

Waterfront Square. Reading. Packaged Living Ltd.

SUSTAINABILITY

STAGE 2 REPORT – RESIDENTIAL PART O ASSESSMENT

REVISION P01 – 11 JULY 2024



STAGE 2

Audit sheet.

Rev.	Date	Description of change / purpose of issue	Prepared	Reviewed	Authorised
P01	11/07/2024	Stage 2 Issue	S. Hunt	R. Palmer	J. Nuttall

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Project number: 23/25365
Internal Document reference: 2325365-HLE-XX-XX-RP-ST-402092.docx
External Document reference:

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1. Executive summary.

This thermal comfort report has been prepared on behalf of Packaged Living Ltd for the proposed residential development Waterfront Square, Reading. The study set out within this report has been undertaken to determine occupant thermal comfort conditions and overheating risk during the summer months within proposed dwellings, in accordance with Building Regulations Approved Document Part O 2021. This assessment has assessed a representative sample of dwellings proposed.

1.1 Part O assessment methodology.

Compliance with the requirement O1 of Approved Document Part O can be demonstrated using either the Simplified method or the Dynamic Thermal Modelling method. The Dynamic Thermal Modelling method, which requires the use of CIBSE TM59 methodology, has been used in this assessment.

The risk of overheating within the proposed apartments has been assessed using the thermal comfort criteria within methodology set out in CIBSE Technical Memorandum 59 (TM59): Design methodology for the assessment of overheating risk in homes with the principles and restrictions of approved document Part O 2021 of the building regulations applied.

The proposed development was modelled in a virtual environment with assigned parameters and then assessed against criteria within the recognised CIBSE TM59 methodology.

The criteria for both predominantly naturally ventilated and predominantly mechanically ventilated spaces have been used for the purpose of the Part O assessment due to acoustic constraints throughout the development.

1.2 Thermal comfort study.

Determining the risk of overheating within the occupied spaces of the proposed dwellings have considered:

- Fabric performance – Beyond Best Practice fabric efficiency and thermal bridges.
- Solar Shading – Reveals of 0.25m have been incorporated within the design, and external balcony areas for the maisonette apartments shade the windows facing out into the atrium.
- Glazing performance – g-values optimised to limit the amount of unwanted solar gain entering the dwellings.
- Ventilation strategy – MVHRs ensure that fresh air can still be provided to the apartments when acoustic restraints limit the use of openable windows.
- Internal gains – As per the TM59 standardised inputs.
- Occupancy profiles – As per the TM59 standardised inputs.
- External weather conditions taken from CIBSE Swindon weather centre future climate data: **Swindon_Brize_Norton_DSY1_2020High50** (Design Summer Year 1: 2020, high emissions scenario (50th percentile)).

It is recommended that at the next design stage, the assessment includes further climate scenarios represented by weather sets DSY2 and DSY3, as well as potentially assessing against risks in other future climate scenarios.

1.3 Summary.

Each dwelling assessed within this study has been shown to satisfy the CIBSE TM59 thermal comfort criteria using the DSY1 climate scenario. This suggests that all proposed dwellings within the Waterfront Square development appear to experience a low risk of overheating in line with the CIBSE TM59 criteria and therefore are compliant with Building Regulations Part O.

The risk of overheating has been minimised through the use of natural air flow through openable windows where acoustic restrictions allow. In spaces where natural ventilation cannot be relied on, when the room temperature is above 22°C, incoming air is supplied at a temperature lower than the dry-resultant temperature of the space meaning it is able to provide passive free cooling. Use of mechanical ventilation also allows for a replenished, constant flow of air within the occupied spaces during operational periods for the mitigation of

excessive internal temperatures and assists in displacing warm air when the windows aren't operational due to acoustic constraints.

1.4 Next steps.

With the increase in extreme weather events, this has resulted in the 2020 weather file no longer being wholly representative of the UK Summer Climate.

Whilst the apartments achieve CIBSE TM59 criteria and therefore Part O when using the parameters listed within this report, an assessment should be made against climate scenarios represented by design summer weather files 2050 and 2080 at Stage 3.

During the Stage 3 design, a strategy should be suggested by the mechanical engineering consultants to demonstrate how the proposed systems can be upgraded to accommodate more extreme climatic events.

2. Introduction.

The internal environment within buildings plays a huge role in occupant comfort and experience. Thermal comfort and temperature within a space, particularly for residents, is paramount to ensuring that designed spaces are usable and fit for purpose.

This thermal comfort report has been prepared on behalf of Packaged Living Ltd for the proposed residential development Waterfront Square, Reading, to determine compliance with Building Regulations Approved Document O, using dynamic thermal modelling to better identify the potential risk of overheating.

2.1 The Proposed Development.

The Proposed Scheme at Waterfront Square will involve the:

“Demolition of the former Covea Insurance building and construction of residential-led development, access from Norman Place and associated car parking, infrastructure and landscaping”.

The Proposed Development seeks to deliver 254 studio, one, two and three bedroom residential dwellings (Use Class C3), together with 278m² (GEA) of flexible Class E floorspace at ground floor level. A series of internal and external amenity spaces feature within the layout. New pedestrian accesses are proposed from Vastern Road and Norman Place and a vehicular access to a ground floor undercroft car parking area is proposed from Norman Place. Substantial public realm surrounds the development, providing significant visual improvement to Vastern Road, Norman Place and the River Thames frontage.

2.2 Thermal comfort study.

This report details the study undertaken to assess the thermal comfort conditions during occupied periods within all dwellings.

The assessment has utilised dynamic simulation modelling to anticipate the internal temperatures likely to be experienced within the apartments during the summer months. The model developed for this study consists of the following input parameters to determine the thermal conditions within the occupied spaces:

- Fabric performance,
- Glazing performance,
- Ventilation strategy,
- Internal gains,
- Occupancy profiles, and;
- External weather conditions taken from CIBSE Swindon weather centre future climate data:
Swindon_Brize_Norton_DSY1_2020High50 (Design Summer Year 1: 2020, high emissions scenario (50th percentile)).

The DSY 1 weather file is recommended to be used as a minimum requirement when assessing thermal comfort, as stated within CIBSE TM59; Design methodology for the assessment of overheating risk in homes. The most appropriate file for the location of the proposed development is deemed to be Swindon.

In line with the TM59 methodology, the study will analyse the thermal comfort conditions between the months of May to September where the risk of overheating is most likely to occur.

2.3 Assessment Methodology.

Thermal comfort methodology has been used to assess the occupied spaces within a representative sample of apartments to determine their risk of overheating during the summer period. The spaces have been assessed against criteria stated within CIBSE Technical Memorandum 59 (TM59): Design methodology for the assessment of overheating risk in homes, in accordance with the dynamic thermal modelling method detailed in Part O of the building regulations.



Figure 2.1 –Sample Layout – Second-Fourth Floor, Waterfront Square provided by Assael Architects.

3. Thermal Comfort Methodology.

Determining the risk of overheating in occupied spaces considers external conditions, fabric, ventilation strategy, internal gains and occupancy profiles.

The proposed dwellings have been modelled in a virtual environment with the assigned parameters and then tested against criteria within thermal comfort methodology.

3.1 What is ‘risk of overheating’?

‘Overheating’ is a widely used term, but it is not precisely defined or understood. Overheating within a space implies that occupants feel uncomfortably hot and that discomfort is caused by indoor temperatures that are too high for comfort. The risk of overheating happens in a building either through poor design, bad management and/or/ inadequate services and results in an internal environment that is too warm for comfort.

CIBSE state that most people begin to feel ‘warm’ at 25°C and ‘hot’ at 28°C. Contributing factors can be from gains derived from occupancy, lighting, solar and electrical appliances among others.

Thermal comfort is subjective and complex. The diagram below illustrates the control system for ensuring the internal body temperature is kept constant.

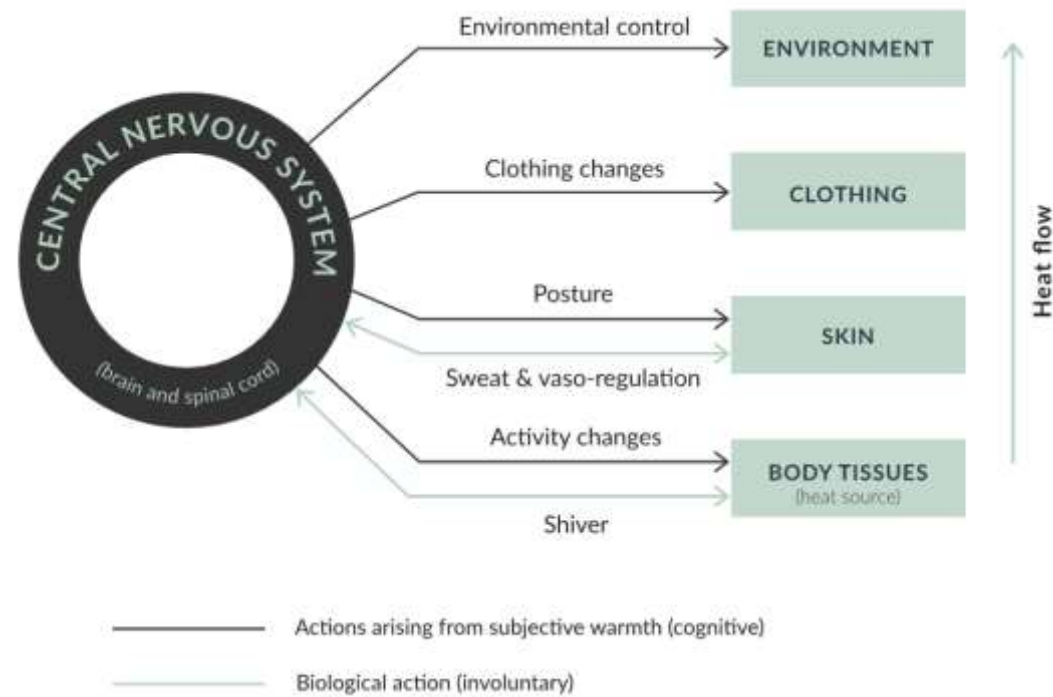


Figure 3.1 - Diagram to Illustrate Factors in order to Maintain Constant Body Temperature

3.2 Assessing the risk of overheating

Thermal comfort methodologies provide guidance assessment methods to quantify overheating risk within occupied spaces. The methodologies consist of criteria by which a space can be categorised as ‘at a risk of overheating’.

