Thermal Comfort Analysis

Semi Detached Houses, 95 Avenue Road, London NW8 6HY

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CONTENTS

DOCUMENT CONTROL

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Revision History

Revision	Date	Details
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This report estimates the thermal behaviour of the 95 Avenue Road, development using detailed thermal modelling methods. Assumptions are made within this process, which may not occur in practice. Whilst E & S Bristol take great care in assembling simulations which provide an accurate depiction of reality, certain variables are difficult to predict, in particular the weather. As such, the data contained within this report is purely advisory and for the purposes of satisfying Part O Building Regulations and CIBSE TM59 overheating metric requirements only. Higher or lower temperatures than those simulated may occur if weather conditions or internal behaviours deviate sufficiently from those modelled.

1. EXECUTIVE SUMMARY

1.1 This report details the results of the thermal comfort analysis completed on the proposed new residential development; 95 Avenue Road, London NW8 6HY. The assessment has been carried out in order to demonstrate the building complies with Part O Building Regulations and CIBSE TM59: Design methodology for the assessment of overheating risk in homes.

1.2 The application consists of the redevelopment of an existing garage space to accommodate 2no semi-detached residential dwellings. The conversion will result in 2no 3-bedroom dwellings totalling 236.46m^2.

1.3 A full dynamic thermal model was carried out on the dwellings. The dynamic thermal model was created using IES Virtual Environment 2023 in accordance with CIBSE AM11: Building Energy and Environmental Modelling. The model has been created using detailed drawings and information supplied by Carnell Warren and in line with the Part L SAP Calculations carried out by E & S Bristol.

1.4 Dynamic thermal modelling has been used to set up the model and run simulations for overheating risk. The dynamic thermal model was created using IES Virtual Environment 2023 in accordance with CIBSE AM11: Building Energy and Environmental Modelling. Detailed overheating optimisation analysis was carried out along with the energy (Part L and SAP Calculations) and daylight analysis to identify the most suitable strategy for the proposed development.

1.5 The optimisation analysis was taken on a step by step basis in collaboration with the architects, M&E Consultant and SAP Assessor. Following this exercise, which is outlined in this report, the final appropriate design specification has been proposed.

1.6 The modelling has incorporated inputs provided within Part O Building Regulations and the TM59 methodology guidance and information provided by the architect which includes:

a. Building construction type and thermal performance
b. Occupancy, lighting, equipment heat gains and profiles
c. Infiltration and mechanical ventilation designed strategy
d. Passive ventilation strategy through openable windows and doors
e. External air speed assumptions

1.7 The thermal model incorporates the restrictions of Part O which limit the extent of openable windows.

1.8 In line with the requirements of the London Borough of Camden planning guidance, the London Plan Policy SI 4 the dwellings have been assessed against Criteria (a) and Criteria (b) of CIBSE TM59 for a current and future weather scenario.

1.9 The cooling hierarchy has been followed, using an iterative design approach with consideration of passive and mechanical strategies. Owing to the restrictions of a natural ventilation strategy, the increased insulation requirements and strict energy targets required by Part L 2021, the development will benefit from a reversible heat pump which provides heating and cooling.

1.10 The results indicate using a mix of passive ventilation, mechanical ventilation and cooling design strategy the building is fully compliant with the requirement of Part O Building regulations and CIBSE TM59 against weather data file London Heathrow (LHR) DSY1 2020s, high emissions, 50% percentile scenario.

1.11 For the more extreme weather assessments, it has been demonstrated the building is fully compliant with the LHR DSY2 2020s, and fully complaint except for one living space in the LHR DSY3 2020s scenario.

2. INTRODUCTION

2.1 This dynamic overheating assessment has been completed by E & S Bristol a specialist environmental consultancy for planning and development, to support the planning application for the proposed development at 95 Avenue Road.

2.2 The purpose of the analysis is to establish whether the internal temperatures simulated within the model achieve the requirements of the CIBSE thermal comfort metric TM59 in order to satisfy the requirements of Part O Building Regulations and London Plan Policy SI4.

2.3 The CIBSE TM59 overheating metric is aimed specifically at residential buildings.

2.4 95 Avenue Road is an existing 9 storey residential development, with link detached garage accommodation at ground floor. The proposals include for the redevelopment of an existing garage space to accommodate 2no semi-detached residential dwellings.

Overheating & Thermal Comfort

2.5 Maintaining thermal comfort conditions in the face of increased temperatures is one of the biggest challenges designers need to address. The main objective will be to achieve thermal comfort without recourse to conventional air-conditioning systems, where typical technologies involve greenhouse gases emissions.

2.6 Dynamic thermal simulations have been carried out for all dwellings. The purpose of the study was to determine whether the units present a risk of overheating and propose appropriate mitigation measures to ensure that comfortable thermal conditions are provided.

2.7 The CIBSE TM59 code adopts Criterion 1 (hours of exceedance) of CIBSE TM52 as a principle definition of overheating. This criterion establishes the amount of time that a room is assessed to be above an established maximum comfort temperature. The maximum comfort temperature is based upon an equation taking into account the weighted running mean of outdoor air temperatures.

2.8 In addition, the code requires that for bedrooms only, the temperature shall not exceed 26°C for more than 1% of annual hours during the time range 10pm -7am. The CIBSE TM59 code also requires that corridor spaces are tested against an overheating metric, which deems a corridor to overheat should it incur temperatures >28°C for more than 3% of annual hours. However, it is not mandatory under the code for this level of performance to be met, it is simply an advisory. This development does not contain any communal access corridors therefore consideration of overheating to corridors will be disregarded.

2.9 As outlined in the London Plan, Thermal Comfort Assessments are required to demonstrate the proposals will not overheat in current and future climate change scenarios. It encourages the design of places and spaces to avoid overheating and excessive heat generation and to reduce overheating due to the impacts of climate change and the urban heat island effect.

2.10 However compliance with future weather simulations is not mandatory for Planning Requirements.

2.11 Any occupied room that fails Criterion 1 and any bedroom which fails the second criteria of the above is potentially at risk of overheating.

2.12 In order to reduce overheating and reliance on air conditioning, the design of the development has followed the Cooling Hierarchy;

1) Minimise internal heat generation through energy efficient design
2) Reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration, insulation and walls
3) Manage the heat within the building through exposed internal thermal mass and high ceilings
4) Passive ventilation
5) Mechanical ventilation
6) Active cooling systems

2.13 Compliance with the cooling hierarchy will be balanced in line with other requirements to meet building regulations and planning policy, such as security risk to openable windows, fire risk, daylight design.

3. COMPLAINCE REQUIREMENTS

Camden Local Plan - Policy CC2 Adapting to climate change

3.1 Camden Local Plan Policy CC2 is outlined below;

The Council will require development to be resilient to climate change.

All development should adopt appropriate climate change adaptation measures such as:

a. the protection of existing green spaces and promoting new appropriate green infrastructure;

b. not increasing, and wherever possible reducing, surface water runoff through increasing permeable surfaces and use of Sustainable Drainage Systems;

c. incorporating bio-diverse roofs, combination green and blue roofs and green walls where appropriate; and

d. d. measures to reduce the impact of urban and dwelling overheating, including application of the cooling hierarchy.

Any development involving 5 or more residential units or 500 sqm or more of any additional floorspace is required to demonstrate the above in a Sustainability Statement.

Sustainable design and construction measures

The Council will promote and measure sustainable design and construction by:

e. ensuring development schemes demonstrate how adaptation measures and sustainable development principles have been incorporated into the design and proposed implementation;

f. encourage new build residential development to use the Home Quality Mark and Passivhaus design standards;

g. encouraging conversions and extensions of 500 sqm of residential floorspace or above or five or more dwellings to achieve "excellent" in BREEAM domestic refurbishment; and

h. expecting non-domestic developments of 500 sqm of floorspace or above to achieve "excellent" in BREEAM assessments and encouraging zero carbon in new development from 2019.

