

Technical Note

Project:	Tariff Street, Manchester
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Subject:	Acoustics Ventilation & Overheating assessment

INTRODUCTION

The planning approval for the residential development on Tariff Street, Manchester, planning reference 135675/FO/2022, includes the following condition relating to noise.

- 13) Notwithstanding the recommendation within the Environmental Noise Study by Fisher Acoustics, dated November 2022 before any above ground works commence details of the following shall be submitted:
- (a) a scheme for acoustically insulating and mechanically ventilating the residential accommodation against local road traffic network, any local commercial/industrial noise sources and the insulation requirements and specification for service risers /lift shafts;
 - (b) An assessment of the potential for overheating and any required mitigation which the noise insulation scheme shall take into account shall be submitted to and approved in writing by the City Council as local planning authority.

The approved noise insulation and ventilation scheme and shall be completed before any of the dwelling units are occupied.

The following noise criteria will be required to be achieved whilst providing adequate ventilation as defined by Approved Document F of the Building Regulations (whole dwelling ventilation):

Bedrooms (night time - 23.00 - 07.00) 30 dB LAeq (individual noise events shall not exceed 45 dB L_{Amax,F} by more than 15 times)

Living Rooms (daytime - 07.00 - 23.00) 35 dB LAeq

The scheme shall be designed to achieve internal noise levels in the 63Hz and 125Hz octave centre frequency bands so as not to exceed (in habitable rooms) 47dB and 41dB (Leq,5min), respectively.

This Technical Note responds to part b) of planning condition 13. A response to part a) of planning condition 13 is provided under separate cover.

An assessment of the control of overheating in the context of environmental noise can be carried out with reference to the following documents:

- 'Acoustics, Ventilation and Overheating, Residential Design Guide', (AVO) published by the Association of Noise Consultants and the Institute of Acoustics in January 2020, and as discussed below.
- Building Regulations Approved Document O 'Overheating'

The apartments of the proposed development at Tariff Street are to be ventilated using continuous mechanical extract ventilation (MEV) units in order to comply with the 'whole dwelling' ventilation requirements of Approved Document F of the Building Regulations (ADF). Purge ventilation is required under ADF to rapidly dilute pollutants (eg paint fumes) and/or disperse water vapour to maintain indoor air quality. Purge ventilation of the apartments is to be provided by opening windows within the curtain wall.

The provisions for purge ventilation (eg openable windows) can also be used to improve thermal comfort. This aspect of building design is controlled by Part O of the Building Regulations, including potential noise impact.

The AVO guide recommends that when using provisions for purge ventilation such as opening windows, an assessment is carried out of the potential effect of the subsequent internal noise levels within apartment rooms.

This Technical Note discusses the potential effect of the control of overheating on the internal noise levels within the proposed apartments of Tariff Street, Manchester.

ACOUSTICS, VENTILATION AND OVERHEATING, RESIDENTIAL DESIGN GUIDE (AVO)

As stated in the Foreword of the document, the AVO

- 'provides an approach as to how the competing aspects of thermal and acoustic comfort can be managed'.

In the current absence of mandatory requirements under the Building Regulations in relation to the overheating of dwellings, the AVO is

