



## Overheating Modelling Report

For

Queens View

Client: Eastleigh Borough Council



Low  
Carbon  
Consultant  
LCC31669



Heat  
Networks  
Consultant  
HNC31669



## DOCUMENT CONTROL

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## **1.0 Introduction and Executive Summary**

Queens View, Eastleigh, is a new development to provide 18no domestic properties. 6no properties are one-bedroom apartments consisting of a double bedroom, bathroom, kitchen-living area, hall, and storage areas. 12no properties are two-bedroom apartments consisting of a double bedroom, a second single or double bedroom, bathroom, kitchen-living area, hall, and storage areas.

Salvis was appointed by Eastleigh Borough Council to undertake building thermal modelling and provide analysis of potential overheating within the properties and communal circulation areas.

Dynamic simulation modelling was undertaken for the Queens View development using IES Virtual Environment software, with building geometry, fabric construction details, and occupancy and behavioural profiles added to model the building heat gains and the response when the windows are opened.

The modelling was undertaken in accordance with the following recognised industry assessment methods:

- CIBSE TM52: 2013 - The limits of thermal comfort: avoiding overheating in European buildings
- CIBSE TM59: 2017 – Design methodology for the assessment of overheating risk in homes

Four different scenarios of mitigating the overheating risk have been run in order all the areas of Queens View development to achieve a pass against TM59 / TM52 and Part O requirements. A room summary of the simulation results is given in Section 5.0, but can be further summarised as:

- The 1<sup>st</sup> overheating simulation was based on the received U / g-values and opening (external doors and windows) information by the architects. All the ground floor bedrooms failed to meet the overheating requirements, as well as the kitchen-living areas of the plots 01, 03, 06, 09, 14.  
Ground floor bedrooms failing was due to openable areas modelled as closed during the nighttime for safety reasons.  
Four of the five kitchen-living areas which fail against the overheating criteria are located in the south east side of the building and one is located in the south west side of the building.
- In the 2<sup>nd</sup> overheating simulation, the model was kept as per the first simulation with exception of the openings (external doors and windows) g-value being changed from 0.57 to 0.50. All ground floor bedrooms failed to meet the overheating requirements, as well as the kitchen-living areas of the plots 03, 06, 14.  
As it was mentioned above the failing of the ground floor bedrooms was caused due to the closed openable areas during the nighttime for safety reasons.  
The three kitchen-living areas which fail against the overheating criteria are all located in the south east side of the building.
- In the 3<sup>rd</sup> overheating simulation, similarly to the 2<sup>nd</sup> simulation, the only change was on the openings g-value which was lowered from 0.50 to 0.40. In this simulation, all the ground floor bedrooms failed to pass the overheating requirements, but all the kitchen-living areas achieved a pass.
- In the 4<sup>th</sup> overheating simulation, the model was kept as per the 3<sup>rd</sup> simulation and 2 ACH (air changes per hour) of mechanical ventilation was applied in the ground floor apartments. All the occupied areas in Queens View development have achieved to pass the overheating requirements.

A 100mm openings reveal depth has been consider throughout the building.

All the side hung openings designed with 90° opening angle.

All the top hung openings designed with 60° opening angle.

## **2.0 Overheating Methodology**

Overheating has become a key problem for building design, and the Chartered Institution of Building Services Engineers has developed the industry recognised methodologies for calculating and assessing the risk of overheating in properties.

The guidance is separate into 2no elements for non-domestic and domestic buildings:

- CIBSE TM52: 2013 - The limits of thermal comfort: avoiding overheating in European buildings.
- CIBSE TM59: 2017 – Design methodology for the assessment of overheating risk in homes.

Non-domestic establishments where people sleep on the premises should meet both TM52 and TM59 criteria in areas where these applied.

### **2.1 CIBSE TM52**

CIBSE Technical Memorandum (TM) 52 considers overheating in non-domestic buildings and sets 3no criteria for limiting overheating. In order to achieve compliance, occupied spaces must satisfy at least two of the set criteria.

TM52 outlines three criteria – a room or building that fails any two of the following three criteria is classed as overheating:

#### **Criterion 1: Hours of Exceedance**

The number of hours during which the internal temperature exceeds the operative (threshold) temperature by 1K (1°C) during the period May to September inclusive shall not be more than 3% of occupied hours.

*To simplify: In the 1<sup>st</sup> Criterion, the overheating limiting factor is equal to 3, which represents the maximum percentage of the number of hours that the operative temperature can exceed the threshold comfort temperature.*

**Operative temperature** is a weighted mean temperature between air and radiant temperatures. The temperature of the environment includes both the air temperature and the radiant temperature.

**Threshold comfort temperature** is the upper limit of the range of comfort temperature.

**Comfort temperature** varies with outdoor temperature in naturally ventilated buildings.

#### **Criterion 2: Daily Weighted Exceedance**

The severity of overheating is limited by the weighted exceedance which shall be less than or equal to 6 in any one day.

*To simplify: In the 2<sup>nd</sup> Criterion, the overheating limiting factor is equal to 6, which represents the severity of overheating within one day – this is function of both temperature rise and it's duration.*

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### Criterion 3: Upper Limit Temperature

The absolute maximum value for the internal temperature in the space shall not exceed 4°C above the operative (threshold) temperature.

*To simplify: In the 3<sup>rd</sup> Criterion, the overheating limiting factor is equal to 4, which represents an absolute maximum daily temperature for a room, beyond which the level of overheating is unacceptable.*

### 2.2 CIBSE TM59

CIBSE Technical Memorandum (TM) 59 considers over heating in domestic properties and sets 2no criteria for limiting overheating. In order to achieve compliance, spaces must satisfy both set criteria.

#### Criteria A: Hours of Exceedance

The number of hours during which the internal temperature exceeds the operative (threshold) temperature by 1K (1°C) during the period May to September inclusive shall not be more than 3% of occupied hours.

*This is the same requirement as Criterion 1 for TM52.*

#### Criteria B: Maximum Temperature Limit

The internal temperature within the bedrooms must not exceed 26°C between 10.00pm and 7.00am for more than 1% of annual hours.

*To simplify: In the Criterion B, the overheating limiting factor is equal to 33, which represents the maximum number of night hours that the internal temperature can exceed 26 °C.*

#### Corridor criterion (non-mandatory): Maximum Temperature Limit

Whilst there is no mandatory target to meet, if an operative temperature of 28 °C is exceeded for more than 3% of the total annual hours, then this should be identified as a significant risk within the report.

