

# Noise impact assessment

YA407.P1

Full planning application for the demolition of existing building and construction of three residential dwellings (Use Class C3), with access, landscaping and associated infrastructure

The Former Grove Public House  
1515 Ashton Old Road  
Manchester M11 1GR

Manchester, UK

Version 1.0

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## Identification

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*Prepared by:* Luis Pereira

*Prepared for:* KMM Homes

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# Acronyms

**ADF** Approved Document F. [8](#), [9](#), [13](#), [23](#), [25](#)

**ADO** Approved Document O. [8](#), [14](#)

**AVO** Acoustics Ventilation And Overheating. [8](#), [10](#), [13](#), [14](#), [22](#), [24](#), [25](#), [26](#)

**CRTN** Calculation of Road Traffic Noise. [16](#)

**DEFRA** Department for Environment, Food and Rural Affairs. [13](#)

**IANLs** Internal Ambient Noise Levels. [8](#), [9](#), [12](#), [13](#), [22](#), [23](#), [24](#), [27](#)

**LOAEL** Lowest Observed Adverse Effect Level. [12](#), [13](#)

**NPPF** National Planning Policy Framework. [10](#), [12](#), [27](#)

**NPSE** Noise Policy Statement for England. [10](#), [12](#), [27](#)

**ProPG** Professional Practice Guidance on Planning & Noise. [8](#), [12](#), [13](#)

**SLM** Sound Level Meter. [17](#)

**SOAEL** Significant Observed Adverse Effect Level. [13](#), [14](#), [24](#)

**SWL** Sound Power Level. [20](#)

**VOCs** Volatile Organic Compounds. [8](#), [9](#), [23](#), [24](#)

# Glossary

**$C_{tr}$**  correction term applied against the sound insulation single-number values ( $R_w$ ,  $D_w$ , and  $D_{nT,w}$ ) to provide a weighting against low frequency performance. [8](#), [9](#), [23](#)

**$D_{ne,w}$  element normalized level difference of small building elements** - difference of the sound pressure level produced in two rooms by a source in one room, where sound transmission is only due to a small technical element (e.g. transfer air devices, electrical cable ducts, transit sealing systems). [8](#), [9](#), [23](#)

**$L_{A10}$  A-weighted sound pressure level exceeded for 10% of the measurement period** - A-weighted sound pressure level obtained using time-weighting “F”, that is exceeded for 10% of the time interval considered. [17](#), [18](#)

**$L_{A10,18hr}$  A-weighted sound pressure level exceeded for 10% of the measurement period** - A-weighted sound pressure level obtained using time-weighting “F”, that is exceeded for 10% of the period 06:00-24:00 hours. [17](#), [18](#)

**$L_{A10,3hr}$  A-weighted sound pressure level exceeded for 10% of the measurement period** - A-weighted sound pressure level obtained using time-weighting “F”, that is exceeded for 10% of a 3 hours period. [17](#), [18](#)

**$L_{Aeq}$  equivalent A-weighted sound pressure level** - value of the A-weighted sound pressure level in decibels (dB) of a steady sound that has the same mean-squared sound pressure as the sound under consideration that varies with time. [10](#), [12](#), [15](#), [17](#), [26](#)

**$L_{Aeq,16hr}$  equivalent A-weighted continuous sound pressure level** - value of the A-weighted sound pressure level in decibels (dB) of a continuous, steady sound that, within the period 07:00-23:00 hours has the same mean-squared sound pressure as the sound under consideration that varies with time. [12](#), [13](#), [17](#), [18](#), [21](#)

**$L_{Aeq,8hr}$  equivalent A-weighted continuous sound pressure level** - value of the A-weighted sound pressure level in decibels (dB) of a continuous, steady sound that, within the period 23:00-07:00 hours has the same mean-squared sound pressure as the sound under consideration that varies with time. [12](#), [17](#), [18](#), [21](#)

**$L_{Aeq,T}$  equivalent A-weighted continuous sound pressure level** - value of the A-weighted sound pressure level in decibels (dB) of a continuous, steady sound that, within a specified time interval, T, has the same mean-squared sound pressure as the sound under consideration that varies with time. 9, 12, 13, 25

**$L_{AFmax}$  maximum A-weighted sound pressure level** - value of the maximum A-weighted sound pressure level obtained using time-weighting “F”, during a specified time interval. 8, 9, 12, 13, 14, 15, 17, 18, 19, 23, 24

**$R_w$  weighted sound reduction index** - single-number quantity which characterizes the airborne sound insulating properties of a material or building element over a range of frequencies. 8, 9, 23

**RT reverberation time** - time that would be required for the sound pressure level to decrease by 60 dB after the sound source has stopped. 22

# Summary

YAcoustics Ltd has been commissioned to provide specialist advice in respect of a new residential development at 1515 Ashton Old Road, Manchester.

The criteria and guidelines set out in [Professional Practice Guidance on Planning & Noise \(ProPG\)](#) [11], the [Acoustics Ventilation And Overheating \(AVO\)](#) guide [14] and [Approved Document O \(ADO\)](#) [14] have been considered.

Noise affecting the proposed development has been measured during the day and night to determine noise impacts.

The primary noise sources affecting the site during both the day and night-time periods is the road traffic on Ashton Old Road (A635).

With windows open, the resulting internal ambient noise levels in the relevant internal areas of the development have the potential to cause significant adverse effects. As such, the recommended facade solutions are considered with windows closed, requiring that provisions for background ventilation and control overheating are made.

## South facing Facades

Regarding south facing facades, calculations indicate that **kitchens** require glazing with a performance of 32 dB  $R_w+C_{tr}$  (e.g. 10 mm glass/16 mm cavity/6 mm glass) and that [Approved Document F \(ADF\)](#) System 1 may be employed with a maximum of 2 trickle ventilators with a performance of 40  $D_{ne,w}+C_{tr}$ .

**Bedrooms** require glazing and a spandrel panel with a performance of 33 dB  $R_w+C_{tr}$  (e.g. 6 mm glass/16 mm cavity/6.8 mm laminated glass), and [ADF](#) System 1 may be employed with a maximum of 2 trickle ventilators with a performance of 42  $D_{ne,w}+C_{tr}$ .

The anticipated [Internal Ambient Noise Levels \(IANLs\)](#) with a partially open window (13 dB attenuation) would be 57 dBA during the day and 48 dBA at night, with overheating design case  $L_{AFmax}$  levels up to 78 dB, and as such opening windows **is not** considered to be a suitable solution for mitigating overheating.

Mechanical cooling is required within **bedrooms** to manage thermal comfort in conjunction with the ventilation system, in which case windows are still openable for rapid dilution of smells, water vapour and **VOCs**.

## North facing Facades

As for north facing facades, calculations indicate that all spaces (i.e. living rooms and bedrooms) require glazing with a performance of 25 dB  $R_w+C_{tr}$  (e.g. 4/16/4 mm) and that ADF System 1 may be employed with a maximum of 2 trickle ventilators with a performance of 34  $D_{ne,w}+C_{tr}$ .

The Overheating Risk – Early Stage Tool indicates a low risk of overheating for north-facing facades.

The anticipated IANLs with a partially open window (13 dB attenuation) to control overheating would be 44 dBA during the day and 35 dBA at night, with overheating design case  $L_{AFmax}$  levels up to 63 dB, and as such opening windows is considered to be a suitable solution for mitigating overheating.

If preferred, mechanical cooling can be used instead to manage thermal comfort in conjunction with the ventilation system, in which case windows are still openable for rapid dilution of smells, water vapour and VOCs.

## Further recommendations

The solutions mentioned above do not constitute a ventilation strategy design, which is the responsibility of the mechanical engineer and as such other ADF Systems may be employed if required, in which case the proposed details should be reassessed for acoustic performance.

If mechanical ventilation systems are preferred for whole-dwelling ventilation, ADF refers that the average A-weighted sound pressure level for a ventilator operating under normal conditions and not at boost rates should not exceed both of the following:

- a) 30dB  $L_{Aeq,T}$  for noise-sensitive rooms (e.g. bedrooms and living rooms) when a continuous mechanical ventilation system is running on its minimum low rate;
- b) 45dB  $L_{Aeq,T}$  in less noise-sensitive rooms (e.g. kitchens and bathrooms) when a continuous operation system is running at the minimum high rate or an intermittent operation system is running.