To determine the risk of overheating within the Proposed Development, the methodology set out in the following guidance document has been selected as most appropriate for this assessment: CIBSE Technical Memorandum 59 (TM59), 2017: Design methodology for the assessment of overheating risk in homes.

The following section details the criteria set out in the CIBSE TM59 guidance methodology in which the proposed development has been assessed against.

3.3 CIBSE TM59 overview

Overheating in spaces has previously been quantified by the number of occupied hours annually that the internal temperature exceeds a maximum temperature irrespective of external temperature.

CIBSE TM59 criteria uses an adaptive comfort and a fixed threshold approach depending on the ventilation methodology:

Adaptive comfort:

Adaptive comfort is where the overheating threshold is dynamic. It is based on the comparison of the anticipated internal conditions against criteria which establishes a maximum acceptable room temperature calculated from the running ‘mean’ outdoor temperature. Research has shown that comfortable room temperatures vary with the external temperature conditions and occupants are generally more accepting of warmer room temperatures if the weather is also warm outside.

Fixed threshold:

CIBSE TM59 criterion 2, used to assess bedrooms only, uses a static measurement where the threshold is fixed. The risk of overheating is quantified by the number of occupied hours annually that the internal conditions exceed a maximum temperature, irrespective of external temperature. It therefore does not vary in line with the external conditions like the adaptive comfort approach. This criterion is required to be satisfied within bedrooms only.

3.4 CIBSE TM59 criteria

CIBSE TM59 for predominantly mechanically ventilated spaces considers the risk of overheating by assessing occupied spaces against criterion one, while predominantly naturally ventilated spaces assess occupied spaces against criterion one and two, as detailed in the table below.

Criterion 1	For Living Rooms, Kitchens and Bedrooms: Criteria sets a limit for the number of hours that the operative temperature can exceed the threshold comfort temperature. To satisfy Criterion 1, the following must not occur for more than 3% of occupied hours: The difference between the actual operative temperature, and the maximum acceptable temperature* is equal to or greater than 1 degree during May to September.
	For Bedrooms Only: Criteria states that peak bedroom temperatures should not exceed an absolute threshold of 26 °C. To satisfy Criterion 2, the operative temperature in the bedrooms from 10 pm to 7 am shall not exceed 26 °C for more than 1% of annual hours.

Table 3.1 - CIBSE TM59 criteria

* Maximum acceptable temperature: CIBSE sets a maximum acceptable temperature of 3°C above the comfort temperature (for new buildings).

3.4.1 Communal Corridors

The inclusion of communal corridors is deemed mandatory where communal pipework runs through the area.

Whilst there is no mandatory target to meet, if the operative temperature of the corridor exceeds 28°C for more than **3%** of the year, the area should be identified as at significant risk of overheating.

4. Thermal Comfort Calculation Parameters.

The thermal comfort study for all dwellings has been undertaken with the consideration of the external climate, applied mechanical ventilation, natural ventilation, internal gains and profiles which are detailed in this section.

The thermal comfort calculation has been undertaken using the government approved dynamic simulation software IESve 2022. Appendix A provides further details on the software and modelling procedure.

4.1 Architecture.

The geometry used to assess proposed dwellings was determined by drawings received from the project architect, Assael Architects.

Table 4.1: Architectural drawing information.

Source	Drawing Type	Description	Data Type	Date Received
Assael Architects	Revit Model	A4012-ASA-ZZ-ZZ-M3-A-0001_P04	rvt.	27/06/2024
Assael Architects	GA Plans	A4012-ASA-XX-GF-DR-A-0200-P014-00 Ground Floor Plan A4012-ASA-XX-01-DR-A-0201-P011-01 First Floor Plan A4012-ASA-XX-02-DR-A-0202-P010-02 Second to Fourth Floor Plan A4012-ASA-XX-05-DR-A-0205-P011-05 Fifth to Sixth Floor Plan A4012-ASA-XX-07-DR-A-0207-P08-07 Seventh Floor Plan A4012-ASA-XX-08-DR-A-0208-P011-08 Eighth Floor Plan A4012-ASA-XX-09-DR-A-0209-P011-09 Ninth to Tenth Floor Plan	dwg.	27/06/2024
Assael Architects	Elevations	A4012-ASA-ZZ-ZZ-DR-A-0400-P03-North Elevation & West Elevation A4012-ASA-ZZ-ZZ-DR-A-0401-P03-South Elevation & East Elevation A4012-ASA-ZZ-ZZ-DR-A-0402-P03-Courtyard West Elevation A4012-ASA-ZZ-ZZ-DR-A-0403-P03-Courtyard East Elevation	dwg.	27/06/2024

4.2 Climate Data.

A building’s thermal performance is its response to external environmental conditions. The more dependant a building is on passive features to achieve acceptable internal comfort, the more important the use of accurate external weather information becomes.

Climate data is assigned to the virtual environment of the dynamic model to simulate external weather conditions that are likely to occur. Thermal comfort calculations require the simulation to be tested against CIBSE Design Summer Year (DSY) climate data.

CIBSE weather files are available for 14 locations in the United Kingdom: Belfast, Birmingham, Cardiff, Edinburgh, Glasgow, Leeds, London, Manchester, Newcastle, Norwich, Nottingham, Plymouth, Southampton and Swindon.

DSY Climate File Variations.

The variations between each DSY file is summarised below:

- DSY 1: moderately warm summer
- DSY 2: short, intense warm spell
- DSY 3: long, less intense warm spell

The DSY files have been developed using a combination of emissions scenarios and timelines, based on the UKCIP09 climate projections:

- 2020s (2010 - 2039) - High emissions scenario
- 2050s (2040 - 2069) - High and medium emissions scenarios
- 2080s (2070 - 2099) - High, medium, and low emissions scenarios

For each timeline/scenario probabilistic data is assigned covering the 10th, 50th, and 90th percentile probabilities of the temperatures being realised.

Climate File Applied.

The CIBSE Swindon Weather Centre DSY climate file has been selected as it is the closest to the proposed development’s location of **Reading**.

The following variant of this DSY has been selected for this thermal comfort assessment in accordance with guidance methodology: DSY 1: 2020, high emissions scenario (50th percentile).

The DSY 1 weather file is recommended as a minimum requirement for assessing thermal comfort, as stated within CIBSE TM59; Design methodology for the assessment of overheating risk in homes.

It is recommended that at the next design stage, the assessment includes further climate scenarios represented by weather sets 2050 and 2080, as well as potentially assessing against risks against more extreme climate scenarios.

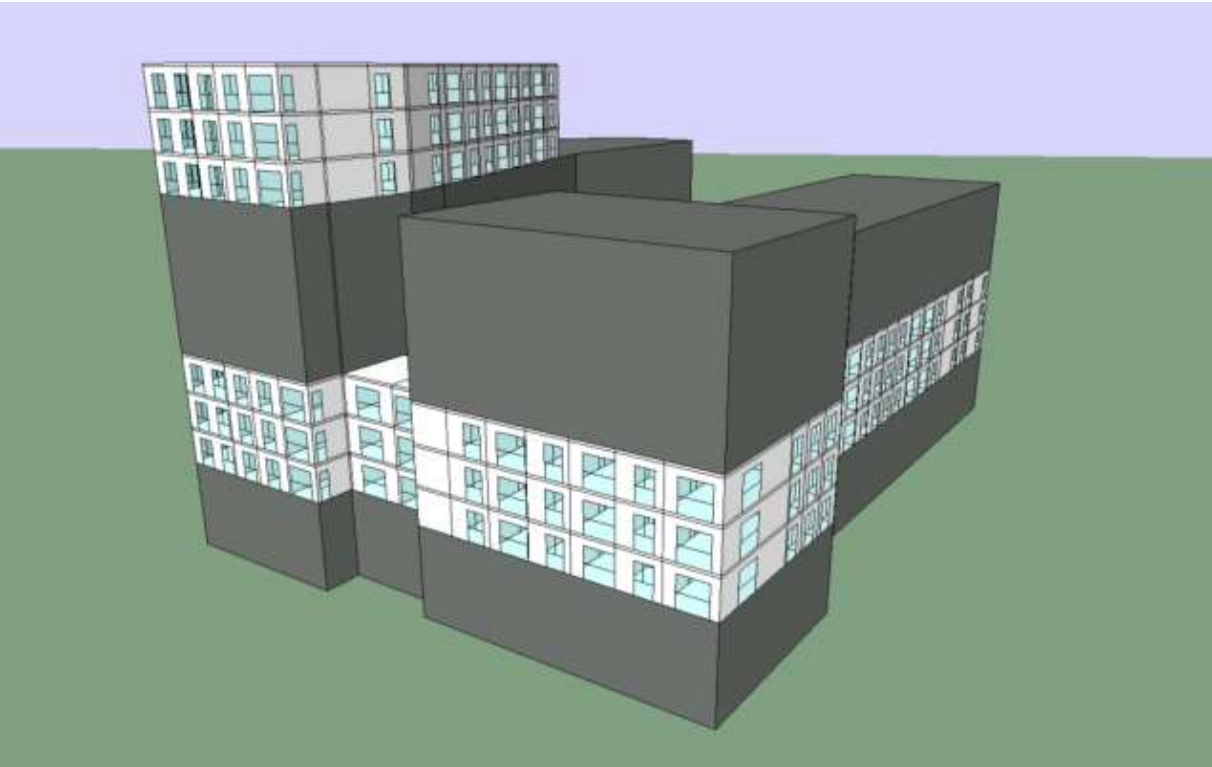


Figure 4.1: DSM model of the proposed Waterfront Square development.

