P4B Architecture Ltd

LANGDALE MEWS

TM59 Overheating Report



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Langdale Mews

TM59 Overheating Report

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REPORT LIMITATIONS

1. EXECUTIVE SUMMARY

Eco Tech has been appointed by P4B Architecture Ltd to assess the overheating risk for a flat block at Langdale Mews, Manchester, M19 3NT.

Site-specific dynamic thermal modelling has been undertaken based on the proposed architectural and assumed thermal design and the defined environmental constraints.

The dwelling passes the requirements of CIBSE TM59 and Approved Document O provided the following mitigation is introduced:

- Glazing providing 0.40 centre-pane g-value
- Mechanical ventilation introduced into Apt 1 Bedroom, providing 15l/s.

2. INTRODUCTION

2.1. PURPOSE

Eco Tech has been appointed by P4B Architecture Ltd to assess the overheating risk for a flat block at Langdale Mews, Manchester, M19 3NT.

This report is necessarily technical in nature. To assist the reader, a glossary of technical terms is provided in Appendix A.

2.2. BASIS OF ASSESSMENT

2.2.1. PLANNING CONDITION NO. 9

Planning Condition No. 9 imposed on the development is as follows:

> 9) a) Before above ground development commences, a scheme for acoustically insulating the proposed residential accommodation against noise from the A6 Stockport Road shall be submitted to and approved in writing by the City Council as local planning authority. There may be other actual or potential sources of noise which require consideration on or near the site, including local commercial premises.
> The potential for overheating shall also be assessed and the noise insulation scheme shall take this into account. The approved noise insulation and ventilation scheme shall be completed before any of the residential units hereby approved are occupied
>
> b) Prior to first occupation of the residential units, a verification report shall be required to validate that the work undertaken throughout the development conforms to the recommendations and requirements in the approved acoustic consultant's report. The report shall also undertake post completion testing to confirm that the internal noise criteria have been met. Any instances of non-conformity with the recommendations in the report shall be detailed along with any measures required to ensure compliance with the internal noise criteria.
>
> Reason - To secure a reduction in noise from traffic or other sources, in order to protect future residents from noise disturbance and to reduce the potential for overheating, pursuant to saved policy DC26 of the Unitary Development Plan for the City of Manchester, policies DM1 and SP1 of the Manchester Core Strategy and the National Planning Policy Framework (NPPF).

This report seeks to provide the basis for overheating mitigation as required above. This report is to be read in conjunction with the Peninsular Acoustics report ref. PA1008-R01-P01, and the noise survey data within this report has informed this assessment.

2.2.2. APPROVED DOCUMENT O

Approved Document O (2021 edition – England) [AD-O] was released in December 2021 and came into force for all Building Regulations building notices, full plans applications and initial notices submitted from 15 June 2022.

Requirement O1 states:

O1 Overheating mitigation

(1) Reasonable provision must be made in respect of a dwelling, institution or any other building containing one or more rooms for residential purposes, other than a room in a hotel ("residences") to—

(a) limit unwanted solar gains in summer;

(b) provide an adequate means to remove heat from the indoor environment.

(2) In meeting the obligations in paragraph (1)—

(a) account must be taken of the safety of any occupant, and their reasonable enjoyment of the residence; and

(b) mechanical cooling may only be used where insufficient heat is capable of being removed from the indoor environment without it.

There are two routes to demonstrate compliance with Requirement O1(1):

- The Simplified Method; and
- Dynamic Thermal Modelling

If adopting the Dynamic Thermal Modelling method for demonstrating compliance, the modelling should follow the requirements of CIBSE TM 59, with additional limits on the modelling as follows:

- Specific operating profiles for openings to rooms occupied in the daytime (8am to 11pm)
- Assumptions for openings to first floor rooms and rooms that are not easily accessible at night
- Assumptions for openings to unoccupied ground floor or easily accessible rooms during the daytime and night-time

The statutory guidance to support Requirement O1(2)(a) contains standards relating to noise at night, pollution, security, protection from falling and protection from entrapment.

For noise at night, paragraph 3.3 states:

> *Windows are likely to be closed during sleeping hours if noise within bedrooms exceeds the following limits:*
>
> *a) 40dB $L_{Aeq,T}$ averaged over 8 hours (between 11pm and 7am)*
>
> *b) 55dB L_{AFmax} more than 10 times a night (between 11pm and 7am)*

For pollution, paragraph 3.5 states:

> *Buildings located near to significant local pollution sources should be designed to minimise the intake of external air pollutants. Guidance is given in Section 2 of Approved Document F, Volume 1: Dwellings.*

These two paragraphs place environmental constraints on the extent of the use of an open window or a natural ventilation opening within the overheating strategy.

To maintain sufficient security, only the proportion of openings that can be opened securely should be considered to provide useful ventilation.

To prevent the risk of falling, only the proportion of openings which can be opened with a very low risk of occupants falling from height should be considered to form part of the overheating mitigation strategy.

To prevent the risk of entrapment of body parts within louvred shutters, window railings and ventilation grilles, there are standards for openings and looped cords which must be followed.