Regarding overheating, the mentioned solutions are considered standard mitigation measures in controlling overheating but must be assessed by the mechanical engineer.

It is recommended that a detailed overheating assessment (e.g. dynamic modelling against CIBSE TM59 [10]) is carried out to determine possible alternative overheating mitigation solutions or to specify the capacity needed for each system.

The AVO guide recommends that mechanical noise to control overheating is limited to 30 dB  $L_{Aeq}$  for bedrooms and 35 dB  $L_{Aeq}$  for living or dining rooms. Such limits should be considered when selecting specific units.

Based on the implementation of the recommendations provided in this report, the development is considered to be suitable in line with the recommendations of the National Planning Policy Framework (NPPF) [12] and the Noise Policy Statement for England (NPSE) [5].

# 1 Introduction

A development consisting of three residential dwellings (Use Class C3), with access, landscaping, and associated infrastructure, is proposed at 1515 Ashton Old Road, Manchester M11 1GR.

YAcoustics Ltd has been commissioned to prepare a noise impact assessment report for the proposed development.

Thus, the relevant acoustic requirements have been identified, and suitable design solutions and recommendations have been provided accordingly.

Figure 1 shows the site location.



Figure 1 – Development location (red line)

## 2 Planning policy and relevant criteria

### 2.1 ProPG guidance

The [ProPG](#) [11] sets out criteria and guidelines for noise management concerning new residential development.

The document provides noise level limits for internal and external amenity areas that are intrinsic to the overall design.

These limits are in line with what the [NPSE](#) [5] identifies as the [Lowest Observed Adverse Effect Level \(LOAEL\)](#) and as such it is considered that by meeting these targets the aims of the [NPPF](#) [12] and the [NPSE](#) [5] are achieved (see Annex A).

The relevant criteria is presented as Table 1.

Table 1 – Internal and external ambient noise levels for dwellings (sources: BS 8233:2014 and ProPG:2017)

| Activity                    | Location              | 07:00 to 23:00                   | 23:00 to 07:00                 |
|-----------------------------|-----------------------|----------------------------------|--------------------------------|
| Resting                     | Living room           | 35 dB $L_{Aeq,16hr}$             | -                              |
| Dinning                     | Dinning room/area     | 40 dB $L_{Aeq,16hr}$             | -                              |
| Sleeping (day-time resting) | Bedroom               | 35 dB $L_{Aeq,16hr}$             | 30 dB $L_{Aeq,8hr}$            |
|                             |                       |                                  | 45 <sup>1</sup> dB $L_{AFmax}$ |
| Leisure                     | Gardens and balconies | 50 – 55 <sup>2</sup> $L_{Aeq,T}$ |                                |

Note: The presented noise limits relate to steady external noise sources.

1: 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 45 dB  $L_{AFmax}$  more than 10 times a night.

2: External noise level should not exceed 50 dB  $L_{Aeq,T}$ , with an upper guideline value of 55 dB  $L_{Aeq,T}$  which would be acceptable in noisier environments.

Section 2.27 of the [ProPG](#) states the following: "Once internal  $L_{Aeq}$  levels exceed the target levels by more than 10 dB, they are highly likely to be regarded as *"unacceptable"* by most people, particularly if such levels occur more than occasionally. Every effort should be made to avoid relevant rooms experiencing *"unacceptable"* noise levels at all and where such levels are likely to occur frequently, the development should be prevented in its proposed form."

As such, [IANLs](#) more than 10 dB above the daytime and night-time values in Table 1 are

identified as the **Significant Observed Adverse Effect Level (SOAEL)**.

Appendix A of the **ProPG** states the following: "it can be concluded that at night (23:00 to 07:00 hrs), a significant effect on sleep disturbance, e.g. behavioural awakening, is likely to occur where the maximum sound level at the façade of a building **with partially open windows** is above:

- 85 dB  $L_{AFmax}$  (where the number of events exceeding this value is  $\leq 20$ ); or
- 80 dB  $L_{AFmax}$  (where the number of events exceeding this value is  $> 20$ )."

Therefore, the above  $L_{AFmax}$  values and number of events are identified as the **SOAEL** where windows are partially open.

Regarding external amenity areas, the 50-55 dB  $L_{Aeq,T}$  limit identified in BS 8233 [7] is considered to be the **LOAEL** and the 66 dB  $L_{Aeq,16hr}$  limit identified in the **Department for Environment, Food and Rural Affairs (DEFRA)** [8] guidance is considered to be the **SOAEL**.

## 2.2 AVO guidance

Section 2.4 of **ProPG** refers to the importance of providing a thermal comfort/cooling strategy to reduce potential impacts of noise on future occupants of new residential development.

The **AVO** guide [14] is intended to demonstrate good acoustics design as described in the **ProPG**, when considering **IANLs** guidelines.

The document suggests that the desirable **IANLs** as shown in Table 1 should be achieved when providing adequate ventilation as defined by **ADF** [6] whole dwelling ventilation.

However, it considers reasonable to allow higher levels of **IANLs** from transport sources when higher rates of ventilation are required in relation to the **overheating condition**.

Qualitative guidance on the combined effect of **IANLs** and duration for the overheating situation is provided in the document.

For the purpose of this assessment, the limits for **IANLs** during the overheating condition, as shown in Figures 2 and 3, have been considered. The **LOAEL** remains the same as identified in Table 1, and the **SOAEL** varies depending on the duration for which the overheating condition occurs.

For night-time periods, the  $L_{AFmax}$  value of 65 dB is identified as the SOAEL.

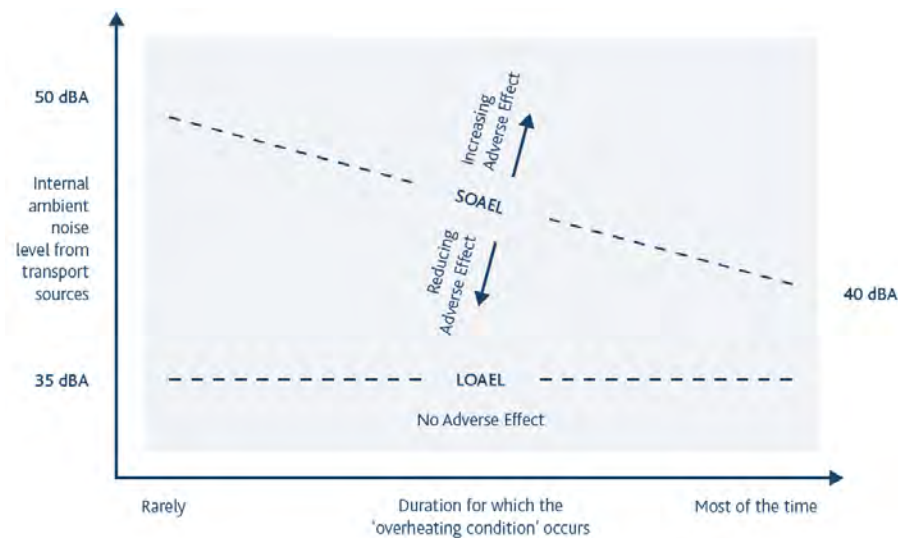


Figure 2 – AVO diagram indicating noise levels associated with adverse effects during the daytime

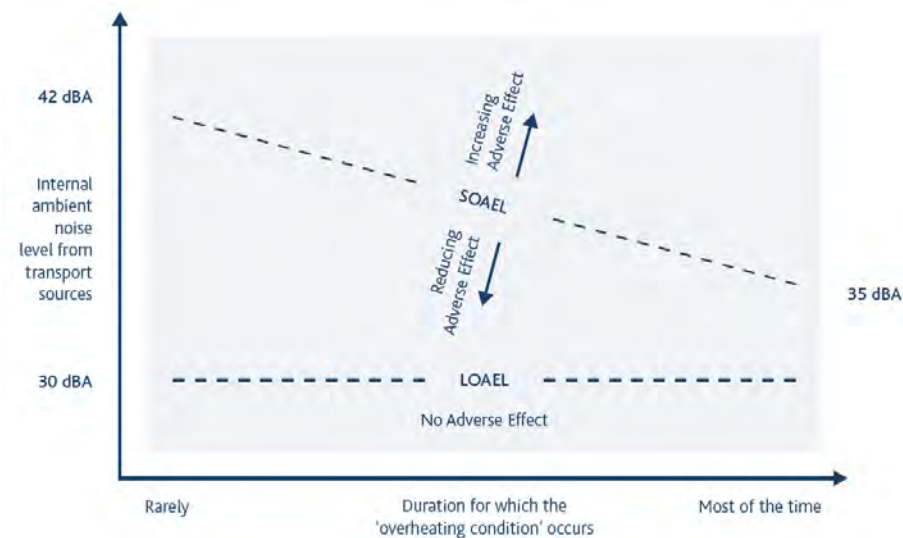


Figure 3 – AVO diagram indicating noise levels associated with adverse effects during the night-time

## 2.3 Approved Document O

Section 3 of Building Regulations ADO [14] mentions that in locations where external noise may be an issue, the overheating mitigation strategy should take account of the likelihood that windows will be closed during sleeping hours (11 pm to 7 am).

