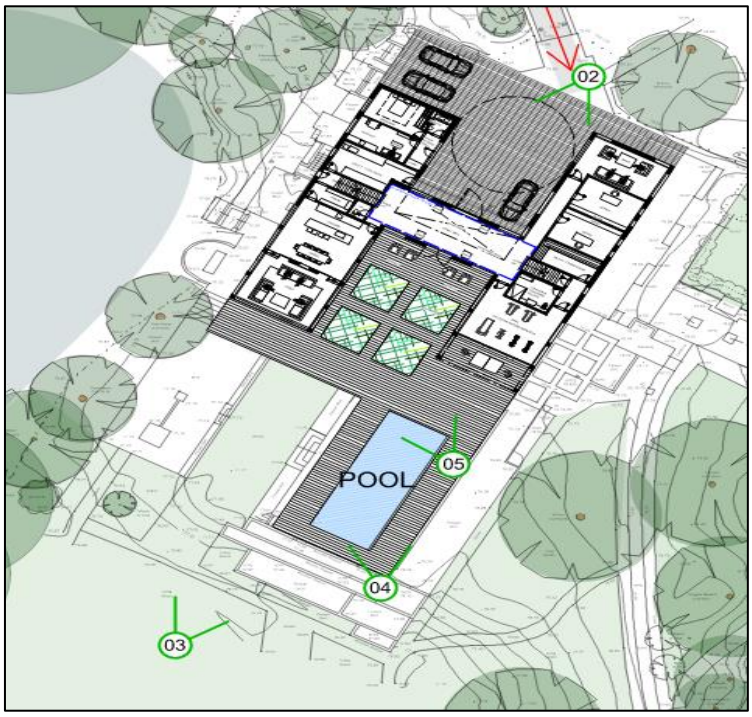
# *Woodland Drive, East Horsley,*

*Innisfree KT24 5AS*

# *Residential Overheating Analysis*

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## RECORD OF REVISIONS.

| Date. | Revision. | Description of change. |
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| 29/01/2024 | 1 | Issued for Submission |
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# 1 INTRODUCTION

Cudd Bentley Consulting has produced the following dynamic thermal model in order to review the buildings overheating and cooling performance for the safety and comfort of its residents, with respect to CIBSE TM59. A sample of proposed bedrooms and living rooms are assessed. The study has been undertaken in accordance with, Guildford borough Local Plan: strategy and sites, Approved Document O (2022) and has been conducted using the datasets of CIBSE TM59 in order to identify the overheating risk.

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 initial drawing used for the thermal model was retrieved from HdAr Architects. The rooms which were assessed for overheating are displayed below in Figure 1 and 2.

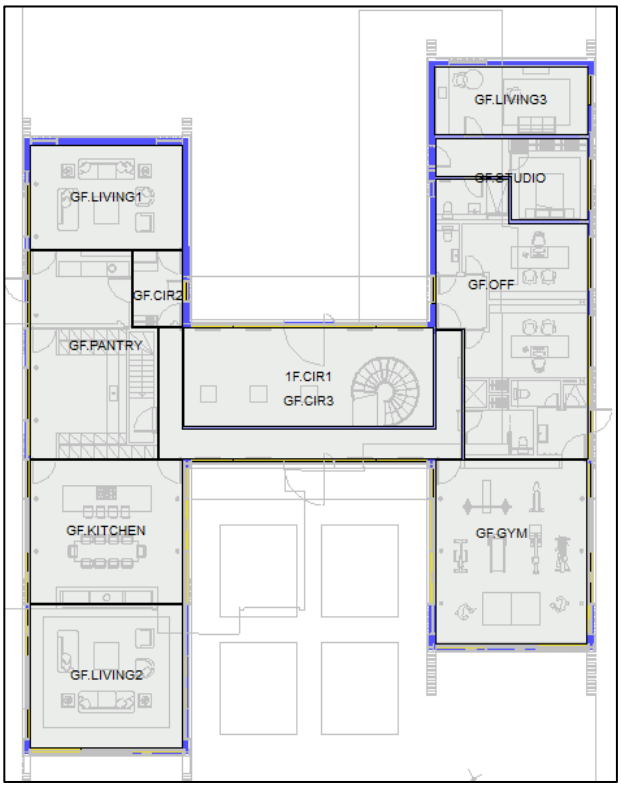


Figure 1 Innisfree East Horsley (Lounges)

