

**Assessment of the Existing Noise Climate in the Vicinity of the
Proposed New Dwelling at the Sacred Heart Football Club, Rochdale**

Report Prepared for:

Sacred Heart Football Club
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1.0 Summary

Outline planning permission is being sought for the construction of a new detached bungalow at the Southern end of the existing Sacred Heart F. C. ground on Bellfield Mill Lane in Rochdale. In support of the planning application Druk Limited was commissioned to undertake an assessment of the existing noise climate in the immediate vicinity of the proposed house and to assess what mitigation measures may be necessary to limit the ingress of external noise.

The existing noise climate in the vicinity of the proposed bungalow on the Sacred Heart F. C. ground was regarded as being pleasantly quiet and was characteristic of an essentially sub-urban area subject to noise contributions primarily from: road traffic, the passage of trains and some noise from the neighbouring properties.

Applying the obtained sound levels from the survey and combining these with the stated assumptions relating to the sound insulation of the façade elements, the calculations have demonstrated that the sound insulation of the façade elements of the proposed bungalow would be sufficient to secure that the break-in noise levels would not exceed the adopted design guide required by Rochdale Borough Council or contained within BS 8233:2014. With reference for the necessity to provide an alternative ventilation strategy in order to meet the adopted design guide values, an initial assessment has been conducted to assess whether such provision would be necessary. Applying the mean and modal values from the 24 hour noise survey and assuming a partially open window, the assessments have suggested that the internal noise levels would comply with the adopted internal noise guide values. Despite this, it is recommended that this element is discussed with the Local Planning Authority.

Turning to the noise climate within the external amenity areas, it is suggested that for the majority of the time the external noise levels would not exceed the stated external noise guide value and as such no additional sound attenuation measures would be required. Despite this, during a football match would it is likely that the external noise guide value would be exceeded. However, as the football matches would persist for only around two hours and would not take place every weekend, it is suggested that to require the provision of any additional sound attenuation measures, such as acoustic fences around the external areas, would again be disproportionate to the benefit that would be derived by the occupants for the vast majority of the time.

As a consequence it is suggested that the sound insulation of the facade elements, combined with the form and overall existing noise climate levels, would be sufficient to comply with the guide values relating to the internal noise levels within the proposed bungalow and the external amenity areas without prejudicing the amenity of the future occupants.

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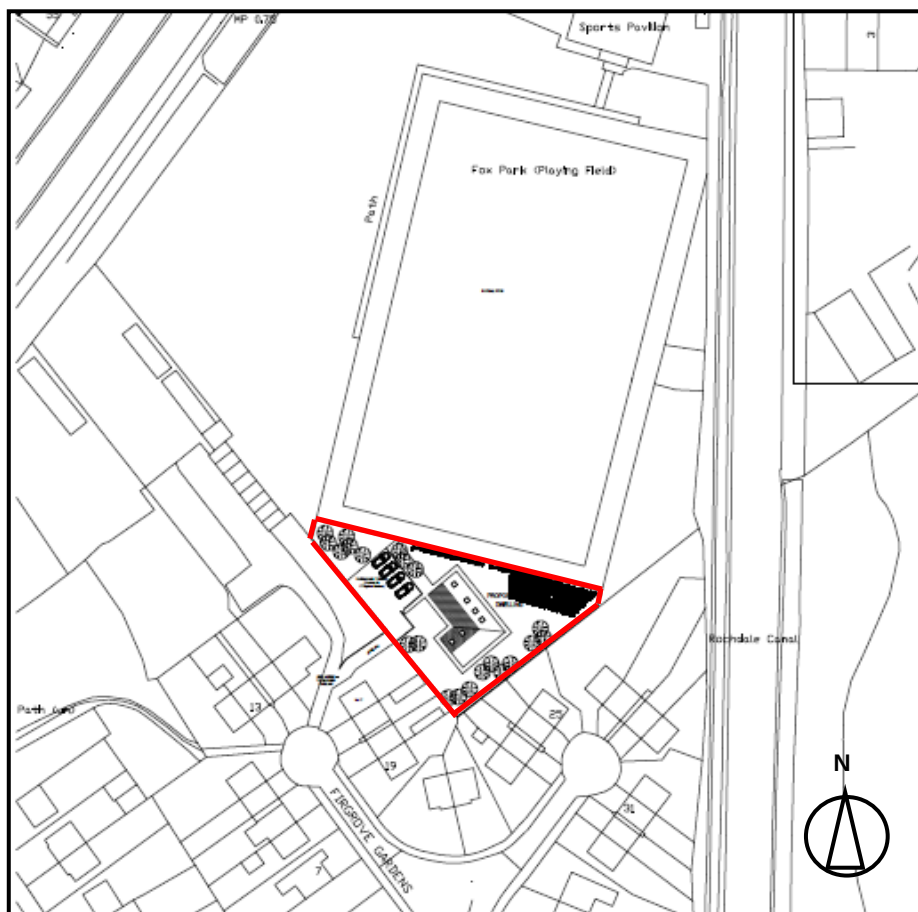
2.0 Introduction

Outline planning permission is being sought for the construction of a new detached three bedroom bungalow with associated car parking area and garden at the Southern end of the existing Sacred Heart F. C. ground on Bellfield Mill Lane in Rochdale. In support of the planning application Druk Limited was commissioned to undertake an assessment of the existing noise climate in the immediate vicinity of the proposed house and to assess what, if any, mitigation measures may be necessary to limit the ingress of external noise.

3.0 Site Description

The proposed bungalow would be built on a parcel of land at the Southern end of the existing Sacred Heart F. C. ground on Bellfield Mill Lane in Roachdale (figure 1 below). To the North of the proposed bungalow is the existing Sacred Heart F. C. ground and sports pavilion, approximately 125metres to the North (photograph 1 overleaf). To the South of the proposed bungalow are the existing houses on Firgrove Gardens (photograph 2 overleaf). To the East of the proposed bungalow are the house on Firgrove Gardens (photograph 3 overleaf) with the Rochdale Canal and a large area of open land beyond. To the West of the proposed bungalow is the Sacred Heart F. C. pitch (photograph 4 overleaf) with the Hollanny Stables and the railway line, approximately 100metres beyond.

Figure 1. Site of the proposed new dwelling (edged in red), Sacred Heart F. C., Rochdale



Photograph 1. Sacred Heart F. C. ground to the North of the proposed bungalow



Photograph 2. Existing houses on Firgrove Gardens to the South of the proposed bungalow



Photograph 3. Existing houses on Firgrove Gardens to the East of the proposed bungalow



Photograph 4. Railway line in a cutting approximately 65metres to the South of the development site



4.0 Assessment Criteria

As planning permission is currently being sought for the proposed bungalow, no planning conditions currently exist. Despite this, comments have been received from the Environmental Health department of Rochdale Council relating to the internal and external noise climate that Rochdale Council regard as being appropriate for the development.

This section cannot support the application in its current form. Given the close proximity to the rail network and the noise of the football club, we require a noise impact assessment to inform the design of the residential units to achieve the following internal noise levels:

- 35 dB(A) L_{eq} (1 hour) in the bedrooms with windows shut and other means of ventilation provided between 7 am and 11pm;
- 30dB(A) L_{eq} 5mins in the bedrooms with windows shut and other means of ventilation provided between 11pm and 7am;
- 35 dB(A) L_{eq} (1 hour) in the living room/s with windows shut and other means of ventilation provided between 7 am and 11pm;
- 40dB(A) L_{eq} (1 hour) in other habitable rooms with windows shut and other means of ventilation provided at all times;

Noise in outdoor areas does not exceed 55dB(A)

Consequently, the principal aim of this report will be to evaluate the potential suitability of the proposed site for residential use with respect to the prevailing noise climate in the immediate vicinity. With reference to these aims, the proposed development will be assessed with reference to the guidance contained within: the National Planning Policy Framework (NPPF), the Noise Policy Statement for England (NPSE) and the National Planning Practice Guidance (NPPG), British Standard (BS) 8233:2014 "Guidance on sound insulation and noise reduction for buildings" and the Planning and Noise: Professional Guidance on Planning and Noise (ProPG), May 2017, document, the guidance contained within the Acoustics, Ventilation and Overheating - Residential Design Guide.

4.1 National Planning Policy Framework (NPPF), the Noise Policy Statement for England (NPSE) and the National Planning Practice Guidance (NPPG)

The National Planning Policy Framework (NPPF), the Noise Policy Statement for England (NPSE), originally released in 2010, and the National Planning Practice Guidance (NPPG) do not provide quantitative criteria for assessment purposes. Instead the documents detail general policy aims, statements as well as providing some guidance on how certain situations can be interpreted.

The main statement on noise contained within the revised NPPF, issued in December 2023, is to be found in paragraph 185:

- 185.** Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to

impacts that could arise from the development. In doing so they should:

- a) Mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life;
- b) Identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason; and
- c) Limit the impact of light pollution from artificial light on local amenity, intrinsically dark landscapes and nature conservation.

In addition, paragraph 187 of the NPPF is also relevant and states:

187. Planning policies and decisions should ensure that new development can be integrated effectively with existing businesses and community facilities (such as places of worship, pubs, music venues and sports clubs). Existing businesses and facilities should not have unreasonable restrictions placed on them as a result of development permitted after they were established. Where the operation of an existing business or community facility could have a significant adverse effect on new development (including changes of use) in its vicinity, the applicant (or ‘agent of change’) should be required to provide suitable mitigation before the development has been completed.

The NPPF also refers to the NPSE and as such details the following aims:

1. The avoidance of significant adverse impacts on health and quality of life;
2. Mitigate and minimise adverse impacts on health and quality of life; and
3. Where possible, contribute to the improvement of health and quality of life.

In order to reflect these objectives the NPSE referenced concepts utilised by the World Health Organisation, which in turn employed concepts from toxicology and applied them to noise impacts. These concepts are:

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

SOAEL is clearly something the policy seeks to avoid in aim 1. Aim 2 represents situations between SOAEL and LOAEL, and seeks to minimise and mitigate the possible effects.

The NPPG section on noise adds some further detail, much of it reproducing the NPPF and NPSE, but some useful qualitative guidance is provided in the noise exposure hierarchy table and this is reproduced in table 1 overleaf.

Table 1. Noise exposure hierarchy table

Perception	Examples of Outcomes	Increasing effect level	Action
Not noticeable	No effect	No Observed Effect	No specific measures required
Noticeable and not intrusive	Noise can be heard, but does not cause any change in behaviour or attitude. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.	No Observed Adverse Effect	No specific measures required
		Lowest Observed Adverse Effect Level	
Noticeable and intrusive	Noise can be heard and causes small changes in behaviour and/or attitude, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
		Significant Observed Adverse Effect Level	
Noticeable and disruptive	The noise causes a material change in behaviour and/or attitude, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect	Avoid
Noticeable and very disruptive	Extensive and regular changes in behaviour and/or an inability to mitigate effect of noise leading to psychological stress or physiological effects, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory	Unacceptable Adverse Effect	Prevent

The NPPG also highlights that the subjective nature of noise means that there is not a simple relationship between noise levels and the possible impact on those affected. It recognises that any effects will depend on how various factors combine in any particular situation, including absolute noise levels and how they may compare with the underlying background noise, the impulsiveness or intermittence pattern of the noise, its spectral content, and the time of day. It discusses in very general terms the issues to consider when introducing noise sources to existing noise sensitive area, new residential

development in areas affected by existing noise sources (most of which have their own specific guidance, such as BS 4142, BS 8233, etc.) and the potential impact on wildlife.

4.2 BS 8233:2014 “Guidance on Sound Insulation and Noise Reduction for Buildings”

The requirements received from Rochdale Borough Council's Environmental Health department essentially replicate the guidance contained within British Standard (BS) 8233:2014 “Guidance on Sound Insulation and Noise Reduction for Buildings”.

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 Standard states that the guidance it contains is applicable to the design of new buildings, or refurbished buildings undergoing a change of use and as such it is deemed applicable to this proposal.

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 dwelling houses flats and rooms in residential use, it is suggested that the guidance is applicable to 'anonymous' noise without a 'specific' character, and this is typically the situation where road traffic type noise or similar transportation noise is the dominant or principal contributor to the existing noise climate. This being the case BS 8233:2014 indicates that it would be desirable for the internal noise levels, resulting from the break-in of external noise, not to exceed the guide values detailed within table 4 of section 7.7.2. The main elements of the guidance contained within table 4 of section 7.7.2 of BS 8233:2014 are reproduced in table 2 below.

Table 2. 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 $L_{Aeq, 16 \text{ hour}}$	-
Dining	Dining room/area	40dB $L_{Aeq, 16 \text{ hour}}$	-
Sleeping (daytime resting)	Bedroom	35dB $L_{Aeq, 16 \text{ hour}}$	30dB $L_{Aeq, 8 \text{ hour}}$

It should also be noted that BS8233:2014 applies the frequently quoted 'rule of thumb' that where a window is partially open for ventilation purposes etc., the sound levels just outside the window will be around 15dB higher than the levels just inside the window.

In addition to the internal noise design guidance detailed above, supplementary notes 5 and 7 to table 4 of section 7.7.2 are deemed appropriate to this assessment and state the following:

Note 5. *If relying on closed windows to meet the guide values, there needs to be an appropriate alternative ventilation that does not compromise the façade insulation or the resulting sound level.*

Note 7. *Where development is considered as necessary or desirable, despite external noise levels above WHO guidelines, the internal target levels may be relaxed by up to 5dB and reasonable internal conditions still achieved.*

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”*.

