



BRAIDEN ACOUSTICS LTD

Innovation Forum // 51 Frederick Road // Salford // Manchester // M6 6FP

ACOUSTICS, VENTILATION & OVERHEATING ASSESSMENT

Prepared For : BTP Architects

Date : 24 May 2021

Site : Glendene, 150 Greenbrow Rd, Wythenshawe

Report No. : 11137revA

1 INTRODUCTION

Braiden Acoustics has been commissioned by BTP Architects to undertake an acoustic survey at the site of Glendene, 150 Greenbrow Rd, Wythenshawe in order to support a planning application for the demolition of the existing buildings and erection of a variety of bungalows and houses for shared ownership and affordable housing.

After the initial report, number 10818 dated 28th March 2020, the Council had the following comments:

"I have reviewed the Residential Acoustic Survey by Braiden Acoustics and a baseline noise survey has been undertaken and the glazing specification given to achieve our criteria. There is no reference to the ventilation systems proposed and the internal criteria will not be achieved with the window open, consideration should be given to the AVO guidance when deciding on suitable ventilation. There is also a validation element to this condition."

Therefore, this is a revised report to assess the noise impacting on the proposed development in line with the Acoustic, Ventilation and Overheating (AVO) guide.

****This is an updated report from 10901revA, as the ventilation strategies have now been changed.**

1.1 AIM

This report assesses potential noise and ventilation impact on the proposed residential site and recommends any mitigation acoustic measures so that the relevant noise thresholds are met.

2 DESCRIPTION OF SITE

The site is a plot of land where the former Glendene Assessment Centre currently occupies.



Figure 1
Street view of site

2.1 SITE LOCATION AND SURROUNDING AREA

The site is bounded by Greenbrow Road to the south east and Wastdale Road to the north east.



Figure 2
Site location and surrounding uses

On the other side of Greenbrow Road, and to the north west, the properties are all residential, apart from local shops opposite the medical centre on Greenbrow Road.

To the south west of the site are three sites that front on to Scout Drive:

- Recently built care provision containing 20 self-contained 1-bed apartments with multifunctional communal/sensory rooms and landscaped gardens - LDP Scout Drive. Forms a 'T' shape.
- Maples Medical Centre
- Paint Pots Day Nursery.

Part of the housing development, during construction, the nursery and the medical centre can be seen more clearly in Figure 3 below:

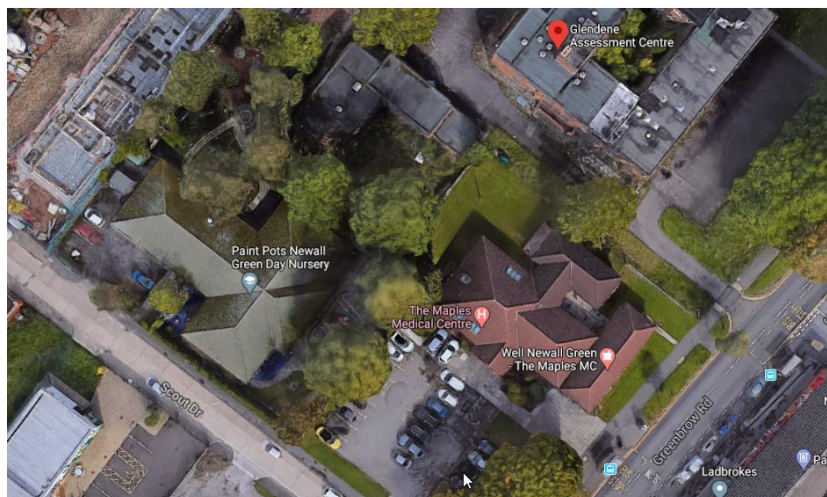


Figure 3
South eastern boundary of site



2.2 WIDER SURROUNDING AREA

Figure 4 shows that beyond the neighbouring uses there is Roundthorn Industrial Estate some 300m north west and the M56 approximately 550m to the east. Whilst noise from the Roundthorn Industrial Estate is not evident on the site, motorway traffic noise can be heard when it is busy.

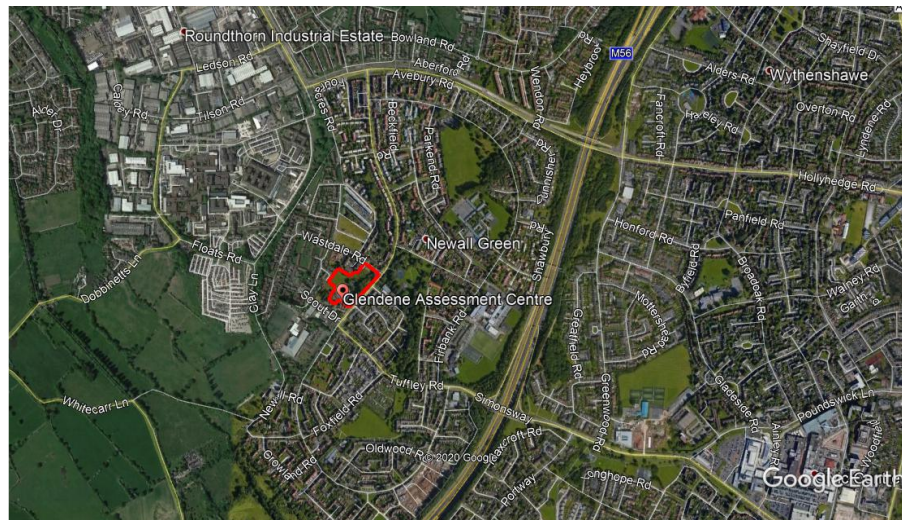


Figure 4
Site location and wider surrounding area

2.3 PROPOSED USE

It is proposed that the existing buildings on the site are demolished to make way for a selection of houses and bungalows with gardens, as Figure 5 shows below.

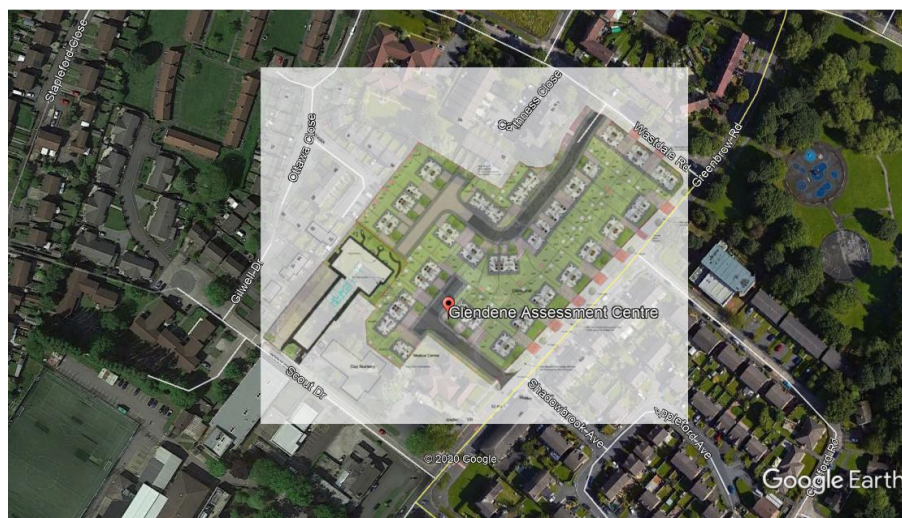


Figure 5
Proposed site layout

3 ACOUSTIC CRITERIA AND METHODOLOGY

This is a residential development that may be susceptible to environmental noise. Potential mitigation measures are determined by recommended indoor noise levels from BS 8233 “Sound insulation and noise reduction for buildings” [1] which, in turn, takes guidance from the research-based World Health Organisation “Guidelines for Community Noise”.

Noise level thresholds are usually given for the night-time – 2300-0700 hrs and day time – 0700-2300 hrs.



3.1 NATIONAL PLANNING POLICY FRAMEWORK (NPPF)

The National Planning Policy Framework is the current document for planning guidance. Paragraph 123 of the NPPF says that planning decisions should aim to:

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

3.2 NOISE POLICY STATEMENT FOR ENGLAND

The main aim of the Noise Policy Statement is to:

Promote good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development.

Therefore, the NPSE is mainly concerned with environmental noise.

The document sets out categories in order to help distinguish if there is an adverse effect due to noise and if there is, how significant it is.

NOEL – No Observed Effect Level

This is the level below which no effect can be detected. In simple terms, below this level, there is no detectable effect on health and quality of life due to the noise.

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

It is not possible to have a single objective noise-based measure that defines SOAEL that is applicable to all sources of noise in all situations. Consequently, the SOAEL is likely to be different for different noise sources, for different receptors and at different times. It is acknowledged that further research is required to increase our understanding of what may constitute a significant adverse impact on health and quality of life from noise. However, not having specific SOAEL values in the NPSE provides the necessary policy flexibility until further evidence and suitable guidance is available.

3.3 PROFESSIONAL PRACTICE GUIDANCE - PROPG: PLANNING & NOISE

This ProPG provides advice for Local Planning Authorities (LPAs), developers and their respective professional advisers. It aims to complement Government planning and noise policy and guidance such as Noise Policy Statement for England (NPSE), the National Planning Policy Framework (NPPF) and Planning Practice Guidance (including PPG-Noise), as well as other authoritative sources of guidance.

Section 1.2 of the guide states:



The scope of this ProPG is restricted to the consideration of new residential development that will be exposed predominantly to airborne noise from transport sources¹

The aims of the guide are to:

- *advocate full consideration of the acoustic environment from the earliest possible stage of the development control process;*
- *encourage the process of **good acoustic design** in and around new residential developments;*
- *outline what should be taken into account in deciding planning applications for new noise-sensitive developments;*
- *improve understanding of how to determine the extent of potential noise impact and effect; and*
- *assist the delivery of sustainable development.*

This ProPG document describes an acoustic design process which seeks to deliver the best acoustic outcome for a particular site and thus promote **good acoustic design** in new residential developments.

The approach involves an initial, and relatively simple, risk assessment of the site to determine the likely importance of noise issues. A more detailed second stage includes a systematic assessment of relevant aspects of the development proposal supported by an Acoustic Design Statement.

The two stages of the assessment are as follows:

1. Stage 1 – an initial noise risk assessment of the proposed development site; and
2. Stage 2 – a systematic consideration of four key elements.

The four key elements are:

- 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”.

3.3.1 Stage 1: Initial Site Noise Risk Assessment

The noise risk assessment should provide an indication of the likely risk of adverse effects from noise were no subsequent mitigation to be included as part of the development proposal. It should indicate whether the proposed site is considered to pose a negligible, low, medium or high risk from a noise perspective.

The noise risk assessment may be based on measurement or prediction (or a combination) as appropriate and should aim to describe noise levels over a “typical worst case” 24-hour day either now or in the foreseeable future.

The risk assessment should include the combined free-field noise level from all relevant sources of transport noise that affect the site. The assessment may also include industrial/commercial noise where this is present but is “not dominant”.

¹ Where industrial or commercial noise is present on the site and is considered to be “dominant” (i.e. where the impact would be rated as adverse or greater (subject to context) if a BS4142:2014 assessment was to be carried out), then the risk assessment should not be applied to the industrial or commercial noise component and the assessed should be based on guidance in BS4142:2014.



Figure 6 summarises the Stage 1 Initial Site Noise Risk Assessment. The figure illustrates how an initial noise risk assessment is linked with an increasing risk of adverse effect from noise and how this in turn is broadly associated with indicative noise levels derived from current guidance and experience. The indicative noise levels are intended to provide a sense of the noise challenge at a potential residential development site and should be interpreted flexibly having regard to the locality, the project and the wider context. Therefore, there are no rigid borders between the risk levels.

In the final column, the initial noise risk assessment is aligned with pre-planning application guidance that highlights the increasing importance of good acoustic design as the noise risk increases.

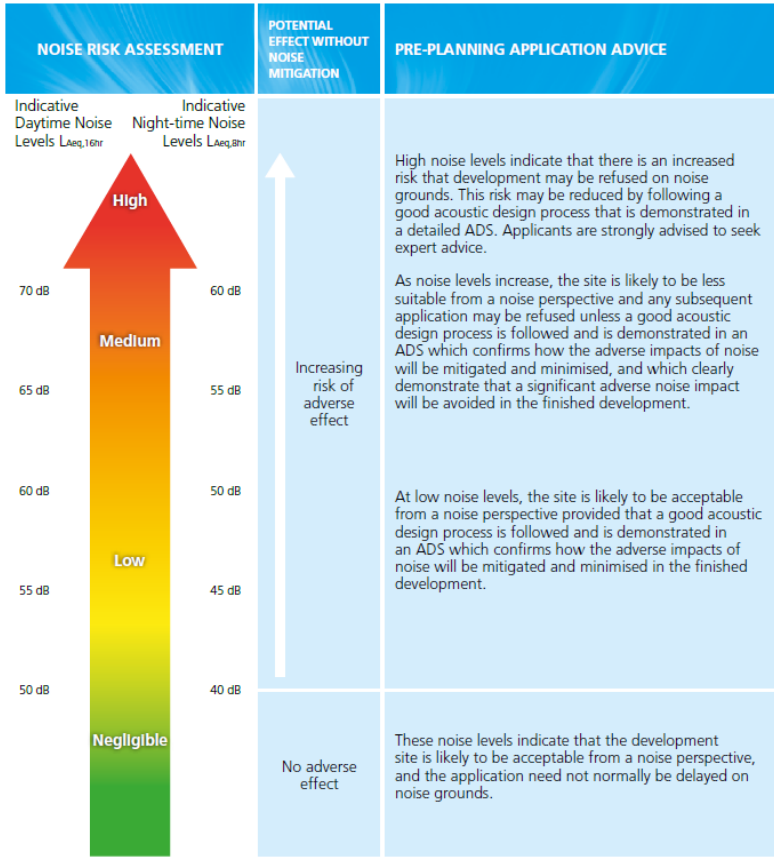


Figure 6
Initial Site Noise Risk Assessment

The risk levels and their associated noise levels are not dissimilar to the A-D categories of the now superseded PPG24: Planning and Noise.

