



The PES

TM59 Thermal Comfort Analysis
25th July 2022

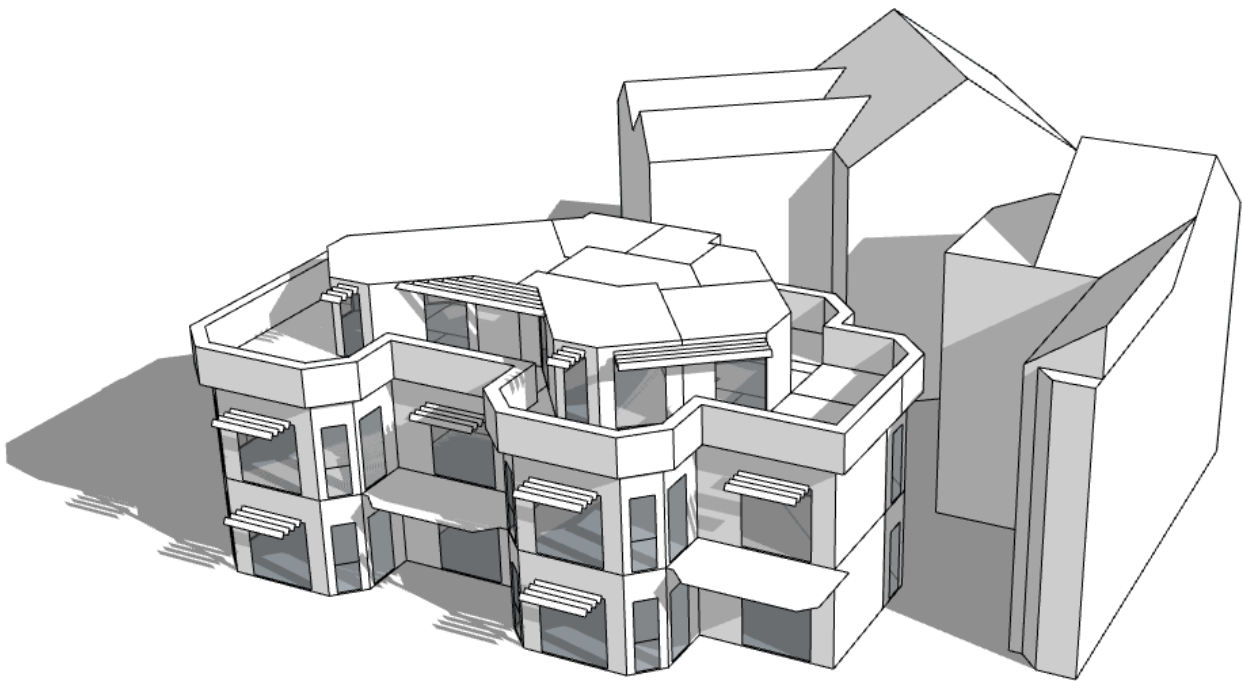
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1.0 Introduction

Proposed Development

Located at the junction of two terraces set at angles to each other on Belmont Avenue, a residential street comprising two storey Victorian houses.

The proposed development at 43 Belmont Avenue comprises of 5 No new C3 residential units on unoccupied land between existing dwellings.

Basis Of analysis

Dynamic Simulation Modelling (DSM) of the building has been carried out to appraise the thermal comfort likely to be experienced based on scheme design and the passive and active measures introduced to help regulate temperatures in the warmer months. The predicted internal temperature was simulated considering all aspects of occupancy, solar gain and predicted internal heat gains based on standardised data and reasonable usage patterns provided by CIBSE TM59. Specific local weather files have been applied to the model in accordance with the guidance within TM49. The development has also been assessed against more extreme weather data for informative purposes only in accordance with GLA guidance – there is no requirement to comply in this area.

2.0 CIBSE Requirements

Software & Assessor compliance

The project is required to formally assess the potential for future overheating.

Dynamic modelling has been undertaken in accordance with CIBSE Guidance using AM11 compliant modelling software: IES Virtual Environment 2022.1.0.0 - Apache.