2.2.3. CIBSE TM59

CIBSE TM59 was published in April 2017 and provides a standardised assessment methodology to determine the risk of overheating in residential properties. It includes assumptions for internal heat gains and occupancy profiles and presents criteria which differ depending on whether the home is predominantly naturally ventilated, or it is predominantly mechanically ventilated.

For homes that are predominantly naturally ventilated, including homes that have mechanical ventilation with heat recovery [MVHR], with good opportunities for natural ventilation in the summer, compliance is based on passing *both* of the following two criteria:

Table 1: CIBSE TM59 Predominantly Naturally Ventilated Criteria

Criterion	Requirement
a)	*For living rooms, kitchens and bedrooms*: the number of hours during which ΔT is greater than or equal to one degree (K) during the period May to September inclusive shall not be more than 3 per cent of occupied hours.
b)	For bedrooms only: to guarantee comfort during the sleeping hours the operative temperature in the bedroom from 10 pm to 7 am shall not exceed 26 °C for more than 1% of annual hours. (Note: 1% of the annual hours between 22:00 and 07:00 for bedrooms is 32 hours, so 33 or more hours above 26 °C will be recorded as a fail).

For homes predominantly mechanically ventilated, because they have either no opportunity or extremely limited opportunities for opening windows (e.g. due to noise levels or air quality), occupied rooms should not exceed an operative temperature of 26 °C for more than 3% of annual occupied hours.

Care homes and accommodation for vulnerable occupants, which are predominantly naturally ventilated, should use criteria (a) and (b), but should assume Type 1 occupancy, as defined in CIBSE TM52. This results in a reduction in the acceptable comfortable temperature range from ±3K to ±2K (and a reduction of predicted mean vote from ±0.5 to ±0.2), reflecting the higher sensitivity of vulnerable occupants to increases in internal temperature.

2.2.4. ACOUSTICS, VENTILATION & OVERHEATING GUIDE

The *Acoustics, Ventilation and Overheating: Residential Design Guide* (AVOG) by the Association of Noise Consultants (ANC) and Institute of Acoustics was released in January 2020. The guide outlines a methodology for the assessment of airborne sound (from transport related sources) during normal ventilation and during overheating conditions, emphasising the co-dependency of acoustics, ventilation and overheating design.

The process is split into two stages. Level 1 considers an initial risk assessment based on external noise levels and Level 2 is a more advanced stage where opening a window to mitigate overheating is not possible.

Figure 3-1 Two-level noise assessment procedure - overheating condition

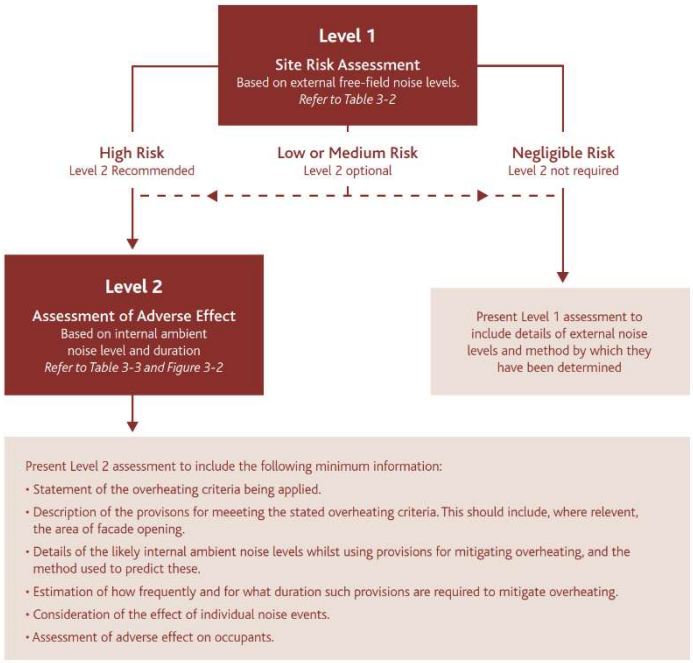


Figure 3-2 Qualitative guidance on combined effect of internal ambient noise level and duration f the overheating situation

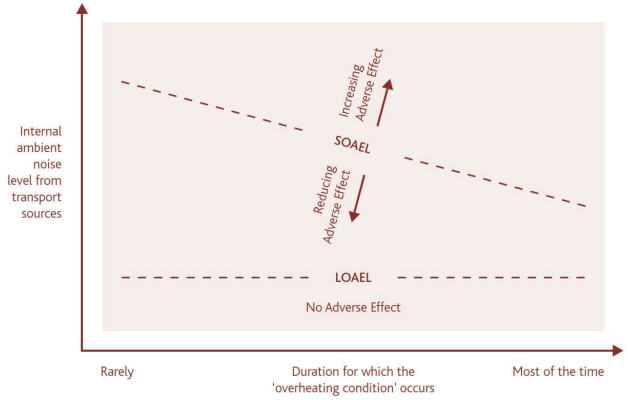


Table 3-3 Guidance for Level 2 assessment of noise from transport noise sources[Note 1] relating to overheating condition

Internal ambient noise level [Note 4]			Examples of Outcomes [Note 9]	
$L_{eq,T}$ [Note 6] during 07:00 – 23:00 [Note 6]	$L_{eq,8h}$ during 23:00 – 07:00	Individual noise events during 23:00 – 07:00 [Note 4]		
> 50 dB	> 42 dB	Normally exceeds 65 dB L_{Amax}	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 noise level			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_{Amax} 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.

