}$				31	36	37	34	30	33	38	43	
M	$L_{Aeq} - D_{n,e} + 10*\log(10) - B + 3$				35.4	27.6	23.2	19.9	22.8	15.1	2.4	-8.7	
N	Internal room noise level, vent open		30		42.7	34.9	34.7	24.8	23.2	15.5	4.2	-6.9	

Glazing: *4mm, 16/20mm, 4mm*

Ventilator type: *Greenwood 4000S*

Proposed house

Master bedroom - gable

* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{Aeq}		54	67	63	60	57	50	49	44	37	31	23
B	Exposed façade, m^2	10.8		10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3
C	Volume of receiving room, m^3	31.6											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1
F	Composite SRI			28.0	33.0	38.0	42.0	50.0	58.0	62.0	62.0	67.0	67.0
G	A + B + E - F		11	39.3	29.9	22.1	14.7	0.4	-8.7	-17.4	-25.1	-36.2	-44.3
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		14	42.3	32.9	25.1	17.7	3.4	-5.7	-14.4	-22.1	-33.2	-41.3

Glazing: *4mm, 16/20mm, 4mm*

Ventilator type: *Greenwood 4000S*

Proposed house

Master bedroom - front elevation

* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{Aeq}		54	67	63	60	57	50	49	44	37	31	23
B	Exposed façade, m^2	6.8		8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3
C	Volume of receiving room, m^3	31.6											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1
F	Composite SRI			20.8	25.8	30.8	27.4	32.5	42.4	45.5	42.5	47.5	52.4
G	A + B + E - F		21	44.5	35.1	27.3	27.3	15.9	4.9	-2.9	-7.6	-18.7	-31.7
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		24	47.5	38.1	30.3	30.3	18.9	7.9	0.1	-4.6	-15.7	-28.7
K	Number of ventilators	1											
L	Ventilator $D_{n,e}$				31	36	37	34	30	33	38	43	
M	$L_{Aeq} - D_{n,e} + 10*\log(10) - B + 3$				36.4	28.6	24.2	20.9	23.8	16.1	3.4	-7.7	
N	Internal room noise level, vent open		28		40.3	32.5	31.2	23.0	23.9	16.2	4.0	-7.1	

Glazing: *4mm, 16/20mm, 4mm*

Ventilator type: *Greenwood 4000S*

Combined noise level, dB(A)	28

Proposed house

Front bedroom - front elevation

* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{Aeq}		54	67	63	60	57	50	49	44	37	31	23
B	Exposed façade, m^2	7.9		9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
C	Volume of receiving room, m^3	29											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-9.8	-9.8	-9.8	-9.8	-9.8	-9.8	-9.8	-9.8	-9.8	-9.8
F	Composite SRI			21.3	26.3	31.3	28.0	33.1	43.1	46.1	43.1	48.1	53.0
G	A + B + E - F		21	45.0	35.6	27.8	27.7	16.3	5.3	-2.5	-7.2	-18.3	-31.3
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		24	48.0	38.6	30.8	30.7	19.3	8.3	0.5	-4.2	-15.3	-28.3
K	Number of ventilators	1											
L	Ventilator $D_{n,e}$				31	36	37	34	30	33	38	43	
M	$L_{Aeq} - D_{n,e} + 10*\log(10) - B + 3$				35.7	27.9	23.5	20.2	23.1	15.4	2.7	-8.4	
N	Internal room noise level, vent open		28		40.4	32.6	31.4	22.8	23.3	15.6	3.5	-7.6	

Glazing: *4mm, 16/20mm, 4mm*

Ventilator type: *Greenwood 4000S*

Proposed house

Front bedroom - gable

	* Octave Band Centre Frequency, Hz		dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{Aeq}		54	67	63	60	57	50	49	44	37	31	23
B	Exposed façade, m^2	9		9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5
C	Volume of receiving room, m^3	29											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-9.8	-9.8	-9.8	-9.8	-9.8	-9.8	-9.8	-9.8	-9.8	-9.8
F	Composite SRI			28.0	33.0	38.0	42.0	50.0	58.0	62.0	62.0	67.0	67.0
G	A + B + E - F		10	38.9	29.5	21.7	14.3	0.0	-9.1	-17.8	-25.5	-36.6	-44.7
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		13	41.9	32.5	24.7	17.3	3.0	-6.1	-14.8	-22.5	-33.6	-41.7
Glazing:	*4mm, 16/20mm, 4mm*												
Ventilator type:	*Greenwood 4000S*												
	Combined noise level, dB(A)		28										