4.3 Planning and Noise: Professional Guidance on Planning and Noise (ProPG)

This document was published in May 2017 and was produced jointly by representatives of the Chartered Institute of Environmental Health (CIEH), the Institute of Acoustics (IoA) and the Association of Noise Consultants (ANC). The ProPG document seeks to provide guidance on and complement the wider aims contained within the Noise Policy Statement for England (NPSE) and the additional guidance contained within the National Planning Policy Framework(NPPF). In addition the ProPG document acknowledges the contribution made by existing guidance contained within both the World Health Organisations (WHO) "Guidelines for Community Noise" and (BS) 8233:2014 "Guidance on sound insulation and noise reduction for buildings".

The ProPG document guidance is restricted to the consideration of new residential developments and the potential implications for these developments arising from predominantly airborne noise that typical emanates from transportation noise sources. The document utilises a risk assessment based two stage approach to: Stage 1 - undertake an "initial noise risk assessment of the proposed development site" and Stage 2 - undertake a "systematic consideration of four key elements". It should however be remembered that these 'noise risk categories' are designed for the initial assessment of the noise exposure of a site and for the categorisation of the prevailing noise climate. With reference to the four key elements of the systematic assessment, these are defined as:

- Element 1 - demonstrating a "Good Acoustic Design Process".
- Element 2 - observing internal "Noise Level Guidelines".
- Element 3 - undertaking an "External Amenity Area Noise Assessment, and.
- Element 4 - consideration of "Other Relevant Issues".

With reference to Stage 1, the requirement to undertake a noise risk assessment of the proposed development site, the site 'risk' category boundaries are described with reference to the external free field noise levels that would affect a proposed development and these are contained within figure 1 of Section 2 of the document. Whilst the ProPG document does not attribute specific noise levels to the 'risk' categories, an interpretation of the noise levels presented within figure 1 of the ProPG document is contained in table 3 overleaf. Again, the guidance relates primarily to 'anonymous' type noise.

Table 3. Level 1 assessment 'risk' boundary noise levels (derived from figure 1 of the ProPG document)

Indicative noise levels		Noise 'risk' assessment
Daytime (07:00 - 23:00) $L_{Aeq, 16 \text{ hour}}$	Night time (23:00 - 07:00) $L_{Aeq, 8 \text{ hour}}$	
$\leq 50\text{dB}$	$\leq 40\text{dB}$	Negligible
$> 50 \text{ and } \leq 63\text{dB}$	$> 40 \text{ and } \leq 53\text{dB}$	Low
$> 63 \text{ and } \leq 68\text{dB}$	$> 53 \text{ and } \leq 58\text{dB}$	Medium
$> 68\text{dB}$	$> 58\text{dB}$	High

The guiding principle of the ProPG document with reference to the existing noise climate is that once the potential impact on a development has been quantified, good acoustic design should be implemented to mitigate the potential effects that the existing noise climate may have on the proposed resident of any new residential development. In this case the good design principle relates to both the internal acoustic environment within dwellings and any external amenity areas serving those dwellings. With reference to good acoustic design Pro PG does recognise that this does not mean "overdesign or gold plating", but it does mean delivering *"the optimum acoustic outcome for a particular site"*.

With respect to the internal noise level guidelines, ProPG makes reference to the guidance contained within table 4 of section 7.7.2BS 8233:2014, reproduced in section 4.2 above. Whilst recognising that it is preferable to achieve the internal noise guidelines ProPG does, at paragraph 2.30, recognise that national planning and noise policy does not always require that these levels are achieved. This is particularly the case where to do so would *"disproportionately increase the cost of the development"*.

Remaining with the issue of internal noise level guidance and the proposed levels for individual noise events, expressed as an L_{max} , the guidance contained within Appendix A of the ProPG is instructive. The Appendix contains a short summary of research into the effects of individual noise events and the effect that these can have on sleep. In the light of this summary the document, at paragraph A.20, states the following, *"...therefore, it is considered that if, in bedrooms at night, the $L_{Amax,F}$ from individual noise events (from all sources) would not normally exceed 45dB more than 10 times a night, then this represents a reasonable threshold below which the events on sleep can be regarded as negligible"*.

The potential impact of ventilation on the acoustic integrity of the façade of a dwelling is also addressed by the ProPG document. The document suggests that good acoustic design should be used to achieve the internal design targets in noise sensitive rooms with windows open. Here it is assumed that this relates to windows partially open for ventilation purposes. Despite this it also recognises the limitations of acoustic design and highlights that internal noise levels may only be achievable with window closed in certain environments such as urban areas or sites adjacent to transportation noise sources. In these situations it is suggested that internal noise levels are assessed with windows closed but with any façade openings used for ventilation purposes in their open position. Finally and with reference to ventilation ProPG at paragraph 2.35 states

that "internal noise level guidance are generally not applicable under purge ventilation conditions".

4.4 Acoustics, Ventilation and Overheating - Residential Design Guide

There is an increasing recognition that in addition to securing an acceptable internal noise climate, there needs to be a degree of integration between acoustic design and the requirement to address both the ventilation and thermal comfort of a dwelling. Typically, achieving a good internal acoustic environment has been achieved by requiring dwelling windows to remain closed, but most ventilation and overheating assessments look to the ability to open windows to permit both adequate ventilation and the management of the internal thermal environment. In many locations, particularly urban environments, it is recognised that opening windows will typically have negative impacts on the internal acoustic environment within a dwelling.

In an attempt to provide additional guidance on the interplay between suitable ventilation to address potential overheating within a noisy environment, The "Acoustics Ventilation and Overheating Residential Design Guidance", hereafter referred to as the AVO Guide, has been formulated by the Association of Noise Consultants (ANC). This comprehensive document seeks to strike a balance between the often competing requirements relating to both good acoustic conditions within a residential dwelling and the provision of ventilation to mitigate potential overheating.

In its simplest form the AVO Guide provides for a two stage assessment procedure. The first stage, level 1, may be considered as a 'site risk' assessment and is based on the external noise levels to which a residential dwelling may be exposed. Again, it should be borne in mind that the 'site risk' relates to the categorisation of the prevailing noise climate. A level 2 assessment seeks to assess the potential adverse effects that may result and would be based on a combination of the internal ambient noise levels the duration, times and the frequency when open windows would be required etc. It should however be remembered that this report will restrict itself to a level 1, 'site risk', assessment. A level 2 assessment is considered to be beyond the remit of this report and should be considered by other parties.

A level 1 assessment is predicated on the adoption of partially open windows as the primary method of internal temperature control. The various site 'risk' categories have been described according to the external free field noise levels that are likely to affect a proposed development and these are detailed in table 3.2 of the Guide. Although the AVO Guide does not attribute specific noise levels to the various 'risk' categories, an interpretation of the noise levels presented within table 3.2 of the AVO Guide and the likely 'risk' categories to which they correspond, is produced in table 4 overleaf. As with the guidance contained within BS 8233:2014 and the ProPG document, the guidance relates primarily to 'anonymous' type noise.

Table 4. Level 1 assessment 'risk' boundary noise levels (derived from table 3.2 of the AVO Guide)

External free - field noise level at façade		
Daytime (07:00 - 23:00) $L_{Aeq, 16 \text{ hour}}$	Night time (23:00 - 07:00) $L_{Aeq, 8 \text{ hour}}$	Level 1 'risk' category
$\leq 52\text{dB}$	$\leq 47\text{dB}$	Negligible
$> 52 \text{ and } \leq 57\text{dB}$	$> 47 \text{ and } \leq 52\text{dB}$	Low
$> 57 \text{ and } \leq 62\text{dB}$	$> 52 \text{ and } \leq 55\text{dB}$	Medium
$> 62\text{dB}$	$> 55\text{dB}$	High

Note 4. Where 78dB L_{AFmax} is normally exceeded during the night time period a level 2 assessment is recommended.

The guidance also recognises that there may be instances where occupants may 'trade' the internal acoustic environment by accepting higher noise levels for a period of time in order to maintain control over the thermal environment.

The document relates primarily to residential developments that are subject to airborne noise from transportation noise sources. Despite its focus on new residential dwellings, predominantly flats and houses, the AVO Guide does suggest that it may also be applicable to other forms of residential dwellings such as care homes and residential institutions.

The potential implications of opening windows on the internal acoustic environment and the possible outcomes for the occupants of the ventilated spaces are summarised in table 5 below, which combines the guidance contained within table 3.3 and figures B-2 and B-3 from the AVO Guide.

Table 5. Guidelines for a level 2 assessment (derived from table 3.3 and figures B.2 and B.3 of the AVO Guide)

Internal ambient noise level (from road traffic noise)			
$L_{Aeq,T}$ during 07:00 - 23:00	$L_{Aeq,T}$ during 23:00 - 07:00	Individual noise events, L_{AFmax} , during 23:00 - 07:00	Potential outcome
$\leq 35\text{dB}$	$\leq 30\text{dB}$	45dB not normally exceeded more than 10 times a night	LOAEL: Noise can be heard but does not cause any change in behaviour
$> 35 \text{ and } \leq 40\text{dB}$	$> 30 \text{ and } \leq 35\text{dB}$	Increasing adverse effect	Increasing adverse effect
$> 40 \text{ and } \leq 50\text{dB}$	$> 35 \text{ and } \leq 42\text{dB}$		
$> 50\text{dB}$	$> 42\text{dB}$	Normally exceeds 65dB	Exceeds SOAEL: Noise causes a material change in behaviour, e.g. keeping windows closed

In essence, the higher the external noise level the more likely it is that the internal noise levels would exceed the guide values detailed within BS 8233:2014 and summarised in table 2 above, with windows partially open for ventilation purposes. As a consequence, as the external noise levels increase it is more than likely that additional or alternative

ventilation requirements will be required in order to ensure the internal areas can be effectively ventilated, in all but purge ventilation conditions, without prejudicing the façade sound insulation and so the internal noise climate. It must however be remembered that where alternative mechanical ventilation is specified, the emission of noise from such systems must not lead to an unnecessary increase in the internal noise climate.

4.5 Approved Document F (ADF) - Ventilation

With reference to the relevant guidance relating to the ventilation of dwellings, this is contained within Approved Document F (ADF) guidance to the Building Regulations 2010, currently in the 2021 edition as it relates to dwellings.

In summary the ventilation strategies outlined in ADF relies on a combination of approaches, including: Extract ventilation to remove water vapour or pollutants; whole dwelling ventilation to provide fresh air to the building and to dilute, disperse and remove water vapour and pollutants not removed by extract ventilation and purge ventilation to remove high concentrations of pollutants and water vapour. With reference to extract ventilation in individual rooms this is typically achieved via intermittent extraction fans, whole house ventilation is often achieved through a combination of background (trickle) ventilators and/or continuous supply fans and. It is acknowledged that purge ventilation is typically achieved through the opening of windows. ADF also states that "*Other ventilation systems may be acceptable if they can be shown to meet an equal level of performance*".

Approved Document F details four main types of ventilation systems that can be used to provide ventilation to dwellings, typically described as systems 1 to 4. A summary of these systems is provided within table 6 below and this table also provides additional annotation that expands upon the details provided within ADF.

Table 6. Summary of the ADF ventilation systems 1 - 4

Ventilation system	Purge ventilation
System 1: background ventilation (trickle ventilators) and intermittent extraction fans	Typically provided by opening windows
System 2: passive stack (natural)	Typically provided by opening windows
System 3: Continuous mechanical extraction (MEV) (Trickle ventilators provide inlet air)	Typically provided by opening windows
System 4: Continuous mechanical supply and extract with heat recovery (MVHR)	Typically provided by opening windows

Ventilation provisions conforming to the descriptions of systems 1, 3 and 4 are most commonly found within dwellings. With reference to purge ventilation, in addition to securing rapid exchange of air to remove pollutants, this can and is typically used to address the thermal comfort of occupants. It must however be remembered that the issue of thermal comfort is not covered by Approved Document F, guidance to the Building Regulations.

It should however be borne in mind that when specifying the ventilation provision for a dwelling, the interaction of the ventilation provision with the internal noise levels should be considered. This interaction is a result of the fact that the provision of suitable ventilation openings in a building façade can affect that the sound insulation of the façade elements, which in turn can affect the level of external noise break-in and so the internal noise levels that will prevail within a dwelling. Whilst this report will specify an appropriate type of ventilation provision in accordance with the general descriptions contained within table above, it is not intended to be a detailed ventilation design statement and a full evaluation of any ventilation provision is beyond the remit of this report.

The ventilation of the internal spaces of a dwelling can include the opening of windows to the provision of dedicated mechanical ventilation. With reference to the opening of windows, as suggested above this will not only permit the exchange of air but will also facilitate the ingress of external noise. In this respect the estimates of the sound insulation provided by a window partially open for ventilation purposes can and do vary. With respect to the level of sound insulation provided by an open window, BS 8233:2014 quotes the 15dB 'rule of thumb' which suggests that where a window is partially open for ventilation purposes etc., the sound levels just outside the window will be around 15dB higher than the levels just inside the window. The "Acoustics Ventilation and Overheating Residential Design Guidance", the AVO Guide, formulated by the Association of Noise Consultants (ANC) suggests that a partially open window can provide a sound insulation value of around 13dB.

