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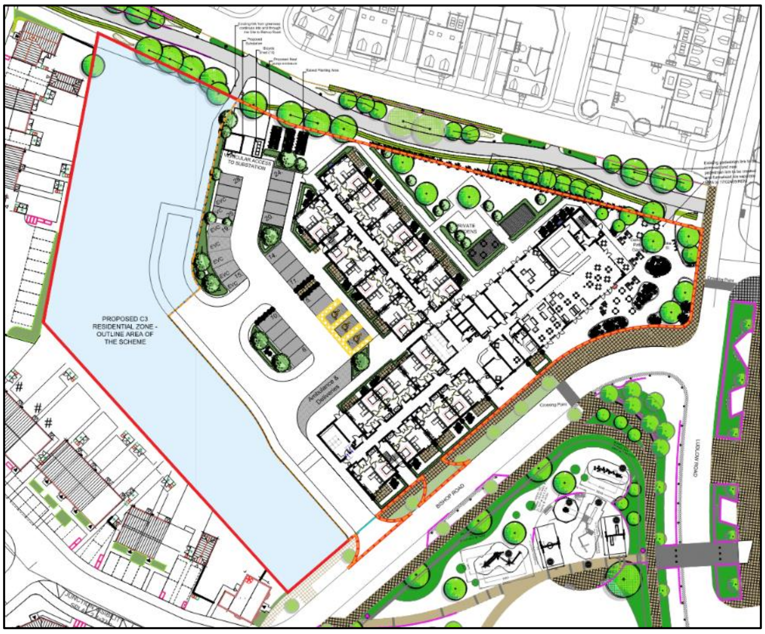
Extra Care, Bicester

Oxfordshire

Overheating Analysis



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RECORD OF REVISIONS.		
Date.	**Revision.**	**Description of change.**
13/10/2023	1	First Issue
18/10/2023	2	Updated Site Plan & Description
25/10/2023	3	Updated to incorporate comments

1 INTRODUCTION

Cudd Bentley Consulting has produced the following dynamic thermal model for the proposed Extra Care, Bicester development in order to review the buildings overheating performance for the safety and comfort of its residents, with respect to CIBSE TM59. A sample model of Extra Care units representing a typical floor are assessed. The study has been undertaken in accordance with the National Planning Policy Framework and within the adopted Development Plans which is Cherwell Local Plan Review (Adopted July 2015). This has been conducted using the datasets of CIBSE TM59 in order to identify the overheating risk.

The Extra Care development in Bicester is a hybrid application comprising (i) in FULL, the construction of an 82 no. apartment affordable extra care (class C2) with associated bistro, open space, landscaping, car/cycle parking, service infrastructure (drainage, highway, lighting), engineering operations, creation of new vehicular access and re-instatement of existing access to footpath, and (ii) in OUTLINE, the construction of a maximum of 14 market residential dwellings (class C3), on land known as Parcel R, Kingsmere, Bicester.

Extra Care provide several benefits for individuals who require assistance with daily activities and those who can no longer live independently due to physical, cognitive, or medical conditions.

Thermal modelling has been undertaken by a Cudd Bentley CIBSE Low Carbon Energy Assessor, who is registered to carry Level 5 Energy Assessments. Level 5 energy assessments account for dynamic thermal modelling, which are preferred when a building has a more complex design and incorporating specialist building fabric design. The SBEM software used to carry out the modelling is Bentley, HEVACOMP, Version V8i, SS1 SP5 which is approved software.

The study is based on dynamic simulation modelling (DSM). Results are determinant on the given inputs listed in this document and indoor climate of rooms are estimated based on these factors:

- Weather file utilized within the model
- Heat loss though building thermal envelope
- Building Heating, Ventilation and Air-conditioning
- Solar heat gain through windows

The assumption and approximation that are inherent in any modelling exercise must be noted. There is a section of the report detailing assumptions and approximations made. It is always possible that results obtained from computer modelling software may not be exact representations of real-life situations, as they are based on climatic conditions and patterns of use. Therefore, results should be read as those following the overheating mitigation risk calculation methodology.

The initial drawing used for the thermal model was retrieved from BMJ Architects. The sample units that are assessed for overheating are displayed below in Figure 1.