Regional Policy: London Plan (2021)

3.2 The relevant policy of the London Plan, Policy SI4 is outlined below;

Policy SI 4 Managing heat risk

a) Development proposals should minimise adverse impacts on the urban heat island through design, layout, orientation, materials and the incorporation of green infrastructure.

b) Major development proposals should demonstrate through an energy strategy how they will reduce the potential for internal overheating and reliance on air conditioning systems in accordance with the following cooling hierarchy:

1) reduce the amount of heat entering a building through orientation, shading, high albedo materials, fenestration, insulation and the provision of green infrastructure

2) minimise internal heat generation through energy efficient design

3) manage the heat within the building through exposed internal thermal mass and high ceilings

4) provide passive ventilation

5) provide mechanical ventilation

6) provide active cooling systems.

Energy Assessment Guidance - Greater London Authority guidance on preparing energy assessments as part of planning applications (June 2022)

3.3 The relevant section of the London Plan Energy Assessment Guidance is outlined below;

Overheating risk analysis

8.3. All developments are required to undertake a detailed analysis of the risk of overheating as part of the planning application. See the requirements set out in Table 6

8.4. It is important to identify potential overheating risk in residential accommodation early on in the design process and then incorporate suitable passive measures within the building envelope and services design to mitigate overheating and reduce cooling demand in line with London Plan Policy SI 4

***Table 6:** GLA overheating requirements*

Residential developments	***Non-residential developments***
Pre-application stage	
Complete the Good Homes Alliance (GHA) Early Stage Overheating Risk Tool and submit it to the GLA as part of the preliminary energy information for the development. More information on the GHA tool can be found in Appendix 1.	*Outline in the preliminary strategy information submitted to the GLA how the overheating risk will be minimised.*
Stage 1	
Include the GHA Early Stage Overheating Risk Tool in the energy assessment.	*N/A*

Applicants should ensure they are familiar with the Approved Document O 'Part 2b – Dynamic thermal modelling method' checklist	*N/A*
Undertake dynamic overheating modelling in line with the guidance and data sets in CIBSE TM59 and TM49 respectively, taking into account the associated Approved Document O requirements	*Undertake dynamic overheating modelling in line with the guidance and data sets in CIBSE TM52 and TM49 respectively*
Stage 2 onwards	
Ensure that the results of the overheating analysis continue to be incorporated into the building design discussions as the design evolves. Any substantive changes from Stage 1 proposals will require revised overheating analysis.	
Ensure final proposals demonstrate compliance with Approved Document O	

Building Regulations: Part O (2021)

3.4 The Building Regulations Part O1 was introduced in 2022. The aim of requirement O1 is to protect the health and welfare of occupants of the building by reducing the occurrence of high indoor temperatures. Part O applies to new development only, Part O does not apply to buildings undergoing a change of use.

3.5 The requirement O1 is met by designing and constructing the building to achieve both of the following.

a) Limiting unwanted solar gains in summer.
b) Providing an adequate means of removing excess heat from the indoor environment

3.6 Compliance with requirement O1 can be demonstrated by using one of the following methods.

a) The simplified method for limiting solar gains and providing a means of removing excess heat,
b) The dynamic thermal modelling method

Part O Simplified Method

3.7 The Simplified Method requires the limit of solar gains and maximise natural ventilation potential through window sizing and window design.

3.8 Using the Simplified Method, designers are required to limit the amount of glazing on the south, west and east facades whilst ensuring there is sufficient openable window area. Details about the glazed area and opening area of every single window are required to complete the calculations.

3.9 In order to achieve compliance the total glazed area within the dwelling must not exceed a limit based on the floor area and orientation of the most glazed facade and the total area in the most glazed room should not exceed a percentage limit which is based on the floor area of that room.

3.10 Factors such as the possibility of cross ventilation will affect the allowable glazed area and Approved Document O also takes into account the differences between dwellings in urban locations and more rural dwellings.

3.11 If using he simplified method and building in a high risk area, such as London, shading should be provided by one of the following means between compass points north-east and north-west via south;

a. External shutters with means of ventilation.
b. Glazing with a maximum g-value of 0.4 and a minimum light transmittance of 0.7.
c. Overhangs with 50 degrees altitude cut-off on due south-facing façades only.

Part O Dynamic Thermal Modelling Method

3.12 The Dynamic Thermal Modelling Method is based on CIBSE's TM59 design methodology. This models heat flow through the building and is more complex provide more flexibility in possible approaches to mitigating overheating than the Simplified Method.

CIBSE TM59 (2017) Assessment Criteria: Dwellings

3.13 Overheating in dwellings is assessed using CIBSE TM59:2017, Design methodology for the assessment of overheating risk in homes. The following two criteria, taken together, provide a robust yet balanced assessment of the risk of overheating of buildings in the UK and Europe.

3.14 This is a standardised approach to predict overheating risk for residential building designs using a dynamic thermal analysis. It provides a baseline which includes specific weather files, defined internal gains and a set of profiles that represent reasonable usage patterns for a home suitable for evaluating overheating risk.

3.15 Table 1 below provides a summary of the assessment criteria outlined in CIBSE TM59. For the purposes of this analysis, the building has been assessed against all three criteria.

Scenario	CIBSE TM59 Compliance Requirement's
Predominantly Naturally Ventilated Dwelling	Criteria (a) for living rooms, kitchen and bedrooms: the number of hours during which ΔT is greater than or equal to one degree (K) during the period May to September inclusive shall not be more than 3% of occupied hours. (CIBSE TM52 Criterion 1: Hours of exceedance, which is the number of hours during which the difference between the actual operative temperature and maximum acceptable temperature); Criteria (b) for bedrooms only: to guarantee comfort during sleeping hours the operative temperature in the bedroom from 22:00 to 07:00 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, therefore 33 or more hours above 26 °C will be recorded as a fail); Note: Criteria 2 and 3 of CIBSE TM52 may fail to be met, but both (a) and (b) above must be passed for all relevant rooms.
Predominantly Mechanically Ventilated Dwelling	CIBSE Guide A Temperature Test: Occupied spaces should not exceed operative temperature of 26°C for more than 3% of annual occupied hours.
Communal Corridors (Where communal heating present)	CIBSE Guide A fixed temperature test: a) Where corridors should not exceed operative temperature of 28°C for total annual hours (262 hours or less)

Table 1: CIBSE TM59 Compliance Requirements

4. DYNAMIC SIMULATION MODEL

4.1 In order to provide a robust set of results and ensure overheating in the dwellings have been properly considered, it is proposed the development is assessed using the Dynamic Simulation Model rather than the simplified method.

4.2 CIBSE has undertaken considerable research on the impact of climate change on the indoor environment and weather data. CIBSE Guide A, Approved Document Part L, Approved Document Part F, Approved Document Part O and the National Calculation Methodology (NCM) Modelling Guide provides data on maximum average temperatures, ventilation rates and overheating criteria.

4.3 DSM building analysis is based on the CIBSE admittance method. This method uses idealised (sinusoidal) weather and thermal response factors (admittance, decrement factor and surface factor) that are based on a 24-hour frequency.

4.4 IESVE v.2023.2.1 has been used to carry out a dynamic simulation to analyse any potential overheating risks of the building, which is in accordance with CIBSE AM11: Building Energy and Environmental Modelling.