Finally, data presented by Søndergaard & Egedal (2016) suggested that for a top hung window with an opening equivalent to 0.35m^2 , a sound insulation value of around 9dB R_w would be expected. With reference to the Søndergaard & Egedal (2016) findings this, in our experience, appears to be a little pessimistic about the potential sound insulation provided by a partially open window. Despite this, the degree of window opening will play a role in determining the sound insulation, a partially open window would be expected to provide more sound insulation than a fully open window.

Consequently, it is suggested that in all but the quietest of areas that the opening of windows, partial or otherwise, would result in the internal noise levels exceeding the adopted internal design guide levels. As such, in the majority of locations it will be necessary to provide alternative methods of ventilation to ensure that the internal spaces can be adequately ventilated without having to resort to opening windows and so detrimentally affecting the internal noise climate.

4.6 Approved Document O - Overheating

The guidance relating to the limitation of unwanted solar gains in summer in addition to providing an 'adequate means' of removing heat from the indoor environment, are contained within Approved Document O (ADO) of the Building Regulations 2010 which came into effect in June 2022. The requirements relate to new residential buildings only, within the categories detailed within ADO being contained within table 7 overleaf.

Table 7. Residential buildings within the scope of approved document O

Title	Purpose for which the building is intended to be used
Residential (dwellings)	Dwellings, which includes both dwellinghouses and flats.
Residential (institutional)	Home, school or other similar establishment, where people sleep on the premises. The building may be living accommodation for the care or maintenance of any of the following. a. Older and disabled people, due to illness or other physical or mental condition. b. People under the age of 5 years.
Residential (other)	Residential college, hall of residence and other student accommodation, and living accommodation for children aged 5 years and older.

Reproduced from Table 0.1 of Approved Document O

The above requirements are not applicable to rooms within a hotel.

Paragraph 2.10 of ADO indicates that the removals of excess heat from the interior spaces of applicable buildings may be achieved by the following methods:

- Opening windows
- Ventilation louvres in external walls
- A mechanical ventilation system
- A mechanical cooling system.

With reference to the use of open windows to remove excess heat, section 3 of ADO considers the situation where the external noise climate is 'noisy' enough to discourage the opening of windows, as this would lead to potentially unacceptable high internal noise levels. In this respect, paragraphs 3.2 and 3.3 of ADO refer to noise within "*bedrooms at night*" and in this respect Section 3.3 of ADO states that:

"Windows are likely to be closed during sleeping hours if noise within bedrooms exceeds the following limits.

- a. 40dB $L_{Aeq,T}$, averaged over 8 hours (between 11pm and 7am).
- b. 55dB L_{AFmax} , more than 10 times a night (between 11pm and 7am)

With reference to the above noise levels, ADO indicates that where the opening of windows to remove excess heat would result in the above noise levels being exceeded, an overheating mitigation strategy must be implemented. However, in the case of mechanical cooling, requirement 02(b) of ADO states that this should only be applied where "*sufficient heat cannot be removed from the indoor environment without it*".

Immediately it can be seen that the suggested indoor noise levels within bedrooms during the night time period detailed within Section 3.3 of ADO, are higher than the guide values for the same environment detailed within BS 8233:2014. This being the case, where an alternative ventilation strategy is considered appropriate, this will be based on securing internal noise levels in compliance with the guide values contained within BS 8233:2014.

4.7 Sound Insulation of a Partially Open Window

As previously stated BS8233:2014 applies the 'rule of thumb' that a window partially open for ventilation purposes, will provide around 15dB sound insulation. In this case it is suggested that the sound levels just outside the window will be around 15dB higher than the levels just inside the window.

With respect to the level of sound insulation provided by a partially open window, these can and do vary. In addition to the 15dB quoted within BS 8233:2014, commonly cited sound insulation values include the "Acoustics Ventilation and Overheating Residential Design Guidance", the AVO Guide (summarised more completely in section 4.4 above) formulated by the Association of Noise Consultants (ANC), which suggests that a partially open window can provide a sound insulation value of around 13dB. Additional data presented by Søndergaard & Egedal (2016) suggested that a top hung window with an opening equivalent to 0.35m^2 , would provide a sound insulation value of around 9dB R_w . With reference to the Søndergaard & Egedal (2016) findings this, in our experience, appears to be a little pessimistic about the potential sound insulation provided by a partially open window. Despite this, the degree of window opening will play a role in determining the sound insulation. In this case a partially open window would be expected to provide more sound insulation than would a fully open window.

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 bungalow were undertaken between 15:20 - 16:50 hours on Saturday 30th November 2024, during a home football match at the Sacred Heart F. C. ground and over a full 24 hour period between 15:30 - 15:30 hours on Thursday 16th and Friday 17th January 2025.

The existing noise climate surveys were and all measurements were conducted by Mr. R Smith of Druk Limited. The surveys were attended for the full duration on the 30th November, but were unattended over the 24 hour period. Despite this, simultaneous audio recordings were made throughout the 24 hour survey period and these audio recordings were subsequently interrogated to obtain a 'picture' of the existing noise climate.

5.2 Weather

Throughout the existing noise climate surveys the weather conditions were as follows:

Saturday 30th November 2024

All surfaces were damp from previous light rain, cloud cover was 100%, the temperature was approximately 13°C, the wind speed ranged between approximately 1.9m/s from a South Westerly direction and the barometric pressure was approximately 1000mb.

Thursday 16th and Friday 17th January 2025

All surfaces were damp from previous light rain, cloud cover ranged between approximately 0 - 60%, the temperature ranged between approximately 1 - 8°C, the wind speed was less than 0.3m/s and the barometric pressure was approximately 1013mb.

5.3 Equipment

All the noise surveys and measurements were conducted using the equipment detailed in the table 8 below. The sound level meter was field calibrated before, after and during the surveys as necessary, during which time no significant deviations in the calibrated levels were observed.

Table 8. Equipment used during the existing noise climate measurements

Equipment description	Manufacturer	Model number	Serial number
Acoustic calibrator	Norsonic AS	Nor 1251	31522
Sound level meter	NTI Audio	XL2-TA	A2A-10232-E
Microphone pre-amplifier	NTI Audio	MA220	5537
Microphone	Norsonic AS	Nor 1225	72843
Microphone weather protection enclosures	NTI Audio	WP30	-

5.4 Measurement Procedure

The location of the proposed dwelling suggested that the principal contributors to the existing noise climate would most probably be road traffic from vehicles primarily on the A664 and the surrounding local roads, trains on the railway line approximately 100 metres to the West, activity noise from the nearby houses and noise from football matches etc., on the Sacred Heart ground. A 'walkover' survey of the development site indicated that the assumptions relating to the principal noise sources were correct. It should also be noted that no industrial noise sources, hospitality venues or venues associated with the night time economy were observed in the neighbourhood.

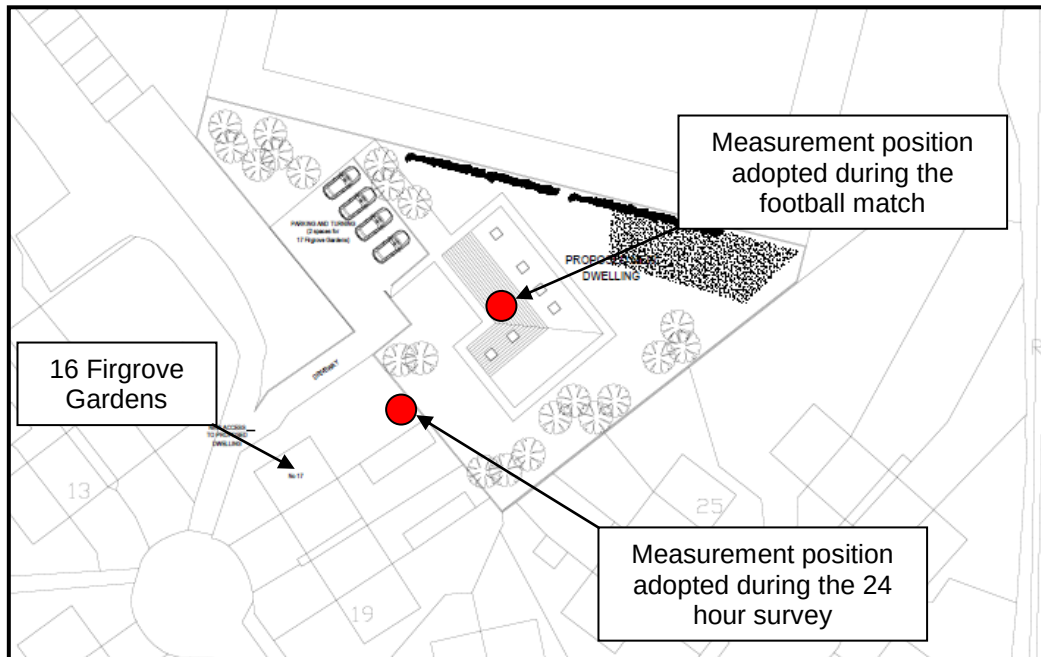
Measurements of the existing noise climate were obtained from two positions. During the course of the football match on Saturday 30th November, permission was obtained from the football club to evaluate the noise climate from within the Sacred Heart ground itself. During the football match the contribution made to the existing noise climate in the immediate vicinity of the proposed bungalow was evaluated in a position that corresponded with the mid position of what would be the footprint of the proposed bungalow.

With reference to the measurements made over a full 24 hour period, as access to the Sacred Heart F. C. ground was not possible during this period, permission was obtained from the occupant of number 16 Firgrove Gardens to place the measuring equipment within their back garden. In this location the equipment was approximately 10 metres further to the South and approximately 8 metres further to West than the proposed

bungalow. Despite the spatial differences in the measurement position and the location of the proposed bungalow, as the differences were relatively small it is not thought that the noise climate in the measurement position would have varied significantly from that of the location of the proposed bungalow.

The approximate location of the measurement positions, overlain on the proposed site layout, is as detailed on figure 2 below.

Figure 2. Approximate location of the measurement positions, proposed site layout



During the measurements made throughout the football match the sound level meter was tripod mounted such that it was approximately 1.3 metres above ground level, and at least 10 metres from the nearest large and potentially reflecting surface. Throughout the 24 hour measurements, the sound level meter microphone was housed within a weather protection enclosure and extended vertically on a mast such that it was approximately 3.0 metres above ground level. Elevating the microphone to 3.0 metres ensured that it had a clear line of sight to the potential noise sources previously identified and was not shielded by any structures such as garden fences etc.

Throughout the surveys all measurements were made with the 'fast' time weighting engaged, the measurement time interval was 5 minutes and with respect to the 24 hour survey simultaneous audio recordings were made.

6.0 Noise Survey Results

The existing noise climate in the vicinity of the proposed bungalow on the Sacred Heart F. C. ground was regarded as being pleasantly quiet and was characteristic of an essentially sub-urban area subject to noise contributions primarily from: road traffic, the passage of trains and some noise from the neighbouring properties. During the course of the football match on the afternoon of Saturday 30th November, the previously mentioned noise contributors were still present although at this time the principal contributor to the existing noise climate was from activity on the football pitch. Despite

this, the noise associated with the football match was not regarded as being particularly 'loud' or of a nature that was thought to be especially intrusive.

For the vast majority of the 24 hour noise survey the existing noise climate was regarded as comprising mainly 'anonymous' noise without specific character. However, during the course of the football match the noise climate did contain noise that may have been regarded as containing contributory elements that did contain a specific character. Despite this, it must be remembered that any noise contribution from the football matches are of limited duration, typically around 90 minutes, and occur relatively infrequently.

The following paragraphs contain brief descriptions of the noise sources noted during the survey periods.

6.1 Qualitative Assessment: November 30th - Football Match

During this period the principal contributors to the existing noise climate were the sound of the players and coaching staff shouting to each other, the sound of the referee's whistle and some occasional shouts from the relatively small number (approximately 40 - 50 people) of spectators, mainly standing on the East and West touchlines. Despite this, it must be borne in mind that the noise contributions from these sources were not continuous but tended to occur in short bursts.

Although other noise sources were audible during the football match, these other noise contributions tended to only be audible during the lulls in the football match noise, such as during the half time interval. During these periods the additional noise sources included road traffic, both distant from the A664 and the local roads, intermittent higher altitude aircraft over flights, occasional noise from the adjacent stables, occasional noise including barking dogs from the surrounding houses and intermittent noise from the railway line to the West of the proposed bungalow. With reference to the noise contribution from the railway line, although the trains were audible in the location of the proposed bungalow they did not appear to have a significant effect on the overall measured sound levels.

6.2 Qualitative Assessment: 24 Hour Survey Period

In essence the principal contributors to the existing noise climate during this period were, with the absence of contributions from the football match, very similar to the additional noise sources detailed above. In general it was thought that the principal contributor to the existing noise climate was road traffic, again from the A664 and the local roads. Although the road traffic noise was audible throughout the noise survey, it was possible to discern a slight but typical general increase during the morning and evening peak periods combined with the general reduction towards the end of the day before reaching a lower level noise plateau through the night time period.

Turning to the noise from the railway line, again although this was audible in the measurement location it did not, for the majority of the period, appear to have a significant effect on the overall noise levels. During the late evening/early night and the earlier morning periods the train noise was again audible, but any effect that the passage of trains had on the existing noise climate was very small indeed. Overall the majority of the trains were passenger trains although a few freight trains

were also noticed through the day and into the evening period. During the peak periods the train movements appeared to be about one every 10 - 15 minutes in both directions. It must however be stressed that the noise from the trains was not regarded as being as significant a contributor to the existing noise climate as was the road traffic.