Proposed house

Rear bedroom - rear elevation

	* Octave Band Centre Frequency, Hz		dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{Aeq}		54	67	63	60	57	50	49	44	37	31	23
B	Exposed façade, m^2	9.2		9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6
C	Volume of receiving room, m^3	27.9											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-9.6	-9.6	-9.6	-9.6	-9.6	-9.6	-9.6	-9.6	-9.6	-9.6
F	Composite SRI			21.8	26.8	31.8	28.7	33.8	43.7	46.7	43.8	48.8	53.7
G	A + B + E - F		21	45.3	35.9	28.1	27.9	16.5	5.4	-2.3	-7.0	-18.1	-31.1
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		24	48.3	38.9	31.1	30.9	19.5	8.4	0.7	-4.0	-15.1	-28.1
K	Number of ventilators	1											
L	Ventilator $D_{n,e}$				31	36	37	34	30	33	38	43	
M	L_{Aeq} - $D_{n,e}$ + 10*log(10) - B + 3				35.1	27.3	22.9	19.6	22.5	14.8	2.1	-9.0	
N	Internal room noise level, vent open		28		40.4	32.6	31.5	22.5	22.6	14.9	3.0	-8.1	
Glazing:	*4mm, 16/20mm, 4mm*												
Ventilator type:	*Greenwood 4000S*												

Proposed house

Rear bedroom - gable

	* Octave Band Centre Frequency, Hz		dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{Aeq}		54	67	63	60	57	50	49	44	37	31	23
B	Exposed façade, m^2	9.4		9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7
C	Volume of receiving room, m^3	27.6											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-9.5	-9.5	-9.5	-9.5	-9.5	-9.5	-9.5	-9.5	-9.5	-9.5
F	Composite SRI			28.0	33.0	38.0	42.0	50.0	58.0	62.0	62.0	67.0	67.0
G	A + B + E - F		11	39.3	29.9	22.1	14.7	0.4	-8.7	-17.4	-25.1	-36.2	-44.3
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		14	42.3	32.9	25.1	17.7	3.4	-5.7	-14.4	-22.1	-33.2	-41.3
Glazing:	*4mm, 16/20mm, 4mm*												
Ventilator type:	*Greenwood 4000S*												
	Combined noise level, dB(A)		28										

Proposed house

Attic bedroom - rear elevation

	* Octave Band Centre Frequency, Hz		dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{Aeq}		54	67	63	60	57	50	49	44	37	31	23
B	Exposed façade, m^2	18.1		12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6
C	Volume of receiving room, m^3	53.6											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4
F	Composite SRI			18.2	23.2	28.2	34.1	39.2	44.3	43.3	51.2	56.2	61.0
G	A + B + E - F		20	49.1	39.7	31.9	22.5	11.1	5.0	1.3	-14.4	-25.5	-38.4
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		23	52.1	42.7	34.9	25.5	14.1	8.0	4.3	-11.4	-22.5	-35.4
K	Number of ventilators	1											
L	Ventilator $D_{n,e}$				31	36	37	34	30	33	38	43	
M	L_{Aeq} - $D_{n,e}$ + 10*log(10) - B + 3				32.1	24.3	19.9	16.6	19.5	11.8	-0.9	-12.0	
N	Internal room noise level, vent open		25		43.0	35.2	26.6	18.6	19.8	12.5	-0.5	-11.6	
Glazing:	*4mm, 16/20mm, 4mm*												
Ventilator type:	*Greenwood 4000S*												

Proposed house

Attic bedroom - rear elevation

	* Octave Band Centre Frequency, Hz		dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{Aeq}		54	67	63	60	57	50	49	44	37	31	23
B	Exposed façade, m^2	24.8		13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9
C	Volume of receiving room, m^3	53.6											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4
F	Composite SRI			15.2	20.2	25.2	21.3	26.3	36.3	39.3	36.3	41.3	46.3
G	A + B + E - F		30	53.4	44.0	36.2	36.7	25.4	14.3	6.6	1.9	-9.2	-22.3
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		33	56.4	47.0	39.2	39.7	28.4	17.3	9.6	4.9	-6.2	-19.3
K	Number of ventilators	1											
L	Ventilator $D_{n,e}$				31	36	37	34	30	33	38	43	
M	$L_{Aeq} - D_{n,e} + 10*\log(10) - B + 3$				30.8	23.0	18.6	15.3	18.2	10.5	-2.2	-13.3	
N	Internal room noise level, vent open		33		47.1	39.3	39.8	28.6	20.8	13.1	5.7	-5.4	
Glazing:	*4mm, 16/20mm, 4mm*												
Ventilator type:	*Greenwood 4000S*												
	Combined noise level, dB(A)		34										