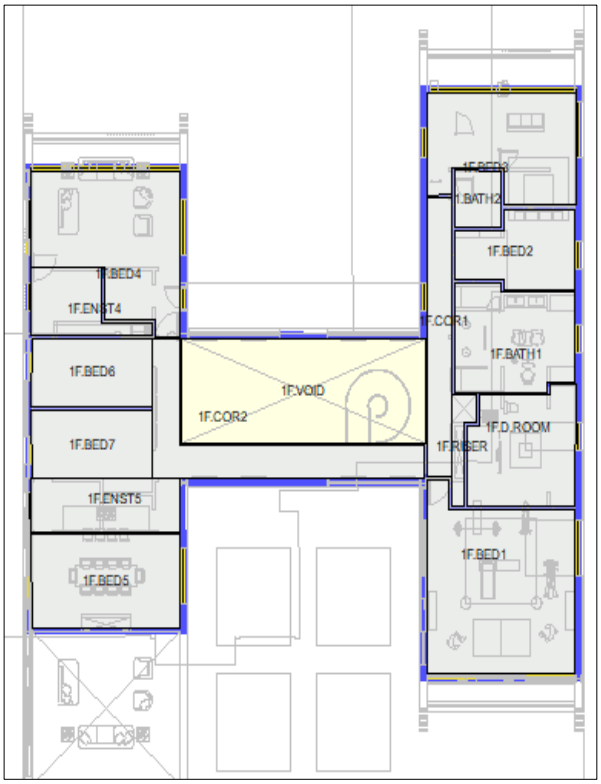


Figure 2 Innisfree East Horsley (Bedrooms)

# 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 = 0.14 W/m².K;
- Exposed Floors - U-value = 0.10 W/m².K;
- Glazing - U-value = 0.8 W/m².K; g-value= 0.36;
- Air Permeability - 1 $m^3/hr/m^2$@ 50 Pa;

## 2.2 ROOM OCCUPANCY AND HEAT GAIN

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

| Number of people | Description | Peak load (W) Sensible | 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 occupancy | 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 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 1-bed: 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-bed: 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-bed: 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-bed: 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-bed: 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-bed: 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-bed: 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-bed: 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-bed: 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/kitchen 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 |

Table 2.1: Occupancy and Heat Gain Profiles

## 2.3 HEAT GAINS

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

- Equipment – 80 Watts (Bedrooms) 450 Watts (Living Room).
- Lighting – 2 W/$m^2$

## 2.4 WINDOWS

The windows are modelled with the following glazing properties:

- Glazing 'U' Value – 0.8 W/$m^2$K;
- Light Transmittance – 0.65;
- G Value – 0.36;
- Shading Co-efficient – 0.36;
- Glazing to Frame Ratio – 0.85.

**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 VENTILATION RATES

| Room | Mechanical Ventilation Rate | Cooling System | Natural ventilation |
|---|---|---|---|
| Lounges | MVHR to allow background ventilation with summer boost mode | Cooling system proposed to comply with TM59 | Natural ventilation through openable windows has been utilized to mitigate overheating |
| Bedrooms | MVHR to allow background ventilation with summer boost mode | Cooling system proposed to comply with TM59 | Natural ventilation through openable windows has been utilized to mitigate overheating |