4.5 The dynamic simulation has been conducted in accordance with CIBSE TM59:2017: Environmental Design this combines the effects of:

- CIBSE Design Summer Year1 (DSY1) weather data, (projected climate change environment)
- Equipment, lighting and people heat gains
- Fresh air supply
- Occupancy and variation
- Building fabric
- Solar heat gains and shading

5. METHODOLOGY

Site External Weather Conditions

5.1 External temperatures and incidental solar gains are greatest during summer months, coinciding with periods of lower wind speeds. However, solar altitude is highest during summer months, increasing the effects of facade shading from balcony overhangs and window reveals. Such considerations should be accounted for when designing for overheating risk.

5.2 The effects of external conditions are vital in an overheating assessment as in particular they influence:

- Solar heat gains (a function of incident direct & diffuse solar radiation and solar altitude);
- Calculated natural ventilation rates (a function of external temperature, wind directions and speeds).

5.3 CIBSE weather data has been used based on geographical location of the site. CIBSE TM59 requires that simulations be tested using DSY1 2020 High 50th Percentile weather data. CIBSE DSY1 represents a moderately warm summer.

5.4 This simulation has been used the London Heathrow_DSY1_2020High50.epw. For the extreme weather scenarios London Heathrow_DSY2_2020 High50.epw and London Heathrow_DSY3_2020High50.epw files have been used.

5.5 London Heathrow Airport data has been used as the development is in Camden and lies outside of the London Central Activity Zone. London Heathrow represents lower density urban and suburban areas.

Model Geometry and Local Shading

5.6 Solar control forms an integral part of overheating mitigation strategies. Horizontal shading devices such as balconies/overhangs are more efficient when applied in south oriented façades and during midday when the solar angle is high. Their role in reducing solar gains in the summer period is paramount.

5.7 The design proposal has no additional external shading. As the building is part of an existing structure, and at lower ground and ground level, opportunities for external shading are limited. The development does benefit from shading from existing structures, namely the residential block; 95 Avenue Road and the adjacent residential block; Park Lodge.

5.8 Internal shading, such as blinds can function as a second layer of solar control. The use of internal blinds throughout the day is instrumental to block the sun and maintain G-values as high as possible to provide good levels of natural daylighting, while taking advantage of the winter solar gains.

5.9 Whilst TM59 does not prohibit the use of internal blinds to manage the incoming solar gain, Part O dictates they should not be taken into account when considering whether requirement O1 has been met.

Glazing Design and Daylighting

5.10 A Detailed Daylight and Sunlight report has been carried out by Avison Young. In order to complete the report, *AY have worked alongside the design team throughout the design process to maximise levels of natural light within the Proposed Development as far as reasonably possible, given the Site context and the need to make efficient use of the land to provide much needed housing.*

5.11 To target compliance with the BRE internal daylight thresholds at the working plane height this concluded;

- *Designing dual aspect habitable rooms where feasible*
- *Arranging layouts to prioritise daylight and sunlight within the main living areas*
- *Arranging room layouts to ensure the potential of each window is realised, as far as reasonable possible*
- *Provision of glazed doors and translucent internal partitions to help circulate natural light within the proposed dwellings.*
- *Where practical, locating non-habitable rooms and those requiring less daylight and sunlight in more obstructed locations*

5.12 The façade design has been enhanced and developed to ensure the daylight metrics are met, so any reduction of glazed area will impact on compliance with the BRE criteria.

Acoustic Conditions & Ventilation Strategy

5.13 Purge ventilation through openable windows is shown to have significant effect in reducing internal temperatures and limit overheating to acceptable levels as well as removing high concentrations of pollutants and water vapour.

5.14 In locations where external noise may be an issue, the overheating mitigation strategy should take account of the likelihood that windows will be closed during sleeping hours (11pm to 7am).

5.15 Part O States windows are likely to be closed during sleeping hours if noise within bedrooms exceeds the following limits.

a. *40dB LAeq,T, averaged over 8 hours (between 11pm and 7am).*
b. *55dB LAFmax, more than 10 times a night (between 11pm and 7am).*

5.16 95 Avenue Road lies in a suburban location in Camden. The area is predominately residential, and the dwelling is located in a sheltered site. There are no identified issues related to noise pollution or air quality which will limit the operation of the window opening profiles. However, as the dwellings are ground and lower ground, there are potential security risks, '*as the openings may be vulnerable to intrusion by a casual or opportunistic burglar'* (Part O Paragraph 3.6).

5.17 In this instance open windows and doors can be made secure by using Fixed or lockable louvred shutters or Fixed or lockable window grilles or railings.

5.18 The model follows the limits outlined in Part O;

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. *ii. At night, windows, patio doors and balcony doors should be modelled as closed.*

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

3.7) Open windows or doors can be made secure by using any of the following.

a. Fixed or lockable louvred shutters.

b. Fixed or lockable window grilles or railings.

5.19 All windows and doors are assumed to be open during the day but closed during night time.

SAP Calculations

5.20 Both the fabric and emissions targets have got significantly stricter within SAP 10. These targets are created from a notional dwelling specification outlined in Part L. The notional dwelling has high levels of insulation, a low air test and high G value, all of which contributes to increase risk of overheating.

5.21 As part of the SAP assessment in order to comply with the targets the proposed dwelling must meet or improve upon the notional dwelling. In this instance the residential units have required a well-insulated structure, an extremely air tight fabric, detailed consideration of the heat loss at the construction junctions as well as low carbon heating systems and heat recovery ventilation to meet these targets.

5.22 It has been difficult to strike a balance between the SAP requirements and mitigating the risk of overheating. For example reducing the G value of the windows resulted in decreased solar gain increasing demand on the heating system causing the primary energy demand in CO_2 emissions to increase. The specification in the following section has been developed by E & S Bristol, in line with the architect, daylight consultant and M&E consultant in order to satisfy each of the SAP metrics.

6. BASELINE DESIGN MODELLING INPUT

Construction Fabric

6.1 The following modelling inputs (Table 3 & 4) have been set up in the baseline dynamic thermal simulation, in line with SAP calculation inputs. As discussed in the previous section the fabric and input data has been developed by E&S Bristol to ensure compliance with the SAP Calculations. CIBSE TM59 Guidance has been used for all occupancy rates and internal heat gain assumptions which will contribute to the risk of overheating.

Element	Construction	U-Value (W/m².K)	Thermal Mass
Basement Floor	Construction Specification to Be Confirmed	0.25 W/m²k	Medium
Internal Floors	Concrete Internal Floors – Suspended Ceiling	N/A	Low
Existing Walls	Construction Specification to Be Confirmed – Internally Insulated	0.30 W/m²k	Low
Retaining Walls	Construction Specification to Be Confirmed - Internally Insulated	0.30 W/m²k	Low
New External Walls	Construction Specification to Be Confirmed	0.18 W/m²k	Medium
Internal Walls	Plasterboard On Dabs, Blockwork Walls	N/A	Medium
Party Walls	Solid - Treated As Non-Heat Loss	0.00 W/m²k	Medium
GF Flat Roof	Construction Specification to Be Confirmed	0.15 W/m²k	Medium
1F Flat Roof	Construction Specification to Be Confirmed	0.15 W/m²k	Medium
Internal Ceilings	Concrete Internal Ceilings – Suspended Ceilings	N/A	Low

Table 2: Thermal Envelope U-Values

Glazing	U-Value (W/m².K)	Frame factor	G-value	LT-value
Entrance Door	1.40	N/A	0.63	0.72
Windows	1.40	30%	0.63	0.72
Glazed Doors & Glazed Walls	1.40	20%	0.63	0.72
Rooflights	1.30	30%	0.63	0.72

Table 3: Opening Parameters

Occupancy and Equipment

6.2 These are the gains associated with humans in the space. Based on CIBSE Guide A (2015a), a maximum sensible heat gain of 75 W/person and a maximum latent heat gain of 55 W/person are assumed in the living spaces. An allowance of 30% reduced gain during sleeping is based on Addendum G to ANSI/ASHRAE Standard 55-2010, Table 5.2.1.2 'Metabolic rates for typical tasks. The values used are summarised in Table 4 below.