Note 2 The values presented in this table should not be regarded as fixed thresholds and reference can also be made to relevant dose-response relationships such as those described in a DEFRA 2014 study [19, 21, 48]. With the exception of individual noise events, the references [19,21] are based on evidence drawn from external noise levels. There is currently very little robust evidence linking internal averaged noise levels with health outcomes and occupant behaviour. Internal ambient noise levels would normally be considered for living rooms and bedrooms during the daytime. At night, the levels would normally only be applicable to bedrooms.

Note 3 A decision must be made regarding the appropriate averaging period to use. The averaging period should reflect the nature of the noise source, the occupancy profile and times at which overheating might be likely to occur. Further guidance can be found within the 2014 EMA Guidelines.

Note 4 Refer to references [9, 11, 16, 48] for further guidance regarding individual noise events. The $L_{Amax,F}$ indicator associated with the upper category is intended for road traffic; it may be more appropriate to use the "one additional noise-induced awakening" method for noise from rail traffic or aircraft.

Note 5 The potential for adverse effect will also depend on how frequently and for what duration the overheating condition occurs. Refer to Figure 3-2.

Note 6 The daytime levels presented in this table may not be appropriate for residential care homes or other situations where conditions for daytime resting are known to be of particular importance.

Note 7 When evaluating the potential for adverse effect, all three aspects of noise exposure (i.e. daytime, night-time and individual noise events) should be evaluated.

Note 8 BS 8233 states that where development is considered necessary or desirable, the internal target levels may be relaxed by up to 5 dB and reasonable internal conditions still achieved.

Note 9 It is known that physiological responses do occur at lower levels of L_{Amax} than 45 dB.

The principle outlined in the guide is to base the internal noise target on how often any overheating mitigation is used.

However, this iterative process is not straight forward when applied in dynamic thermal modelling. Considered another way, the 'duration for which the overheating condition occurs' would be reduced where the design incorporates more measures to reduce heat gains.

For this project, a points system using the following considerations has been collated based on the design (total available points 10) to determine the daytime internal noise target.

Benefit to Reducing Overheating	Measures	Points per Measure
Primary Measure	▪ Rooms > 45m^3 ▪ External shading ▪ Centre-pane g-value ≤0.40 ▪ Approx. glazing area as a proportion of floor area < 25 % ▪ Building located in Northern England, Wales or Scotland ▪ High exposed thermal mass ▪ Dual aspect ▪ Most glazed façade to North or East	1
Secondary Measure	▪ Ceiling heights > 2.4m ▪ Bedrooms > 15m^2 ▪ Open plan living/kitchen ▪ Kitchen not on façade	0.5

From these factors, assigning a point for each that apply, the internal noise levels have been targeted based on the below scale.

Points	Daytime $L_{Aeq,16h}$ in Rooms used During the Day
10	50 dB
7 to 9	47 dB
4 to 6	44 dB
1 to 3	42 dB
<1	40 dB

Table 2: Target Daytime Noise Levels for Overheating Assessment

During the night-time in bedrooms, the internal noise standards of Approved Document O apply.

3. SITE DETAILS

3.1. ORIENTATION

The dwelling is located on site as per the below site plan.