3.3.2 Stage 2: Full Assessment – the four key elements

Stage 2 of the recommended approach contains four key elements to be undertaken in parallel and each is considered in turn below in the following sub-sections.



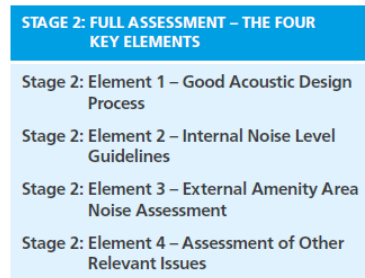


Figure 7
The four elements of the Stage 2 Full Assessment

3.3.2.1 Element 1: Good Acoustic Design Process

Good acoustic design is not just compliance with recommended internal and external noise exposure standards. Good acoustic design should provide an integrated solution whereby the optimum acoustic outcome is achieved, without design compromises that will adversely affect living conditions and the quality of life of the inhabitants or other sustainable design objectives and requirements. Therefore, using fixed unopenable glazing for sound insulation purposes is generally unsatisfactory and should be avoided as occupants generally prefer the ability to have control over the internal environment using openable windows, even if the acoustic conditions would be considered unsatisfactory when open.

Planning applications for new residential developments should include evidence that the following aspects of good acoustic design have been properly considered:

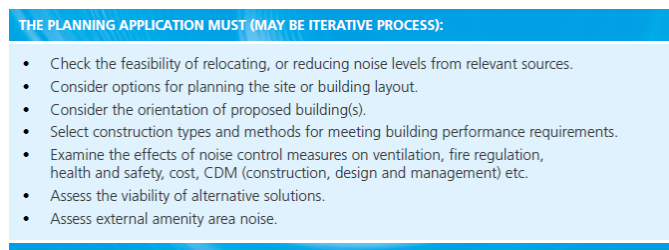


Figure 8
Aspects of Good Acoustic Design

3.3.2.2 Element 2: Internal Noise Level Guidelines

The second element of Stage 2 is to seek to achieve recommended noise levels inside noise sensitive rooms in new residential development.

It is considered that suitable guidance on internal noise levels can be found in “BS8233:2014: Guidance on sound insulation and noise reduction for buildings”. Table 4 in Section 7.7.2 of the standard suggests indoor ambient noise levels for dwellings (when unoccupied) and states that “in general, for steady external noise sources, it is desirable that the internal ambient noise level does not exceed the guideline values”. The standard states (Section 7.7.1) that “occupants are usually more tolerant of noise without a specific character” and only noise without such character is considered in Table 4 of the standard (also see Section 3.4.3.1).



ACTIVITY	LOCATION	07:00 – 23:00 HRS	23:00 – 07:00 HRS
Resting	Living room	35 dB $L_{Aeq,16\text{ hr}}$	-
Dining	Dining room/area	40 dB $L_{Aeq,16\text{ hr}}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,16\text{ hr}}$	30 dB $L_{Aeq,8\text{ hr}}$ 45 dB $L_{Amax,F}$ (Note 4)

Figure 9

Table 4 of BS8233:2104 with additional maximum levels included in ProPG Noise

The unoccupied noise levels given in Table 4 of BS 8233 includes a night time maximum level (as in the previous version of the standard). The notes associated with the table have been updated in the ProPG document, in particular Notes 4 & 5.

NOTE 4 Regular individual noise events (for example, scheduled aircraft or passing trains) can cause sleep disturbance. A guideline value may be set in terms of SEL or $L_{Amax,F}$, depending on the character and number of events per night. Sporadic noise events could require separate values. In most circumstances in noise sensitive rooms at night (e.g. bedrooms) good acoustic design can be used so that individual noise events do not normally exceed 45dB $L_{Amax,F}$ more than 10 times a night. However, where it is not reasonably practicable to achieve this guideline then the judgement of acceptability will depend not only on the maximum noise levels but also on factors such as the source, number, distribution, predictability and regularity of noise events.

NOTE 5 Designing the site layout and the dwellings so that the internal target levels can be achieved with open windows in as many properties as possible demonstrates good acoustic design. Where it is not possible to meet internal target levels with windows open, internal noise levels can be assessed with windows closed, however any façade openings used to provide whole dwelling ventilation (e.g. trickle ventilators) should be assessed in the “open” position and, in this scenario, the internal L_{Aeq} target levels should not normally be exceeded.

The above table plus supporting notes are referred to as ProPG internal noise level guidelines.

It should be noted that the acoustic performance of the building envelope will be reduced in the event windows are opened for ventilation or cooling purposes, typically reducing the insulation to no more than 10 to 15 dB(A). Most residents value the ability to open windows at will, for a variety of reasons, and LPAs should therefore normally request that designers principally aim, through the use of good acoustic design, to achieve the internal noise level guidelines in noise-sensitive rooms with windows open. Where internal noise levels are assessed with windows closed the justification for this should be included in the ADS. Where the LPA accepts that there is a justification that the internal target noise levels can only be practically achieved with windows closed, which may be the case in urban areas and at sites adjacent to transportation noise sources, special care must be taken to design the accommodation so that it provides good standards of acoustics, ventilation and thermal comfort without unduly compromising other aspects of the living environment. In such circumstances, internal noise levels can be assessed with windows closed but with any façade openings used to provide “whole dwelling ventilation” in accordance with Building Regulations Approved Document F (e.g. trickle ventilators) in the open position.

NB It should also be noted that the internal noise level guidelines are generally not applicable under “purge ventilation” conditions as defined by Building Regulations Approved Document F, as this should only occur occasionally (e.g. to remove odour from painting and decorating or from burnt food).**

In addition to providing purge ventilation, open windows can also be used to mitigate overheating. Therefore, should the LPA accept a scheme is to be assessed with windows closed, but this scheme is reliant on open windows to mitigate overheating, **it is also necessary to consider the potential noise impact during the overheating condition.** In this case a more detailed assessment of the potential impact on occupants should be provided in the ADS (also see AVO Guide in Section 3.3.2.3).



Where mechanical services are used as part of the ventilation or thermal comfort strategy for the scheme, the impact of noise generated by these systems on occupants should also be assessed.

3.3.2.3 Element 3 – External Amenity Area Noise Assessment

The third element of Stage 2 is a noise assessment of external amenity areas. The term “assessment” is deliberately used because this element concerns more than just the level of noise outside.

BS8233:2014 states that “the acoustic environment of external amenity areas that are an intrinsic part of the overall design should always be assessed and noise levels should ideally not be above the range 50 – 55 dB LAeq,16hr”. The standard continues... “These guideline values may not be achievable in all circumstances where development might be desirable. In such a situation, development should be designed to achieve the lowest practicable noise levels in these external amenity spaces but should not be prohibited.”

Therefore, every effort should be made to mitigate noise in external amenity areas, even when the 50 – 55 dB range has been breached. For example, balcony boundary treatments can be specified in a similar manner to other boundary treatment, i.e. a continuous barrier (without gaps) that has a surface density of, at least, 10 kgm⁻².

PPG-Noise states: “If external amenity spaces are an intrinsic part of the overall design, the acoustic environment of those spaces should be considered so that they can be enjoyed as intended”.

Where, despite following a good acoustic design process, significant adverse noise impacts remain on any private external amenity space (e.g. garden or balcony) then that impact may be partially offset if the residents are provided, through the design of the development or the planning process, with access to:

- a relatively quiet facade (containing openable windows to habitable rooms) or a relatively quiet externally ventilated space (i.e. an enclosed balcony) as part of their dwelling; and/or
- a relatively quiet alternative or additional external amenity space for sole use by a household, (e.g. a garden, roof garden or large open balcony in a different, protected, location); and/or
- a relatively quiet, protected, nearby, external amenity space for sole use by a limited group of residents as part of the amenity of their dwellings; and/or
- a relatively quiet, protected, publicly accessible, external amenity space (e.g. a public park or a local green space designated because of its tranquillity) that is nearby (e.g. within a 5-minute walking distance). The local planning authority could link such provision to the definition and management of Quiet Areas under the Environmental Noise Regulations.

3.3.2.4 Element 4 – Assessment of Other Relevant Issues

The fourth and final element of Stage 2 is an assessment of other relevant issues. This element seeks to build upon relevant national and local planning and noise policies (item 4(i)) to provide a systematic list of recommendations for the issues that should be considered before making a judgement about the noise aspects of a particular planning proposal for new residential development.



**Stage 2: Element 4 – Assessment
of Other Relevant Issues**

- 4(i) compliance with relevant national and local policy
- 4(ii) magnitude and extent of compliance with ProPG
- 4(iii) likely occupants of the development
- 4(iv) acoustic design v unintended adverse consequences
- 4(v) acoustic design v wider planning objectives

Figure 10
Element 4 – Assessment of other relevant issues

3.4 ACOUSTICS, VENTILATION & OVERHEATING (AVO) GUIDE

The Acoustics, Ventilation & Overheating (AVO) guide came into effect in 2020 and it aims to assess all three elements simultaneously when considering residential developments. Previously, each element was considered independently and at different stages of the planning and development of a residential site. internal noise levels are usually considered with the windows closed whereas ventilation and overheating requirements rely on open windows; clearly these requirements are in conflict so the AVO guide considers all three elements so that pragmatic solutions can be achieved.

The AVO Guide includes:

- *an explanation of ventilation requirements under The Building Regulations as described in 'Approved Document F – Means of Ventilation, 2010 Edition' [3] ('ADF') along with typical ventilation strategies and associated noise considerations;*
- *an explanation of the overheating assessment methodology described in CIBSE 'Design methodology for the assessment of overheating risk in homes' ('TM59');*
- *potential acoustic scale and guidance relating to different ventilation and overheating conditions, for both environmental noise ingress and building services noise; and*
- *a worked example of the application of the AVO Guide including indicative design constraints for different ventilation and overheating mitigation strategies.*

In the case of environmental noise ingress, a two-level assessment procedure is described for the overheating condition. The first level is a site risk assessment based on external noise levels and the assumption that opening windows are the primary means of mitigating overheating. The second level assessment considers the potential for adverse effect on occupants based on internal ambient noise levels.

The scope of the methodology of the AVO guide follows on from ProPG: Noise (see Section 3.3) whereby

The AVO Guide is intended for the consideration of new residential development that will be exposed predominantly to airborne sound from transport sources, and to sound from mechanical services that are serving the dwelling in question.

3.4.1 Approved Document F : Ventilation

Section 2 of the AVO guide gives an overview of the relevant legislation and guidance, in particular, Approved Document F (ADF) that deals with ventilation as part of the Building Regulations.

There are three main types of ventilation requirements:



Type of ventilation	Definition in ADF	Location/reason for ventilation	Required
Whole Dwelling Ventilation [Note 1]	Whole building ventilation (general ventilation) is nominally continuous ventilation of rooms or spaces at a relatively low rate to dilute and remove pollutants and water vapour not removed by operation of extract ventilation, purge ventilation or infiltration, as well as supplying outdoor air into the building. For an individual dwelling this is referred to as "whole dwelling ventilation".	To provide fresh air to the building and to dilute and disperse residual water vapour not dealt with by extract ventilation as well as removing other pollutants which are released throughout the building.	Continuously
Extract Ventilation	Extract ventilation is the removal of air directly from a space or spaces to the outside. Extract ventilation may be provided by natural means (e.g. by passive stack ventilation) or by mechanical means (e.g. by an extract fan or central system).	From rooms where most water vapour and/or pollutants are released, e.g. due to activities such as cooking or bathing. This is to minimise their spread to the rest of the building.	Continuously or intermittently
Purge Ventilation	Purge ventilation is manually controlled ventilation of rooms or spaces at a relatively high rate to rapidly dilute pollutants and / or water vapour. Purge ventilation may be provided by natural means (e.g. an openable window) or by mechanical means (e.g. a fan).	Throughout the building to aid removal of high concentrations of pollutants and water vapour released from occasional activities such as painting and decorating or accidental releases such as smoke from burnt food or spillage of water.	Occasionally

Note 1 'Whole Dwelling Ventilation' is often confused with 'background ventilation', a term used in the 1995 version of ADF. In the current ADF, the term 'background ventilator' refers to trickle vents.

Figure 11
Types of ventilation requirements

in order to achieve the various ventilation requirements described in Figure 11, there are four main different ventilation strategies:

Ventilation system	Provision with ADF system / purpose		
	Whole dwelling ventilation	Extract ventilation	Purge ventilation
System 1: Background ventilators and intermittent extract fans	Background ventilators (trickle vents)	Intermittent extract fans	Typically provided by opening windows
System 2: Passive stack ("natural")	Background ventilators (trickle vents) and passive stack ventilation	Continuous via passive stack	Typically provided by opening windows
System 3: Continuous mechanical extract (MEV)	Continuous mechanical extract – minimum low rate Trickle vents provide inlet air	Continuous mechanical extract – minimum high rate Trickle vents provide inlet air	Typically provided by opening windows
System 4: Continuously mechanical supply and extract with heat recovery (MVHR)	Continuous mechanical supply and extract – minimum low rate	Continuous mechanical supply and extract – minimum high rate	Typically provided by opening windows

Figure 12
Ventilation strategies

3.4.2 Overheating

There are no specific requirements relating to overheating in The Building Regulations or Planning. Both ADF and Approved Document L1A of The Building Regulations briefly mention overheating but do not provide details on what constitutes overheating.

For the purposes of this document, overheating is taken to mean:

John Braiden BSc MSc MIOA
Acoustic Consultant

0161 743 3621
john@braidenacoustics.co.uk



“ the phenomenon of excessive or prolonged high temperatures in homes, resulting from internal or external heat gains, which may have adverse effects on the comfort, health or productivity of the occupants.”