4.3 Fabric Parameters.

The fabric performance for the Proposed Development is listed below and used within our thermal comfort assessment. These have been discussed with Assael Architects and are understood to be achievable at this stage.

Element	U-Value (W/m².K)
Roof	0.10
Ground/Exposed Floor	0.10
External Wall (Residential)	0.15
Glazing (g-value)	1.20 (0.40)
Partition (Lifts/Risers/Stairs)	0.22
Ceiling (False Ceiling and Ceiling Slab)	2.36 / 1.00
Door (Non-Glazed)	2.00
Air Permeability	3 m³/m².hr @ 50Pa

Table 4.2 - Fabric parameters

A 250mm recess has been included around the windows which provides further shading.

4.4 Internal Gains.

The internal gains within the assessed occupied spaces of the proposed residential development are listed below for occupancy, lighting and small power gains.

Occupancy Gains:

The occupancy gain inputs are listed below:

Space Type	Maximum Number of Occupants*
Studio	2
1 Bedroom – Kitchen/ Living Room	1
2 Bedroom – Kitchen/ Living Room	2
3 Bedroom – Kitchen/ Living Room	3
Double Bedroom	2
Single Bedroom	1

Table 4.3- Number of occupants per space type

- * Gains associated per occupant:
- Sensible gain: 75 W/person
 - Latent gain: 55 W/person
 - Total gain: 130 W/person

Clothing levels

Based on the information stated in CIBSE Guide A Table 1.5, the following clothing levels have been applied:

- Living / Kitchen: 0.55
- Bedroom: 1.20

Lighting and Equipment Gains:

The lighting and equipment gain inputs are listed below for each space type:

Space Type	Lighting Gain	Maximum Equipment Gain
1 Bedroom – Kitchen/ Living Room	2 W/m²	450 W
2 Bedroom – Kitchen/ Living Room		450 W
3 Bedroom – Kitchen/ Living Room		450 W
Double Bedroom		80 W
Single Bedroom		80 W

Table 4.4 - Lighting and equipment gains per space type

Internal Gain Profiles.

The occupancy, lighting and equipment profiles associated with the internal gains for each day are outlined in Appendix B. These are specified from CIBSE TM59 guidance methodology.

Communal Corridor Gains.

The lighting and equipment gain inputs are listed below for the communal corridors.

Space Type	Lighting Gain	Maximum Service Gain
Communal Corridors	2 W/m²	0 W/m² (due to decentralised servicing strategy)

Table 4.5: Lighting and equipment per space type

As the Proposed Development uses individual electric heater within each apartment there is no pipework through the communal corridors and therefore no corridor services heat gain.

4.6 Ventilation strategy

Thermal comfort is subjective, and the perception of overheating can be reduced by air movement even if the air is warm. Our bodies sweat as an automatic physiological reaction when it's hot so when air passes across skin, such as a breeze through an open window, this increases the body's heat loss through evaporation and results in a sense of feeling cooler.

4.6.1 Natural Ventilation

Where possible, openable windows will be utilised to provide natural ventilation. However, Part O requirements and acoustic constraints restrict the ability to rely on openable windows to ventilate the dwellings.

It should be noted that this assessment does not take into account other environmental constraints such as air quality, which may recommend that windows cannot be relied on for natural ventilation and so an independent assessment by an air quality consultant should be undertaken.

4.6.1.1 Opening Profile

Part O states that:

- 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 the 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 or 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.

4.6.1.2 Acoustic Restrictions on Openings

An acoustic assessment has been undertaken to determine any areas within the Proposed Development where noise levels exceed the acceptable limit.

The acoustic assessment found that selected spaces along the facades overlooking the courtyard have a low acoustic risk and can therefore utilise openable windows. Appendix E contains mark-ups provided by the acoustician which highlight the facades able to utilise openable windows.

TM59 assessment:

For the purpose of the TM59 assessment, the acoustician advised that all bedrooms and living rooms along the 'green' facades can incorporate a 0.5m² window opening per room, during the day and night.

4.6.1.3 Free area & Opening Types

The window opening per room are limited to an opening area of 0.5m². The 'equivalent free area' for each window type within the model as well as opening category is detailed within the table below.

As the total room window opening is restricted to 0.5m², only one window per room has been modelled as openable.

Space Type	Total Window Area (m²)	Equivalent Orifice Area (%)	Opening Type
Single Window	1.24	35.9	Side Hung
Double Window – Right Side	0.74	69.8	Side Hung
Triple Window	2.60	12.7	Side Hung
Balcony door – Right Side	2.71	19.3	Sliding

Table 4.6.2.1 Opening Types

4.6.2 Mechanical Ventilation with Heat Recovery

Supply air will be provided to all dwellings via a mechanical ventilation system in order to boost the amount of fresh air the apartments receive and minimise the risk of excessive internal temperatures during the summer months.

To avoid overheating, the following Auxiliary Ventilation flow rates have been proposed:

Table 4.6.2: Flow rates for each room type

Space Type	Flow Rate (l/s)
Studio	80.00
1 bed – Kitchen/ Living room	50.00
1 bed – Bedroom	30.00
2 bed – Kitchen/ Living room	36.0
2 bed – Bedroom	22.0
3 bed – Kitchen/ Living room	29.0
3 bed – Bedroom	18.0

When the temperature inside the room is below 22°C, air is supplied at external air temperature. When the room air temperature is greater than 22°C, trim cooling will provide enhanced ventilation to applicable dwelling where natural ventilation cannot be relied upon according to acoustic constraints. The supply air temperature conditions for enhanced ventilation are described in Table 4.6.3 below.

Table 4.6.3: Temperature supply profile.

Temperature Supply Profile	
Trim Cooling Supply	When the temperature inside the room is above 22°C, enhanced ventilation is activated using the below temperature supply profile. Ramp(to,26,16,30,18) If outside air is lower than 26°C then supply at 16°C. If outside air is between 26°C and 30°C then ramp between 16°C and 18°C. If outside air is higher than 30°C then supply at 18°C.

5. Part O CIBSE TM59 Results.

The results for the CIBSE TM59 assessment are shown below for each occupied space within the apartments assessed for Waterfront Square.

Trim cooling has only been installed in dwellings which are unable to utilise openable windows to ventilate the space. As these dwellings cannot rely on window openings, the apartments have been assessed as 'predominantly mechanically ventilated' and must only comply with TM59 criterion 1.

Dwellings which are able to utilise openable windows have not been installed with a trim cooling unit and have been assessed as 'predominantly naturally ventilated'. These spaces must comply with TM59 criterion 1 and 2:

- Criterion 1 is achieved when the threshold temperature is not exceeded for more than 3% of the occupied hours.
- Criterion 2 is achieved the operative temperature in the bedrooms from 10 pm to 7 am shall not exceed 26°C for more than 1% of annual hours.

	Predominantly naturally ventilated		Predominantly mechanically ventilated	Overall Results
Room Name	TM59 Criterion 1	TM59 Criterion 2	TM59 Criterion 1	
Bedrooms	All Compliant	All Compliant	All Compliant	All Compliant
Kitchen / Living	All Compliant	N/A	All Compliant	All Compliant

Table 1 - Block B CIBSE TM59 results, 2020 weather file.

A full breakdown of compliant results can be found in Appendix D.

At this stage, it is anticipated that **67%** (83/245) of the apartments will need a trim cooling unit to reduce the risk of overheating and achieve compliance with TM59 requirements.

5.1 Communal Corridor Overheating

All communal corridors on the residential levels that include sample apartments have been assessed according to CIBSE TM59.

All communal corridors within the Proposed Development have been found to have no overheating risk and therefore comply with Building regulations Part O.

5.2 Extreme Climatic Events

With the increase in extreme weather events, this has resulted in the 2020 weather file no longer being wholly representative of the UK Summer Climate.

Whilst the apartments achieve CIBSE TM59 criteria and therefore Part O when using the parameters listed within this report, it is recommended an assessment is made at Stage 3 against future climate scenarios represented by design summer weather files 2050 and 2080.

6. Summary.

This thermal comfort report has been prepared on behalf of Packaged Living Ltd for the proposed Waterfront Square residential development in Reading. The study set out within this report has been undertaken to determine occupant thermal comfort conditions and risk of overheating during the summer months within proposed dwellings, in accordance with Building Regulations Approved Document Part O 2021. This assessment has assessed a representative sample of dwellings within the block to ensure that the Stage 2 design is suggested to meet thermal comfort criteria for all proposed dwellings.

6.1 Part O assessment methodology.

Compliance with the requirements of Part O Requirement O1 can be demonstrated using either the Simplified method or Dynamic Thermal Modelling method. The Dynamic Thermal Modelling method, which requires the use of CIBSE TM59 methodology, has been used in this assessment.