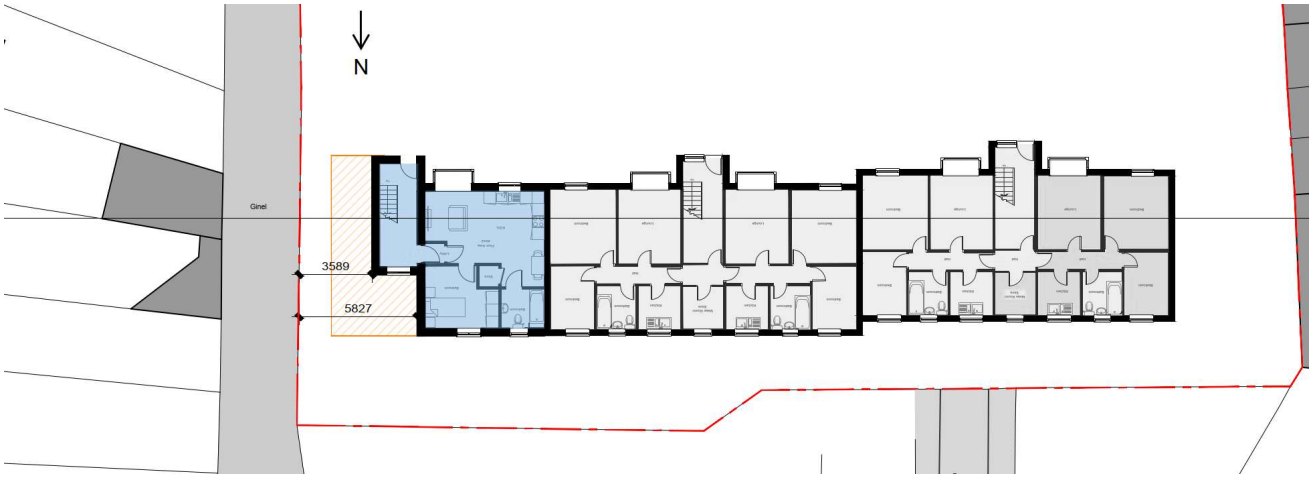


Figure 1: Site Plan

3.2. DESIGN

The dwelling comprises of 3 apartments, Apartments 1 and 2 are both single storey flats to include Kitchen/Dining/Living Rooms, Bedroom and Bathroom and Apartment 3 is a duplex flat to include a Kitchen/Dining Room, Lounge, Bedroom and Bathroom.



Figure 2: Ground Floor Plan (Apt 1)

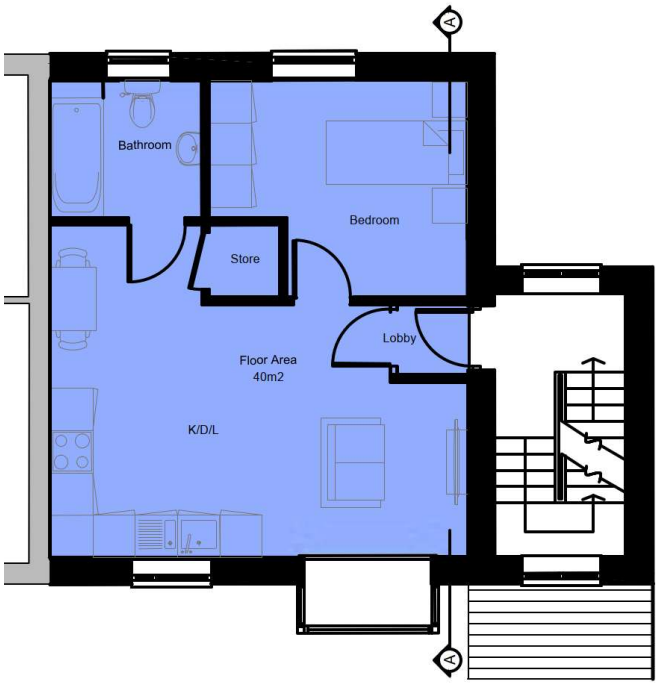


Figure 3: First Floor Plan (Apt 2)

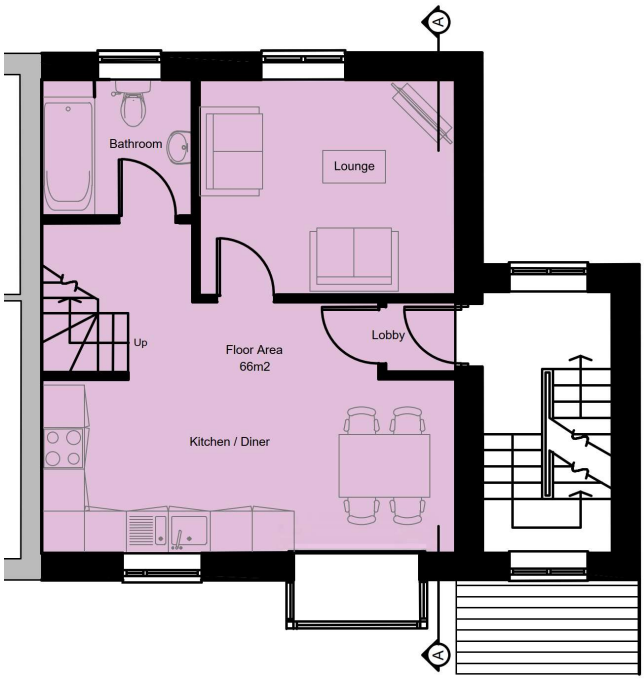


Figure 4: Second Floor Plan (Apt 3)