The analysis has been carried out by Neil Ingham of eb7 Sustainability Ltd, who is suitably qualified as a Level 5 Low Carbon Energy Assessor with CIBSE accreditation – LCEA158593.

CIBSE TM52 Assessment Criteria

The CIBSE Overheating Task Force decided that a new approach to the definition of overheating is necessary, particularly for buildings without mechanical cooling. This will follow the methodology and recommendations of BS EN 15251 (BSI, 2007) to determine whether an existing occupied building can be classed as overheating or a proposed building is in danger of becoming overheated.

The following three criteria, taken together, provide a robust yet balanced assessment of the risk of overheating of buildings in the UK and Europe. A room or building that fails any two of the three criteria is classed as overheating.

(1) The first criterion sets a limit for the number of hours that the operative temperature can exceed the threshold comfort temperature (upper limit of the range of comfort temperature) by 1K or more during the occupied hours of a typical non-heating season (1 May to 30 September).

(2) The second criterion deals with the severity of overheating within any one day, which can be as important as its frequency, the level of which is a function of both temperatures rise and its duration. This criterion sets a daily limit for acceptability.

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

Occupancy patterns, estimated heat loads and the adaptive behaviour of the building occupants are derived from guidance within CIBSE Guide A.

For a building to meet the Adaptive Thermal Comfort criteria, the following conditions must be met:

$$T_{\text{comf}} = 0.33T_{\text{rm}} + 18.8 \text{ and } T_{\text{max}} = T_{\text{comf}} + A_r$$

Hence:

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

The three criteria for overheating are all defined in terms of ΔT , the difference between the actual operative temperature in the room at any time, T_{op} , and T_{max} the limiting maximum acceptable temperature. ΔT is calculated as:

$$\Delta T = T_{op} - T_{max} (^{\circ}\text{C})$$

ΔT is rounded to the nearest degree (i.e., for ΔT between 0.5 and 1.5 the value used is 1°C, for 1.5 to 2.5 the value used is 2°C and so on). The building is deemed to be at risk of overheating if two or more of the following three criteria are exceeded:

- Criteria 1 – Hours of Exceedance (H_e):
 - The number of hours (H_e) that ΔT is greater than or equal to 1°C during the five summer months (May to September) shall not be more than 3%.

An understanding of how often a building is likely to exceed its own comfort range during the summer months. This simple “hours of exceedance” criterion is something that designers are familiar with and provides a good first assessment of acceptability.

- Criteria 2 – Daily Weighted Exceedance (W_e):
 - To allow for the severity of overheating the weighted exceedance (W_e) shall be less than or equal to 6 in any one day where:
 - $W_e = \sum H_e \times W_f = (H_{e1} \times 1) + (H_{e2} \times 2) + (H_{e3} \times 3)$ and
- $W_f = 0$ if $\Delta T \leq 0$, otherwise $W_f = \Delta T$, and H_{ey} = time in hours when $W_f = y$.

This criterion sets an acceptable level for the severity of overheating and is based on Annex F Method B, ‘Degree-hours criteria’ in BS EN 15251 (BSI, 2007). It is the time (hours and part hours) during which the operative temperature exceeds the specified range during the occupied hours, weighted by a factor that is a function depending on by how many degrees the range has been exceeded.

- Criteria 3 – Upper Limit Temperature (T_{upp}):
 - ΔT is not to exceed 4°C.

To set an absolute maximum value for the indoor operative temperature.

The threshold or upper limit temperature is fairly self-explanatory and sets a limit beyond which normal adaptive actions will be insufficient to restore personal comfort.

TM59 Adaptation

The above methodology has been adapted for the assessment of dwellings under the guidance set out in TM59.

For predominately naturally ventilated homes, compliance is based on passing both of the following two criteria:

(a) For living rooms, kitchens 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 per cent of occupied hours. (CIBSE TM52 Criterion 1: Hours of exceedance).