## 2.6 WEATHER DATA

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

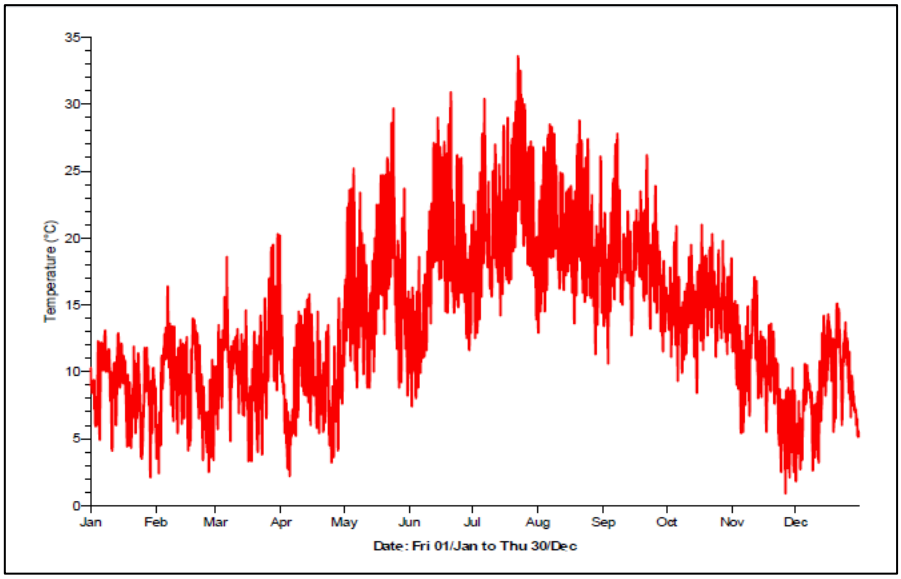


Figure 2.1: CIBSE Design Summer Year London – DSY1

# 3 OVERHEATING REQUIREMENTS

CIBSE TM59 requirements

Compliance with CIBSE TM59 for residential 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 residential 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).

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 and mechanically ventilated scenario. The simulation was run using two scenarios, one with a cooling system, then the other only utilising natural ventilated with MVHR at 3 air changes. The results can be found in section 4.1 and 4.2 of this report.

## 4.1 NATURALLY VENTILATED WITH MVHR

The thermal model demonstrates that for DSY 1 CIBSE weather data the development's design and services strategy deliver thermal comfort levels in lounge spaces in accordance with the requirements set out within TM59 CIBSE Guide. But the results for the bedrooms were failing marginally as shown below in table 4.1. This simulation was run using openable windows with MVHR at 3 air changes.

| Room | Pass/Fail | % above 1% 26°C Threshold (for bedrooms) | % above 3% 26°C Threshold (Lounges/ Studios) |
|---|---|---|---|
| GF. LIVING 1 | Pass | n/a | - |
| GF. LIVING 2 | Pass | n/a | - |
| GF. LIVING 3 | Pass | n/a | - |
| GF. STUDIO | Fail | 3.0 | n/a |
| 1F.BED 1 | Fail | 5.3 | n/a |
| 1F.BED 2 | Fail | 1.0 | n/a |
| 1F.BED 3 | Fail | 3.1 | n/a |
| 1F.BED 4 | Fail | 3.0 | n/a |
| 1F.BED 5 | Fail | 2.0 | n/a |
| 1F.BED 6 | Fail | 1.4 | n/a |
| 1F.BED 7 | Fail | 1.4 | n/a |

Table 4.1: CIBSE TM59 and TM52 Results – DSY1 (Naturally ventilated with MVHR at 3 air changes)

## 4.2 COOLING SYSYTEM

The thermal models demonstrate that for DSY 1 CIBSE weather data the development's design and services strategy deliver thermal comfort levels in all occupied spaces when use of a cooling system is added to the simulation. All rooms now comply with the requirements set out within TM59 CIBSE Guides.

| Room | Pass/Fail | % above 3% 26°C Threshold (Lounges/ Bedrooms) |
|---|---|---|
| GF. LIVING 1 | Pass | - |
| GF. LIVING 2 | Pass | - |
| GF. LIVING 3 | Pass | - |
| GF. STUDIO | Pass | - |
| 1F.BED 1 | Pass | - |
| 1F.BED 2 | Pass | - |
| 1F.BED 3 | Pass | - |
| 1F.BED 4 | Pass | - |
| 1F.BED 5 | Pass | - |
| 1F.BED 6 | Pass | - |
| 1F.BED 7 | Pass | - |

Table 4.2: CIBSE TM59 Results – DSY1 (Cooling)

# 5 CONCLUSION

The simulation was run with two scenarios: one involving natural ventilation with MVHR at 3 air changes, and the other incorporating a cooling system. The bedrooms with natural ventilation and MVHR at 3 air changes was failing marginally from the required overheating criteria, whereas the living rooms on the ground floor complied with the TM59 criteria, as shown in Table 4.1.

Subsequently, another simulation was run with a cooling system and MVHR at 3 air changes. The results clearly indicate that all bedrooms and living rooms meet the requirements outlined in the CIBSE TM59 guide when a cooling system is employed. Therefore, it can be concluded that through use of proposed ventilation strategy all rooms will comply with TM59 criteria.

In summary, all rooms comply with TM59 CIBSE guide through use of a cooling system.