The document also mentions that windows are likely to be closed during sleeping hours if noise within bedrooms exceeds the following limits:

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

## 3 Site survey

### 3.1 Methodology

The site was initially inspected to determine the existing relevant noise sources.

No commercial noise sources were detected and it was noticeable that the main noise source affecting the proposed development during both the day and night-time is the road traffic on Ashton Old Road (A635).

To quantify its impacts, attended monitoring was carried out over three consecutive hours (from 10:00 to 13:00) on the 7<sup>th</sup> of March 2020 in line with the shortened measurement procedure included in the [Calculation of Road Traffic Noise \(CRTN\)](#) document [1].

Figure 4 illustrates the position adopted. The microphone was placed at a height of 1.5 meters above ground level and at a distance of 2 meters from the existing building.



Figure 4 – Measurement position (source: Google Maps)

The measured noise levels have been converted to the indexes  $L_{A10,18hr}$ ,  $L_{Aeq,16hr}$  and  $L_{Aeq,8hr}$  in line with the guidelines for modelling traffic noise included in BS 8233 [7] and the conversion method included in TRL [4].

The procedure can be briefly described as follows:

1. Measurements of  $L_{A10}$  over any 3 consecutive hours between 10:00 and 17:00h;
2. Calculation of  $L_{A10,18hr}$  as per the following equation:

$$L_{A10,18hr} = L_{A10,3hr} - 1dB \quad (3.1)$$

3. Calculation of  $L_{Aeq,16hr}$  as per the following equation:

$$L_{Aeq,16hr} = L_{A10,18hr} - 2dB \quad (3.2)$$

4. Calculation of  $L_{Aeq,8hr}$  for a non-motorway road as per the following equation:

$$L_{night} = 0.90 * L_{A10,18hr} - 3.77dB \quad (3.3)$$

Night time measurements have also been carried out to determine typical  $L_{AFmax}$  levels of individual events. Such measurements have been carried out for a total of 2 hour (from 23:00 to 01:00) since traffic on Ashton Old Road was noted to decrease after this time.

The microphone was placed at the same position.

The Sound Level Meter (SLM) was setup to measure  $L_{Aeq}$  values over 1 second intervals and a wind-shield was used as a precaution against interference.

The measurements were carried out in the absence of rain or wind speeds higher than  $5m/s^{-1}$ .

The SLM used meet the technical specifications of BS 7445 [2] and have current calibration certificates traceable to national standards. The equipment was field-calibrated before and after the measurement with no significant drift in sensitivity noted.

Table 2 – Equipment used

| Equipment         | Model                      | Serial no. |
|-------------------|----------------------------|------------|
| Sound Level Meter | Svantek SV307              | 82048      |
| Calibrator        | (with built-in calibrator) |            |

## 3.2 Results

The measured noise levels for the 3 hour period are presented as Table 3, the calculated day and night-time indexes are presented as Table 4 and the calculated daytime spectrum is presented as Table 5.

Table 3 – Measured  $L_{A10}$  values

| Period         | Measured $L_{A10}$ dB |
|----------------|-----------------------|
| 10:00 to 11:00 | 76                    |
| 11:00 to 12:00 | 75                    |
| 12:00 to 13:00 | 76                    |

Table 4 – Calculated day and night-time indexes

| Period             | Measured         | Calculated        |                   |                  |
|--------------------|------------------|-------------------|-------------------|------------------|
|                    | $L_{A10,3hr}$ dB | $L_{A10,18hr}$ dB | $L_{Aeq,16hr}$ dB | $L_{Aeq,8hr}$ dB |
| 10:30 to 13:30 hrs | 76               | 75                | 73                | 64               |

Table 5 – Daytime and night-time spectrum

| Parameter         | Freq. (Hz) |        |        |        |       |       |       | Total |
|-------------------|------------|--------|--------|--------|-------|-------|-------|-------|
|                   | 63 Hz      | 125 Hz | 250 Hz | 500 Hz | 1 kHz | 2 kHz | 4 kHz |       |
| $L_{Aeq,16hr}$ dB | 42         | 53     | 60     | 65     | 70    | 67    | 58    | 73    |
| $L_{Aeq,8hr}$ dB  | 30         | 42     | 48     | 54     | 61    | 58    | 49    | 64    |

The ten highest recorded values of  $L_{AFmax}$ , associated with specific events during the night are shown in Table 6.

Table 6 – Night-time measured  $L_{AFmax}$  events

| Event type | Recorded $L_{AFmax}$ | Time  |
|------------|----------------------|-------|
| car pass   | 91                   | 23:15 |
| car pass   | 86                   | 23:40 |
| car pass   | 85                   | 23:17 |
| car pass   | 83                   | 23:13 |
| car pass   | 83                   | 23:26 |
| car pass   | 82                   | 23:53 |
| car pass   | 81                   | 23:49 |
| car pass   | 81                   | 23:49 |
| car pass   | 80                   | 23:40 |
| car pass   | 80                   | 23:25 |

## 4 Facade noise

### 4.1 Methodology

Predictions of the noise emitted by the relevant existing noise sources at the proposed development various facades have been carried out by means of a digital geometric acoustics software.

The proprietary software Olive Tree Lab - Suite developed by the Mediterranean Acoustics Research & Development (PEMARD) has been used, in line with the methodology laid out in ISO 9613-2 [3].

The input data used and parameters used were the following:

- Site layout: Data of the site layout and model dimensions has been taken from the Architect drawings and from Google Earth;
- Surfaces absorption characteristics: All building surfaces absorption have been set as  $\alpha = 0.1$  (0.5 dB reflection loss);
- Ground factor: Ground factor have been set as 0 (hard floor);
- Order of reflections: A reflection order of 3 has been used<sup>1</sup>;

The **Sound Power Level (SWL)** of the relevant sources have been defined based on the measured noise levels.

Figure 5 shows the developed digital geometric acoustics model.

<sup>1</sup> A suitable reflection order has been determined based on the specific site geometry and the source-receiver positions.



Figure 5 – 3D view of the digital geometric acoustics model

## 4.2 Results

The calculated daytime noise levels at the proposed development facades are presented as Table 7.

Table 7 – Calculated facade noise levels (2 m from facade surface)

| Façade    | Parameter         | Octave band mid frequency in Hz |     |     |     |    |    |    | Global |
|-----------|-------------------|---------------------------------|-----|-----|-----|----|----|----|--------|
|           |                   | 63                              | 125 | 250 | 500 | 1k | 2k | 4k |        |
| South     | $L_{Aeq,16hr}$ dB | 42                              | 53  | 60  | 65  | 70 | 67 | 58 | 73     |
|           | $L_{Aeq,8hr}$ dB  | 30                              | 42  | 48  | 54  | 61 | 58 | 49 | 64     |
| North     | $L_{Aeq,16hr}$ dB | 29                              | 40  | 47  | 52  | 57 | 54 | 45 | 60     |
|           | $L_{Aeq,8hr}$ dB  | 17                              | 29  | 35  | 41  | 48 | 45 | 36 | 51     |
| East/West | $L_{Aeq,16hr}$ dB | 38                              | 49  | 56  | 61  | 66 | 63 | 54 | 69     |
|           | $L_{Aeq,8hr}$ dB  | 26                              | 38  | 44  | 50  | 57 | 54 | 45 | 60     |

## 5 Internal ambient noise levels

### 5.1 Impacts with open windows

The difference between free field and internal ambient noise levels through a partially open window is approximately 13 dB [11].