TM59 (CIBSE: Design methodology for the assessment of overheating risk in homes) sets out a methodology for predicting temperatures inside dwellings and provides overheating compliance criteria. **To undertake the assessment, information on the heat loads, thermal properties of the building construction, weather data and methods of providing ventilation are required.**

To minimise the risk of overheating in most residential buildings, it is normally necessary to use some form of cooling system. The three main methods of providing additional ‘rapid’ cooling are:

- Passive ventilative cooling – Introducing external air to a space to provide a cooling effect without the use of fans. The most common method is to use open windows but other façade openings can also be used. Note that trickle vents do not enable sufficient airflow to have a significant cooling effect.
- Mechanical ventilative cooling – Using fans to introduce external air to a space to provide a cooling effect. Due to the airflow required, this type of system often involves significant plant and duct size requirements.
- Comfort cooling – Using a mechanical system to cool the air within a space to achieve a user-defined setpoint. This type of system will require some form of mechanical device to cool the air, such as a fan coil unit (FCU).

3.4.3 Acoustics

The overarching policy on noise management is set out in the Noise Policy Statement for England (‘NPSE’). The NPSE contains the vision of promoting good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development.

In the explanatory note to the NPSE, reference is made to concepts from toxicology that had previously been applied to noise impacts (e.g. by the World Health Organisation). They are:

- No Observed Effect Level (NOEL) which is the level below which no effect can be detected;
- Lowest Observed Adverse Effect Level (LOAEL) which is the level above which adverse effects on health and quality of life can be detected.
- Significant Observed Adverse Effect Level (SOAEL) which is the level above which significant adverse effects on health and quality of life occur

Although the word ‘level’ is used, this does not mean that the impact can only be described as an individual noise level or exposure. It could also include factors such as the number of times the noise impact occurs, the duration of the impact, and the time of day the impact occurs. Thus, depending on the circumstance, the noise impact could be managed by reducing how often it occurs rather than just reducing the level of impact when it does occur.

The NPSE states that it is not possible to have a single objective noise-based measure that defines SOAEL that is applicable to all sources of noise in all situations. Consequently, the SOAEL is likely to be different for different noise sources, for different receptors and at different times.

In the PPG(N) document (see Section 3.3) it includes a table which summarises the noise exposure hierarchy based on the likely average response.



Perception	Examples of Outcomes	Increasing Effect Level	Action
Not present	No Effect	No Observed Effect	No specific measures required
Present 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	
Present 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	
Present 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 ^[Note 1]
Present 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

Figure 13

Summary of noise exposure hierarchy based on the likely average response (from PPG(N))

Most local authorities have used the values in Table 4 of BS 8233:2014 (see Section 3.4.3.1) to represent LOAEL as far as applying the policy in the NPPF and NPSE.

3.4.3.1 Noise Level Guidelines

The AVO Guide presents guidance regarding indoor ambient noise levels in new residential development that will be exposed predominantly to airborne sound from transport sources, and to sound from mechanical systems serving the development. The contribution to internal noise levels from transport sources and from mechanical services are considered separately and independently because there is evidence that occupants have a different tolerance to each. For both sources of noise, the guidance makes a clear distinction between provisions for fresh air to achieve whole dwelling ventilation rates ('ADF ventilation condition'), and provisions for rapid cooling to mitigate overheating ('overheating condition'). In terms of noise effect, the important distinction between these two situations is that the ADF ventilation condition applies for the entire time whereas the overheating condition applies only for part of the time. In the case of noise from mechanical services, the guidance for the overheating condition refers to existing guidance documents. In the case of noise from transport sources, there is no appropriate existing guidance for the overheating condition. Instead, the guidance presented here **considers the suitability of higher internal ambient noise levels in terms of the overheating effect (i.e. open windows) on occupants. When considering the overheating condition, higher noise levels than those given in Table 4 of BS8233:2014 are allowed as the overheating condition occurs for only part of the time.** During this period, occupants may



Risk category for Level 1 assessment [Note 5]	Potential Effect without Mitigation	Recommendation for Level 2 assessment
L_{Aeq, T} [Note 3] during 07:00 - 23:00 L_{Aeq, 8hr} during 23:00 - 07:00 High 65 dB 55 dB Medium 60 dB 50 dB Low 55 dB Negligible 50 dB 45 dB	Increasing risk of adverse effect	Recommended Optional
	Use of opening windows as primary means of mitigating overheating is not likely to result in adverse effect	Not required

Figure 14
Guidance for Level 1 site risk assessment of noise from predominantly transport noise sources relating to
overheating condition

Present Level 2 assessment to include the following minimum information:

- Statement of the overheating criteria being applied.
- Description of the provisions for meeting the stated overheating criteria. This should include, where relevant, the area of facade opening (see DEFRA document on attenuation of open windows).
- Details of the likely internal ambient noise levels whilst using provisions for mitigating overheating, and the method used to predict these. (i.e. calculate the internal noise level assuming windows open for rapid cooling using the long method in Bs 8233, for example.)
- Estimation of how frequently and for what duration such provisions are required to mitigate overheating
- Consideration of the effect of individual noise events.
- Assessment of adverse effect on occupants.



Internal ambient noise level [Note 2]			Examples of Outcomes [Note 5]	
$L_{Aeq,T}$ [Note 3] during 07:00 – 23:00 [Note 6]	$L_{Aeq,8h}$ during 23:00 – 07:00	Individual noise events during 23:00 – 07:00 [Note 4]		
> 50 dB	> 42 dB	Normally exceeds 65 dB $L_{AF,max}$	Noise causes a material change in behaviour e.g. having to keep windows closed most of the time	Avoiding certain activities during periods of intrusion. 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.
			Increasing likelihood of impact on reliable speech communication during the day or sleep disturbance at night	At higher noise levels, more significant behavioural change is expected and may only be considered suitable if occurring for limited periods. As noise levels increase, small behaviour changes are expected e.g. turning up the volume on the television; speaking a little more loudly; having to close windows for certain activities, for example ones which require a high level of concentration. Potential for some reported sleep disturbance. Affects the acoustic environment inside the dwelling such that there is a perceived change in quality of life. At lower noise levels, limited behavioural change is expected unless conditions are prevalent for most of the time. [Note 8]
≤ 35 dB	≤ 30 dB	Do not normally exceed $L_{AF,max}$ 45 dB more than 10 times a night	Noise can be heard, but does not cause any change in behaviour	Noise can be heard, but does not cause any change in behaviour, attitude, or other physiological response [Note 9]. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.

Note 1 The noise levels suggested in Tables 3-2 and 3-3 assume a steady road traffic noise source but may be adapted for other types of transport.

Figure 15

Guidance for Level 2 assessment of noise from transport noise sources relating to overheating condition

For the daytime period, the upper category in Figure 15 is defined on the basis that L_{Aeq} 50 dB represents the upper end of the range for reliable speech communication (as shown in Table 7 of BS 8233:2014).

For the night-time period, the upper category in Figure 15 is defined with reference to the WHO Night Noise guidelines, which state that for external levels should not exceed L_{Aeq} 55 dB in order to avoid “a sizeable proportion of the population being highly annoyed and sleep-disturbed”.

3.4.3.2 Internal Ambient Noise Levels from Mechanical Services

Human hearing response, annoyance and the health-related effects of noise are of primary concern when considering building services noise in dwellings. Research demonstrates that occupants will adjust mechanical ventilation systems to a level of noise that is tolerable or disable it entirely. Either of these actions result in insufficient ventilation; the adverse effects of this include poor indoor air quality for the occupants in airtight dwellings.

ADF suggests that to ensure good acoustic conditions, the noise levels within living rooms and bedrooms should not exceed $L_{Aeq,T}$ 30 dB for mechanical systems operating at the whole dwelling ventilation rate.



This originates from the BS 8233:1999 noise limits for noise ingress. Evidence indicates that “a more prudent limit for mechanical services noise around 24 – 26 dB(A) is likely to be required to prevent an adverse reaction from most occupants while falling asleep.”

Recommendations for desirable internal ambient noise levels for ADF ventilation conditions are set out in Figure 16.

Ventilation condition	Possible system or design solution	Desirable internal ambient noise levels from mechanical services
ADF – Whole Dwelling Ventilation	System 3: Continuous mechanical extract (MEV), minimum low ventilation rates System 4: Continuous mechanical supply and extract with heat recovery (MVHR), minimum low ventilation rates	Bedrooms $\leq L_{Aeq} 26$ or 30 dB [Note 1] Living Rooms $\leq L_{Aeq} 30$ dB
ADF – Extract Ventilation	System 1: Intermittent extract fans System 3: Continuous mechanical extract (MEV), minimum high ventilation rates System 4: Continuous mechanical supply and extract with heat recovery (MVHR), minimum high ventilation rates	Bedrooms $\leq L_{Aeq} 26$ or 30 dB Living / Dining Rooms $\leq L_{Aeq} 35$ dB Bathroom / WC / Kitchen $\leq L_{Aeq} 45$ dB
ADF – Purge Ventilation	Manually controlled fan exchanging a minimum 4 air changes per hour	No desirable noise levels are currently proposed based on the lack of evidence of acceptable noise levels when providing purge ventilation for the purpose of rapidly diluting indoor pollutants.

Note 1 A lower level may be more appropriate.

Figure 16

Indoor ambient noise levels from mechanical services - ADF ventilation condition

The use of mechanical systems to control overheating could include systems which provide ambient air at high ventilation rates (ventilative cooling) or systems which provide cooled air, commonly referred to as comfort cooling systems. These systems would normally be occupant controlled, but there may be options for automation. Recommendations for desirable internal ambient noise levels for overheating conditions are set out below.

Possible system or design solution	Desirable upper internal ambient noise levels from mechanical services
Ventilative cooling or Comfort cooling	Bedrooms $L_{Aeq} 30 (\pm 5)$ dB Living / Dining Rooms $L_{Aeq} 35 (\pm 5)$ dB

Figure 17

Indoor ambient noise levels from mechanical services - Overheating condition

A range of +/- 5 dB may be acceptable depending on the particular situation.

The duration, how frequently they occur, degree of occupant control and magnitude of the noise levels associated with the overheating condition should be taken into consideration when establishing suitable noise levels. Higher noise levels, e.g. 5 or 10 dBA higher are likely to be acceptable in some operating scenarios, where rapid changes to the cooling or ventilation rates quickly improve the thermal comfort of the occupant. Equally, lower noise levels may be appropriate for some types of residential development.

3.4.3.3 AVO assessment strategy

The AVO assessment can be broken down into three distinct stages:

1. Quantify and assess external noise levels



2. Assess noise & ventilation
3. Assess noise & overheating.

Step	Activity	Output advice
1	Quantify external noise levels Determine external noise levels impacting on proposed living rooms and bedrooms.	Report the following values and describe the method by which they have been determined. These should consider any increases that may reasonably be expected in the foreseeable future. • Daytime ($L_{Aeq,16h}$) • Night-time ($L_{Aeq,8h}$) • Ventilation design case night-time maximum (L_{AFmax}) level. • Overheating design case night-time maximum (L_{AFmax}) level.
2	Assess noise & ventilation Consider the effect of the proposed or potential ventilation strategies on the acoustic conditions in living rooms and bedrooms. Consider noise ingress through other parts of the building envelope as appropriate.	Refer to Table 3-1 for indoor ambient noise level guidelines from external sources, and Table 3-4 for mechanical services noise associated with ventilation provision. The facade sound insulation assessment should either include details of the proposed ventilation strategy and facade element sound insulation performance, or identify feasible ventilation strategies and the associated acoustic constraints for facade element performances. Section on Beginning Step 2 (paragraphs B11 to B35) gives further information on this.
3	Assess noise & overheating Rooms may be grouped by Negligible, Low, Medium and High risk categories according to Table 3-2 to determine the extent of further analysis or mitigation required. Consider noise from mechanical systems associated with controlling overheating.	It may be appropriate to carry out an overheating assessment regardless of the noise impact on the proposed development. Risk factors for overheating are listed in CIBSE TM59, although other methods of carrying out an overheating assessment may also be suitable. Refer to Table 3-5 for mechanical services noise associated with controlling overheating. Follow procedure in Figure 3-1 for noise from external sources. Negligible risk category rooms according to Level 1 assessment A "Level 1" assessment is sufficient, as noise can be heard but does not cause any change in behaviour. Low risk category rooms according to Level 1 assessment A "Level 1" assessment is likely to be sufficient. It is unlikely that external noise ingress will be problematic if using opening windows to mitigate overheating, although it may be appropriate to demonstrate this with calculations. Medium risk category rooms according to Level 1 assessment It would be prudent to carry out more detailed analysis for rooms in this category, because if open windows are required for extended periods to reduce potential overheating (i.e. during the "overheating condition") the noise impact may be significant. It may be appropriate to consider the generic overheating risk factors for the proposed development (refer to Appendix A, paragraph A.23, or use of the Good Homes Alliance Early Stage Overheating Risk Tool) along with the noise levels in order to take a balanced view of the level of formal assessment that is suitable. High risk category rooms according to Level 1 assessment A "Level 2" assessment is normally appropriate in accordance with Table 3-3. For rooms in this noise exposure category, an integrated approach should consider the overheating strategy along with external noise ingress. The potential adverse acoustic impact during the overheating condition should be assessed. Section on Beginning Step 3 (paragraphs B36 to B49) gives further information on assessing noise and overheating.

Figure 18

Three key steps in considering noise in relation to ventilation and overheating strategies

Before considering the assessment, it is helpful to know what the preferred ventilation strategy is and deduce whether it is suitable given the external noise climate.