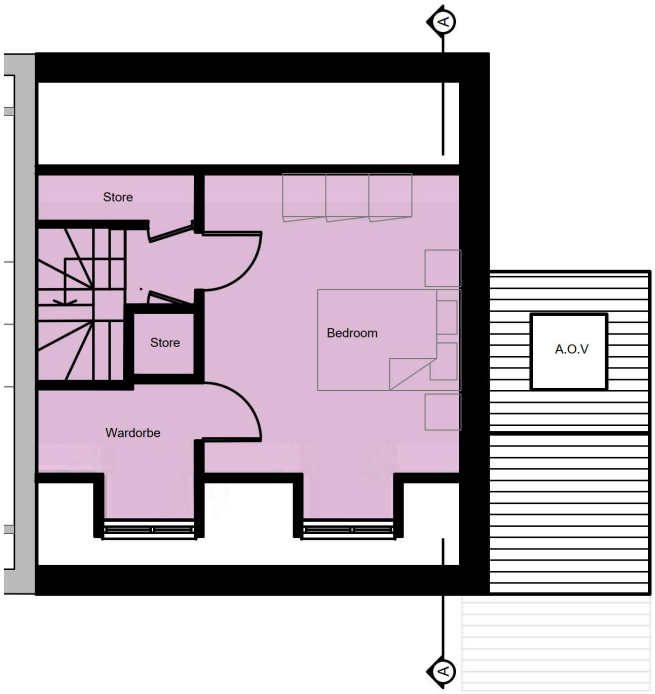
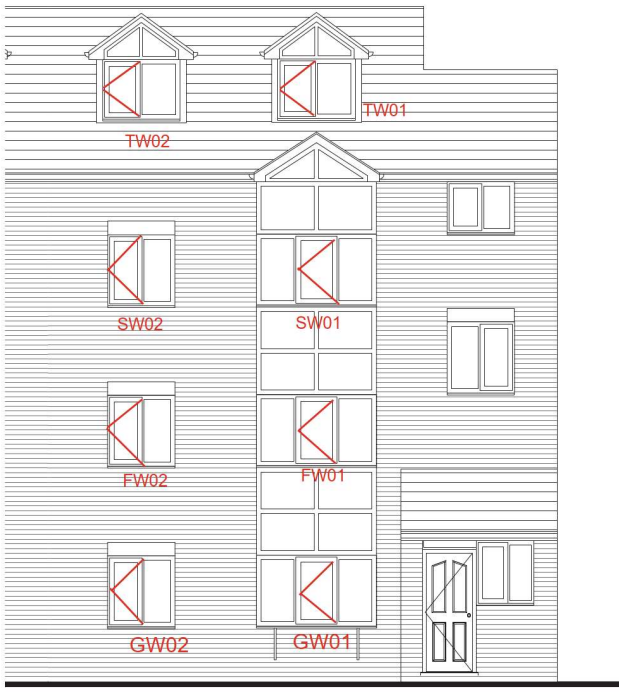
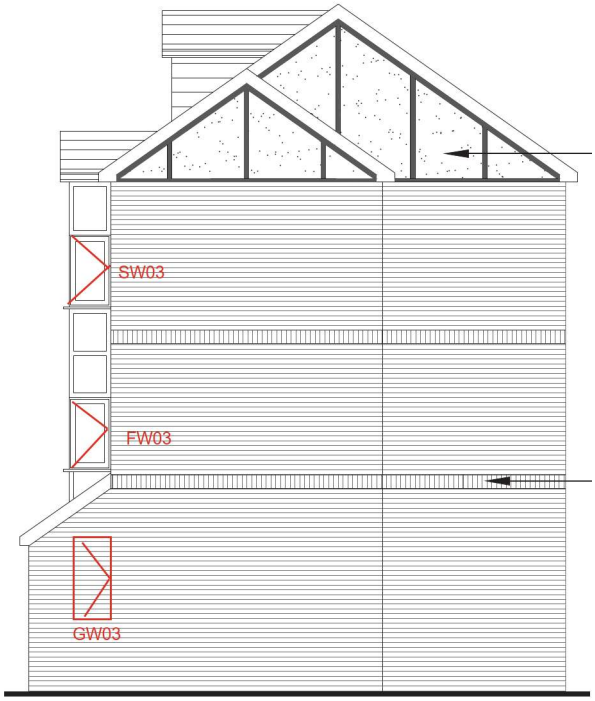


Figure 5: Third Floor Plan (Apt 3)



Front Elevation



Side Elevation



Rear Elevation

Figure 6: Elevations

3.3. NOISE CONSTRAINTS

The acoustic report by Peninsular Acoustics (ref. PA1008-R01-P01) confirms the following noise exposure.

Elevation	Daytime (Living Rooms)	Night-time (Bedrooms)
Front (road traffic noise)	51 dB $L_{Aeq,16h}$	46 dB $L_{Aeq,8h}$ / 58 dB 10th highest L_{AFmax}
Rear (plant noise)	64 dB $L_{Ar,Tr}$	64 dB $L_{Ar,Tr}$ / 63 dB 10th highest L_{AFmax}

Table 3: Noise Exposure

The dwelling is proposed to have the following heat gain controlling measures:

Measure	Points
Rooms > 45m^3	1
Centre-pane g-value ≤0.40	1
Approx. glazing area as a proportion of floor area < 25%	1
Building located in Northern England, Wales or Scotland	1
High exposed thermal mass	1
Dual aspect	1
Most glazed façade to north or east	1
Ceiling heights > 2.4m	0.5
Open plan living/kitchen	0.5
Total	**8**

Table 4: Calculation of Daytime Internal Noise Limit

Based on this and the proposed dwelling details, daytime internal ambient noise levels are to be designed to not exceed 47 dB $L_{Aeq,16h}$ during summertime overheating and the following outside to inside level difference is required by the window openings.