(b) For bedrooms only: to guarantee comfort during the sleeping hours the operative temperature in the bedroom from 10 pm to 7 am shall not exceed 26 °C for more than 1% of annual hours. (Note: 1% of the annual hours between 22:00 and 07:00 for bedrooms is 32 hours, so 33 or more hours above 26 °C will be recorded as a “fail”).

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.”

For predominately mechanically ventilated homes, in which window openings are restricted, the CIBSE fixed temperature test must be followed, i.e., all occupied rooms should not exceed an operative temperature of 26° for more than 3% of the annual occupied hours (CIBSE Guide A (2015a)).

This is a standardised approach to predicting overheating risk for residential building designs using dynamic thermal analysis.

The methodology was developed to allow different designs to be compared with a common approach, based on reasonable assumptions; support design decisions that improve comfort without cooling; and provide consistency across the industry.

It will not however, guarantee that people will always be comfortable in compliant spaces.

Sampling Approach

CIBSE TM59 indicates that a sample of the overall number of dwellings can be used in order to interpret the overheating risk of the overall development.

This should, however, be based on the assessor’s interpretation of the dwellings that are most likely to be at risk of overheating. When trying to identify an appropriate sample, dwellings with the following criteria should be considered:

- | | |
|------------------------|------------------------------|
| A) Large, glazed areas | D) Large, sun-facing windows |
| B) The topmost floor | E) Single aspect |
| C) Less shading | F) Limited opening windows |

Weather Files

TM59 states that developments should refer to the latest CIBSE design summer year (DSY) weather files and be required to pass using the DSY1 file most appropriate to the site location, for the 2020s, high emissions, 50% percentile scenario.

Other files including the more extreme DSY2 and DSY3 files, 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.

Design summer years (DSYs) should always be used for analysis of overheating, and it is good practice to take into account future weather files (see CIBSE TM48: Use of climate change data in building simulation: the CIBSE Future Weather Years (2009), TM49: Design Summer Years for London (2014a) and CIBSE's Probabilistic Climate Profiles (ProCliPs) (2014b) for further advice).

3.0 Methodology

The methodology behind the overheating analysis has been followed in accordance with the latest CIBSE Technical Memorandum 59 - Design methodology for the assessment of overheating risk in homes.

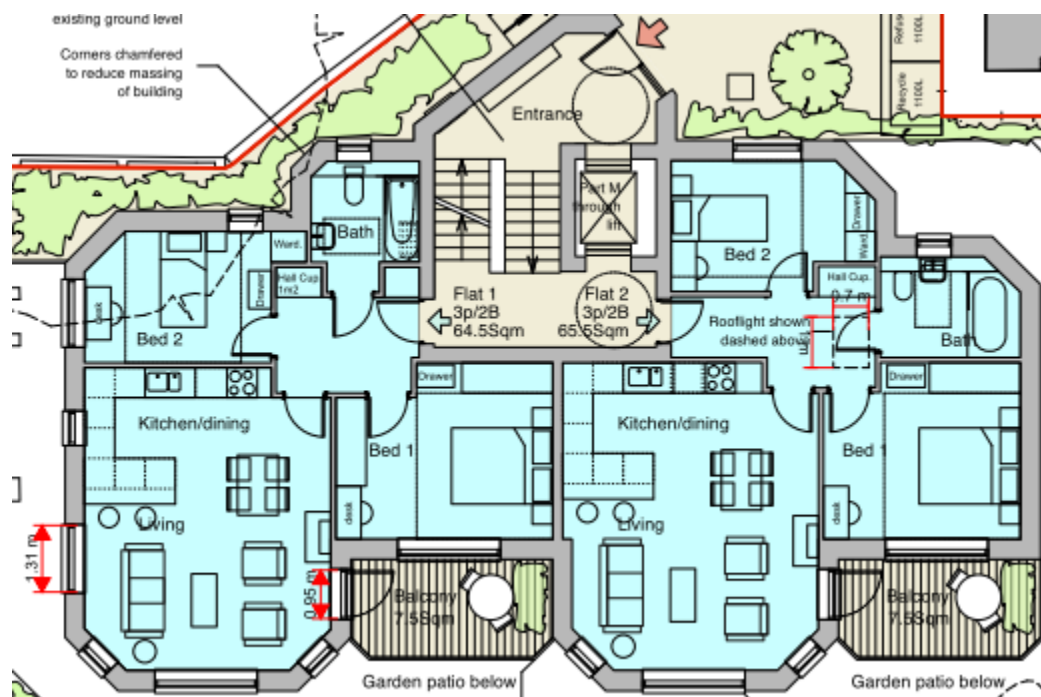
TM59 set the requirements and parameters for occupancy levels, internal gains and the scheduling of window openings.

