

# EVERY STREET, MANCHESTER

## TM59 OVERHEATING ANALYSIS

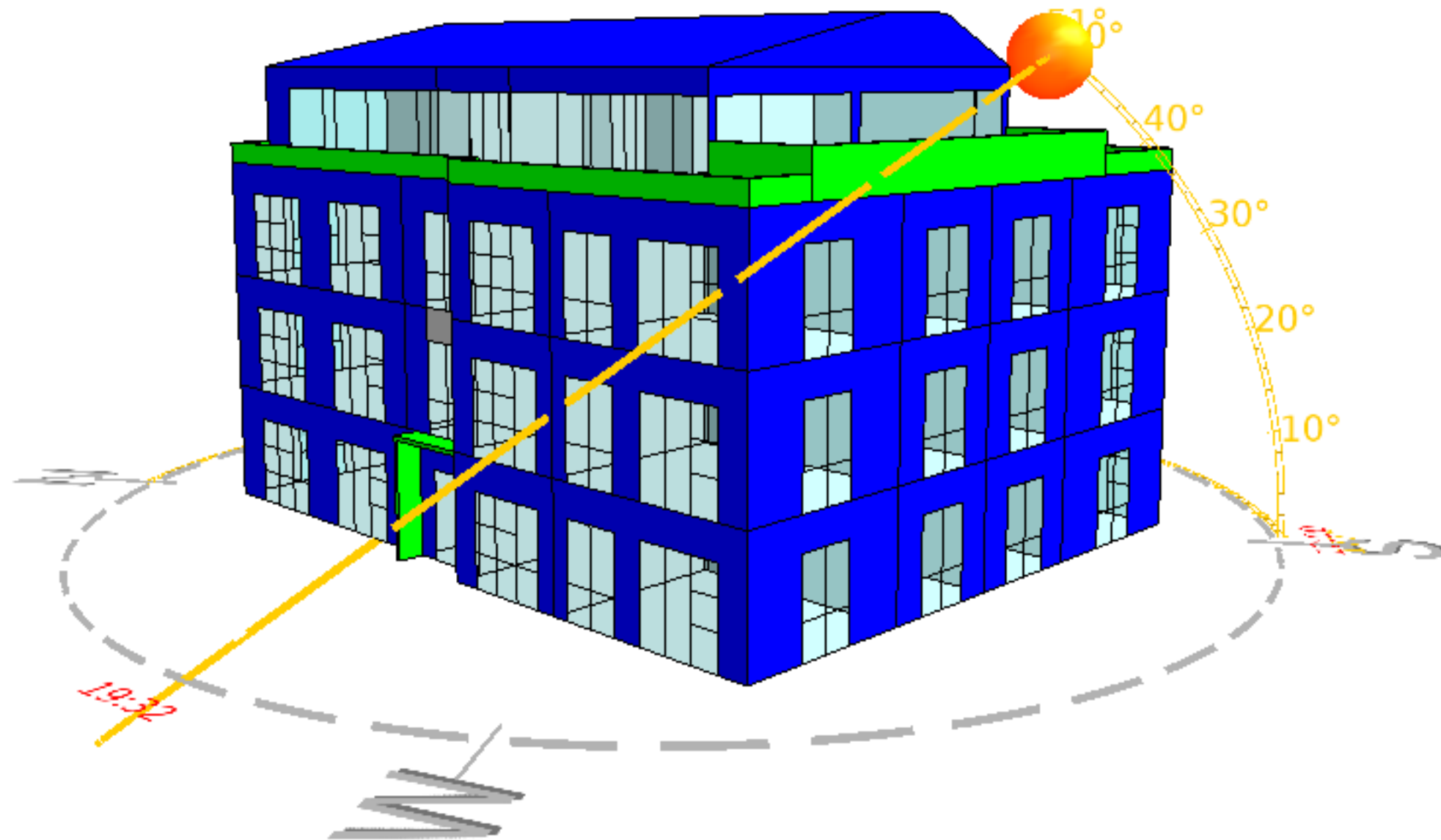
JUNE 2024

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# Every Street, Manchester, M4 7DQ

## CIBSE TM59 Overheating Analysis



OVERHEATING REPORT OF EVERY STREET, MANCHESTER

Contents

1    **Executive Summary** .....1

2    **Introduction** .....3

    2.1    *Project Scope* .....3

3    **OVERHEATING ASSESSMENT CRITERIA** .....4

4    **Design Principles** .....5

    4.1    *Limits on CIBSE's TM59 modelling* .....5

    4.2    *Limiting solar gains* .....6

    4.3    *Removing excess heat* .....6

5    **Design Criteria** .....7

    5.1    *Air permeability* .....7

    5.2    *External Envelope* .....7

    5.3    *Glazing Specification*.....7

    5.4    *Internal window blinds*.....7

    5.5    *Weather*.....7

    5.6    *Site & Orientation* .....7

6    **Reference data**.....8

7    **Internal Gains**.....9

    7.1    *Occupancy* .....9

    7.2    *Lighting* .....10

    7.3    *Equipment*.....10

8    **Ventilation** .....11

    8.1    *Natural ventilation*.....11

    8.2    *Internal Doors*.....11

    8.3    *Window Opening Schedule – Natural Ventilation Scenario* .....12

**8.4    WINDOW OPENING SCHEDULE – RESTRICTED WINDOW OPENINGS SCENARIO** .....13

    8.5    *Mechanical ventilation – Intermittent Extract Ventilation*.....14

    8.6    *Trickle Ventilators*.....14

    8.7    *Mechanical ventilation - MVHR* .....15

    8.8    *Mechanical ventilation – Mechanical Input Ventilation*.....16

9    **Ensuring the Overheating Strategy is Usable** .....17

    9.1    *Noise* .....17

    9.2    *Pollution* .....17

    9.3    *Security* .....17

    9.4    *Protection from Falling*.....17

10   **Results Summary** .....18

11   **Assessment Summary** .....19

12 Modelling Disclaimer .....20

13 Appendix A – Detailed Results – Model ran without Blinds or MVHR to Ground Floor Bedrooms.....21

14 Appendix B – Detailed Results – Model ran with Blinds .....22

15 Appendix C – Detailed Results – Model ran with Blinds – Restricted Window Openings Scenario .....23

16 Appendix D - Detailed Occupancy Schedules – CIBSE TM59 Heat gain Profile .....24

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## 1 EXECUTIVE SUMMARY

An overheating assessment has been undertaken for the 10 proposed apartments over 4 floors at the residential development of Every Street, Manchester, to demonstrate the potential conditions and risk of overheating.

The apartments have been informed with the information provided by the design team which align with the proposed SAP calculations. The TM59 results for the assessed dwellings have been produced and can be seen in the results section of this report.

The proposed ventilation strategy includes openable windows as per the architectural drawings/elevations and mechanical ventilation in the form of MVHR. Opening schedules are detailed within this report, with maximal permissible opening angles on all windows have been assumed (not exceeding the 650mm reach limit from the inside wall face as specified in *Approved Document K*), whereas patio doors have assumed to be entirely openable.

Modelling has found ground floor bedrooms require a form of mechanical supply ventilation to rates of around 20l/s when internal temperatures exceed 22°C per space due to the window opening restrictions, this can be achieved by the installed MVHR units.

A glazing g value of 0.62 has been considered, whilst blinds have been modelled on all windows to prevent excessive solar gains. As per TM59 guidance, the blinds must be demonstrated to not interfere with the opening of the window, therefore careful consideration should be taken to the proposed window / blinds design.

The described strategy as outlined above works on the assumption there are no noise / air quality restrictions imposed on the site which would prevent or limit the ventilation strategy – which has been found to mitigate the overheating risk to the apartments.

### **Restricted Window Openings Scenario**

However, a scenario where the noise from the nearby road(s) prevents the use of openable windows to bedroom spaces for overheating mitigation has also been modelled. A solution to this scenario is to apply the same MVHR units to all bedrooms throughout the development as like those required on ground floor bedrooms in the existing ventilation strategy – which has been found to be a working solution for the site. The results to this scenario can be found in Appendix C to the foot of this report.



Figure 1: IES Models 3D view and site plan of the proposed development

### Assessment findings

The assessment found the assessed dwellings are able to meet the TM59 overheating criteria and therefore achieve TM59 compliance with the building design described in this report. A summary of measures that form the overheating mitigating strategy include:

- Natural ventilation via window openings as per the architectural drawings
- Window openings to be opened to maximal permissible opening angles in accordance with Approved Document K (safeguarding measures may be required)
- Glazing solar performance (g value) of 0.62
- Mechanical supply ventilation (by MVHR) to rates of 20l/s.
- Internal blinds to all glazing (demonstrated to not interfere with window opening free areas)

| Floor | Description                                                                  | Plots Covered | No. Apartments | Overheating Strategy Summary                                                                                                                                                         | TM59 Compliance | Notes                                                                                                                                                   |
|-------|------------------------------------------------------------------------------|---------------|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| 00    | Ground floor apartments,<br>1no. 1 Bed   2 Persons<br>2no. 2 Bed   4 Persons | 1,2 & 3       | 3              | <ul style="list-style-type: none"> <li>• Natural Ventilation via unrestricted opening windows</li> </ul>                                                                             | ☑               | 20l/s supply ventilation to <u>ground floor bedrooms only</u> via MVHR units                                                                            |
| 01    | First floor apartments,<br>1no. 3 Bed   5 Persons<br>2no. 2 Bed   4 Persons  | 4, 5 & 6      | 3              | <ul style="list-style-type: none"> <li>• Glazing g value of 0.62</li> <li>• Internal blinds to all glazing (demonstrated to not interfere with window opening free areas)</li> </ul> | ☑               | Passive overheating strategy sufficient to apartments on floors 1 and above provided there are no window opening restrictions.                          |
| 02    | Second floor apartments,<br>1no. 3 Bed   5 Persons<br>2no. 2 Bed   4 Persons | 7, 8 & 9      | 3              | <ul style="list-style-type: none"> <li>• 20l/s supply ventilation to <u>ground floor bedrooms only</u> via MVHR units</li> </ul>                                                     | ☑               | In the event of requiring all bedroom windows to be closed - 20l/s supply ventilation via MVHR units is extended to all bedrooms across the development |
| 03    | Third floor apartment,<br>1no. 3 Bed   6 Persons                             | 10            | 1              |                                                                                                                                                                                      | ☑               |                                                                                                                                                         |
|       |                                                                              |               | 10             |                                                                                                                                                                                      |                 |                                                                                                                                                         |

## 2 INTRODUCTION

### 2.1 PROJECT SCOPE

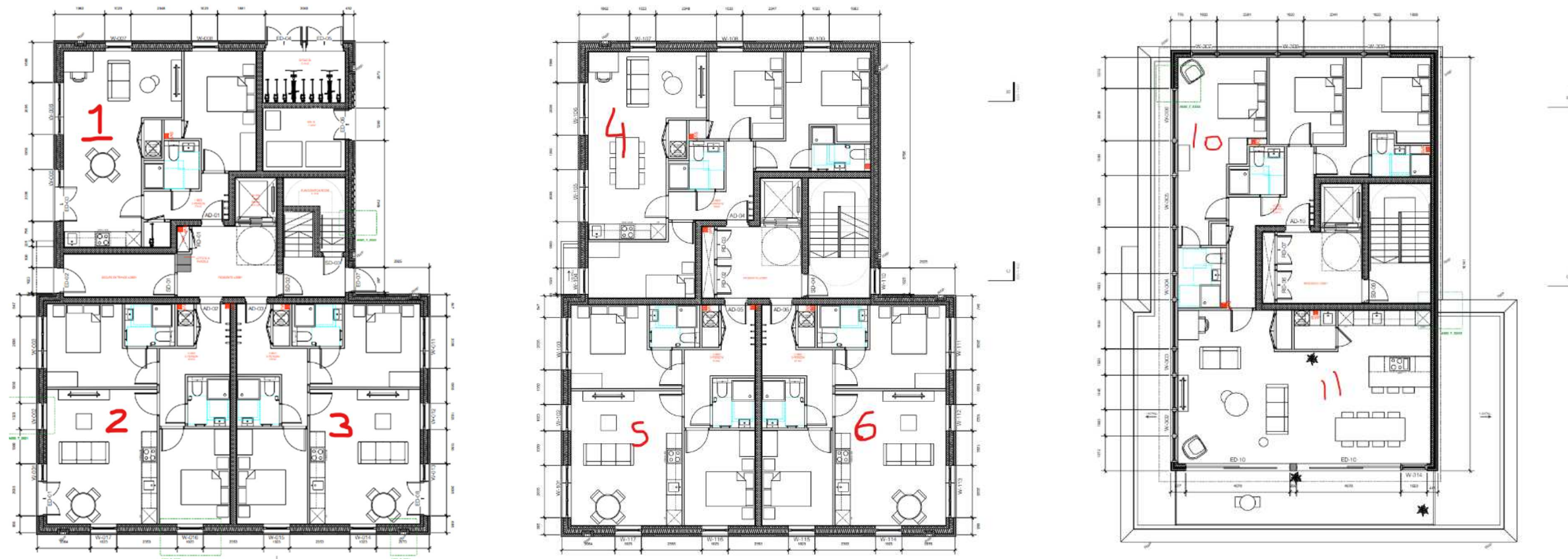
This report has been prepared in support of the planning application only for the construction of the 10 proposed apartments over 4 storeys on the Every Street residential development, Manchester.