L_{Aeq} Assessment, night time

Proposed house

Master bedroom - gable

	* Octave Band Centre Frequency, Hz		dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{Aeq}		52	64	60	59	55	46	45	42	40	35	26
B	Exposed façade, m^2	10.8		10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3
C	Volume of receiving room, m^3	31.6											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1
F	Composite SRI			28.0	33.0	38.0	42.0	50.0	58.0	62.0	62.0	67.0	67.0
G	A + B + E - F		9	36.2	27.1	20.9	13.0	-3.4	-12.7	-19.8	-22.2	-31.9	-40.6
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		12	39.2	30.1	23.9	16.0	-0.4	-9.7	-16.8	-19.2	-28.9	-37.6
Glazing:	*4mm, 16/20mm, 4mm*												
Ventilator type:	*Greenwood 4000S*												

Proposed house

Master bedroom - front elevation

	* Octave Band Centre Frequency, Hz		dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{Aeq}		52	64	60	59	55	46	45	42	40	35	26
B	Exposed façade, m^2	6.8		8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3
C	Volume of receiving room, m^3	31.6											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1
F	Composite SRI			20.8	25.8	30.8	27.4	32.5	42.4	45.5	42.5	47.5	52.4
G	A + B + E - F		19	41.4	32.3	26.1	25.6	12.1	0.9	-5.3	-4.7	-14.4	-28.0
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		22	44.4	35.3	29.1	28.6	15.1	3.9	-2.3	-1.7	-11.4	-25.0
K	Number of ventilators	1											
L	Ventilator $D_{n,e}$				31	36	37	34	30	33	38	43	
M	$L_{Aeq} - D_{n,e} + 10*\log(10) - B + 3$				33.6	27.4	22.5	17.1	19.8	13.7	6.3	-3.4	
N	Internal room noise level, vent open		25		37.5	31.3	29.5	19.2	19.9	13.8	6.9	-2.8	
Glazing:	*4mm, 16/20mm, 4mm*												
Ventilator type:	*Greenwood 4000S*												
	Combined noise level, dB(A)		26										

Proposed house

Front bedroom - front elevation

	** Octave Band Centre Frequency, Hz*		dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{Aeq}		52	64	60	59	55	46	45	42	40	35	26
B	Exposed façade, m^2	7.9		9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
C	Volume of receiving room, m^3	29											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-9.8	-9.8	-9.8	-9.8	-9.8	-9.8	-9.8	-9.8	-9.8	-9.8
F	Composite SRI			21.3	26.3	31.3	28.0	33.1	43.1	46.1	43.1	48.1	53.0
G	A + B + E - F		19	41.9	32.8	26.6	26.0	12.5	1.3	-4.9	-4.3	-14.0	-27.6
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		22	44.9	35.8	29.6	29.0	15.5	4.3	-1.9	-1.3	-11.0	-24.6
K	Number of ventilators	1											
L	Ventilator $D_{n,e}$				31	36	37	34	30	33	38	43	
M	L_{Aeq} - $D_{n,e}$ + 10*log(10) - B + 3				32.9	26.7	21.8	16.4	19.1	13.0	5.6	-4.1	
N	Internal room noise level, vent open		25		37.6	31.4	29.7	19.0	19.3	13.2	6.4	-3.3	
Glazing:	*4mm, 16/20mm, 4mm*												
Ventilator type:	*Greenwood 4000S*												

Proposed house

Front bedroom - gable

	** Octave Band Centre Frequency, Hz*		dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{Aeq}		52	64	60	59	55	46	45	42	40	35	26
B	Exposed façade, m^2	9		9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5
C	Volume of receiving room, m^3	29											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-9.8	-9.8	-9.8	-9.8	-9.8	-9.8	-9.8	-9.8	-9.8	-9.8
F	Composite SRI			28.0	33.0	38.0	42.0	50.0	58.0	62.0	62.0	67.0	67.0
G	A + B + E - F		8	35.8	26.7	20.5	12.6	-3.8	-13.1	-20.2	-22.6	-32.3	-41.0
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		11	38.8	29.7	23.5	15.6	-0.8	-10.1	-17.2	-19.6	-29.3	-38.0
Glazing:	*4mm, 16/20mm, 4mm*												
Ventilator type:	*Greenwood 4000S*												
	Combined noise level, dB(A)		25										

