Thermal Model & Overheating Analysis

31 Elsworthy Road, London NW3 3BT

September 2024
revA

E & S Bristol Ltd
info@eandsbristol.co.uk
www.eandsbristol.co.uk

Contents

INTRODUCTION 3
CIBSE TM52 Overheating Criteria 5
CIBSE TM59 Overheating Criteria 6
BASE MODEL SPECIFICATION 7
Construction Fabric 7
Glazing Parameters 7
Occupancy and Equipment 8
Lighting Gains 9
Infiltration 9
Internal Shading 9
MODEL SCENARIOS 10
Scenario 1 10
Scenario 2 10
Scenario 3 10
OVERHEATING RESULTS 11
Basement Results 11
Scenario 1: Passive Ventilation 11
Scenario 2: Mechanical Ventilation 12
Scenario 3: Mechanical Ventilation and Cooling 13
Existing House Results 14
Criterion (a) Results Summary 15
Criterion (b) Results Summary 15
Results Summary 16
SUMMARY AND CONCLUSIONS 17

Disclaimer

INTRODUCTION

E & S Bristol has been commissioned by Carnell Warren Associates to carry out a dynamic thermal simulation of the proposed residential extension and refurbishment at 31 Elsworthy Road, London NW3 3BT. This report details the results of the thermal comfort analysis completed in order to demonstrate the building complies with CIBSE TM59 guidance related to overheating in homes.

The following works to the existing property at 31 Elsworthy Road consists of:

- Excavation of a single storey basement under the footprint of the existing property and to the front and rear garden including a lightwell
- Single storey rear extension at ground floor to the kitchen / reception room, creating new Garden Room
- Infilling of existing windows opening at ground floor to the side elevation and creation of a new window
- openings
- Changes to rear fenestration
- Replacement of the existing garage door
- Full refurbishment of the existing property including replacement of heating and hot water services, upgraded fabric and windows

The new basement extension is proposed to contain a cinema / games room, wine store, utility room, plant room, storage room, guest toilet, pool plant room, swimming pool, changing facilities, steam room, sauna, gym with changing facilities. The pool and gym both open onto the rear lightwell. Large windows will look onto the rear lightwell to maximise the natural light received by these rooms.

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 TM52 and TM59. The CIBSE TM59 overheating metric is aimed specifically at residential buildings, whilst CIBSE TM52 covers non-domestic situations. The results of the analysis will be used to assist the ventilation and cooling strategy of the development.

The calculations have been carried out using Dynamic Simulation Modelling, whereby the whole dwelling has been incorporated into the calculations.

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.

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 and the National Calculation Methodology (NCM) Modelling Guide provides data on maximum average temperatures, ventilation rates and overheating criteria.

A full dynamic thermal model was carried out on the development. The dynamic thermal model was created using IES Virtual Environment 2022 in accordance with CIBSE AM11: Building Energy and Environmental Modelling. The model has been created using detailed drawings and information supplied by Carnell Warren Associates.

The modelling has incorporated inputs provided within the TM52 and TM59 methodology guidance, information provided by the architect and M&E consultant which includes:

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

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.

This simulation has been used the London_Weather_Centre_DSY1_2020High50.epw.

In order to reduce overheating and reliance on air conditioning, the design of the basement 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.

CIBSE TM52 Overheating Criteria

Overheating for the basement areas is assessed using CIBSE TM52. The following three criteria, taken together, provide a robust yet balanced assessment of the risk of overheating of buildings in the UK and Europe.

CIBSE recommends that new buildings, major refurbishments and adaptation strategies should conform to Category II in BS EN 15251 (BSI, 2007), which sets a maximum acceptable temperature of 3 °C above the comfort temperature for buildings in free-running mode. For such buildings the maximum acceptable temperature (Tmax) can be calculated from the running mean of the outdoor temperature (Trm) using the formula:

$T_{max} = 0.33\ T_{rm} + 21.8$

The criteria are all defined in terms of ΔT the difference between the actual operative temperature in the room at any time (Top) and Tmax the limiting maximum acceptable temperature. ΔT is calculated as:

ΔT = Top – Tmax

The first criterion sets a limit for the number of hours that the operative temperature exceeds the comfort temperature by 1°K or more during the occupied hours over the summer period (1st May to 30th September). The exceedance limit is 3% of occupied times.

The second criterion deals with the severity of the overheating within any one day. This sets a daily limit for acceptability.

The third criterion sets an absolute maximum daily temperature for the room, beyond which the level of overheating is unacceptable.

A room or building that fails any two of the three criteria above is potentially at risk of overheating.