*To simplify: In the Corridor Criterion, the overheating limiting factor is equal to 263, which represents the maximum number of hours annually that the internal temperature in corridors can exceed 28 °C.*

### 2.3 Approved Document O

In June 2022, the new Approved Document, Part O, introduced to tackle overheating in residential buildings. Part O applies to all new residential building in England including dwelling, institutional buildings where people sleep on the premises, and multi-use residential building such as student accommodation.

Two routes are provided to demonstrate compliance with Part O:

1. The simplified method, limiting solar gains and maximising natural ventilation potential through window sizing or window design; and
2. The dynamic thermal modelling route, based on CIBSE's TM59 Design methodology for assessment of overheating document.

To demonstrate compliance using dynamic thermal modelling, the CIBSEs TM59 methodology should be followed in accordance with the Part O mitigation hierarchy.

### **3.0 IES VE**

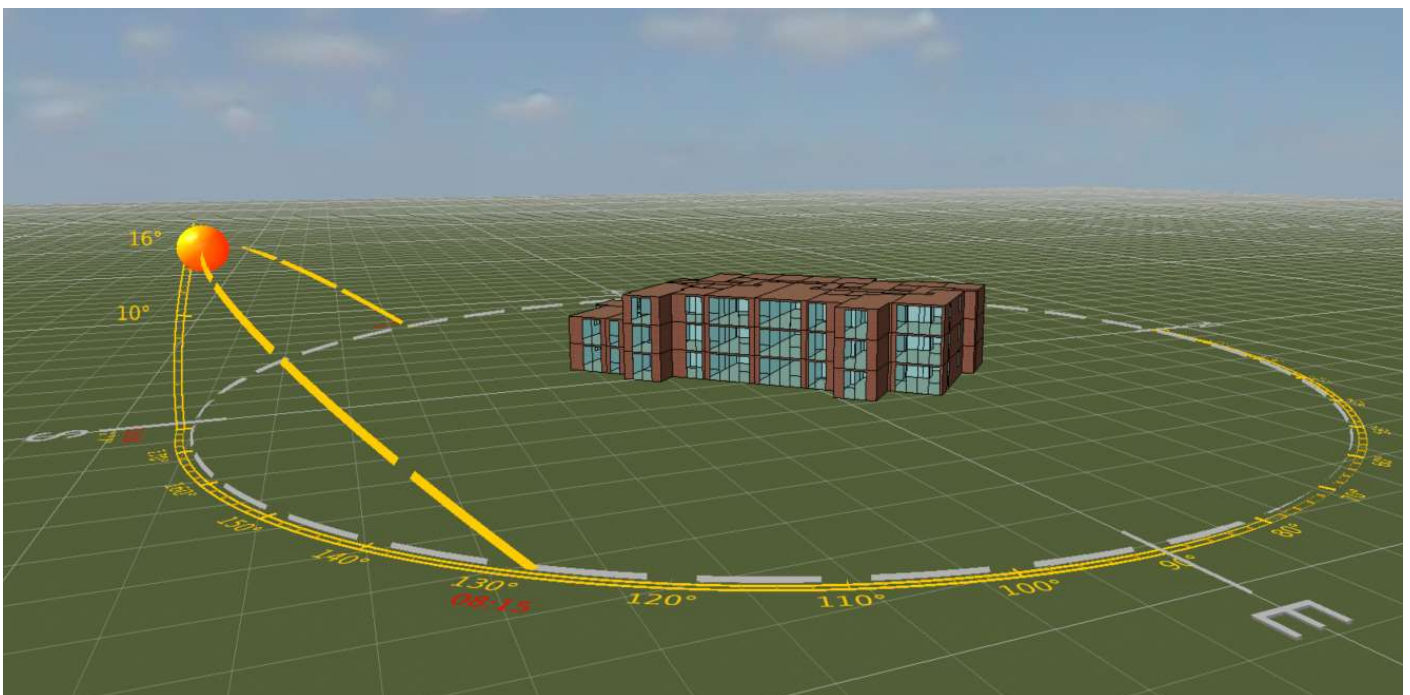
IES VE, a dynamic building modelling software, was used to simulate the thermal performance of the building and undertake steady state heat loss as well as overheating calculations.

Integrated Environmental Solutions Virtual Environment (IES VE) is an industry leading building modelling software which allows energy analysis and performance modelling to optimise building efficiency and develop the services strategy.

IES VE can provide modelling and calculations of:

- Heating and cooling loads
- Summertime overheating
- Natural ventilation air flow
- Energy consumption and carbon emissions
- Building Regulations Part L compliance
- Daylighting

A 3D model of the building was constructed in IES VE, to which the design building fabric elements and their performance was then applied.



### **4.0 Simulation Parameters**

The following details the design input parameters used in the steady state building heat loss simulations.

## 4.1 Building Geometry

The building geometry was taken from architectural floor plan, sections and elevations provided by the Client.

### Ground Floor Plan



### First Floor Plan



## Second Floor Plan



### 4.2 Construction Performance

The original U-values of building envelope are given below:

| Element               | 'U' Value                                   |
|-----------------------|---------------------------------------------|
| External Walls        | 0.13 W(m <sup>2</sup> ,K)                   |
| Ground Floor          | 0.10 W(m <sup>2</sup> ,K)                   |
| Roof                  | 0.11 W(m <sup>2</sup> ,K)                   |
| Triple-glazed Windows | 0.80 W(m <sup>2</sup> ,K) with 0.57 g-value |

The building air tightness was taken as:

| Air Exchange     | Rate                                             |
|------------------|--------------------------------------------------|
| Infiltration     | 0.15 ACH                                         |
| Air Permeability | 4.0 m <sup>3</sup> /(h.m <sup>2</sup> ) at 50 Pa |

### 4.3 Weather Data

The CIBSE weather data for Southampton DSY1 2020 High 50th Percentile weather data has been used in the simulation model.

Both TM52 and TM59 require that simulations be completed using DSY 2020 High 50th Percentile weather data.

#### 4.4 Opening Window Profiles

The windows dimensions were taken from the Architect's building elevation drawings, however, as the final specification of the windows is still to be confirmed, the window free area could not be provided. This was therefore assumed as being top-hung windows and side-hung balcony doors with a free area of not less than 85%.