This report assesses the overheating risk of the dwellings. The intention is that this study helps inform and verify the design proposals, thereby providing the basis for mitigating overheating risk and producing a building that provides comfortable environmental conditions for occupants.

It is important to note that with any modelling exercise there are assumptions and approximations that have to be made. As far as possible, details of all assumptions and approximations are supplied within the report. These were predominantly informed by information provided by design team and should be reviewed carefully.

All results are based on the output from computer modelling software and should be taken as an indication of the likely final situation, but these conditions cannot be guaranteed.

Moreover, this Overheating Assessment across the development supports the Planning Application and demonstrate that the proposed development complies with the relevant current guidance CIBSE TM59: Design Methodology for the Assessment of Overheating Risk in Homes (2017).



*Figure 2: Floor Plans of Proposed Development (Ground Floor left, First and Second Floors middle, Third Floor right)*

### 3 OVERHEATING ASSESSMENT CRITERIA

TM59 sets different overheating compliance criteria for homes that are predominantly naturally ventilated and for homes that are predominantly mechanically ventilated.

For homes that are predominantly naturally ventilated, the method with two criteria should be used to assess overheating. The first overheating criteria, which applies to both living rooms/kitchens and bedrooms, is an adaptive criteria. The second overheating criterion is a fixed temperature criteria which applies only to bedrooms. Both criteria must be met for all spaces within a home to demonstrate compliance.

For mechanically ventilated homes, the fixed temperature method with a single criterion should be used to assess overheating. This single criterion must be met for all spaces (living rooms/kitchens and bedrooms) within a mechanically ventilated home to demonstrate compliance.

The TM59 criteria for naturally and mechanically ventilated homes are summarised in the following table. The dwellings in this assessment are assessed against 'predominantly naturally ventilated' criteria.

All criteria must be met for all spaces within a home to demonstrate full compliance.

Table 3: Overheating Assessment Categorisation

| Assessment Type                      | Assessment Criteria | Applicable Rooms                    | Occupied Hours                                                                               | Naturally Ventilated Homes (open windows)                                                                                                                                                                          | Mechanically Ventilated Homes (closed windows)                                                                                                                                                                                                                                     |
|--------------------------------------|---------------------|-------------------------------------|----------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Predominantly Natural Ventilation    | Criterion 1         | Living rooms, kitchens and bedrooms | Living / Kitchen / Dining rooms – 9am to 10pm (13 hours/day)<br>Bedrooms – 24-hour occupancy | The number of hours during which external and internal temperature difference is greater than or equal to one degree (K) during the period May to September inclusive shall not be more than 3% of occupied hours. | Not Applicable                                                                                                                                                                                                                                                                     |
|                                      | Criterion 2         | Bedrooms only                       | Bedrooms – 24-hour occupancy                                                                 | The operative temperature in the bedroom from 10 pm to 7 am shall not exceed 26 °C for more than 1% of annual hours.<br>33 or more hours above 26 °C will be a fail                                                | Not Applicable                                                                                                                                                                                                                                                                     |
| Predominantly Mechanical Ventilation | Criterion 3         | Living rooms, kitchens and bedrooms | Living / Kitchen / Dining rooms – 9am to 10pm (13 hours/day)<br>Bedrooms – 24-hour occupancy | Not applicable                                                                                                                                                                                                     | The operative temperature in occupied all occupied rooms should not exceed 26 °C for more than 3% of the annual occupied annual hours.<br>143 or more hours above 26 °C for living rooms and kitchens will be a fail.<br>263 or more hours above 26 °C for bedrooms will be a fail |

## 4 DESIGN PRINCIPLES

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To demonstrate compliance using the dynamic thermal modelling method, all of the following have been followed:

- a) CIBSE TM59 methodology for predicting overheating risk
- b) The limits on the use of CIBSE TM59 methodology set out below
- c) The acceptable strategies for reducing overheating risk

### 4.1 LIMITS ON CIBSE'S TM59 MODELLING

All of the following limits on CIBSE's TM59, section 3.3 apply.

- a) When a room is occupied during the day (8am to 11pm), openings should be modelled to do all of the following:
  - i. Start to open when the internal temperature exceeds 22°C
  - ii. Be fully open when the internal temperature exceeds 26°C
  - iii. Start to close when internal temperature falls below 26°C
  - iv. Be fully closed when the internal temperature falls below 22°C
- b) At night (11pm to 8am), openings should be modelled as fully open if both of the following apply:
  - i. The opening is on the first floor or above and not easily accessible
  - ii. The internal temperature exceeds 23°C at 11pm.
- c) When a ground floor of easily accessible room is unoccupied, both of the following apply:
  - i. In the day, windows, patio doors and balcony doors should be modelled as open, if this can be done securely, following the guidance in paragraph 3.7 below.
  - ii. At night, windows, patio doors and balcony doors should be modelled as closed.

An entrance door should be included, which should be shut all the time.

Acceptable strategies for reducing overheating risk

## **4.2 LIMITING SOLAR GAINS**

Solar gains in summer should be limited by any of the following means:

- a) Fixed shading devices, comprising any of the following.
  - i. Shutters
  - ii. External blinds
  - iii. Overhangs
  - iv. Awnings
- b) Glazing design, involving any of the following solutions
  - v. Size
  - vi. Orientation
  - vii. g-value
  - viii. Depth of the window reveal
- c) Building design – for example, the placement of balconies
- d) Shading provided by adjacent permanent buildings, structures, or landscaping.

## **4.3 REMOVING EXCESS HEAT**

Excess heat should be removed from the residential building by any of the following means.

- a) Opening windows (the effectiveness of this method is improved by cross-ventilation)
- b) Ventilation louvres in external walls
- c) A mechanical ventilation system
- d) A mechanical cooling system

## 5 DESIGN CRITERIA

The following general criteria have been used throughout the simulation:-

### 5.1 AIR PERMEABILITY

An air infiltration rate of 0.25ACH has been applied to all 10 apartments based on Table 4.24 of CIBSE Guide A for an air permeability target of 5 m<sup>3</sup>/(h · m<sup>2</sup>).

### 5.2 EXTERNAL ENVELOPE

The following U-values have been used:-

| Element        | Proposed U-value (W/m <sup>2</sup> K) | Part L1A U-value (W/m <sup>2</sup> K) |
|----------------|---------------------------------------|---------------------------------------|
| External Walls | 0.20                                  | 0.18                                  |
| Exposed floor  | 0.12                                  | 0.13                                  |
| Roof           | 0.15                                  | 0.11                                  |
| Glazing        | 1.00                                  | 1.40                                  |
| Doors          | 1.20                                  | 1.00                                  |

Building envelope U-values

### 5.3 GLAZING SPECIFICATION

The glazing is based on a G-value of 0.62

### 5.4 INTERNAL WINDOW BLINDS

Internal blinds have been included in the calculations. The blinds have been modelled with a shading coefficient of 0.4 and a Short-wave radiant fraction of 0.3. Careful consideration should be taken when selecting the blinds as they must be demonstrated to not restrict/interact with the window openings.

### 5.5 WEATHER

The building is to be located in Manchester. Weather file used in the calculation:- Manchester\_DSY1\_2020High50\_.epw. The peak summer temperature is 30°C.

### 5.6 SITE & ORIENTATION

The dwelling has been modelled in its correct orientation as per the Site Plan Drawing.

