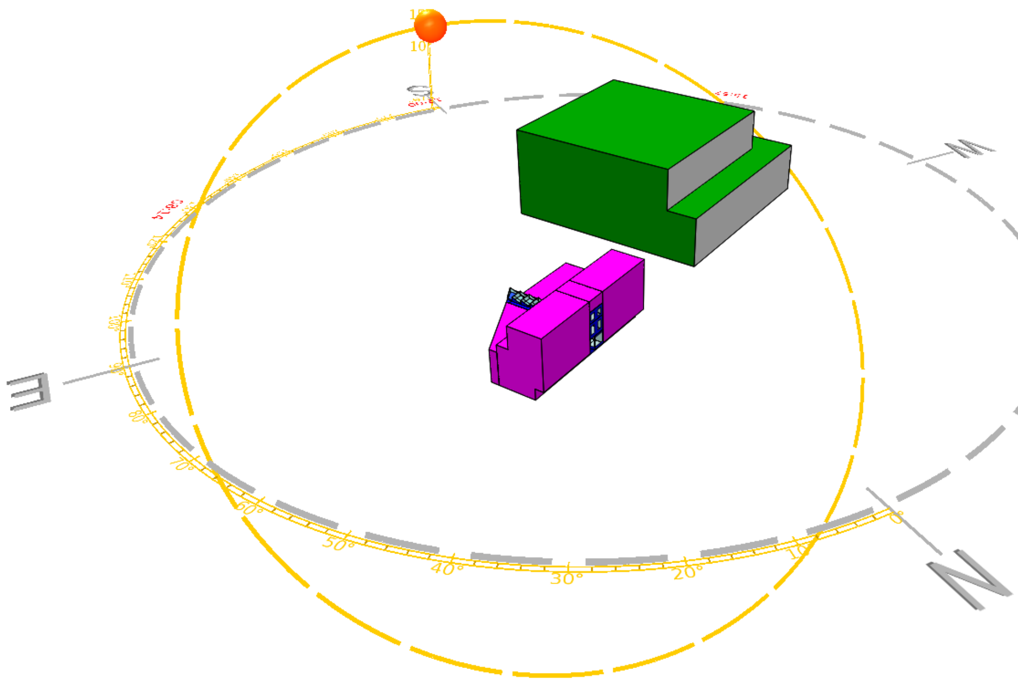
TM52 Thermal Comfort Analysis

47 Theobalds Road
Holborn
WC1X

April 2022

Contents



1.0 Introduction

Proposed Development

This report provides results of the overheating analysis performed by eb7 Sustainability in order to assess performance of the proposed development at 47 Theobalds Road against the CIBSE TM52 defining criteria of thermal comfort.

The existing site at 47 Theobalds Road is currently occupied by a converted Georgian, five-story mid-terrace house comprising a rear two-storey extension and a shop front to Theobalds Road.

The proposed development includes the change of use from A2 (Solicitors) to D1 (Art gallery) as well as internal alterations, and general refurbishment.

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 . 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 2021.4.0.0 - 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:

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

Hence:

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

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:

$$\Delta T = T_{op} - T_{max} \ (°C)$$

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 exceed:

- Criteria 1 – Hours of Exceedance (H_e):

  - The number of hours (He) 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.

Weather File

TM52 states that, in order for the simulation to be applicable in periods when overheating is likely to occur, it is suggested that an appropriate 'design summer year' (DSY) weather file is used in the simulation.

3.0 Methodology

The methodology behind the overheating analysis has been followed in accordance with the latest CIBSE Technical Memorandum 52 – Limiting Overheating.

CIBSE Guide A sets the requirements and parameters for occupancy levels, internal gains and the scheduling of window openings.

The 3D model is based on the architectural drawings.

Weather File

As per the guidance set out in TM52 and reproduced above in Section 2.0, the DSY1 file most appropriate to the site location, for the 2020s, high emissions, 50% percentile scenario.

Construction U values

Building Elements	Design Parameters
Roof	0.18 W/m2K
External Wall	1.60 W/m2K
Opening	1.60 W/m2K
Glazing G Value	0.63

Ventilation Strategy and Flow Rates

The analysis has assumed the use of mechanical supply in order to improve air quality and reduce the risk of overheating within the space. This has been implemented into the analysis at a rate of 10l/s/p.

The infiltration rate that has been used for the assessment is the default 0.25 ach

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 two different types of windows included in the assessment of 47 Theobalds Road are as follows:

Opening Type	**Opening Area %**	**Max Opening Angle°**	**Free Area % of Gross**
Centre tilt roof light	50	30	24.19
Sash window	50	N/A	52.42

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 TM52 and CIBSE Guide A and were assigned as per the appropriate room type in line with TM52.

The data contained in the thermal templates assigned to occupied rooms is set out below:

Room Type	Occupancy	Lighting	Equipment	Infiltration	Auxiliary
Office	14m^2/person	8 W/m^2	8.1 W/m^2	0.25 ach	10 l/s
Gallery	4m^2/person	12 W/m^2	5.4 W/m^2	0.25 ach	10 l/s

4.0 Results

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

Room Name	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing
Gallery - Mezz	6.8	33	5	1 & 2 & 3
Gallery - GF	16.9	53	7	1 & 2 & 3

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 TM52 has been followed in its intent to find pragmatic solutions to satisfying both areas with the proposed design.

The TM52 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.

However, given that the building is existing and set in its form, the design team are limited with the impact they can have vi build form.

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.

Although the fenestration of the building cannot change, the existing design does already benefit from large areas of display glazing to the north to maximise natural light whilst minimising solar gains. The southern aspect has limited glazing and the rooflights at the rear are also angled to minimise the amount of exposure to the southern aspect.

In the previous consented refurbished a wide range of building performance improvements were made including replacement of existing glazing to improve efficiency and thermal qualities - minimising thermal transfer as well as reducing the g value when compared to the original single glazing.

Despite this, the results clearly show that compliance with TM52 is unfeasible given the highly unpredictable occupancy levels; the associated heat gains; and the limits on the design team imposed by the original building.