The opening window profile, the behavioural pattern which determines when the windows will be opened, is set to an opening threshold of 22°C during the daytime and 23°C during the night, and the windows would be closed when the internal (operative) temperature falls below this temperature. This opening threshold temperature is a requirement of Building Regulations Approved Document, Part O.

#### 4.5 Comfort Parameters

The TM52 adaptive comfort setting gives 3 no options for the building type:

| <u>Category</u> | <u>Description</u>                                                                            | <u>Range</u> |
|-----------------|-----------------------------------------------------------------------------------------------|--------------|
| <b>I</b>        | High level of expectation only used for spaces occupied by very sensitive and fragile persons | +/-2K        |
| <b>II</b>       | Normal expectation (for new buildings and renovations)                                        | +/-3K        |
| <b>III</b>      | A moderate expectation (used for existing buildings)                                          | +/-4K        |

Building Category II, as recommended in the CIBSE TM52 guidance, was used.

A summer (elevated) air speed of 0.10 m/s was used, as detailed in the TM52 guidance for natural ventilation via opening windows.

### 5.0 Overheating Simulation Results

#### 5.1 Simulation 1 - TM52 & TM59 Results

This simulation has been run based on the received U / g-values and opening information by the architects (refer to paragraph 4.2).

| <u>TM52</u>                         | Criterion 1 | Criterion 2 | Criterion 3 |
|-------------------------------------|-------------|-------------|-------------|
| <b>Overheating Limiting Factors</b> | <b>3.0</b>  | <b>6.0</b>  | <b>4.0</b>  |
| Room Name                           |             |             |             |
| <u>Passed:</u>                      |             |             |             |
| GF - Plot 02 - Single Bedroom       | 2.4         | 20          | 4           |
| GF - Plot 02 - Kitchen Living 2B3P  | 2.5         | 12          | 3           |

|                                    |     |    |   |
|------------------------------------|-----|----|---|
| GF - Plot 02 - Double Bedroom      | 1.1 | 10 | 2 |
| GF - Plot 04 - Double Bedroom 01   | 1.3 | 9  | 2 |
| GF - Plot 04 - Double Bedroom 02   | 2   | 12 | 3 |
| GF - Plot 04 - Kitchen Living 2B4P | 1.9 | 11 | 3 |
| GF - Plot 05 - Double Bedroom 01   | 1.3 | 9  | 2 |
| GF - Plot 05 - Double Bedroom 02   | 2   | 12 | 3 |
| GF - Plot 05 - Kitchen Living 2B4P | 1.9 | 10 | 3 |
| GF - Plot 07 - Kitchen Living 2B4P | 2.1 | 11 | 3 |
| GF - Plot 07 - Double Bedroom 01   | 2.4 | 12 | 3 |
| GF - Plot 07 - Double Bedroom 02   | 2.2 | 12 | 3 |
| 1F - Plot 08 - Single Bedroom      | 1.8 | 16 | 4 |
| 1F - Plot 08 - Kitchen Living 2B3P | 1.8 | 8  | 2 |
| 1F - Plot 08 - Double Bedroom      | 0.7 | 7  | 2 |
| 1F - Plot 09 - Double Bedroom      | 2.4 | 19 | 4 |
| 1F - Plot 10 - Double Bedroom 01   | 1.4 | 11 | 3 |
| 1F - Plot 10 - Double Bedroom 02   | 2.8 | 16 | 4 |
| 1F - Plot 10 - Kitchen Living 2B4P | 1.5 | 10 | 3 |
| 1F - Plot 11 - Double Bedroom 01   | 1.4 | 11 | 3 |
| 1F - Plot 11 - Double Bedroom 02   | 2.8 | 16 | 4 |
| 1F - Plot 11 - Kitchen Living 2B4P | 1.5 | 10 | 3 |
| 1F - Plot 12 - Double Bedroom      | 2.2 | 19 | 4 |
| 1F - Plot 12 - Kitchen Living 1B2P | 3   | 17 | 3 |
| 1F - Plot 13 - Kitchen Living 2B4P | 1.5 | 10 | 3 |

|                                    |     |    |   |
|------------------------------------|-----|----|---|
| 1F - Plot 13 - Double Bedroom 01   | 2.9 | 16 | 4 |
| 1F - Plot 13 - Double Bedroom 02   | 2.8 | 16 | 4 |
| 1F - Plot 01 - Double Bedroom 01   | 1.9 | 15 | 3 |
| 1F - Plot 01 - Double Bedroom 02   | 1   | 8  | 2 |
| 2F - Plot 14 - Double Bedroom      | 1.8 | 17 | 4 |
| 2F - Plot 15 - Double Bedroom 01   | 1.1 | 9  | 2 |
| 2F - Plot 15 - Double Bedroom 02   | 2.4 | 14 | 4 |
| 2F - Plot 15 - Kitchen Living 2B4P | 0.9 | 7  | 2 |
| 2F - Plot 16 - Double Bedroom 01   | 1.1 | 9  | 2 |
| 2F - Plot 16 - Double Bedroom 02   | 2.4 | 14 | 4 |
| 2F - Plot 16 - Kitchen Living 2B4P | 0.9 | 7  | 2 |
| 2F - Plot 17 - Double Bedroom      | 1.6 | 16 | 4 |
| 2F - Plot 17 - Kitchen Living 1B2P | 1.7 | 11 | 2 |
| 2F - Plot 18 - Kitchen Living 2B4P | 1.3 | 8  | 3 |
| 2F - Plot 18 - Double Bedroom 01   | 2.5 | 15 | 4 |
| 2F - Plot 18 - Double Bedroom 02   | 2.3 | 14 | 4 |
| <b>Failed:</b>                     |     |    |   |
| GF - Plot 01 - Kitchen Living 2B4P | 3.2 | 14 | 3 |
| GF - Plot 03 - Kitchen Living 1B2P | 5.6 | 26 | 3 |
| GF - Plot 03 - Double Bedroom      | 4.3 | 26 | 4 |
| GF - Plot 06 - Double Bedroom      | 3.2 | 21 | 4 |
| GF - Plot 06 - Kitchen Living 1B2P | 5.6 | 26 | 3 |
| 1F - Plot 09 - Kitchen Living 1B2P | 3.3 | 18 | 3 |