Space	Maximum Sensible Gain (W/Person)	Maximum Latent Gain (W/Person)
Occupied Spaces	75	55

Table 4: Occupancy Heat Gains

6.3 Table 5 shows the occupancy and equipment levels in each room. The profiles used to describe when the occupants will be present are shown in Appendix A were extracted from TM59 methodology.

Unit/Room Type	Occupancy	Equipment load
Studio	2 People at all times	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-Bed Apartment Kitchen / Living / Dining	1 person from 9am to 10pm; 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-Bed Apartment Kitchen / Living / Dining	2 people from 9am to 10pm; 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-Bed Apartment Kitchen / Living / Dining	3 people from 9am to 10pm; 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
Double Bedroom	2 people at 70% gains from 11pm to 8am; 2 people at full gains from 8am to 9am and from 10pm to 11pm; 1 person at full gain from 9am to 10pm.	Peak load of 80 W from 8 am to 11 pm Base load of 10 W during sleeping hours

Table 5: Occupancy and equipment gain description

Lighting Gains

6.4 Following CIBSE TM59 methodology, an internal lighting gain of 2.0 W/m² from 6pm to 11pm has been assumed to the living / dining / kitchen rooms and bedrooms, as acceptable daylight levels are available to these dwellings.

Ventilation

6.5 The model has been based the dwellings using the openable windows to increase natural ventilation.

6.6 The side hung windows are considered to be open when the internal dry bulb temperature exceeds 22°C and the room is occupied, in line with TM59 methodology. The openable angle has been input to be a maximum of 40°. Top hung windows will operate the same.

6.7 All windows and rooflights are assumed to be opened to their maximum angle, only during daytime occupied hours during the summer months when the temperature exceeds 22°C. All sliding doors are also modelled as fully open during daytime occupied hours during the summer months when the temperature exceeds 22°C.

6.8 Owing to security to concerns, all windows and doors in the simulation have been modelled as fully closed after 10pm.

6.9 The apartments will have mechanical ventilation & heat recovery (MVHR). Air will be extracted from the Kitchen/Living/Dining space (K/L/D) and bathrooms, with supply ventilation provided in the K/L/D and bedrooms.

6.10 The system is sized to have provide a boosted supply rate of 80 l/s across the dwelling. The MVHR will operate with a summer bypass; the system will automatically divert outgoing air around the heat recovery cell, so that the incoming air will no longer be warmed by the outgoing air.

6.11 For the openable windows for the dwelling are shown in their respective tables below and shown in the 3D model images below.

Opening Type	Opening Category	Restrictors/Opening Angles	Colour
Windows, Doors and Rooflights	Fixed Pane	Unopenable / Always Closed	
Window	Top Hung	No Restrictions Maximum Angle 40° Closed Overnight	
Window	Top Hung	No Restrictions Maximum Angle 45° Open Overnight	
Window	Top Hung	Sheltered Maximum Angle 45° Closed Overnight	
Glazed Doors	Side Hung	No Restrictions Closed Overnight	
Glazed Doors	Sliding	No Restrictions Closed Overnight	

Table 6: Infiltration Rates

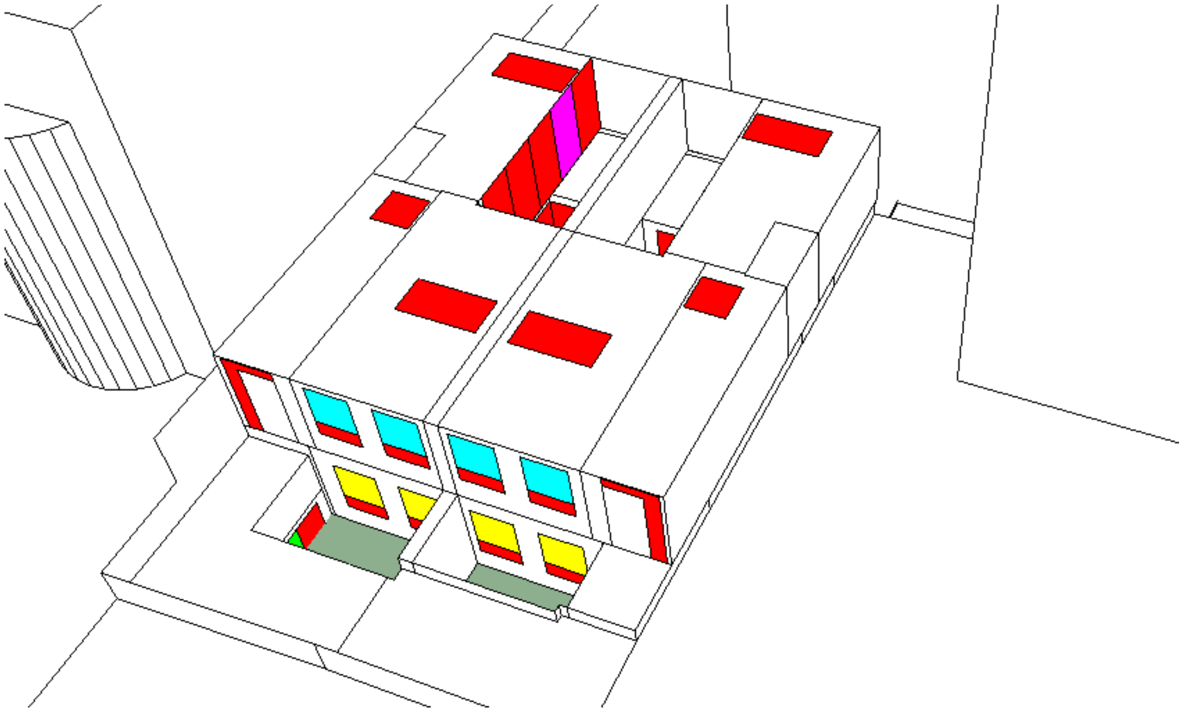

Figure 1: Front Elevation Window Openings – (East)

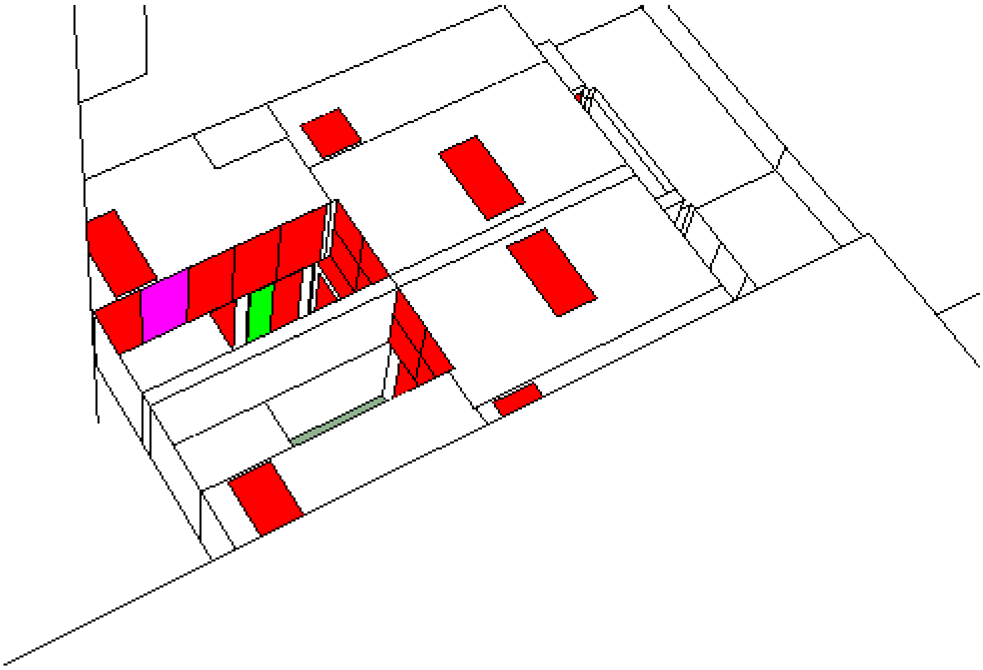

Figure 2: Rear Elevation Light Wells Window Openings – (South)