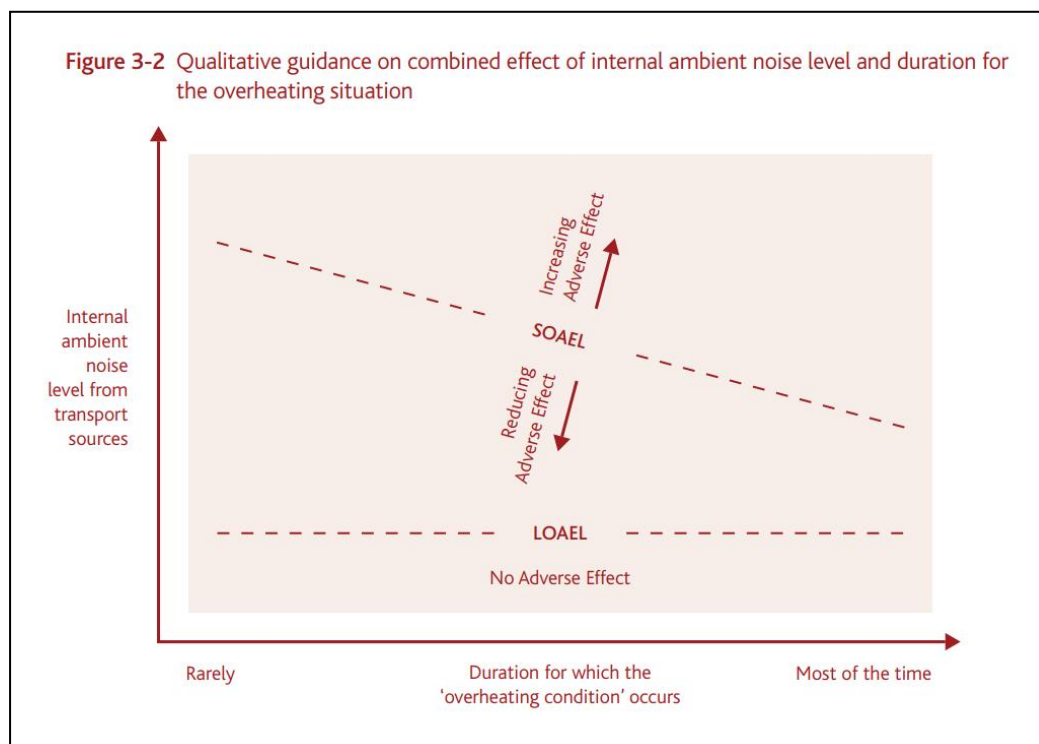
- 'intended to be used by acoustics practitioners as well as all those involved in the planning, development, design and commissioning of new dwellings. It recommends an approach to acoustic assessments for new residential development that takes due regard of the interdependence of provisions for acoustics, ventilation, and overheating'.

The AVO presents a method for assessing the risk of an adverse effect on occupants depending on 1) the potential internal noise level within apartments with windows open and 2) the duration of window opening.

With regard to the duration of window opening required to mitigate overheating, the AVO states:

- No quantitative guidance regarding the combined effect of level and duration for the overheating condition is included in the current version of this document. However, the situation is summarised qualitatively in Figure 3-2 and also addressed in the worked examples included in Appendix B.

Figure 3-2 from the AVO is reproduced below.



It will be noted that no absolute noise levels are indicated on the y-axis and no specific durations are identified on the x-axis of Figure 3.2.

With regard to the duration of the overheating condition (i.e. the time that windows or purge panels may be open), 'rarely' and 'most of the time', as referenced in Figure 3-2 of the AVO are not defined, although reference is made to 'Overheating in New Homes', published by the Good Homes Alliance in July 2019, which provides an early design stage tool in order to identify key factors contributing to overheating risk, and possible mitigation measures.

The tool 'is not meant to provide a detailed assessment, but instead to sit between existing high level guidance...and detailed calculation and modelling tools...'.

The AVO recognises that further development work is required to better understand how long people will tolerate higher noise levels in their homes in order to stay cool, with the ultimate aim of creating 'cost effective and sustainable buildings'.

Furthermore, the AVO advises that:

- In the case of the overheating condition, the effect of increased internal ambient noise from external noise sources will depend both on the absolute noise level and the amount of time for which the overheating condition occurs. A good design process should therefore, as a priority, seek to minimise heat gains thereby reducing the amount and duration of ventilation required to control overheating and the consequential effect from increased ingress of noise.