Additional noise sources noted during the survey included birdsong, the sound of children playing (particularly during the afternoon and early evening period), some noise from the surrounding houses including the sound of central heating boilers and power tool use, quite frequent dog barking noise and the infrequent sound of horses whinnying.

6.3 Basic Results and Discussion

By virtue of the significant amounts of measured noise data collected during the noise surveys tables 9 and 10 and graphs 1 and 2 below and overleaf, contain the data from the noise measurements made during the football match and the 24 hour survey. Summaries of the measured noise data are presented in Appendix 1.

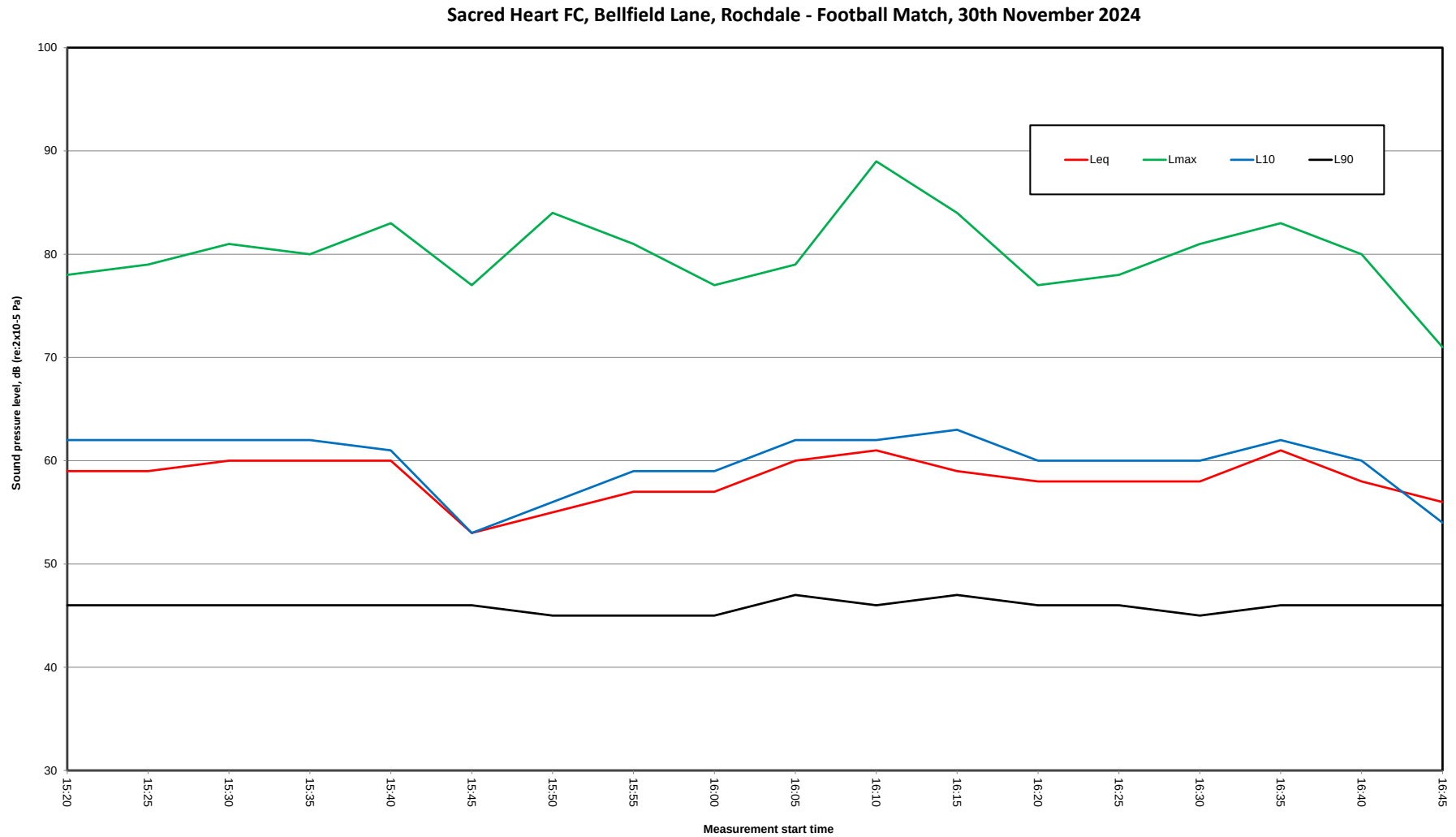
Table 9. Measured sound level summary, football match, 30th November 2024

	$L_{Aeq,T}$	$L_{Amax,T}$	$L_{A10,T}$	$L_{A90,T}$
Standard deviation, match period	2.11	3.85	2.88	0.58
Mean (log), match period	59	82	61	46
Modal value, match period	60	81	62	46
Maximum value match period	61	89	63	47
Minimum value match period	53	71	53	45

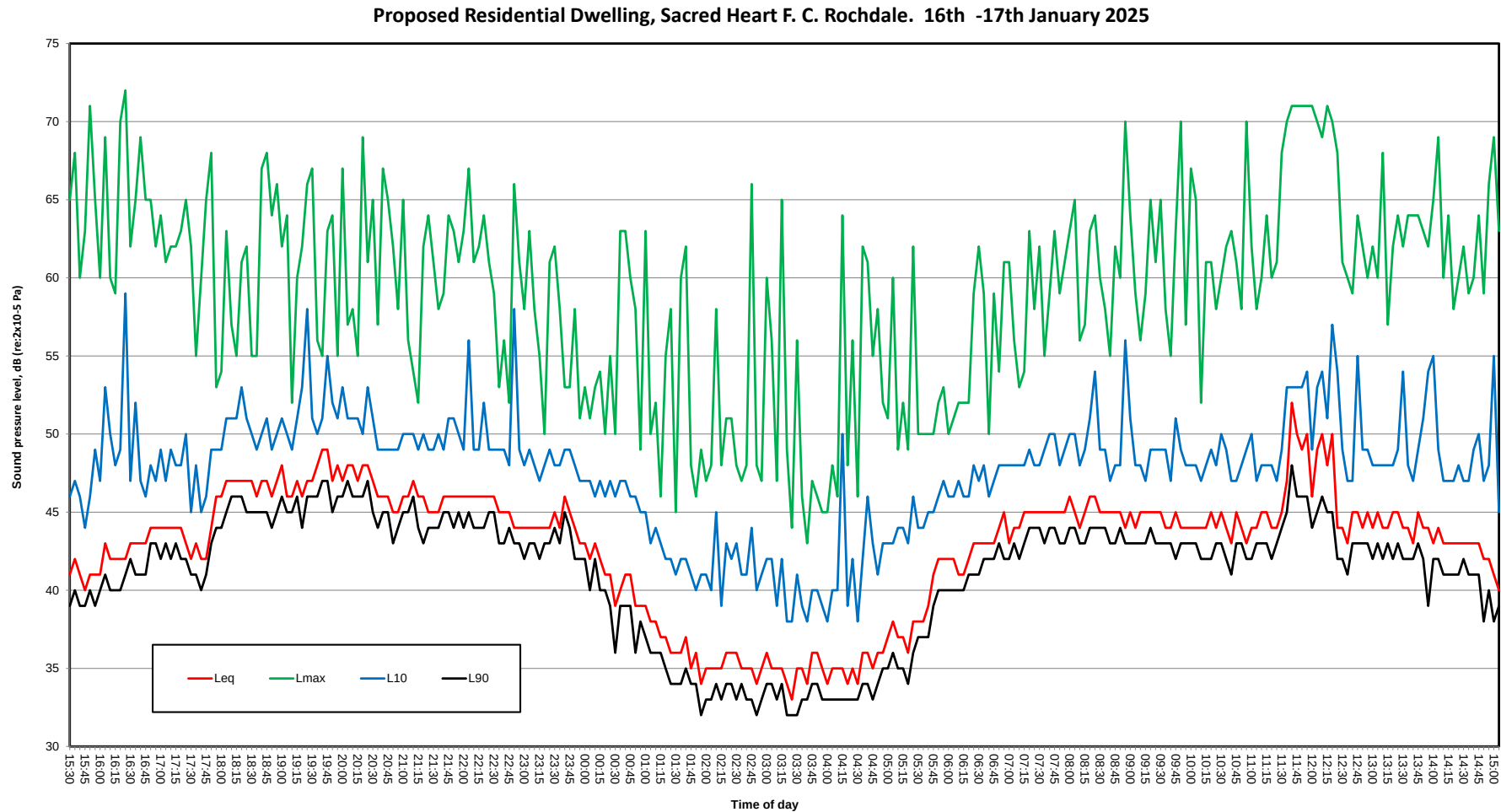
Table 10. Measured sound level summary, 24 hour survey, 16th - 17th January 2025

	$L_{Aeq,T}$	$L_{Amax,T}$	$L_{A10,T}$	$L_{A90,T}$
Standard deviation, daytime period	2.17	4.66	2.55	2.09
Standard deviation, night time period	3.84	5.82	3.26	3.66
Mean (log), daytime period	45	64	50	44
Mean (log), night time period	39	57	45	40
Modal value, daytime period	45	62	49	43
Modal value, night time period	33	50	46	35
Maximum value daytime period	52	72	59	48
Minimum value daytime period	38	52	44	37
Maximum value night time period	45	66	50	46
Minimum value night time period	32	43	38	33

Graph1. Measured sound level summary, football match, 30th November 2024



Graph 2. Measured sound level summary, 24 hour survey, 16th - 17th January 2025



Starting with the measurements made during the football match, reference to table 9 and graph 1 indicates that the noise climate, in terms of the L_{Aeq} , L_{A10} and L_{A90} parameters, remained relatively steady throughout the period. A slight reduction in the measured levels can be seen between 15:45 – 16:00 hours, which coincided with half time. Turning to the measured L_{Amax} levels, these were associated with shouting from either the pitch or the coaching staff on the touch line and the intermittent sounding of the referees whistle.

With reference to the measurements made over the full 24 hour period, it can be seen from graph 2 that the noise climate in this position demonstrated a fairly 'typical' diurnal pattern with higher noise levels during the day, reducing during the late evening to a relatively steady plateau during the 'dead' of night before increasing again in the early morning. The relatively higher measured sound levels, particularly the L_{Amax} levels, that occurred between approximately 11:30 - 12:30 hours were a result of what sounded like a prolonged period of dog barking noise from the surrounding area. Reference to the results summary in table 10 above, highlight that the overall noise climate was a little more variable during the night time period than was the case during the daytime period. Despite this the overall noise climate during both periods was regarded as being pleasantly quiet.

During the course of the 24 hour survey period the mean day and night time L_{Aeq} levels were 45 and 39dB respectively, which would support the previous contention that the existing noise climate was regarded as being pleasantly quiet. A comparison with the noise 'risk' assessments under both the ProPG and AVO schemes indicates that the existing noise climate in the vicinity of the proposed bungalow would fall within the 'negligible' category for both the day and night time periods.

An initial assessment of the potential ventilation requirements for the proposed bungalow will be undertaken and this initial assessment will be made with reference to the 13dB 'rule of thumb' for the sound attenuation offered by a partially open window and detailed in the AVO Guide. This initial assessment would suggest that taking the mean (log) L_{Aeq} values from the 24 hour period, 45 and 39 dB L_{Aeq} for the day and night time periods respectively, a partially open window for ventilation purposes would not result in the internal noise levels exceeding the guide values detailed within BS 8233:2014. Additionally, comparing the calculated mean (log) L_{Aeq} and L_{Amax} values, 39 and 57dB respectively, and assuming the 13dB reduction provided by a partially open window, it can be seen that the 40 and 55dB guide values contained within ADO would be not be exceeded. This suggests that windows may be kept partially open for ventilation purposes and still accord with the guide values within ADO.

7.0 Noise Transmission Calculations

The subsequent assessment of the potential internal noise levels within the proposed bungalow will be assessed using the highest measured L_{Aeq} levels from both the football match and full 24 hour noise surveys and these levels are detailed in tables 11 and 12 overleaf.

Table 11. Highest measured sound levels used in the assessment, football match survey results

OBCF, Hz*	63	125	250	500	1k	2k	4k	8k	Overall, dB(A)
Period, L_{Aeq} , (16:10 - 16:15 hours)	56	52	48	55	54	57	54	38	61

Table 12. Highest measured sound levels used in the assessment, 24 hour survey results

OBCF, Hz*	63	125	250	500	1k	2k	4k	8k	Overall, dB(A)
Daytime, L_{Aeq} , (11:40 - 11:45 hours)	53	56	50	45	47	46	39	29	52
Night time, L_{Aeq} , (23:40 – 23:45 hours)	45	41	43	43	43	30	17	12	45

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 and ventilation provision that can be considered as the ‘weak’ links acoustically, therefore increasing the sound insulation of these elements will improve the overall sound insulation of the façade. The result of the calculation is a composite sound insulation value for the whole façade.

The following assessments of the likely internal noise levels within the proposed bungalow have been undertaken according to the room and façade dimensions detailed on the drawings issued by the Northern Design Partnership of Oldham. To facilitate the calculations, the following assumptions have been employed:

- The reverberation times within the houses will be 0.5 seconds.
- The floor to ceiling height will be approximately 2.4 metres.
- The calculations have been produced assuming the windows would be closed but with the ventilation openings, open.
- The sound levels detailed in tables 11 and 12 above would be equally incident upon all the elevations of the proposed bungalow.