Based on this assumption and the noise levels stated in Table 5, to achieve suitable IANLs, windows are required to remain closed and to provide sufficient insulation. Therefore, appropriate facade and ventilation solutions have been calculated.

### 5.2 Facade acoustic requirements

#### 5.2.1 Methodology

To determine facade and ventilation solutions to achieve suitable IANLs within each relevant space, the methodology laid out in BS 8233 [7], BS EN ISO 12354-3 [9] and the guidance included in the AVO guide [14] have been considered.

The Overheating Risk – Early Stage Tool [13] produced by the Good Homes Alliance has been used to determine the proposed development risk of overheating.

The calculations have been carried out for rooms that are exposed to the highest noise levels and with the most significant ratio of glazing area to the room volume.

The dimensions and characteristics of each radiating surface (i.e. windows, external walls) and room volumes have been provided by the architect - see Annex B.

Average reverberation times RT of 0.5 and 0.8 seconds was considered adequate for bedrooms and living rooms or kitchens, respectively, due to the average room volumes and surface finishes characteristics.

Noise break-in through masonry elements is considered to be negligible.

Annex C, includes details for the calculations carried out.

## 5.2.2 South Facades

### Ventilation design case

Calculations indicate that **kitchens** require glazing with a performance of 32 dB  $R_w+C_{tr}$  (e.g. 10 mm glass/16 mm cavity/6 mm glass) and that ADF System 1 may be employed with a maximum of 2 trickle ventilators with a performance of 40  $D_{ne,w}+C_{tr}$ . The anticipated IANLs, with such solutions in place, would be 39 dBA during the day.

**Bedrooms** require glazing and a spandrel panel with a performance of 33 dB  $R_w+C_{tr}$  (e.g. 6 mm glass/16 mm cavity/6.8 mm laminated glass), and ADF System 1 may be employed with a maximum of 2 trickle ventilators with a performance of 42  $D_{ne,w}+C_{tr}$ . With such solutions in place, the anticipated IANLs for the most exposed bedroom would be 35 dBA during the day, 24 dBA during the night, and 45 dBA  $L_{AFmax}$  during night-time.

### Overheating design case

The Overheating Risk – Early Stage Tool indicates a high risk of overheating for south-facing facades.

The anticipated IANLs with a partially open window (13 dB attenuation) would be 57 dBA during the day and 48 dBA at night, with overheating design case  $L_{AFmax}$  levels up to 78 dB, and as such opening windows **is not** considered to be a suitable solution for mitigating overheating.

Mechanical cooling is required within **bedrooms** to manage thermal comfort in conjunction with the ventilation system, in which case windows are still openable for rapid dilution of smells, water vapour and VOCs.

## 5.2.3 North Facades

### Ventilation design case

Calculations indicate that all spaces (i.e. living rooms and bedrooms) require glazing with a performance of 25 dB  $R_w+C_{tr}$  (e.g. 4/16/4 mm) and that ADF System 1 may be employed with a maximum of 2 trickle ventilators with a performance of 34  $D_{ne,w}+C_{tr}$ . The anticipated IANLs, with such solutions in place, would vary between 30-33 dBA during the day and 20-23 dBA during the night.

## 5.2.4 Overheating design case

The Overheating Risk – Early Stage Tool indicates a low risk of overheating for north-facing facades.

The anticipated IANLs with a partially open window (13 dB attenuation) to control overheating would be 44 dBA during the day and 35 dBA at night, with overheating design case  $L_{AFmax}$  levels up to 63 dB, and as such opening windows is considered to be a suitable solution for mitigating overheating.

Considering these levels on the AVO diagrams presented as Figures 2 and 3, these levels are below the SOAEL level, and below a level at which noise causes a material change in behaviour. They are considered to be suitable for occupants.

If preferred, mechanical cooling can be used instead to manage thermal comfort in conjunction with the ventilation system, in which case windows are still openable for rapid dilution of smells, water vapour and VOCs.

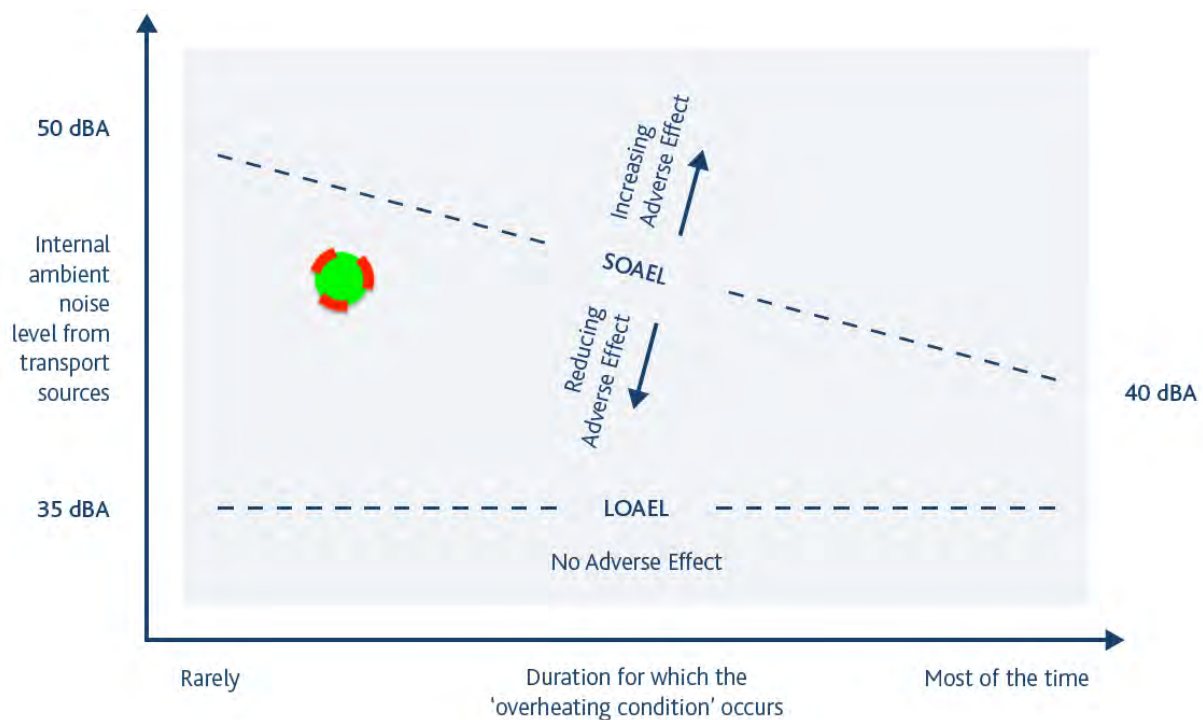


Figure 6 – AVO diagram illustrating daytime conditions for spaces facing the north facade

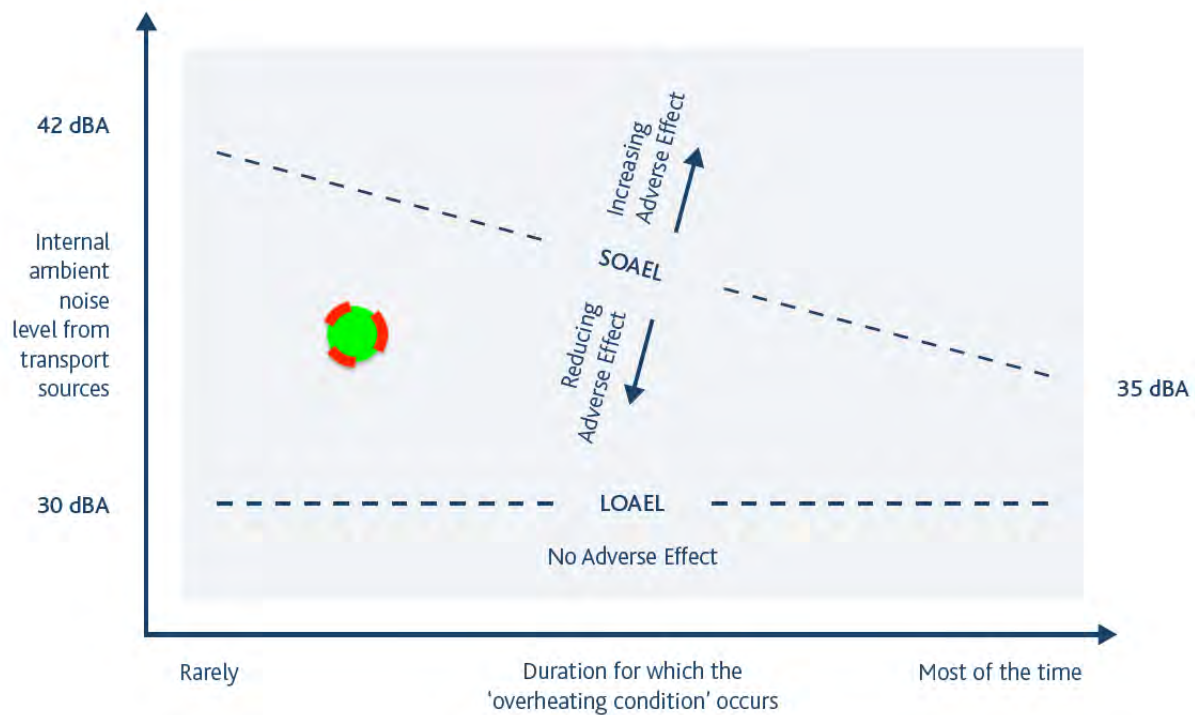


Figure 7 – AVO diagram illustrating night-time conditions for spaces facing the north facade