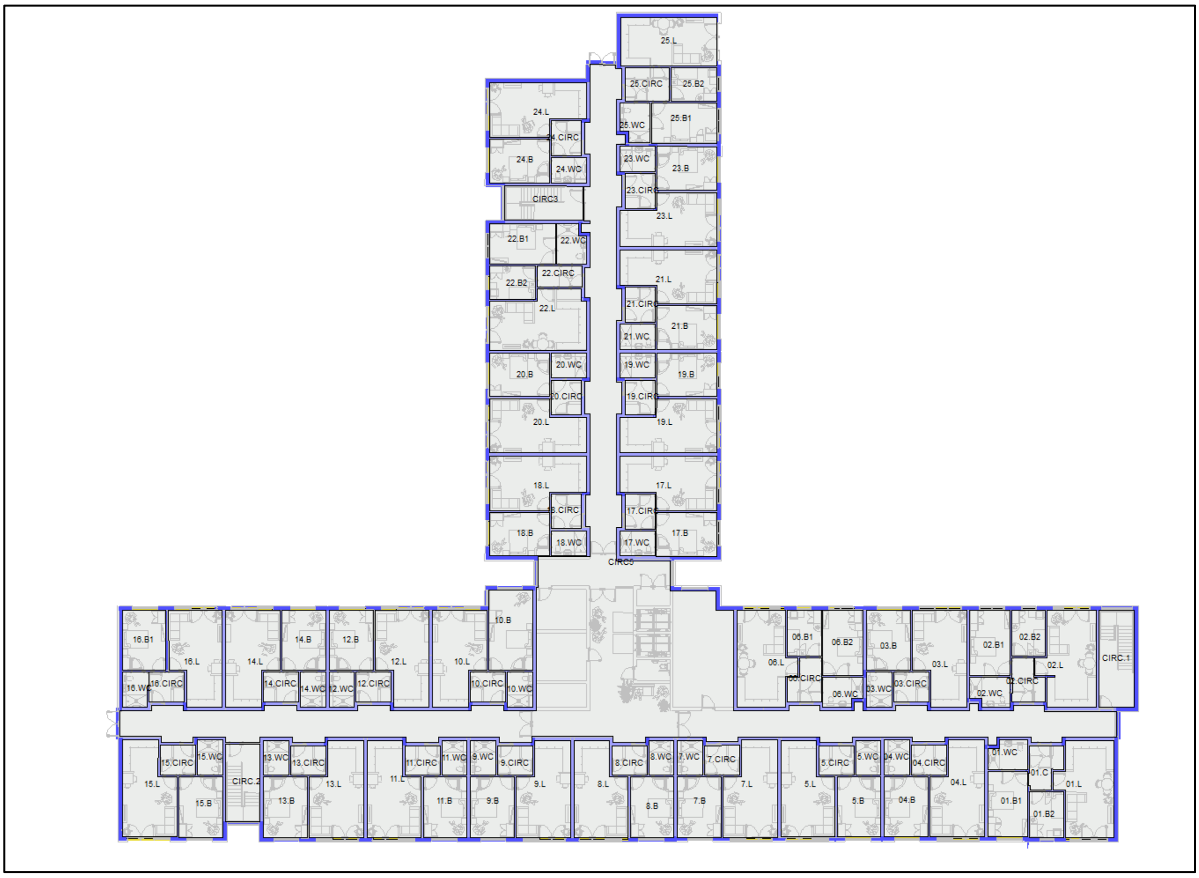


Figure 1: Bicester Extra Care (First Floor Sample apartments)

The sample floor modelled above follows the TM59 methodology, which provides detailed criteria for the configuration of the model and simulation software, covering:

- Internal air speed and mixing
- Heat losses and gains from pipework
- Sampling of dwellings
- Weather data
- Exposure, air infiltration and mechanical bedrooms
- Window and door openings, blinds and shading devices

2 DESIGN PARAMETERS

The following design parameters have been utilised to create the thermal model.

2.1 CONSTRUCTION ELEMENTS

The following U- values and construction detailed have been used within the thermal model:

- External Walls - U-value = 0.26 W/m².K;
- Exposed Floors - U-value = 0.16 W/m².K;
- Exposed Roofs - U-value = 0.18 W/m².K;
- Glazing - U-value = 0.82 W/m².K, g-value 0.36
- Air Permeability - 5 $m^3/hr/m^2$@ 50 Pa;

2.2 ROOM OCCUPANCY AND HEAT GAIN

Table 1 below outlines the occupancy and heat gain profiles utilised within the thermal model.