If a building or a room fails either CIBSE TM52:2013 limits, measures should be investigated to reduce internal temperatures and, therefore, reduce the likelihood of overheating.

CIBSE TM59 Overheating Criteria

Overheating in the bedrooms and living spaces 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.

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.

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

BASE MODEL SPECIFICATION

Construction Fabric

Construction fabric used within the calculation is based upon architectural information provided by Carnell Warren. For existing elements SAP Appendix S U-Values have been used, based on the existing property age.

Element	Construction	U-Value (W/m².K)	Thermal Mass KJ/(m².K)
Existing Ground Floor	Uninsulated Concrete Slab	0.58	152
New Basement Slab	Screed, insulation, concrete slab	0.18	75
Existing External Walls	Retrospectively Internally Insulated Solid Brick Walls	0.35	55
Existing Dormer Walls	Timber Frame Walls insulated between studs	0.55	30
New External Walls Above Ground	Brickwork, Cavity, Insulation, Blockwork, Dabs Cavity, Plasterboard	0.18	141
New Basement Walls	Concrete Retaining Wall, Internally Insulated	0.18	141
Existing Pitched Roofs & Dormer Roofs	Lightweight Construction, Insulation through joists	0.35	11
Existing Flat Roof	Lightweight Construction, Insulation through joists	0.35	11
New Flat Roof	Warm Flat Roof, Insulation over joists	0.12	8
Separating Floors	Timber Separating Floors	N/A	28
Lightweight Internal Walls	Plasterboard, Mineral wool between studs, Plasterboard	0.30	9
Heavyweight Internal Walls	Dense Plaster on concrete blocks	1.2	122

Table 2: Thermal Envelope U-Values

Glazing Parameters

Glazing parameters have been input based on architectural window schedule drawings and information provided by Eddie Trott.

Glazing	U-Value (W/m².K)	Frame factor	G-Value	LT-Value (Light Transmittance
New Windows	1.4	30%	0.40	0.72
New Fully Glazed Doors	1.4	30%	0.40	0.72

Table 3: Glazing Parameters

Occupancy and Equipment

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 the Table below.

Space	Maximum Sensible Gain (W/Person)	Maximum Latent Gain (W/Person)	Additional Gains (W/m^2)
Occupied Spaces	75	55	-
Gym	102	198	50
Swimming Pool	55	105	65

Table 4: Occupancy Heat Gains

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.

Room Type	Occupancy	Equipment load
Kitchen / Living / Dining Room	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
Gym	6m^2 per person at 100% gains from 9am to 10pm; unoccupied for the rest of the day	Peak Load at 16W/m^2
Swimming Pool	6m^2 per person at 100% gains from 9am to 10pm; unoccupied for the rest of the day	Peak Load at 2W/m^2

Table 5: Occupancy and equipment gain description

Lighting Gains

Following CIBSE TM59 methodology, an internal lighting gain of 2.0 W/m^2 from 6pm to 11pm has been assumed to the living / dining / kitchen rooms and bedrooms, as acceptable daylight levels are available to these dwellings.
Swimming Pool and Gym areas are set a 5.2 W/m^2

Infiltration

The existing building areas have been simulated using an air permeability of $15m^3/hm^2$ at 50Pa. The new building areas have been simulated using an air permeability of $5m^3/hm^2$ at 50Pa. The corresponding infiltration rate for the Dwelling has been derived from CIBSE Guide A (2015a) Tables 4.16 - 4.24.

The model uses an infiltration rate into the existing areas at a rate of 0.75ACH
The model uses an infiltration rate into the new build areas at a rate of 0.25ACH

Internal Shading

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

No Internal shading has been modelled in the assessment.

MODEL SCENARIOS

An iterative approach has been taken in the assessment in line with the cooling hierarchy in order to ascertain how the building will perform in throughout the year. This also allows for the most appropriate solution to be progressed with in the design.

The following scenarios have been simulated, the specification has only been altered to the new build basement areas.

Scenario 1

Passive ventilation with extract only.

Scenario 2

Air handling unit with supply and extract mechanical ventilation.

Scenario 3

Air handling unit with supply and extract mechanical ventilation and Cooling to gym, cinema and hallway.

The cooling hierarchy also requires consideration of minimise 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.

As the development consists of the construction of a new basement under an existing property, there are restrictions to the passive measures that can be considered. Any fenestrations must be built with lightwells, and will need to be closed overnight owing to security concerns. Internal heat gain from solar radiation is however reduced as the majority of the development is underground.

The orientation and layout is dictated by the existing layout of the property. The basement has already been designed to maximise thermal mass and uses appropriate height ceilings throughout..