Elevation	Min. Outside to Inside Level Difference from Window Openings	
	Living Rooms/Kitchens/Studies	*Bedrooms*
Front	4 dB	6 dB
Rear	17 dB	24 dB

Table 5: Window Opening Sound Insulation Provision

3.3.1. OPEN WINDOW CONSTRAINTS

The following open window noise constraints apply:



Figure 7: Day Time Noise Plan



Figure 8: Night Time Noise Plan

3.4. PROTECTION FROM FALLING, ENTRAPMENT AND SECURITY

3.4.1. GUARD RAILS

Where windowsill heights are below 1000mm, a guard rail is to be fitted.

The following windows must have guard rails (see **Error! Reference source not found.** for references):

FW01	FW02	FW03	FW04
SW01	SW02	SW03	SW04

Section 3.9 of Approved Document O advises that guarding should not allow children to easily climb it. Therefore, horizontal bars should generally be avoided.

Any Juliet Balconies must have an opening profile of at least 70% free area.

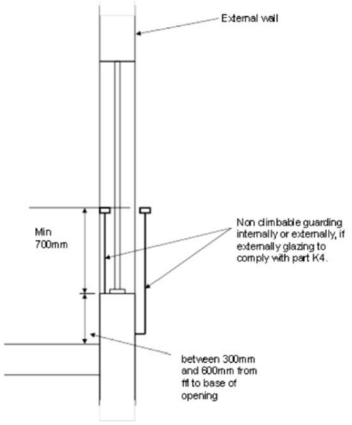


Diagram 3 – Indicates acceptable guarding arrangements where cill heights are between 600mm and 800mm above finished floor level. In this case the cill is not considered to be readily climbable by children, so compliance can be achieved by providing barrier rails to maintain an overall guard height of 800mm above floor level.

4. ASSESSMENT METHODOLOGY

4.1.1. MODELLING ASSUMPTIONS

4.1.1.1. Dynamic Thermal Modelling Software

Dynamic thermal modelling has been undertaken utilising 10-minute sample periods using IES Virtual Environment (version 2024.0.0.0).

4.1.1.2. Building Fabric

The building fabric for all variants assumes the following thermal parameters.

Building Fabric	Construction	U-value (W/m^2K)	Centre-pane G-value	Thermal Mass (kJ/m^2K)
External wall	Cavity Wall	0.18	n/a	84
Ground floor	Suspended Concrete Floor	0.18	n/a	66
Roof	Plasterboard, insulated slope	0.15	n/a	8
Glazing	Double Glazed	1.40	0.40	n/a

Table 6: Thermal and Solar Performance of Building Fabric Elements

4.1.1.3. Internal Gains

Solar Gain

Solar gains are calculated automatically by the modelling software based on the orientation of the building, the transmission coefficients of the glazing and the solar angles. The Manchester 2020 DSY1 50th percentile high emissions weather file has been used.

Occupancy, Equipment and Lighting Gains

Occupancy, equipment lighting gains for the residential spaces are based on the guidance in CIBSE TM59 Design methodology for the assessment of overheating risk in homes. The following table lists rooms and the associated TM59 profiles.

Room	TM59 Type
Bedroom (Apt 3)	Double Bedroom
Bedrooms (Apt 1 and 2)	Single Bedroom
Living/Kitchen room	1 Bed Living/Kitchen
Lounge	1 Bed Living Room
Bathroom	Bathroom

Table 7: Room TM59 Assignment

Ventilation

Infiltration & Background Ventilation (Approved Document F)

The dwelling is assumed to have an air permeability of 5.0 m³/hr/m² @ 50 Pa related to its construction year. This has been taken to correspond to an average infiltration rate of 0.25 ach.

Year-round background ventilation for the dwelling has been assumed to provide 0.48 l/s per m^2 for Apartments 1 and 2 and 0.30 l/s per m^2 for Apartment 3 as per Approved Document F.

Natural Ventilation

Openable windows are provided for ventilation and are assumed to be able to be opened by occupants in warm weather, restricted if required as per the noise limitations.