|                                         |                  |                   |                  |
|-----------------------------------------|------------------|-------------------|------------------|
| 2F - Plot 14 - Kitchen<br>Living 1B2P   | 6.2              | 25                | 3                |
|                                         |                  |                   |                  |
| <u>TM59</u>                             | Criterion A (<3) | Criterion B (<33) | Criteria failing |
| <b>Overheating Limiting<br/>Factors</b> | <b>3.0</b>       | <b>33</b>         |                  |
| Room Name                               |                  |                   |                  |
| GF - Plot 02 - Single<br>Bedroom        | 2.4              | 147               | B                |
| GF - Plot 02 - Double<br>Bedroom        | 1.1              | 150               | B                |
| GF - Plot 03 - Double<br>Bedroom        | 4.3              | 321               | A & B            |
| GF - Plot 04 - Double<br>Bedroom 01     | 1.3              | 216               | B                |
| GF - Plot 04 - Double<br>Bedroom 02     | 2                | 277               | B                |
| GF - Plot 05 - Double<br>Bedroom 01     | 1.3              | 214               | B                |
| GF - Plot 05 - Double<br>Bedroom 02     | 2                | 273               | B                |
| GF - Plot 06 - Double<br>Bedroom        | 3.2              | 285               | A & B            |
| GF - Plot 07 - Double<br>Bedroom 01     | 2.4              | 298               | B                |
| GF - Plot 07 - Double<br>Bedroom 02     | 2.2              | 274               | B                |
| 1F - Plot 08 - Single<br>Bedroom        | 1.8              | 5                 | -                |
| 1F - Plot 08 - Double<br>Bedroom        | 0.7              | 9                 | -                |
| 1F - Plot 09 - Double<br>Bedroom        | 2.4              | 10                | -                |
| 1F - Plot 10 - Double<br>Bedroom 01     | 1.4              | 10                | -                |
| 1F - Plot 10 - Double<br>Bedroom 02     | 2.8              | 11                | -                |
| 1F - Plot 11 - Double<br>Bedroom 01     | 1.4              | 10                | -                |
| 1F - Plot 11 - Double<br>Bedroom 02     | 2.8              | 11                | -                |
| 1F - Plot 12 - Double<br>Bedroom        | 2.2              | 10                | -                |
| 1F - Plot 13 - Double<br>Bedroom 01     | 2.9              | 11                | -                |

|                                  |                    |    |   |
|----------------------------------|--------------------|----|---|
| 1F - Plot 13 - Double Bedroom 02 | 2.8                | 11 | - |
| 1F - Plot 01 - Double Bedroom 01 | 1.9                | 2  | - |
| 1F - Plot 01 - Double Bedroom 02 | 1                  | 7  | - |
| 2F - Plot 14 - Double Bedroom    | 1.8                | 6  | - |
| 2F - Plot 15 - Double Bedroom 01 | 1.1                | 5  | - |
| 2F - Plot 15 - Double Bedroom 02 | 2.4                | 10 | - |
| 2F - Plot 16 - Double Bedroom 01 | 1.1                | 5  | - |
| 2F - Plot 16 - Double Bedroom 02 | 2.4                | 10 | - |
| 2F - Plot 17 - Double Bedroom    | 1.6                | 6  | - |
| 2F - Plot 18 - Double Bedroom 01 | 2.5                | 10 | - |
| 2F - Plot 18 - Double Bedroom 02 | 2.3                | 10 | - |
|                                  |                    |    |   |
| TM59                             | Corridor Criterion |    |   |
| Overheating Limiting Factors     | 263                |    |   |
| Room Name                        |                    |    |   |
| GF - SW stair core - Corridor    | 32                 |    |   |
| GF - NE stair core - Corridor    | 24                 |    |   |
| 1F - SW stair core - Corridor    | 158                |    |   |
| 1F - NE stair core - Corridor    | 175                |    |   |
| 2F - SW stair core - Corridor    | 84                 |    |   |
| 2F - NE stair core - Corridor    | 173                |    |   |
|                                  |                    |    |   |

## 5.2 Simulation 2 - TM52 & TM59 Results

This simulation has been run based on the received U / g-values and opening information by the architects (refer to paragraph 4.2) with exception of the g-value which is equal to 0.50.

| TM52                                | Criterion 1 | Criterion 2 | Criterion 3 |
|-------------------------------------|-------------|-------------|-------------|
| <b>Overheating Limiting Factors</b> | <b>3.0</b>  | <b>6.0</b>  | <b>4.0</b>  |
| Room Name                           |             |             |             |
| <u>Passed:</u>                      |             |             |             |
| GF - Plot 01 - Kitchen Living 2B4P  | 2.7         | 12          | 2           |
| GF - Plot 02 - Single Bedroom       | 1.9         | 16          | 4           |
| GF - Plot 02 - Kitchen Living 2B3P  | 1.9         | 10          | 3           |
| GF - Plot 02 - Double Bedroom       | 0.8         | 8           | 2           |
| GF - Plot 03 - Double Bedroom       | 2.7         | 19          | 4           |
| GF - Plot 04 - Double Bedroom 01    | 0.9         | 8           | 2           |
| GF - Plot 04 - Double Bedroom 02    | 1.7         | 11          | 2           |
| GF - Plot 04 - Kitchen Living 2B4P  | 1.5         | 10          | 3           |
| GF - Plot 05 - Double Bedroom 01    | 0.9         | 8           | 2           |
| GF - Plot 05 - Double Bedroom 02    | 1.7         | 11          | 2           |
| GF - Plot 05 - Kitchen Living 2B4P  | 1.5         | 9           | 3           |
| GF - Plot 06 - Double Bedroom       | 2.2         | 18          | 4           |
| GF - Plot 07 - Kitchen Living 2B4P  | 1.6         | 10          | 3           |
| GF - Plot 07 - Double Bedroom 01    | 1.8         | 11          | 2           |
| GF - Plot 07 - Double Bedroom 02    | 1.7         | 11          | 2           |
| 1F - Plot 08 - Single Bedroom       | 1.3         | 13          | 3           |
| 1F - Plot 08 - Kitchen Living 2B3P  | 1.4         | 7           | 2           |
| 1F - Plot 08 - Double Bedroom       | 0.6         | 6           | 1           |
| 1F - Plot 09 - Kitchen Living 1B2P  | 2.5         | 12          | 2           |
| 1F - Plot 09 - Double Bedroom       | 1.5         | 15          | 3           |