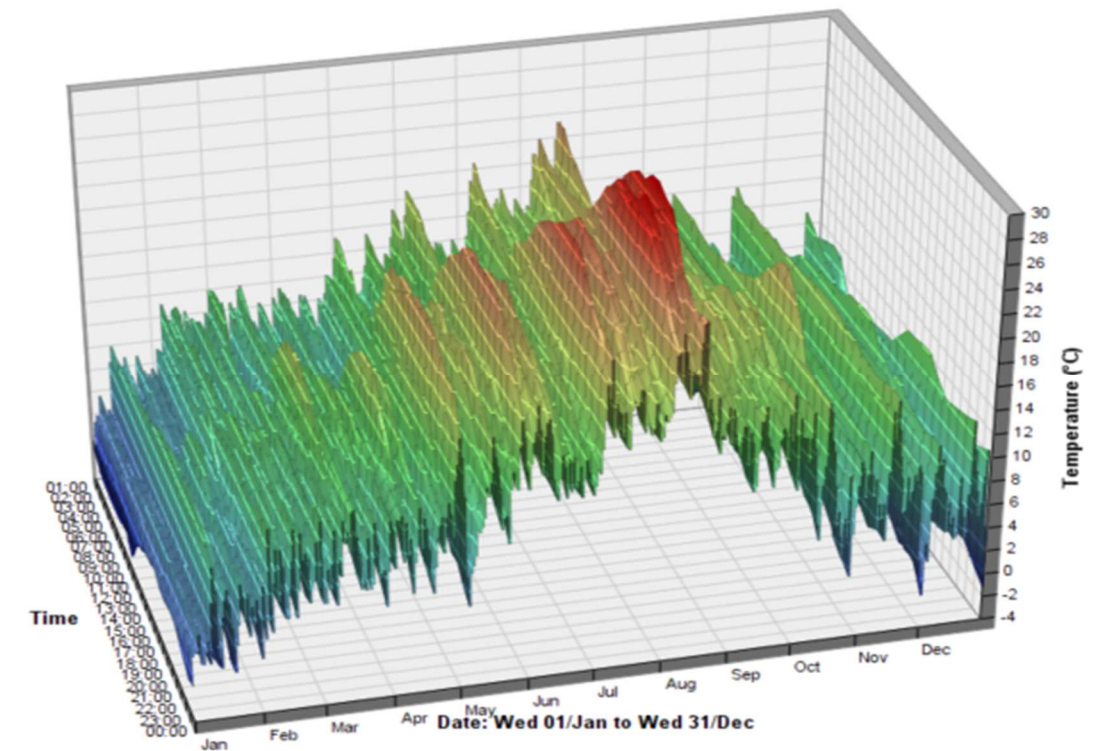


Figure 3: Annual dry-bulb temperature graph of modelled weather file

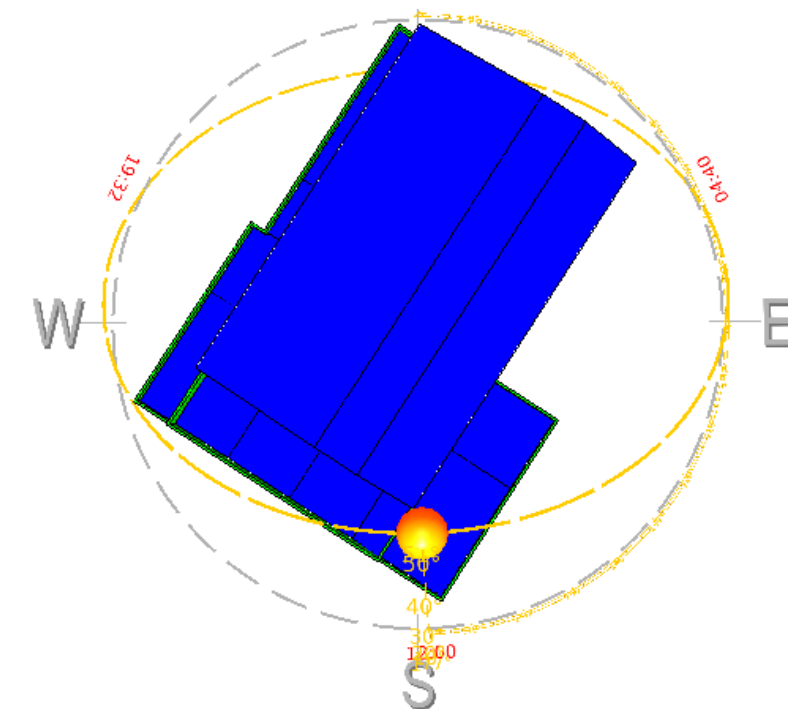


Figure 4: Site orientation of the proposed development

## 6 REFERENCE DATA

### Architectural Drawings (Ollier Smurthwaite Architects)

#### Floor Plans

Ground Floor - A695-T-110B

First Floor - A695-T-111B

Second Floor - A695-T-112B

Third Floor - A695-T-113B

#### Elevations

North Elevation - 695-T-310B

East Elevation - 695-T-311B

South Elevation - 695-T-311B

West Elevation - 695-T-313B

#### Sections

Section AA - 695-T-400

Section BB - 695-T-401

Section CC - 695-T-402

#### Site Plan

A695-T-101A

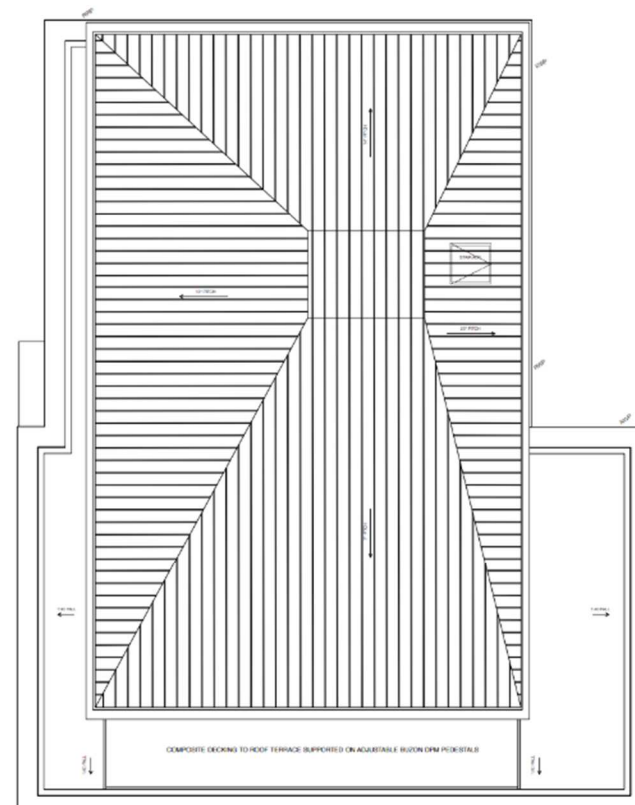
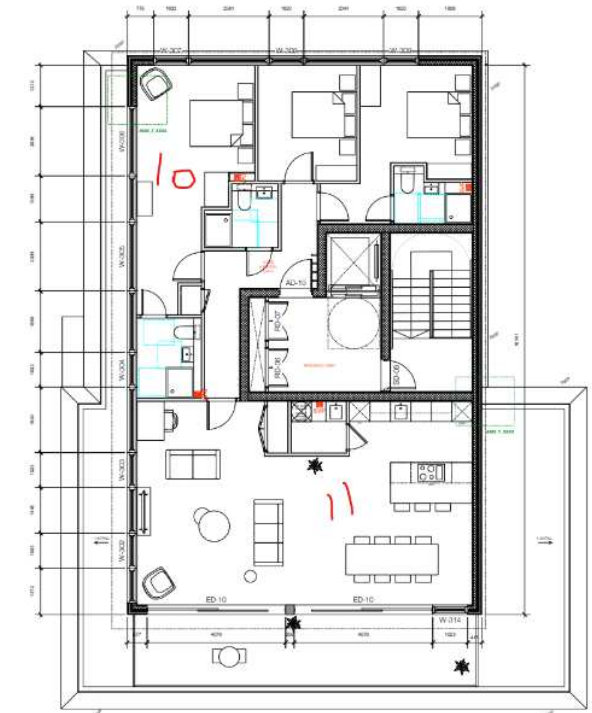
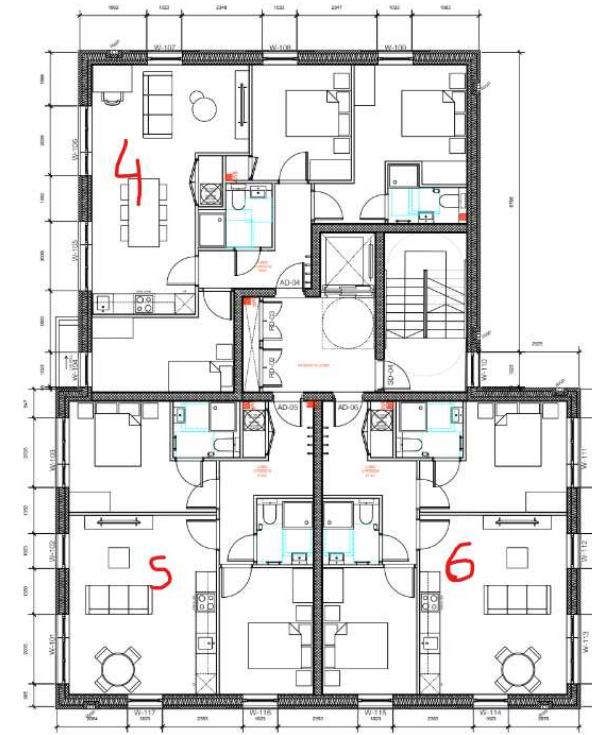
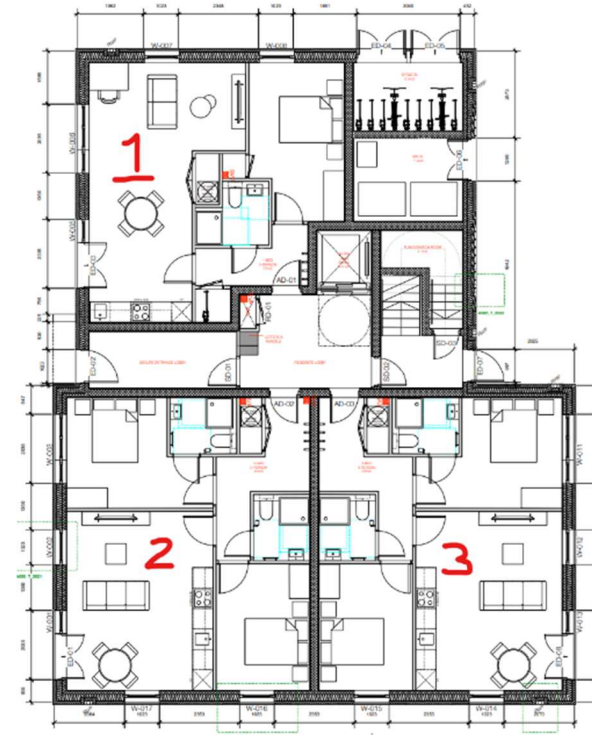


Figure 5: Selection of architectural drawings examples used to inform thermal model

## 7 INTERNAL GAINS

The internal gains used throughout the simulations are detailed below. No differences between weekdays and weekends are considered. Bedrooms are set with a 24 hour occupancy profile which means that one person is always considered in each bedroom during the daytime and two people in each double bedroom at night. Kitchen/living rooms are unoccupied during sleeping hours and occupied during the rest of the day. Occupied periods are totalled as 3672 hours per year for bedrooms (24/7 May to September) and 1989 hours for living areas (13 hours per day May to September).

See Appendix C for a detailed CIBSE TM59 internal gain schedule.

### 7.1 OCCUPANCY

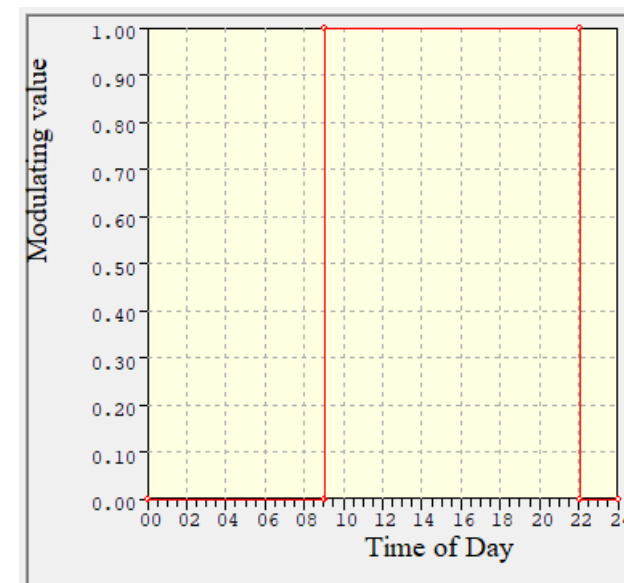
Based on CIBSE Guide A (2015a), a maximum sensible heat gain of 75W/person is assumed in the living spaces. An allowance for 30% reduced gain during sleeping is based on Addendum g to ANSI/ASHRAE Standard 55-2010.

| Activity | Sensible heat gain per person (W) |
|----------|-----------------------------------|
| Standard | 75                                |
| Sleeping | 55                                |

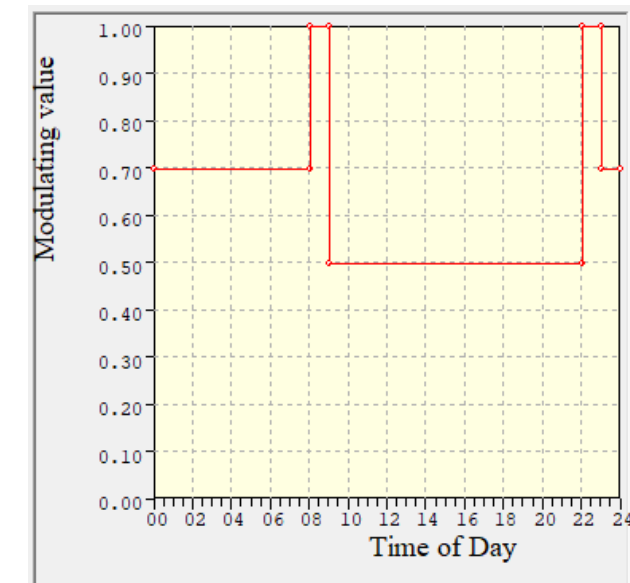
#### Occupant Gains

| Unit/room type              | Occupancy                                                                                                                                      |
|-----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1 bed living/kitchen</b> | 1 person from 9am to 10pm<br>room is unoccupied for the rest of the day                                                                        |
| <b>2 bed living/kitchen</b> | 2 people from 9am to 10pm<br>room is unoccupied for the rest of the day                                                                        |
| <b>3 bed living/kitchen</b> | 3 people from 9am to 10pm<br>room is unoccupied for the rest of the day                                                                        |
| <b>Double bedroom</b>       | 2 people at 70% gain from 11pm to 8am<br>2 people at full gain from 8am to 9am and from 10pm to 11pm<br>1 person at full gain from 9am to 10pm |
| <b>Single bedroom</b>       | 1 person at 70% gain from 11pm to 8am<br>1 person at full gain from 8am to 11pm                                                                |

#### Occupancy



Typical living/kitchen occupancy profile



Typical double bedroom occupancy profile

## 7.2 LIGHTING

Lighting energy is assumed to be proportional to floor area. A default value of 2W/m<sup>2</sup> is applied to all occupied areas from 6pm to 11 pm.

| Zone Type                             | Gain (W/m <sup>2</sup> ) |
|---------------------------------------|--------------------------|
| living/kitchen/dining areas, bedrooms | 2<br>0                   |

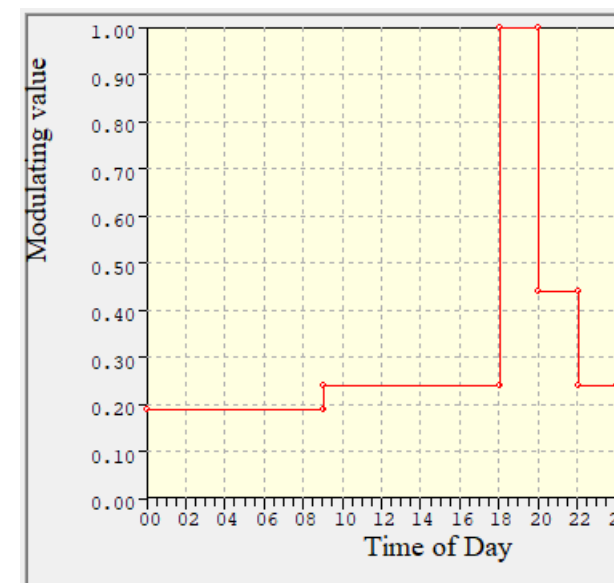
Lighting gains

## 7.3 EQUIPMENT

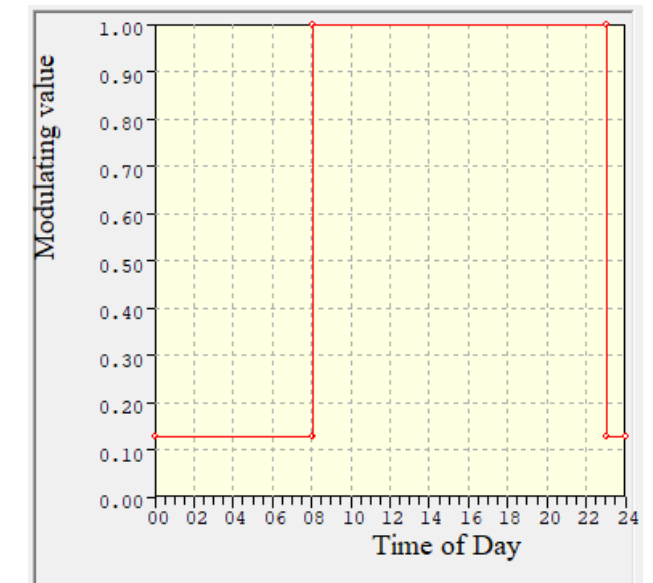
Equipment gains per room type are listed in the table below.