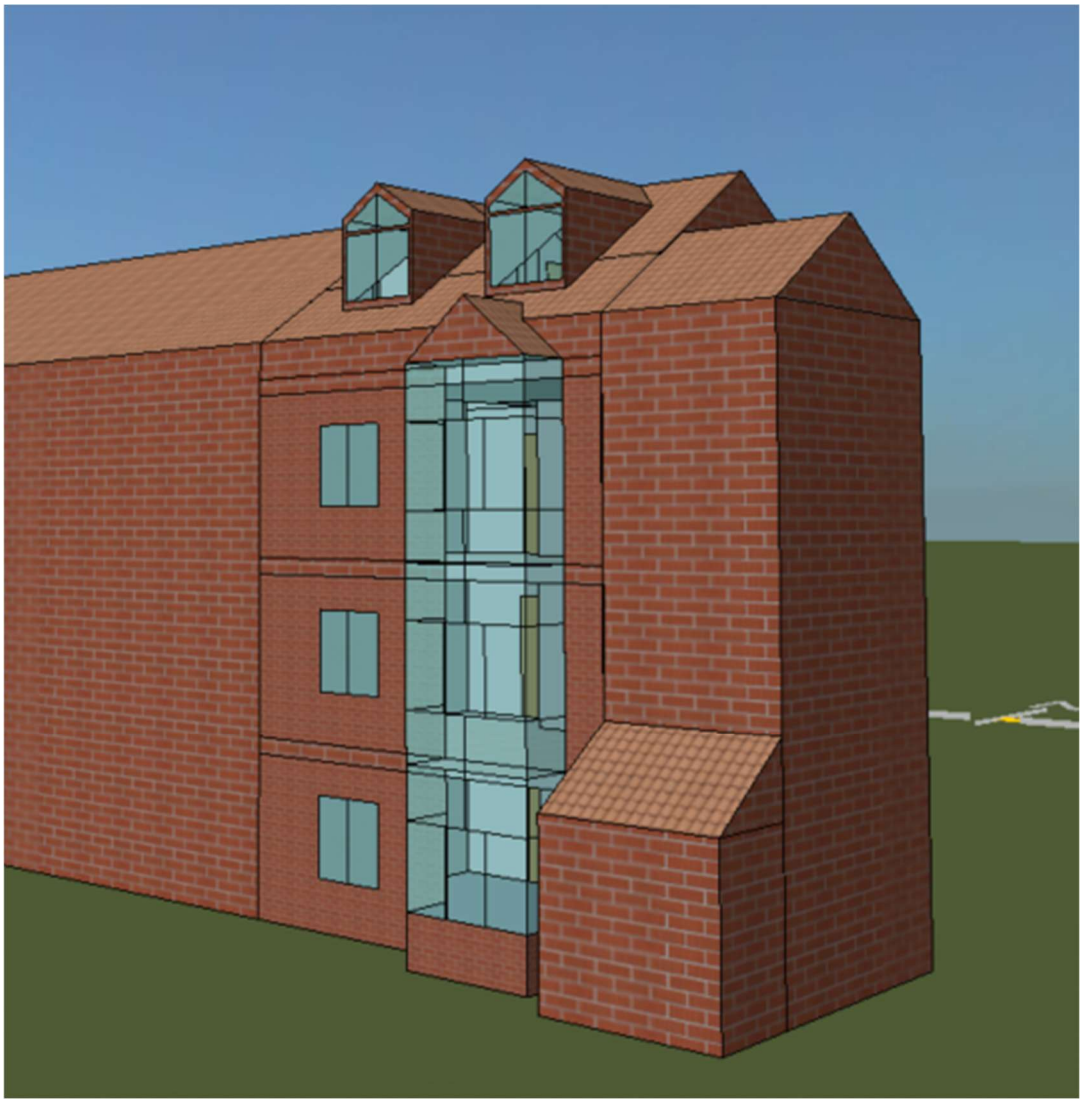
Window Ref.	No. Panes Openable	Opening Angle per Pane (degrees)		Total Equivalent Area (m^2)		Daytime Total Outside to Inside Sound Level Difference (dB)	Nighttime Total Outside to Inside Sound Level Difference (dB)
		Day	Night	Day	Night		
GW01_Side_Front_Grnd	1	80	0	0.66	0	14	n/a
GW02_Side_Front_Grnd	1	90	0	0.53	0	15	n/a
GW03_Side_Side_Grnd	2	90	0	1.25	0	11	n/a
GW04_Side_Rear_Grnd **(N)**	1	90	0	0.55	0	18	>20
GW05_Top_Rear_Grnd	1	90	0	0.26	0	n/a	n/a
FW01_Side_Front_Grnd	1	57	0	0.62	0	14	14
FW02_Side_Front_Upper	1	44	44	0.44	0.44	15	15
FW03_Side_Side_Upper	2	65	65	1.19	1.19	11	11
FW04_Side_Rear_Upper **(N)**	1	3	0	0.06	0	18	>20
FW05_Top_Rear_Upper	1	90	90	0.26	0.26	n/a	n/a
SW01_Side_Front_Upper	1	57	57	0.62	0.62	16	16
SW02_Side_Front_Upper	1	44	44	0.44	0.44	18	18
SW03_Side_Side_Upper	2	65	65	1.19	1.19	13	13
SW04_Side_Rear_Upper **(N)**	1	42	42	0.46	0.46	18	>20
SW05_Top_Rear_Upper	1	90	90	0.26	0.26	n/a	n/a
TW01_Side_Front_Upper	1	57	57	0.52	0.52	11	11
TW02_Side_Front_Upper	1	57	57	0.52	0.52	n/a	n/a

EA-Easily Accessible, N-Noise Constraints, P-Pollution Constraints, S- Shading

Table 8: Window Opening Specifications

All internal doors are assumed to be open during the day to allow cross ventilation between rooms and closed at night when people are sleeping.

4.1.2. MODEL IMAGE



5. OVERHEATING STRATEGY

5.1. BASELINE RESULTS

The base case consists of no mitigation other than opening windows.

The results of the base case model are set out below, these have been evaluated for TM52 occupant category Type 2.