Proposed house

Rear bedroom - rear elevation

	** Octave Band Centre Frequency, Hz*		dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{Aeq}		52	64	60	59	55	46	45	42	40	35	26
B	Exposed façade, m^2	9.2		9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6
C	Volume of receiving room, m^3	27.9											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-9.6	-9.6	-9.6	-9.6	-9.6	-9.6	-9.6	-9.6	-9.6	-9.6
F	Composite SRI			21.8	26.8	31.8	28.7	33.8	43.7	46.7	43.8	48.8	53.7
G	A + B + E - F		19	42.2	33.1	26.9	26.2	12.7	1.4	-4.7	-4.1	-13.8	-27.4
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		22	45.2	36.1	29.9	29.2	15.7	4.4	-1.7	-1.1	-10.8	-24.4
K	Number of ventilators	1											
L	Ventilator $D_{n,e}$				31	36	37	34	30	33	38	43	
M	L_{Aeq} - $D_{n,e}$ + 10*log(10) - B + 3				32.3	26.1	21.2	15.8	18.5	12.4	5.0	-4.7	
N	Internal room noise level, vent open		25		37.6	31.4	29.8	18.7	18.6	12.5	5.9	-3.8	
Glazing:	*4mm, 16/20mm, 4mm*												
Ventilator type:	*Greenwood 4000S*												

Proposed house

Rear bedroom - gable

	** Octave Band Centre Frequency, Hz*		dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{Aeq}		52	64	60	59	55	46	45	42	40	35	26
B	Exposed façade, m^2	9.4		9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7
C	Volume of receiving room, m^3	27.6											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-9.5	-9.5	-9.5	-9.5	-9.5	-9.5	-9.5	-9.5	-9.5	-9.5
F	Composite SRI			28.0	33.0	38.0	42.0	50.0	58.0	62.0	62.0	67.0	67.0
G	A + B + E - F		9	36.2	27.1	20.9	13.0	-3.4	-12.7	-19.8	-22.2	-31.9	-40.6
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		12	39.2	30.1	23.9	16.0	-0.4	-9.7	-16.8	-19.2	-28.9	-37.6
Glazing:	*4mm, 16/20mm, 4mm*												
Ventilator type:	*Greenwood 4000S*												
	Combined noise level, dB(A)		25										

Proposed house

Attic bedroom - rear elevation

	* Octave Band Centre Frequency, Hz		dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{Aeq}		52	64	60	59	55	46	45	42	40	35	26
B	Exposed façade, m^2	18.1		12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6
C	Volume of receiving room, m^3	53.6											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4
F	Composite SRI			18.2	23.2	28.2	34.1	39.2	44.3	43.3	51.2	56.2	61.0
G	A + B + E - F		18	46.0	36.9	30.7	20.8	7.3	1.0	-1.1	-11.5	-21.2	-34.7
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		21	49.0	39.9	33.7	23.8	10.3	4.0	1.9	-8.5	-18.2	-31.7
K	Number of ventilators	1											
L	Ventilator $D_{n,e}$				31	36	37	34	30	33	38	43	
M	$L_{Aeq} - D_{n,e} + 10*log(10) - B + 3$				29.3	23.1	18.2	12.8	15.5	9.4	2.0	-7.7	
N	Internal room noise level, vent open		23		40.2	34.0	24.9	14.8	15.8	10.1	2.4	-7.3	
Glazing:	*4mm, 16/20mm, 4mm*												
Ventilator type:	*Greenwood 4000S*												

Proposed house

Attic bedroom - rear elevation

	* Octave Band Centre Frequency, Hz		dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{Aeq}		52	64	60	59	55	46	45	42	40	35	26
B	Exposed façade, m^2	24.8		13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9
C	Volume of receiving room, m^3	53.6											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4
F	Composite SRI			18.2	23.2	28.2	34.1	39.2	44.2	43.3	51.2	56.2	61.0
G	A + B + E - F		20	47.3	38.2	32.0	22.2	8.7	2.4	0.2	-10.1	-19.8	-33.3
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		23	50.3	41.2	35.0	25.2	11.7	5.4	3.2	-7.1	-16.8	-30.3
K	Number of ventilators	1											
L	Ventilator $D_{n,e}$				31	36	37	34	30	33	38	43	
M	$L_{Aeq} - D_{n,e} + 10*log(10) - B + 3$				28.0	21.8	16.9	11.5	14.2	8.1	0.7	-9.0	
N	Internal room noise level, vent open		24		41.4	35.2	25.8	14.6	14.7	9.3	1.3	-8.4	
Glazing:	*4mm, 16/20mm, 4mm*												
Ventilator type:	*Greenwood 4000S*												
	Combined noise level, dB(A)		26										