Figure 1 Heat gain profile

Number of people	Description	Peak load (W) Sensible	Peak load (W) Latent	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 occupancy	75	55	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 cccupancy	150	110	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 occupancy	150	110	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 occupancy	75	55	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 occupancy	75	55	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 occupancy	75	55	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 occupancy	150	110	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 occupancy	150	110	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 occupancy	150	110	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 occupancy	225	165	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 occupancy	225	165	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 occupancy	225	165	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
	Single bedroom equipment	80		0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.13
	Double bedroom equipment	80		0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.13
	Studio equipment	450		0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	1	1	0.44	0.44	0.24	0.24
	Living/litchen equipment	450		0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	1	1	0.44	0.44	0.24	0.24
	Living equipment	150		0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	1	1	1	1	0.4	0.4
	Kitchen equipment	300		0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	1	1	0.17	0.17	0.17	0.17
	Lighting profile	2 (W/m2)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0

<u>Table 2.1: Occupancy and Heat Gain Profiles</u>

2.3 HEAT GAINS

The following heat gains have been implemented within the thermal model:

- Equipment – 450 Watts (Lounges), 80W (Bedrooms)
- Lighting –2W/m^2 (Bedrooms/Lounges)

(These values have been outlined within table 2.1)

2.4 WINDOWS

The windows are modelled with the following glazing properties:

- Glazing 'U' Value – 0.82 W/m^2K;
- Light Transmittance – 0.65;
- G Value – 0.36;
- Glazing to Frame Ratio – 0.70.

Daylight

High levels of natural daylight will be provided, wherever possible, through effective window design. The glazing specification for the new development will be optimised to ensure that the glazed elements provide excellent thermal performance combined with optimum solar reflectance to minimise summer solar heat gains along with high daylight transmittance factors to maximise daylight factors. Encouraging the correct quality and quantity of daylight to penetrate the building is key to reducing the amount of light required from artificial sources and hence energy requirements.

2.5 WINDOW OPENABLILITY

An acoustic report was provided by **Creative Consulting Engineers Limited** to allow the use of correct window opening control strategy, informing the design team whether windows are openable or not for the facades around the Bicester Extra Care development.

An acoustic report is a comprehensive document that provides an analysis of the acoustic environment in a specific location. It is typically prepared by acoustic consultants or experts and is used to assess the noise levels, sound characteristics, and potential impact on the environment and surrounding areas. Acoustic reports are often required for various projects, such as construction sites, industrial developments, roadways, entertainment venues, and residential areas.

The document details all windows within the development openable, except ones facing Vendee drive (shown in figure 2.6) whilst running the overheating analysis due to road traffic noise on vendee drive.

Acoustic Report reference - FV_JEB_P15-874_02 Rev B*

2.6 HYBRID SYSTEM PROPOSAL

Since the façade's facing vendee drive have been identified to being at risk of high noise levels, they have been assumed closed within the overheating analysis. Due to this a hybrid ventilation strategy has been proposed. Figure 2.6 below highlights which room windows are openable, and which room windows aren't.

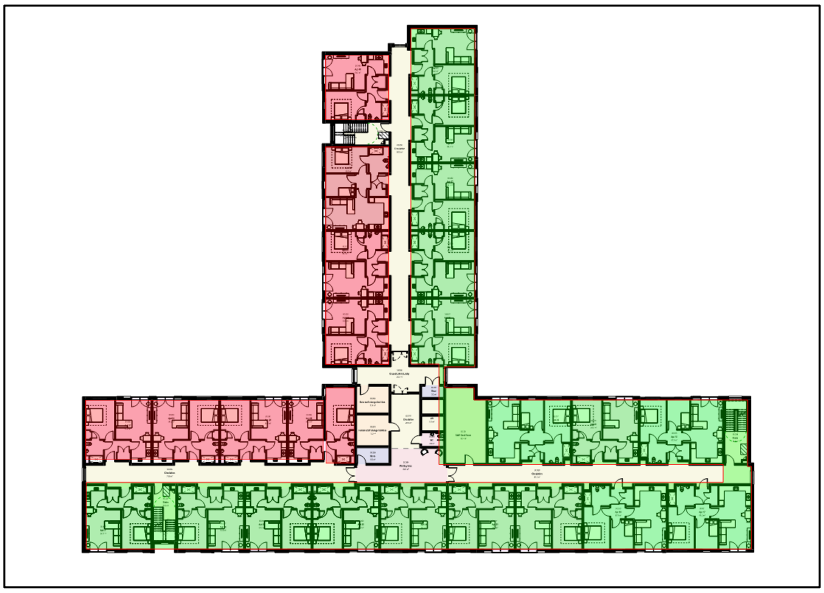


Figure 2.6: Identification of which rooms contain windows which are/ are not openable

The green areas show the rooms where the windows are openable, whereas the red rooms highlight the rooms where the windows aren't openable.