The risk of overheating within sample apartments selected have been assessed using the thermal comfort criteria within methodology set out in CIBSE Technical Memorandum 59 (TM59): Design methodology for the assessment of overheating risk in homes with the principles and restrictions of approved document Part O 2021 applied. The Proposed Development was modelled in a virtual environment with the assigned parameters listed within the appendices and then assessed against criteria within the CIBSE TM59 methodology.

6.2 Thermal comfort study.

Determining the risk of overheating within the occupied spaces of the proposed dwellings have considered:

- Fabric performance – Beyond Best Practice fabric efficiency and thermal bridges.
- Solar Shading – Reveals of 0.25m have been incorporated within the design, and external balcony areas for the maisonette apartments shade the windows facing out into the atrium.
- Glazing performance – g-values optimised to limit the amount of unwanted solar gain entering the dwellings.
- Ventilation strategy – MVHRs ensure that fresh air can still be provided to the apartments when acoustic restraints limit the use of openable windows.
- Internal gains – As per the TM59 standardised inputs.
- Occupancy profiles – As per the TM59 standardised inputs.
- External weather conditions taken from CIBSE Swindon weather centre future climate data: **Swindon_Brize_Norton_DSY1_2020High50** (Design Summer Year 1: 2020, high emissions scenario (50th percentile)).

It is recommended that at the next design stage, the assessment includes further climate scenarios represented by 2050 and 2080 weather sets assessing against risks in other future climate scenarios.

6.3 Summary.

All dwellings assessed within this study has been shown to satisfy the CIBSE TM59 thermal comfort criteria using the DSY1 climate scenario. This was achieved by utilising openable windows where acoustic restriction allowed and supplying trim cooling to dwellings that could not rely to natural ventilation. All proposed dwellings now experience a low risk of overheating in line with the CIBSE TM59 criteria and are therefore compliant with Building Regulations Part O.

At this stage, it is anticipated that **67%** (83/245) of the apartments will need a trim cooling unit to reduce the risk of overheating and achieve compliance with TM59 requirements.

As part of the Stage 3 actions, a strategy should be suggested by the mechanical engineering consultants to demonstrate how the proposed systems can be upgraded to accommodate more extreme climatic events, particularly for those apartments which are deemed to be close to the criteria thresholds listed in Appendix D.

Appendix A: Modelling Procedure and Software.

Dynamic simulation models were created to assess the proposed developments.

Integrated Environmental Solutions Virtual Environment (IESve) is a Dynamic Simulations Modelling (DSM) software package which has the capabilities of enabling the user to create a virtual representation of a building. The results presented in this report were calculated using the approved software, IESve 2022.4.1.0.

The IESve model for the proposed development was drawn to geometry received from Assael Architects. The drawings used to create the model are listed within the 'calculation parameters' section of this report.

The images show the IES models created to assess thermal comfort.

IES Modelling Disclaimer.

The calculations produced by Hoare Lea have been carried out with the information provided by Assael Architects and based on gains taken from TM59 typical profiles to determine whether the proposed development can achieve criteria within the thermal comfort methodologies specified in 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 usage for the building once occupied may vary from the calculated values. 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, how the building services plant is used and the design criteria with regards to how the rooms are environmentally controlled.

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

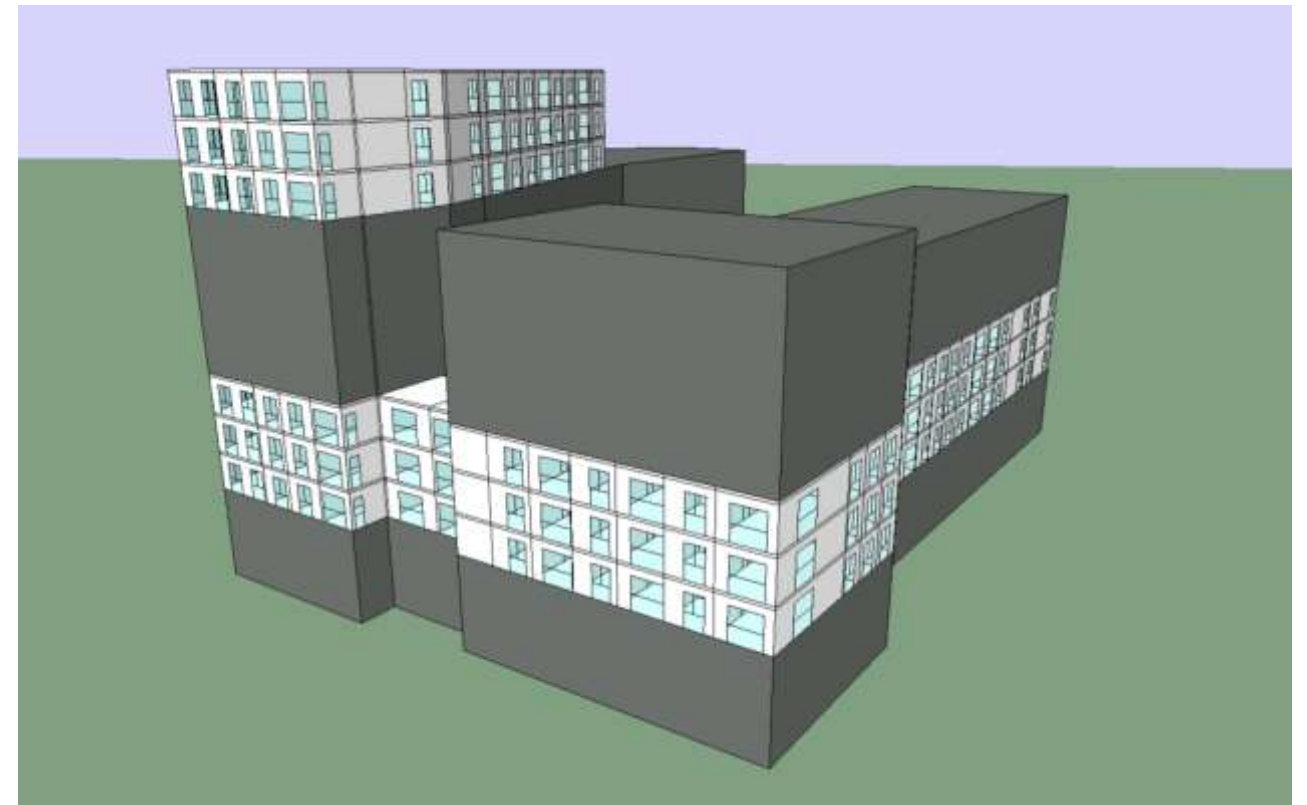


Figure A - Images of IESve model of the proposed development.

Appendix B: Occupancy Lighting & Equipment Profiles.

The profiles for occupancy, lighting and equipment are shown within this section for each occupied space as stated within CIBSE TM59.

Lighting profile

In line with CIBSE TM59, lighting energy is assumed to be proportional to floor area and the load is measured in W/m²:

- 2 W/m² lighting gains as stated in CIBSE TM59.

Occupancy & equipment profiles

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
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
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
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 gain 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

Appendix C: Equivalent Orifice Area Calculation

The ‘equivalent free area’ for each space type used within the model as well as opening category is detailed within the table below.

Table C1: Window opening types.

Space Type	Total Window Area (m²)	Equivalent Orifice Area (%)	Opening Type
Single Window	1.24	35.9	Side Hung
Double Window – Right Side	0.74	69.8	Side Hung
Triple Window	2.60	12.7	Side Hung
Balcony door – Right Side	2.71	19.3	Sliding

In order to calculate the equivalent orifice area, the ratio of width to height of the window dimensions must be defined. Based on Figure , a constant coefficient is generated thereby allowing the calculation of the orifice area which goes as follows:

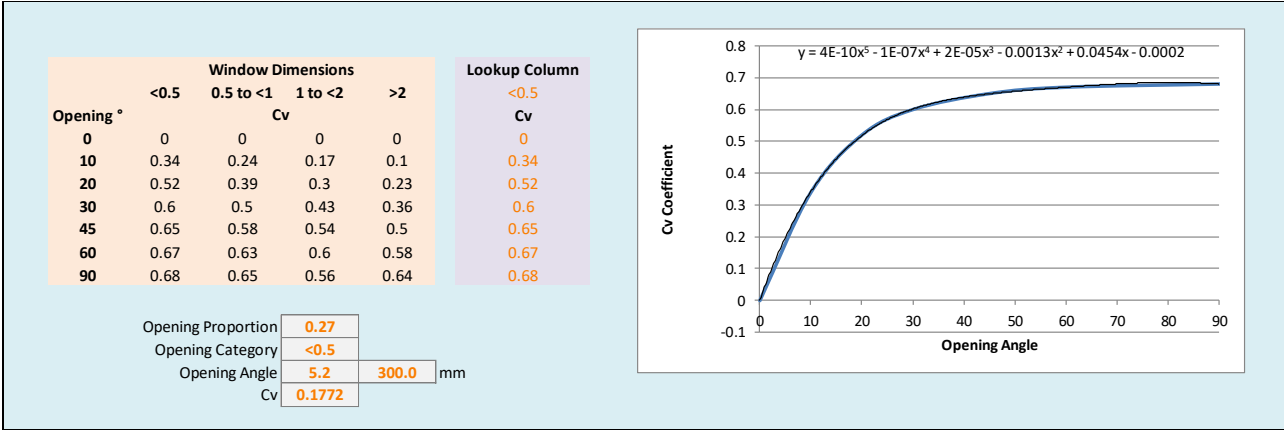


Figure C1 - Calculation of Coefficient (Cv) for Orifice Area.