|                                    |     |    |   |
|------------------------------------|-----|----|---|
| 1F - Plot 10 - Double Bedroom 01   | 1.2 | 10 | 2 |
| 1F - Plot 10 - Double Bedroom 02   | 2.3 | 13 | 3 |
| 1F - Plot 10 - Kitchen Living 2B4P | 1.2 | 7  | 2 |
| 1F - Plot 11 - Double Bedroom 01   | 1.2 | 10 | 2 |
| 1F - Plot 11 - Double Bedroom 02   | 2.2 | 13 | 3 |
| 1F - Plot 11 - Kitchen Living 2B4P | 1.2 | 7  | 2 |
| 1F - Plot 12 - Double Bedroom      | 1.4 | 14 | 3 |
| 1F - Plot 12 - Kitchen Living 1B2P | 2   | 11 | 2 |
| 1F - Plot 13 - Kitchen Living 2B4P | 1.3 | 7  | 2 |
| 1F - Plot 13 - Double Bedroom 01   | 2.4 | 15 | 3 |
| 1F - Plot 13 - Double Bedroom 02   | 2.2 | 13 | 3 |
| 1F - Plot 01 - Double Bedroom 01   | 1.5 | 12 | 3 |
| 1F - Plot 01 - Double Bedroom 02   | 0.7 | 6  | 2 |
| 2F - Plot 14 - Double Bedroom      | 1.1 | 13 | 3 |
| 2F - Plot 15 - Double Bedroom 01   | 0.8 | 8  | 2 |
| 2F - Plot 15 - Double Bedroom 02   | 1.9 | 13 | 3 |
| 2F - Plot 15 - Kitchen Living 2B4P | 0.8 | 5  | 2 |
| 2F - Plot 16 - Double Bedroom 01   | 0.8 | 8  | 2 |
| 2F - Plot 16 - Double Bedroom 02   | 1.9 | 12 | 3 |
| 2F - Plot 16 - Kitchen Living 2B4P | 0.8 | 5  | 2 |
| 2F - Plot 17 - Double Bedroom      | 1.1 | 12 | 3 |
| 2F - Plot 17 - Kitchen Living 1B2P | 1   | 7  | 1 |
| 2F - Plot 18 - Kitchen Living 2B4P | 1.2 | 7  | 2 |

|                                     |                  |                   |                  |
|-------------------------------------|------------------|-------------------|------------------|
| 2F - Plot 18 - Double Bedroom 01    | 2                | 13                | 3                |
| 2F - Plot 18 - Double Bedroom 02    | 1.9              | 13                | 3                |
|                                     |                  |                   |                  |
|                                     |                  |                   |                  |
| Failed:                             |                  |                   |                  |
| GF - Plot 03 - Kitchen Living 1B2P  | 3.7              | 17                | 3                |
| GF - Plot 06 - Kitchen Living 1B2P  | 4.1              | 20                | 3                |
| 2F - Plot 14 - Kitchen Living 1B2P  | 4.3              | 20                | 3                |
|                                     |                  |                   |                  |
| TM59                                | Criterion A (<3) | Criterion B (<33) | Criteria failing |
| <b>Overheating Limiting Factors</b> | <b>3.0</b>       | <b>33</b>         |                  |
| Room Name                           |                  |                   |                  |
| GF - Plot 02 - Single Bedroom       | 1.9              | 131               | B                |
| GF - Plot 02 - Double Bedroom       | 0.8              | 133               | B                |
| GF - Plot 03 - Double Bedroom       | 2.7              | 258               | B                |
| GF - Plot 04 - Double Bedroom 01    | 0.9              | 180               | B                |
| GF - Plot 04 - Double Bedroom 02    | 1.7              | 240               | B                |
| GF - Plot 05 - Double Bedroom 01    | 0.9              | 178               | B                |
| GF - Plot 05 - Double Bedroom 02    | 1.7              | 234               | B                |
| GF - Plot 06 - Double Bedroom       | 2.2              | 210               | B                |
| GF - Plot 07 - Double Bedroom 01    | 1.8              | 264               | B                |
| GF - Plot 07 - Double Bedroom 02    | 1.7              | 242               | B                |
| 1F - Plot 08 - Single Bedroom       | 1.3              | 4                 | -                |
| 1F - Plot 08 - Double Bedroom       | 0.6              | 8                 | -                |
| 1F - Plot 09 - Double Bedroom       | 1.5              | 10                | -                |
| 1F - Plot 10 - Double Bedroom 01    | 1.2              | 7                 | -                |

|                                     |                    |    |   |
|-------------------------------------|--------------------|----|---|
| 1F - Plot 10 - Double Bedroom 02    | 2.3                | 11 | - |
| 1F - Plot 11 - Double Bedroom 01    | 1.2                | 7  | - |
| 1F - Plot 11 - Double Bedroom 02    | 2.2                | 10 | - |
| 1F - Plot 12 - Double Bedroom       | 1.4                | 10 | - |
| 1F - Plot 13 - Double Bedroom 01    | 2.4                | 11 | - |
| 1F - Plot 13 - Double Bedroom 02    | 2.2                | 11 | - |
| 1F - Plot 01 - Double Bedroom 01    | 1.5                | 2  | - |
| 1F - Plot 01 - Double Bedroom 02    | 0.7                | 5  | - |
| 2F - Plot 14 - Double Bedroom       | 1.1                | 6  | - |
| 2F - Plot 15 - Double Bedroom 01    | 0.8                | 5  | - |
| 2F - Plot 15 - Double Bedroom 02    | 1.9                | 7  | - |
| 2F - Plot 16 - Double Bedroom 01    | 0.8                | 5  | - |
| 2F - Plot 16 - Double Bedroom 02    | 1.9                | 7  | - |
| 2F - Plot 17 - Double Bedroom       | 1.1                | 5  | - |
| 2F - Plot 18 - Double Bedroom 01    | 2                  | 7  | - |
| 2F - Plot 18 - Double Bedroom 02    | 1.9                | 7  | - |
|                                     |                    |    |   |
| <u>TM59</u>                         | Corridor Criterion |    |   |
| <b>Overheating Limiting Factors</b> | <b>263</b>         |    |   |
| Room Name                           |                    |    |   |
| GF - SW stair core - Corridor       | 0                  |    |   |
| GF - NE stair core - Corridor       | 0                  |    |   |
| 1F - SW stair core - Corridor       | 25                 |    |   |
| 1F - NE stair core - Corridor       | 25                 |    |   |

|                                  |    |
|----------------------------------|----|
| 2F - SW stair core -<br>Corridor | 40 |
| 2F - NE stair core -<br>Corridor | 47 |
|                                  |    |