2.7 VENTILATION RATES

Room	Natural Ventilation	Mechanical Ventilation Rate	Cooling System
Corridors	Openable windows will allow fresh air to flow easier through corridors	Not Applicable	Not Applicable
Bedrooms/Lounges	Acoustic report allows openable windows for facades not facing Vendee Drive, allowing fresh air to flow easier	MVHR to allow ventilation with summer boost mode	Cooling to provide extra Ventilation support to the MVHR, for facades facing Vendee Drive

2.8 WEATHER DATA

The CIBSE Design Summer Year Oxfordshire 2020s, high emissions, 50 percentile scenario, DSY 1, has been imported within the calculations to represent a typical year for the Oxfordshire geographical location of the development.

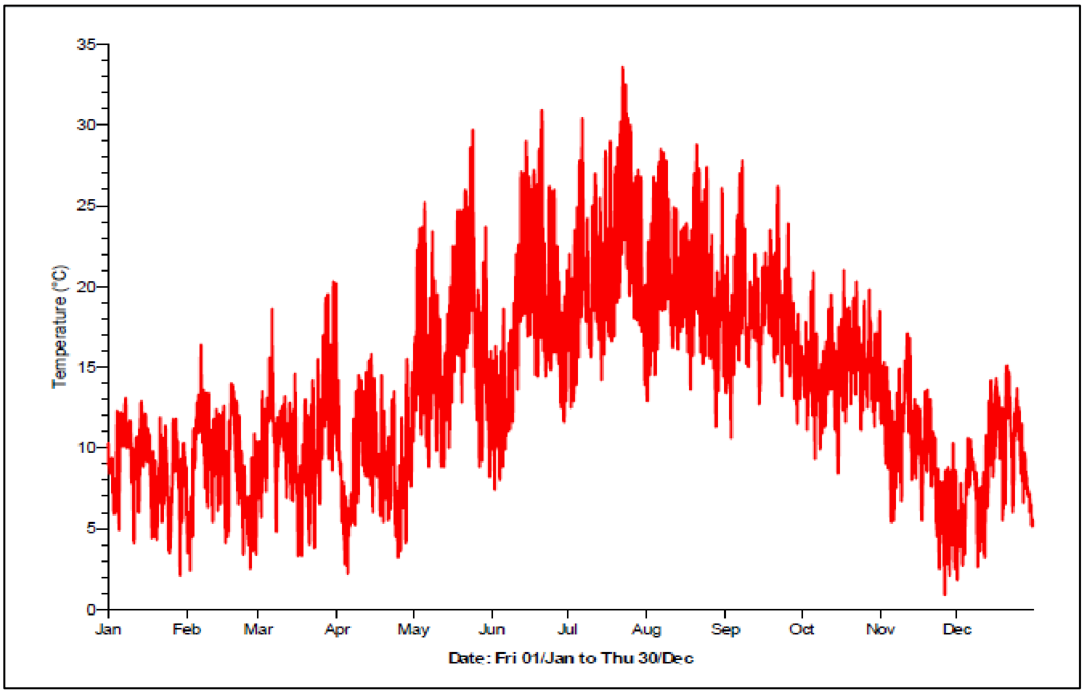


Figure 2.1: CIBSE Design Summer Year Oxfordshire – DSY1

3 OVERHEATING REQUIREMENTS

CIBSE TM59 requirements

Compliance with CIBSE TM59 for extra care space that are predominantly mechanically ventilated is based on the following criteria:

- All occupied rooms should not exceed an operative temperature of 26°C for more than 3% of the annual occupied annual hour.

Compliance with CIBSE TM59 for extra care space that are predominantly naturally ventilated is based on the following criteria:

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

Internal Conditions are defined by a dynamic simulation as per the TM59 – 2017 [Section 6, Table 2], shown below in table 3.1.