L_{A1} Assessment, night time

Proposed house

Master bedroom - gable

	* Octave Band Centre Frequency, Hz		dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{A1}		57	67	63	61	57	51	53	48	44	40	32
B	Exposed façade, m^2	10.8		10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3
C	Volume of receiving room, m^3	31.6											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1
F	Composite SRI			28.0	33.0	38.0	42.0	50.0	58.0	62.0	62.0	67.0	67.0
G	A + B + E - F		11	39.6	30.0	22.9	15.1	1.5	-5.2	-14.2	-18.0	-27.1	-35.3
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		14	42.6	33.0	25.9	18.1	4.5	-2.2	-11.2	-15.0	-24.1	-32.3
Glazing:	*4mm, 16/20mm, 4mm*												
Ventilator type:	*Greenwood 4000S*												

Proposed house

Master bedroom - front elevation

* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{A1}		57	67	63	61	57	51	53	48	44	40	32
B	Exposed façade, m^2	6.8		8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3
C	Volume of receiving room, m^3	31.6											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1
F	Composite SRI			20.8	25.8	30.8	27.4	32.5	42.4	45.5	42.5	47.5	52.4
G	A + B + E - F		22	44.8	35.2	28.1	27.7	17.0	8.4	0.3	-0.5	-9.6	-22.7
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		25	47.8	38.2	31.1	30.7	20.0	11.4	3.3	2.5	-6.6	-19.7
K	Number of ventilators	1											
L	Ventilator $D_{n,e}$				31	36	37	34	30	33	38	43	
M	L_{Aeq} - $D_{n,e}$ + 10*log(10) - B + 3				36.5	29.4	24.6	22.0	27.3	19.3	10.5	1.4	
N	Internal room noise level, vent open		30		40.4	33.3	31.6	24.1	27.4	19.4	11.1	2.0	

Glazing: *4mm, 16/20mm, 4mm*

Ventilator type: *Greenwood 4000S*

Combined noise level, dB(A) **30**

Proposed house

Front bedroom - front elevation

* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{A1}		57	67	63	61	57	51	53	48	44	40	32
B	Exposed façade, m^2	7.9		9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
C	Volume of receiving room, m^3	29											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-9.8	-9.8	-9.8	-9.8	-9.8	-9.8	-9.8	-9.8	-9.8	-9.8
F	Composite SRI			21.3	26.3	31.3	28.0	33.1	43.1	46.1	43.1	48.1	53.0
G	A + B + E - F		22	45.3	35.7	28.6	28.1	17.4	8.8	0.7	-0.1	-9.2	-22.3
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		25	48.3	38.7	31.6	31.1	20.4	11.8	3.7	2.9	-6.2	-19.3
K	Number of ventilators	1											
L	Ventilator $D_{n,e}$				31	36	37	34	30	33	38	43	
M	L_{Aeq} - $D_{n,e}$ + 10*log(10) - B + 3				35.8	28.7	23.9	21.3	26.6	18.6	9.8	0.7	
N	Internal room noise level, vent open		30		40.5	33.4	31.8	23.9	26.8	18.8	10.6	1.5	

Glazing: *4mm, 16/20mm, 4mm*

Ventilator type: *Greenwood 4000S*

Proposed house

Front bedroom - gable

* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{A1}		57	67	63	61	57	51	53	48	44	40	32
B	Exposed façade, m^2	9		9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5
C	Volume of receiving room, m^3	29											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-9.8	-9.8	-9.8	-9.8	-9.8	-9.8	-9.8	-9.8	-9.8	-9.8
F	Composite SRI			28.0	33.0	38.0	42.0	50.0	58.0	62.0	62.0	67.0	67.0
G	A + B + E - F		11	39.2	29.6	22.5	14.7	1.1	-5.6	-14.6	-18.4	-27.5	-35.7
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		14	42.2	32.6	25.5	17.7	4.1	-2.6	-11.6	-15.4	-24.5	-32.7

