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OVERHEATING ASSESSMENT (TM52)

9.370 – 330 GRAY'S INN ROAD

20/02/2023 *by CP, reviewed by SG*

All habitable rooms assessed for the proposed non-residential part of the development at 330 Gray's Inn Road, in the London Borough of Camden, were found to meet the CIBSE TM52 overheating risk criteria when including a combination of mechanical ventilation, comfort cooling and solar control techniques within the design. Due to noise constraints on site, windows won't be openable and the non-domestic units were found to require some form of cooling. However, the inclusion of certain measures such as efficient lighting and solar control glazing is recommended to reduce cooling loads.

EXECUTIVE SUMMARY

An overheating analysis has been conducted for the proposed non-residential part of the development at 330 Gray's Inn Road, located in the London Borough of Camden. The purpose of this analysis is to test the proposed building design and recommend design measures to mitigate any potential overheating risks within the occupied zones across the development as well as to future-proof the scheme by taking into account projected increased ambient air temperatures from climate change.

In order to assess the thermal performance of the development, a thermal model was constructed within specialist simulation software. The internal temperature, lighting and ventilation conditions were estimated for all the internal spaces in line with CIBSE guidelines.

With the aim of giving the most robust consideration, performance of the development's summertime performance was compared with CIBSE Technical Memorandum 52 performance recommendations. These are rigorous targets that determine the acceptability of overheating based on the temperature differential between the internal and the external environment (ΔT), considering the frequency of high temperature difference, the severity, and an absolute peak difference beyond which the level of overheating is considered unacceptable. All the non-domestic areas of the development were assessed against CIBSE TM52 criteria which is the most relevant industry standard for evaluating non-domestic spaces.

The spaces were modelled as free running following CIBSE TM52 recommendations. The thermal simulations indicate that the hotel bedroom units are predicted to satisfy the overheating risk criteria through the use of natural ventilation with opening Free Areas of 20%, enhanced g-values for glazing as well as mechanical ventilation. For the Office building the relevant areas are predicted to satisfy the overheating risk criteria through the use of mechanical ventilation, enhanced g-values for glazing as well as comfort cooling.

Due to noise issues on site, the implementation of natural ventilation strategy to the hotel and office building via openable windows was deemed unfeasible. Additional scenarios with closed windows were tested in order to mitigate any risk of overheating. The analysis indicated that for both buildings the TM52 criteria are satisfied through the use of mechanical ventilation, enhanced g-values for glazing as well as comfort cooling.

METHODOLOGY

3D thermal models of the proposed scheme at 330 Gray's Inn Road development have been developed based on the architectural drawings. To better assess the development, two separate models were created. The hotel building and the office were modelled and assessed individually to identify the most appropriate strategy to eliminate overheating based on the CIBSE TM52 criteria.