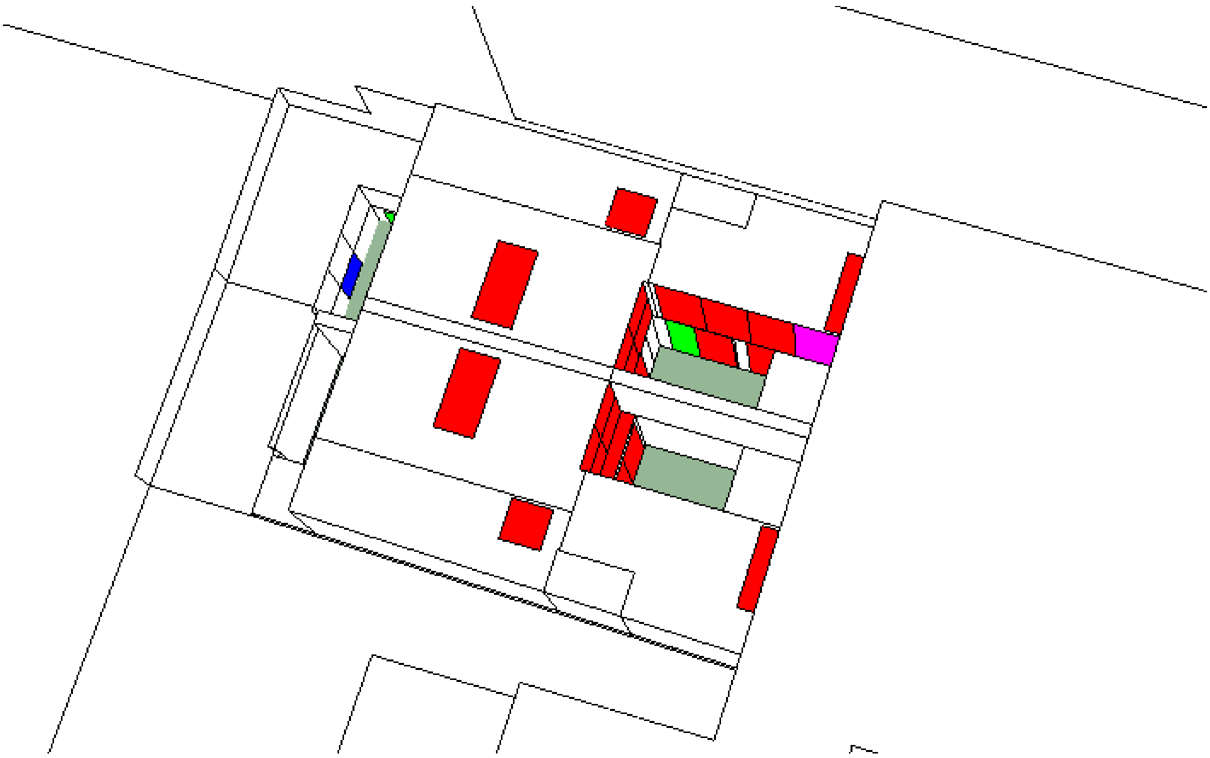

Figure 3: Rear Elevation Light Wells Window Openings – (North)

Infiltration

6.12 The building has been simulated using an air permeability of 6.0m^3/hm^2 at 50Pa. The corresponding infiltration rate for the dwellings has been derived from CIBSE Guide A (2015a) Table 4.24 as outlined in the following Table 8. This infiltration rate is the average, assuming air leakage on each dwelling is pressure tested separately.

Built Form	Air Changes per Hour
Dwelling	0.7 ACH

Table 7: Infiltration Rates

Internal Shading

6.13 TM59 methodology prescribes that internal blinds can be included for the analysis only if specifically included in the design, provided in the base build and explained within the associated home user guide. In addition, blinds should not be used if they clash with the opening of windows.

6.14 However Part O states; "*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.*"

6.15 No Internal shading has been modelled in the assessment.

7. SUMMARY OF RESULTS

7.1 The following tables show the results of the thermal modelling study using the design specification and assumptions detailed in this report. The air speed has been set at 0.1m/s in line with CIBSE TM59 requirements. Whilst the occupancy tables show reduced occupancy in line with CIBSE TM59, the results are based on a 24-hour frequency.

Baseline Scenario

7.2 According to CIBSE TM59 guidance, as the dwellings are predominately mechanically ventilated, Occupied spaces should not exceed operative temperature of 26°C for more than 3% of annual occupied hours.

7.3 Table 8 below summarises the results for the baseline scenario, including the following summarised measures:

- Low Window G-value of 0.63;
- MVHR with summer bypass to achieve boosted air flow 80l/s across dwelling
- Windows/Balcony doors open between 7am-11pm when internal temperature exceeds 22°C

Room name	No. hours > 26°C	% Annual hours > 26°C	Pass/Fail
House 1 - Bedroom 1	529	6.0	Fail
House 1 - Bedroom 2	572	6.5	Fail
House 1 - Bedroom 3	336	3.8	Fail
House 1 - Kitchen/Breakfast	293	6.2	Fail
House 1 - Living Room	371	7.8	Fail
House 2 - Bedroom 2	872	10	Fail
House 2 - Bedroom 3	643	7.3	Fail
House 2 - Bedroom 3	972	11.1	Fail
House 2 - Kitchen/Breakfast	472	9.9	Fail
House 2 - Living Room	427	9.0	Fail

Table 8: Baseline Overheating Results

7.4 The results show that all of the living rooms and bedrooms across the development exceed the recommended targets.

7.5 This is due to their south, east and west orientation, lack of external shading, high levels of glazing to meet the daylighting criteria and lack of ability to open the windows overnight.

7.6 Some of the bedrooms fall short of the requirements owing to limited cross ventilation as the windows are required to be shut, especially at night.

Additional Mitigation Measures

7.7 As the baseline model has fallen short of the mandatory targets an iterative approach has been taken in the assessment in line with the cooling hierarchy in order to ascertain how the building will perform throughout the year. This also allows for the most appropriate solution to be progressed with in the design.

7.8 The cooling hierarchy requires consideration of minimising internal heat generation through energy efficient design, reducing the amount of heat entering a building in summer through orientation, shading, albedo, fenestration, insulation and green roofs and walls and manage the heat within the building through exposed internal thermal mass and high ceilings.

Design Scenario 1

7.9 As the development has fallen well short of the overheating metrics following discussions with the design team, in line with the cooling hierarchy the following passive measures will be introduced.

- Lower window, rooflight and glazed door G-value of 0.40;
- Increased thermal mass using two layers of dense plasterboard internally
- Increased openable Windows to light wells (See Appendix B)
- Top and Side Hung windows on Secure hold open devices Maximum 10° Opening
- Openable Rooflights
- Increased MVHR Capacity to 2ACH in Bedrooms and 3ACH in K/L/D

7.10 The results show that al large number of the living rooms and bedrooms across the development still exceed the recommended targets.