OVERHEATING RESULTS

The following tables show the results of the thermal modelling study using the design specification and assumptions detailed in this report. The basement zones as part of the new extension have been assessed against the requirements of CIBSE TM52:2013 as they are not strictly residential spaces. Criteria 1 is the equivalent compulsory criteria of CIBSE TM59.

Basement Results

The Basement results have been compared against the recommendations given in CIBSE TM52:2013, using the 3 assessment criteria below:

- The first criterion sets a limit for the number of hours that the operative temperature exceeds the comfort temperature by 1°C or more during the occupied hours over the summer period (1st May to 30th September)
- The second criterion deals with the severity of the overheating within any one day. This sets a daily limit for acceptability.
- The third criterion sets an absolute maximum daily temperature for the room, beyond which the level of overheating is unacceptable.
- Items within the table:
  - Items in RED DO NOT comply with the CIBSE recommendations
  - Items in GREEN DO comply with the CIBSE recommendations

A room or building that fails any two of the three criteria above is potentially at risk of overheating.

Scenario 1: Passive Ventilation

Room Name	CIBSE TM52:2013			TM52 Compliance
	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	
Living Room	3.5	20	3	Fail
Gym	6.3	41	5	Fail
Swimming Pool	26.3	34	4	Fail

Table 6: Scenario 1 Results.

Table 6 shows that all occupied rooms in the basement will exceed the overheating criteria using a natural ventilation strategy. This is owing to the activity of the rooms, plus the limited ability to open windows, especially overnight due to security risks.

Scenario 2: Mechanical Ventilation

The basement model has been updated with mechanical ventilation & heat recovery (MVHR). Air will be extracted from the living room, changing room, pool and gym, with supply ventilation provided back into these spaces.

The MVHR will operate with a summer bypass with a set point of 20°C; 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.

The mechanical ventilation is specified in the basement to support the humidity associated with the swimming pool. The flow rates in the table below have been included in the assessment.

Room	Supply/Extract Flow Rate
Basement Living Room	20 l/s
Changing Room	30 l/s
Gym	50 l/s
Swimming Pool	150 l/s

Table 7: MVHR Extract Flow Rates

The results of incorporating MVHR into the model is shown in the table below.

Room Name	CIBSE TM52:2013			TM52 Compliance
	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	
Living Room	1.3	20	3	Pass
Gym	5.3	39	5	Fail
Swimming Pool	24.1	32	4	Fail

Table 8: Scenario 2 Results.

Table 8 shows that when mechanical ventilation with heat recovery is incorporated, whilst the extent of overheating is considerably reduced, the occupied rooms, except the Living Room in the basement will still exceed the overheating criteria.

Scenario 3: Mechanical Ventilation and Cooling

The model has been updated with a cooling system supplying the living room, gym, central hallway and swimming pool. Note, cooling has been specified in the swimming pool zone for illustration only.

Room Name	CIBSE TM52:2013			TM52 Compliance
	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	
Living Room	1.1	18	2	Pass
Gym	2.4	15	1	Pass
Swimming Pool	2.9	29	4	Pass

Table 9: Scenario 3 Results.

Table 9 shows that when mechanical ventilation with heat recovery is incorporated alongside cooling, the occupied rooms in the basement will meet the overheating criteria.

Existing House Results

The existing living room, study, kitchen, new garden room and bedrooms results have been compared against the recommendations given in CIBSE TM59, using the 2 assessment criteria below:

- The first criterion sets a limit for the number of hours that the operative temperature exceeds the comfort temperature by 1°C or more during the occupied hours over the summer period (1st May to 30th September)
- The second criterion for bedrooms only, 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);

Room Name	Criterion (A) Result	Criterion (B) Result	Overall TM59 Result
Bedroom - Principal	Pass	Pass	**Pass**
Bedroom - Principal	Pass	Pass	**Pass**
Bedroom 02	Pass	Pass	**Pass**
Bedroom 03	Pass	Pass	**Pass**
Bedroom 04	Pass	Pass	**Pass**
Bedroom 05	Pass	Pass	**Pass**
Bedroom 06	Pass	Pass	**Pass**
Bedroom 07	Pass	Pass	**Pass**
Dining Room	Pass	N/A	**Pass**
K/L/D	Pass	N/A	**Pass**
Kitchen	Pass	N/A	**Pass**
Office	Pass	N/A	**Pass**
Garden Room	Pass	N/A	**Pass**

Table 10: Overall Results

Table 10 shows that all assessed bedroom and living spaces comply with both Criterion (a) and Criterion (b) of CIBSE TM59. This demonstrates the building is fully compliant with the CIBSE targets and risk of overheating is considered not significant.