Glazing: *4mm, 16/20mm, 4mm*

Ventilator type: *Greenwood 4000S*

Combined noise level, dB(A) **30**

Proposed house

Rear bedroom - rear elevation

* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{A1}		57	67	63	61	57	51	53	48	44	40	32
B	Exposed façade, m^2	9.2		9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6
C	Volume of receiving room, m^3	27.9											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-9.6	-9.6	-9.6	-9.6	-9.6	-9.6	-9.6	-9.6	-9.6	-9.6
F	Composite SRI			21.8	26.8	31.8	28.7	33.8	43.7	46.7	43.8	48.8	53.7
G	A + B + E - F		22	45.6	36.0	28.9	28.3	17.6	8.9	0.9	0.1	-9.0	-22.1
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		25	48.6	39.0	31.9	31.3	20.6	11.9	3.9	3.1	-6.0	-19.1
K	Number of ventilators	1											
L	Ventilator $D_{n,e}$				31	36	37	34	30	33	38	43	
M	L_{Aeq} - $D_{n,e}$ + 10*log(10) - B + 3				35.2	28.1	23.3	20.7	26.0	18.0	9.2	0.1	
N	Internal room noise level, vent open		30		40.5	33.4	31.9	23.6	26.1	18.1	10.1	1.0	

Glazing: *4mm, 16/20mm, 4mm*

Ventilator type: *Greenwood 4000S*

Proposed house

Rear bedroom - gable

	** Octave Band Centre Frequency, Hz*		dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{A1}		57	67	63	61	57	51	53	48	44	40	32
B	Exposed façade, m^2	9.4		9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7
C	Volume of receiving room, m^3	27.6											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-9.5	-9.5	-9.5	-9.5	-9.5	-9.5	-9.5	-9.5	-9.5	-9.5
F	Composite SRI			28.0	33.0	38.0	42.0	50.0	58.0	62.0	62.0	67.0	67.0
G	A + B + E - F		11	39.6	30.0	22.9	15.1	1.5	-5.2	-14.2	-18.0	-27.1	-35.3
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		14	42.6	33.0	25.9	18.1	4.5	-2.2	-11.2	-15.0	-24.1	-32.3
Glazing:	*4mm, 16/20mm, 4mm*												
Ventilator type:	*Greenwood 4000S*												
	Combined noise level, dB(A)		30										

Proposed house

Attic bedroom - rear elevation

	** Octave Band Centre Frequency, Hz*		dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{A1}		57	67	63	61	57	51	53	48	44	40	32
B	Exposed façade, m^2	18.1		12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6
C	Volume of receiving room, m^3	53.6											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4
F	Composite SRI			18.2	23.2	28.2	34.1	39.2	44.3	43.3	51.2	56.2	61.0
G	A + B + E - F		21	49.4	39.8	32.7	22.9	12.2	8.5	4.5	-7.3	-16.4	-29.4
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		24	52.4	42.8	35.7	25.9	15.2	11.5	7.5	-4.3	-13.4	-26.4
K	Number of ventilators	1											
L	Ventilator $D_{n,e}$				31	36	37	34	30	33	38	43	
M	$L_{Aeq} - D_{n,e} + 10*\log(10) - B + 3$				32.2	25.1	20.3	17.7	23.0	15.0	6.2	-2.9	
N	Internal room noise level, vent open		27		43.1	36.0	27.0	19.7	23.3	15.7	6.6	-2.5	
Glazing:	*4mm, 16/20mm, 4mm*												
Ventilator type:	*Greenwood 4000S*												

Proposed house

Attic bedroom - rear elevation

	** Octave Band Centre Frequency, Hz*		dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{A1}		57	67	63	61	57	51	53	48	44	40	32
B	Exposed façade, m^2	24.8		13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9
C	Volume of receiving room, m^3	53.6											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4
F	Composite SRI			18.2	23.2	28.2	34.1	39.2	44.2	43.3	51.2	56.2	61.0
G	A + B + E - F		22	50.7	41.1	34.0	24.3	13.6	9.9	5.8	-5.9	-15.0	-28.0
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		25	53.7	44.1	37.0	27.3	16.6	12.9	8.8	-2.9	-12.0	-25.0
K	Number of ventilators	1											
L	Ventilator $D_{n,e}$				31	36	37	34	30	33	38	43	
M	$L_{Aeq} - D_{n,e} + 10*\log(10) - B + 3$				30.9	23.8	19.0	16.4	21.7	13.7	4.9	-4.2	
N	Internal room noise level, vent open		27		44.3	37.2	27.9	19.5	22.2	14.9	5.5	-3.6	
Glazing:	*4mm, 16/20mm, 4mm*												
Ventilator type:	*Greenwood 4000S*												
	Combined noise level, dB(A)		30										