Room name	No. hours > 26°C	% Annual hours > 26°C	Pass/Fail
House 1 - Bedroom 1	179	2.0	Pass
House 1 - Bedroom 2	260	3.0	Pass
House 1 - Bedroom 3	229	2.6	Pass
House 1 - Kitchen/Breakfast	180	3.8	Fail
House 1 - Living Room	185	3.9	Fail
House 2 - Bedroom 1	197	2.2	Pass
House 2 - Bedroom 2	271	3.1	Fail
House 2 - Bedroom 3	276	3.2	Fail
House 2 - Kitchen/Breakfast	225	4.7	Fail
House 2 - Living Room	196	4.1	Fail

Table 9: Mitigation Measures 1 Overheating Results

7.11 Again, this is due to their south, east and west orientation, lack of external shading in some of the windows of the particular rooms. The occupied hours for the K/L/D are much lower than the bedrooms, therefore the 3% occupied hours is harder to achieve.

Design Scenario 2

7.12 According to the cooling hierarchy and Part O after the application of all possible passive mitigation measures, all dwellings can be provided with comfort cooling, as a last resort for providing acceptable internal temperatures.

7.13 All practical and feasible design solutions have been incorporated, ensuring the daylight design and Part L SAP calculations meet their mandatory requirements. Amending the building design in order to satisfy the overheating metrics is having negative implications on compliance with Part L and daylighting.

7.14 As the dwellings, in order to comply with Part L and SAP are using a Daikin Altherma Heat Pump which is reversible, it is suggested to utilise the cooling aspect in the model.

7.15 Table 10 below presents the results when comfort cooling operates for a few hours a day (Midday - 11pm), during peak temperatures at a 22°C setpoint, all rooms now meet the mandatory criteria.

7.16 The cooling is specified to supply the K/L/D and the bedrooms. It should be noted that the operation hours and setpoint temperature are subject to occupant's preferences, and the particular schedules have been used as a potential scenario.

DSY1 Weather Data Scenario

Room Name	No. hours > 26°C	% Annual hours > 26°C	Pass/Fail
House 1 - Bedroom 1	0	0	Pass
House 1 - Bedroom 2	0	0	Pass
House 1 - Bedroom 3	0	0	Pass
House 1 - Kitchen/Breakfast	0	0	Pass
House 1 - Living Room	0	0	Pass
House 2 - Bedroom 2	0	0	Pass
House 2 - Bedroom 3	0	0	Pass
House 2 - Bedroom 3	0	0	Pass
House 2 - Kitchen/Breakfast	60	1.3	Pass
House 2 - Living Room	0	0	Pass

Table 10: Mitigation Measures 2020 Weather Data Overheating Results

7.17 With the cooling specified to supply the K/L/D and the bedrooms, full Part O and CIBSE TM59 compliance has been achieved .

7.18 As part of the London Plan requirements, simulations must also be carried out using more extreme weather scenarios, using DSY 2 and DSY 3 data. The results are in Tables 11 and 12 below.

DSY2 Weather Data Scenario

Room Name	No. hours > 26°C	% Annual hours > 26°C	Pass/Fail
House 1 - Bedroom 1	0	0	Pass
House 1 - Bedroom 2	0	0	Pass
House 1 - Bedroom 3	0	0	Pass
House 1 - Kitchen/Breakfast	0	0	Pass

House 1 - Living Room	0	0	Pass
House 2 - Bedroom 2	0	0	Pass
House 2 - Bedroom 3	0	0	Pass
House 2 - Bedroom 3	0	0	Pass
House 2 - Kitchen/Breakfast	116	2.4	Pass
House 2 - Living Room	0	0	Pass

Table 11: Mitigation Measures 2050 Weather Data Overheating Results

DSY3 Weather Data Scenario

Room Name	No. hours > 26^{o}C	% Annual hours > 26^{o}C	Pass/Fail
House 1 - Bedroom 1	0	0	Pass
House 1 - Bedroom 2	0	0	Pass
House 1 - Bedroom 3	0	0	Pass
House 1 - Kitchen/Breakfast	0	0	Pass
House 1 - Living Room	0	0	Pass
House 2 - Bedroom 2	0	0	Pass
House 2 - Bedroom 3	0	0	Pass
House 2 - Bedroom 3	0	0	Pass
House 2 - Kitchen/Breakfast	189	4.0	Fail
House 2 - Living Room	0	0	Pass

Table 12: Mitigation Measures 2080 Weather Data Overheating Results

7.19 Tables 11 and 12 show that all assessed bedrooms meet the overheating criteria in the DSY 1, DSY 2 and DSY 3 weather data set. All living spaces pass the DSY 2 and DSY 3 weather data scenarios except House 2 - Kitchen/Breakfast which marginally falls short of the DSY 3 most extreme weather scenario.

7.20 Although 1 room falls short of the targets for the most extreme DSY3 scenario these are not mandatory for compliance.

8. CONCLUSION

8.1 This report details the methodology and findings of a study into the overheating risk of two change of use dwellings at 95 Avenue Road, located in the London Borough of Camden. The analysis was undertaken with the use of dynamic thermal modelling and sets out appropriate measures to mitigate the overheating risk.

8.2 The analysis has been undertaken in line with the Greater London Authority (GLA)'s guidance on preparing energy assessments (June 2022) and the London Plan Policy SI4 Managing heat risk.

8.3 The mitigation guidance provided here has been informed by a solar design study and a detailed overheating optimisation analysis carried out along with energy (SAP and Part L) and daylight analysis to identify the most suitable strategy for the proposed development.

8.4 Due to the level (Lower Ground and Ground Floor) of the dwellings, there are security risks which limit openable windows which reduces the availability of natural ventilation at night time. This report has taken into account these restrictions. Furthermore discussions and consideration has been given to the fenestration to ensure the daylight criteria is met in with BRE following the reports and analysis carried out by Avison Young. The fabric and services specification have been developed in line with the SAP assessor.

8.5 For the purposes of this report, it assumed that all units are using a combination of passive mechanical ventilation with heat recovery, in conjunction with natural purge ventilation to mitigate the overheating risk in line with the Cooling Hierarchy of Policy SI4 in the London Plan (2021). Following an iterative design process outlined in this report, it has been demonstrated it is not possible to meet the overheating metrics without active measures.

8.6 Therefore, active cooling will also be provided to K/L/D and Bedrooms spaces using the reversible heat pump specified to ensure compliance with the SAP calculations.

8.7 The assessment has been undertaken using approved IES software. The model carried out in accordance with CIBSE AM11 and also based on information provided by the architects, M&E consultant and daylight consultant. All inputs and assumptions have been outlined within this report.

8.8 The performance of the units has been assessed against the Chartered Institute of Building Services Engineers (CIBSE) guidance documents TM59 and Building Regulations document Part O.

8.9 The representative units have been modelled against CIBSE Design Summer Year for London Weather Centre for the 2020s, high emissions, 50% percentile scenario as required by CIBSE TM59 guidance.

Recommendations and Summary of Results

8.10 The building design and building services design have maximised all available measures to minimise heat generation within the dwellings, reduce the amount of heat entering the building, and use a passive strategy to ventilation the dwellings in line with the cooling hierarchy.

8.11 The risk of overheating in the building has been minimised to within acceptable levels as the following measures have been implemented upon construction.

- Improved building fabric
- Provision of solar control glass with a g-value of 0.40 to all façades
- Provision of openable windows and doors to all habitable rooms – However these are to remain closed at night owing to security risk
- Cold radiation from the thermal mass
- External shading to South and West elevations
- MVHR with Summer Bypass
- Daikin Altherma Reversible Heat Pump providing cooling to the Bedrooms and K/L/D

8.12 Based on key design features and a list of mitigation measures, all occupied rooms demonstrate an acceptable level of overheating.