7.1 Construction Specification

The external walls of the proposed bungalow is likely to be of cavity masonry construction around 300 mm thick and the following general composition has been assumed: an external brick leaf, a 75 - 100mm cavity and a 100mm thick aggregate 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 52dB R_w , with the octave band sound insulation values being as detailed in table 13 overleaf.

Table 13. Masonry Cavity Wall Construction, 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 suggested glazing would be of the sealed unit type and would be of the following nominal specification: 4mm pane - 12 to 20mm cavity - 4mm pane. Laboratory test data obtained from Pilkington Glass indicate that this configuration should provide a sound insulation value of around 29dB R_w . The octave band sound insulation values are as detailed in table 14 below. Alternative glazing configurations would be acceptable providing the sound insulation performances are at least equivalent to the specifications detailed in table 14 below.

Table 14. Glazing, octave band sound insulation values

OBCF, Hz*	125	250	500	1k	2k	4k	Overall, R_w (C_{tr}) dB
4mm, 12 - 20mm, 4mm	21	17	25	35	37	315	29 (-4)

* Octave Band Centre Frequency

Ventilation

The initial assessments of the façade sound insulation and so the resulting internal noise levels will be undertaken assuming a ventilation system with input air being provided by window frame mounted 'background' (trickle) ventilators. In this case the selected window frame mounted background ventilator of the Greenwood 4000EAV type would be sufficient.

Laboratory test data indicates that the Greenwood window frame mounted ventilator should provide a sound insulation value of 33dB $D_{n,e,w}$ in its open position. The octave band sound insulation values for the selected ventilator are detailed in table 15 below. Alternative ventilator configurations would be acceptable providing the sound insulation performance of the units is at least equivalent to the specification detailed in table 15.

Table 15. Background ventilation, octave band sound insulation values

OBCF, Hz*	125	250	500	1k	2k	4k	Overall, $D_{n,e,w}$ dB
Greenwood 4000EAV	36	37	34	30	33	38**	33

* Octave Band Centre Frequency. ** Extrapolated value

Roof Structure

It has been assumed that the roof will be of the following basic type: plasterboard ceiling supported on trussed rafters, with mineral fibre placed on the roof void side of the ceiling. The external elements will comprise a sarking felt fixed to the trussed rafters, with double lapped roof slates fixed to slate 'lats'. Test results for a similar construction suggest that a roof of this type should provide an overall sound insulation of around

46dB R_w , with the octave band sound insulation values being as detailed in table 16 below.

Table 16. Roof Structure, Octave Band Sound Insulation Values

OBCF, Hz*	125	250	500	1k	2k	4k	Overall, R_w dB(A)
Sound Insulation, dB	23	34	47	52	58	66	46

7.2 Calculation Results and Discussion

For the purposes of the calculations the noise levels detailed in tables 11 and 12 above were used. For the purposes of the calculations it has been assumed that the windows would remain closed, but the passive ventilation opening would be in their open position. As the existing noise climate was regarded as comprising mainly 'anonymous' noise without specific character, the internal noise levels calculations will be undertaken with reference to the design guide values specified by Rochdale Borough Council's Environmental Health department and the guidance contained within BS 8233:2014.

The results of the break-in noise calculations for the proposed bungalow, including the assumptions relating to the proposed façade elements detailed above, are presented in table 17 below. With respect to the presentation of the results of the calculations and with reference to the results obtained using the highest measured levels from the football match noise survey, these are presented in the daytime column with the results being contained within brackets. Full data are available in Appendix 3.

Table 17. Calculated internal noise levels, proposed bungalow

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}
Living room	35	24 (31)	-	-
Kitchen/dining room	35	23 (32)	-	-
Ground floor bedroom	35	27 (35)	30 (45)	21
First floor (small) bedroom	35	26 (33)	30 (45)	19
First floor (large) bedroom	35	25 (32)	30 (45)	18

As can be seen from table 17 above, based on: the stated assumptions relating to the sound insulation of the proposed façade elements, under the windows closed but ventilation openings open scenario and employing the measured levels from the noise surveys, the calculated internal noise levels within the permitted houses, resulting from external noise break-in, would not exceed the internal levels specified by Rochdale Borough Council's Environmental Health department or the design guide values contained within BS 8233:2014. The results presented within table 17 above also indicate that compliance with the internal levels is achieved using both the highest measured levels from both the football match and general existing noise climate

surveys. It should however be remembered that the results presented in table 17 above must be considered as a worst case using the highest measured levels and as a result, it is suggested that the internal levels within the proposed bungalow could, for the majority of the time, be below the levels presented within table 17.

Applying the mean or modal daytime noise levels (both 45dB(A)) from the 24 hour survey and assuming the 13dB 'rule of thumb' for the sound attenuation offered by a partially open window to the measured levels from the survey, would suggest that the internal levels would probably not exceed the guide values during the daytime with partially open windows. However, applying the mean and modal values (59 and 60dB(A) respectively) from the football match to the proposed bungalow under the windows partially open scenario, would see the internal noise guide values exceeded by a greater margin. Turning to the existing night time noise climate, applying the mean and modal values (39 and 33dB(A) respectively) would probably not result in the internal noise guide values being exceeded. The initial assessments suggest that, based on the mean and modal values, that an alternative ventilation strategy for the proposed bungalow may not be required during the day or night time period in the absence of any noise contributions from a football match.

Applying the mean and modal match day noise levels would probably see the internal noise guide values exceed by around 11- 12dB, although this level of exceedance would only persist for the duration of the football matches. As the matches would persist for around two hours and would more than likely not occur every weekend, it could be argued that requiring the provision of an alternative ventilation strategy may be disproportionate to the value that would be derived by the future occupants of the bungalow. Consequently, with reference to the necessity for an alternative ventilation provision and the proposed limited benefit that may be derived from any future occupants, it is recommended that this element is discussed with the Local Planning Authority.

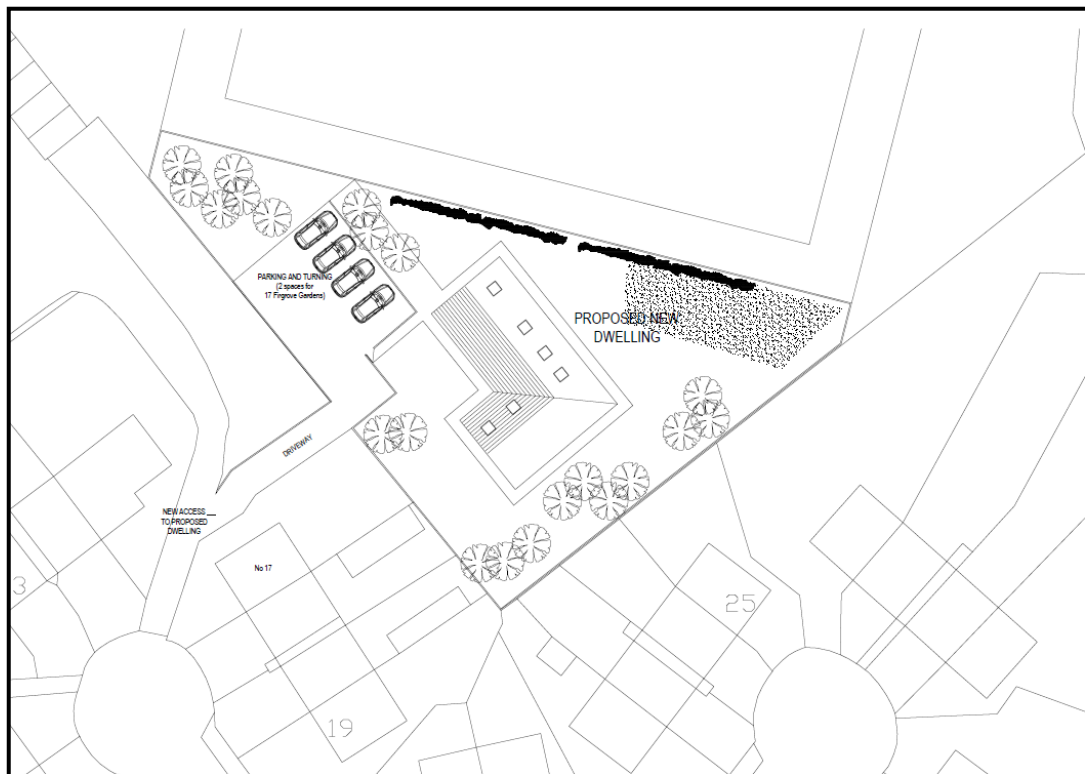
As a consequence of the foregoing, it is suggested the sound insulation of the proposed façade elements would be sufficient to limit the ingress of external noise to the proposed bungalow in compliance with the adopted design guidance. The proposed mitigation measures would also comply with the requirement contained within the ProPG document which requires that the acoustic design statement, *"confirms how the adverse impacts of noise will be mitigated and minimised, and which clearly demonstrate that a significant adverse noise impact will be avoided in the finished development"*. The assessment also highlights that the proposed bungalow could be integrated into the existing environment without the potential for "unreasonable restrictions" to be placed upon already established uses in the vicinity.

7.3 External Amenity Areas

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"*. In addition Rochdale Council's Environmental Health department requirements have indicated that noise in the outdoor areas serving the proposed bungalow should not exceed 55dB(A).

With reference to the location and layout of the proposed bungalow, detailed on figure 3 below, it can be seen that the proposed bungalow is surrounded on its Northern, Eastern and Southern elevations by what may be regarded as external amenity space. Applying the previously detailed mean and modal daytime noise levels (both 45dB(A)) from the 24 hour survey, it can be seen that these noise levels would comply with the guide value stated by both Rochdale Council and BS 8233:2014. However, applying the mean and modal values (59 and 60dB(A) respectively) from the football match, the 55dB(A) guide value would be exceeded. Again, reference is drawn to the fact that that the matches would persist for around two hours and would not take place on every weekend.

Figure 3. Arrangement of the proposed bungalow detailing the external amenity areas



As such it is suggested that to require the provision of any additional sound attenuation measures, such as acoustic fences around the external areas, would again be disproportionate to the benefit that would be derived by the occupants for the vast majority of the time. Again, it is suggested that it would be prudent to discuss this with the Local Planning Authority.

8.0 Conclusion

The existing noise climate in the vicinity of the proposed bungalow on the Sacred Heart F. C. ground was regarded as being pleasantly quiet and was characteristic of an essentially sub-urban area subject to noise contributions primarily from: road traffic, the passage of trains and some noise from the neighbouring properties.

Applying the obtained sound levels from the survey and combining these with the stated assumptions relating to the sound insulation of the façade elements, the calculations have demonstrated that the sound insulation of the façade elements of the proposed bungalow would be sufficient to secure that the break-in noise levels would not exceed the adopted design guide required by Rochdale Borough Council or contained within BS 8233:2014. With reference for the necessity to provide an alternative ventilation strategy in order to meet the adopted design guide values, the assessments have suggested that that applying the mean and modal values from the 24 hour noise survey and assuming a partially open window, that the internal noise levels would comply with the adopted internal noise guide values. Despite this, it is recommended that this element is discussed with the Local Planning Authority.

Turning to the noise climate within the external amenity areas, as the mean noise levels during the existing noise climate survey was 45dB(A), it is suggested that for the majority of the time the external noise levels would not exceed the stated guide value and as such no additional sound attenuation measures would be required. Despite this, the mean and modal values (59 and 60dB(A) respectively) during a football match would suggest that the guide value would be exceeded. However, as the football matches would persist for around two hours and would not take place on every weekend, it is suggested that to require the provision of any additional sound attenuation measures, such as acoustic fences around the external areas, would again be disproportionate to the benefit that would be derived by the occupants for the vast majority of the time.

As a consequence it is suggested that the sound insulation of the facade elements, combined with the form and overall existing noise climate levels, would be sufficient to comply with the guide values relating to the internal noise levels within the proposed bungalow and the external amenity areas without prejudicing the amenity of the future occupants.