| Unit/room type              | Load                                                                                                                                            |
|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1 bed living/kitchen</b> | Peak load of 450W from 6pm to 8pm<br>200W from 8pm to 10pm<br>110W from 9am to 6pm and 10pm to 12pm<br>Base load of 85W for the rest of the day |
| <b>2 bed living/kitchen</b> | Peak load of 450W from 6pm to 8pm<br>200W from 8pm to 10pm<br>110W from 9am to 6pm and 10pm to 12pm<br>Base load of 85W for the rest of the day |
| <b>3 bed living/kitchen</b> | Peak load of 450W from 6pm to 8pm<br>200W from 8pm to 10pm<br>110W from 9am to 6pm and 10pm to 12pm<br>Base load of 85W for the rest of the day |
| <b>Double bedroom</b>       | Peak load of 80W from 8am to 11pm<br>Base load of 10W during sleeping hours                                                                     |
| <b>Single bedroom</b>       | Peak load of 80W from 8am to 11pm<br>Base load of 10W during sleeping hours                                                                     |
| <b>Communal corridors</b>   | Assumed to be zero                                                                                                                              |

Equipment gains



Typical living/kitchen equipment profile



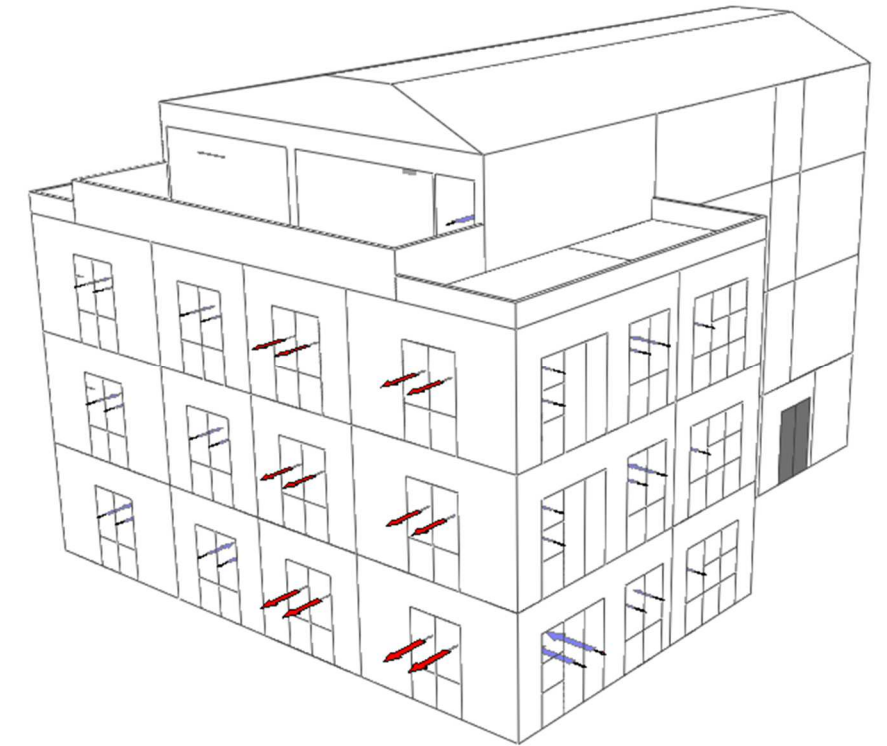
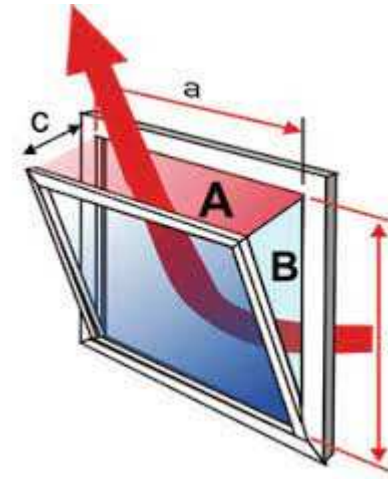
Typical double bedroom equipment profile

## 8 VENTILATION

### 8.1 NATURAL VENTILATION

The windows have been modelled using an opening profile that simulates the occupants within the rooms opening the windows when the internal air temperature reaches 22°C, as stipulated by *TM59*. The same procedure operates in reverse as the air temperature cools.

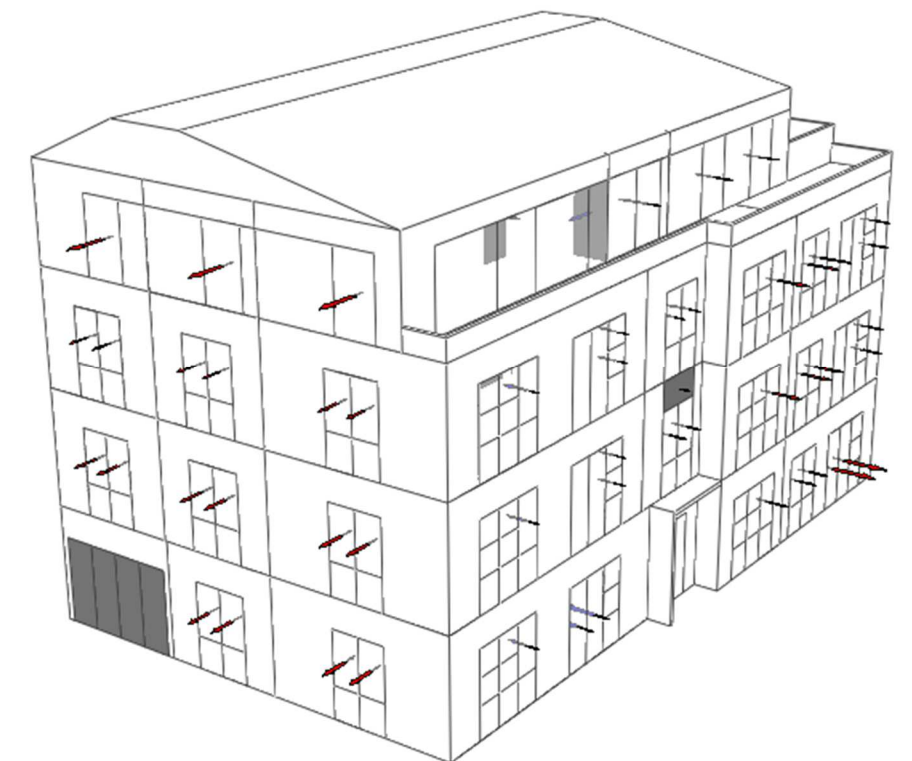
The free area is a way of measuring what the equivalent completely open area is for a glazing assembly. Sufficient free area to the opening windows in a dwelling is vital to the overheating mitigation strategy and can be calculated using the combined areas of A+B (in m<sup>2</sup>).



### 8.2 INTERNAL DOORS

It is recommended for dwelling occupants to keep internal doors open at all times where possible so to allow air movement between rooms. Openable windows in non-habitable spaces such as landing/halls and bathrooms have been modelled and can contribute to the overall natural ventilation strategy for the dwelling.

*TM59* stipulates bedroom doors must be modelled to be closed during sleeping hours, however there are no constraints during the day and are therefore modelled as open. All non-bedroom doors are considered open on a 24/7 basis.



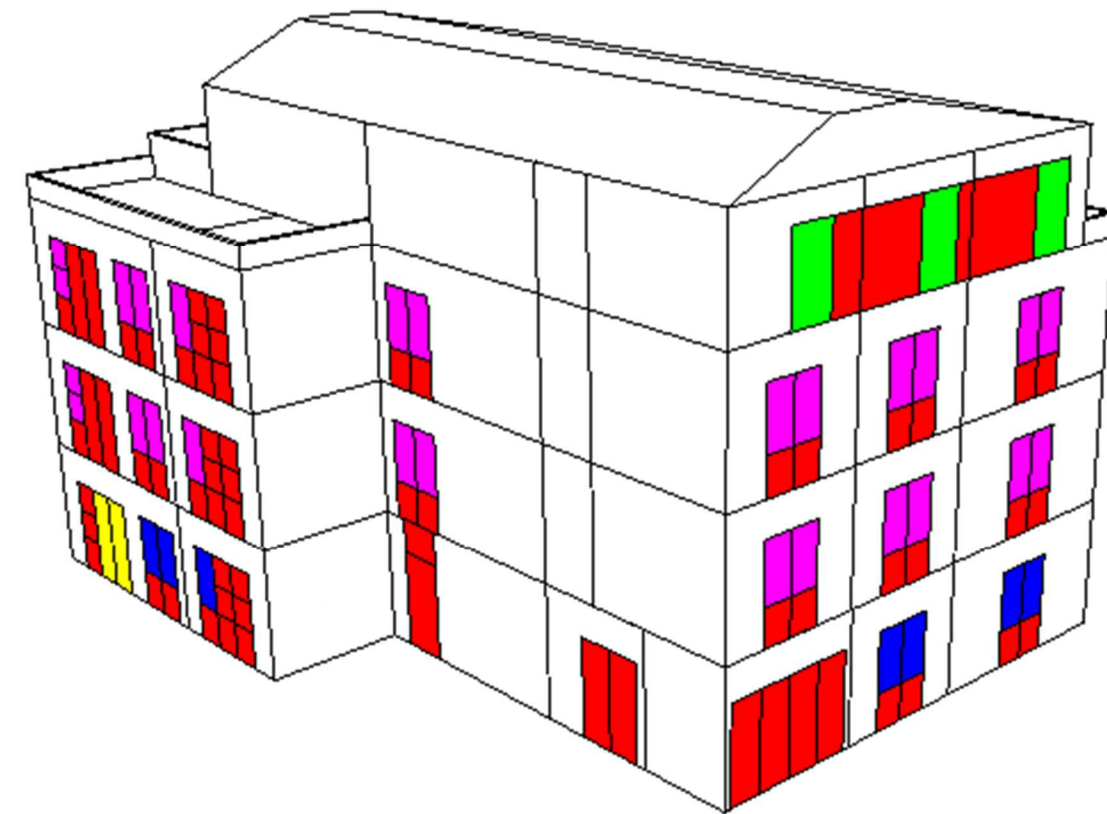
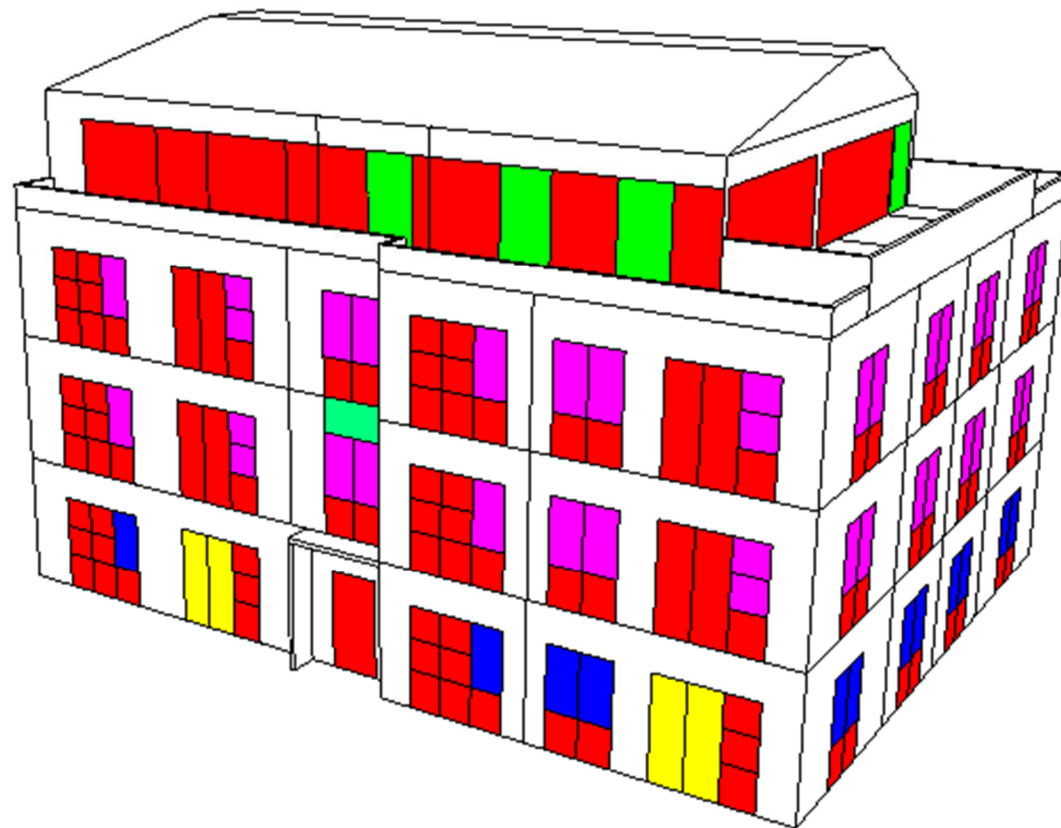
### 8.3 WINDOW OPENING SCHEDULE – NATURAL VENTILATION SCENARIO

Opening Schedule Description:

- **Window/Door Closed:** Fixed pane, unopenable
- **Openable Window (day):** Window opening, night closed
- **Openable Window (night):** Doors opening, night open
- **Patio Doors (day):** Doors opening, night closed