Equivalent Free Area = (Cv (coefficient) / opening angle) * pane width * pane length

Equivalent Orifice Area Percentage = Equivalent Free Area / Pane Area

All of the parameters outlined in Table C1 are incorporated into the model with a modulating profile which follows the TM59 methodology for day and night operation.

Appendix D: Detailed Part O Results

Naturally ventilated rooms – criterion 1

Room name	Occupied hours	No. hours ΔT ≥ 1°K	% Occupied hours ΔT ≥ 1°K	Criterion 1 check
O3-1B2P-A1-6-Living/ Kitchen	1989	0	0.0	Pass
O3-1B2P-A1-6-Double Bedroom 1	3672	0	0.0	Pass
O3-1B1P-A1-7-Living/ Kitchen	1989	0	0.0	Pass
O3-1B1P-A1-7-DoubleBedroom 1	3672	0	0.0	Pass
O3-1B1P-A1-8-Living/ Kitchen	1989	0	0.0	Pass
O3-1B1P-A1-8-Double Bedroom 1	3672	0	0.0	Pass
O3-1B1P-A1-9-Double Bedroom 1	3672	0	0.0	Pass
O3-1B1P-A1-9-Living/ Kitchen	1989	0	0.0	Pass
O3-1B1P-A1-10-DoubleBedroom 1	3672	1	0.0	Pass
O3-1B1P-A1-10-Living/Kitchen	1989	0	0.0	Pass
O3-2B3P-A1-11-Double Bedroom 2	3672	2	0.1	Pass
O3-2B3P-A1-11-Living/Kitchen	1989	0	0.0	Pass
O3-2B3P-A1-5-Double Bedroom 2	3672	0	0.0	Pass
O3-2B3P-A1-5-Double Bedroom 1	3672	0	0.0	Pass
O3-2B3P-A2-6-Double Bedroom 2	3672	5	0.1	Pass
O3-2B3P-A2-6-Double Bedroom 1	3672	2	0.1	Pass
O3-3B5P-A2-5-DoubleBedroom 2	3672	0	0.0	Pass
O3-3B5P-A2-5-Single Bedroom	3672	0	0.0	Pass
O3-3B5P-A2-5-Double Bedroom 1	3672	0	0.0	Pass
O3-2B3P-B1-4-Double Bedroom 1	3672	0	0.0	Pass
O3-1B1P-B2-3-Double Bedroom 1	3672	5	0.1	Pass
O3-1B1P-B2-2-Living/ Kitchen	1989	0	0.0	Pass
O3-1B1P-B2-2-Double Bedroom 1	3672	0	0.0	Pass
O3-2B3P-B1-3-Double Bedroom 1	3672	2	0.1	Pass
O3-2B3P-B1-3-Double Bedroom 2	3672	0	0.0	Pass
O3-2B3P-B1-3-Living/Kitc hen	1989	0	0.0	Pass
O3-1B1P-B2-3-Living/ Kitchen	1989	0	0.0	Pass
O3-2B3P-B1-1-DoubleBedroom 1	3672	1	0.0	Pass
O3-2B3P-B1-1-Double Bedroom 2	3672	0	0.0	Pass
O3-2B3P-B1-1-Living/ Kitchen	1989	0	0.0	Pass

Room name	Occupied hours	No. hours ΔT ≥ 1°K	% Occupied hours ΔT ≥ 1°K	Criterion 1 check
O3-2B3P-B1-2-Double Bedroom 1	3672	8	0.2	Pass
O3-2B3P-B1-2-Living/ Kitchen	1989	0	0.0	Pass
O3-2B3P-B1-2-Double Bedroom 2	3672	5	0.1	Pass
O3-2B3P-B1-4-Double Bedroom 2	3672	4	0.1	Pass
O9-1B1P-B1-9-Living/ Kitchen	1989	2	0.1	Pass
O9-2B3P-B1-1-Living/ Kitchen	1989	0	0.0	Pass
O2-1B2P-A1-6-Living/ Kitchen	1989	0	0.0	Pass
O2-1B2P-A1-6-Double Bedroom 1	3672	0	0.0	Pass
O2-1B1P-A1-7-Living/ Kitchen	1989	0	0.0	Pass
O2-1B1P-A1-7-Double Bedroom 1	3672	0	0.0	Pass
O2-1B1P-A1-8-Living/ Kitchen	1989	0	0.0	Pass
O2-1B1P-A1-8-Double Bedroom 1	3672	0	0.0	Pass
O2-1B1P-A1-9-Double Bedroom 1	3672	0	0.0	Pass
O2-1B1P-A1-9-Living/ Kitchen	1989	0	0.0	Pass
O2-1B1P-A1-10-Double Bedroom 1	3672	1	0.0	Pass
O2-1B1P-A1-10-Living/Kitchen	1989	0	0.0	Pass
O2-2B3P-A1-11-Double Bedroom 2	3672	2	0.1	Pass
O2-2B3P-A1-11-Living/ Kitchen	1989	0	0.0	Pass
O2-2B3P-A1-5-Double Bedroom 2	3672	0	0.0	Pass
O2-2B3P-A1-5-Double Bedroom 1	3672	0	0.0	Pass
O2-2B3P-A2-6-Double Bedroom 2	3672	5	0.1	Pass
O2-2B3P-A2-6-Double Bedroom 1	3672	4	0.1	Pass
O2-3B5P-A2-5-Double Bedroom 2	3672	0	0.0	Pass
O2-3B5P-A2-5-Single Bedroom	3672	0	0.0	Pass
O2-3B5P-A2-5-Double Bedroom 1	3672	0	0.0	Pass
O2-2B3P-B1-4-Double Bedroom 1	3672	0	0.0	Pass
O2-1B1P-B2-3-Double Bedroom 1	3672	5	0.1	Pass
O2-1B1P-B2-2-Living/ Kitchen	1989	0	0.0	Pass
O2-1B1P-B2-2-Double Bedroom 1	3672	0	0.0	Pass
O2-2B3P-B1-3-Double Bedroom 1	3672	3	0.1	Pass
O2-2B3P-B1-3-Double Bedroom 2	3672	0	0.0	Pass
O2-2B3P-B1-3-Living/Kitc hen	1989	0	0.0	Pass
O2-1B1P-B2-3-Living/ Kitchen	1989	0	0.0	Pass
O2-2B3P-B1-1-DoubleBedroom 1	3672	1	0.0	Pass

Room name	Occupied hours	No. hours $\Delta T \geq 1^{\circ}K$	% Occupied hours $\Delta T \geq 1^{\circ}K$	Criterion 1 check
O2-2B3P-B1-1-Double Bedroom 2	3672	0	0.0	Pass
O2-2B3P-B1-1-Living/ Kitchen	1989	0	0.0	Pass
O2-2B3P-B1-2-Double Bedroom 1	3672	8	0.2	Pass
O2-2B3P-B1-2-Living/ Kitchen	1989	0	0.0	Pass
O2-2B3P-B1-2-Double Bedroom 2	3672	5	0.1	Pass
O2-2B3P-B1-4-Double Bedroom 2	3672	4	0.1	Pass
O4-1B2P-A1-6-Living/ Kitchen	1989	0	0.0	Pass
O4-1B2P-A1-6-Double Bedroom 1	3672	0	0.0	Pass
O4-1B1P-A1-7-Living/ Kitchen	1989	0	0.0	Pass
O4-1B1P-A1-7-Double Bedroom 1	3672	0	0.0	Pass
O4-1B1P-A1-8-Living/ Kitchen	1989	0	0.0	Pass
O4-1B1P-A1-8-Double Bedroom 1	3672	0	0.0	Pass
O4-1B1P-A1-9-Double Bedroom 1	3672	0	0.0	Pass
O4-1B1P-A1-9-Living/ Kitchen	1989	0	0.0	Pass
O4-1B1P-A1-10-Double Bedroom 1	3672	0	0.0	Pass
O4-1B1P-A1-10-Living/ Kitchen	1989	0	0.0	Pass
O4-2B3P-A1-11-Double Bedroom 2	3672	2	0.1	Pass
O4-2B3P-A1-11-Living/ Kitchen	1989	0	0.0	Pass
O4-2B3P-A1-5-Double Bedroom 2	3672	0	0.0	Pass
O4-2B3P-A1-5-Double Bedroom 1	3672	0	0.0	Pass
O4-2B3P-A2-6-Double Bedroom 2	3672	5	0.1	Pass
O4-2B3P-A2-6-Double Bedroom 1	3672	2	0.1	Pass
O4-3B5P-A2-5-Double Bedroom 2	3672	0	0.0	Pass
O4-3B5P-A2-5-Single Bedroom	3672	0	0.0	Pass
O4-3B5P-A2-5-Double Bedroom 1	3672	0	0.0	Pass
O4-2B3P-B1-4-Double Bedroom 1	3672	0	0.0	Pass
O4-1B1P-B2-3-Double Bedroom 1	3672	5	0.1	Pass
O4-1B1P-B2-2-Living/ Kitchen	1989	0	0.0	Pass
O4-1B1P-B2-2-Double Bedroom 1	3672	0	0.0	Pass
O4-2B3P-B1-3-Double Bedroom 1	3672	2	0.1	Pass
O4-2B3P-B1-3-Double Bedroom 2	3672	0	0.0	Pass
O4-2B3P-B1-3-Living/Kitc hen	1989	0	0.0	Pass
O4-1B1P-B2-3-Living/ Kitchen	1989	0	0.0	Pass
O4-2B3P-B1-1-Double Bedroom 1	3672	1	0.0	Pass