Appendix 1: Existing Noise Climate Survey, Measured Sound Levels

Measured noise levels, 30th November 2024, football match

Start Time	<i>L</i> _{Aeq} 5mins	<i>L</i> _{Amax} , 5mins	<i>L</i> _{A10} , 5mins	<i>L</i> _{A90} , 5mins
15:20	59	78	62	46
15:25	59	79	62	46
15:30	60	81	62	46
15:35	60	80	62	46
15:40	60	83	61	46
15:45	53	77	53	46
15:50	55	84	56	45
15:55	57	81	59	45
16:00	57	77	59	45
16:05	60	79	62	47
16:10	61	89	62	46
16:15	59	84	63	47
16:20	58	77	60	46
16:25	58	78	60	46
16:30	58	81	60	45
16:35	61	83	62	46
16:40	58	80	60	46
16:45	56	71	54	46

Measured noise levels, Thursday 16th and Friday 17th January 2025

Start Time	L _{Aeq} 5mins	L _{Amax} , 5mins	L _{A10} , 5mins	L _{A90} , 5mins
15:30	41	65	46	39
15:35	42	68	47	40
15:40	41	60	46	39
15:45	40	63	44	39
15:50	41	71	46	40
15:55	41	65	49	39
16:00	41	60	47	40
16:05	43	69	53	41
16:10	42	60	50	40
16:15	42	59	48	40
16:20	42	70	49	40
16:25	42	72	59	41
16:30	43	62	47	42
16:35	43	65	52	41
16:40	43	69	47	41
16:45	43	65	46	41
16:50	44	65	48	43
16:55	44	62	47	43
17:00	44	64	49	42
17:05	44	61	47	43
17:10	44	62	49	42
17:15	44	62	48	43
17:20	44	63	48	42
17:25	43	65	50	42

Start Time	L _{Aeq} 5mins	L _{Amax} , 5mins	L _{A10} , 5mins	L _{A90} , 5mins
17:30	42	62	45	41
17:35	43	55	48	41
17:40	42	60	45	40
17:45	42	65	46	41
17:50	44	68	49	43
17:55	46	53	49	44
18:00	46	54	49	44
18:05	47	63	51	45
18:10	47	57	51	46
18:15	47	55	51	46
18:20	47	61	53	46
18:25	47	62	51	45
18:30	47	55	50	45
18:35	46	55	49	45
18:40	47	67	50	45
18:45	47	68	51	45
18:50	46	64	49	44
18:55	47	66	50	45
19:00	48	62	51	46
19:05	46	64	50	45
19:10	46	52	49	45
19:15	47	60	51	46
19:20	46	62	53	44
19:25	47	66	58	46

Start Time	$L_{Aeq, 5mins}$	$L_{Amax, 5mins}$	$L_{A10, 5mins}$	$L_{A90, 5mins}$
19:30	47	67	51	46
19:35	48	56	50	46
19:40	49	55	51	47
19:45	49	63	55	47
19:50	47	64	52	45
19:55	48	55	51	46
20:00	47	67	53	46
20:05	48	57	51	47
20:10	48	58	51	46
20:15	47	55	51	46
20:20	48	69	50	46
20:25	48	61	53	47
20:30	47	65	51	45
20:35	46	57	49	44
20:40	46	67	49	45
20:45	46	65	49	45
20:50	45	62	49	43
20:55	45	58	49	44
21:00	46	65	50	45
21:05	46	56	50	45
21:10	47	54	50	46
21:15	46	52	49	44
21:20	46	62	50	43
21:25	45	64	49	44

Start Time	$L_{Aeq, 5mins}$	$L_{Amax, 5mins}$	$L_{A10, 5mins}$	$L_{A90, 5mins}$
21:30	45	61	49	44
21:35	45	58	50	44
21:40	46	59	49	45
21:45	46	64	51	45
21:50	46	63	51	44
21:55	46	61	50	45
22:00	46	63	49	44
22:05	46	67	56	45
22:10	46	61	49	44
22:15	46	62	49	44
22:20	46	64	52	44
22:25	46	61	49	45
22:30	46	59	49	45
22:35	45	53	49	43
22:40	45	56	49	43
22:45	45	52	48	44
22:50	44	66	58	43
22:55	44	61	49	43
23:00	44	58	48	42
23:05	44	63	49	43
23:10	44	58	48	43
23:15	44	55	47	42
23:20	44	50	48	43
23:25	44	61	49	43

Start Time	$L_{Aeq, 5mins}$	$L_{Amax, 5mins}$	$L_{A10, 5mins}$	$L_{A90, 5mins}$
23:30	45	62	48	44
23:35	44	58	48	43
23:40	45	53	49	45
23:45	45	53	49	44
23:50	43	58	48	42
23:55	43	51	47	42
00:00	43	53	47	42
00:05	42	51	47	40
00:10	43	53	46	42
00:15	42	54	47	40
00:20	41	50	46	40
00:25	41	55	47	39
00:30	39	50	46	36
00:35	40	63	47	39
00:40	41	63	47	39
00:45	41	60	46	39
00:50	39	58	46	36
00:55	39	49	45	38
01:00	39	63	45	37
01:05	38	50	43	36
01:10	38	52	44	36
01:15	37	46	43	36
01:20	37	55	42	35
01:25	36	58	42	34

Start Time	$L_{Aeq, 5mins}$	$L_{Amax, 5mins}$	$L_{A10, 5mins}$	$L_{A90, 5mins}$
01:30	36	45	41	34
01:35	36	60	42	34
01:40	37	62	42	35
01:45	35	48	41	34
01:50	36	46	40	34
01:55	34	49	41	32
02:00	35	47	41	33
02:05	35	48	40	33
02:10	35	58	45	34
02:15	35	48	39	33
02:20	36	51	43	34
02:25	36	51	42	34
02:30	36	48	43	33
02:35	35	47	41	34
02:40	35	48	41	33
02:45	35	66	44	33
02:50	34	48	40	32
02:55	35	47	41	33
03:00	36	60	42	34
03:05	35	56	42	34
03:10	35	47	39	33
03:15	35	65	42	34
03:20	34	49	38	32
03:25	33	44	38	32

Start Time	L_{Aeq} 5mins	L_{Amax} , 5mins	L_{A10} , 5mins	L_{A90} , 5mins
03:30	35	56	41	32
03:35	35	46	39	33
03:40	34	43	38	33
03:45	36	47	40	34
03:50	36	46	40	34
03:55	35	45	39	33
04:00	34	45	38	33
04:05	35	48	40	33
04:10	35	46	40	33
04:15	35	64	50	33
04:20	34	48	39	33
04:25	35	56	42	33
04:30	34	46	38	33
04:35	36	62	42	34
04:40	36	61	46	34
04:45	35	55	43	33
04:50	36	58	41	34
04:55	36	52	43	35
05:00	37	51	43	35
05:05	38	60	43	36
05:10	37	49	44	35
05:15	37	52	44	35
05:20	36	49	43	34
05:25	38	62	46	36

Start Time	L_{Aeq} 5mins	L_{Amax} , 5mins	L_{A10} , 5mins	L_{A90} , 5mins
05:30	38	50	44	37
05:35	38	50	44	37
05:40	39	50	45	37
05:45	41	50	45	39
05:50	42	52	46	40
05:55	42	53	47	40
06:00	42	50	46	40
06:05	42	51	46	40
06:10	41	52	47	40
06:15	41	52	46	40
06:20	42	52	46	41
06:25	43	59	48	41
06:30	43	62	47	41
06:35	43	59	48	42
06:40	43	50	46	42
06:45	43	59	47	42
06:50	44	54	48	43
06:55	45	61	48	42
07:00	43	61	48	42
07:05	44	56	48	43
07:10	44	53	48	42
07:15	45	54	48	43
07:20	45	63	49	44
07:25	45	58	48	44

Start Time	$L_{Aeq, 5mins}$	$L_{Amax, 5mins}$	$L_{A10, 5mins}$	$L_{A90, 5mins}$
07:30	45	62	48	44
07:35	45	55	49	43
07:40	45	59	50	44
07:45	45	63	50	44
07:50	45	59	48	43
07:55	45	61	49	43
08:00	46	63	50	44
08:05	45	65	50	44
08:10	44	56	48	43
08:15	45	57	49	43
08:20	46	63	51	44
08:25	46	64	54	44
08:30	45	60	49	44
08:35	45	58	49	44
08:40	45	55	47	43
08:45	45	62	48	43
08:50	45	60	48	44
08:55	44	70	56	43
09:00	45	64	51	43
09:05	44	59	48	43
09:10	45	56	48	43
09:15	45	59	47	43
09:20	45	65	49	44
09:25	45	61	49	43

Start Time	$L_{Aeq, 5mins}$	$L_{Amax, 5mins}$	$L_{A10, 5mins}$	$L_{A90, 5mins}$
09:30	45	65	49	43
09:35	44	58	49	43
09:40	44	55	47	43
09:45	45	63	51	42
09:50	44	70	49	43
09:55	44	57	48	43
10:00	44	67	48	43
10:05	44	65	48	43
10:10	44	52	47	42
10:15	44	61	48	42
10:20	45	61	49	42
10:25	44	58	48	43
10:30	45	60	50	43
10:35	44	62	49	42
10:40	43	63	47	41
10:45	45	61	47	43
10:50	44	58	48	43
10:55	43	70	49	42
11:00	44	62	50	42
11:05	44	58	47	43
11:10	45	60	48	43
11:15	45	64	48	43
11:20	44	60	48	42
11:25	44	61	47	43

Start Time	$L_{Aeq, 5mins}$	$L_{Amax, 5mins}$	$L_{A10, 5mins}$	$L_{A90, 5mins}$
11:30	45	68	49	44
11:35	47	70	53	45
11:40	52	71	53	48
11:45	50	71	53	46
11:50	49	71	53	46
11:55	50	71	54	46
12:00	46	71	49	44
12:05	49	70	53	45
12:10	50	69	54	46
12:15	48	71	51	45
12:20	50	70	57	45
12:25	44	68	54	42
12:30	44	61	49	42
12:35	43	60	47	41
12:40	45	59	47	43
12:45	45	64	55	43
12:50	44	62	49	43
12:55	45	60	49	43
13:00	44	62	48	42
13:05	45	60	48	43
13:10	44	68	48	42
13:15	44	57	48	43
13:20	45	62	48	42
13:25	45	64	49	43

Start Time	$L_{Aeq, 5mins}$	$L_{Amax, 5mins}$	$L_{A10, 5mins}$	$L_{A90, 5mins}$
13:30	44	62	54	42
13:35	44	64	48	42
13:40	43	64	47	42
13:45	45	64	49	43
13:50	44	63	51	42
13:55	44	62	54	39
14:00	43	65	55	42
14:05	44	69	49	42
14:10	43	60	47	41
14:15	43	64	47	41
14:20	43	58	47	41
14:25	43	60	48	41
14:30	43	62	47	42
14:35	43	59	47	41
14:40	43	60	49	41
14:45	43	64	50	41
14:50	42	59	47	38
14:55	42	66	48	40
15:00	41	69	55	38
15:05	40	63	45	39
15:10	39	58	46	37
15:15	39	56	45	37
15:20	38	58	47	37
15:25	39	61	47	37

Appendix 2: Break-in Noise Calculations

Proposed bungalow, Sacred Heart F. C. Rochdale														
Break-in Noise Calculations														
Proposed Bungalow														
L _{Aeq} Assessment, daytime														
Living room - S. E. elevation														
* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*	
A	Measured L _{eq}		52	52	53	56	50	45	47	46	39	29	11	
B	Exposed façade, m ²	19.8		13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	
C	Volume of receiving room, m ³	122												
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))			-16.0	-16.0	-16.0	-16.0	-16.0	-16.0	-16.0	-16.0	-16.0	-16.0	
F	Composite SRI			22.8	27.8	32.8	29.9	35.1	45.0	48.0	45.1	50.1	54.9	
G	A + B + E - F		11	25.9	21.9	19.9	16.7	6.6	-1.3	-5.3	-9.4	-24.4	-47.3	
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	28.9	24.9	22.9	19.7	9.6	1.7	-2.3	-6.4	-21.4	-44.3	
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				18.7	16.7	9.7	7.7	13.7	9.7	-2.3	-17.3		
N	Internal room noise level, vent open		18		25.8	23.8	20.2	11.8	14.0	10.0	-0.9	-15.9		
Glazing:		4mm, 16/20mm, 4mm												
Ventilator type:		Greenwood 4000EAV												
Living room - S. W. elevation														
* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*	
A	Measured L _{eq}		52	52	53	56	50	45	47	46	39	29	11	
B	Exposed façade, m ²	14.7		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	122												
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))			-16.0	-16.0	-16.0	-16.0	-16.0	-16.0	-16.0	-16.0	-16.0	-16.0	
F	I bed existing			22.8	27.8	32.8	29.9	35.1	45.0	48.0	45.1	50.1	54.9	
G	A + B + E - F		10	24.6	20.6	18.6	15.4	5.3	-2.6	-6.6	-10.7	-25.7	-48.6	
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		13	27.6	23.6	21.6	18.4	8.3	0.4	-3.6	-7.7	-22.7	-45.6	
Glazing:		-												
Ventilator type:		-												
Living room - N. W. elevation														
* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*	
A	Measured L _{eq}		52	52	53	56	50	45	47	46	39	29	11	
B	Exposed façade, m ²	14.7		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	122												
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))			-16.0	-16.0	-16.0	-16.0	-16.0	-16.0	-16.0	-16.0	-16.0	-16.0	
F	Composite SRI			17.2	22.2	27.2	23.4	28.4	38.4	41.4	38.4	43.4	48.4	
G	A + B + E - F		16	30.2	26.2	24.2	22.0	12.0	4.0	0.0	-4.0	-19.0	-42.0	
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		19	33.2	29.2	27.2	25.0	15.0	7.0	3.0	-1.0	-16.0	-39.0	
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				20.0	18.0	11.0	9.0	15.0	11.0	-1.0	-16.0		
N	Internal room noise level, vent open		21		29.7	27.7	25.2	16.0	15.7	11.7	2.0	-13.0		
Glazing:		4mm, 16/20mm, 4mm												
Ventilator type:		Greenwood 4000EAV												
			Combined sound level, dB(A)	24										