L_{Amax} Assessment, night time

Proposed house

Master bedroom - gable

* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{Amax}		72	71	67	64	62	64	70	64	58	56	40
B	Exposed façade, m^2	10.8		10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3
C	Volume of receiving room, m^3	31.6											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1
F	Composite SRI			28.0	33.0	38.0	42.0	50.0	58.0	62.0	62.0	67.0	67.0
G	A + B + E - F		18	43.5	33.8	26.6	19.8	14.4	11.9	2.4	-3.7	-10.8	-26.5
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		21	46.5	36.8	29.6	22.8	17.4	14.9	5.4	-0.7	-7.8	-23.5
Glazing:	*4mm, 16/20mm, 4mm*												
Ventilator type:	*Greenwood 4000S*												

Proposed house

Master bedroom - front elevation

* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{Amax}		72	71	67	64	62	64	70	64	58	56	40
B	Exposed façade, m^2	6.8		8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3
C	Volume of receiving room, m^3	31.6											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1
F	Composite SRI			20.8	25.8	30.8	33.1	45.9	53.9	53.1	59.1	64.1	66.3
G	A + B + E - F		23	48.7	39.0	31.8	26.7	16.5	14.0	9.3	-2.8	-9.9	-27.8
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		26	51.7	42.0	34.8	29.7	19.5	17.0	12.3	0.2	-6.9	-24.8
K	Number of ventilators	1											
L	Ventilator $D_{n,e}$				31	36	37	34	30	33	38	43	
M	L_{Aeq} - $D_{n,e}$ + 10*log(10) - B + 3				40.3	33.1	29.3	34.9	44.4	35.9	24.8	17.7	
N	Internal room noise level, vent open		45		44.2	37.0	32.5	35.0	44.4	35.9	24.8	17.7	
Glazing:	*4mm, 16/20mm, 4mm*												
Ventilator type:	*Greenwood 4000S*												
	Combined noise level, dB(A)		45										

Proposed house

Front bedroom - front elevation

* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{Amax}		72	71	67	64	62	64	70	64	58	56	40
B	Exposed façade, m^2	7.9		9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
C	Volume of receiving room, m^3	29											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-9.8	-9.8	-9.8	-9.8	-9.8	-9.8	-9.8	-9.8	-9.8	-9.8
F	Composite SRI			21.3	26.3	31.3	28.0	33.1	43.1	46.1	43.1	48.1	53.0
G	A + B + E - F		31	49.2	39.5	32.3	32.8	30.3	25.9	17.3	14.2	7.1	-13.5
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		34	52.2	42.5	35.3	35.8	33.3	28.9	20.3	17.2	10.1	-10.5
K	Number of ventilators	1											
L	Ventilator $D_{n,e}$				31	36	37	34	30	33	38	43	
M	L_{Aeq} - $D_{n,e}$ + 10*log(10) - B + 3				39.6	32.4	28.6	34.2	43.7	35.2	24.1	17.0	
N	Internal room noise level, vent open		45		44.3	37.1	36.5	36.8	43.9	35.4	24.9	17.8	
Glazing:	*4mm, 16/20mm, 4mm*												
Ventilator type:	*Greenwood 4000S*												

Proposed house

Front bedroom - gable

* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{Amax}		72	71	67	64	62	64	70	64	58	56	40
B	Exposed façade, m^2	9		9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5
C	Volume of receiving room, m^3	29											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-9.8	-9.8	-9.8	-9.8	-9.8	-9.8	-9.8	-9.8	-9.8	-9.8
F	Composite SRI			28.0	33.0	38.0	42.0	50.0	58.0	62.0	62.0	67.0	67.0
G	A + B + E - F		18	43.1	33.4	26.2	19.4	14.0	11.5	2.0	-4.1	-11.2	-26.9
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		21	46.1	36.4	29.2	22.4	17.0	14.5	5.0	-1.1	-8.2	-23.9
Glazing:	*4mm, 16/20mm, 4mm*												
Ventilator type:	*Greenwood 4000S*												
	Combined noise level, dB(A)		45										