Criterion (a) Results Summary

Table 10 below shows a summary of how the assessed bedrooms rooms have performed against CIBSE Criterion (a). Criterion (a) states that for living rooms, kitchens and bedrooms, the number of hours during which ΔT is greater than or equal to 1°K from May to September shall not exceed 3% of occupied hours.

Room Name	Occupied Hours	No. Hours Δt ≥ 1°K	% Occupied Hours Δt ≥ 1°K	Pass/Fail
Bedroom - Principal	3672	20	0.5	Pass
Bedroom - Principal	3672	21	0.6	Pass
Bedroom 02	3672	18	0.5	Pass
Bedroom 03	3672	17	0.5	Pass
Bedroom 04	3672	7	0.2	Pass
Bedroom 05	3672	14	0.4	Pass
Bedroom 06	3672	18	0.5	Pass
Bedroom 07	3672	18	0.5	Pass
Dining Room	1989	21	1.1	Pass
K/L/D	1989	36	1.8	Pass
Kitchen	1989	16	0.8	Pass
Office	1989	22	1.1	Pass
Garden Room	1989	58	2.9	Pass

Table 11: TM59 Criterion A results

Criterion (b) Results Summary

Table 11 below shows a summary of how the assessed bedrooms rooms have performed against CIBSE Criterion (b). Criterion (b) states that the operative temperature of the bedrooms from 22:00-07:00 shall not exceed 26°C for more than 1% of annual hours (33 hours is therefore recorded as a fail).

Room Name	Total Hours > 26°C	Percentage Hours > 26°C	Pass/Fail
Bedroom - Principal	13	0.35%	Pass
Bedroom - Principal	14	0.38%	Pass
Bedroom 02	23	0.63%	Pass
Bedroom 03	18	0.49%	Pass
Bedroom 04	29	0.79%	Pass
Bedroom 05	32	0.87%	Pass
Bedroom 06	22	0.60%	Pass
Bedroom 07	22	0.60%	Pass
Dining Room	N/A	N/A	N/A
K/L/D	N/A	N/A	N/A
Kitchen	N/A	N/A	N/A
Office	N/A	N/A	N/A
Garden Room	N/A	N/A	N/A

Table 12: TM59 Criterion B results

Table 12 shows that for all scenarios, the bedrooms are within the overheating targets and do not exceed 26ºC for more than 1% of the annual hours overnight (32 hours over the course of a year between the hours of 10pm and 7am).

Therefore, nighttime overheating risk is considered not significant.

Results Summary

The results demonstrate that owing to the usages in the basement, these will exceed the overheating criteria outlined in CIBSE TM52. The swimming pool is expected to be at a constant temperature of around 32°C year round, with constant gains of around 65 W/m^2 from the water. The gym and living room/cinema both have equipment which will generate heat. As there are limited openable windows to these spaces they are predicted the to exceed the limits of TM52.

It becomes apparent that these spaces are warm, as the adjacent hallway spaces is also anticipated to overheat.

Introducing a mechanical ventilation system, the internal temperature and extent of overheating is considerably reduced. However this is not sufficient to reduce the temperature enough to meet the criteria in the gym or basement hallway. Therefore, in order to meet the criteria mechanical cooling is required in these spaces.

As part of the basement assessment, the living spaces have also been assessed. As there is suitable cross ventilation and openable window areas, the results indicate these spaces can meet the requirements of CIBSE TM59.

SUMMARY AND CONCLUSIONS

This report provides a summary of the overheating risk assessment undertaken on the proposed basement development at 31 Elsworthy Road. As part of the basement assessment, consideration has been given to the existing living spaces and bedrooms.

The assessment has been undertaken using approved IES software. The model carried out in accordance with CISE AM11 incorporated inputs in line with the TM59 methodology guidance, and also based on information provided by the architects and mechanical and electrical consultants. All inputs and assumptions have been outlined within this report.

This overheating assessment demonstrates that the development at 31 Elsworthy Road has demonstrated compliance with:

- Camden Planning Policy on Overheating
- The London Plan Cooling Hierarchy
- Methodology as set out in CIBSE TM52 and complies with the overheating criteria
- Methodology as set out in CIBSE TM59 and complies with the overheating criteria

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

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 new glazing
- Provision of openable windows and doors to all habitable rooms
- Mechanical ventilation and heat recovery in the basement
- Cooling to the basement living room, gym and basement hallway
- Cold radiation from the thermal mass
- Stack ventilation through the risers and stair cores

The building is fully compliant against the mandatory criteria set out in CIBSE TM52 and TM59, only with the introduction of cooling to the basement. The mixture of a passive and mechanical design strategy has been shown to be sufficient to meet the requirements.

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.