Kitchen/dining room - S. E. elevation														
* Octave Band Centre Frequency, Hz				dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{eq}		52		52	53	56	50	45	47	46	39	29	11
B	Exposed façade, m ²	10.6			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	50												
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))				-12.1	-12.1	-12.1	-12.1	-12.1	-12.1	-12.1	-12.1	-12.1	-12.1
F	Composite SRI				20.7	25.7	30.7	27.3	32.4	42.4	45.4	42.4	47.4	52.3
G	A + B + E - F		15		29.1	25.1	23.1	20.5	10.4	2.5	-1.6	-5.6	-20.6	-43.5
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		18		32.1	28.1	26.1	23.5	13.4	5.5	1.4	-2.6	-17.6	-40.5
K	Number of ventilators	2												
L	Ventilator $D_{n,e}$					31	36	37	34	30	33	38	43	
M	$L_{Aeq} - D_{n,e} + 10 \cdot \log(10) - B$					24.5	22.5	15.5	13.5	19.5	15.5	3.5	-11.5	
N	Internal room noise level, vent open		23			29.7	27.7	24.1	16.5	19.6	15.6	4.4	-10.6	
Glazing: 4mm, 16/20mm, 4mm														
Ventilator type: Greenwood 4000EAV														
G F bedroom - S. E. elevation														
* Octave Band Centre Frequency, Hz				dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{eq}		52		52	53	56	50	45	47	46	39	29	11
B	Exposed façade, m ²	6.1			7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9
C	Volume of receiving room, m ³	41												
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))				-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3
F	Composite SRI				20.1	25.1	30.1	26.6	31.7	41.6	44.7	41.7	46.7	51.6
G	A + B + E - F		14		28.2	24.2	22.2	19.7	9.6	1.7	-2.4	-6.4	-21.4	-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		17		31.2	27.2	25.2	22.7	12.6	4.7	0.6	-3.4	-18.4	-41.3
K	Number of ventilators	2												
L	Ventilator $D_{n,e}$					31	36	37	34	30	33	38	43	
M	$L_{Aeq} - D_{n,e} + 10 \cdot \log(10) - B$					26.9	24.9	17.9	15.9	21.9	17.9	5.9	-9.1	
N	Internal room noise level, vent open		25			30.0	28.0	23.9	17.5	21.9	17.9	6.3	-8.7	
Glazing: 4mm, 16/20mm, 4mm														
Ventilator type: Greenwood 4000EAV														
G F bedroom - N. W. elevation														
* Octave Band Centre Frequency, Hz				dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{eq}		52		52	53	56	50	45	47	46	39	29	11
B	Exposed façade, m ²	16.1			12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1
C	Volume of receiving room, m ³	41												
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))				-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3
F	Composite SRI				22.1	27.1	32.1	29.1	34.2	44.1	47.2	44.2	49.2	54.1
G	A + B + E - F		16		30.4	26.4	24.4	21.4	11.3	3.4	-0.6	-4.7	-19.7	-42.6
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		19		33.4	29.4	27.4	24.4	14.3	6.4	2.4	-1.7	-16.7	-39.6
K	Number of ventilators	2												
L	Ventilator $D_{n,e}$					31	36	37	34	30	33	38	43	
M	$L_{Aeq} - D_{n,e} + 10 \cdot \log(10) - B$					22.6	20.6	13.6	11.6	17.6	13.6	1.6	-13.4	
N	Internal room noise level, vent open		23			30.2	28.2	24.8	16.2	18.0	14.0	3.3	-11.7	
Glazing: 4mm, 16/20mm, 4mm														
Ventilator type: Greenwood 4000EAV														
G F bedroom - S. W. elevation														
* Octave Band Centre Frequency, Hz				dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{eq}		52		52	53	56	50	45	47	46	39	29	11
B	Exposed façade, m ²	6.1			7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9
C	Volume of receiving room, m ³	41												
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))				-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3
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		1		20.3	16.3	14.3	4.3	-8.7	-14.7	-19.7	-26.7	-41.7	-59.7
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		4		23.3	19.3	17.3	7.3	-5.7	-11.7	-16.7	-23.7	-38.7	-56.7
Glazing: -														
Ventilator type: -														
Combined sound level, dB(A)				27										

F F (small) bedroom - N. E. elevation													
* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{eq}		52	52	53	56	50	45	47	46	39	29	11
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			16.8	21.8	26.8	28.2	33.5	43.4	46.5	43.6	48.5	53.2
G	A + B + E - F		17	34.4	30.4	28.4	21.0	10.7	2.8	-1.3	-5.4	-20.3	-43.0
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		20	37.4	33.4	31.4	24.0	13.7	5.8	1.7	-2.4	-17.3	-40.0
K	Number of ventilators	2											
L	Ventilator $D_{n,e}$				31	36	37	34	30	33	38	43	
M	$L_{Aeq} - D_{n,e} + 10 \cdot \log(10) - B$				24.9	22.9	15.9	13.9	19.9	15.9	3.9	-11.1	
N	Internal room noise level, vent open		24		33.9	31.9	24.6	16.8	20.1	16.1	4.8	-10.2	
Glazing: 4mm, 16/20mm, 4mm													
Ventilator type: Greenwood 4000EAV													
F F (small) bedroom - N. W. elevation													
* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{eq}		52	52	53	56	50	45	47	46	39	29	11
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	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		3	21.8	17.8	15.8	5.8	-7.2	-13.2	-18.2	-25.2	-40.2	-58.2
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		6	24.8	20.8	18.8	8.8	-4.2	-10.2	-15.2	-22.2	-37.2	-55.2
Glazing: 4mm, 16/20mm, 4mm													
Ventilator type: -													
F F (small) bedroom - S. W. elevation													
* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{eq}		52	52	53	56	50	45	47	46	39	29	11
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			16.8	21.8	26.8	28.2	33.5	43.4	46.5	43.6	48.5	53.2
G	A + B + E - F		17	34.4	30.4	28.4	21.0	10.7	2.8	-1.3	-5.4	-20.3	-43.0
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		20	37.4	33.4	31.4	24.0	13.7	5.8	1.7	-2.4	-17.3	-40.0
Glazing: -													
Ventilator type: -													
Combined sound level, dB(A)			26										

F F (large) bedroom - N. W. elevation													
* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{eq}		52	52	53	56	50	45	47	46	39	29	11
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	46											
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))			-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8
F	Composite SRI			16.8	21.8	26.8	28.2	33.5	43.4	46.5	43.6	48.5	53.2
G	A + B + E - F		15	32.9	28.9	26.9	19.5	9.3	1.4	-2.7	-6.9	-21.8	-44.5
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		18	35.9	31.9	29.9	22.5	12.3	4.4	0.3	-3.9	-18.8	-41.5
K	Number of ventilators	2											
L	Ventilator $D_{n,e}$				31	36	37	34	30	33	38	43	
M	$L_{Aeq} - D_{n,e} + 10 \cdot \log(10) - B$				24.9	22.9	15.9	13.9	19.9	15.9	3.9	-11.1	
N	Internal room noise level, vent open		24		32.7	30.7	23.4	16.2	20.0	16.0	4.6	-10.4	
Glazing: 4mm, 16/20mm, 4mm													
Ventilator type: Greenwood 4000EAV													
F F (large) bedroom - S. W. elevation													
* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{eq}		52	52	53	56	50	45	47	46	39	29	11
B	Exposed façade, m ²	7.6		8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8
C	Volume of receiving room, m ³	46											
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))			-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8
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		1	20.7	16.7	14.7	4.7	-8.3	-14.3	-19.3	-26.3	-41.3	-59.3
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		4	23.7	19.7	17.7	7.7	-5.3	-11.3	-16.3	-23.3	-38.3	-56.3
Glazing: 4mm, 16/20mm, 4mm													
Ventilator type: -													
F F (large) bedroom - S. E. elevation													
* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{eq}		52	52	53	56	50	45	47	46	39	29	11
B	Exposed façade, m ²	12.2		10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9
C	Volume of receiving room, m ³	46											
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))			-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8
F	Composite SRI			16.8	21.8	26.8	37.2	46.0	54.0	59.6	60.9	62.2	62.2
G	A + B + E - F		13	34.0	30.0	28.0	11.6	-2.2	-8.2	-14.8	-23.1	-34.4	-52.4
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		16	37.0	33.0	31.0	14.6	0.8	-5.2	-11.8	-20.1	-31.4	-49.4
Glazing: -													
Ventilator type: -													
Combined sound level, dB(A)			25										

<u>L_{Aeq} Assessment, night time</u>													
<u>G F bedroom - S. E. elevation</u>													
<u>* Octave Band Centre Frequency, Hz</u>			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L _{eq}		45	45	45	41	43	43	43	30	17	12	10
B	Exposed façade, m ²	6.1		7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9
C	Volume of receiving room, m ³	41											
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))			-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3
F	Composite SRI			20.1	25.1	30.1	26.6	31.7	41.6	44.7	41.7	46.7	51.6
G	A + B + E - F		8	21.2	16.2	7.2	12.7	7.9	-2.3	-18.1	-28.4	-38.4	-45.3
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		11	24.2	19.2	10.2	15.7	10.9	0.7	-15.1	-25.4	-35.4	-42.3
K	Number of ventilators	2											
L	Ventilator D _{n,e}				31	36	37	34	30	33	38	43	
M	L _{Aeq} - D _{n,e} + 10*log(10) - B				18.9	9.9	10.9	14.2	17.9	2.2	-16.1	-26.1	
N	Internal room noise level, vent open		20		22.0	13.0	16.9	15.8	17.9	2.2	-15.7	-25.7	
<u>Glazing:</u>													
<u>Ventilator type:</u>													
<u>G F bedroom - N. W. elevation</u>													
<u>* Octave Band Centre Frequency, Hz</u>			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L _{eq}		45	45	45	41	43	43	43	30	17	12	10
B	Exposed façade, m ²	16.1		12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1
C	Volume of receiving room, m ³	41											
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))			-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3
F	Composite SRI			22.1	27.1	32.1	29.1	34.2	44.1	47.2	44.2	49.2	54.1
G	A + B + E - F		10	23.4	18.4	9.4	14.4	9.6	-0.6	-16.3	-26.7	-36.7	-43.6
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		13	26.4	21.4	12.4	17.4	12.6	2.4	-13.3	-23.7	-33.7	-40.6
K	Number of ventilators	2											
L	Ventilator D _{n,e}				31	36	37	34	30	33	38	43	
M	L _{Aeq} - D _{n,e} + 10*log(10) - B				14.6	5.6	6.6	9.9	13.6	-2.1	-20.4	-30.4	
N	Internal room noise level, vent open		17		22.2	13.2	17.8	14.5	14.0	-1.7	-18.7	-28.7	
<u>Glazing:</u>													
<u>Ventilator type:</u>													
<u>G F bedroom - S. W. elevation</u>													
<u>* Octave Band Centre Frequency, Hz</u>			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L _{eq}		45	45	45	41	43	43	43	30	17	12	10
B	Exposed façade, m ²	6.1		7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9
C	Volume of receiving room, m ³	41											
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))			-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3
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		-8	13.3	8.3	-0.7	-2.7	-10.4	-18.7	-35.4	-48.7	-58.7	-60.7
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		-5	16.3	11.3	2.3	0.3	-7.4	-15.7	-32.4	-45.7	-55.7	-57.7
<u>Glazing:</u>													
<u>Ventilator type:</u>													
Combined sound level, dB(A)			21										

F F (small) bedroom - N. E. elevation													
* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{eq}		45	45	45	41	43	43	43	30	17	12	10
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			16.8	21.8	26.8	28.2	33.5	43.4	46.5	43.6	48.5	53.2
G	A + B + E - F		10	27.4	22.4	13.4	14.0	9.0	-1.2	-17.0	-27.4	-37.3	-44.0
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	30.4	25.4	16.4	17.0	12.0	1.8	-14.0	-24.4	-34.3	-41.0
K	Number of ventilators	2											
L	Ventilator $D_{n,e}$				31	36	37	34	30	33	38	43	
M	$L_{Aeq} - D_{n,e} + 10 \cdot \log(10) - B$				16.9	7.9	8.9	12.2	15.9	0.2	-18.1	-28.1	
N	Internal room noise level, vent open		18		25.9	16.9	17.6	15.1	16.1	0.4	-17.2	-27.2	
Glazing: 4mm, 16/20mm, 4mm													
Ventilator type: Greenwood 4000EAV													
F F (small) bedroom - N. W. elevation													
* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{eq}		45	45	45	41	43	43	43	30	17	12	10
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	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		-6	14.8	9.8	0.8	-1.2	-8.9	-17.2	-33.9	-47.2	-57.2	-59.2
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		-3	17.8	12.8	3.8	1.8	-5.9	-14.2	-30.9	-44.2	-54.2	-56.2
Glazing: 4mm, 16/20mm, 4mm													
Ventilator type: -													
F F (small) bedroom - S. W. elevation													
* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{eq}		45	45	45	41	43	43	43	30	17	12	10
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			16.8	21.8	26.8	28.2	33.5	43.4	46.5	43.6	48.5	53.2
G	A + B + E - F		10	27.4	22.4	13.4	14.0	9.0	-1.2	-17.0	-27.4	-37.3	-44.0
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	30.4	25.4	16.4	17.0	12.0	1.8	-14.0	-24.4	-34.3	-41.0
Glazing: -													
Ventilator type: -													
Combined sound level, dB(A)			19										
F F (large) bedroom - N. W. elevation													
* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{eq}		45	45	45	41	43	43	43	30	17	12	10
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	46											
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))			-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8
F	Composite SRI			16.8	21.8	26.8	28.2	33.5	43.4	46.5	43.6	48.5	53.2
G	A + B + E - F		8	25.9	20.9	11.9	12.5	7.6	-2.6	-18.4	-28.9	-38.8	-45.5
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		11	28.9	23.9	14.9	15.5	10.6	0.4	-15.4	-25.9	-35.8	-42.5
K	Number of ventilators	2											
L	Ventilator $D_{n,e}$				31	36	37	34	30	33	38	43	
M	$L_{Aeq} - D_{n,e} + 10 \cdot \log(10) - B$				16.9	7.9	8.9	12.2	15.9	0.2	-18.1	-28.1	
N	Internal room noise level, vent open		18		24.7	15.7	16.4	14.5	16.0	0.3	-17.4	-27.4	
Glazing: 4mm, 16/20mm, 4mm													
Ventilator type: Greenwood 4000EAV													