Proposed house

Rear bedroom - rear elevation

* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{Amax}		72	71	67	64	62	64	70	64	58	56	40
B	Exposed façade, m^2	9.2		9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6
C	Volume of receiving room, m^3	27.9											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-9.6	-9.6	-9.6	-9.6	-9.6	-9.6	-9.6	-9.6	-9.6	-9.6
F	Composite SRI			21.8	26.8	31.8	28.7	33.8	43.7	46.7	43.8	48.8	53.7
G	A + B + E - F		31	49.5	39.8	32.6	33.0	30.5	26.0	17.5	14.4	7.3	-13.3
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		34	52.5	42.8	35.6	36.0	33.5	29.0	20.5	17.4	10.3	-10.3
K	Number of ventilators	1											
L	Ventilator $D_{n,e}$				31	36	37	34	30	33	38	43	
M	$L_{Aeq} - D_{n,e} + 10*\log(10) - B + 3$				39.0	31.8	28.0	33.6	43.1	34.6	23.5	16.4	
N	Internal room noise level, vent open		45		44.3	37.1	36.6	36.5	43.2	34.7	24.4	17.3	

Glazing: *4mm, 16/20mm, 4mm*

Ventilator type: *Greenwood 4000S*

Proposed house

Rear bedroom - gable

* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{Amax}		72	71	67	64	62	64	70	64	58	56	40
B	Exposed façade, m^2	9.4		9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7
C	Volume of receiving room, m^3	27.6											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-9.5	-9.5	-9.5	-9.5	-9.5	-9.5	-9.5	-9.5	-9.5	-9.5
F	Composite SRI			28.0	33.0	38.0	42.0	50.0	58.0	62.0	62.0	67.0	67.0
G	A + B + E - F		18	43.5	33.8	26.6	19.8	14.4	11.9	2.4	-3.7	-10.8	-26.5
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		21	46.5	36.8	29.6	22.8	17.4	14.9	5.4	-0.7	-7.8	-23.5

Glazing: *4mm, 16/20mm, 4mm*

Ventilator type: *Greenwood 4000S*

Combined noise level, dB(A)	45

Proposed house

Attic bedroom - rear elevation

* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{Amax}		72	71	67	64	62	64	70	64	58	56	40
B	Exposed façade, m^2	18.1		12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6
C	Volume of receiving room, m^3	53.6											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4
F	Composite SRI			18.2	23.2	28.2	34.1	39.2	44.3	43.3	51.2	56.2	61.0
G	A + B + E - F		30	53.3	43.6	36.4	27.6	25.1	25.6	21.1	7.0	-0.1	-20.6
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		33	56.3	46.6	39.4	30.6	28.1	28.6	24.1	10.0	2.9	-17.6
K	Number of ventilators	1											
L	Ventilator $D_{n,e}$				31	36	37	34	30	33	38	43	
M	$L_{Aeq} - D_{n,e} + 10*\log(10) - B + 3$				36.0	28.8	25.0	30.6	40.1	31.6	20.5	13.4	
N	Internal room noise level, vent open		42		46.9	39.7	31.7	32.6	40.4	32.3	20.9	13.8	

Glazing: *4mm, 16/20mm, 4mm*

Ventilator type: *Greenwood 4000S*

Proposed house

Attic bedroom - rear elevation

* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{Amax}		72	71	67	64	62	64	70	64	58	56	40
B	Exposed façade, m^2	24.8		13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9
C	Volume of receiving room, m^3	53.6											
D	Reverb Time, seconds			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	10 x Log(RT60/(0.163 x V)			-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4
F	Composite SRI			18.2	23.2	28.2	34.1	39.2	44.2	43.3	51.2	56.2	61.0
G	A + B + E - F		31	54.6	44.9	37.7	29.0	26.5	27.0	22.4	8.4	1.3	-19.2
H	K = 3			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
I													
J	Calculated internal noise level		34	57.6	47.9	40.7	32.0	29.5	30.0	25.4	11.4	4.3	-16.2
K	Number of ventilators	1											
L	Ventilator $D_{n,e}$				31	36	37	34	30	33	38	43	
M	$L_{Aeq} - D_{n,e} + 10*\log(10) - B + 3$				34.7	27.5	23.7	29.3	38.8	30.3	19.2	12.1	
N	Internal room noise level, vent open		41		48.1	40.9	32.6	32.4	39.3	31.5	19.8	12.7	

Glazing: *4mm, 16/20mm, 4mm*

Ventilator type: *Greenwood 4000S*

Combined noise level, dB(A)	44