#### Opening Type

- XTRN0000 (Window / Door Closed)
- XTRN0002 (Internal Doors Living)
- XTRN0003 (Internal Doors Bedrooms)
- XTRN0004 (Patio Doors (Day))
- XTRN0005 (Openable Window (Day))
- XTRN0006 (Openable Window (Third Floor) (Night))
- XTRN0007 (Openable Window (Night))



*Figure 7: Window opening schedule key of the proposed apartment block*

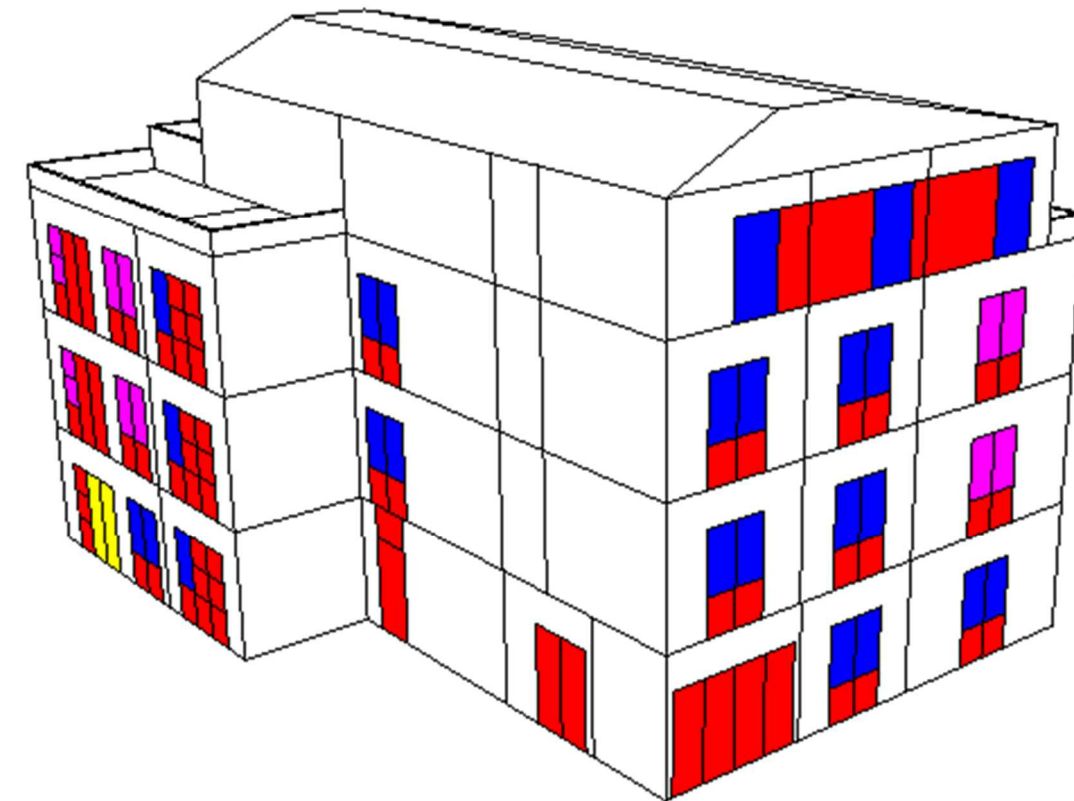
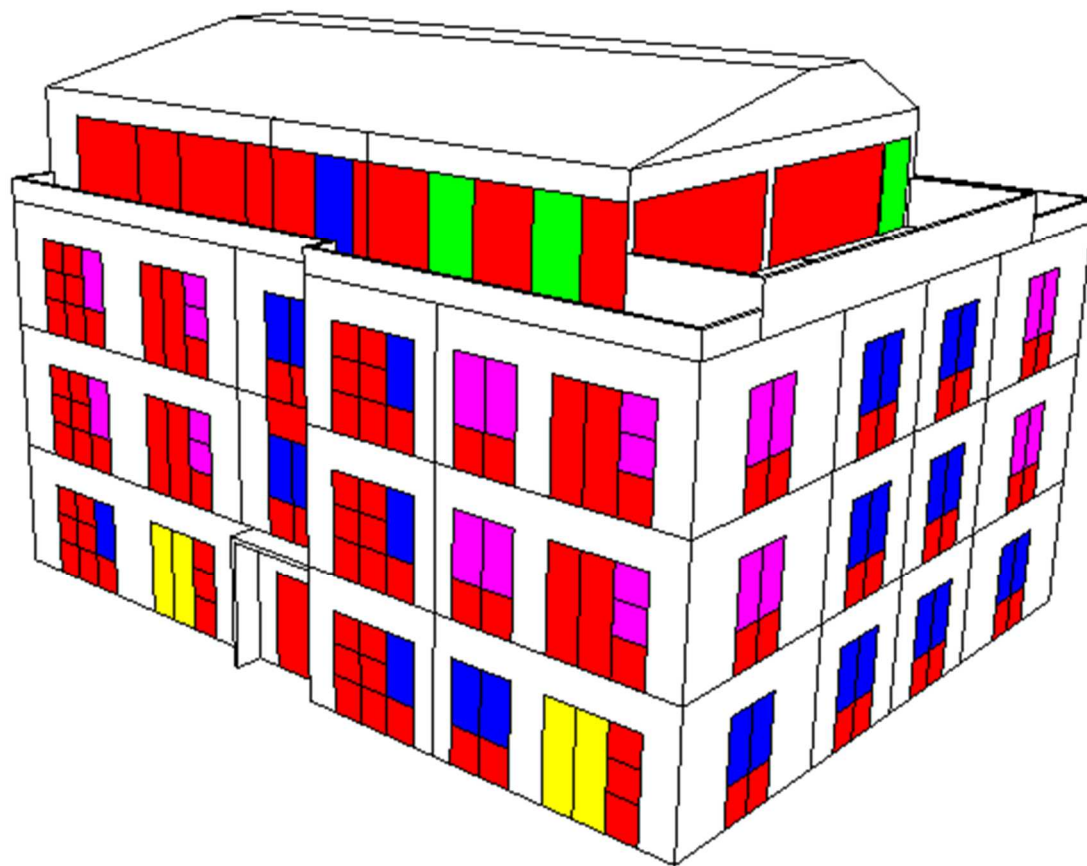
#### 8.4 WINDOW OPENING SCHEDULE – RESTRICTED WINDOW OPENINGS SCENARIO

Opening Schedule Description:

- **Window/Door Closed:** Fixed pane, unopenable
- **Openable Window (day):** Window opening, night closed
- **Openable Window (night):** Doors opening, night open
- **Patio Doors (day):** Doors opening, night closed

##### Opening Type

- XTRN0000 (Window / Door Closed)
- XTRN0002 (Internal Doors Living)
- XTRN0003 (Internal Doors Bedrooms)
- XTRN0004 (Patio Doors (Day))
- XTRN0005 (Openable Window (Day))
- XTRN0006 (Openable Window (Third Floor) (Night))
- XTRN0007 (Openable Window (Night))



## 8.5 MECHANICAL VENTILATION – INTERMITTENT EXTRACT VENTILATION

Mechanical ventilation in the form of intermittent extract ventilation is a low energy; intermittent extract ventilation system and is designed to remove dirty air within wet rooms (e.g. Kitchens and Bathrooms). These fans are On or Off dependent on manual controls or linked to a light switch with a run-on timer (typically 15 minutes). The minimum extract rates for intermittent systems must meet those shown below in Table 1.1 – taken from AD F.

As there is no supply ventilation with this system, trickle ventilators must be installed above windows and doors for supply/preplacement air.

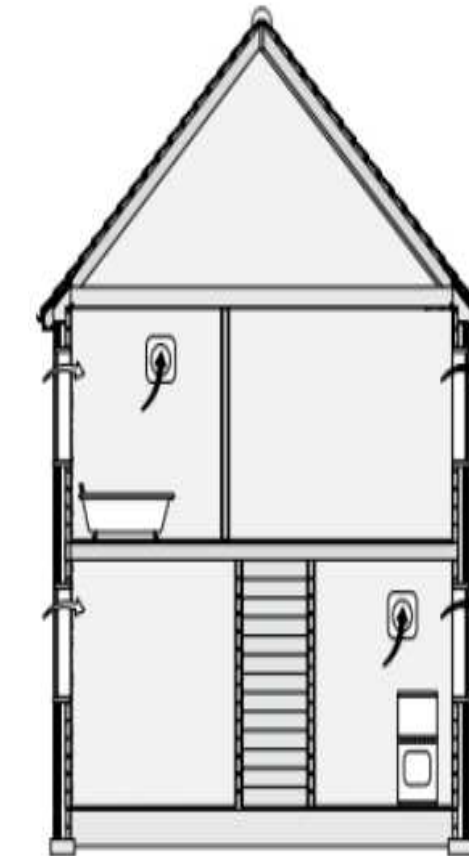
For more information, please refer to *Approved Document F, Volume 1: Dwellings*.

## 8.6 TRICKLE VENTILATORS

As per section 1.64 of *Approved Document F*, where intermittent extract ventilation is present, supply/replacement air is to be provided by trickle ventilators in windows and meet the following conditions:

- Not be in wet rooms
- Provide a minimum equivalent area of 4000mm<sup>2</sup> for each habitable room in the dwelling
- Provide a minimum total number of ventilators that is the same as the number of bedrooms plus two ventilators (i.e. a one-bedroom dwelling should have three background ventilators, a two bedroom dwelling should have four background ventilators, etc.)

Background ventilators  
and intermittent extract fans



*Figure 8: Depiction of intermittent extract systems*

**Table 1.1 Minimum extract ventilation rates for intermittent extract systems**

| Room                                                                                   | Intermittent extract rate (l/s) |
|----------------------------------------------------------------------------------------|---------------------------------|
| Kitchen (cooker hood extracting to the outside) <sup>(1)</sup>                         | 30                              |
| Kitchen (no cooker hood or cooker hood does not extract to the outside) <sup>(2)</sup> | 60                              |
| Utility room                                                                           | 30                              |
| Bathroom                                                                               | 15                              |
| Sanitary accommodation <sup>(3)</sup>                                                  | 6                               |

**NOTES:**

- See Diagram 1.1
- See Diagram 1.2.
- As an alternative for sanitary accommodation, the purge ventilation guidance may be used.

## 8.7 MECHANICAL VENTILATION - MVHR

Mechanical ventilation in the form of MVHR is proposed for all dwellings. To mitigate overheating, MVHR is required for all ground floor apartments only as they are impacted by the window opening restrictions of TM59 in the natural ventilation scenario. However, this strategy is required to be implemented to all bedrooms throughout the development in the restricted window openings scenario.

This is a low energy, continuous mechanical ventilation system designed to replace conventional extract ventilation systems (such as intermittent systems) by drawing moisture laden air out of the kitchen and wet rooms (bathrooms and utility) while supplying fresh air to habitable rooms such as Bedrooms and Living spaces.

An additional benefit is an air pathway is also formed drawing warm air out of habitable spaces and evacuated from the dwelling, with the makeup air being provided by mechanically supplied air from the unit in addition to any windows in habitable spaces (when opened).

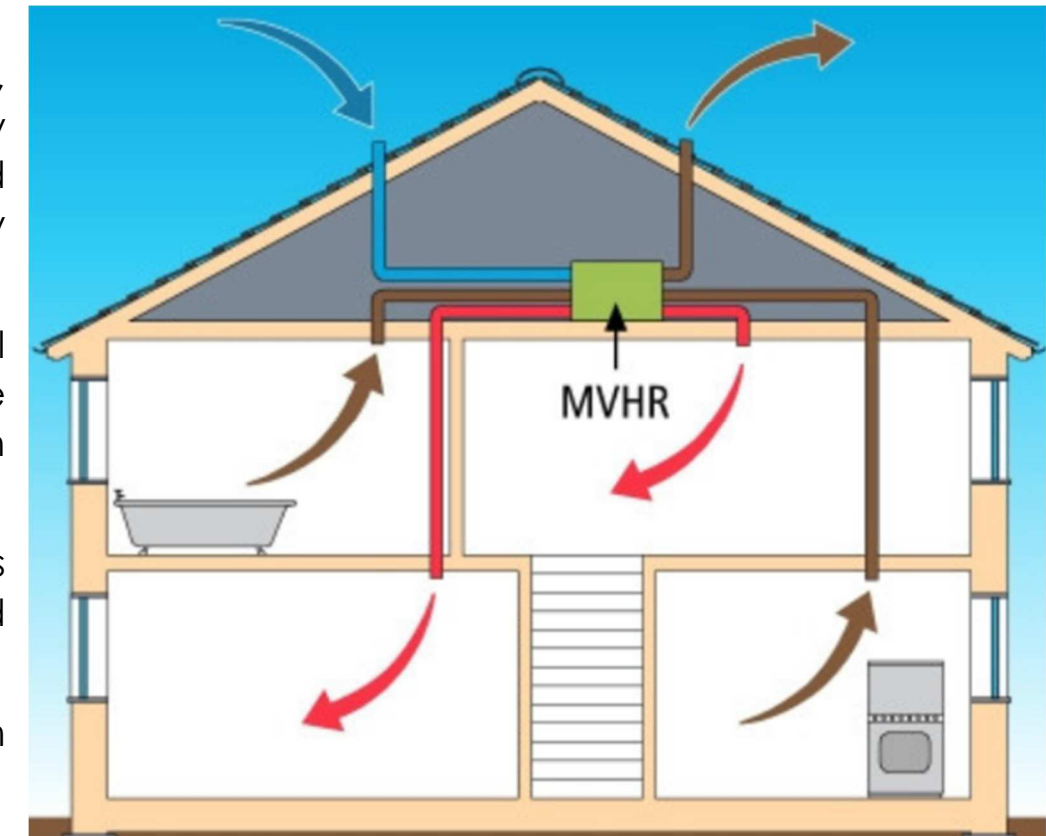
The minimum whole house ventilation rates can be seen in table 1.3 – these have been taken from *Approved Document F*.