ADF System	External noise ingress considerations	Mechanical system noise considerations	Approximate guideline free-field external noise limits. [Note 1]
1 or 2	Noise ingress is likely to be defined by the performance of the background ventilators (trickle vents), windows and other façade elements. Note that use of System 1, relying on the use of open trickle vents without opening windows may give rise to poor indoor air quality in airtight dwellings outside the winter period.	For System 1, intermittent kitchen and bathroom fans should have suitable noise levels to meet the guidelines in Table 3-4. System 2 has no mechanical components.	With standard double glazing and two trickle vents: • $\sim L_{Aeq,16h}$ 56 dB day • $\sim L_{Aeq,8h}$ 51 dB night • L_{AFmax} not normally exceeding ~ 67 dB more than 10x per night With high performing acoustic glazing and two 'acoustic' trickle vents: • $\sim L_{Aeq,16h}$ 66 dB day • $\sim L_{Aeq,8h}$ 61 dB night • L_{AFmax} not normally exceeding ~ 80 dB more than 10x per night
3	Noise ingress is likely to be defined by the performance of the background ventilators (trickle vents), windows and other façade elements. ADF advises that: <i>"controllable background ventilators having a minimum equivalent area of 2,500 mm² should be fitted in each room, except wet rooms..."</i>	This could be a centralised or decentralised MEV system. Guideline levels are shown in Table 3-4. For a centralised system, the location of the fan is important for structure-borne and airborne noise. System noise may affect living rooms and bedrooms as well as the rooms in which the extract inlets are located i.e. wet rooms. For a decentralised system, there are individual fans extracting from each bathroom, toilet, kitchen and utility room. The noise effects on adjacent living rooms and bedrooms should be considered. [Note 2]	With standard double glazing and trickle vent: • $\sim L_{Aeq,16h}$ 58 dB day • $\sim L_{Aeq,8h}$ 53 dB night • L_{AFmax} not normally exceeding ~ 69 dB more than 10x per night With high performing acoustic glazing and an 'acoustic' trickle vent: • $\sim L_{Aeq,16h}$ 68 dB day • $\sim L_{Aeq,8h}$ 63 dB night • L_{AFmax} not normally exceeding ~ 83 dB more than 10x per night
4	No trickle vents required. Consider noise ingress through other façade elements.	MVHR is a centralised system ducted to supply outlets in living rooms and bedrooms as well as to extracts in wet rooms. Guideline levels are shown in Table 3-4. The unit location is important for structure-borne and airborne noise. Consider ducted noise, particularly to bedrooms. Consider also cross-talk sound transmission via ducts. [Note 2]	With standard double glazing and no trickle vent: • $\sim L_{Aeq,16h}$ 62 dB day • $\sim L_{Aeq,8h}$ 57 dB night • L_{AFmax} not normally exceeding ~ 76 dB more than 10x per night With high performing acoustic glazing: • $\sim L_{Aeq,16h}$ 73 dB day • $\sim L_{Aeq,8h}$ 68 dB night • L_{AFmax} not normally exceeding ~ 90 dB more than 10x per night N.B. With secondary glazing higher sound insulation may be achieved.

Note 1 Refer to paragraphs B14 to B27 for the basis of calculated noise levels

Note 2 Hybrid ventilation strategies may involve mechanical supply and/or extract to specific habitable rooms, in which case those sources of noise should be considered.

Figure 19

Summary of potential noise issues associated with ventilation strategies described in ADF

An initial Level 1 assessment can suggest the suitability of a proposed ventilation scheme given the criteria in Figure 19.

The following summary of the AVO assessment is as follows:

1. Ensure that the predominant noise source is due to transportation noise
2. Take noise levels around the site and for both day and night
 - a. $L_{Aeq,day}$,
 - b. $L_{Aeq,night}$,
 - c. $L_{AFmax,night}$ (not normally exceeded 10 times) and
 - d. $L_{AFmax,night}$.
3. Determine Level 1 Risk Assessment Outcome (see also Figure 20). If a Level 2 assessment is required then the following steps should be taken.



4. Calculate internal noise levels (using BS8233 detailed calculation, where possible) based on area and type of chosen façade elements and any mechanical ventilation system for the following situations:
 - a. Ventilation Condition (windows closed by any trickle vents open)
 - b. Overheating Condition (windows open or alternative purge ventilations)
 - c. any noise from mechanical ventilation.
5. Internal design noise levels should achieve those given in Figure 21.
6. Post completion testing of internal noise levels in a sample of rooms across the site where appropriate.

A useful table to determine the Level 1 Risk Factor is given in the Quick Start - Acoustics Ventilation Overheating: Residential Design Guide (AVO Guide) by Apex Acoustics, shown in Figure 20.

External free-field ambient noise level at façade location ²			Example Level 1 noise & overheating risk assessment outcome	Suggested action in the design process
Daytime $L_{Aeq, 16\text{ hr}}$	Night-time $L_{Aeq, 8\text{ hr}}$	Night-time $L_{A_{Fmax}}$ ³		
> 63 dB	> 55 dB	Normally exceeds 78 dB $L_{A_{Fmax}}$	High	Indicates that opening windows are likely to be unsuitable to mitigate overheating for any duration. Carry out a Level 2 assessment.
> 53 dB and ≤ 63 dB	> 48 dB and ≤ 55 dB	-	Medium	If opening windows are proposed to control overheating, carry out a Level 2 assessment and use AVO Diagram to assess risk of adverse noise effects.
> 48 dB and ≤ 53 dB	> 43 dB and ≤ 48 dB	-	Low	Mitigate and minimise noise impact where possible, although open windows are likely to enable reasonable conditions.
≤ 48 dB	≤ 43 dB	Do not normally exceed $L_{A_{Fmax}}$ 58 dB more than 10 times a night	Negligible	Nothing – open windows are likely to be suitable.

Figure 20

Example Level 1 noise & overheating assessment category boundaries and suggested actions in the design process

Noise Source	Time Period / function	Living rooms	Bedrooms	Bath, WC, Kitchen
Environmental noise ingress limit with provisions for whole dwelling ventilation rate	Daytime, $L_{Aeq, 16\text{h}}$	≤ 35 dB	≤ 35 dB	-
	Night-time, $L_{Aeq, 8\text{h}}$	-	≤ 30 dB	-
	Night-time, ventilation design case $L_{A_{Fmax}}$	-	≤ 45 dB	-
Environmental noise ingress limit with provisions for mitigating overheating	Daytime, $L_{Aeq, 16\text{h}}$	≤ 50 dB	≤ 50 dB	-
	Night-time, $L_{Aeq, 8\text{h}}$	-	≤ 42 dB	-
	Night-time, overheating design case $L_{A_{Fmax}}$	-	≤ 65 dB	-
Mechanical services noise, where systems present	Whole dwelling ventilation rate, $L_{Aeq, T}$	≤ 30 dB	≤ 26 or 30 dB [Note 2]	-
	Extract ventilation rate, $L_{Aeq, T}$	≤ 35 dB	≤ 26 or 30 dB [Note 2]	≤ 45 dB
	At design duty to control overheating [Note 3]	≤ 35 dB	≤ 30 dB	-

Figure 21

Internal noise level design and testing targets



3.4.3.4 Post completion internal noise testing

Noise levels within a sample of appropriate rooms across the site should be undertaken to check for compliance prior to occupation which the following stipulations:

1. Measurements should be carried out and reported by a suitably qualified person following procedures in the latest version of the ANC Guide to Measurement of Sound Levels in Buildings.
2. Specific rooms for sampling should be agreed with the local authority, or at least notified to them in writing, prior to commencing measurements.
3. Environmental noise levels may be measured in a representative sample comprising at least two dwellings on each façade where there are different provisions for façade sound insulation. The rooms sampled should include those most exposed to environmental noise ingress, i.e. those with the highest external noise impact and those most susceptible to external noise ingress due to the façade elements and element areas.
4. Measurements of mechanical services noise may be made in at least one in ten dwellings. Mechanical services noise should be free from audible tones or particular characteristics that attract attention.
5. A set of measurements in a dwelling may comprise measurements in all habitable rooms serviced by the mechanical systems, for ventilation and mitigating overheating separately. The measurements may be standardised to a reference reverberation time of 0.5 seconds across the frequency range and corrected for background sound if required.

3.5 DEFRA 'OPEN/CLOSED WINDOW RESEARCH'

An assessment and discussion of the sound insulation of open and closed windows was undertaken by The Building Performance Centre (BPC), School of the Built Environment, Napier University in 2007 for the Department of Environment, Food and Rural Affairs (DEFRA) in a document called NANR116: 'OPEN/CLOSED WINDOW RESEARCH' SOUND INSULATION THROUGH VENTILATED DOMESTIC WINDOWS.

A summary of the performance of a variety of open window areas, in octave band and overall levels, were given in Table 5-6 of the document.

Opening size	Octave Band Centre Frequency (Hz)							$D_{n,e,W}$ (C;C _{tr})
	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	
50k (mm ²)	23	17	19	20	16	21	23	19 (0; -1)
100k (mm ²)	22 ^I	16	17	18	15	19	21	18 (-1; -1)
200k (mm ²)	20	14	14	16	14	17	19	16 (0; -1)

Figure 22

Statistically Derived $D_{n,e}$ insulation ratings for window openings (dB) derived from Table 5-6 of DEFRA

it is usual, as a worst-case scenario and without fully knowing the opening characteristics of proposed glazing, that the 200,000 mm² opening is used in assessments.

3.6 BS 8233: 2014

The British Standard BS 8233:2014 "Guidance on sound insulation and noise reduction for buildings" gives guidance on recommended indoor ambient noise levels for residential dwellings.



Room	Criterion	$L_{Aeq,T}$	
		night	day
Bedroom	Sleeping	30	35
Dining Room/Area	Dining	--	40
Living Room	Resting	--	35

Table 1

Recommending indoor ambient noise level thresholds from anonymous noise (taken from Table 4, BS 8233:2014)

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

Internal noise levels in habitable rooms are calculated using either the simple or rigorous method as described in Annex G in BS 8233:2014.

3.6.1 Noise levels in external living areas

For external living areas such as gardens and balconies, BS 8233:2014 § 7.7.3.2 recommends an upper limit of 55dB $L_{Aeq,day}$ although there is a caveat:

However, it is also recognized that these guideline values are not achievable in all circumstances where development might be desirable. In higher noise areas, such as city centres or urban areas adjoining the strategic transport network, a compromise between elevated noise levels and other factors, such as the convenience of living in these locations or making efficient use of land resources to ensure development needs can be met, might be warranted. In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces but should not be prohibited.

3.6.2 Maximum noise levels

In the 2014 edition of the Standard, the criterion of 45dB L_{AFMax} inside bedrooms has been removed although there is Note 4:

NOTE 4 regular individual noise events (for example, scheduled aircraft or passing trains) can cause sleep disturbance. A guideline value may be set in terms of SEL or $L_{Amax,P}$ depending on the character and number of events per night. Sporadic noise events could require separate values.

3.7 COUNCIL CRITERIA

For residential developments, Manchester Council's document "Noise and Planning Guidance" dated 2015, Section 3.6.1.1 states:

Manchester City Council has adopted the following noise limits for residential properties:

- *Bedrooms (night time - 23.00 - 07.00) 30 dB L_{Aeq} (individual noise events should not normally exceed 45 dB $L_{Amax,F}$ by more than 15 times)*
- *Living Rooms (daytime - 07.00 - 23.00) 35 dB L_{Aeq}*
- *Gardens and terraces (daytime) 55 dB L_{Aeq}*

These criteria have been adopted for the following reasons:

BS 8233: 2014 recognises these levels as a good standard for resting/sleeping conditions.

- *The WHO document 'Guidelines for Community Noise' recommends an internal L_{Aeq} of 30dB for optimal sleep conditions (and no more than 35dB for internal rooms during daytime).*



- The performance of acoustic insulation schemes can often be below that specified, according to the quality of installation, materials, noise spectrum and deterioration / wear and tear of building elements. A high design specification introduces a 'safety margin' should building elements not perform as well as expected ('on-site' performance).
- Performance specification for glazing does not usually take into account the detrimental effect of vents on the sound insulation. Even 'acoustic' vents will reduce the performance of the facade insulation, as they will inherently contain a free open area for air exchange.
- There is a general increase in urban noise levels, which can in the future be reasonably accommodated by these standards.
- The standards support the Local Authority corporate objective to prevent ill-health and improve local people's health and well-being.

4 MONITORING DETAILS

Noise measurements focussed on the road traffic noise from Greenbrow Road. The other potential noise source is the play area of the nursery but this was not in use during the monitoring period.

4.1 MONITORING OVERVIEW

Personnel: John Braiden, BSc & MSc Acoustics, MIOA.

Equipment: NTi XL2 integrated real time analyser & B&K 4231 calibrator.

The sound level meter was calibrated before after the measurements with no significant drift reported.

Monitoring was unmanned with audio recorded.

4.2 VISIT ONE - FRONT

The first visit was to monitor noise levels at the front of the site.

Date: Thurs 27th Feb – Fri 28th Feb (>18 hours)

Weather: 4 – 9°C temperature; ~5ms⁻¹ wind; ~20-40% cloud;

Monitor location: 1.2m from ground and at least 3.5m from any other reflecting surface – see white arrow in Figure 2. The monitoring location was approx. 30m from the middle of the road.

4.2.1 Results

Date	Time		Duration	Time Period	L _{A90} dB	L _{Aeq} dB	L _{Amax} dB
	Start	Finish					
Thurs 27/02/2020	15:03:16	23:00:00	07:56:18	day	45.4	54.4	86.1
	23:00:00	07:00:00	08:00:00	night	44.0	50.3	73.9
	07:00:00	09:53:47	02:52:15	day	54.0	58.6	76.6

Table 2
Summary of visit 1 - front

The measured noise levels were dominated by road traffic noise from nearby roads.