### 5.2.5 Further recommendations

The solutions mentioned above do not constitute a ventilation strategy design, which is the responsibility of the mechanical engineer and as such other ADF Systems may be employed if required, in which case the proposed details should be reassessed for acoustic performance.

If mechanical ventilation systems are preferred for whole-dwelling ventilation, ADF refers that the average A-weighted sound pressure level for a ventilator operating under normal conditions and not at boost rates should not exceed both of the following:

- 30dB  $L_{Aeq,T}$  for noise-sensitive rooms (e.g. bedrooms and living rooms) when a continuous mechanical ventilation system is running on its minimum low rate;
- 45dB  $L_{Aeq,T}$  in less noise-sensitive rooms (e.g. kitchens and bathrooms) when a continuous operation system is running at the minimum high rate or an intermittent operation system is running.

Regarding overheating, the mentioned solutions are considered standard mitigation measures in controlling overheating but must be assessed by the mechanical engineer.

It is recommended that a detailed overheating assessment (e.g. dynamic modelling against CIBSE TM59 [10]) is carried out to determine possible alternative overheating mitigation solutions or to specify the capacity needed for each system.

The AVO guide recommends that mechanical noise to control overheating is limited to 30 dB  $L_{Aeq}$  for bedrooms and 35 dB  $L_{Aeq}$  for living or dining rooms. Such limits should be considered when selecting specific units.

## Final considerations

A detailed assessment of noise impacts on the proposed development has been carried out. Reference has been made to current national guidance and a noise survey was carried out to determine the site's acoustics characteristics and to develop mitigation requirements necessary to achieve adequate [IANLs](#).

It has been determined that windows are required to be closed to achieve adequate [IANLs](#) within living areas. Appropriate facade and ventilation solutions and options have been provided accordingly.

Based on the implementation of the recommendations provided in this report, the development is considered to be suitable in line with the recommendations of the [NPPF](#) [12] and the [NPSE](#) [5].

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- [11] ProPG: Planning & Noise. Technical document, Association of Noise Consultants (ANC), Institute of Acoustics (IOA) and Chartered Institute of Environmental Health (CIEH), 2017. Cited 3 on pages [8](#), [12](#), and [22](#).

- [12] National Planning Policy Framework. Technical document, Ministry of Housing, communities and local government, 2018. Cited 4 on pages [10](#), [12](#), [27](#), and [31](#).
- [13] Overheating in new homes - Tool and guidance for identifying and mitigating early stage overheating risks in new homes. Technical document, Good Homes Alliance, 2019. Cited in page [22](#).
- [14] Acoustics Ventilation and Overheating. Technical document, Association of Noise Consultants (ANC), 2020. Cited 4 on pages [8](#), [13](#), [14](#), and [22](#).

# Annexes

# ANNEX A – National Planning Policy

## A.1 National Planning Policy Framework (NPPF)

The National Planning Policy Framework [12] sets out the Government's planning policies for England and how these should be applied. It provides a framework within which locally-prepared plans for housing and other development can be produced.

In regards to noise, Paragraphs 170, 180, 204 and 205 state the following:

170. Planning policies and decisions should contribute to and enhance the natural and local environment by:

- e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans.

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

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

204. Planning policies should:

- g) when developing noise limits, recognise that some noisy short-term activities, which may otherwise be regarded as unacceptable, are unavoidable to facilitate minerals extraction.

205. When determining planning applications, great weight should be given to the benefits of mineral extraction, including to the economy. In considering proposals for mineral extraction, minerals planning authorities should:

- c) ensure that any unavoidable noise, dust and particle emissions and any blasting vibrations are controlled, mitigated or removed at source, and establish appropriate noise limits for extraction in proximity to noise sensitive properties.

## A.2 Noise Policy Statement for England (NPSE)

The Noise Policy Statement for England [5] long term vision 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"*.

The NPSE states the three following policy aims:

First Aim:

Avoid significant adverse impacts on health and quality of life from environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development;

Second Aim:

Mitigate and minimise adverse impacts on health and quality of life from environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development;

Third Aim:

Where possible, contribute to the improvement of health and quality of life through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development.

The NPSE uses two established concepts from toxicology that are currently being applied to noise impacts, for example, by the World Health Organisation. These are extended to the concept of a significant observed adverse effect level as follows:

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.

The first aim of the NPSE states that significant adverse effects on health and quality of life should be avoided while also taking into account the guiding principles of sustainable development (paragraph 1.8).

The second aim of the NPSE refers to the situation where the impact lies somewhere between LOAEL and SOAEL. It requires that all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life while also taking into account the guiding principles of sustainable development (paragraph 1.8). This does not mean that such adverse effects cannot occur.

The third aim seeks, where possible, positively to improve health and quality of life through the pro-active management of noise while also taking into account the guiding principles of sustainable development (paragraph 1.8), recognising that there will be opportunities for such measures to be taken and that they will deliver potential benefits to society. The protection of quiet places and quiet times as well as the enhancement of the acoustic environment will assist with delivering this aim.

# ANNEX B – Proposed architectural plans

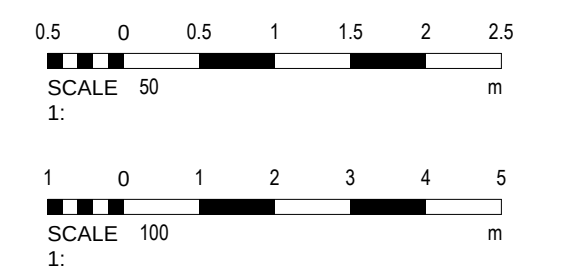
Copyright: All rights reserved.  
This drawing must not be reproduced without permission.  
This drawing must not be scaled. Dimensions are in millimetres unless specified.



**KEY:**



A photograph of a sample of brickwork, labeled A5, showing a mix of reddish-brown and dark grey bricks. The bricks are laid in a pattern on a wooden surface. A ruler is visible on the right side of the image.