Importantly, the AVO acknowledges that

- Appropriate research work is urgently needed to better inform the guidance for the overheating condition.

and

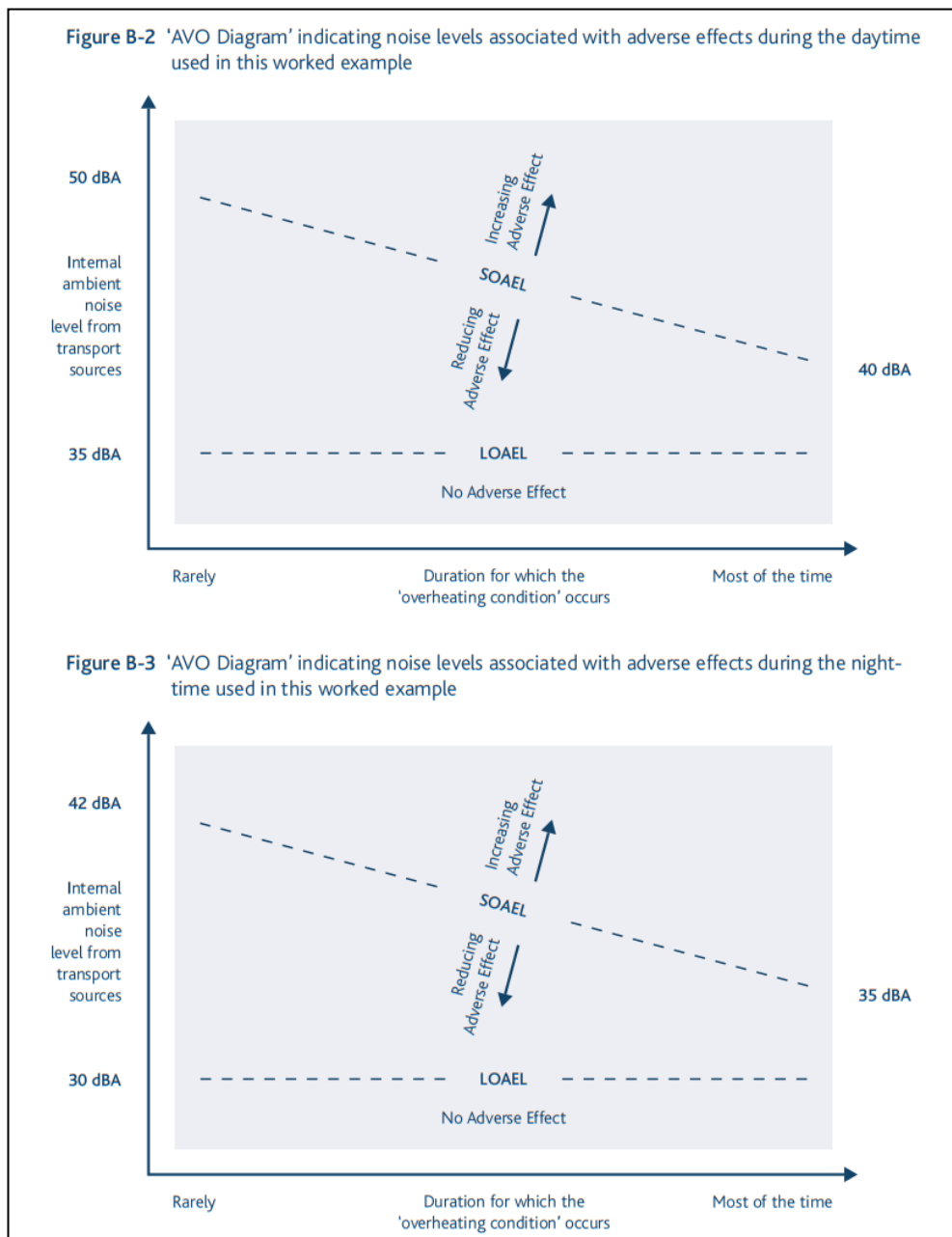
- There are other benefits for occupants from opening windows, such as the connection with the outside, sense of fresh air, experience of draughts when overheating, and sense of control over one's environment' and states that 'consideration of these factors is also beyond the scope of the AVO Guide.

Worked examples are provided in Appendix B of the AVO. These examples give suggested absolute dB levels for the SOAEL (Significant Observed Adverse Effect Level) and LOAEL (Lowest Observed Adverse Effect Level) curves in Figure 3-2. The LOAEL is defined as the level above which adverse effects on health and quality of life can be detected. The SOAEL is defined as the level above which significant adverse effects on health and quality of life occur.