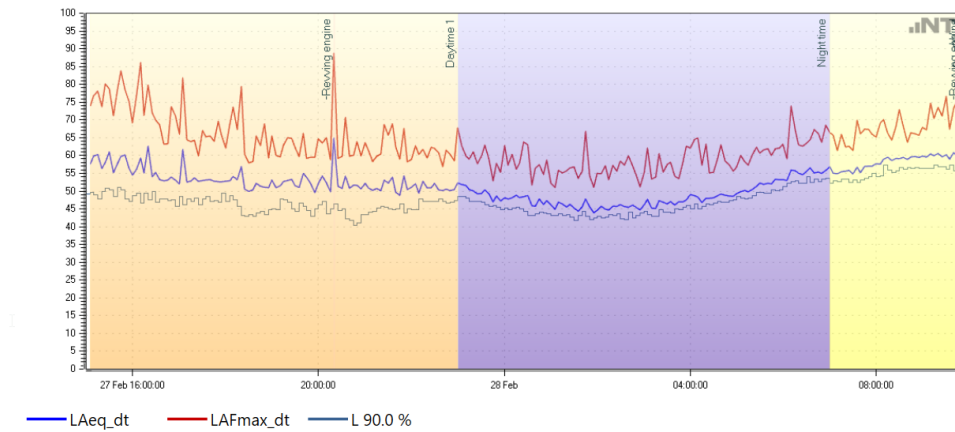


Figure 23
Time history

L_{Aeq} (night) 51 dB(A)
 L_{Aeq} (day) 57 dB(A)

5 ACOUSTIC, VENTILATION & OVERHEATING ASSESSMENT

5.1 STAGE 1 – RISK ASSESSMENT

The initial assessment is to categorise the external noise levels on site.

The site is split into elevations near to and with direct line of sight to, Greenbrow Road – as denoted in red in the figure below. All other elevations will either be too far away from the road or have no direct line of sight or both. These elevations will have a reduction of noise at least 10 dB below the more exposed elevations in red.



Figure 24
Proposed layout with more exposed elevations shown in red.



The nearest façade to the middle of the road is approximately 7m. This is in contrast to the monitoring location of 30m from the middle of the road; thus, there is a distance correction of $10 \cdot \log_{10}(30/6)^2 = 6$ dB.

The exposed elevations are subjected to the following day and night noise levels:

$$L_{Aeq}(\text{night}) \quad 51 + 6 = 57 \text{ dB(A)}$$

$$L_{Amax, <10}(\text{night}) \quad 65 + 6 = 71 \text{ dB(A)}$$

$$L_{Amax}(\text{night}) \quad 74 + 6 = 80 \text{ dB(A)}$$

$$L_{Aeq}(\text{day}) \quad 57 + 6 = 63 \text{ dB(A)}$$

Summary of External Noise Level at the FRONT elevations				
Time Period	L_{Aeq} dB	$L_{Amax, <10}$ dB	L_{Amax} dB	Risk Level
Day	63	n/a	n/a	Medium
Night	57	71	80	Medium

Figure 25
Summary of external Noise Level to the front

The more exposed elevations (shown in red in Figure 24) will require a Stage 2 assessment.

The noise levels to the rear are 10 dB less due to shielding from local road noise.

Summary of External Noise Level at the REAR				
Time Period	L_{Aeq} dB	$L_{Amax, <10}$ dB	L_{Amax} dB	Risk Level
Day	53	n/a	n/a	Negligible
Night	47	61	70	Negligible

Figure 26
Summary of external Noise Level to the rear

The least exposed elevations (not shown in red in Figure 24) do not require a Stage 2 assessment and can achieve reasonable internal noise levels with open windows for rapid cooling.

5.2 STAGE 2 ASSESSMENT

5.2.1 Ventilation scheme

There are now two proposed ventilation schemes for the development:

- 2 & 3 bed, bungalows
System 3: Continuous Extract for kitchen & bathroom included in system. Fresh air vents to habitable rooms.

² attenuation is 10log due to traffic noise being a line source.



2. 4 bed

System 2: Standard extract fans to kitchens, bathrooms. Trickle vents to windows.

5.2.1.1 System 3: Nibe F730 Exhaust air heat pump

For the majority of properties (all except the 4-beds), the Nibe F730 exhaust heat pump will provide hot water for the radiators and domestic hot water .

Warm exhaust air is drawn from the wet rooms, such as bathroom and kitchens. The heat pump extracts as much energy from the warm air before it is sent to atmosphere via an extract duct. There is also an air supply duct that brings in outdoor air to assist the unit with the refrigerant cycle and is connected to the exhaust ducting at the unit.

Fresh air is supplied to the habitable rooms via Fresh TL-F Wall Vents (shown bottom right of Figure 27). The fresh air ventilators should have a sound reduction index as good as the windows.

F730 Principle of Operation

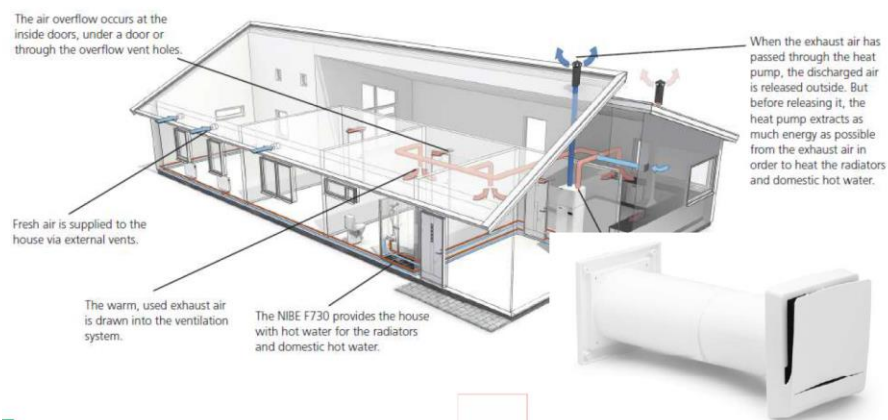


Figure 27
F730 Principal of Operation

5.2.1.2 System 2: Nibe 2040 Air Source Heat Pump

For the air source pump, there are 4 stages of the ‘Vapour Compression Cycle’:

1. Evaporation – Low temperature heat is taken from the source (ground or air) and transfers it to the circulating refrigerant. The liquid is converted to a gas via an expansion valve and compressor.
2. Compression – The compression converts the low temperature, low pressure gas into a high temperature, high pressure gas.
3. Condenser – The high-pressure hot gas then gives up heat into the water or air circulating around the system and turns back into a liquid as it condenses.
4. Expansion - The high-pressure refrigerant liquid from the condenser travels through the expansion valve, which acts as a pressure differential valve (high pressure on one side and low pressure the other), turning it into a low pressure, and hence low temperature liquid.

The 2040 Air Source Heat Pump will be located externally near the rear wall of the properties and supply the hot water. There will be standard wet room extraction fans and trickle vents to the windows in habitable rooms.





Figure 28
Drawing showing locations of the Air Source Heat Pumps (ASHPs)

5.2.2 Internal Noise Levels

5.2.3 Simple initial assessment

Given the external noise levels shown in Figure 25 and Figure 26, the initial glazing scheme can be suggested. However, it should be noted that this assumes windows closed in order to achieve the internal noise levels based on BS 8223.

The amount of attenuation from the building façades were readily computed using the simple method in Appendix G of BS 8233:2014 whereby the sound insulation index (SRI) of the glazing (the weakest element of the building façade, acoustically) is determined by simply deducting the required internal noise level from the external free field noise level³.

No 3dB façade correction was necessary as the noise monitoring was free field.

A correction of +6dB was attributed to the measured noise levels for properties fronting Greenbrow Road.

There is no barrier correction for properties fronting Greenbrow Road due to direct line of sight to the road.

Hence, the day and night levels used for the assessment are:

$$L_{Aeq}(\text{night}) \quad 51 + 6 = 57 \text{ dB(A)}$$

³ When the measured levels are façade levels, then 3dB is deducted to obtain the free field levels.



$$L_{Amax <10} \text{ (night)} \quad 65 + 6 = 71 \text{ dB(A)}$$

$$L_{Amax} \text{ (night)} \quad 74 + 6 = 80 \text{ dB(A)}$$

$$L_{Aeq} \text{ (day)} \quad 57 + 6 = 63 \text{ dB(A)}$$

The front and side elevations (marked in red in Figure 24) shall be assessed using the noise data above. The least exposed (no direct line of sight to Greenbrow Road) elevations will be 10dB less due to shielding from road noise.

Façade	period	room	External Levels measured / calc'd		Internal Levels recommended		Required glazing	
			L_{Aeq} (dB)	L_{Amax} (dB)	L_{Aeq} (dB)	L_{Amax} (dB)	SRI ($R_w + C_{tr}$)	Example Spec ⁴
Exposed	night	bedroom	57	71	30	45	27	6 / (6-20) / 4
	day	lounge	63	--	35	--	28	6 / (6-20) / 4
Not exposed	night	bedroom	47	61	30	45	17	4 / (6-20) / 4
	day	lounge	53		35		18	4 / (6-20) / 4

*Table 3
Calculated SRI values and recommended glazing*

The front and side elevations will require uprated glazing with a Sound Reduction Index of 28 dB $R_w + C_{tr}$ for all habitable rooms. This can be achieved with 6 / (6-20) / 4mm glazing which should give a sound reduction value of 28 dB $R_w + C_{tr}$ according to Table B.1 in BS 12354-3.

The rear elevations (and non-exposed properties) will suffice with standard 4mm double glazed units.

5.2.4 Detailed Assessment

Using the measured external noise levels, the internal noise levels, due to environmental (road) noise, have also been calculated using the detailed method in Section G.2.1 in BS 8233:2014 – see Equation (1). This calculation gives an internal noise level given the sound reduction indices of various building elements that noise may pass through, as well as the size and typical sound absorption of the room under assessment.

As Block B is predominant house type facing Greenbrow Road, then this configuration will be used to assess noise break-in.

5.2.4.1 Plot B - layout

The elevation and plan drawings are shown below with dimensions.

⁴ Example glazing build up and performance from Saint Gobain – table in Appendix. Other glazing build-ups available.





Figure 29
Front Elevation – Block B

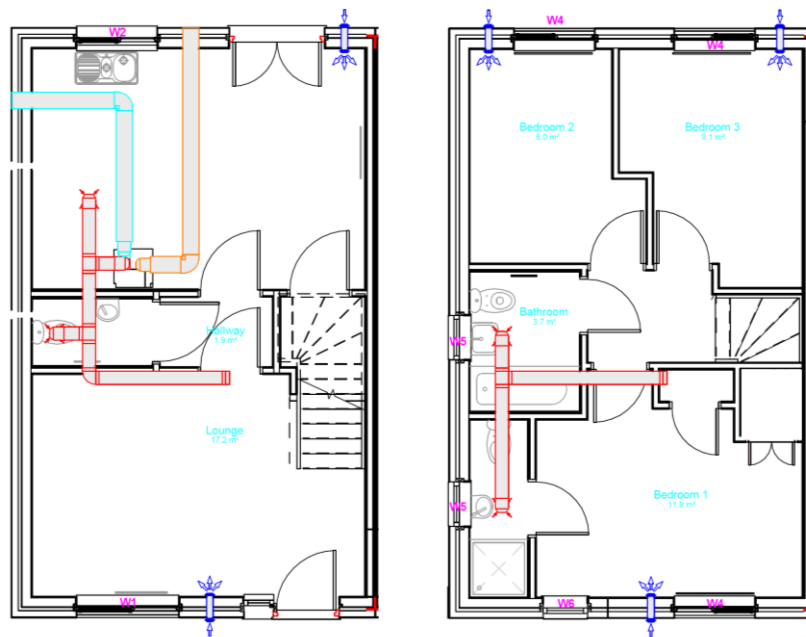


Figure 30
Plan view – Block B

5.2.4.2 Glazing

The glazing that has been installed is Saint Gobain 4 / 18 / 6.8mm with a performance of 31 dB $R_w + C_{tr}$. This is in excess of the 28 dB, as suggested in Table 3.

5.2.4.3 Exterior wall

The exterior wall build up is shown in Figure 31. It is, essentially, a 140mm timber stud wall on the inner leaf and a 150mm masonry wall on the exterior leaf, with a 50mm clear cavity in-between.



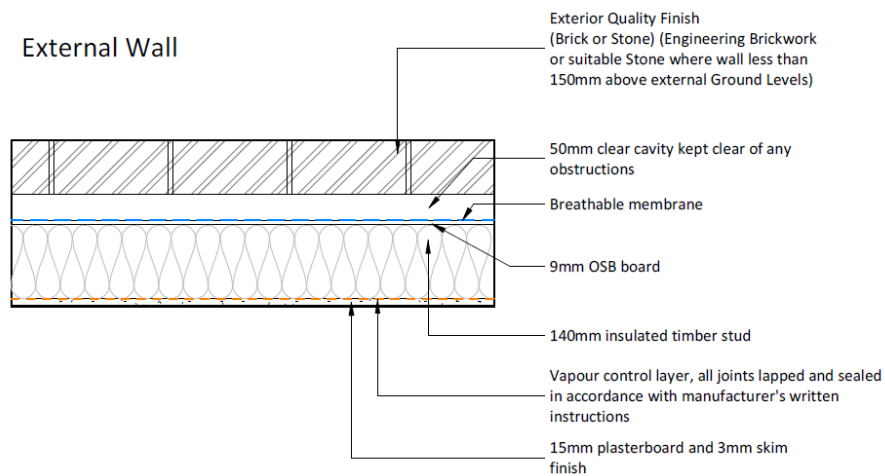
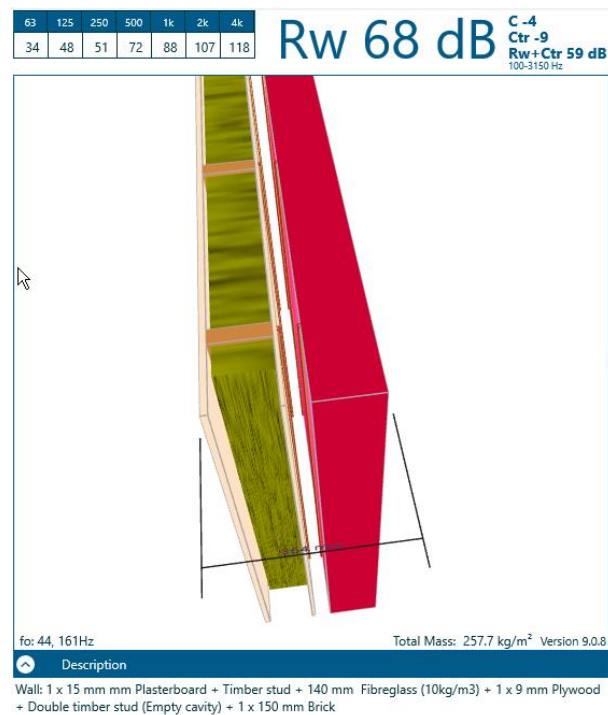


Figure 31
Exterior wall build up

The above build-up was modelled in Insul to determine the likely Sound Reduction Index of the exterior wall.