For more information, please refer to *Approved Document F, Volume 1: Dwellings*.

The following required supply rates for TM59 compliance in habitable rooms are as follows:

- Bedrooms: 6l/s (boosted to 20 l/s)

Boost mode has been modelled to operate when internal temperatures exceed 22°C.



**Table 1.3 Minimum whole dwelling ventilation rates by no. of bedrooms**

| Number of bedrooms <sup>(1)(2)</sup> | Minimum ventilation rate by no. of bedrooms (l/s) |
|--------------------------------------|---------------------------------------------------|
| 1                                    | 19                                                |
| 2                                    | 25                                                |
| 3                                    | 31                                                |
| 4                                    | 37                                                |
| 5                                    | 43                                                |

**NOTES:**

1. If the dwelling only has one habitable room, a minimum ventilation rate of 13l/s should be used.
2. For each additional bedroom add 6l/s to the values in Table 1.3

▲ *Total Combined rate of continuous ventilation in the dwelling needs to meet the above minimum rates.*



**Figure 9: Depiction of MVHR Systems**

## 8.8 MECHANICAL VENTILATION – MECHANICAL INPUT VENTILATION

An alternative solution to MVHR for the ground floor apartment bedrooms highlighted as being at a heightened overheating risk is the use of MIV – Mechanical Input Ventilation. However, this strategy is required to be implemented to all bedrooms throughout the development in the restricted window openings scenario.

This is a low energy, through-wall fan provides continuous mechanical ventilation, supplying fresh air directly to habitable rooms such as Bedrooms. This system has been selected so that bedrooms can use from supply of air at external conditions to help cool the internal temperature as the windows cannot be opened overnight for acoustical reasons.

During the warmest periods of the year, the cooler night-time temperatures provide dwellings an opportunity to expel the built-up warm air accumulated throughout the day – which this system takes advantage of in the absence of natural ventilation from the mandatory closing of external windows as stipulated by TM59.

The following required supply rates for TM59 compliance in habitable rooms which require the bedroom windows to be closed overnight are as follows:

- Bedrooms: 6l/s (boosted to 20 l/s)

Boost mode has been modelled to operate when internal temperatures exceed 22°C.

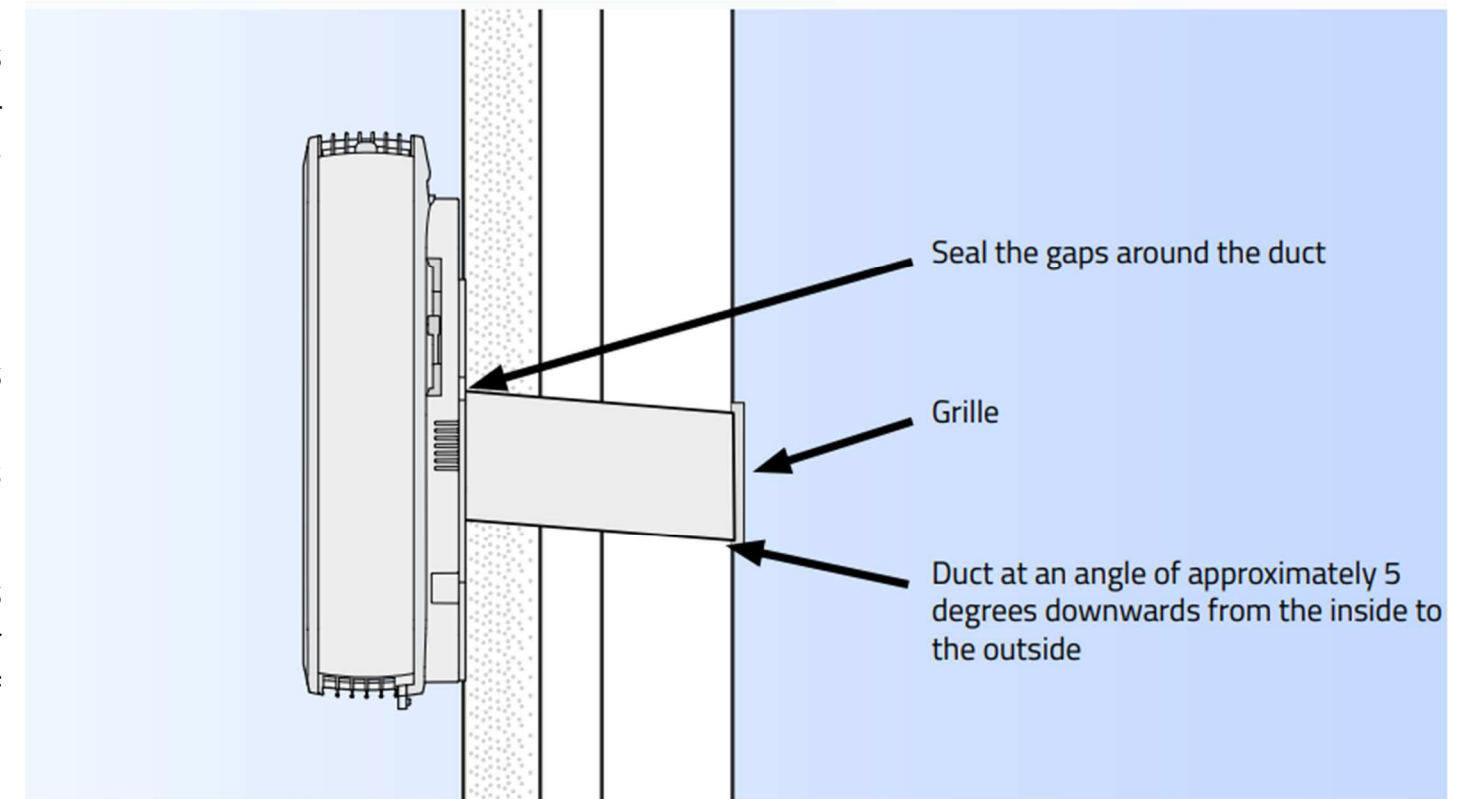


Figure 10: Depiction of local MIV proposed for ground floor bedrooms

## 9 ENSURING THE OVERHEATING STRATEGY IS USABLE

Approved Document O lists a number of measures to ensure the overheating mitigation strategy can be feasibly implemented in reality, as well as complying with overlapping building codes. The full literature can be found in Section 3: *Ensuring the overheating mitigation strategy is usable* of Approved Document O. A summary of these standards has been compiled below:

### 9.1 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).

### 9.2 POLLUTION

- **3.5)** 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.

### 9.3 SECURITY

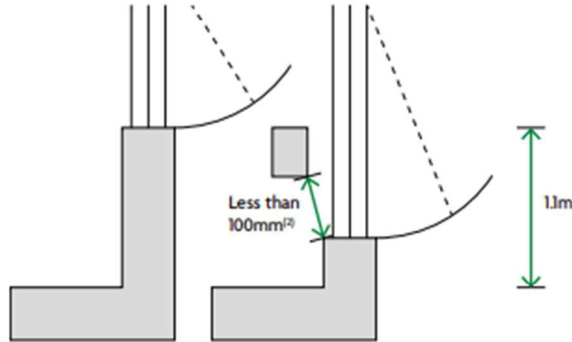
- **3.6)** When determining the free area available for ventilation during sleeping hours, only the proportion of openings that can be opened securely should be considered to provide useful ventilation. This particularly applies in the following locations, where openings may be vulnerable to intrusion by a casual or opportunistic burglar.
  - a) Ground floor bedrooms
  - b) Easily accessible bedrooms

### 9.4 PROTECTION FROM FALLING

- **3.8)** Openings which are intended to be open for long periods to reduce overheating risk might pose a higher risk of falls from height. 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.
- **3.9)** Openings that can be opened wider than 100mm may form part of the overheating mitigation strategy where they meet all of the following conditions:
  - a) Window handles on windows that open outwards are not more than 650mm from the inside face of the wall when the window is at its maximum openable angle.
  - b) Guarding meets the minimum standards in Table 3.1
  - c) Guarding does not allow children to easily climb it. For example, horizontal bars should generally be avoided.

For more information, please refer to *Approved Document K*.

| Table 3.1 Guarding heights                       |                                |
|--------------------------------------------------|--------------------------------|
| Change in floor level between inside and outside | Guarding height <sup>(1)</sup> |
| Less than 600mm                                  | See Approved Document K        |
| More than 600mm                                  | 1.1m                           |



**NOTES:**

1. This approved document has increased levels of protection from falling compared to Approved Document K. Where applicable, the higher standard applies.
2. Guarding should be sized to prevent the passage of a 100mm sphere.

*Figure 11: Guarding heights (from Approved Document K)*

## 10 RESULTS SUMMARY

The summary results table below details the overheating assessment findings of the assessed dwellings:

### Results Summary

| Floor | Description                                                                  | Plots Covered | No. Apartments | Overheating Strategy Summary                                                                                                                                                     | TM59 Compliance | Notes                                                                                                                                                   |
|-------|------------------------------------------------------------------------------|---------------|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| 00    | Ground floor apartments,<br>1no. 1 Bed   2 Persons<br>2no. 2 Bed   4 Persons | 1,2 & 3       | 3              | <ul style="list-style-type: none"> <li>Natural Ventilation via unrestricted opening windows</li> </ul>                                                                           | ☑               | 20l/s supply ventilation to <u>ground floor bedrooms only</u> via MVHR units                                                                            |
| 01    | First floor apartments,<br>1no. 3 Bed   5 Persons<br>2no. 2 Bed   4 Persons  | 4, 5 & 6      | 3              | <ul style="list-style-type: none"> <li>Glazing g value of 0.62</li> <li>Internal blinds to all glazing (demonstrated to not interfere with window opening free areas)</li> </ul> | ☑               | Passive overheating strategy sufficient to apartments on floors 1 and above provided there are no window opening restrictions.                          |
| 02    | Second floor apartments,<br>1no. 3 Bed   5 Persons<br>2no. 2 Bed   4 Persons | 7, 8 & 9      | 3              | <ul style="list-style-type: none"> <li>20l/s supply ventilation <u>ground floor bedrooms only</u> via MVHR units</li> </ul>                                                      | ☑               | In the event of requiring all bedroom windows to be closed - 20l/s supply ventilation via MVHR units is extended to all bedrooms across the development |
| 03    | Third floor apartment,<br>1no. 3 Bed   6 Persons                             | 10            | 1              |                                                                                                                                                                                  | ☑               |                                                                                                                                                         |
|       |                                                                              |               | 10             |                                                                                                                                                                                  |                 |                                                                                                                                                         |

## 11 ASSESSMENT SUMMARY

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The assessment has shown that the 10 proposed residential apartments at the Every Street, Manchester site presents a low chance of overheating – with the detailed dynamic thermal modelling showing where the risks are likely to occur.

Ground floor spaces are limited to a 'daytime only' window opening schedule which limits the amount of hours which natural ventilation can take place. Secondly, these spaces cannot take advantage of cooler night temperatures to purge the room of the warm air from internal and solar gains accumulated throughout the day. However, overheating issues can be avoided when mechanical supply ventilation by MVHR at rates shown in this report.

A scenario whereby the nearby road(s) cause acoustical limitations to the window openings to bedrooms has also been modelled. A working solution was to also apply the when mechanical supply ventilation by MVHR (like to the ground floor bedrooms in the natural ventilation scenario).

A summary of the proposed overheating mitigation measures include:

- Natural ventilation via window openings as per the architectural drawings
- Window openings to be opened to maximal permissible opening angles in accordance with Approved Document K (safeguarding measures may be required)
- Keeping the external patio doors fully open throughout the day (when required/applicable) to stimulate air movement throughout the entire apartment
- Adhering to the glazing g value as modelled in this assessment
- Internal doors to be left open when possible to promote air movement in and out of rooms within the apartments
- MVHR (system 4) providing mechanical supply into ground floor apartment bedrooms at Approved Document F minimum rates
- Ground floor bedrooms require additional boosted rates of up to 20l/s each to ensure TM59 compliance
- Blinds have been modelled as part of this assessment. Careful consideration should be taken when selecting the blinds as it must be demonstrated that they do not interfere with the window openings as stipulated by the TM59 framework.