The AVO advises that

- 'although for both LOAEL and SOAEL, 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.

Figures B-2 and B-3 from the AVO worked examples are reproduced below.



The AVO advises that the NPSE (Noise Policy Statement for England) states 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.

The AVO states that the suggested upper daytime noise limit of 50 dB $L_{Aeq,T}$ is defined on the basis that it represents the upper end of the range for reliable speech communication. The upper night time noise limit of 42 dB $L_{Aeq,T}$ is defined in the AVO with reference to the WHO Night Noise guidelines, which state that for external levels above 55dB $L_{Aeq,T}$, 'adverse health effects occur frequently and a sizeable proportion of the population is highly annoyed and sleep-disturbed'.

A noise level of 50dB $L_{Aeq,T}$ is also the upper limit for indoor long-term ambient noise within open plan offices recommended in BS8233: 2014 'Guidance on sound insulation and noise reduction for buildings'.

The value of 'T', the averaging period used to determine the 'average' noise level 'L_{Aeq,T}', is not defined in the AVO. However, when discussing the further work required to better understand the issue of noise disturbance when windows are opened to control overheating, AVO states that further information is required, including

- how long will people tolerate higher noise levels in order to stay cool? One suggestion is to consider the overall average day (16h) and night (8h) time average noise levels. There is some logic to this as we all know that we can tolerate high noise levels for a short duration and moderately high levels for a little longer.

With regard to the absolute dB noise levels representing the LOAEL and the SOAEL in Figures B-2 and B-3, AVO states:

- The values presented....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. the references 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.

Therefore, the noise levels identified in Figures B-2 and B-3 must be viewed with caution.

BUILDING REGULATIONS APPROVED DOCUMENT O, 2021

Require O1 of Approved Document O 'Overheating' of the Building Regulations states

- 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.

In the Secretary of State's view, requirement O1(2)(a) is met in a new residential building if the building's overheating mitigation strategy for use by occupants takes account of all of the following.

- a. Noise at night – paragraphs 3.2 - 3.4.
- b. Pollution – paragraphs 3.5
- c. Security – paragraphs 3.6 and 3.7.
- d. Protection from falling – paragraphs 3.8 - 3.10.
- e. Protection from entrapment – paragraph 3.11

Section 3: Ensuring the overheating strategy is usable

Noise

- 3.2. In locations where external noise may be an issue (for example, where the local planning authority considered external noise to be an issue at the planning stage), the overheating mitigation strategy should take account of the likelihood that windows will be closed during sleeping hours (11pm to 7am).
- 3.3 Windows are likely to be closed during sleeping hours if noise within bedrooms exceeds the following limits.
 - a. 40dB LAeq,T, averaged over 8 hours (between 11pm and 7am).
 - b. 55dB LAFmax, more than 10 times a night (between 11pm and 7am).
- 3.4 Where in-situ noise measurements are used as evidence that these limits are not exceeded, measurements should be taken in accordance with the Association of Noise Consultants' Measurement of Sound Levels in Buildings with the overheating mitigation strategy in use. Guidance on reducing the passage of external noise into buildings can be found in the National Model Design Code: Part 2 – Guidance Notes (MHCLG, 2021) and the Association of Noise Consultants' Acoustics, Ventilation and Overheating: Residential Design Guide (2020).

Therefore, Approved Document O, whilst referring to the AVO solely in relation to methods to reduce external noise ingress, only requires that internal noise levels within bedrooms at night achieve a certain criterion. No requirement for the achievement of daytime internal noise levels within dwellings in the overheating condition is presented in Approved Document O.

CIBSE TECHNICAL MEMORANDUM 59 'DESIGN METHODOLOGY FOR THE ASSESSMENT OF OVERHEATING RISK IN HOMES (TM59)'

CIBSE TM59 provides guidance on the assessment of overheating in dwellings. The document sets out a standardised methodology for predicting temperatures inside dwellings using dynamic thermal modelling and also provides overheating compliance criteria.

Dynamic thermal modelling has been carried out by Futureserv for a number of representative apartments within the proposed development at Tariff Street. The detailed output from the modelling studies is provided under separate cover.