5.2.4.4 Roof / ceiling

The roof is comprised of interlocking concrete tiles on a roofing felt breather membrane with a total of 500mm of mineral wool, with a single layer of plasterboard attached to the underside of the ceiling joists.



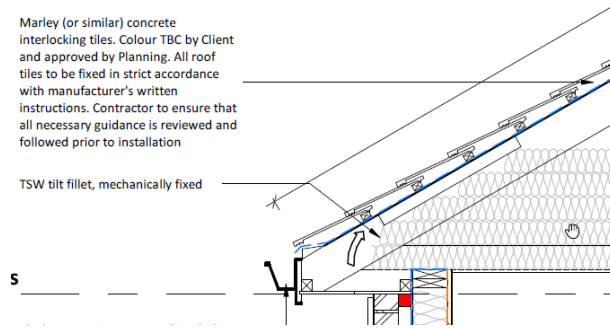


Figure 32
Build-up of the roof and ceiling

5.2.4.5 Calculation

Internal noise levels will be calculated for the closed window⁵ position to see if the internal thresholds can still be met. If not, improved building elements will be put forward so that the BS8233 internal noise levels can be met. Once done, these building elements will be used to calculate the open window position.

$$L_{eq,int} = L_{eq,ff} + 10 \log \left(\frac{A_0}{S} \cdot 10^{-\frac{D_{n,e}}{10}} + \frac{S_{wi}}{S} \cdot 10^{-\frac{R_{wi}}{10}} + \frac{S_{ew}}{S} \cdot 10^{-\frac{R_{ew}}{10}} + \frac{S_{rr}}{S} \cdot 10^{-\frac{R_{rr}}{10}} \right) + 10 \log \left(\frac{S}{A} \right) + 3 \quad (1)$$

where $L_{eq,int}$ = internal reverberant SPL, dB

$L_{eq,ff}$ = external open air (free field) sound pressure level (SPL), dB

A_0 = a reference absorption area of 10 m² and is independent of frequency

S_f = the total facade area in square metres of the room in question, m²

S_{wi} = area of the window(s), m²

S_{ew} = area of the exterior wall, m²

S_{rr} = area of the ceiling / roof, m²

S = the total area of elements, through which, noise enters the room, m²

$D_{n,e}$ = the insulation of the trickle ventilator measured according to BS EN ISO 10140

R_{wi} = the sound reduction index (octave band value) of the window

R_{ew} = the sound reduction index (octave band value) of the exterior wall

R_{rr} = sound reduction index of ceiling / roof.

A = is the equivalent absorption area of the receiving room being considered, m²

3 = correction for façade effect.

5.2.4.6 Closed window position

The internal noise levels were calculated using the Equation (1) above in order to see if the day and night time noise levels thresholds, with windows closed, could still be achieved.

The actually glazing installed is 4 / 18 / 6.8 – see Appendix for further details.

The calculations are shown below for both the night (bedroom) and daytime (lounge).

⁵ And open trickle ventilators, if used.



Glendene 150 Greenbrow Road		BS 8233 Break-in calc	Block B > Bedroom - Front (windows CLOSED)	Octave band centre frequency								Total level
Term	Value	Description	Details	63	125	250	500	1000	2000	4000		
$L_{eq,ff}$		External free field noise level	LAeq [dB] Night	39.4	40.3	38.7	46.6	54.2	48.7	43.0		
$D_{n,e}$		SRI of ventilator	TL98F fresh air vent	48.3	45.7	43.4	36.7	35.0	39.2	44.8		
R_{wi}	5.9 m ²	SRI glazing	4 (12) 6 Saint Gobain	23.0	27.0	23.0	27.0	39.0	40.0	41.0		
R_{ew}	19.3 m ²	SRI of external wall	Wall: 1 x 15 mm mm Plasterboard + Timber stud + 140 mm Fibreglass	46.0	53.3	62.2	81.0	95.1	112.0	126.2		
R_{tr}	11.9 m ²	SRI of roof / ceiling	Tiles on felt, pitched roof with 100 mm mineral wool on plasterboard ceiling	22.0	28.0	34.0	40.0	45.0	49.0	53.0		
SRI_{tot}		Total SRI of façade	Log sum	-25.5	-30.8	-30.3	-33.9	-39.4	-42.8	-46.4		
S	37.1 m ²	10*log10(S/A)	Absorption values (A) taken from BS8233 Table G.1	6.7	5.3	4.2	3.7	3.7	3.9	3.9		
	3 dB	Façade effect	yes	3.0	3.0	3.0	3.0	3.0	3.0	3.0		
		A weighting	no	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
$L_{Amax, int}$		Internal reverberant level		24	18	16	19	21	13	4	27.6	dB

Figure 33

Detailed BS8233 calculation for internal bedroom noise levels on front elevation with windows closed

Glendene 150 Greenbrow Road		BS 8233 Break-in calc	Lounge - Front (windows CLOSED)	Octave band centre frequency								Total level
Term	Value	Description	Details	63	125	250	500	1000	2000	4000		
$L_{eq,ff}$		External free field noise level	Daytime w/ dist corr	75.6	68.9	59.9	54.5	57.8	54.8	48.4		
$D_{n,e}$		SRI of ventilator	TL98F fresh air vent	48.3	45.7	43.4	36.7	35.0	39.2	44.8		
R_{wi}	9.0 m ²	SRI glazing	4 (6) 6.4 Saint Gobain	22.3	25.8	25.6	27.0	35.5	42.0	44.2		
R_{ew}	25.6 m ²	SRI of external wall	Wall: 1 x 15 mm mm Plasterboard + Timber stud + 140 mm Fibreglass	46.0	53.3	62.2	81.0	95.1	112.0	126.2		
R_{tr}	0.0 m ²	SRI of roof / ceiling	Tiles on felt, pitched roof with 100 mm mineral wool on plasterboard ceiling	22.0	28.0	34.0	40.0	45.0	49.0	53.0		
SRI_{tot}		Total SRI of façade	Log sum	-28.1	-31.6	-31.4	-32.4	-37.9	-42.9	-47.1		
S	34.6 m ²	10*log10(S/A)	Absorption values (A) taken from BS8233 Table G.1	6.4	5.0	3.9	3.3	3.3	3.6	3.6		
	-3 dB	Façade effect	yes	3.0	3.0	3.0	3.0	3.0	3.0	3.0		
		A weighting	yes	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0		
$L_{Aeq, int}$		Internal reverberant level		31	29	27	25	26	20	9	35.2	dB

Figure 34

Detailed BS8233 calculation for internal lounge noise levels on front elevation with windows closed

The detailed calculations show that the internal noise levels are still met with windows closed but fresh air vents open.

5.2.4.7 Open window position - Overheating

With the upgrade to the building elements, noise ingress was calculated for the open window position, again for the lounge and bedroom.

Glendene 150 Greenbrow Road		BS 8233 Break-in calc	Bedroom - Front (windows OPEN)	Octave band centre frequency								Total level
Term	Value	Description	Details	63	125	250	500	1000	2000	4000		
$L_{eq,ff}$		External free field unweighted noise	LAeq [dB] Night	39.4	40.3	38.7	46.6	54.2	48.7	43.0		56.3
$D_{n,e}$		SRI of ventilator	TL98F fresh air vent	48.3	45.7	43.4	36.7	35.0	39.2	44.8		
R_{wi}	5.9 m ²	SRI glazing	200k (mm2) open	20.0	14.0	14.0	16.0	14.0	17.0	19.0		
R_{ew}	19.3 m ²	SRI of external wall	Wall: 1 x 15 mm mm Plasterboard + Timber stud + 140 mm Fibreglass	46.0	53.3	62.2	81.0	95.1	112.0	126.2		
R_{tr}	11.9 m ²	SRI of roof / ceiling	Tiles on felt, pitched roof with 100 mm mineral wool on plasterboard ceiling	22.0	28.0	34.0	40.0	45.0	49.0	53.0		
SRI_{tot}		Total SRI of façade	Log sum	-24.4	-21.6	-21.9	-23.9	-21.9	-24.9	-27.0		
S	37.1 m ²	10*log10(S/A)	Absorption values (A) taken from BS8233 Table G.1	6.7	5.3	4.2	3.7	3.7	3.9	3.9		
	-3 dB	Façade effect	yes	3.0	3.0	3.0	3.0	3.0	3.0	3.0		
		A weighting	no	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
$L_{Aeq, int}$		Internal reverberant level		25	27	24	29	39	31	23	40.5	dB

Figure 35

Detailed BS8233 calculation for internal bedroom noise levels on front elevation with windows OPEN



Glendene 150 Greenbrow Road		BS 8233 Break-in calc	Lounge - Front (windows OPEN)	Octave band centre frequency								Total level
Term	Value	Description	Details	63	125	250	500	1000	2000	4000		
$L_{eq,ff}$		External free field unweighted noise	Daytime w/ dist corr	75.6	68.9	59.9	54.5	57.8	54.8	48.4		76.7
$D_{n,e}$		SRI of ventilator	Sound attenuated trickle ventilator (BS 8233 Table G.1)	37.0	37.0	36.0	35.0	36.0	34.0	34.0		
R_{wi}	9.0 m ²	SRI glazing	200k (mm2) opem	20.0	14.0	14.0	16.0	14.0	17.0	19.0		
R_{ew}	25.6 m ²	SRI of external wall	Wall: 1 x 15 mm mm Plasterboard + Timber stud + 140 mm Fibreglass	46.0	53.3	62.2	81.0	95.1	112.0	126.2		
R_{tr}	0.0 m ²	SRI of roof / ceiling	Tiles on felt, pitched roof with 100 mm mineral wool on plasterboard ceiling	22.0	28.0	34.0	40.0	45.0	49.0	53.0		
SRI_{tot}		Total SRI of façade	Log sum	-25.7	-19.8	-19.8	-21.8	-19.8	-22.8	-24.7		
S	34.6 m ²	10*log10(S/A)	Absorption values (A) taken from BS8233 Table G.1	6.4	5.0	3.9	3.3	3.3	3.6	3.6		
	-3 dB	Façade effect	yes	3.0	3.0	3.0	3.0	3.0	3.0	3.0		
		A weighting	yes	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0		
$L_{Aeq, int}$		Internal reverberant level		33	41	38	36	44	40	31	48.0	dB

Figure 36

Detailed BS8233 calculation for internal lounge noise levels on front elevation with windows OPEN

The calculation was repeated for the maximum level noise event during the night.

Glendene 150 Greenbrow Road		BS 8233 Break-in calc	Bedroom - Front (windows OPEN)	Octave band centre frequency								Total level
Term	Value	Description	Details	63	125	250	500	1000	2000	4000		
$L_{eq,ff}$		External free field unweighted noise	LZfmax [dB] NIGHT	67.0	66.5	70.5	71.1	77.2	73.4	57.3		80.4
$D_{n,e}$		SRI of ventilator	TL98F fresh air vent	48.3	45.7	43.4	36.7	35.0	39.2	44.8		
R_{wi}	5.9 m ²	SRI glazing	200k (mm2) opem	20.0	14.0	14.0	16.0	14.0	17.0	19.0		
R_{ew}	19.3 m ²	SRI of external wall	Wall: 1 x 15 mm mm Plasterboard + Timber stud + 140 mm Fibreglass	46.0	53.3	62.2	81.0	95.1	112.0	126.2		
R_{tr}	11.9 m ²	SRI of roof / ceiling	Tiles on felt, pitched roof with 100 mm mineral wool on plasterboard ceiling	22.0	28.0	34.0	40.0	45.0	49.0	53.0		
SRI_{tot}		Total SRI of façade	Log sum	-24.4	-21.6	-21.9	-23.9	-21.9	-24.9	-27.0		
S	37.1 m ²	10*log10(S/A)	Absorption values (A) taken from BS8233 Table G.1	6.7	5.3	4.2	3.7	3.7	3.9	3.9		
	-3 dB	Façade effect	yes	3.0	3.0	3.0	3.0	3.0	3.0	3.0		
		A weighting	yes	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0		
$L_{Aeq, int}$		Internal reverberant level		26	37	47	51	62	57	38	63.4	dB

Table 4

Detailed calculation of internal noise level due to maximum noise event

5.2.4.8 Internal Ambient Noise Levels from Mechanical Services

Table 3-4 of the AVO Guide gives desirable internal noise levels due to mechanical services.

Table 3-4 Indoor ambient noise levels from mechanical services - ADF ventilation condition

Ventilation condition	Possible system or design solution	Desirable internal ambient noise levels from mechanical services
ADF – Whole Dwelling Ventilation	System 3: Continuous mechanical extract (MEV), minimum low ventilation rates System 4: Continuous mechanical supply and extract with heat recovery (MVHR), minimum low ventilation rates	Bedrooms $\leq L_{Aeq}$ 26 or 30 dB (Note 1) Living Rooms $\leq L_{Aeq}$ 30 dB
ADF – Extract Ventilation	System 1: Intermittent extract fans System 3: Continuous mechanical extract (MEV), minimum high ventilation rates System 4: Continuous mechanical supply and extract with heat recovery (MVHR), minimum high ventilation rates	Bedrooms $\leq L_{Aeq}$ 26 or 30 dB Living / Dining Rooms $\leq L_{Aeq}$ 35 dB Bathroom / WC / Kitchen $\leq L_{Aeq}$ 45 dB
ADF – Purge Ventilation	Manually controlled fan exchanging a minimum 4 air changes per hour	No desirable noise levels are currently proposed based on the lack of evidence of acceptable noise levels when providing purge ventilation for the purpose of rapidly diluting indoor pollutants.