Table 2 Occupancy and equipment gain descriptions

Unit/ room type	Occupancy	Equipment load
Studio	2 people at 70% gains from 11 pm to 8 am 2 people at 100% gains from 8 am to 11 pm	Peak load of 450 W from 6 pm to 8 pm*. 200 W from 8 pm to 10 pm 110 W from 9 am to 6 pm and 10 pm to 12 pm Base load of 85 W for the rest of the day
1-bedroom apartment: living room/kitchen	1 person from 9 am to 10 pm; room is unoccupied for the rest of the day	Peak load of 450 W from 6 pm to 8 pm 200 W from 8 pm to 10 pm 110 W from 9 am to 6 pm and from 10 pm to 12 pm Base load of 85 W for the rest of the day
1-bedroom apartment: living room	1 person at 75% gains from 9 am to 10 pm; room is unoccupied for the rest of the day	Peak load of 150 W from 6 pm to 10 pm 60 W from 9 am to 6 pm and from 10 pm to 12 pm Base load of 35 W for the rest of the day
1-bedroom apartment: kitchen	1 person at 25% gains from 9 am to 10 pm; room is unoccupied for the rest of the day	Peak load of 300 W from 6 pm to 8 pm Base load of 50 W for the rest of the day
2-bedroom apartment: living room/kitchen	2 people from 9 am to 10 pm; room is unoccupied for the rest of the day	Peak load of 450 W from 6 pm to 8 pm 200 W from 8 pm to 10 pm 110 W from 9 am to 6 pm and from 10 pm to 12 pm Base load of 85 W for the rest of the day
2-bedroom apartment: living room	2 people at 75% gains from 9 am to 10 pm; room is unoccupied for the rest of the day	Peak load of 150 W from 6 pm to 10 pm 60 W from 9 am to 6 pm and from 10 pm to 12 pm Base load of 35 W for the rest of the day
2-bedroom apartment: kitchen	2 people at 25% gains from 9 am to 10 pm; room is unoccupied for the rest of the day	Peak load of 300 W from 6 pm to 8 pm Base load of 50 W for the rest of the day
3-bedroom apartment: living room/kitchen	3 people from 9 am to 10 pm; room is unoccupied for the rest of the day	Peak load of 450 W from 6 pm to 8 pm 200W from 8 pm to 10 pm 110 W from 9 am to 6 pm and from 10 pm to 12 pm Base load of 85 W for the rest of the day
3-bedroom apartment: living room	3 people at 75% gains from 9 am to 10 pm; room is unoccupied for the rest of the day	Peak load of 150 W from 6 pm to 10 pm 60 W from 9 am to 6 pm and from 10 pm to 12 pm Base load of 35 W for the rest of the day
3-bedroom apartment: kitchen	3 people at 25% gains from 9 am to 10 pm; room is unoccupied for the rest of the day	Peak load of 300 W from 6 pm to 8 pm base load of 50 W for the rest of the day
Double bedroom	2 people at 70% gains from 11 pm to 8 am 2 people at full gains from 8 am to 9 am and from 10 pm to 11 pm 1 person at full gains in the bedroom from 9 am to 10 pm	Peak load of 80 W from 8 am to 11 pm Base load of 10 W during the sleeping hours
Single bedroom (too small to accommodate double bed)	1 person at 70% gains from 11 pm to 8 am 1 person at full gains from 8 am to 11 pm	Peak load of 80 W from 8 am to 11 pm Base load of 10 W during sleeping hours
Communal corridors	Assumed to be zero	Pipework heat loss only; see section 3.1 above

* All times in GMT

Table 3.1

CIBSE TM52 requirements

TM52 states that in hot periods people's perception of heat is better coped with during long periods exposed to warmth. In order to assess this, TM52 requires an analysis of the following:

- Hours of Exceedance (He);
- Daily Weighted Exceedance (We);
- Upper Limit Temperature (Tupp).