8.13 Having followed the cooling hierarchy, overall the building is fully compliant against the mandatory criteria set out in the London Plan, CIBSE TM59 and the Building Regulations Part O.

8.14 As part of the requirements of the London Plan, the development must be assessed against DSY 2 and DSY 3 weather data sets. Whilst the development has shown a single room falls short of the DSY 2 and DSY 3 dataset, these are not compulsory for compliance. CIBSE TM59 states;

"Other files including the more extreme DSY2 and DSY3 files, as well as future files (i.e. 2050s or 2080s), should be used to further test designs of particular concern, as described below, but a pass is not mandatory for the purposes of the simpler test presented in this document.

A minimum requirement for passing the test is proposed here by using a single dsy (DSY1), with the use of additional weather files recommended to explore performance where there is particular concern (e.g. the presence of vulnerable occupants) and/or where required in the client's brief or for demonstrating mitigation options under more extreme events (e.g. heatwaves)"

8.15 It is not considered occupiers of building will be vulnerable, therefore compliance with these more extreme scenarios is not required or sought at this time. In order to mitigate the overheating in extreme weather conditions, the occupants can use fans, or use internal shading. Neither of these have been considered in thermal model report, though these would have a significant impact on the final results.

8.16 DSY3 is based on a year with a prolonged period of sustained warmth, which is unlikely to happen regularly. The London plan states "……*It is acknowledged that meeting the CIBSE compliance criteria is challenging for the DSY 2 & 3 weather files, although it is expected that in the majority of cases a significant proportion of spaces will be able to achieve compliance if passive measures are fully exploited"*

8.17 The bedrooms have shown full compliance with the DSY 1, DSY 2 and DSY 3 weather conditions which are the priority spaces. The living spaces have fallen short of criterion a in the DSY 3 scenario as the occupied hours are 1,989 over the course of a year and these are during the day time, when the weather is warmer.

8.18 Overall the building is fully compliant against the mandatory criteria set out in the London Plan, CIBSE TM59 and the Building Regulations Part O. With the implementation of the cooling system, overheating risk is not considered significant.

8.19 NOTE: Data set consideration must be made to the variation profiles assumed within the analysis for occupancy, lighting and equipment that is detailed within this report. Changing any of the inputs within the thermal model will impact on overall results.

APPENDIX A

CIBSE TM59 Profiles

Figure 1 Heat gain profile

Number of people	Description	Peak load (W)		Period																							
		Sensible	Latent	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

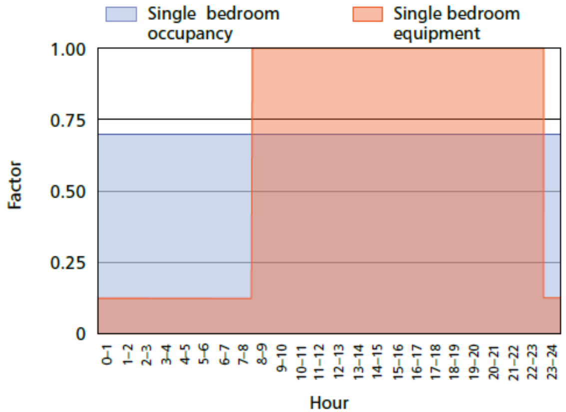

Figure 2 Heat gain profile: single bedroom

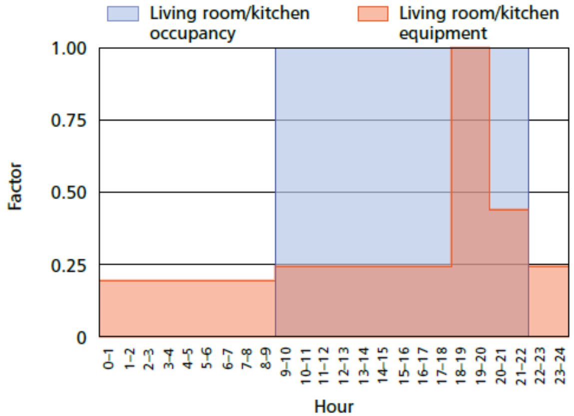

Figure 4 Heat gain profile: combined living room/kitchen

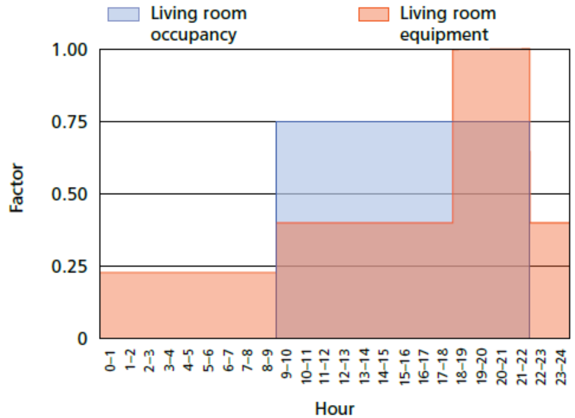

Figure 5 Heat gain profile: living room

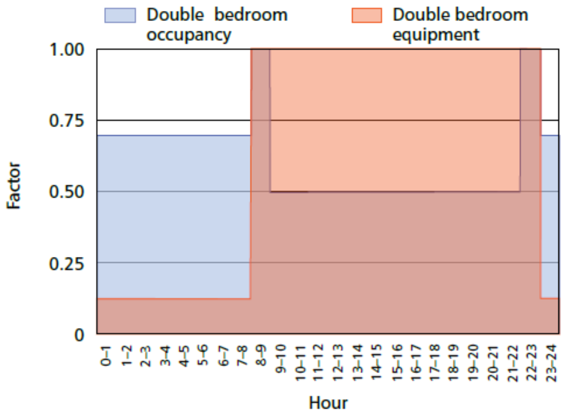

Figure 3 Heat gain profile: double bedroom

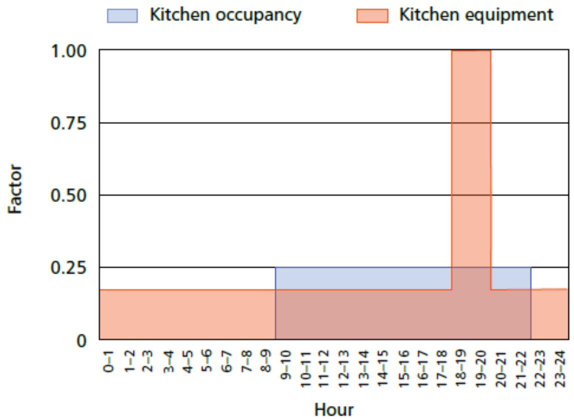

Figure 6 Heat gain profile: kitchen

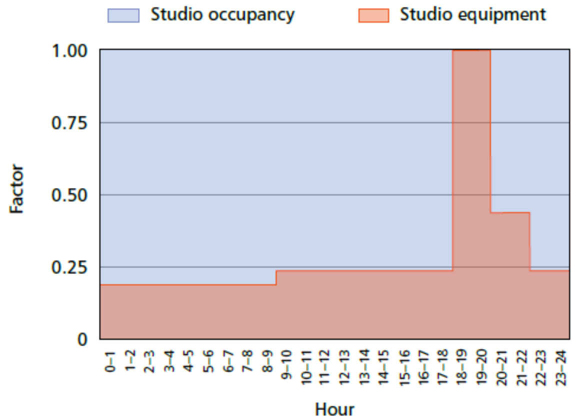

Figure 7 Heat gain profile: studio

APPENDIX B

Revised Window Openings

Opening Type	Opening Category	Restrictors/Opening Angles	Colour
Windows, Doors and Rooflights	Fixed Pane	Unopenable / Always Closed	
Window	Top Hung	No Restrictions Maximum Angle 40° Open Overnight	
Window	Top Hung	Sheltered Maximum Angle 40° Closed Overnight	
Window	Top Hung	Sheltered Maximum Angle 40° Open Overnight	
Window	Small Top Hung	Sheltered Maximum Angle 40° Open Overnight	
Glazed Doors	Side Hung	No Restrictions Closed Overnight	
Glazed Doors	Sliding	No Restrictions Closed Overnight	
Rooflights	Hinged	Maximum Angle 30° Closed Overnight	