Note 1 A lower level may be more appropriate;

Figure 37

Desirable internal noise levels due to mechanical services

For the plots with the ASHPs, the heating system is more like a conventional boiler type system with radiators and no internal mechanical services.



For all other plots with the internal Nibe F730 Exhaust air heat pumps, there will be no mechanical services noise in the habitable rooms, as the extract ducts are only in the wet rooms. The fresh air supply will be via the in-wall ventilators; these have been part of the façade break-in calculations in the last two sections.

5.3 AVO ASSESSMENT SUMMARY

The results for internal noise levels are summarised in the following table for the front and side elevations of exposed properties (see Figure 24). The internal noise levels are compared with those given in Table 3-3 in the AVO guide (see Figure 21 in this report).

5.3.1 Noise ingress

The internal noise levels, calculated using the detailed methodology in BS8233, have been collated and compared to the noise thresholds in Figure 21.

Block B Room (FRONT)	Window	Internal Levels recommended			Internal Levels measured / calc'd		
		$L_{Aeq, DAY}$ (dB)	$L_{Aeq, NIGHT}$ (dB)	$L_{Amax, NIGHT}$ (dB)	$L_{Aeq, DAY}$ (dB)	$L_{Aeq, NIGHT}$ (dB)	$L_{Amax, NIGHT}$ (dB)
Bedroom	Open	≤50	≤42	≤65	--	40	63
	Closed	≤35	≤30	≤45	--	28	45
Lounge	Open	≤50	≤42	≤65	48	--	--
	Closed	≤35	≤30	≤45	35	--	--

Table 5
Internal noise level summary – FRONT elevation

The internal noise levels are coloured coded as per Table 3-3 in AVO.

	Internal Levels recommended Overheating (windows open)			Examples of Outcomes
	$L_{Aeq, DAY}$ (dB)	$L_{Aeq, NIGHT}$ (dB)	$L_{Amax, NIGHT}$ (dB)	
Green	≤35	≤30	Not Normally exceeds 45 (x 10)	Noise can be heard, but does not cause any change in behaviour
Amber	>35 & ≤50	>30 & ≤42	≤45 & ≤65	Increasing likelihood of impact on reliable speech communication during the day or sleep disturbance at night
Red	>50	>42	Normally exceeds 65	Noise causes change in behaviour e.g. having to keep windows closed most of the time

Table 6
Summary of internal noise levels

The green levels are also the levels for closed windows.

Essentially 'red' internal noise levels should be avoided wherever possible.

The above Tables show the internal noise levels are within acceptable limits.

Therefore, it has been shown that it is acceptable to open windows for the overheating condition. Internal noise levels for both open and closed window adhere to the criteria in the AVO guide, pending the recommendations in this report.

5.4 BS 4142 ASSESSMENT – ETERNAL PLANT NOISE

There will be up 3 types of external plant associated with the site:

1. Air Source Heat Pump



2. Exhaust Heat Pump – exhaust duct
3. Exhaust Heat Pump – extract duct

For each of these noise sources, the resident of the house will not be considered as the Nearest Sensitive Receptor (NSR) as it is, effectively, ‘their noise’, and thus less sensitive to it. Therefore, the next nearest resident will be deemed the NSR.

5.4.1 Air Source Heat Pumps

The ASHPs will be located at the rear of the 4-bed properties.

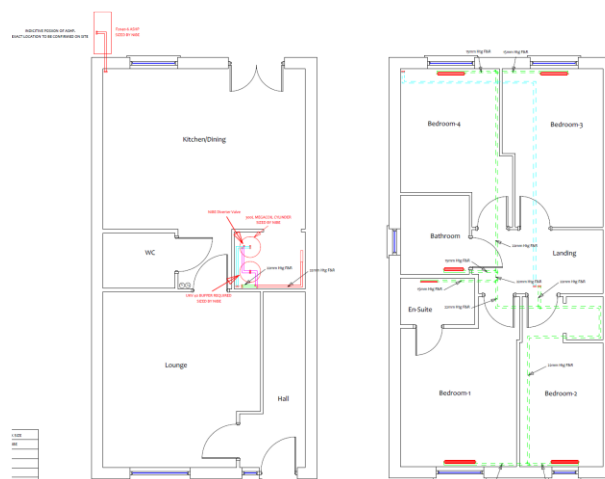


Figure 38
Block C showing ASHP at the rear

Noise levels from the ASHPs are shown below.

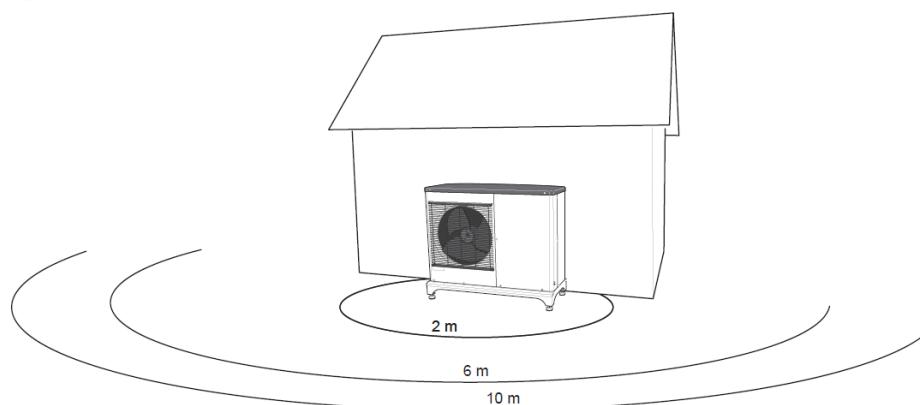
Sound pressure levels

F2040 is usually placed next to a house wall, which gives a directed sound distribution that should be considered. Accordingly, you should always attempt when positioning to choose the side that faces the least sound sens-

itive neighbouring area.

The sound pressure levels are further affected by walls, bricks, differences in ground level, etc and should therefore only be seen as guide values.

F2040 adjusts the fan speed depending on the ambient temperature and evaporation temperature.



Air/water heat pump		F2040-6	F2040-8	F2040-12	F2040-16
Sound power level* According to EN12102 at 7/45 (nominal)	$L_{w(A)}$	50	54	57	61
Sound pressure level at 2 m free standing.*	dB(A)	36	40	43	47
Sound pressure level at 6 m free standing.*	dB(A)	26.5	30.5	33.5	37.5
Sound pressure level at 10 m free standing.*	dB(A)	22	26	29	33

* Free space.

Figure 39
Noise levels from F2040 ASHP



The suffix '-8' for example, denoted capacity.

For the Glendene project the F2040-6 ASHP will be installed.

The distance from an ASHP to the nearest neighbouring habitable room is at least 4m.

The typical Background Noise Level at the rear, is 41 dB L_{A90} .

BS 4142 Noise Assessment (ASHP)	Value	dB
Noise level– F2040-6 dB L_{pA}	@ 2m	36
Directivity – 2 surfaces		+6
Distance	4m	-6
BS 4141		
Tonality	0/2/4/4	0
Impulsivity	0/3/6/9	0
Intermittency	0/3	3
Rating Noise Level		39
Background, L_{A90}		41
Rating minus Background		-2

Table 7
BS4142 assessment – ASHP

The Rating Level of the F2040-6 Air Source Heat Pump is 2 dB less than the typical Background Noise Level, and therefore within acceptable noise limits.

****Please note that F2040 has a silent operation function that allows scheduling when F2040 must operate at an even quieter noise level****

5.4.2 Exhaust Air Heat Pumps

The Exhaust Air Heat Pumps (EAHP), vent to atmosphere via extract and supply ducts, as shown in Figure 42.

The layout of Block A has been used as it has the shortest duct run and is therefore a worst-case scenario.

Duct calculations have been used with octave band noise data for the F730 EAHP.

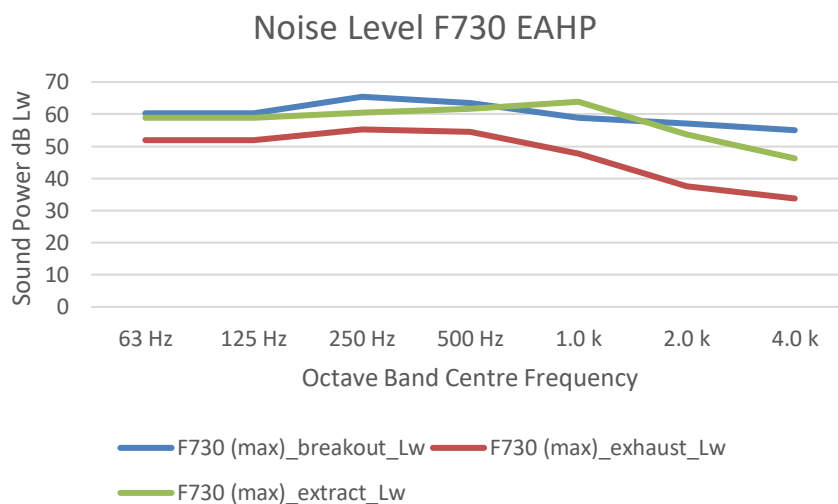


Figure 40
Noise Levels of F730 EAHP



The fresh air intake is supplied to the exhaust, therefore, noise emissions from the intake duct uses the exhaust noise levels in the previous figure.

The extract duct expels the unwanted air to atmosphere.

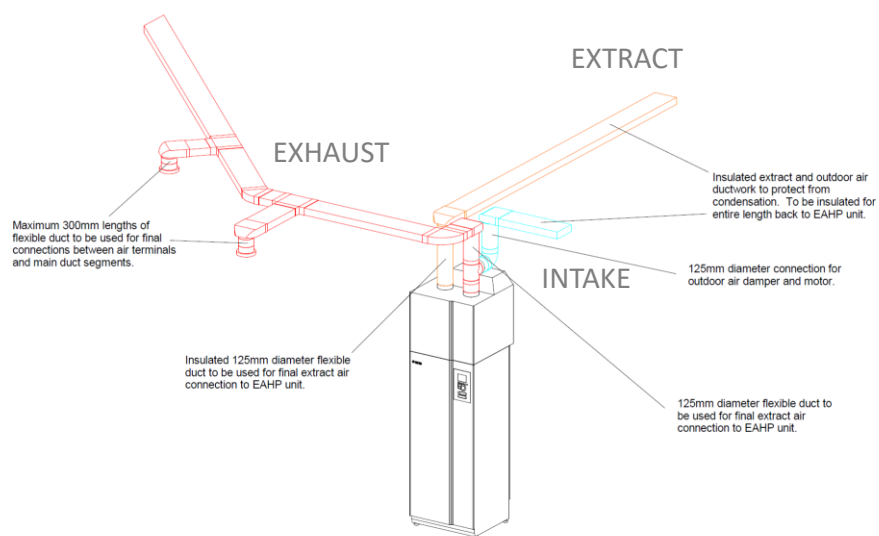


Figure 41
F730 typical layout

The layout for Block A is shown in Figure 42 below.

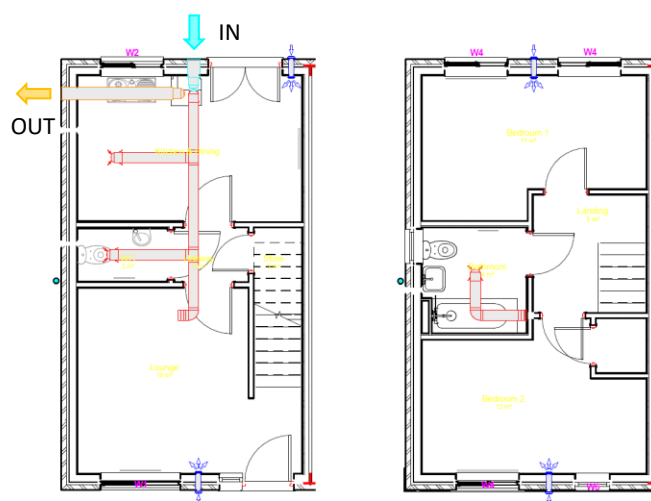


Figure 42
Exhaust Air Heat Pump duct layout – Block A

The distance from the exhaust and supply grilles to nearby neighbouring habitable windows are shown below.



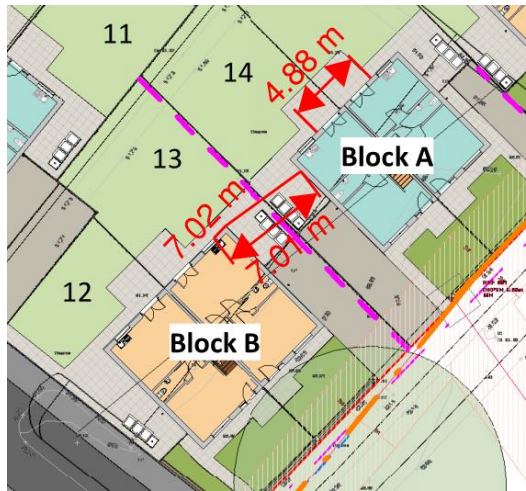


Figure 43
Distances from EAHP grilles to nearby habitable windows

5.4.2.1 Exhaust

The calculation for the Specific Noise Level, at the nearest neighbouring habitable room is shown in Figure 45.

The subsequent BS 4142 assessment is then shown in Table 9.