The above analysis should then be assessed against the following criteria within TM52 which states that should any two of the three criteria fail, a building or room is classed as overheating:

- The first criterion sets a limit for the number of hours that the operative temperature can exceed the threshold comfort temperature (upper limit of the range of comfort temperature) by 1 K or more during the occupied hours of a typical non-heating season (1 May to 30 September). This is further detailed within TM52 as the *He* shall not exceed 3% of the total occupied hours.
- The second criterion deals with the severity of overheating within any one day, which can be as important as its frequency, the level of which is a function of both temperature rise and its duration. This criterion sets a daily limit for acceptability. This is further detailed within TM52 as the *We* shall be less than or equal to 6 in any one day.
- The third criterion sets an absolute maximum daily temperature for a room, beyond which the level of overheating is unacceptable. This is further detailed within TM52 as the *Tupp* shall not exceed 4K.

3.1 APPROVED DOCUMENT 0

Requirement O1 Overheating Mitigation

1. Reasonable provision must be made in respect of a dwelling, institution or any other building containing one or more rooms for residential purposes, other than a room in a hotel ("residences") to -
    a) Limit unwanted solar gains in summer;
    b) Provide an adequate means to remove heat from the indoor environment

2. In meeting the obligations in paragraph (1) –
    a) Account must be taken of the safety of any occupant, and their reasonable enjoyment of the residence; and
    b) Mechanical cooling may only be used where insufficient heat is capable of being removed from the indoor environment without it.

Paragraph 2.8

Although internal blinds and curtains provide some reduction in solar gains, they should not be taken into account when considering whether requirement O1 has been met.

4 RESULTS

This section looks at the simulation results for the naturally ventilated and mechanically ventilated scenarios. The simulation was run using two scenarios, looking at various ways to make all rooms comply as per the TM59 guidelines and minimise the use of cooling.

4.1 NATURAL VENTILATION WITH MVHR AT 3 AIR CHANGES

The thermal models demonstrates that for DSY 1 CIBSE weather data the development's design and services strategy is capable of delivering the thermal comfort levels in all rooms with openable windows, in accordance with the requirements set out within TM59 and TM52 CIBSE Guides. In the rooms referenced in table 4.1, a MVHR is utilized alongside natural ventilation. Table 4.1 below shows the results obtained for the selected rooms.

Room	Pass/Fail	% above 3% 26°C Threshold (Lounges)	% above 1% 26°C Threshold (Bedrooms)
1.1.B1	Pass		
1.1.B2	Pass		
1.1.L	Pass		
1.2.B	Pass		
1.2.L	Pass		
1.3.B	Pass		
1.3.L	Pass		
1.4.B	Pass		
1.4.L	Pass		
1.5.B	Pass		
1.5.L	Pass		
1.6.B1	Pass		
1.6.B2	Pass		
1.6.L	Pass		
1.7.B	Pass		
1.7.L	Pass		
1.8.B	Pass		
1.8.L	Pass		
1.9.B	Pass		
1.9.L	Pass		
1.11.B	Pass		
1.11.L	Pass		
1.13.B	Pass		
1.13.L	Pass		
1.15.B	Pass		
1.15.L	Pass		
1.17.B	Pass		
1.17.L	Pass		
1.19.B	Pass		
1.19.L	Pass		
1.21.B	Pass		
1.21.L	Pass		
1.23.B	Pass		
1.23.L	Pass		
1.25.B1	Pass		

1.25.B2	Pass		
1.25.L	Pass		

Table 4.1: Rooms with Openable Windows, CIBSE TM59 and TM52 Results – DSY1 (With MVHR at 3 Air Changes)

4.2 MVHR ONLY WITH COOLING SYSTEM

The thermal models demonstrates that for DSY 1 CIBSE weather data the development's design and services strategy is capable of delivering the thermal comfort levels in all room's with acoustic restraints, in accordance with the requirements set out within the TM59 CIBSE Guide. In the rooms referenced in table 4.2, an MVHR is utilized alongside a cooling system. Table 4.2 below shows the results obtained for the selected rooms.

Room	Pass/Fail	% above 3% 26°C Threshold (Lounges and Bedrooms)
1.10.B	Pass	
1.10.L	Pass	
1.12.B	Pass	
1.12.L	Pass	
1.14.B	Pass	
1.14.L	Pass	
1.16.B	Pass	
1.16.L	Pass	
1.18.B	Pass	
1.18.L	Pass	
1.20.B	Pass	
1.20.L	Pass	
1.22.B1	Pass	
1.22.B2	Pass	
1.22.L	Pass	
1.24.B	Pass	
1.24.L	Pass	

Table 4.2: Rooms with Closed Windows, CIBSE TM59 Results – DSY1 (With MVHR and Cooling systems at 3 Air Changes)