F F (large) bedroom - S. W. elevation													
* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{eq}		45	45	45	41	43	43	43	30	17	12	10
B	Exposed façade, m ²	7.6		8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8
C	Volume of receiving room, m ³	46											
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))			-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8
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		-7	13.7	8.7	-0.3	-2.3	-10.0	-18.3	-35.0	-48.3	-58.3	-60.3
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		-4	16.7	11.7	2.7	0.7	-7.0	-15.3	-32.0	-45.3	-55.3	-57.3
Glazing: 4mm, 16/20mm, 4mm													
Ventilator type: -													
F F (large) bedroom - S. E. elevation													
* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{eq}		45	45	45	41	43	43	43	30	17	12	10
B	Exposed façade, m ²	12.2		10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9
C	Volume of receiving room, m ³	46											
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))			-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8
F	Composite SRI			16.8	21.8	26.8	37.2	46.0	54.0	59.6	60.9	62.2	62.2
G	A + B + E - F		2	27.0	22.0	13.0	4.6	-3.9	-12.2	-30.5	-45.1	-51.4	-53.4
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		5	30.0	25.0	16.0	7.6	-0.9	-9.2	-27.5	-42.1	-48.4	-50.4
Glazing: -													
Ventilator type: -													
Combined sound level, dB(A)			18										

Proposed Bungalow - Football Match Noise Levels													
<u>L_{Aeq} Assessment, daytime</u>													
Living room - S. E. elevation													
* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L _{eq}		61	60	56	52	48	55	54	57	54	38	25
B	Exposed façade, m ²	19.8		13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0
C	Volume of receiving room, m ³	122											
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))			-16.0	-16.0	-16.0	-16.0	-16.0	-16.0	-16.0	-16.0	-16.0	-16.0
F	Composite SRI			22.8	27.8	32.8	29.9	35.1	45.0	48.0	45.1	50.1	54.9
G	A + B + E - F		16	33.7	24.7	16.6	14.5	16.7	6.0	6.0	5.9	-15.4	-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		19	36.7	27.7	19.6	17.5	19.7	9.0	9.0	8.9	-12.4	-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				21.5	13.4	7.5	17.8	21.0	21.0	13.0	-8.3	
N	Internal room noise level, vent open		26		28.6	20.5	18.0	21.9	21.3	21.3	14.4	-6.9	
Glazing: 4mm, 16/20mm, 4mm													
Ventilator type: Greenwood 4000EAV													
Living room - S. W. elevation													
* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L _{eq}		61	60	56	52	48	55	54	57	54	38	25
B	Exposed façade, m ²	14.7		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	122											
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))			-16.0	-16.0	-16.0	-16.0	-16.0	-16.0	-16.0	-16.0	-16.0	-16.0
F	lbed existing			22.8	27.8	32.8	29.9	35.1	45.0	48.0	45.1	50.1	54.9
G	A + B + E - F		15	32.4	23.4	15.3	13.2	15.4	4.7	4.7	4.6	-16.7	-34.6
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		18	35.4	26.4	18.3	16.2	18.4	7.7	7.7	7.6	-13.7	-31.6
Glazing: -													
Ventilator type: -													
Living room - N. W. elevation													
* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L _{eq}		61	60	56	52	48	55	54	57	54	38	25
B	Exposed façade, m ²	14.7		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	122											
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))			-16.0	-16.0	-16.0	-16.0	-16.0	-16.0	-16.0	-16.0	-16.0	-16.0
F	Composite SRI			17.2	22.2	27.2	23.4	28.4	38.4	41.4	38.4	43.4	48.4
G	A + B + E - F		22	38.0	29.0	20.9	19.8	22.1	11.3	11.3	11.3	-10.0	-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	41.0	32.0	23.9	22.8	25.1	14.3	14.3	14.3	-7.0	-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				22.8	14.7	8.8	19.1	22.3	22.3	14.3	-7.0	
N	Internal room noise level, vent open		29		32.5	24.4	23.0	26.1	23.0	23.0	17.3	-4.0	
Glazing: 4mm, 16/20mm, 4mm													
Ventilator type: Greenwood 4000EAV													
Combined sound level, dB(A)			31										

Kitchen/dining room - S. E. elevation														
* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*	
A	Measured L_{eq}		61	60	56	52	48	55	54	57	54	38	25	
B	Exposed façade, m ²	10.6		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	50												
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))			-12.1	-12.1	-12.1	-12.1	-12.1	-12.1	-12.1	-12.1	-12.1	-12.1	
F	Composite SRI			20.7	25.7	30.7	27.3	32.4	42.4	45.4	42.4	47.4	52.3	
G	A + B + E - F		20	36.9	27.9	19.8	18.3	20.5	9.8	9.7	9.7	-11.6	-29.5	
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		23	39.9	30.9	22.8	21.3	23.5	12.8	12.7	12.7	-8.6	-26.5	
K	Number of ventilators	2												
L	Ventilator $D_{n,e}$				31	36	37	34	30	33	38	43		
M	$L_{Aeq} - D_{n,e} + 10 \cdot \log(10) - B$				27.3	19.2	13.3	23.6	26.8	26.8	18.8	-2.5		
N	Internal room noise level, vent open		32		32.5	24.4	21.9	26.6	26.9	26.9	19.7	-1.6		
Glazing: 4mm, 16/20mm, 4mm														
Ventilator type: Greenwood 4000EAV														
G F bedroom - S. E. elevation														
* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*	
A	Measured L_{eq}		61	60	56	52	48	55	54	57	54	38	25	
B	Exposed façade, m ²	6.1		7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	
C	Volume of receiving room, m ³	41												
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))			-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	
F	Composite SRI			20.7	25.7	30.7	27.3	32.4	42.3	45.4	42.4	47.4	52.3	
G	A + B + E - F		19	35.4	26.4	18.3	16.8	19.0	8.3	8.2	8.2	-13.1	-31.0	
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	38.4	29.4	21.3	19.8	22.0	11.3	11.2	11.2	-10.1	-28.0	
K	Number of ventilators	2												
L	Ventilator $D_{n,e}$				31	36	37	34	30	33	38	43		
M	$L_{Aeq} - D_{n,e} + 10 \cdot \log(10) - B$				29.7	21.6	15.7	26.0	29.2	29.2	21.2	-0.1		
N	Internal room noise level, vent open		34		32.5	24.4	21.2	27.4	29.2	29.2	21.6	0.3		
Glazing: 4mm, 16/20mm, 4mm														
Ventilator type: Greenwood 4000EAV														
G F bedroom - N. W. elevation														
* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*	
A	Measured L_{eq}		61	60	56	52	48	55	54	57	54	38	25	
B	Exposed façade, m ²	16.1		12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	
C	Volume of receiving room, m ³	41												
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))			-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	
F	Composite SRI			27.7	32.7	37.7	29.8	34.9	44.8	47.9	44.9	49.9	54.8	
G	A + B + E - F		20	37.6	28.6	20.5	18.5	20.7	10.0	9.9	9.9	-11.4	-29.3	
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	40.6	31.6	23.5	21.5	23.7	13.0	12.9	12.9	-8.4	-26.3	
K	Number of ventilators	1												
L	Ventilator $D_{n,e}$				31	36	37	34	30	33	38	43		
M	$L_{Aeq} - D_{n,e} + 10 \cdot \log(10) - B$				22.4	14.3	8.4	18.7	21.9	21.9	13.9	-7.4		
N	Internal room noise level, vent open		28		32.1	24.0	21.7	24.9	22.5	22.4	16.4	-4.9		
Glazing: 4mm, 16/20mm, 4mm														
Ventilator type: Greenwood 4000EAV														
G F bedroom - S. W. elevation														
* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*	
A	Measured L_{eq}		61	60	56	52	48	55	54	57	54	38	25	
B	Exposed façade, m ²	6.1		7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	
C	Volume of receiving room, m ³	41												
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))			-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	-11.3	
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		3	28.1	19.1	11.0	2.1	1.4	-7.4	-8.4	-11.4	-32.7	-45.7	
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		6	31.1	22.1	14.0	5.1	4.4	-4.4	-5.4	-8.4	-29.7	-42.7	
Glazing: -														
Ventilator type: -														
Combined sound level, dB(A)			35											

F F (small) bedroom - N. E. elevation													
* Octave Band Centre Frequency, Hz													
			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{eq}		61	60	56	52	48	55	54	57	54	38	25
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			16.8	21.8	26.8	28.2	33.5	43.4	46.5	43.6	48.5	53.2
G	A + B + E - F		21	42.2	33.2	25.1	18.8	20.8	10.1	10.0	9.9	-11.3	-29.0
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		24	45.2	36.2	28.1	21.8	23.8	13.1	13.0	12.9	-8.3	-26.0
K	Number of ventilators	2											
L	Ventilator $D_{n,e}$				31	36	37	34	30	33	38	43	
M	$L_{Aeq} - D_{n,e} + 10 \cdot \log(10) - B$				27.7	19.6	13.7	24.0	27.2	27.2	19.2	-2.1	
N	Internal room noise level, vent open		32		36.7	28.6	22.4	26.9	27.4	27.4	20.1	-1.2	
Glazing:													
Ventilator type:													
F F (small) bedroom - N. W. elevation													
* Octave Band Centre Frequency, Hz													
			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{eq}		61	60	56	52	48	55	54	57	54	38	25
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	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		4	29.6	20.6	12.5	3.6	2.9	-5.9	-6.9	-9.9	-31.2	-44.2
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		7	32.6	23.6	15.5	6.6	5.9	-2.9	-3.9	-6.9	-28.2	-41.2
Glazing:													
Ventilator type:													
F F (small) bedroom - S. W. elevation													
* Octave Band Centre Frequency, Hz													
			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{eq}		61	60	56	52	48	55	54	57	54	38	25
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			16.8	21.8	26.8	28.2	33.5	43.4	46.5	43.6	48.5	53.2
G	A + B + E - F		21	42.2	33.2	25.1	18.8	20.8	10.1	10.0	9.9	-11.3	-29.0
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		24	45.2	36.2	28.1	21.8	23.8	13.1	13.0	12.9	-8.3	-26.0
Glazing:													
Ventilator type:													
Combined sound level, dB(A)			33										

F F (large) bedroom - N. W. elevation													
* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{eq}		61	60	56	52	48	55	54	57	54	38	25
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	46											
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))			-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8
F	Composite SRI			16.8	21.8	26.8	28.2	33.5	43.4	46.5	43.6	48.5	53.2
G	A + B + E - F		19	40.7	31.7	23.6	17.3	19.4	8.7	8.6	8.4	-12.8	-30.5
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		22	43.7	34.7	26.6	20.3	22.4	11.7	11.6	11.4	-9.8	-27.5
K	Number of ventilators	2											
L	Ventilator $D_{n,e}$				31	36	37	34	30	33	38	43	
M	$L_{Aeq} - D_{n,e} + 10 \cdot \log(10) - B$				27.7	19.6	13.7	24.0	27.2	27.2	19.2	-2.1	
N	Internal room noise level, vent open		32		35.5	27.4	21.2	26.3	27.3	27.3	19.9	-1.4	
Glazing: 4mm, 16/20mm, 4mm													
Ventilator type: Greenwood 4000EAV													
F F (large) bedroom - S. W. elevation													
* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{eq}		61	60	56	52	48	55	54	57	54	38	25
B	Exposed façade, m ²	7.6		8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8
C	Volume of receiving room, m ³	46											
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))			-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8
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		3	28.5	19.5	11.4	2.5	1.8	-7.0	-8.0	-11.0	-32.3	-45.3
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		6	31.5	22.5	14.4	5.5	4.8	-4.0	-5.0	-8.0	-29.3	-42.3
Glazing: 4mm, 16/20mm, 4mm													
Ventilator type: -													
F F (large) bedroom - S. E. elevation													
* Octave Band Centre Frequency, Hz			dB(A)	31.5*	63*	125*	250*	500*	1k*	2k*	4k*	8k*	16k*
A	Measured L_{eq}		61	60	56	52	48	55	54	57	54	38	25
B	Exposed façade, m ²	12.2		10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9
C	Volume of receiving room, m ³	46											
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))			-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8	-11.8
F	Composite SRI			16.8	21.8	26.8	37.2	46.0	54.0	59.6	60.9	62.2	62.2
G	A + B + E - F		13	41.8	32.8	24.7	9.4	7.9	-0.9	-3.5	-7.8	-25.4	-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		16	44.8	35.8	27.7	12.4	10.9	2.1	-0.5	-4.8	-22.4	-35.4
Glazing: -													
Ventilator type: -													
Combined sound level, dB(A)			32										

Appendix 3: References

L.S. Søndergaard, R. Egeda. "Open windows with better sound insulation", DELTA Acoustics, Denmark, 2016.