With the above measures implemented, the modelling found all spaces in the assessed dwellings to pass the overheating criteria and comply with TM59.

Though the regulations do not permit the use of blinds and curtains in the calculations, if the sun shines directly into a living space, the occupant should consider closing the curtains or blinds to limit solar gains and try and keep rooms as cool as possible.

If it's cooler inside than outside, it is advised that occupants should keep their windows closed, to prevent bringing warm air in. If it reaches a point where the temperature inside the house is equal to that outside, then you should open the windows, keeping the curtains closed.

## 12 MODELLING DISCLAIMER

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The calculations produced by Element Sustainability have been carried out with the information provided by others to determine whether the thermal model of the proposed building can achieve compliance, at design stage, with the stated criteria within this report.

It should be noted that the data generated by this work is obtained using computer simulations. These simulations are the best means of predicting the performance of the building at this stage. Full certainty can only be achieved by measuring the performance of the building and associated systems after a period of use.

The actual operative temperatures within the building once occupied may vary from the calculated values within this report. These differences will occur due to a number of variable parameters between the modelled building and the actual building. Such differences will include the hours, levels of occupancy, equipment, how the windows are used etc.

Whilst the simulations have been undertaken in good faith using reasonable skill and care, Element Sustainability can take no responsibility for differences between the computer simulations and the actual performance of the completed development due to the inherent complexity and variability of the physics in a building and its environment.

## 13 APPENDIX A – DETAILED RESULTS – MODEL RAN WITHOUT BLINDS OR MVHR TO GROUND FLOOR BEDROOMS

| TM59 Criteria - Kitchen/Living/Dining |                   |                                |                   |                              |                                     |                                               |                                                                |                 |
|---------------------------------------|-------------------|--------------------------------|-------------------|------------------------------|-------------------------------------|-----------------------------------------------|----------------------------------------------------------------|-----------------|
| Location                              | Occupied days (%) | Criteria 1 (%Hrs Top-Tmax>=1K) | Criteria 1 Status | Occupied hours 09:00 - 22:00 | Hours above threshold temp. of 26 C | % of time room is above threshold temperature | Results based on over all % of time over threshold temperature | Overall Results |
| FF - Flat 4 - Kitchen / Living        | 100               | 3.1                            | FAIL              | -                            | -                                   | -                                             | -                                                              | FAIL            |
| FF - Flat 5 - Kitchen / Living        | 100               | 4.1                            | FAIL              | -                            | -                                   | -                                             | -                                                              | FAIL            |
| FF - Flat 6 - Kitchen / Living        | 100               | 3.1                            | FAIL              | -                            | -                                   | -                                             | -                                                              | FAIL            |
| GF - Flat 1 - Kitchen / Living        | 100               | 1.7                            | PASS              | -                            | -                                   | -                                             | -                                                              | PASS            |
| GF - Flat 2 - Kitchen / Living        | 100               | 3.3                            | FAIL              | -                            | -                                   | -                                             | -                                                              | FAIL            |
| GF - Flat 3 - Kitchen / Living        | 100               | 2.2                            | PASS              | -                            | -                                   | -                                             | -                                                              | PASS            |
| SF - Flat 7 - Kitchen / Living        | 100               | 3.5                            | FAIL              | -                            | -                                   | -                                             | -                                                              | FAIL            |
| SF - Flat 8 - Kitchen / Living        | 100               | 4                              | FAIL              | -                            | -                                   | -                                             | -                                                              | FAIL            |
| SF - Flat 9 - Kitchen / Living        | 100               | 2.8                            | PASS              | -                            | -                                   | -                                             | -                                                              | PASS            |
| TF - Flat 10 - Kitchen / Living       | 100               | 6.2                            | FAIL              | -                            | -                                   | -                                             | -                                                              | FAIL            |

| TM59 Criteria - Bedrooms         |                   |                                |                   |                              |                              |                                     |                                               |                                                                |                 |
|----------------------------------|-------------------|--------------------------------|-------------------|------------------------------|------------------------------|-------------------------------------|-----------------------------------------------|----------------------------------------------------------------|-----------------|
| Location                         | Occupied days (%) | Criteria 1 (%Hrs Top-Tmax>=1K) | Criteria 1 Status | Sleeping hours 22:00 - 24:00 | Sleeping hours 24:00 - 07:00 | Hours above threshold temp. of 26 C | % of time room is above threshold temperature | Results based on over all % of time over threshold temperature | Overall Results |
| FF - Flat 4 - Double Bedroom 01  | 100               | 0                              | PASS              | 1                            | 0                            | 1                                   | 0.0%                                          | PASS                                                           | PASS            |
| FF - Flat 4 - Double Bedroom 02  | 100               | 0.2                            | PASS              | 2                            | 0                            | 2                                   | 0.1%                                          | PASS                                                           | PASS            |
| FF - Flat 4 - Single Bedroom     | 100               | 0.5                            | PASS              | 1                            | 0                            | 1                                   | 0.0%                                          | PASS                                                           | PASS            |
| FF - Flat 5 - Double Bedroom 01  | 100               | 2.2                            | PASS              | 16                           | 5                            | 21                                  | 0.6%                                          | PASS                                                           | PASS            |
| FF - Flat 5 - Double Bedroom 02  | 100               | 1.6                            | PASS              | 12                           | 1                            | 13                                  | 0.4%                                          | PASS                                                           | PASS            |
| FF - Flat 6 - Double Bedroom 01  | 100               | 1.4                            | PASS              | 10                           | 2                            | 12                                  | 0.4%                                          | PASS                                                           | PASS            |
| FF - Flat 6 - Double Bedroom 02  | 100               | 1.4                            | PASS              | 8                            | 1                            | 9                                   | 0.3%                                          | PASS                                                           | PASS            |
| GF - Flat 1 - Double Bedroom 01  | 100               | 0.1                            | PASS              | 4                            | 38                           | 42                                  | 1.3%                                          | FAIL                                                           | FAIL            |
| GF - Flat 2 - Double Bedroom 01  | 100               | 1.4                            | PASS              | 15                           | 77                           | 92                                  | 2.8%                                          | FAIL                                                           | FAIL            |
| GF - Flat 2 - Double Bedroom 02  | 100               | 2.7                            | PASS              | 21                           | 84                           | 105                                 | 3.2%                                          | FAIL                                                           | FAIL            |
| GF - Flat 3 - Double Bedroom 01  | 100               | 1.3                            | PASS              | 14                           | 85                           | 99                                  | 3.0%                                          | FAIL                                                           | FAIL            |
| GF - Flat 3 - Double Bedroom 02  | 100               | 2.6                            | PASS              | 21                           | 104                          | 125                                 | 3.8%                                          | FAIL                                                           | FAIL            |
| SF - Flat 7 - Double Bedroom 01  | 100               | 0                              | PASS              | 5                            | 0                            | 5                                   | 0.2%                                          | PASS                                                           | PASS            |
| SF - Flat 7 - Double Bedroom 02  | 100               | 0.3                            | PASS              | 5                            | 0                            | 5                                   | 0.2%                                          | PASS                                                           | PASS            |
| SF - Flat 7 - Single Bedroom     | 100               | 0.8                            | PASS              | 3                            | 0                            | 3                                   | 0.1%                                          | PASS                                                           | PASS            |
| SF - Flat 8 - Double Bedroom 01  | 100               | 2.2                            | PASS              | 16                           | 5                            | 21                                  | 0.6%                                          | PASS                                                           | PASS            |
| SF - Flat 8 - Double Bedroom 02  | 100               | 1.5                            | PASS              | 12                           | 1                            | 13                                  | 0.4%                                          | PASS                                                           | PASS            |
| SF - Flat 9 - Double Bedroom 01  | 100               | 1.3                            | PASS              | 7                            | 1                            | 8                                   | 0.2%                                          | PASS                                                           | PASS            |
| SF - Flat 9 - Double Bedroom 02  | 100               | 1.2                            | PASS              | 10                           | 1                            | 11                                  | 0.3%                                          | PASS                                                           | PASS            |
| TF - Flat 10 - Double Bedroom 01 | 100               | 4.1                            | FAIL              | 4                            | 0                            | 4                                   | 0.1%                                          | PASS                                                           | FAIL            |
| TF - Flat 10 - Double Bedroom 02 | 100               | 1.7                            | PASS              | 3                            | 0                            | 3                                   | 0.1%                                          | PASS                                                           | PASS            |
| TF - Flat 10 - Double Bedroom 03 | 100               | 0.5                            | PASS              | 3                            | 0                            | 3                                   | 0.1%                                          | PASS                                                           | PASS            |

## 14 APPENDIX B – DETAILED RESULTS – MODEL RAN WITH BLINDS

| TM59 Criteria - Kitchen/Living/Dining |                   |                                |                   |                              |                                     |                                               |                                                                |                 |
|---------------------------------------|-------------------|--------------------------------|-------------------|------------------------------|-------------------------------------|-----------------------------------------------|----------------------------------------------------------------|-----------------|
| Location                              | Occupied days (%) | Criteria 1 (%Hrs Top-Tmax>=1K) | Criteria 1 Status | Occupied hours 09:00 - 22:00 | Hours above threshold temp. of 26 C | % of time room is above threshold temperature | Results based on over all % of time over threshold temperature | Overall Results |
| FF - Flat 4 - Kitchen / Living        | 100               | 1.5                            | PASS              | -                            | -                                   | -                                             | -                                                              | PASS            |
| FF - Flat 5 - Kitchen / Living        | 100               | 1.9                            | PASS              | -                            | -                                   | -                                             | -                                                              | PASS            |
| FF - Flat 6 - Kitchen / Living        | 100               | 1.2                            | PASS              | -                            | -                                   | -                                             | -                                                              | PASS            |
| GF - Flat 1 - Kitchen / Living        | 100               | 0.9                            | PASS              | -                            | -                                   | -                                             | -                                                              | PASS            |
| GF - Flat 2 - Kitchen / Living        | 100               | 1.4                            | PASS              | -                            | -                                   | -                                             | -                                                              | PASS            |
| GF - Flat 3 - Kitchen / Living        | 100               | 1.1                            | PASS              | -                            | -                                   | -                                             | -                                                              | PASS            |
| SF - Flat 7 - Kitchen / Living        | 100               | 1.7                            | PASS              | -                            | -                                   | -                                             | -                                                              | PASS            |
| SF - Flat 8 - Kitchen / Living        | 100               | 1.7                            | PASS              | -                            | -                                   | -                                             | -                                                              | PASS            |
| SF - Flat 9 - Kitchen / Living        | 100               | 1.1                            | PASS              | -                            | -                                   | -                                             | -                                                              | PASS            |
| TF - Flat 10 - Kitchen / Living       | 100               | 2.9                            | PASS              | -                            | -                                   | -                                             | -                                                              | PASS            |