The input parameters for the TM59 model for Tariff Street Blocks 1 and 2 are identified in Table 1.

Parameter	Performance
External wall U value (W/m2. K)	0.14
Windows U value (W/m2. K), incl frame	1.0
Roof U value (W/m2. K)	0.1
Windows G-value (Block 1 SE and SW facades, Block 2 SW facade)	0.35
Windows G-value (all other facades)	0.4
Façade layout	As per floor plans
Weather data	Manchester_DSY1_2020High50.epw
Airflow rates – bedrooms	8 l/s
Airflow rates – Living/Kitchen	13 l/s
Airflow rates – overheating bedrooms	11 l/s
Window opening conditions	Side-hung, openable to 90 degrees
Bedroom and living room ventilation opening hours profile (N & W facades)	Open 8am-11pm <u>and</u> when the temperature exceeds 22°C
Bedroom and living room ventilation opening hours profile (S & E facades)	Open when the temperature exceeds 22°C

Table 1: CIBSE TM59 model assumptions

The 'DSY1' weather data used in the model is the 30-year average of weather years from 2009 to 2039.

It will be noted that in the TM59 model, the windows to rooms on the north and west facades of Block 1 are prevented from opening between 11pm and 8am. Thus if compliance with the bedroom criterion of TM59 is achieved, then the windows to these bedrooms can remain closed all night and the internal night time noise criteria of Manchester City Council can be achieved.

It should be noted that the opening hours of the windows are based on the windows opening at an internal temperature of 22 deg C. It could be considered that the TM59 model represents a worst case in terms of opening hours, as not all occupants may feel the need to open a window at this temperature.

Furthermore, the TM59 modelling results identify the opening hours of the vent on the basis of the vent only closing when the internal temperature has dropped to 22 Deg C.

Therefore the opening hours of the windows identified by the TM59 model are not necessarily the opening hours required to maintain thermal comfort as determined by the individual occupant. It would be quite possible to achieve thermal comfort with shorter opening hours than those stipulated by the TM59 modelling results.

The building design incorporates the following measures to mitigate overheating:

- 1) Low G value (0.35 to 0.4) of windows to minimize solar heat gain to apartments
- 2) Continuously-running mechanical extract ventilation (MEV) units within each apartment
- 3) Passive ventilative cooling via opening windows

TARIFF STREET DEVELOPMENT SITE

The proposed development comprises two residential blocks, Blocks 1 and 2 located on a site between Port Street and Tariff Street.

EXTERNAL NOISE LEVELS

The prevailing noise levels at the development site have been determined by Fisher Acoustics by reference to noise surveys carried out around the site by Fisher Acoustics.

Figure 1 shows the external daytime average (LAeq) noise levels incident upon the lower-level façades of the proposed buildings.



Figure 1: Summary external daytime noise levels incident on each façade (dB LAeq)

Figure 2 shows the external night time average (LAeq) noise levels incident upon the lower-level façades of the proposed buildings.