RACHEL  
M  
CREATIVE  
MELL

THE GROVE SITE

Proposed Floor Plans & Elevations

0000\_ 10400

REV P1

STATUS | PLANNING

SCALE | As indicated

DRAWN BY | RM

DATE | 23.03.22

0001- RM- ZZ- ZZ- DR- A- 10400

# ANNEX C – Calculation details

| ROOM DETAILS            |                          |
|-------------------------|--------------------------|
| ID                      | south_fcd_kitchen        |
| Type                    | Living room/dinning room |
| Volume (m3)             | 21.6                     |
| Wall (m2)               | 0.0                      |
| Window 1 (m2)           | 2.4                      |
| Window 2 (m2)           | 0.0                      |
| Roof (m2)               | 0.0                      |
| Wall vent (m2)          | 0.0                      |
| No. of passive vents    | 2.0                      |
| Element total area (m2) | 2.4                      |

| TERM                    | DESCRIPTION       | Rw (C;Ctr) | Octave band mid frequency in Hz |     |     |     |      |      |      | GLOBAL dB(A) |
|-------------------------|-------------------|------------|---------------------------------|-----|-----|-----|------|------|------|--------------|
|                         |                   |            | 63                              | 125 | 250 | 500 | 1000 | 2000 | 4000 |              |
| L <sub>Aeq</sub> ,16hrs | External ff noise | -          | 39                              | 50  | 57  | 62  | 67   | 64   | 55   | 70           |
| L <sub>Aeq</sub> ,8hrs  | External ff noise |            | 27                              | 39  | 45  | 51  | 58   | 55   | 46   | 61           |
| RT (s)                  | RT (s)            | -          | 0.8                             | 0.8 | 0.8 | 0.8 | 0.8  | 0.8  | 0.8  | -            |
| Abs. Area (m2)          | Abs. Area (m2)    | -          | 4                               | 4   | 4   | 4   | 4    | 4    | 4    | -            |
| 10log A                 | 10log A           | -          | 6                               | 6   | 6   | 6   | 6    | 6    | 6    | -            |

|                                |                             |             |     |     |     |     |     |     |     |   |
|--------------------------------|-----------------------------|-------------|-----|-----|-----|-----|-----|-----|-----|---|
| R (Wall)                       | n/a                         | -           | 100 | 100 | 100 | 100 | 100 | 100 | 100 | - |
| R (Window 1)                   | 10 mm / (6-16mm) / 6 mm     | 35 (-1; -3) | 22  | 24  | 24  | 32  | 37  | 37  | 44  | - |
| R (Window 2)                   | n/a                         | -           | 100 | 100 | 100 | 100 | 100 | 100 | 100 | - |
| R (Roof)                       | n/a                         | -           | 100 | 100 | 100 | 100 | 100 | 100 | 100 | - |
| D <sub>ne</sub> (Ventilator 1) | 2500ea.ac1 (window mounted) | 42 (-1;-2)  | 30  | 41  | 40  | 47  | 47  | 43  | 47  | - |
| D <sub>ne</sub> (Ventilator 2) | 2500ea.ac1 (window mounted) | 42 (-1;-2)  | 30  | 41  | 40  | 47  | 47  | 43  | 47  | - |
| R (Vent)                       | n/a                         | -           | 100 | 100 | 100 | 100 | 100 | 100 | 100 |   |

|            |                     |   |    |    |    |    |    |    |    |   |
|------------|---------------------|---|----|----|----|----|----|----|----|---|
| R (Facade) | All façade elements | - | 18 | 23 | 23 | 31 | 34 | 32 | 37 | - |
|------------|---------------------|---|----|----|----|----|----|----|----|---|

|                         |       |   |    |    |    |    |    |    |    |    |
|-------------------------|-------|---|----|----|----|----|----|----|----|----|
| L <sub>Aeq</sub> ,16hrs | IANLs | - | 21 | 27 | 34 | 31 | 33 | 32 | 19 | 39 |
| L <sub>Aeq</sub> ,8hrs  | IANLs | - | 9  | 16 | 22 | 20 | 24 | 23 | 10 | 29 |

| ROOM DETAILS            |                    |
|-------------------------|--------------------|
| ID                      | south_fcd_bedroom2 |
| Type                    | Bedroom            |
| Volume (m3)             | 24.0               |
| Wall (m2)               | 0.0                |
| Window 1 (m2)           | 2.4                |
| Window 2 (m2)           | 0.0                |
| Roof (m2)               | 0.0                |
| Wall vent (m2)          | 0.0                |
| No. of passive vents    | 2.0                |
| Element total area (m2) | 2.4                |

| TERM                    | DESCRIPTION       | Rw (C;Ctr) | Octave band mid frequency in Hz |     |     |     |      |      |      | GLOBAL dB(A) |
|-------------------------|-------------------|------------|---------------------------------|-----|-----|-----|------|------|------|--------------|
|                         |                   |            | 63                              | 125 | 250 | 500 | 1000 | 2000 | 4000 |              |
| L <sub>Aeq</sub> ,16hrs | External ff noise | -          | 39                              | 50  | 57  | 62  | 67   | 64   | 55   | 70           |
| L <sub>Aeq</sub> ,8hrs  | External ff noise |            | 27                              | 39  | 45  | 51  | 58   | 55   | 46   | 61           |
| RT (s)                  | RT (s)            | -          | 0.5                             | 0.5 | 0.5 | 0.5 | 0.5  | 0.5  | 0.5  | -            |
| Abs. Area (m2)          | Abs. Area (m2)    | -          | 8                               | 8   | 8   | 8   | 8    | 8    | 8    | -            |
| 10log A                 | 10log A           | -          | 9                               | 9   | 9   | 9   | 9    | 9    | 9    | -            |

|                                |                                                |             |     |     |     |     |     |     |     |   |
|--------------------------------|------------------------------------------------|-------------|-----|-----|-----|-----|-----|-----|-----|---|
| R (Wall)                       | n/a                                            | -           | 100 | 100 | 100 | 100 | 100 | 100 | 100 | - |
| R (Window 1)                   | 6 mm / 16mm argon / 6.8 mm Pilkington Optiphon | 38 (-2; -5) | 20  | 22  | 27  | 35  | 42  | 41  | 48  | - |
| R (Window 2)                   | n/a                                            | -           | 100 | 100 | 100 | 100 | 100 | 100 | 100 | - |
| R (Roof)                       | n/a                                            | -           | 100 | 100 | 100 | 100 | 100 | 100 | 100 | - |
| D <sub>ne</sub> (Ventilator 1) | 2500ea.ac2 (windowmounted)                     | 45 (-2;-3)  | 30  | 42  | 40  | 46  | 48  | 53  | 57  | - |
| D <sub>ne</sub> (Ventilator 2) | 2500ea.ac2 (windowmounted)                     | 45 (-2;-3)  | 30  | 42  | 40  | 46  | 48  | 53  | 57  | - |
| R (Vent)                       | n/a                                            | -           | 100 | 100 | 100 | 100 | 100 | 100 | 100 |   |

|            |                     |   |    |    |    |    |    |    |    |   |
|------------|---------------------|---|----|----|----|----|----|----|----|---|
| R (Facade) | All façade elements | - | 17 | 22 | 25 | 33 | 37 | 39 | 45 | - |
|------------|---------------------|---|----|----|----|----|----|----|----|---|

|                         |       |   |    |    |    |    |    |    |    |    |
|-------------------------|-------|---|----|----|----|----|----|----|----|----|
| L <sub>Aeq</sub> ,16hrs | IANLs | - | 20 | 26 | 29 | 27 | 28 | 23 | 8  | 34 |
| L <sub>Aeq</sub> ,8hrs  | IANLs | - | 8  | 15 | 17 | 16 | 19 | 14 | -1 | 24 |

| ROOM DETAILS            |                         |
|-------------------------|-------------------------|
| ID                      | south_fcd_masterbedroom |
| Type                    | Bedroom                 |
| Volume (m3)             | 33.6                    |
| Wall (m2)               | 0.0                     |
| Window 1 (m2)           | 5.5                     |
| Window 2 (m2)           | 1.5                     |
| Roof (m2)               | 0.0                     |
| Wall vent (m2)          | 0.0                     |
| No. of passive vents    | 2.0                     |
| Element total area (m2) | 7.0                     |

| TERM           | DESCRIPTION       | Rw (C;Ctr) | Octave band mid frequency in Hz |     |     |     |      |      |      | GLOBAL dB(A) |
|----------------|-------------------|------------|---------------------------------|-----|-----|-----|------|------|------|--------------|
|                |                   |            | 63                              | 125 | 250 | 500 | 1000 | 2000 | 4000 |              |
| LAeq,16hrs     | External ff noise | -          | 39                              | 50  | 57  | 62  | 67   | 64   | 55   | 70           |
| LAeq,8hrs      | External ff noise |            | 27                              | 39  | 45  | 51  | 58   | 55   | 46   | 61           |
| RT (s)         | RT (s)            | -          | 0.5                             | 0.5 | 0.5 | 0.5 | 0.5  | 0.5  | 0.5  | -            |
| Abs. Area (m2) | Abs. Area (m2)    | -          | 11                              | 11  | 11  | 11  | 11   | 11   | 11   | -            |
| 10log A        | 10log A           | -          | 10                              | 10  | 10  | 10  | 10   | 10   | 10   | -            |