Room	Room Type	Occupied Summer Hours	Max. Daytime Hours	Max. Night-time Hours	Criterion a (≤3%) Pass/Fail	Criterion b (≤32) Pass/Fail
01 Bedroom	Bedroom	3672	110	32	0	59
02 Bedroom	Bedroom	3672	110	32	0	29
03 Bedroom	Bedroom	3672	110	32	0.1	8
03 Lounge	Kitchen/Living/Dining	1989	59	N/A	0	
01 Kitchen/Dining/Living	Kitchen/Living/Dining	1989	59	N/A	0.5	
02 Kitchen/Dining/Living	Kitchen/Living/Dining	1989	59	N/A	0.6	
03 Kitchen/Diner	Kitchen/Living/Dining	1989	59	N/A	0.5	

Table 9: Baseline Passive Results - No Mitigation

5.2. OVERHEATING DESIGN & RESULTS

Element		Approach
	Ensure that the maximum openable area is being utilised to ventilate the building	Use window openings where available
	Minimise solar gain	Introduce a G Glazing of 0.4
	Provide mechanical ventilation	To be introduced as mitigation.

Mechanical Ventilation of 15l/s to Apartment 1 Bedroom was necessary to be introduced, as to mitigate. Please see results below, reflecting this mitigation:

Room	Room Type	Occupied Summer Hours	Max. Daytime Hours	Max. Night-time Hours	Criterion a (≤3%) Pass/Fail	Criterion b (≤32) Pass/Fail
01 Bedroom	Bedroom	3672	110	32	0	24
02 Bedroom	Bedroom	3672	110	32	0	28
03 Bedroom	Bedroom	3672	110	32	0.1	8
03 Lounge	Kitchen/Living/Dining	1989	59	N/A	0	

Room	Room Type	Occupied Summer Hours	Max. Daytime Hours	Max. Night-time Hours	Criterion a (≤3%) Pass/Fail	Criterion b (≤32) Pass/Fail
01 Kitchen/Dining/Living	Kitchen/Living/Dining	1989	59	N/A	0.4	
02 Kitchen/Dining/Living	Kitchen/Living/Dining	1989	59	N/A	0.6	
03 Kitchen/Diner	Kitchen/Living/Dining	1989	59	N/A	0.5	

Table 10: Results Table

5.3. SPECIFICATIONS

Based on the sample modelling, the below overheating mitigation is required.

Apartment	Mitigation		Requirement
1		Additional mechanical ventilation	Bedroom: 15l/s air exchange, circa. 6,000mm^2 Equivalent Area ventilators

6. CONCLUSIONS

This dynamic thermal modelling report provides overheating analysis for a flat block at Langdale Mews, Manchester, M19 3NT.

A noise assessment has been undertaken by Peninsular Acoustics. Using the established external noise levels, internal noise targets have been established utilising *Approved Document O* and the *Acoustics, Ventilation and Overheating: Residential Design Guide*. Restricted window openings have been defined where necessary to achieve these target internal noise levels.

Dynamic thermal modelling has been undertaken based on these constraints and the following fabric performances:

Building Fabric	U-value (W/m^{2}K)	Centre-pane G-value	Thermal Mass (kJ/m^{2}K)
External wall	0.18	n/a	84
Internal walls	1.68	n/a	9
Ground floor	0.18	n/a	66
Roof	0.15	n/a	8
Windows	1.40	0.40	n/a

Appendix A

TECHNICAL TERMINOLOGY

Overheating Strategy Overheating Condition	The situation where measures are in place to mitigate overheating to meet agreed compliance criteria.
Dynamic thermal modelling	A technique that can be used to simulate internal temperatures in dwellings before they are built
Ventilative cooling	Cooling by means of introducing external ambient temperature air at a high ventilation rate. Can be either passive (no fans) or mechanical (with fans).
Purge ventilation	Ventilation 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.
Mechanical cooling	Cooling by means of a refrigerant cycle. This would include 'air conditioning' systems and the use of fan coil units (FCUs).
Equivalent area, A_{eq} **a.k.a. EA**	The area of a sharp-edged, circular orifice that gives the same flow rate as the actual opening at a given pressure-difference. In other words, the free-area of a notional circular hole made in an infinitely thin, infinite extent baffle that gives the same air-flow performance as the real opening. Used to describe the area of trickle vents in Approved Document F. Not to be confused with Effective area.
Equivalent continuous sound pressure level ($L_{eq,T}$)	The average of the total sound energy over a specified time period (T). L_{eq} represents the equivalent sound level that a fluctuating source would have compared to a steady source with the same total sound energy over a specific time period. Commonly used as a descriptor of human perception of sound over time.
Internal Ambient Noise Level (IANL)	The noise level within a room or enclosed space. Usually determined as an equivalent continuous sound pressure level over a specific time period ($L_{Aeq,T}$, dB)
"Free area" as used in AD-O	Approved Document O uses the term "Minimum free area" that is required to be achieved by the Equivalent area of the window openings. AD-O provides the accepted definition of Equivalent area for the description of "free area". The term "free area" is therefore avoided in this document to avoid further confusion.

Appendix B

REPORT LIMITATIONS

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