| TM59 Criteria - Bedrooms         |                   |                                |                   |                              |                              |                                     |                                               |                                                                |                 |
|----------------------------------|-------------------|--------------------------------|-------------------|------------------------------|------------------------------|-------------------------------------|-----------------------------------------------|----------------------------------------------------------------|-----------------|
| Location                         | Occupied days (%) | Criteria 1 (%Hrs Top-Tmax>=1K) | Criteria 1 Status | Sleeping hours 22:00 - 24:00 | Sleeping hours 24:00 - 07:00 | Hours above threshold temp. of 26 C | % of time room is above threshold temperature | Results based on over all % of time over threshold temperature | Overall Results |
| FF - Flat 4 - Double Bedroom 01  | 100               | 0                              | PASS              | 1                            | 0                            | 1                                   | 0.0%                                          | PASS                                                           | PASS            |
| FF - Flat 4 - Double Bedroom 02  | 100               | 0.1                            | PASS              | 1                            | 0                            | 1                                   | 0.0%                                          | PASS                                                           | PASS            |
| FF - Flat 4 - Single Bedroom     | 100               | 0.4                            | PASS              | 0                            | 0                            | 0                                   | 0.0%                                          | PASS                                                           | PASS            |
| FF - Flat 5 - Double Bedroom 01  | 100               | 0.7                            | PASS              | 7                            | 1                            | 8                                   | 0.2%                                          | PASS                                                           | PASS            |
| FF - Flat 5 - Double Bedroom 02  | 100               | 0.5                            | PASS              | 4                            | 0                            | 4                                   | 0.1%                                          | PASS                                                           | PASS            |
| FF - Flat 6 - Double Bedroom 01  | 100               | 0.1                            | PASS              | 4                            | 0                            | 4                                   | 0.1%                                          | PASS                                                           | PASS            |
| FF - Flat 6 - Double Bedroom 02  | 100               | 0.5                            | PASS              | 4                            | 0                            | 4                                   | 0.1%                                          | PASS                                                           | PASS            |
| GF - Flat 1 - Double Bedroom 01  | 100               | 0                              | PASS              | 0                            | 0                            | 0                                   | 0.0%                                          | PASS                                                           | PASS            |
| GF - Flat 2 - Double Bedroom 01  | 100               | 0.5                            | PASS              | 3                            | 8                            | 11                                  | 0.3%                                          | PASS                                                           | PASS            |
| GF - Flat 2 - Double Bedroom 02  | 100               | 0.8                            | PASS              | 11                           | 11                           | 22                                  | 0.7%                                          | PASS                                                           | PASS            |
| GF - Flat 3 - Double Bedroom 01  | 100               | 0.4                            | PASS              | 4                            | 7                            | 11                                  | 0.3%                                          | PASS                                                           | PASS            |
| GF - Flat 3 - Double Bedroom 02  | 100               | 0.1                            | PASS              | 8                            | 15                           | 23                                  | 0.7%                                          | PASS                                                           | PASS            |
| SF - Flat 7 - Double Bedroom 01  | 100               | 0                              | PASS              | 1                            | 0                            | 1                                   | 0.0%                                          | PASS                                                           | PASS            |
| SF - Flat 7 - Double Bedroom 02  | 100               | 0.1                            | PASS              | 1                            | 0                            | 1                                   | 0.0%                                          | PASS                                                           | PASS            |
| SF - Flat 7 - Single Bedroom     | 100               | 0.3                            | PASS              | 1                            | 0                            | 1                                   | 0.0%                                          | PASS                                                           | PASS            |
| SF - Flat 8 - Double Bedroom 01  | 100               | 0.6                            | PASS              | 7                            | 0                            | 7                                   | 0.2%                                          | PASS                                                           | PASS            |
| SF - Flat 8 - Double Bedroom 02  | 100               | 0.5                            | PASS              | 3                            | 0                            | 3                                   | 0.1%                                          | PASS                                                           | PASS            |
| SF - Flat 9 - Double Bedroom 01  | 100               | 0.4                            | PASS              | 4                            | 0                            | 4                                   | 0.1%                                          | PASS                                                           | PASS            |
| SF - Flat 9 - Double Bedroom 02  | 100               | 0.1                            | PASS              | 4                            | 0                            | 4                                   | 0.1%                                          | PASS                                                           | PASS            |
| TF - Flat 10 - Double Bedroom 01 | 100               | 2.2                            | PASS              | 1                            | 0                            | 1                                   | 0.0%                                          | PASS                                                           | PASS            |
| TF - Flat 10 - Double Bedroom 02 | 100               | 0.9                            | PASS              | 0                            | 0                            | 0                                   | 0.0%                                          | PASS                                                           | PASS            |
| TF - Flat 10 - Double Bedroom 03 | 100               | 0.1                            | PASS              | 0                            | 0                            | 0                                   | 0.0%                                          | PASS                                                           | PASS            |

## 15 APPENDIX C – DETAILED RESULTS – MODEL RAN WITH BLINDS – RESTRICTED WINDOW OPENINGS SCENARIO

| TM59 Criteria - Kitchen/Living/Dining |                   |                                |                   |                              |                                     |                                               |                                                                |                 |
|---------------------------------------|-------------------|--------------------------------|-------------------|------------------------------|-------------------------------------|-----------------------------------------------|----------------------------------------------------------------|-----------------|
| Location                              | Occupied days (%) | Criteria 1 (%Hrs Top-Tmax>=1K) | Criteria 1 Status | Occupied hours 09:00 - 22:00 | Hours above threshold temp. of 26 C | % of time room is above threshold temperature | Results based on over all % of time over threshold temperature | Overall Results |
| FF - Flat 4 - Kitchen / Living        | 100               | 1.6                            | PASS              | -                            | -                                   | -                                             | -                                                              | PASS            |
| FF - Flat 5 - Kitchen / Living        | 100               | 1.9                            | PASS              | -                            | -                                   | -                                             | -                                                              | PASS            |
| FF - Flat 6 - Kitchen / Living        | 100               | 1.2                            | PASS              | -                            | -                                   | -                                             | -                                                              | PASS            |
| GF - Flat 1 - Kitchen / Living        | 100               | 0.9                            | PASS              | -                            | -                                   | -                                             | -                                                              | PASS            |
| GF - Flat 2 - Kitchen / Living        | 100               | 1.4                            | PASS              | -                            | -                                   | -                                             | -                                                              | PASS            |
| GF - Flat 3 - Kitchen / Living        | 100               | 1.1                            | PASS              | -                            | -                                   | -                                             | -                                                              | PASS            |
| SF - Flat 7 - Kitchen / Living        | 100               | 1.8                            | PASS              | -                            | -                                   | -                                             | -                                                              | PASS            |
| SF - Flat 8 - Kitchen / Living        | 100               | 1.7                            | PASS              | -                            | -                                   | -                                             | -                                                              | PASS            |
| SF - Flat 9 - Kitchen / Living        | 100               | 1.1                            | PASS              | -                            | -                                   | -                                             | -                                                              | PASS            |
| TF - Flat 10 - Kitchen / Living       | 100               | 3.0                            | PASS              | -                            | -                                   | -                                             | -                                                              | PASS            |

| TM59 Criteria - Bedrooms         |                   |                                |                   |                              |                              |                                     |                                               |                                                                |                 |
|----------------------------------|-------------------|--------------------------------|-------------------|------------------------------|------------------------------|-------------------------------------|-----------------------------------------------|----------------------------------------------------------------|-----------------|
| Location                         | Occupied days (%) | Criteria 1 (%Hrs Top-Tmax>=1K) | Criteria 1 Status | Sleeping hours 22:00 - 24:00 | Sleeping hours 24:00 - 07:00 | Hours above threshold temp. of 26 C | % of time room is above threshold temperature | Results based on over all % of time over threshold temperature | Overall Results |
| FF - Flat 4 - Double Bedroom 01  | 100               | 0                              | PASS              | 3                            | 3                            | 6                                   | 0.2%                                          | PASS                                                           | PASS            |
| FF - Flat 4 - Double Bedroom 02  | 100               | 0.2                            | PASS              | 3                            | 3                            | 6                                   | 0.2%                                          | PASS                                                           | PASS            |
| FF - Flat 4 - Single Bedroom     | 100               | 0.4                            | PASS              | 2                            | 0                            | 2                                   | 0.1%                                          | PASS                                                           | PASS            |
| FF - Flat 5 - Double Bedroom 01  | 100               | 0.8                            | PASS              | 8                            | 4                            | 12                                  | 0.4%                                          | PASS                                                           | PASS            |
| FF - Flat 5 - Double Bedroom 02  | 100               | 0.5                            | PASS              | 5                            | 4                            | 9                                   | 0.3%                                          | PASS                                                           | PASS            |
| FF - Flat 6 - Double Bedroom 01  | 100               | 0.2                            | PASS              | 8                            | 5                            | 13                                  | 0.4%                                          | PASS                                                           | PASS            |
| FF - Flat 6 - Double Bedroom 02  | 100               | 0.5                            | PASS              | 6                            | 4                            | 10                                  | 0.3%                                          | PASS                                                           | PASS            |
| GF - Flat 1 - Double Bedroom 01  | 100               | 0                              | PASS              | 1                            | 4                            | 5                                   | 0.2%                                          | PASS                                                           | PASS            |
| GF - Flat 2 - Double Bedroom 01  | 100               | 0.5                            | PASS              | 3                            | 9                            | 12                                  | 0.4%                                          | PASS                                                           | PASS            |
| GF - Flat 2 - Double Bedroom 02  | 100               | 0.8                            | PASS              | 12                           | 15                           | 27                                  | 0.8%                                          | PASS                                                           | PASS            |
| GF - Flat 3 - Double Bedroom 01  | 100               | 0.5                            | PASS              | 4                            | 9                            | 13                                  | 0.4%                                          | PASS                                                           | PASS            |
| GF - Flat 3 - Double Bedroom 02  | 100               | 0.2                            | PASS              | 8                            | 16                           | 24                                  | 0.7%                                          | PASS                                                           | PASS            |
| SF - Flat 7 - Double Bedroom 01  | 100               | 0                              | PASS              | 3                            | 5                            | 8                                   | 0.2%                                          | PASS                                                           | PASS            |
| SF - Flat 7 - Double Bedroom 02  | 100               | 0.2                            | PASS              | 3                            | 5                            | 8                                   | 0.2%                                          | PASS                                                           | PASS            |
| SF - Flat 7 - Single Bedroom     | 100               | 0.3                            | PASS              | 2                            | 0                            | 2                                   | 0.1%                                          | PASS                                                           | PASS            |
| SF - Flat 8 - Double Bedroom 01  | 100               | 0.7                            | PASS              | 8                            | 4                            | 12                                  | 0.4%                                          | PASS                                                           | PASS            |
| SF - Flat 8 - Double Bedroom 02  | 100               | 0.5                            | PASS              | 5                            | 4                            | 9                                   | 0.3%                                          | PASS                                                           | PASS            |
| SF - Flat 9 - Double Bedroom 01  | 100               | 0.5                            | PASS              | 7                            | 4                            | 11                                  | 0.3%                                          | PASS                                                           | PASS            |
| SF - Flat 9 - Double Bedroom 02  | 100               | 0.2                            | PASS              | 7                            | 4                            | 11                                  | 0.3%                                          | PASS                                                           | PASS            |
| TF - Flat 10 - Double Bedroom 01 | 100               | 2.2                            | PASS              | 3                            | 3                            | 6                                   | 0.2%                                          | PASS                                                           | PASS            |
| TF - Flat 10 - Double Bedroom 02 | 100               | 0.9                            | PASS              | 2                            | 2                            | 4                                   | 0.1%                                          | PASS                                                           | PASS            |
| TF - Flat 10 - Double Bedroom 03 | 100               | 0.1                            | PASS              | 2                            | 3                            | 5                                   | 0.2%                                          | PASS                                                           | PASS            |

16 APPENDIX D - DETAILED OCCUPANCY SCHEDULES – CIBSE TM59 HEAT GAIN PROFILE

| Number of People | Description /Occupancy     | Period      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
|------------------|----------------------------|-------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|                  |                            | 00-01       | 01-02 | 02-03 | 03-04 | 04-05 | 05-06 | 06-07 | 07-08 | 08-09 | 09-10 | 10-11 | 11-12 | 12-13 | 13-14 | 14-15 | 15-16 | 16-17 | 17-18 | 18-19 | 19-20 | 20-21 | 21-22 | 22-23 | 23-24 |
|                  |                            | Hour ending |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
|                  |                            | 1.00        | 2.00  | 3.00  | 4.00  | 5.00  | 6.00  | 7.00  | 8.00  | 9.00  | 10.00 | 11.00 | 12.00 | 13.00 | 14.00 | 15.00 | 16.00 | 17.00 | 18.00 | 19.00 | 20.00 | 21.00 | 22.00 | 23.00 | 24.00 |
| 1                | Single Bedroom             | 0.7         | 0.7   | 0.7   | 0.7   | 0.7   | 0.7   | 0.7   | 0.7   | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 0.7   |
| 2                | Double Bedroom             | 0.7         | 0.7   | 0.7   | 0.7   | 0.7   | 0.7   | 0.7   | 0.7   | 1     | 0.5   | 0.5   | 0.5   | 0.5   | 0.5   | 0.5   | 0.5   | 0.5   | 0.5   | 0.5   | 0.5   | 0.5   | 0.5   | 1     | 0.7   |
| 2                | Studio                     | 0.7         | 0.7   | 0.7   | 0.7   | 0.7   | 0.7   | 0.7   | 0.7   | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 0.7   |
| 1                | 1-bedroom /living/Kitchen  | 0           | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 0     | 0     |
| 1                | 1 - bedroom /living        | 0           | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0.75  | 0.75  | 0.75  | 0.75  | 0.75  | 0.75  | 0.75  | 0.75  | 0.75  | 0.75  | 0.75  | 0.75  | 0.75  | 0     | 0     |
| 1                | 1 - bedroom Kitchen        | 0           | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0.25  | 0.25  | 0.25  | 0.25  | 0.25  | 0.25  | 0.25  | 0.25  | 0.25  | 0.25  | 0.25  | 0.25  | 0.25  | 0     | 0     |
| 2                | 2-bedroom /living/Kitchen  | 0           | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 0     | 0     |
| 2                | 2 - bedroom /living        | 0           | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0.75  | 0.75  | 0.75  | 0.75  | 0.75  | 0.75  | 0.75  | 0.75  | 0.75  | 0.75  | 0.75  | 0.75  | 0.75  | 0     | 0     |
| 2                | 2 - bedroom Kitchen        | 0           | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0.25  | 0.25  | 0.25  | 0.25  | 0.25  | 0.25  | 0.25  | 0.25  | 0.25  | 0.25  | 0.25  | 0.25  | 0.25  | 0     | 0     |
| 3                | 3 - bedroom/living/Kitchen | 0           | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 0     | 0     |
| 3                | 3 - bedroom /living        | 0           | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0.75  | 0.75  | 0.75  | 0.75  | 0.75  | 0.75  | 0.75  | 0.75  | 0.75  | 0.75  | 0.75  | 0.75  | 0.75  | 0     | 0     |
| 3                | 3 - bedroom Kitchen        | 0           | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0.25  | 0.25  | 0.25  | 0.25  | 0.25  | 0.25  | 0.25  | 0.25  | 0.25  | 0.25  | 0.25  | 0.25  | 0.25  | 0     | 0     |