Room name	Occupied hours	No. hours $\Delta T \geq 1^{\circ}K$	% Occupied hours $\Delta T \geq 1^{\circ}K$	Criterion 1 check
O4-2B3P-B1-1-Double Bedroom 2	3672	0	0.0	Pass
O4-2B3P-B1-1-Living/ Kitchen	1989	0	0.0	Pass
O4-2B3P-B1-2-Double Bedroom 1	3672	9	0.2	Pass
O4-2B3P-B1-2-Living/ Kitchen	1989	0	0.0	Pass
O4-2B3P-B1-2-Double Bedroom 2	3672	5	0.1	Pass
O4-2B3P-B1-4-Double Bedroom 2	3672	4	0.1	Pass
O8-2B3P-B1-2-Double Bedroom 2	3672	14	0.4	Pass
O8-2B3P-B1-2-Living/ Kitchen	1989	2	0.1	Pass
O8-2B3P-B1-2-Double Bedroom 1	3672	11	0.3	Pass
O8-2B3P-B1-1-Double Bedroom 1	3672	10	0.3	Pass
O8-2B3P-B1-1-Living/ Kitchen	1989	6	0.3	Pass
O8-2B3P-B1-1-Double Bedroom 2	3672	11	0.3	Pass
10-1B1P-B1-9-Living/ Kitchen	1989	2	0.1	Pass
10-2B3P-B1-1-Living/ Kitchen	1989	0	0.0	Pass

Naturally ventilated rooms – criterion 2

Room name	No. hours > 26°C 22:00-24:00	No. hours > 26°C 00:00-07:00	Total hours > 26°C	Criterion 2 check
03-1B2P-A1-6-Double Bedroom 1	0	0	0	Pass
03-1B1P-A1-7-Double Bedroom 1	1	0	1	Pass
03-1B1P-A1-8-Double Bedroom 1	1	0	1	Pass
03-1B1P-A1-9-Double Bedroom 1	1	0	1	Pass
03-1B1P-A1-10-Double Bedroom 1	3	0	3	Pass
03-2B3P-A1-11-Double Bedroom 2	3	0	3	Pass
03-2B3P-A1-5-Double Bedroom 2	0	0	0	Pass
03-2B3P-A1-5-Double Bedroom 1	0	0	0	Pass
03-2B3P-A2-6-Double Bedroom 2	3	0	3	Pass
03-2B3P-A2-6-Double Bedroom 1	3	0	3	Pass
03-3B5P-A2-5-Double Bedroom 2	1	0	1	Pass
03-3B5P-A2-5-Single Bedroom	1	0	1	Pass
03-3B5P-A2-5-Double Bedroom 1	1	0	1	Pass
03-2B3P-B1-4-Double Bedroom 1	0	0	0	Pass
03-1B1P-B2-3-Double Bedroom 1	2	0	2	Pass
03-1B1P-B2-2-Double Bedroom 1	2	0	2	Pass
03-2B3P-B1-3-Double Bedroom 1	4	0	4	Pass
03-2B3P-B1-3-Double Bedroom 2	4	0	4	Pass
03-2B3P-B1-1-Double Bedroom 1	5	0	5	Pass
03-2B3P-B1-1-Double Bedroom 2	4	0	4	Pass
03-2B3P-B1-2-Double Bedroom 1	5	0	5	Pass
03-2B3P-B1-2-Double Bedroom 2	4	0	4	Pass
03-2B3P-B1-4-Double Bedroom 2	0	0	0	Pass
02-1B2P-A1-6-Double Bedroom 1	1	0	1	Pass
02-1B1P-A1-7-Double Bedroom 1	2	0	2	Pass
02-1B1P-A1-8-Double Bedroom 1	2	0	2	Pass
02-1B1P-A1-9-Double Bedroom 1	3	0	3	Pass
02-1B1P-A1-10-Double Bedroom 1	3	0	3	Pass
02-2B3P-A1-11-Double Bedroom 2	4	0	4	Pass
02-2B3P-A1-5-Double Bedroom 2	1	0	1	Pass
02-2B3P-A1-5-Doubl Bedroom 1	1	0	1	Pass

Room name	No. hours > 26°C 22:00-24:00	No. hours > 26°C 00:00-07:00	Total hours > 26°C	Criterion 2 check
02-2B3P-A2-6-Double Bedroom 2	4	0	4	Pass
02-2B3P-A2-6-Double Bedroom 1	4	0	4	Pass
02-3B5P-A2-5-Double Bedroom 2	1	0	1	Pass
02-3B5P-A2-5-Single Bedroom	1	0	1	Pass
02-3B5P-A2-5-Double Bedroom 1	2	0	2	Pass
02-2B3P-B1-4-Double Bedroom 1	0	0	0	Pass
02-1B1P-B2-3-Double Bedroom 1	3	0	3	Pass
02-1B1P-B2-2-Double Bedroom 1	3	0	3	Pass
02-2B3P-B1-3-Double Bedroom 1	4	0	4	Pass
02-2B3P-B1-3-Double Bedroom 2	4	0	4	Pass
02-2B3P-B1-1-Double Bedroom 1	5	0	5	Pass
02-2B3P-B1-1-Double Bedroom 2	4	0	4	Pass
02-2B3P-B1-2-Double Bedroom 1	5	0	5	Pass
02-2B3P-B1-2-Double Bedroom 2	4	0	4	Pass
02-2B3P-B1-4-Double Bedroom 2	1	0	1	Pass
04-1B2P-A1-6-Double Bedroom 1	0	0	0	Pass
04-1B1P-A1-7-Double Bedroom 1	1	0	1	Pass
04-1B1P-A1-8-Double Bedroom 1	1	0	1	Pass
04-1B1P-A1-9-Double Bedroom 1	1	0	1	Pass
04-1B1P-A1-10-Double Bedroom 1	2	0	2	Pass
04-2B3P-A1-11-Double Bedroom 2	3	0	3	Pass
04-2B3P-A1-5-Double Bedroom 2	0	0	0	Pass
04-2B3P-A1-5-Double Bedroom 1	0	0	0	Pass
04-2B3P-A2-6-Double Bedroom 2	3	0	3	Pass
04-2B3P-A2-6-Double Bedroom 1	3	0	3	Pass
04-3B5P-A2-5-Double Bedroom 2	1	0	1	Pass
04-3B5P-A2-5-Single Bedroom	0	0	0	Pass
04-3B5P-A2-5-Double Bedroom 1	1	0	1	Pass
04-2B3P-B1-4-Double Bedroom 1	0	0	0	Pass
04-1B1P-B2-3-Double Bedroom 1	1	0	1	Pass
04-1B1P-B2-2-Double Bedroom 1	2	0	2	Pass
04-2B3P-B1-3-Double Bedroom 1	3	0	3	Pass
04-2B3P-B1-3-Double Bedroom 2	3	0	3	Pass

Room name	No. hours > 26°C 22:00-24:00	No. hours > 26°C 00:00-07:00	Total hours > 26°C	Criterion 2 check
04-2B3P-B1-1-Double Bedroom 1	4	0	4	Pass
04-2B3P-B1-1-Double Bedroom 2	4	0	4	Pass
04-2B3P-B1-2-Double Bedroom 1	5	0	5	Pass
04-2B3P-B1-2-Double Bedroom 2	4	0	4	Pass
04-2B3P-B1-4-Double Bedroom 2	0	0	0	Pass
08-2B3P-B1-2-Double Bedroom 2	5	0	5	Pass
08-2B3P-B1-2-Double Bedroom 1	5	0	5	Pass
08-2B3P-B1-1-Double Bedroom 1	6	0	6	Pass
08-2B3P-B1-1-Double Bedroom 2	7	0	7	Pass

Mechanically ventilated rooms.

Room name	No. hours > 26°C	% Annual hours > 26°C	Mechanically ventilated check
03-2B3P-A1-11-Double Bedroom 1	1	0.0	Pass
03-2B3P-A1-1-Double Bedroom 1	0	0.0	Pass
03-2B3P-A1-1-Living/ Kitchen	0	0.0	Pass
03-2B3P-A1-1-Double Bedroom 2	0	0.0	Pass
03-1B1P-A1-2-Double Bedroom 1	0	0.0	Pass
03-1B1P-A1-2-Living/ Kitchen	0	0.0	Pass
03-1B1P-A1-3-Living/ Kitchen	0	0.0	Pass
03-1B1P-A1-3-Double Bedroom	0	0.0	Pass
03-2B3P-A1-4-Double Bedroom 1	0	0.0	Pass
03-2B3P-A1-4-Double Bedroom 2	3	0.0	Pass
03-2B3P-A1-4-Living/ Kitchen	0	0.0	Pass
03-2B3P-A1-5-Living/ Kitchen	7	0.1	Pass
03-2B3P-A2-6-Living/ Kitchen	0	0.0	Pass
03-3B5P-A2-1-Double Bedroom 1	47	0.5	Pass
03-3B5P-A2-1-Double Bedroom 2	36	0.4	Pass
03-3B5P-A2-1-Living/ Kitchen	20	0.4	Pass
03-3B5P-A2-1-Single Bedroom	21	0.2	Pass
03-1B1P-A2-4-Double Bedroom 1	0	0.0	Pass
03-1B1P-A2-4-Living/ Kitchen	0	0.0	Pass
03-1B1P-A2-3-Living/ Kitchen	0	0.0	Pass
03-1B1P-A2-3-Double Bedroom 1	0	0.0	Pass
03-1B1P-A2-2-Double Bedroom 1	0	0.0	Pass
03-1B1P-A2-2-Living/ Kitchen	0	0.0	Pass
03-3B5P-A2-5-Living/ Kitchen	0	0.0	Pass
03-2B3P-B1-6-Double Bedroom 1	1	0.0	Pass
03-1B1P-B1-5-Double Bedroom 1	0	0.0	Pass
03-2B3P-B2-1-Double Bedroom 1	0	0.0	Pass
03-2B3P-B2-1-Living/ Kitchen	0	0.0	Pass
03-2B3P-B2-1-Double Bedroom 2	0	0.0	Pass
03-2B3P-B2-6-Living/Kitchen	0	0.0	Pass
03-2B3P-B2-6-Double Bedroom 2	0	0.0	Pass