### 5.3 Simulation 3 - TM52 & TM59 Results

This simulation has been run based on the received U / g-values and opening information by the architects (refer to paragraph 4.2) with exception of the g-value which is equal to 0.40.

| TM52                                  | Criterion 1 | Criterion 2 | Criterion 3 |
|---------------------------------------|-------------|-------------|-------------|
| <b>Overheating Limiting Factors</b>   | <b>3.0</b>  | <b>6.0</b>  | <b>4.0</b>  |
| Room Name                             |             |             |             |
| Passed:                               |             |             |             |
| GF - Plot 01 - Kitchen<br>Living 2B4P | 1.7         | 9           | 2           |
| GF - Plot 02 - Single<br>Bedroom      | 1.4         | 13          | 3           |
| GF - Plot 02 - Kitchen<br>Living 2B3P | 1.7         | 7           | 2           |
| GF - Plot 02 - Double<br>Bedroom      | 0.6         | 7           | 2           |
| GF - Plot 03 - Kitchen<br>Living 1B2P | 2.5         | 12          | 2           |
| GF - Plot 03 - Double<br>Bedroom      | 1.5         | 14          | 3           |
| GF - Plot 04 - Double<br>Bedroom 01   | 0.7         | 5           | 1           |
| GF - Plot 04 - Double<br>Bedroom 02   | 1.3         | 9           | 2           |
| GF - Plot 04 - Kitchen<br>Living 2B4P | 1.2         | 6           | 2           |
| GF - Plot 05 - Double<br>Bedroom 01   | 0.7         | 5           | 1           |
| GF - Plot 05 - Double<br>Bedroom 02   | 1.3         | 9           | 2           |
| GF - Plot 05 - Kitchen<br>Living 2B4P | 1.2         | 6           | 2           |
| GF - Plot 06 - Double<br>Bedroom      | 1.3         | 14          | 3           |
| GF - Plot 06 - Kitchen<br>Living 1B2P | 2.6         | 12          | 2           |
| GF - Plot 07 - Kitchen<br>Living 2B4P | 1.3         | 7           | 2           |

|                                    |     |    |   |
|------------------------------------|-----|----|---|
| GF - Plot 07 - Double Bedroom 01   | 1.3 | 9  | 2 |
| GF - Plot 07 - Double Bedroom 02   | 1.3 | 9  | 2 |
| 1F - Plot 08 - Single Bedroom      | 0.9 | 9  | 2 |
| 1F - Plot 08 - Kitchen Living 2B3P | 1.2 | 6  | 2 |
| 1F - Plot 08 - Double Bedroom      | 0.4 | 4  | 1 |
| 1F - Plot 09 - Kitchen Living 1B2P | 1.2 | 6  | 1 |
| 1F - Plot 09 - Double Bedroom      | 1   | 11 | 3 |
| 1F - Plot 10 - Double Bedroom 01   | 0.7 | 7  | 2 |
| 1F - Plot 10 - Double Bedroom 02   | 1.5 | 11 | 3 |
| 1F - Plot 10 - Kitchen Living 2B4P | 0.8 | 5  | 2 |
| 1F - Plot 11 - Double Bedroom 01   | 0.7 | 7  | 2 |
| 1F - Plot 11 - Double Bedroom 02   | 1.5 | 11 | 3 |
| 1F - Plot 11 - Kitchen Living 2B4P | 0.8 | 5  | 2 |
| 1F - Plot 12 - Double Bedroom      | 1   | 11 | 3 |
| 1F - Plot 12 - Kitchen Living 1B2P | 1   | 6  | 1 |
| 1F - Plot 13 - Kitchen Living 2B4P | 1.1 | 6  | 2 |
| 1F - Plot 13 - Double Bedroom 01   | 1.6 | 11 | 3 |
| 1F - Plot 13 - Double Bedroom 02   | 1.5 | 11 | 3 |
| 1F - Plot 01 - Double Bedroom 01   | 1.1 | 10 | 2 |
| 1F - Plot 01 - Double Bedroom 02   | 0.4 | 4  | 1 |
| 2F - Plot 14 - Kitchen Living 1B2P | 2.1 | 13 | 2 |
| 2F - Plot 14 - Double Bedroom      | 0.7 | 9  | 2 |
| 2F - Plot 15 - Double Bedroom 01   | 0.4 | 5  | 1 |

|                                     |                  |                   |                  |
|-------------------------------------|------------------|-------------------|------------------|
| 2F - Plot 15 - Double Bedroom 02    | 1.1              | 9                 | 2                |
| 2F - Plot 15 - Kitchen Living 2B4P  | 0.5              | 4                 | 1                |
| 2F - Plot 16 - Double Bedroom 01    | 0.4              | 5                 | 2                |
| 2F - Plot 16 - Double Bedroom 02    | 1.1              | 9                 | 2                |
| 2F - Plot 16 - Kitchen Living 2B4P  | 0.5              | 4                 | 1                |
| 2F - Plot 17 - Double Bedroom       | 0.7              | 9                 | 2                |
| 2F - Plot 17 - Kitchen Living 1B2P  | 0.4              | 4                 | 1                |
| 2F - Plot 18 - Kitchen Living 2B4P  | 1                | 6                 | 2                |
| 2F - Plot 18 - Double Bedroom 01    | 1.2              | 9                 | 2                |
| 2F - Plot 18 - Double Bedroom 02    | 1.1              | 9                 | 2                |
| Failed:                             |                  |                   |                  |
| -                                   | -                | -                 | -                |
| TM59                                | Criterion A (<3) | Criterion B (<33) | Criteria failing |
| <b>Overheating Limiting Factors</b> | <b>3.0</b>       | <b>33</b>         |                  |
| Room Name                           |                  |                   |                  |
| GF - Plot 02 - Single Bedroom       | 1.4              | 102               | B                |
| GF - Plot 02 - Double Bedroom       | 0.6              | 116               | B                |
| GF - Plot 03 - Double Bedroom       | 1.5              | 165               | B                |
| GF - Plot 04 - Double Bedroom 01    | 0.7              | 152               | B                |
| GF - Plot 04 - Double Bedroom 02    | 1.3              | 165               | B                |
| GF - Plot 05 - Double Bedroom 01    | 0.7              | 152               | B                |
| GF - Plot 05 - Double Bedroom 02    | 1.3              | 161               | B                |
| GF - Plot 06 - Double Bedroom       | 1.3              | 147               | B                |
| GF - Plot 07 - Double Bedroom 01    | 1.3              | 190               | B                |