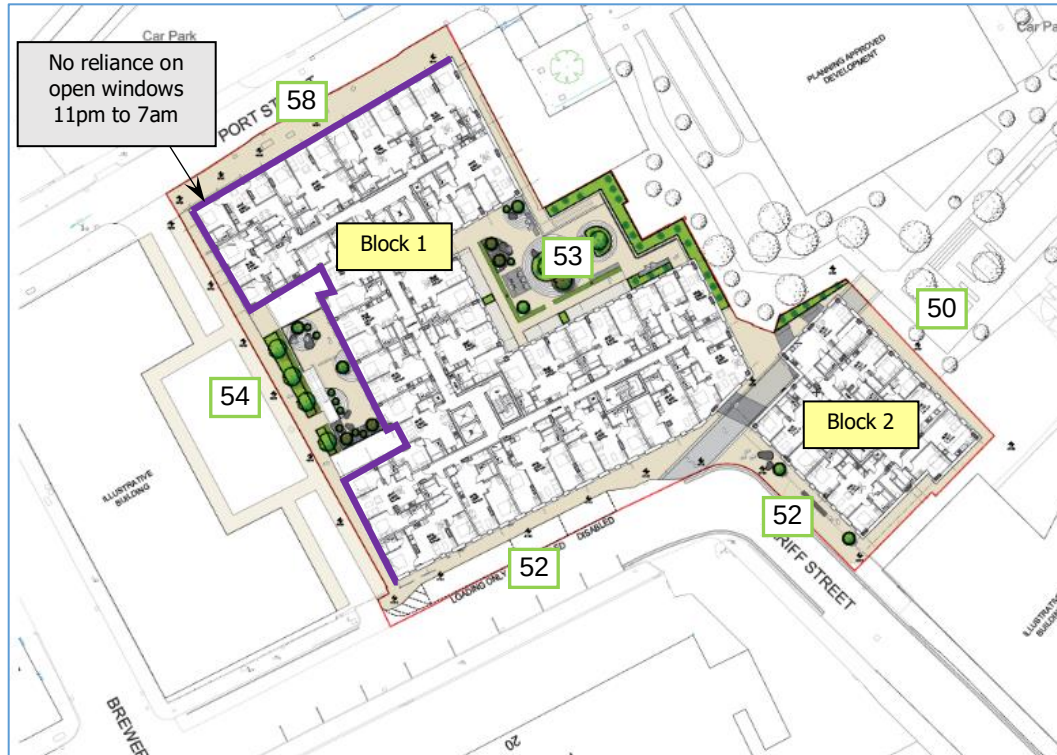


Figure 2: Summary external night time noise levels incident on each façade (dB LAeq)

Figure 2 identifies the elevations on which bedroom windows must remain closed overnight (11pm to 7am) in order to achieve the internal due to comply with Part O of the Building Regulations.

RESULTS OF TM59 DYNAMIC THERMAL MODELLING

Night time

The dynamic thermal modelling carried out by Futureserv has confirmed that the night time criterion of TM59 is achieved without the need to open windows to the bedrooms and of the apartments identified in Figure 2 between 11pm and 7am.

Therefore, bedrooms on the highlighted elevations will enjoy the full acoustic benefit of closed windows overnight whilst complying with both the ventilation requirements of Approved Document F and the thermal comfort criteria of TM59.

The TM59 model assumes that the windows to all other bedrooms can be opened as required between 7am and 7pm.

Daytime

As identified in Table 1 above, the TM59 model assumes that the windows to all bedrooms can be opened as required between 8am and 11pm.

In addition, the TM59 model assumes that the windows to living rooms can be opened as required between 8am and 11pm.

Potential average internal daytime noise levels in living rooms and bedrooms

Given the external noise levels identified in Figures 1 and 2 and the potential maximum opening hours during the day of 15 hours, the internal daytime noise levels in living rooms and bedrooms have been determined.

The potential internal noise level within apartment rooms with the windows open can be estimated by assuming a partially open window will provide an outside-to-inside level difference of 13 dB.

Tables 2 and 3 identify the expected daytime noise levels ($L_{Aeq,16}$ hours) and night noise levels ($L_{Aeq,8}$ hours) in the apartments of Block 1. The reported noise levels are applicable to all levels of the building

In reality, as thermal comfort could be maintained with shorter opening hours than those identified by the TM59 model, the internal noise levels could be lower than stated in Tables 2 and 3.

Elevation	Potential daytime internal noise level given windows open for 15 hours
	Open Plan Living Room/ Kitchen (dB $L_{Aeq,16hrs}$)
North	48
East	42
South	45
West	44

Table 2: Potential daytime internal noise level with open windows, Tariff Street Block 1

Elevation	Potential night time internal noise level given windows open for 8 hours
	Bedroom (dB LAeq,8hrs)
North	not applicable – windows closed
East	40
South	39
West	not applicable – windows closed

Table 3: Potential night time internal noise level with open windows, Tariff Street Block 1

The TM59 thermal modelling study for Block 1 has determined that living room windows would need to be opened for 15 hours during the day only for the months of July and August to achieve the TM thermal comfort criterion. During the months of May, June and September windows would only need to be opened for an average of 8 hours a day. During these months, average daytime internal noise levels would be approximately 3 dB lower than those identified on Table 2.