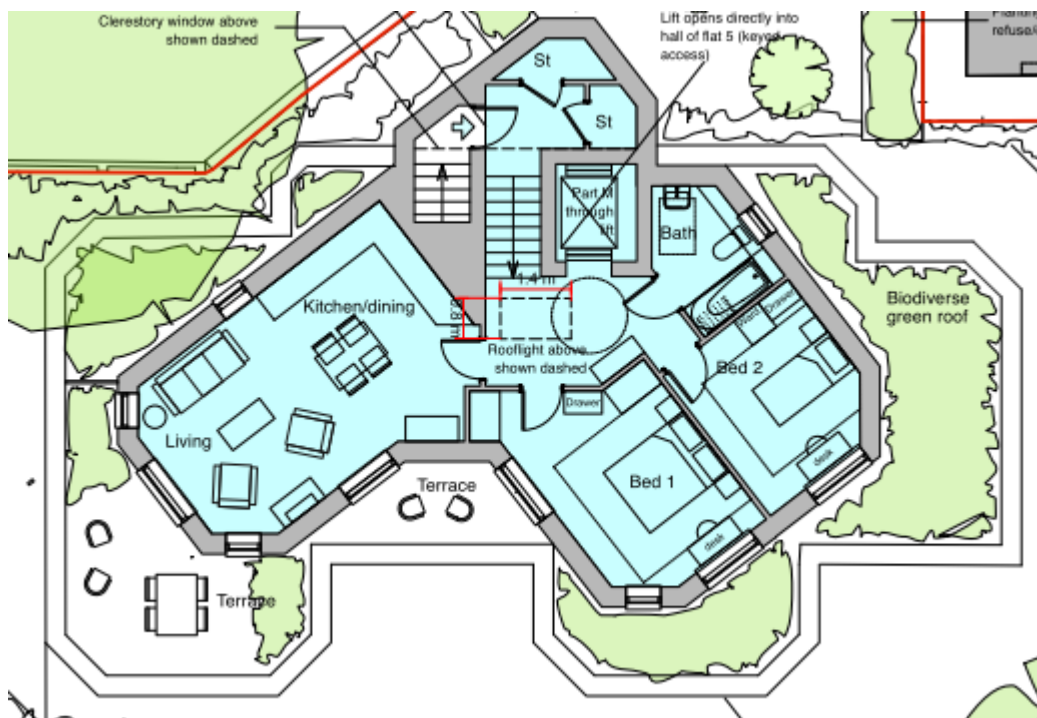
The 3D model is based on the architectural drawings of the entire scheme. All of the proposed flats have been modelled in order to assess accurately the dynamics of the heat and air flow across the adjacent flats and communal zones.

Selected Sample

CIBSE TM59 sets allows a select sample of the most exposed and vulnerable units to be analysed rather than the whole development, however given the relatively small number of units within the proposal, the design team agreed that a sample would not provide sufficient coverage of the development and as such all of the units were modelled and included within the analysis.

The layouts of the ground and first floor have been included below to give an indicative example of the scheme layout:





Weather Files

As per the guidance set out in TM59 and reproduced above in Section 2.0, the DSY1 file most appropriate to the site location, for the 2020s, high emissions, 50% percentile scenario and the more extreme DSY2 and DSY3 files have also been used for informative purposes in line with GLA guidance.