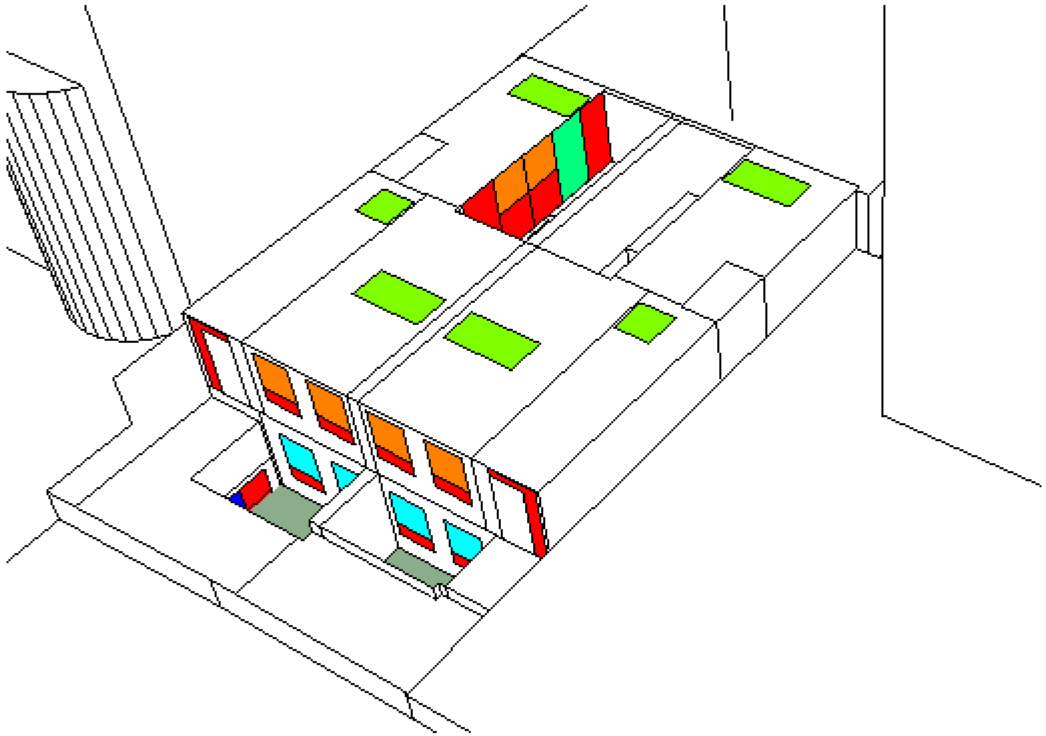

Figure 4: Front Elevation Window Openings – (East)

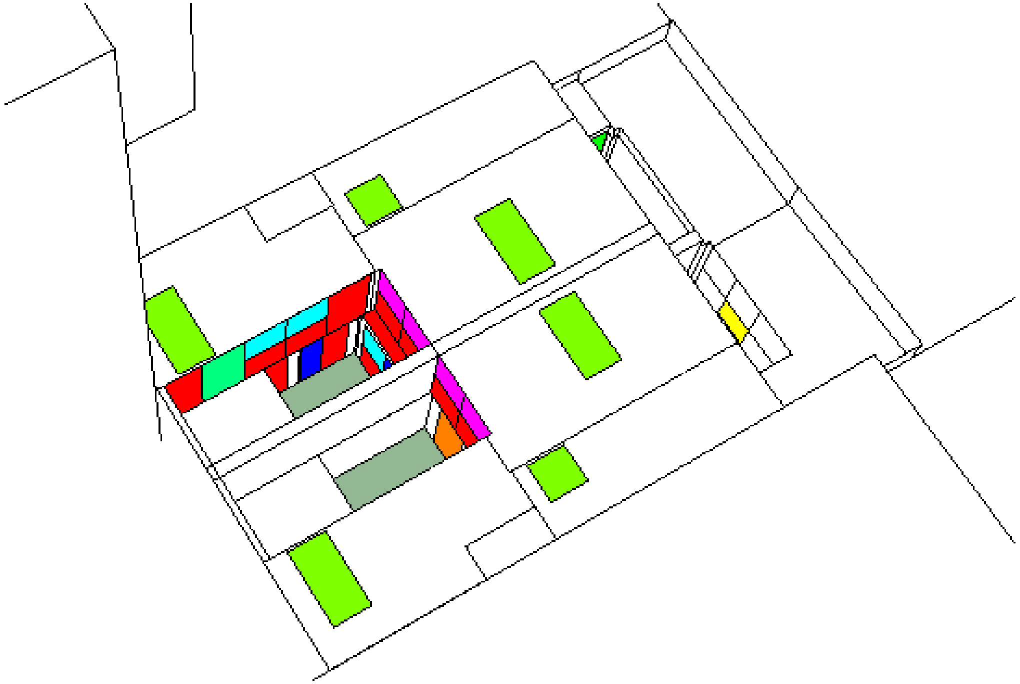

Figure 5: Rear Elevation Light Wells Window Openings – (South)

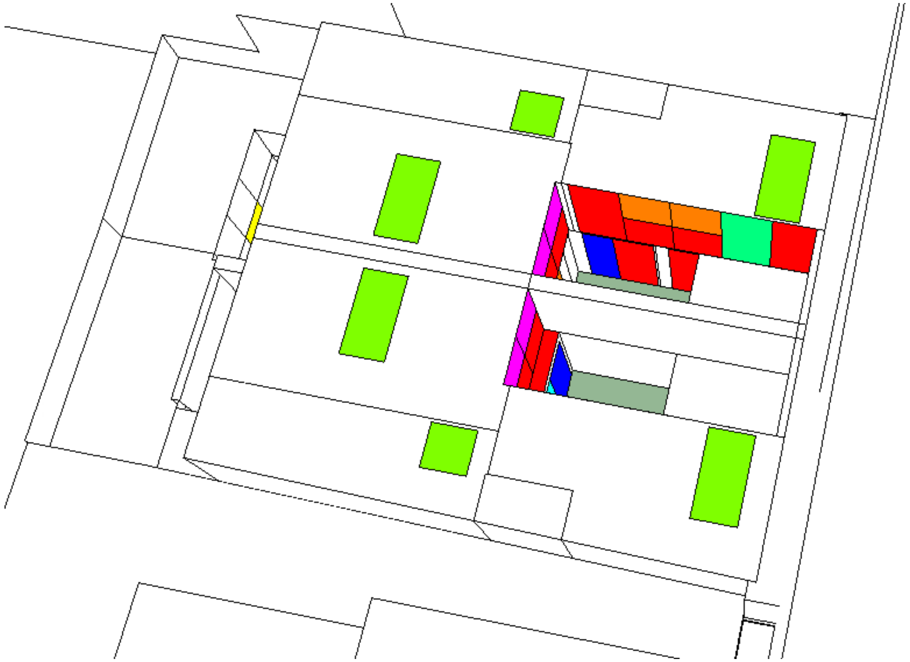

Figure 6: Rear Elevation Light Wells Window Openings – (North)