Room name	No. hours > 26°C	% Annual hours > 26°C	Mechanically ventilated check
O3-2B3P-B2-6-Double Bedroom 1	3	0.0	Pass
O3-2B3P-B2-5-Living/ Kitchen	6	0.1	Pass
O3-2B3P-B2-5-Double Bedroom 2	21	0.2	Pass
O3-2B3P-B2-5-Double Bedroom 1	13	0.1	Pass
O3-2B3P-B2-4-Double Bedroom 2	12	0.1	Pass
O3-2B3P-B2-4-Double Bedroom 1	25	0.3	Pass
O3-2B3P-B1-6-Living/ Kitchen	9	0.2	Pass
O3-2B3P-B1-6-Double Bedroom 2	21	0.2	Pass
O3-1B1P-B1-7-Double Bedroom 1	5	0.1	Pass
O3-1B1P-B1-7-Living/ Kitchen	2	0.0	Pass
O3-2B3P-B1-8-Double Bedroom 1	13	0.1	Pass
O3-2B3P-B1-8-Double Bedroom 2	25	0.3	Pass
O3-2B3P-B1-8-Living/ Kitchen	12	0.3	Pass
O3-1B1PS-B1-9-Liv/Kitch/Bed	9	0.1	Pass
O3-2B3P-B1-10-Double Bedroom 1	22	0.3	Pass
O3-2B3P-B1-10-Double Bedroom 2	28	0.3	Pass
O3-2B3P-B1-10-Living/ Kitchen	21	0.4	Pass
O3-2B3P-B2-4-Living/ Kitchen	18	0.4	Pass
O3-2B3P-B1-4-Living/ Kitchen	7	0.1	Pass
O3-1B1P-B1-5-Living/ Kitchen	0	0.0	Pass
O9-1B1P-B1-9-Double Bedroom 1	40	0.5	Pass
O9-1B1PS-B1-8-Liv/Kitch/Bed	17	0.2	Pass
O9-2B3P-B1-7-Double Bedroom 1	41	0.5	Pass
O9-2B3P-B1-7-Living/ Kitchen	28	0.6	Pass
O9-2B3P-B1-7-Double Bedroom 2	24	0.3	Pass
O9-1B1P-B1-6-Double Bedroom 1	12	0.1	Pass
O9-1B1P-B1-6-Living/ Kitchen	6	0.1	Pass
O9-2B4P-B1-5-Double Bedroom 1	46	0.5	Pass
O9-1B1P-B1-4-Double Bedroom 1	0	0.0	Pass
O9-2B4P-B1-5-Living/ Kitchen	49	1.0	Pass
O9-2B3P-B1-3-Living/ Kitchen	11	0.2	Pass
O9-2B3P-B1-3-Double Bedroom 2	23	0.3	Pass
O9-2B3P-B1-2-Double Bedroom 2	26	0.3	Pass

Room name	No. hours > 26°C	% Annual hours > 26°C	Mechanically ventilated check
O9-2B3P-B1-2-Living/ Kitchen	9	0.2	Pass
O9-2B3P-B1-2-Double Bedroom 1	21	0.2	Pass
O9-2B3P-B1-1-Double Bedroom 1	28	0.3	Pass
O9-2B3P-B1-1-Double Bedroom 2	63	0.7	Pass
O9-2B4P-B1-5-Double Bedroom 2	22	0.3	Pass
O9-1B1P-B1-4-Living/ Kitchen	0	0.0	Pass
O9-2B3P-B1-3-Double Bedroom 1	16	0.2	Pass
O2-2B3P-A1-11-Double Bedroom 1	6	0.1	Pass
O2-2B3P-A1-1-Double Bedroom 1	0	0.0	Pass
O2-2B3P-A1-1-Living/ Kitchen	0	0.0	Pass
O2-2B3P-A1-1-Double Bedroom 2	0	0.0	Pass
O2-1B1P-A1-2-Double Bedroom 1	0	0.0	Pass
O2-1B1P-A1-2-Living/ Kitchen	0	0.0	Pass
O2-1B1P-A1-3-Living/ Kitchen	0	0.0	Pass
O2-1B1P-A1-3-Double Bedroom	0	0.0	Pass
O2-2B3P-A1-4-Double Bedroom 1	2	0.0	Pass
O2-2B3P-A1-4-Double Bedroom 2	9	0.1	Pass
O2-2B3P-A1-4-Living/ Kitchen	0	0.0	Pass
O2-2B3P-A1-5-Living/ Kitchen	14	0.3	Pass
O2-2B3P-A2-6-Living/ Kitchen	2	0.0	Pass
O2-3B5P-A2-1-Double Bedroom 1	69	0.8	Pass
O2-3B5P-A2-1-Double Bedroom 2	61	0.7	Pass
O2-3B5P-A2-1-Living/ Kitchen	35	0.7	Pass
O2-3B5P-A2-1-Single Bedroom	34	0.4	Pass
O2-1B1P-A2-4-Double Bedroom 1	0	0.0	Pass
O2-1B1P-A2-4-Living/ Kitchen	0	0.0	Pass
O2-1B1P-A2-3-Living/ Kitchen	0	0.0	Pass
O2-1B1P-A2-3-Double Bedroom 1	0	0.0	Pass
O2-1B1P-A2-2-Double Bedroom 1	0	0.0	Pass
O2-1B1P-A2-2-Living/ Kitchen	0	0.0	Pass
O2-3B5P-A2-5-Living/ Kitchen	2	0.0	Pass

Room name	No. hours > 26°C	% Annual hours > 26°C	Mechanically ventilated check
O2-2B3P-B1-6-Double Bedroom 1	6	0.1	Pass
O2-1B1P-B1-5-Double Bedroom 1	0	0.0	Pass
O2-2B3P-B2-1-Double Bedroom 1	0	0.0	Pass
O2-2B3P-B2-1-Living/ Kitchen	0	0.0	Pass
O2-2B3P-B2-1-Double Bedroom 2	0	0.0	Pass
O2-2B3P-B2-6-Living/Kitchen	0	0.0	Pass
O2-2B3P-B2-6-Double Bedroom 2	0	0.0	Pass
O2-2B3P-B2-6-Double Bedroom 1	4	0.0	Pass
O2-2B3P-B2-5-Living/ Kitchen	11	0.2	Pass
O2-2B3P-B2-5-Double Bedroom 2	23	0.3	Pass
O2-2B3P-B2-5-Double Bedroom 1	15	0.2	Pass
O2-2B3P-B2-4-Double Bedroom 2	15	0.2	Pass
O2-2B3P-B2-4-Double Bedroom 1	30	0.3	Pass
O2-2B3P-B1-6-Living/ Kitchen	14	0.3	Pass
O2-2B3P-B1-6-Double Bedroom 2	28	0.3	Pass
O2-1B1P-B1-7-Double Bedroom 1	6	0.1	Pass
O2-1B1P-B1-7-Living/ Kitchen	4	0.1	Pass
O2-2B3P-B1-8-Double Bedroom 1	16	0.2	Pass
O2-2B3P-B1-8-Double Bedroom 2	29	0.3	Pass
O2-2B3P-B1-8-Living/ Kitchen	17	0.4	Pass
O2-2B3P-B1-10-Double Bedroom 1	25	0.3	Pass
O2-2B3P-B1-10-Double Bedroom 2	33	0.4	Pass
O2-2B3P-B1-10-Living/ Kitchen	23	0.5	Pass
O2-2B3P-B2-4-Living/ Kitchen	22	0.5	Pass
O2-2B3P-B1-4-Living/ Kitchen	13	0.3	Pass
O2-1B1P-B1-5-Living/ Kitchen	0	0.0	Pass
O4-2B3P-A1-11-Double Bedroom 1	0	0.0	Pass
O4-2B3P-A1-1-Double Bedroom 1	0	0.0	Pass
O4-2B3P-A1-1-Living/ Kitchen	0	0.0	Pass

Room name	No. hours > 26°C	% Annual hours > 26°C	Mechanically ventilated check
O4-2B3P-A1-1-Double Bedroom 2	0	0.0	Pass
O4-1B1P-A1-2-Double Bedroom 1	0	0.0	Pass
O4-1B1P-A1-2-Living/ Kitchen	0	0.0	Pass
O4-1B1P-A1-3-Living/ Kitchen	0	0.0	Pass
O4-1B1P-A1-3-Double Bedroom	0	0.0	Pass
O4-2B3P-A1-4-Double Bedroom 1	0	0.0	Pass
O4-2B3P-A1-4-Double Bedroom 2	1	0.0	Pass
O4-2B3P-A1-4-Living/ Kitchen	0	0.0	Pass
O4-2B3P-A1-5-Living/ Kitchen	6	0.1	Pass
O4-2B3P-A2-6-Living/ Kitchen	0	0.0	Pass
O4-3B5P-A2-1-Double Bedroom 1	37	0.4	Pass
O4-3B5P-A2-1-Double Bedroom 2	31	0.4	Pass
O4-3B5P-A2-1-Living/ Kitchen	11	0.2	Pass
O4-3B5P-A2-1-Single Bedroom	10	0.1	Pass
O4-1B1P-A2-4-Double Bedroom 1	0	0.0	Pass
O4-1B1P-A2-4-Living/ Kitchen	0	0.0	Pass
O4-1B1P-A2-3-Living/ Kitchen	0	0.0	Pass
O4-1B1P-A2-3-Double Bedroom 1	0	0.0	Pass
O4-1B1P-A2-2-Double Bedroom 1	0	0.0	Pass
O4-1B1P-A2-2-Living/ Kitchen	0	0.0	Pass
O4-3B5P-A2-5-Living/ Kitchen	0	0.0	Pass
O4-2B3P-B1-6-Double Bedroom 1	0	0.0	Pass
O4-1B1P-B1-5-Double Bedroom 1	0	0.0	Pass
O4-2B3P-B2-1-Double Bedroom 1	0	0.0	Pass
O4-2B3P-B2-1-Living/ Kitchen	0	0.0	Pass
O4-2B3P-B2-1-Double Bedroom 2	0	0.0	Pass
O4-2B3P-B2-6-Living/Kitchen	0	0.0	Pass
O4-2B3P-B2-6-Double Bedroom 2	0	0.0	Pass
O4-2B3P-B2-6-Double Bedroom 1	1	0.0	Pass