For the proposed development at Belmont Avenue, the following weather files have been used for the assessment:

- London_LHR_DSY1_2020High50.epw
- London_LHR_DSY2_2020High50.epw
- London_LHR_DSY3_2020High50.epw

Construction values

Building Elements	Design Parameters
Roof	0.12 W/m ² k.
Ground Floor	0.14 W/m ² k.
External Wall	0.17 W/m ² k.
Opening	1.2 W/m ² k.
Glazing G Value	0.45

Ventilation Strategy and Flow Rates

The proposed development will employ a natural ventilation strategy - system 1 within AD Part F - with trickle ventilators, purge ventilation via opening windows and wet room extracts.

The default infiltration rate of 0.25ach has been assumed throughout the building.

Window Openings

The opening of windows for purge ventilation is a key aspect of mitigation against the risk of overheating. The open areas were modelled as per the architectural drawings and are separately controlled to be open both when the internal dry-bulb temperature exceeds 22° and the room is occupied.

The types of windows included in the assessment are as follows:

Opening Type	Opening Area %	Max Opening Angle°	Free Area % of Gross
Side Hung	90	75	88.55
Patio Door	90	90	92.90

CIBSE TM59 states that patio doors must be closed throughout the night for security reasons, unless there is a mechanism for the doors to be “locked open” as such, the design team have incorporated this into the design with the use of “tilt ‘n’ turn” doors which can securely open as bottom hung windows throughout the night to aid in purge ventilation.

CIBSE profiles

Thermal templates have been assigned to all of the zones that have been included in the model. These are templates which contain data for a variety of internal gains, occupancy profiles and air exchanges. The data set in these profiles is strictly in accordance with the guidance given in CIBSE TM59 and CIBSE Guide A and were assigned as per the appropriate room type in line with TM59.

The data contained in the thermal templates is set out below:

Room Type	Occupancy	Lighting	Equipment	Infiltration	Auxiliary
2 Bed LKD	2 People	2 W/m ²	450W	0.25 ach	N/A
Single Bed	1 Person	2 W/m ²	80W	0.25 ach	N/A
Double Bed	2 People	2 W/m ²	80W	0.25 ach	N/A

Communal Spaces

CIBSE TM59 guidance states that if a development has a HVAC system that provides space and water heating via a community heating system, the hot water will likely be distributed through ceiling voids in corridors and other common spaces. Although the pipework should be well insulated, given that it is constantly emitting heat, it can cause an increase in temperature within these spaces. Therefore, the communal corridor on the top floor of the development has been included within the analysis.

The assessment has taken into account the heating pipework distribution gains on the communal side of the HIU as well as losses from the HIU itself.

As per CIBSE TM59 the losses included in the analysis were taken from Table 5 of the domestic building services compliance guide 2013. Based on the assumption of 22mm pipework the maximum heat loss per metre run of pipe was modelled at 9.12w/m.

The overheating test for corridors is to be based on the number of annual hours for which an operative temperature of 28°C is exceeded.

Although there is no mandatory target for the communal corridors to meet, if an operative temperature of 28°C is exceeded for more than 3% of the total annual hours then this should be identified as a significant risk.

The results are produced below:

Location	(TM 52/CIBSE) (°C) - % hours > 28°
	> 28.00
LGF – Corridor	0.7
GF – Corridor	0.8

4.0 Results

The results of the analysis are presented in the table below:

	Criteria 1 scores		Criteria 2 scores		Highlight colour of the box	
	<2%		Less than 24 hours		Green	
	2% - 3%		24-32 hours		Amber	
	>3%		33 hours or more		Red	
	DSY 1		DSY 2		DSY 3	
	Criteria 1	Criteria 2	Criteria 1	Criteria 2	Criteria 1	Criteria 2
BedD1 - Flat 1	0.6	22	1.4	41	2.1	60
BedD1 - Flat 2	0.6	21	1.5	39	2.2	57
BedD1 - Flat 3	0.6	25	1.5	42	2.2	61
BedD1 - Flat 4	0.7	22	1.5	39	2.2	57
BedD1 - Flat 5	0.9	14	1.8	21	2.7	33
BedS1 - Flat 1	0.8	23	1.6	31	2.4	59
BedS1 - Flat 2	0.6	19	1.5	31	2.1	45
BedS1 - Flat 3	0.8	24	1.7	32	2.5	60
BedS1 - Flat 4	0.7	18	1.6	29	2.5	41
BedS1 - Flat 5	0.7	25	1.6	43	2.4	63
LKD2 - Flat 1	1.7		3.3		4.6	
LKD2 - Flat 2	1.4		3		4.2	
LKD2 - Flat 3	1.8		3.4		4.8	
LKD2 - Flat 4	1.6		3		4.3	
LKD2 - Flat 5	1.6		3.1		4.7	

5.0 Conclusion

The design team have attempted to balance the often-contradicting philosophies of the energy efficiency of the development with its potential to overheat. CIBSE TM59 has been followed in its intent to find pragmatic solutions to satisfying both areas with the proposed design.

The TM59 methodology is not in place to guarantee the constant thermal comfort of occupants within their residence; but to encourage building forms and façade designs that support better comfort in hot weather.

Mitigation

The design team have implemented passive design measures in order to reduce the impact of rising temperatures and subsequently reduce the risk of overheating within the development.

Sufficient areas of opening windows have been included to allow sufficient levels of purge ventilation as well as local shading in the form of external brise soleil, as well as external roller blinds. As the climate of the United Kingdom moves closer to that of other European countries such as France, Spain and Italy, the industry must be willing to adapt to similar methods of mitigation against the heat. As such, external roller blinds have been incorporated into the design in order to completely shut out the sun during peak times throughout the summer.

Internal blinds have also been included in the design in order to further aid in the reduction of solar gain and radiant heat felt by the occupants during peak exposure. This has been modelled in a way that assumes blinds will be lowered when the surfaces of individual window surfaces receive an excessive amount of solar radiation. This is beyond the required scope of modelling and helps to provide a more accurate assessment of reality.

The results, when assessed against DSY1, clearly show compliance with both criteria of CIBSE TM59.

In line with GLA guidance, the development was also assessed against:

- DSY2 – 2003: a year with a very intense single warm spell.
- DSY3 – 1976: a year with a prolonged period of sustained warmth.

This is for informative purposes only as there is no requirement to achieve compliance against these extreme design years.

However, the results of this modelling do indicate that, should the temperature on the weather file used be realistic, occupants should be aware that during peak summer day's façade openings may need to be closed during the hottest parts of the day to reduce the amount of warm air entering the space.

This is an issue familiar to people who live in warmer climates such as Spain or Italy. Although currently an alien concept to people in the UK, in the future, it is likely to become a much more common concept along with the requirement to close blinds during the day.

Therefore, it is important that these concepts are communicated to future occupants of the building.

It should be noted that the weather file has the largest impact on the overheating results. We cannot control the weather or the behaviour of people in their own homes. Thermal modelling can never fully represent the actions, or inactions of occupants.

Thermal dynamic simulation modelling makes reasonable assumptions that are in reality solely reliant upon the occupants in the room and their perception of comfort - both thermal and acoustic.

If further mitigative measures are required, a solar film could be applied to the external surfaces of the windows in order to significantly reduce solar gain. As a product, solar films are relatively cheap to buy and install and can have a significant impact on the potential for a building to overheat, whilst avoiding other measures that will have an impact on the design of the building.

The design team have deliberately avoided this measure currently, as it is not necessary at the moment to achieve CIBSE TM59 compliance and has a significant detrimental impact on the energy efficiency of the development. As such, it is recommended that careful consideration is taken upon both matters if considering this option in the future.

Given the technological advancement of the previous 20-30 years, it is assumed that there will be far more appropriate and efficient solutions in another 20-30 years, should this matter still be relevant.