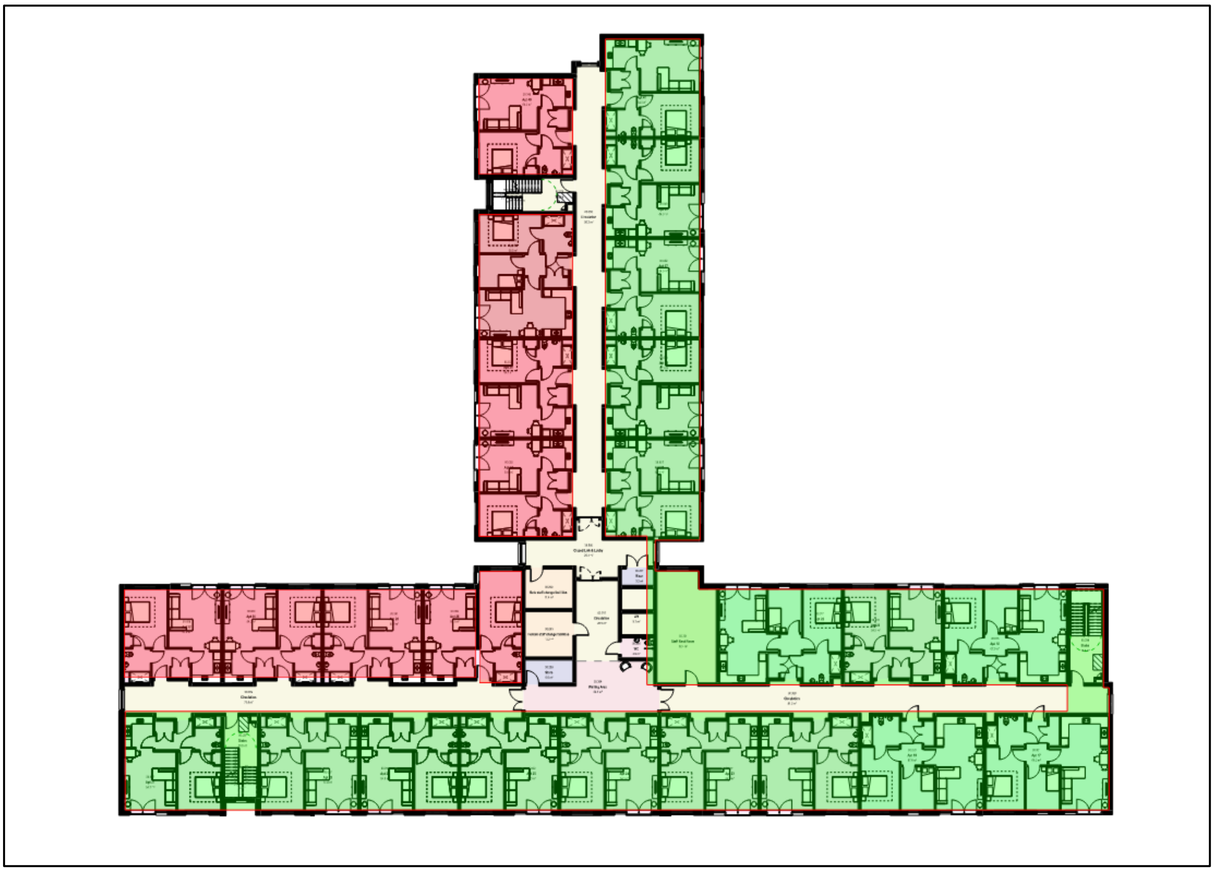
5 CONCLUSION

From running the simulation, it is evident all rooms with openable windows allowed (as per the acoustic report) comply with the CIBSE TM59 guide if a MVHR at 3 air changes with natural ventilation is utilized. Within rooms that have acoustic restraint (windows closed) an MVHR with cooling system will need to be utilized to comply with the CIBSE TM59 guide. For corridors an extract fan with a minimum 2.5 air changes will be sufficient for corridors to comply with the CIBSE TM59 guide.

The simulation was run on sample apartments, but the results can be extended across all floors. Therefore, it can be concluded that through use of proposed ventilation strategy all rooms comply with TM59 and TM52 criteria.

6 APPENDIX A

6.1 OPENABLE WINDOWS VISUALIZED



Rooms with Openable Windows – Green

Rooms with Closed Windows – Red