|                                     |                    |     |   |
|-------------------------------------|--------------------|-----|---|
| GF - Plot 07 - Double Bedroom 02    | 1.3                | 170 | B |
| 1F - Plot 08 - Single Bedroom       | 0.9                | 4   | - |
| 1F - Plot 08 - Double Bedroom       | 0.4                | 6   | - |
| 1F - Plot 09 - Double Bedroom       | 1                  | 6   | - |
| 1F - Plot 10 - Double Bedroom 01    | 0.7                | 5   | - |
| 1F - Plot 10 - Double Bedroom 02    | 1.5                | 9   | - |
| 1F - Plot 11 - Double Bedroom 01    | 0.7                | 5   | - |
| 1F - Plot 11 - Double Bedroom 02    | 1.5                | 9   | - |
| 1F - Plot 12 - Double Bedroom       | 1                  | 6   | - |
| 1F - Plot 13 - Double Bedroom 01    | 1.6                | 9   | - |
| 1F - Plot 13 - Double Bedroom 02    | 1.5                | 9   | - |
| 1F - Plot 01 - Double Bedroom 01    | 1.1                | 7   | - |
| 1F - Plot 01 - Double Bedroom 02    | 0.4                | 5   | - |
| 2F - Plot 14 - Double Bedroom       | 0.7                | 5   | - |
| 2F - Plot 15 - Double Bedroom 01    | 0.4                | 5   | - |
| 2F - Plot 15 - Double Bedroom 02    | 1.1                | 5   | - |
| 2F - Plot 16 - Double Bedroom 01    | 0.4                | 5   | - |
| 2F - Plot 16 - Double Bedroom 02    | 1.1                | 5   | - |
| 2F - Plot 17 - Double Bedroom       | 0.7                | 5   | - |
| 2F - Plot 18 - Double Bedroom 01    | 1.2                | 5   | - |
| 2F - Plot 18 - Double Bedroom 02    | 1.1                | 5   | - |
|                                     |                    |     |   |
| <u>TM59</u>                         | Corridor Criterion |     |   |
| <b>Overheating Limiting Factors</b> | <b>263</b>         |     |   |

| Room Name                     |   |
|-------------------------------|---|
| GF - SW stair core - Corridor | 0 |
| GF - NE stair core - Corridor | 0 |
| 1F - SW stair core - Corridor | 0 |
| 1F - NE stair core - Corridor | 0 |
| 2F - SW stair core - Corridor | 5 |
| 2F - NE stair core - Corridor | 0 |
|                               |   |

#### 5.4 Simulation 4 - TM52 & TM59 Results

This simulation has been run based on the received U / g-values and opening information by the architects (refer to paragraph 4.2) with exception of the g-value which is equal to 0.40. Also, 2 ACH (air changes per hour) of mechanical ventilation was applied in the ground floor apartments.

| TM52                                | Criterion 1 | Criterion 2 | Criterion 3 |
|-------------------------------------|-------------|-------------|-------------|
| <b>Overheating Limiting Factors</b> | <b>3.0</b>  | <b>6.0</b>  | <b>4.0</b>  |
| Room Name                           |             |             |             |
| <u>Passed:</u>                      |             |             |             |
| GF - Plot 01 - Kitchen Living 2B4P  | 1.3         | 8           | 2           |
| GF - Plot 02 - Single Bedroom       | 1.1         | 11          | 3           |
| GF - Plot 02 - Kitchen Living 2B3P  | 1.3         | 7           | 2           |
| GF - Plot 02 - Double Bedroom       | 0.4         | 4           | 1           |
| GF - Plot 03 - Kitchen Living 1B2P  | 0.6         | 5           | 1           |
| GF - Plot 03 - Double Bedroom       | 0.9         | 10          | 2           |
| GF - Plot 04 - Double Bedroom 01    | 0.4         | 4           | 1           |
| GF - Plot 04 - Double Bedroom 02    | 0.6         | 5           | 1           |
| GF - Plot 04 - Kitchen Living 2B4P  | 0.8         | 5           | 2           |
| GF - Plot 05 - Double Bedroom 01    | 0.4         | 4           | 1           |

|                                    |     |    |   |
|------------------------------------|-----|----|---|
| GF - Plot 05 - Double Bedroom 02   | 0.6 | 5  | 1 |
| GF - Plot 05 - Kitchen Living 2B4P | 0.7 | 5  | 2 |
| GF - Plot 06 - Double Bedroom      | 0.9 | 10 | 3 |
| GF - Plot 06 - Kitchen Living 1B2P | 0.6 | 5  | 1 |
| GF - Plot 07 - Kitchen Living 2B4P | 1.2 | 6  | 2 |
| GF - Plot 07 - Double Bedroom 01   | 0.7 | 5  | 1 |
| GF - Plot 07 - Double Bedroom 02   | 0.6 | 5  | 1 |
| 1F - Plot 08 - Single Bedroom      | 0.8 | 9  | 2 |
| 1F - Plot 08 - Kitchen Living 2B3P | 1.1 | 6  | 2 |
| 1F - Plot 08 - Double Bedroom      | 0.2 | 3  | 1 |
| 1F - Plot 09 - Kitchen Living 1B2P | 0.6 | 5  | 1 |
| 1F - Plot 09 - Double Bedroom      | 0.9 | 10 | 2 |
| 1F - Plot 10 - Double Bedroom 01   | 0.5 | 5  | 2 |
| 1F - Plot 10 - Double Bedroom 02   | 1.3 | 10 | 2 |
| 1F - Plot 10 - Kitchen Living 2B4P | 0.7 | 5  | 2 |
| 1F - Plot 11 - Double Bedroom 01   | 0.5 | 5  | 2 |
| 1F - Plot 11 - Double Bedroom 02   | 1.3 | 9  | 2 |
| 1F - Plot 11 - Kitchen Living 2B4P | 0.7 | 5  | 2 |
| 1F - Plot 12 - Double Bedroom      | 0.8 | 9  | 2 |
| 1F - Plot 12 - Kitchen Living 1B2P | 0.5 | 5  | 1 |
| 1F - Plot 13 - Kitchen Living 2B4P | 1.1 | 6  | 2 |
| 1F - Plot 13 - Double Bedroom 01   | 1.4 | 11 | 3 |
| 1F - Plot 13 - Double Bedroom 02   | 1.3 | 10 | 2 |