The TM59 thermal modelling study has also determined that bedroom windows would only need to be opened overnight in July and August to achieve the TM59 thermal comfort criterion, such that during all other months of the year bedroom windows can remain closed.

Therefore the internal noise levels identified in Tables 2 and 3 would only prevail for two months of the year.

Tables 4 and 5 identify the expected daytime noise levels (LAeq,16 hours) and night noise levels (LAeq,8 hours) in the apartments of Block 2. The reported noise levels are applicable to all levels of the building

In reality, as thermal comfort could be maintained with shorter opening hours than those identified by the TM59 model, the internal noise levels could be lower than stated in Tables 4 and 5.

Elevation	Potential daytime internal noise level given windows open for 15 hours
	Open Plan Living Room/ Kitchen (dB LAeq,16hrs)
North	39
East	39
South	not applicable (no opening windows)
West	43

Table 4: Potential daytime internal noise level with open windows, Tariff Street Block 2

Elevation	Potential night time internal noise level given windows open for 8 hours
	Bedroom (dB LAeq,8hrs)
North	37
East	37
South	not applicable (no opening windows)
West	39

Table 5: Potential night time internal noise level with open windows, Tariff Street Block 2

The TM59 thermal modelling study for Block 2 has determined that living room windows would need to be opened for 15 hours during the day only for the month of August to achieve the TM59 thermal comfort criterion. In July, living room windows would only need to be opened for an average of 8 hours a day, such that average daytime internal noise levels would be approximately 3 dB lower than those identified on Table 4.

During the months of May, June and September living room windows would only need to be opened for an average of 1 hour a day. During these months, average daytime internal noise levels would be approximately 12 dB lower than those identified on Table 4.

The TM59 thermal modelling study has also determined that in Block 2, bedroom windows would only need to be opened overnight in July and August to achieve the TM59 thermal comfort criterion, such that during all other months of the year bedroom windows can remain closed.

Therefore the internal noise levels identified in Tables 4 and 5 would only prevail for two months of the year.

SUMMARY & CONCLUSION

The potential effect of the control of overheating on the internal noise levels within the proposed apartments of Blocks 1 and 2, Tariff Street, Manchester has been assessed in line with 'Acoustics, Ventilation and Overheating, Residential Design Guide', (AVO) published by the Association of Noise Consultants and the Institute of Acoustics and with Approved Document O of the Building Regulations.

Dynamic thermal modelling has been carried out to determine whether the buildings within the proposed development achieve the performance criteria of CIBSE Technical Memorandum 59 (TM59).

In particular, the TM59 modelling results identify the daily opening hours of the windows to the proposed apartments on the basis that the windows are opened when the internal temperature within a room reaches 22 Deg C and are closed when the internal temperature has dropped to 22 Deg C. The daily opening hours are identified between the months of May and September.

Following detailed assessments, the building design incorporates the following measures to mitigate overheating:

- 1) Low G value (0.35 to 0.4) of windows to minimize solar heat gain to apartments
- 2) Continuously-running mechanical extract ventilation (MEV) units within each apartment
- 3) Passive ventilative cooling via opening windows

The modelling has confirmed that the night time temperature criterion of TM59 is achieved without the need to open windows to the bedrooms and living rooms of all apartments on the north and west elevations of Block 1 of the proposed development between the hours of 11pm and 7am. Therefore, the internal noise night time noise criteria of Manchester City Council for bedrooms at night time (30dB LAeq) can be achieved whilst avoiding overheating as defined by TM59.

The modelling has also confirmed that the windows to the remaining bedrooms are only required to open overnight for the warmest two months of the year to achieve the TM59 criterion. Given the measured external noise levels on these other elevations, the internal night time noise criteria of Approved Document O and the AVO guide can be achieved.

The modelling has confirmed that the noise levels within living rooms given the required opening hours of windows to achieve the TM59 criterion would achieve the recommended internal noise levels of the AVO guide.

The calculated noise levels are considered to be acceptable in the context of the control of overheating and with regard to the AVO Guide.