|                    |                                                |             |     |     |     |     |     |     |     |   |
|--------------------|------------------------------------------------|-------------|-----|-----|-----|-----|-----|-----|-----|---|
| R (Wall)           | n/a                                            | -           | 100 | 100 | 100 | 100 | 100 | 100 | 100 | - |
| R (Window 1)       | 6 mm / 16mm argon / 8.8 mm Pilkington Optiphon | 41 (-3; -7) | 22  | 24  | 26  | 40  | 48  | 46  | 54  | - |
| R (Window 2)       | 6 mm / 16mm argon / 8.8 mm Pilkington Optiphon | 41 (-3; -7) | 22  | 24  | 26  | 40  | 48  | 46  | 54  | - |
| R (Roof)           | n/a                                            | -           | 100 | 100 | 100 | 100 | 100 | 100 | 100 | - |
| Dne (Ventilator 1) | 2500ea.ac2 (windowmounted)                     | 45 (-2;-3)  | 30  | 42  | 40  | 46  | 48  | 53  | 57  | - |
| Dne (Ventilator 2) | 2500ea.ac2 (windowmounted)                     | 45 (-2;-3)  | 30  | 42  | 40  | 46  | 48  | 53  | 57  | - |
| R (Vent)           | n/a                                            | -           | 100 | 100 | 100 | 100 | 100 | 100 | 100 |   |

|            |                     |   |    |    |    |    |    |    |    |   |
|------------|---------------------|---|----|----|----|----|----|----|----|---|
| R (Facade) | All façade elements | - | 20 | 24 | 26 | 38 | 42 | 44 | 50 | - |
|------------|---------------------|---|----|----|----|----|----|----|----|---|

|            |       |   |    |    |    |    |    |    |    |    |
|------------|-------|---|----|----|----|----|----|----|----|----|
| LAeq,16hrs | IANLs | - | 20 | 27 | 33 | 25 | 26 | 21 | 6  | 35 |
| LAeq,8hrs  | IANLs | - | 8  | 16 | 21 | 14 | 17 | 12 | -3 | 24 |

| ROOM DETAILS            |                      |
|-------------------------|----------------------|
| ID                      | north_fcd_livingroom |
| Type                    | Living room          |
| Volume (m3)             | 31.2                 |
| Wall (m2)               | 0.0                  |
| Window 1 (m2)           | 5.2                  |
| Window 2 (m2)           | 0.0                  |
| Roof (m2)               | 0.0                  |
| Wall vent (m2)          | 0.0                  |
| No. of passive vents    | 2.0                  |
| Element total area (m2) | 5.2                  |

| TERM                    | DESCRIPTION       | Rw (C;Ctr) | Octave band mid frequency in Hz |     |     |     |      |      |      | GLOBAL dB(A) |
|-------------------------|-------------------|------------|---------------------------------|-----|-----|-----|------|------|------|--------------|
|                         |                   |            | 63                              | 125 | 250 | 500 | 1000 | 2000 | 4000 |              |
| L <sub>Aeq</sub> ,16hrs | External ff noise | -          | 26                              | 37  | 44  | 49  | 54   | 51   | 42   | 57           |
| L <sub>Aeq</sub> ,8hrs  | External ff noise |            | 14                              | 26  | 32  | 38  | 45   | 42   | 33   | 48           |
| RT (s)                  | RT (s)            | -          | 0.8                             | 0.8 | 0.8 | 0.8 | 0.8  | 0.8  | 0.8  | -            |
| Abs. Area (m2)          | Abs. Area (m2)    | -          | 6                               | 6   | 6   | 6   | 6    | 6    | 6    | -            |
| 10log A                 | 10log A           | -          | 8                               | 8   | 8   | 8   | 8    | 8    | 8    | -            |

|                                |                          |             |     |     |     |     |     |     |     |   |
|--------------------------------|--------------------------|-------------|-----|-----|-----|-----|-----|-----|-----|---|
| R (Wall)                       | n/a                      | -           | 100 | 100 | 100 | 100 | 100 | 100 | 100 | - |
| R (Window 1)                   | 4 mm / (6-16mm) / 4 mm   | 29 (-1; -4) | 17  | 21  | 17  | 25  | 35  | 37  | 31  | - |
| R (Window 2)                   | n/a                      | -           | 100 | 100 | 100 | 100 | 100 | 100 | 100 | - |
| R (Roof)                       | n/a                      | -           | 100 | 100 | 100 | 100 | 100 | 100 | 100 | - |
| D <sub>ne</sub> (Ventilator 1) | dn vent (window mounted) | 37 (-1;-3)  | 30  | 39  | 39  | 37  | 36  | 39  | 37  | - |
| D <sub>ne</sub> (Ventilator 2) | dn vent (window mounted) | 37 (-1;-3)  | 30  | 39  | 39  | 37  | 36  | 39  | 37  | - |
| R (Vent)                       | n/a                      | -           | 100 | 100 | 100 | 100 | 100 | 100 | 100 |   |

|            |                     |   |    |    |    |    |    |    |    |   |
|------------|---------------------|---|----|----|----|----|----|----|----|---|
| R (Facade) | All façade elements | - | 16 | 21 | 17 | 24 | 29 | 32 | 28 | - |
|------------|---------------------|---|----|----|----|----|----|----|----|---|

|                         |       |   |    |    |    |    |    |    |    |    |
|-------------------------|-------|---|----|----|----|----|----|----|----|----|
| L <sub>Aeq</sub> ,16hrs | IANLs | - | 12 | 18 | 29 | 27 | 27 | 22 | 16 | 33 |
| L <sub>Aeq</sub> ,8hrs  | IANLs | - | -0 | 7  | 17 | 16 | 18 | 13 | 7  | 23 |

| ROOM DETAILS            |                    |
|-------------------------|--------------------|
| ID                      | north_fcd_bedroom1 |
| Type                    | Bedroom            |
| Volume (m3)             | 26.4               |
| Wall (m2)               | 0.0                |
| Window 1 (m2)           | 2.4                |
| Window 2 (m2)           | 0.0                |
| Roof (m2)               | 0.0                |
| Wall vent (m2)          | 0.0                |
| No. of passive vents    | 2.0                |
| Element total area (m2) | 2.4                |

| TERM                    | DESCRIPTION       | Rw (C;Ctr) | Octave band mid frequency in Hz |     |     |     |      |      |      | GLOBAL dB(A) |
|-------------------------|-------------------|------------|---------------------------------|-----|-----|-----|------|------|------|--------------|
|                         |                   |            | 63                              | 125 | 250 | 500 | 1000 | 2000 | 4000 |              |
| L <sub>Aeq</sub> ,16hrs | External ff noise | -          | 26                              | 37  | 44  | 49  | 54   | 51   | 42   | 57           |
| L <sub>Aeq</sub> ,8hrs  | External ff noise |            | 14                              | 26  | 32  | 38  | 45   | 42   | 33   | 48           |
| RT (s)                  | RT (s)            | -          | 0.5                             | 0.5 | 0.5 | 0.5 | 0.5  | 0.5  | 0.5  | -            |
| Abs. Area (m2)          | Abs. Area (m2)    | -          | 8                               | 8   | 8   | 8   | 8    | 8    | 8    | -            |
| 10log A                 | 10log A           | -          | 9                               | 9   | 9   | 9   | 9    | 9    | 9    | -            |

|                                |                          |             |     |     |     |     |     |     |     |   |
|--------------------------------|--------------------------|-------------|-----|-----|-----|-----|-----|-----|-----|---|
| R (Wall)                       | n/a                      | -           | 100 | 100 | 100 | 100 | 100 | 100 | 100 | - |
| R (Window 1)                   | 4 mm / (6-16mm) / 4 mm   | 29 (-1; -4) | 17  | 21  | 17  | 25  | 35  | 37  | 31  | - |
| R (Window 2)                   | n/a                      | -           | 100 | 100 | 100 | 100 | 100 | 100 | 100 | - |
| R (Roof)                       | n/a                      | -           | 100 | 100 | 100 | 100 | 100 | 100 | 100 | - |
| D <sub>ne</sub> (Ventilator 1) | dn vent (window mounted) | 37 (-1;-3)  | 30  | 39  | 39  | 37  | 36  | 39  | 37  | - |
| D <sub>ne</sub> (Ventilator 2) | dn vent (window mounted) | 37 (-1;-3)  | 30  | 39  | 39  | 37  | 36  | 39  | 37  | - |
| R (Vent)                       | n/a                      | -           | 100 | 100 | 100 | 100 | 100 | 100 | 100 |   |