|                                     |                  |                   |                  |
|-------------------------------------|------------------|-------------------|------------------|
| 1F - Plot 01 - Double Bedroom 01    | 1                | 10                | 2                |
| 1F - Plot 01 - Double Bedroom 02    | 0.3              | 4                 | 1                |
| 2F - Plot 14 - Kitchen Living 1B2P  | 2                | 12                | 2                |
| 2F - Plot 14 - Double Bedroom       | 0.7              | 9                 | 2                |
| 2F - Plot 15 - Double Bedroom 01    | 0.4              | 4                 | 1                |
| 2F - Plot 15 - Double Bedroom 02    | 1.1              | 9                 | 2                |
| 2F - Plot 15 - Kitchen Living 2B4P  | 0.5              | 4                 | 1                |
| 2F - Plot 16 - Double Bedroom 01    | 0.4              | 4                 | 1                |
| 2F - Plot 16 - Double Bedroom 02    | 1.1              | 8                 | 2                |
| 2F - Plot 16 - Kitchen Living 2B4P  | 0.5              | 4                 | 1                |
| 2F - Plot 17 - Double Bedroom       | 0.7              | 9                 | 2                |
| 2F - Plot 17 - Kitchen Living 1B2P  | 0.3              | 4                 | 1                |
| 2F - Plot 18 - Kitchen Living 2B4P  | 1                | 6                 | 2                |
| 2F - Plot 18 - Double Bedroom 01    | 1.2              | 9                 | 2                |
| 2F - Plot 18 - Double Bedroom 02    | 1.1              | 9                 | 2                |
| Failed:                             |                  |                   |                  |
| -                                   | -                | -                 | -                |
| <u>TM59</u>                         | Criterion A (<3) | Criterion B (<33) | Criteria failing |
| <b>Overheating Limiting Factors</b> | <b>3.0</b>       | <b>33</b>         |                  |
| Room Name                           |                  |                   |                  |
| GF - Plot 02 - Single Bedroom       | 1.1              | 21                | -                |
| GF - Plot 02 - Double Bedroom       | 0.4              | 21                | -                |
| GF - Plot 03 - Double Bedroom       | 0.9              | 22                | -                |
| GF - Plot 04 - Double Bedroom 01    | 0.4              | 21                | -                |

|                                  |     |    |   |
|----------------------------------|-----|----|---|
| GF - Plot 04 - Double Bedroom 02 | 0.6 | 25 | - |
| GF - Plot 05 - Double Bedroom 01 | 0.4 | 20 | - |
| GF - Plot 05 - Double Bedroom 02 | 0.6 | 25 | - |
| GF - Plot 06 - Double Bedroom    | 0.9 | 21 | - |
| GF - Plot 07 - Double Bedroom 01 | 0.7 | 27 | - |
| GF - Plot 07 - Double Bedroom 02 | 0.6 | 29 | - |
| 1F - Plot 08 - Single Bedroom    | 0.8 | 4  | - |
| 1F - Plot 08 - Double Bedroom    | 0.2 | 5  | - |
| 1F - Plot 09 - Double Bedroom    | 0.9 | 5  | - |
| 1F - Plot 10 - Double Bedroom 01 | 0.5 | 5  | - |
| 1F - Plot 10 - Double Bedroom 02 | 1.3 | 7  | - |
| 1F - Plot 11 - Double Bedroom 01 | 0.5 | 5  | - |
| 1F - Plot 11 - Double Bedroom 02 | 1.3 | 7  | - |
| 1F - Plot 12 - Double Bedroom    | 0.8 | 5  | - |
| 1F - Plot 13 - Double Bedroom 01 | 1.4 | 7  | - |
| 1F - Plot 13 - Double Bedroom 02 | 1.3 | 7  | - |
| 1F - Plot 01 - Double Bedroom 01 | 1   | 2  | - |
| 1F - Plot 01 - Double Bedroom 02 | 0.3 | 5  | - |
| 2F - Plot 14 - Double Bedroom    | 0.7 | 5  | - |
| 2F - Plot 15 - Double Bedroom 01 | 0.4 | 5  | - |
| 2F - Plot 15 - Double Bedroom 02 | 1.1 | 5  | - |
| 2F - Plot 16 - Double Bedroom 01 | 0.4 | 5  | - |
| 2F - Plot 16 - Double Bedroom 02 | 1.1 | 5  | - |

|                                     |                    |   |   |
|-------------------------------------|--------------------|---|---|
| 2F - Plot 17 - Double Bedroom       | 0.7                | 5 | - |
| 2F - Plot 18 - Double Bedroom 01    | 1.2                | 5 | - |
| 2F - Plot 18 - Double Bedroom 02    | 1.1                | 5 | - |
|                                     |                    |   |   |
| <u>TM59</u>                         | Corridor Criterion |   |   |
| <b>Overheating Limiting Factors</b> | <b>263</b>         |   |   |
| Room Name                           |                    |   |   |
| GF - SW stair core - Corridor       | 0                  |   |   |
| GF - NE stair core - Corridor       | 0                  |   |   |
| 1F - SW stair core - Corridor       | 0                  |   |   |
| 1F - NE stair core - Corridor       | 0                  |   |   |
| 2F - SW stair core - Corridor       | 0                  |   |   |
| 2F - NE stair core - Corridor       | 0                  |   |   |
|                                     |                    |   |   |

## 6.0 Conclusions

It has been demonstrated that the current 'as designed' building fabric generally has a good performance in mitigating building overheating. Although 7 of the 48 occupied areas fail to meet the 1<sup>st</sup> Criterion of the TM59, this can be resolved by decreasing the glazing g-value of the openings from 0.57 to 0.40. The glazing g-value of the openings could be lowered to façades which enclose the rooms which failing to meet the 1<sup>st</sup> Criterion of the TM59 only or to the whole building for an improved performance against the overheating.

Ventilation is a key factor in mitigating overheating, and this demonstrated on the ground floor bedrooms where all the bedrooms fail to comply with the 2<sup>nd</sup> Criterion of the TM59 due to the lack of nighttime natural ventilation. Mechanical ventilation, with a minimum rate of 2 ACH (air changes per hour), is proposed in these areas in order to meet the TM59 - 2<sup>nd</sup> Criterion requirements, if natural ventilation cannot be achieved by openable windows.