Room name	No. hours > 26°C	% Annual hours > 26°C	Mechanically ventilated check
O4-2B3P-B2-5-Living/ Kitchen	6	0.1	Pass
O4-2B3P-B2-5-Double Bedroom 2	21	0.2	Pass
O4-2B3P-B2-5-Double Bedroom 1	13	0.1	Pass
O4-2B3P-B2-4-Double Bedroom 2	10	0.1	Pass
O4-2B3P-B2-4-Double Bedroom 1	25	0.3	Pass
O4-2B3P-B1-6-Living/ Kitchen	9	0.2	Pass
O4-2B3P-B1-6-Double Bedroom 2	17	0.2	Pass
O4-1B1P-B1-7-Double Bedroom 1	5	0.1	Pass
O4-1B1P-B1-7-Living/ Kitchen	1	0.0	Pass
O4-2B3P-B1-8-Double Bedroom 1	12	0.1	Pass
O4-2B3P-B1-8-Double Bedroom 2	24	0.3	Pass
O4-2B3P-B1-8-Living/ Kitchen	10	0.2	Pass
O4-2B3P-B1-10-Double Bedroom 1	18	0.2	Pass
O4-2B3P-B1-10-Double Bedroom 2	25	0.3	Pass
O4-2B3P-B1-10-Living/ Kitchen	15	0.3	Pass
O4-2B3P-B2-4-Living/ Kitchen	14	0.3	Pass
O4-2B3P-B1-4-Living/ Kitchen	7	0.1	Pass
O4-1B1P-B1-5-Living/ Kitchen	0	0.0	Pass
O8-1B1P-B1-9-Living/ Kitchen	3	0.1	Pass
O8-1B1P-B1-9-Double Bedroom 1	9	0.1	Pass
O8-2B3P-B1-7-Double Bedroom 1	42	0.5	Pass
O8-2B3P-B1-7-Living/ Kitchen	30	0.6	Pass
O8-2B3P-B1-7-Double Bedroom 2	26	0.3	Pass
O8-1B1P-B1-6-Double Bedroom 1	12	0.1	Pass
O8-1B1P-B1-6-Living/ Kitchen	8	0.2	Pass
O8-2B4P-B1-5-Double Bedroom 1	49	0.6	Pass
O8-1B1P-B1-4-Double Bedroom 1	0	0.0	Pass
O8-2B4P-B1-5-Living/ Kitchen	51	1.1	Pass
O8-2B3P-B1-3-Living/ Kitchen	18	0.4	Pass

Room name	No. hours > 26°C	% Annual hours > 26°C	Mechanically ventilated check
O8-2B3P-B1-3-Double Bedroom 2	26	0.3	Pass
O8-2B4P-B1-5-Double Bedroom 2	22	0.3	Pass
O8-1B1P-B1-4-Living/ Kitchen	0	0.0	Pass
O8-2B3P-B1-3-Double Bedroom 1	24	0.3	Pass
10-1B1P-B1-9-Double Bedroom 1	42	0.5	Pass
10-2B3P-B1-7-Double Bedroom 1	37	0.4	Pass
10-2B3P-B1-7-Living/ Kitchen	28	0.6	Pass
10-2B3P-B1-7-Double Bedroom 2	24	0.3	Pass
10-1B1P-B1-6-Double Bedroom 1	12	0.1	Pass
10-1B1P-B1-6-Living/ Kitchen	4	0.1	Pass
10-2B4P-B1-5-Double Bedroom 1	43	0.5	Pass
10-1B1P-B1-4-Double Bedroom 1	0	0.0	Pass
10-2B4P-B1-5-Living/ Kitchen	45	0.9	Pass
10-2B3P-B1-3-Living/ Kitchen	8	0.2	Pass
10-2B3P-B1-3-Double Bedroom 2	19	0.2	Pass
10-2B3P-B1-2-Double Bedroom 2	20	0.2	Pass
10-2B3P-B1-2-Living/ Kitchen	5	0.1	Pass
10-2B3P-B1-2-Double Bedroom 1	18	0.2	Pass
10-2B3P-B1-1-Double Bedroom 1	27	0.3	Pass
10-2B3P-B1-1-Double Bedroom 2	60	0.7	Pass
10-2B4P-B1-5-Double Bedroom 2	21	0.2	Pass
10-1B1P-B1-4-Living/ Kitchen	0	0.0	Pass
10-2B3P-B1-3-Double Bedroom 1	12	0.1	Pass

Appendix E: Acoustic Constraints

For our sample, only Level 02-04 and 08-10 have been modelled. The acoustic constraint mark ups for these floors are below:

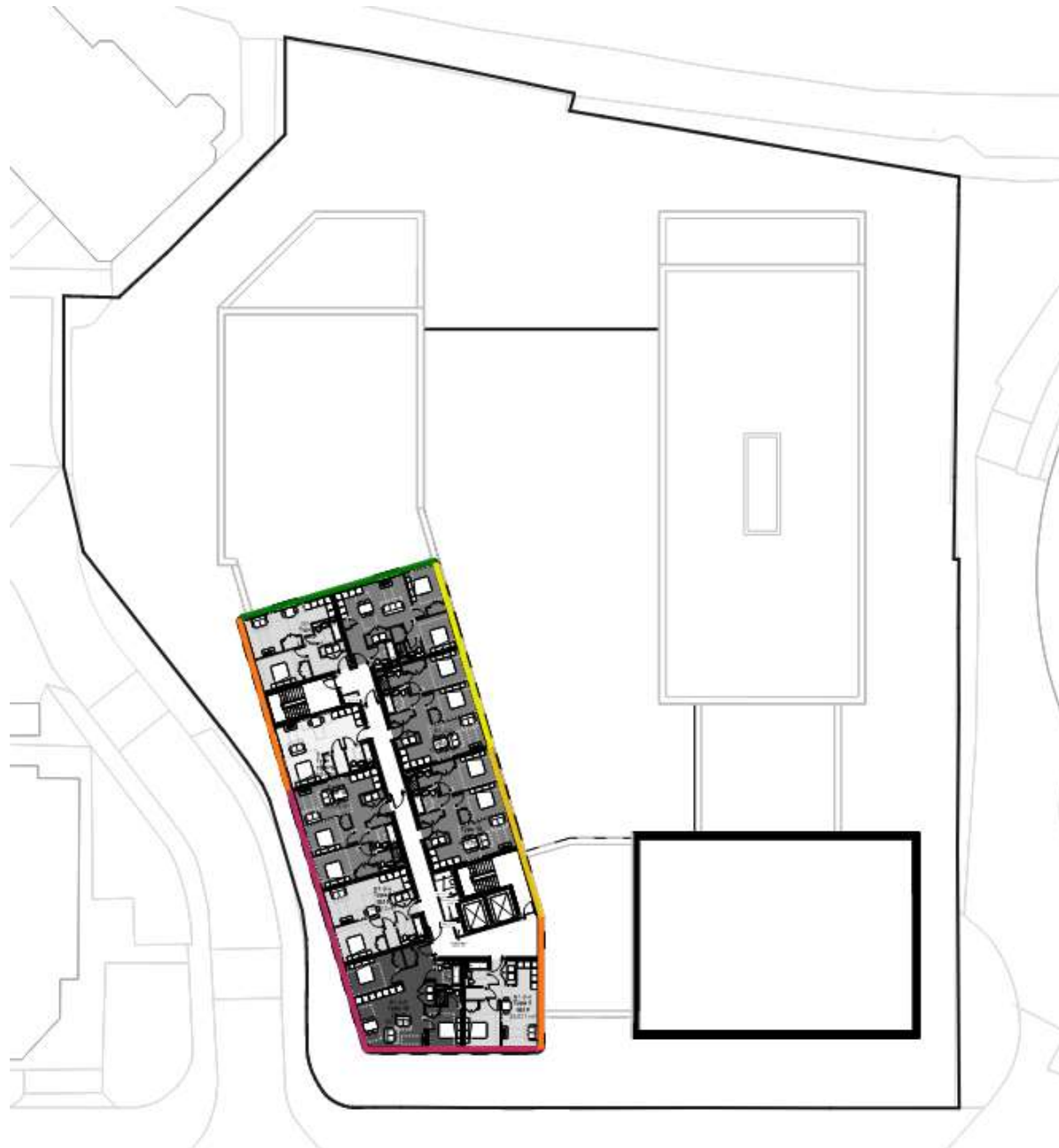
Level 02-04:



Level 08:



Level 09-10:





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