|            |                     |   |    |    |    |    |    |    |    |   |
|------------|---------------------|---|----|----|----|----|----|----|----|---|
| R (Facade) | All façade elements | - | 15 | 20 | 17 | 23 | 26 | 29 | 26 | - |
|------------|---------------------|---|----|----|----|----|----|----|----|---|

|                         |       |   |    |    |    |    |    |    |    |    |
|-------------------------|-------|---|----|----|----|----|----|----|----|----|
| L <sub>Aeq</sub> ,16hrs | IANLs | - | 8  | 14 | 25 | 23 | 25 | 19 | 13 | 30 |
| L <sub>Aeq</sub> ,8hrs  | IANLs | - | -4 | 3  | 13 | 12 | 16 | 10 | 4  | 20 |

| ROOM DETAILS            |                    |
|-------------------------|--------------------|
| ID                      | north_fcd_bedroom3 |
| Type                    | Bedroom            |
| Volume (m3)             | 24.0               |
| Wall (m2)               | 0.0                |
| Window 1 (m2)           | 2.4                |
| Window 2 (m2)           | 0.0                |
| Roof (m2)               | 0.0                |
| Wall vent (m2)          | 0.0                |
| No. of passive vents    | 2.0                |
| Element total area (m2) | 2.4                |

| TERM                    | DESCRIPTION       | Rw (C;Ctr) | Octave band mid frequency in Hz |     |     |     |      |      |      | GLOBAL dB(A) |
|-------------------------|-------------------|------------|---------------------------------|-----|-----|-----|------|------|------|--------------|
|                         |                   |            | 63                              | 125 | 250 | 500 | 1000 | 2000 | 4000 |              |
| L <sub>Aeq</sub> ,16hrs | External ff noise | -          | 26                              | 37  | 44  | 49  | 54   | 51   | 42   | 57           |
| L <sub>Aeq</sub> ,8hrs  | External ff noise |            | 14                              | 26  | 32  | 38  | 45   | 42   | 33   | 48           |
| RT (s)                  | RT (s)            | -          | 0.5                             | 0.5 | 0.5 | 0.5 | 0.5  | 0.5  | 0.5  | -            |
| Abs. Area (m2)          | Abs. Area (m2)    | -          | 8                               | 8   | 8   | 8   | 8    | 8    | 8    | -            |
| 10log A                 | 10log A           | -          | 9                               | 9   | 9   | 9   | 9    | 9    | 9    | -            |

|                                |                          |             |     |     |     |     |     |     |     |   |
|--------------------------------|--------------------------|-------------|-----|-----|-----|-----|-----|-----|-----|---|
| R (Wall)                       | n/a                      | -           | 100 | 100 | 100 | 100 | 100 | 100 | 100 | - |
| R (Window 1)                   | 4 mm / (6-16mm) / 4 mm   | 29 (-1; -4) | 17  | 21  | 17  | 25  | 35  | 37  | 31  | - |
| R (Window 2)                   | n/a                      | -           | 100 | 100 | 100 | 100 | 100 | 100 | 100 | - |
| R (Roof)                       | n/a                      | -           | 100 | 100 | 100 | 100 | 100 | 100 | 100 | - |
| D <sub>ne</sub> (Ventilator 1) | dn vent (window mounted) | 37 (-1;-3)  | 30  | 39  | 39  | 37  | 36  | 39  | 37  | - |
| D <sub>ne</sub> (Ventilator 2) | dn vent (window mounted) | 37 (-1;-3)  | 30  | 39  | 39  | 37  | 36  | 39  | 37  | - |
| R (Vent)                       | n/a                      | -           | 100 | 100 | 100 | 100 | 100 | 100 | 100 |   |

|            |                     |   |    |    |    |    |    |    |    |   |
|------------|---------------------|---|----|----|----|----|----|----|----|---|
| R (Facade) | All façade elements | - | 15 | 20 | 17 | 23 | 26 | 29 | 26 | - |
|------------|---------------------|---|----|----|----|----|----|----|----|---|

|                         |       |   |    |    |    |    |    |    |    |    |
|-------------------------|-------|---|----|----|----|----|----|----|----|----|
| L <sub>Aeq</sub> ,16hrs | IANLs | - | 8  | 14 | 25 | 24 | 26 | 20 | 14 | 30 |
| L <sub>Aeq</sub> ,8hrs  | IANLs | - | -4 | 3  | 13 | 13 | 17 | 11 | 5  | 20 |

| ROOM DETAILS            |                   |
|-------------------------|-------------------|
| ID                      | east_fcd_bedroom3 |
| Type                    | Bedroom           |
| Volume (m3)             | 24.0              |
| Wall (m2)               | 0.0               |
| Window 1 (m2)           | 1.5               |
| Window 2 (m2)           | 0.0               |
| Roof (m2)               | 0.0               |
| Wall vent (m2)          | 0.0               |
| No. of passive vents    | 2.0               |
| Element total area (m2) | 1.5               |

| TERM                    | DESCRIPTION       | Rw (C;Ctr) | Octave band mid frequency in Hz |     |     |     |      |      |      | GLOBAL dB(A) |
|-------------------------|-------------------|------------|---------------------------------|-----|-----|-----|------|------|------|--------------|
|                         |                   |            | 63                              | 125 | 250 | 500 | 1000 | 2000 | 4000 |              |
| L <sub>Aeq</sub> ,16hrs | External ff noise | -          | 35                              | 46  | 53  | 58  | 63   | 60   | 51   | 66           |
| L <sub>Aeq</sub> ,8hrs  | External ff noise |            | 23                              | 35  | 41  | 47  | 54   | 51   | 42   | 57           |
| RT (s)                  | RT (s)            | -          | 0.5                             | 0.5 | 0.5 | 0.5 | 0.5  | 0.5  | 0.5  | -            |
| Abs. Area (m2)          | Abs. Area (m2)    | -          | 8                               | 8   | 8   | 8   | 8    | 8    | 8    | -            |
| 10log A                 | 10log A           | -          | 9                               | 9   | 9   | 9   | 9    | 9    | 9    | -            |

|                                |                            |             |     |     |     |     |     |     |     |   |
|--------------------------------|----------------------------|-------------|-----|-----|-----|-----|-----|-----|-----|---|
| R (Wall)                       | n/a                        | -           | 100 | 100 | 100 | 100 | 100 | 100 | 100 | - |
| R (Window 1)                   | 6 mm / (6-16mm) / 4 mm     | 32 (-2; -4) | 17  | 21  | 20  | 26  | 38  | 37  | 39  | - |
| R (Window 2)                   | n/a                        | -           | 100 | 100 | 100 | 100 | 100 | 100 | 100 | - |
| R (Roof)                       | n/a                        | -           | 100 | 100 | 100 | 100 | 100 | 100 | 100 | - |
| D <sub>ne</sub> (Ventilator 1) | 2500ea.ac2 (windowmounted) | 45 (-2;-3)  | 30  | 42  | 40  | 46  | 48  | 53  | 57  | - |
| D <sub>ne</sub> (Ventilator 2) | 2500ea.ac2 (windowmounted) | 45 (-2;-3)  | 30  | 42  | 40  | 46  | 48  | 53  | 57  | - |
| R (Vent)                       | n/a                        | -           | 100 | 100 | 100 | 100 | 100 | 100 | 100 |   |

|            |                     |   |    |    |    |    |    |    |    |   |
|------------|---------------------|---|----|----|----|----|----|----|----|---|
| R (Facade) | All façade elements | - | 15 | 21 | 19 | 25 | 34 | 36 | 38 | - |
|------------|---------------------|---|----|----|----|----|----|----|----|---|

|                         |       |   |    |    |    |    |    |    |    |    |
|-------------------------|-------|---|----|----|----|----|----|----|----|----|
| L <sub>Aeq</sub> ,16hrs | IANLs | - | 16 | 21 | 29 | 28 | 25 | 20 | 9  | 33 |
| L <sub>Aeq</sub> ,8hrs  | IANLs | - | 4  | 10 | 17 | 17 | 16 | 11 | -0 | 22 |

Yacoustics LTD Reg. No. 11747271  
**T:** +44 (0) 7769 377068  
**E:** [hello@yacoustics.co.uk](mailto:hello@yacoustics.co.uk)  
**[www.yacoustics.co.uk](http://www.yacoustics.co.uk)**