Block A, Glendene		Duct Calculation	EAHP EXTRACT	Octave band centre frequency							Total level
Item	Quantity	Description	Details	63	125	250	500	1000	2000	4000	
		Sound Pressure Level @ Xm	SWL data used	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		Sound Power Level of unit	F730 (max)_extract_Lw	58.8	58.8	60.5	61.8	63.9	53.8	46.2	68.4
		A weighting	yes	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	
		PLENUM Insetion Loss	no								
	2.44 m	Duct Length in metres	Rectangular 150 x 150	-1.6	-1.6	-1.2	-0.9	-0.9	-0.9	-0.9	
	0	Number of bends	500mm round bend	0	0	0	0	0	0	0	
	0 mm	Branch area	10log(branch mm2/duct mm2)	0	0	0	0	0	0	0	
		Silencer attenuation (1)	no silencer or n/a	0	0	0	0	0	0	0	
		Silencer attenuation (2)	no silencer or n/a	0	0	0	0	0	0	0	
		Att due to end reflection	250 mm end reflection	-12	-8	-4	-1	0	0	0	
		Louvre attenuation	no acoustic louvre or n/a	0	0	0	0	0	0	0	
		Sound power at termination		19.0	33.1	46.7	56.7	63.0	54.1	46.4	64.5
		Directivity	0.05m2 @ 100° - 1 surface	3	2	2	-1	-4	-13	-13	
	7 m	Distance Attenuation	20*log10(r)	-16.90	-16.90	-16.90	-16.90	-16.90	-16.90	-16.90	
		Air absorption	15°C; 80% humidity	0.00	0.00	-0.01	-0.02	-0.03	-0.06	-0.17	
		Numerical correction	SPL = SWL - 20log(r) + DI - 11	-11.00	-11.00	-11.00	-11.00	-11.00	-11.00	-11.00	
	0.1	Barrier	yes	-5.7	-6.5	-7.7	-9.5	-11.7	-14.2	-16.9	
		SPL(A) at NSR	$L_{pA,NSR}$	0.0	0.8	13.1	18.3	19.4	0.0	0.0	22.6 dB

Figure 44
Duct calculation for EAHP Extract

The Specific Noise Level of 23 dB is then the basis of the BS 4142 assessment, as before.



BS 4142 Noise Assessment (EAHP – Supply)		Value	dB
Noise level– @ NSR			23
BS 4141			
Tonality	0/2/4/4		0
Impulsivity	0/3/6/9		0
Intermittency	0/3		3
Rating Noise Level			26
Background, LA90			41
Rating minus Background			-15

Table 8
BS4142 assessment – EAHP Supply

The Rating Level of the EAHP – Extract grille is 15 dB less than the typical Background Noise Level and therefore within acceptable noise limits.

5.4.2.2 Supply

The calculation for the Specific Noise Level, at the nearest neighbouring habitable room is shown in Figure 45.

The subsequent BS 4142 assessment is then shown in Table 9.

Block A, Glendene		Duct Calculation	EAHP SUPPLY (via exhaust)	Octave band centre frequency							Total level
Item	Quantity	Description	Details	63	125	250	500	1000	2000	4000	
		Sound Pressure Level @ Xm	SWL data used	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		Sound Power Level of unit	F730 (max)_exhaust_Lw	51.9	51.9	55.2	54.4	47.7	37.6	33.7	59.9
		A weighting	yes	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	
		PLENUM Insetion Loss	no								
	1 m	Duct Length in metres	Rectangular 150 x 150	-0.7	-0.7	-0.5	-0.4	-0.4	-0.4	-0.4	
	0	Number of bends	500mm round bend	0	0	0	0	0	0	0	
	0 mm	Branch area	10log(branch mm2/duct mm2)	0	0	0	0	0	0	0	
		Silencer attenuation (1)	no silencer or n/a	0	0	0	0	0	0	0	
		Silencer attenuation (2)	no silencer or n/a	0	0	0	0	0	0	0	
		Att due to end reflection	250 mm end reflection	-12	-8	-4	-1	0	0	0	
		Louvre attenuation	no acoustic louvre or n/a	0	0	0	0	0	0	0	
		Sound power at termination		13.0	27.1	42.1	49.9	47.3	38.5	34.4	52.5
		Directivity	0.05m2 @ 80° - 1 surface	3	2	1	-1	-1	-4	-4	
	5 m	Distance Attenuation	20*log10(r)	-13.98	-13.98	-13.98	-13.98	-13.98	-13.98	-13.98	
		Air absorption	15°C; 80% humidity	0.00	0.00	-0.01	-0.01	-0.02	-0.04	-0.12	
		Numerical correction	SPL = SWL - 20log(r) + DI - 11	-11.00	-11.00	-11.00	-11.00	-11.00	-11.00	-11.00	
	6	Barrier	no	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		SPL(A) at NSR	L _{pA,NSR}	0.0	4.1	18.2	23.9	21.3	9.4	5.3	26.6 dB

Figure 45
Duct calculation for EAHP Supply

The Specific Noise Level of 27 dB is then the basis of the BS 4142 assessment, as with the ASHP.



BS 4142 Noise Assessment (EAHP – Supply)		Value	dB
Noise level– @ NSR			27
BS 4141			
Tonality	0/2/4/4		0
Impulsivity	0/3/6/9		0
Intermittency	0/3		3
Rating Noise Level			30
Background, LA90			41
Rating minus Background			-11

Table 9
BS4142 assessment – EAHP Supply

The Rating Level of the EAHP – Supply grille is 11 dB less than the typical Background Noise Level and therefore within acceptable noise limits.

6 CONCLUSION

An Acoustics, Ventilation & Overheating assessment has taken place at the Glendene, 150 Greenbrow Rd, Wythenshawe to support a planning application for the erection of residential dwellings.

Plots with direct line of sight, and fronting, Greenbrow Road boundary require mitigation. All other elevations can achieve reasonable internal noise levels with standard double glazing, even with open windows.

In addition to the original report, a more thorough assessment has been undertaken to account for ventilation and rapid cooling due to overheating as per the Acoustic, Ventilation & Overheating guide 2020.

From the assessment the following mitigation measures are recommended:

- standard double glazing to the rear.
- 6 / 6 to 20 mm / 4 or equivalent glazing to the front and side elevations (as defined in Figure 24).

Plots adjacent to the nursery's play area should be bungalows with the following boundary treatment:

- 2.1m high close boarded fence with a surface density of 10kg/m².

All the mechanical services, such as Air Source Heat Pumps and Exchange Air Heat Pumps, have been assessed according to BS 4142 and it has been shown that noise levels are within acceptable limits.

7 REFERENCES

- [1] BS8233: 2014
Sound Insulation and noise reduction for buildings – Code of Practice,
British Standards Institute, 2014.



Appendix

A1 GLAZING TYPES FROM BS 12354-2

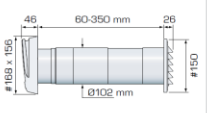
Table B.1 - Examples of the sound reduction index of glazing

Glazing type	Sound reduction index (dB)						
	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	R_w (C; C _{tr}) dB
Single panes (mm)							
3	14	19	25	29	33	25	28 (-1; -4)
4	17	20	26	32	33	26	29 (-2; -3)
5	19	22	29	33	29	31	30 (-1; -2)
6	18	23	30	35	27	32	31 (-2; -3)
8	20	24	29	34	29	37	32 (-2; -3)
10	23	26	32	31	32	39	33 (-2; -3)
12	27	29	31	32	38	47	34 (0; -2)
Laminated panes (mm) + plastic laminate (0,5 to 1) mm							
6+	20	23	29	34	32	38	32 (-1; -3)
8+	20	25	32	35	34	42	33 (-1; -3)
10+	24	26	33	33	35	44	34 (-1; -3)
Double pane units with single or laminated panes (mm); air filled cavity from (6 to 16) mm							
4-(6-16)-4	21	17	25	35	37	31	29 (-1; -4)
6-(6-16)-4	21	20	26	38	37	39	32 (-2; -4)
6-(6-16)-6	20	18	28	38	34	38	31 (-1; -4)
8-(6-16)-4	22	21	28	38	40	47	33 (-1; -4)
8-(6-16)-6	20	21	33	40	36	48	35 (-2; -6)
10-(6-16)-4	24	21	32	37	42	43	35 (-2; -5)
10-(6-16)-6	24	24	32	37	37	44	35 (-1; -3)
6-(6-16)-6+	20	19	30	39	37	46	33 (-2; -5)
6-(6-16)-10+	24	25	33	39	40	49	37 (-1; -5)
NOTE 1 This selection and the values are in accordance with prEN 12758-1. The single number ratings are deduced from results in 1/3-octave bands and therefore single number ratings deduced from the given octave band data might result in values which differ 1 dB at the most.							
NOTE 2 Though it is known that for a given double pane unit the sound reduction increases with increasing cavity width, this effect has been found to be too small to take into account here for air filled cavities in the light of the inherent spread in results for nominally identical units.							

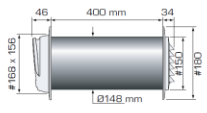


A2 FRESH AIR VENTS

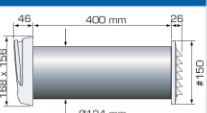
Standard

TL98F			
			
Art no	Max airflow	Hole opening	Sound reduction
629840	10 Pa; 8,1 l/s	Ø105mm	300 mm; 32 dB

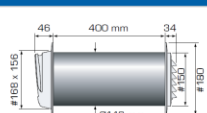
Acoustic vent

TL98F-dB			
			
Art no	Max airflow	Hole opening	Sound reduction
639840	10 Pa; 8,1 l/s	Ø150mm	300 mm; 46 dB

Acoustic vent

TL80F-dBS			
			
Art no	Max airflow	Hole opening	Sound reduction
638050	10 Pa; 7,8 l/s	Ø125mm	300 mm; 46 dB

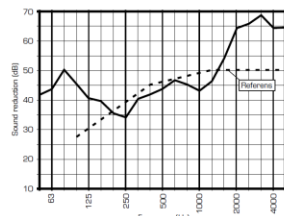
Acoustic vent

TL80F-dB			
			
Art no	Max airflow	Hole opening	Sound reduction
638040	10 Pa; 7,8 l/s	Ø150mm	300 mm; 49 dB

Sound data

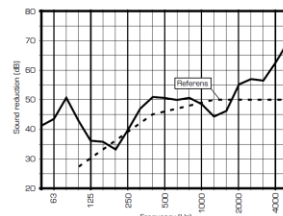
The diagrams show sound reduction with fully open vent and 300mm wall.
The test has been made according to ISO 140-10.
Normalized level diff. for building section, calculating on 10 m².

TL80F-dBS



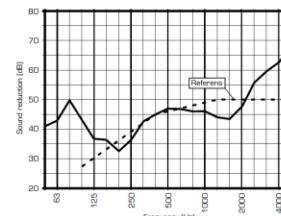
D n,e,w 46 dB
(C:Ctr) (0;-3) Sum Dev. 25,6
(C:Ctr) (1;-3) Max Dev. 5,8
50-5000 Frequency 1000

TL80F-dB



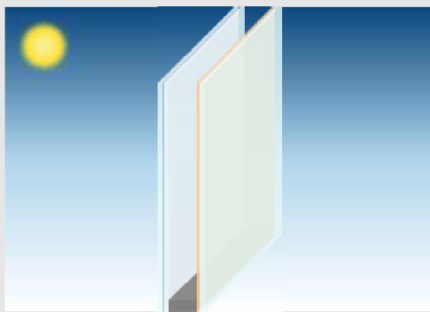
D n,e,w 49 dB
(C:Ctr) (-2;-5) Sum Dev. 27,9
(C:Ctr) (-1;-5) Max Dev. 8,8
50-5000 Frequency 1250

TL98F-dB



D n,e,w 46 dB
(C:Ctr) (-1;-3) Sum Dev. 27,9
(C:Ctr) (0;-3) Max Dev. 6,9
50-5000 Frequency 1600





Pane 1	PLANICLEAR (3 mm) PVB standard (2 x 0.38 mm) PLANICLEAR (3 mm)
Cavity 1	ARGON (90%) / AIR (10%) / 18 mm
Pane 2	PLANITHERM TOTAL+ FG PLANICLEAR (4 mm)

Oakland Glass Ltd

Helen Pickles

helen@oaklandglass.net

	LUMINOUS FACTORS	CIE (15-2004)
	Light transmission (TL %)	78.4 %
	Outdoor reflection (RLe %)	12.9 %
	Indoor (RLi %)	13.0 %

	SOLAR FACTORS	EN410 (2011-04)
	Solar factor (g)	0.6559
	Shading Coefficient (SC)	0.7539

	COLOR RENDERING	CIE (15-2004)
	Transmission (Ra)	98.6
	Reflection (Ra)	89.9

	BURGLAR RESIST	EN356
	Result :	P1A/NPD

	CARBON FOOTPRINT	EN15804 [A2]
	Global warming potential 'GWP' 48 Kg(CO2)/m² (A1-A3)	

	ENERGY FACTORS	EN410 (2011-04)
	Transmission (Te)	57.4 %
	Reflection (Ree)	17.4 %
	Indoor (Rei)	21.1 %
	Absorption (AE1)	16.5 %
	Absorption (AE2)	8.8 %

	THERMAL TRANSMISSION	EN673 (2011-04)
	Ug	1.197 W/m².K
	0° related to vertical position	

	MANUFACTURING SIZES	
	Nominal thickness	28.8 mm
	Weight	25.8 kg/m²

	PENDULUM RESISTANCE	EN12600
	Result :	1B1/NPD

	ACOUSTICS	EN12758
	Acoustic simulated values - V2.0	Rw(C,Ctr) = 37(-2;-6) dB
	OITC (ASTM E1332)	29
	STC (ASTM E413)	37



Calumen III calculates the photometric characteristics and thermal transmission of glass using calculation algorithms which comply with the following standards: the European standards EN 410 and EN 673, the international standard ISO9050, the Japanese standard JIS R 3106/3107 and the Korean standard KS L 2514/2525. The functional output and calculation rules of Calumen for standards EN 410 and EN 673 have been validated by TDV Rheinland (report 89212133401). The technical performances obtained according to these standards are provided for information only and are subject to amendment. Only the values entered in the performance declarations available on the CE marking site of Saint-Gobain Glass are official. The sound attenuation indices are measured under laboratory conditions according to the standards EN ISO 10140 and EN 12758. The calculated indices are provided for information only. The accuracy for Rw index lies within a range of +/-2dB. The glass thickness calculations comply with the 2012 version of the DTU39-P4 description. The USER is responsible for ensuring that the correct calculation hypotheses are entered and the DTU39 is applied appropriately for the project concerned.