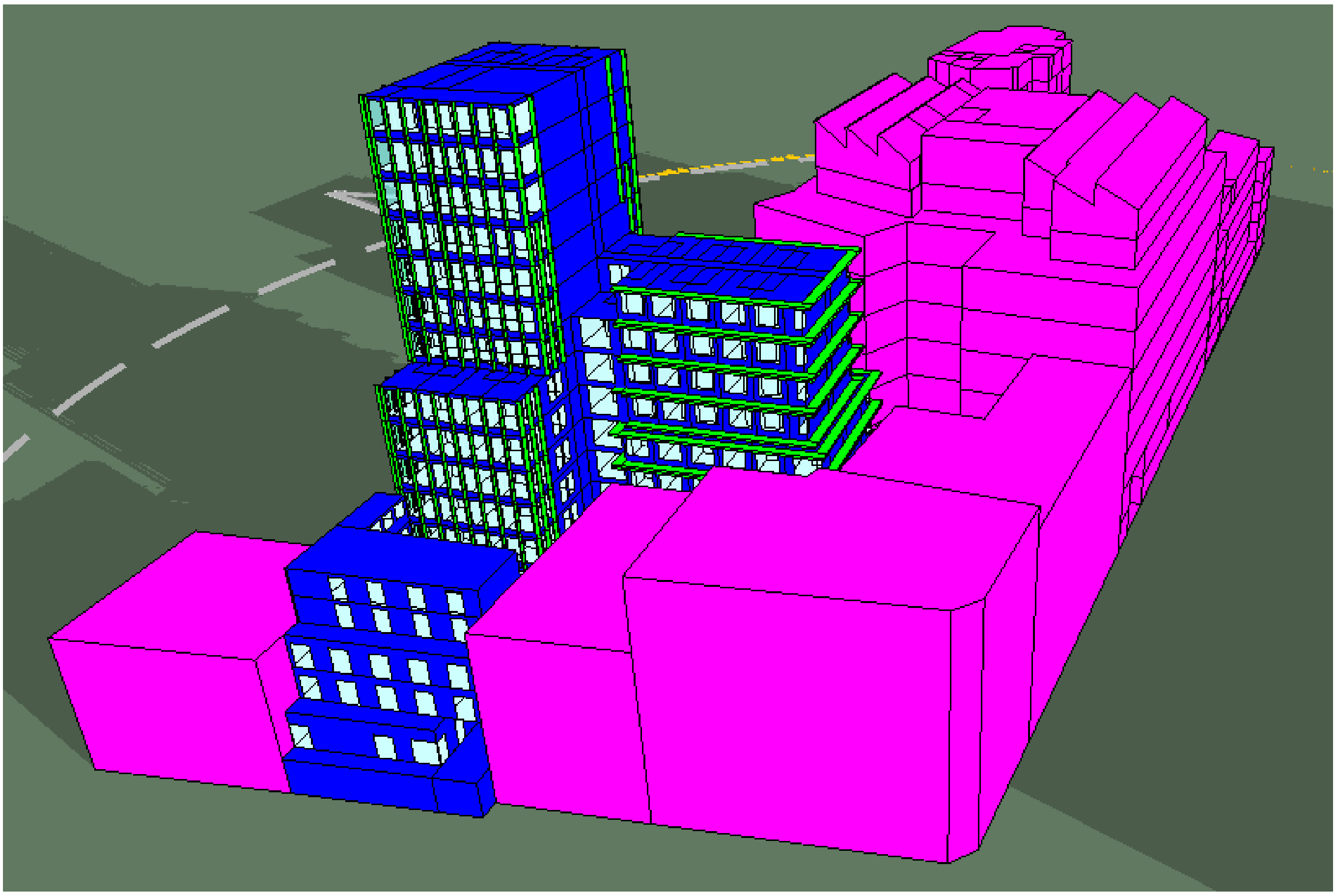

Figure 1: Axonometric view of the dynamic thermal model – Hotel

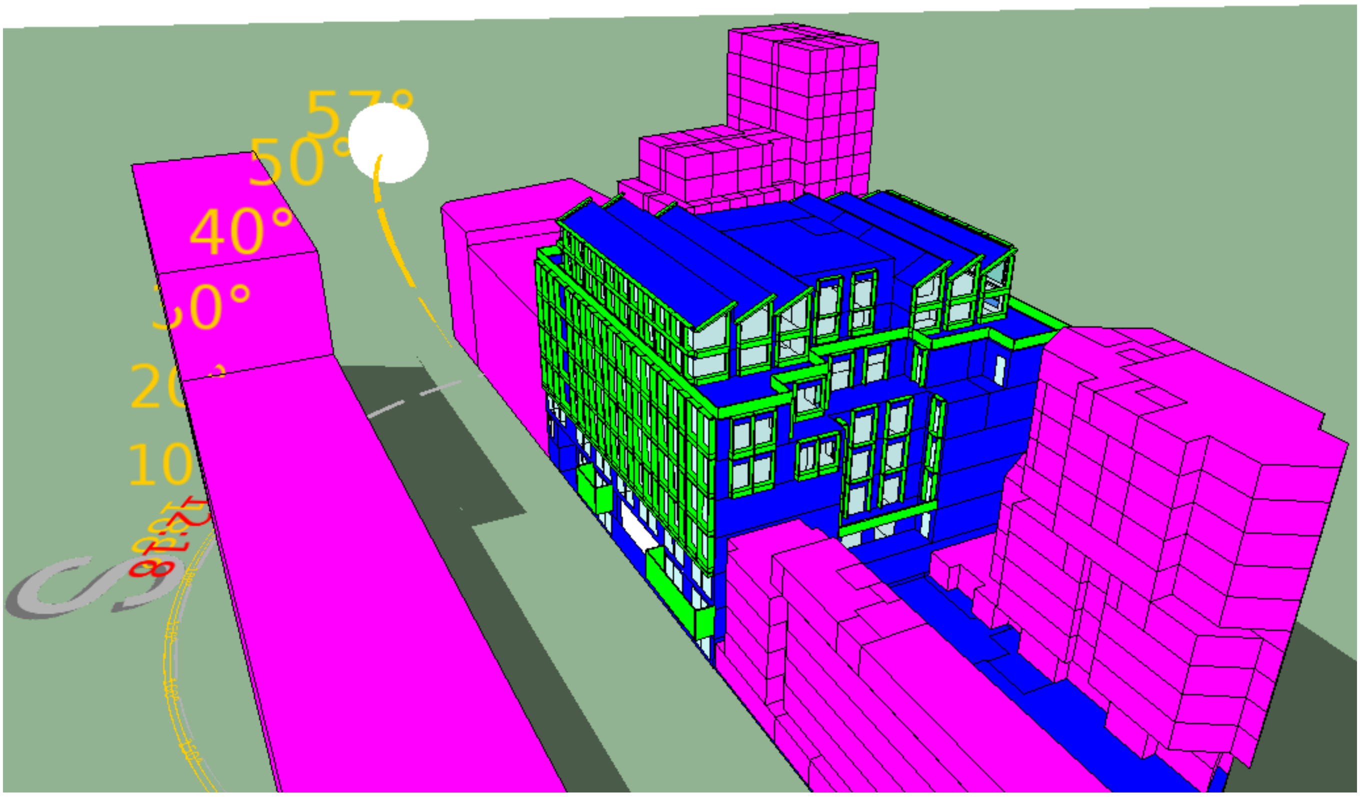

Figure 2: Axonometric view of the dynamic thermal model – Office

The overheating risks of the spaces were assessed for current and future climate scenarios. Following the methodology set out in CIBSE TM49 Design Summer Years for London, the following three years were selected to form the set of probabilistic design summer years for the future weather scenarios:

- 2020 (DSY1-High Emissions 50 Percentile)
- 2020 (DSY2-High Emissions 50 Percentile)
- 2020 (DSY3-High Emissions 50 Percentile)

The first of these years, 2020 (DSY1-High Emissions 50 Percentile) represents a moderately warm summer, as is interpreted in current CIBSE guidance. The years 2020 (DSY2-High Emissions 50 Percentile) and 2020 (DSY3-High Emissions 50 Percentile) were chosen as more extreme years with different types of summer: the former has a more intense single warm spell, whereas the latter represents a year with a long period of persistent warmth.

The development has been modelled using dynamic thermal simulation software, which is fully compliant with CIBSE Applications Manual AM11. The software can compute operative temperatures using CIBSE weather data sets, building fabric specification, window areas and openings, all aspects of solar and internal gains as well as natural ventilation flows within the building. Compliance of the design with the CIBSE TM52 assessment criteria has been sought and recommendations are formulated to future-proof the design for further interventions in the future.

ASSESSMENT CRITERIA

The performance standards set out within CIBSE TM52 have been used to assess the overheating risk within the proposed non-residential parts of the development.

Two of the following three criteria must be met for all habitable areas:

- **Hours of exceedance (H_e):**
  The number of hours (H_e) 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.

- **Daily weighted exceedance (W_e):**
  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 should not be higher than 6 on any given day.

- **Upper Limit Temperature (T_{upp}):**
  To set an absolute maximum value for the indoor operative temperature, the value of ΔT shall not exceed 4°C.

MODELLING ASSUMPTIONS

FABRIC PERFORMANCE

The fabric specification is summarised in the table below:

Table 1: Building fabric assumptions for first iteration.

Element	Specification	
Non-domestic	**U-value [W/m².K]**	
External Walls	0.15	
Ground Floor	0.10	
Roof	0.10	
Non-domestic	**U-value [W/m².K]**	**g-value**
Window	1.2	0.30
All buildings	**Air permeability (@50Pa)**	
	3.0 m³/m².h	

OCCUPANCY

In line with the TM52 requirements; the occupancy patterns for the non-domestic space has been based on the national calculation methodology. These are then programmed into the dynamic software model to calculate the relative occupancy gains for the designated spaces.

Table 2: Occupancy assumptions for each room type assessed.

Area	Predicted occupation pattern
Bedrooms (Hotel)	24 hours a day as per National Calculation Methodology
Kitchen	06:00 – 24:00 as per National Calculation Methodology
Restaurant	07:00 – 23:00 as per National Calculation Methodology
Offices	07:00-19:00 as per National Calculation Methodology
Classrooms	07:00-19:00 as per National Calculation Methodology
Laboratory	07:00-19:00 as per National Calculation Methodology

Area	Predicted occupation pattern
Gym	09:00-21:00 as per National Calculation Methodology

INTERNAL GAINS

Similar to the predicted occupancy hours, the prediction of internal gains (lighting, equipment, and people) for occupied areas is incorporated in line with the guidance set out in national calculation methodology.

Table 3 sets out the input internal gains for the assessed rooms within the buildings; these are then programmed into the dynamic software model to calculate the relative internal gains for the designated space.

Non-occupied spaces such as circulation, bathrooms and storage, were modelled based on typical internal gains incorporating TM52's guidance for factoring in heat gains where appropriate.

Table 3: Internal Gains modelled for each room type assessed.

Area	Predicted Internal Gains		
	Lighting gains	Occupancy gains	Equipment gains
Bedroom	5.20 W/m^2	61 W sensible, 39 W latent	4.05 W/m^2
Kitchen	26.0 W/m^2	63 W sensible, 117 W latent	28.72 W/m^2
Restaurant	10.40 W/m^2	61.7 W sensible, 42.90 W latent	14.72 W/m^2
Office	11.25 W/m^2	73 W sensible, 50 W latent	11.68 W/m^2
Gym	15.60 W/m^2	102 W sensible, 198 W latent	15.00 W/m^2
Classroom	11.25 W/m^2	70 W sensible, 70 W latent	4.74 W/m^2
Laboratory	18.75 W/m^2	97.60 W sensible, 62.40 W latent	8.47 W/m^2

VENTILATION

The proposed ventilation strategy for the development entails the use of Mechanical Ventilation with Heat Recovery (MVHR) for the whole year. Therefore, the estimated auxiliary ventilation flow rates have been included in the model in line with Part F requirements for background ventilation. The ventilation rates used are set out below:

- 13 litres/second for office spaces;
- 13 litres/second for restaurant and kitchen areas;
- 8 litres/second for hotel bedrooms;
- 8 litres/second per person for all other non-domestic spaces.

According to CIBSE TM52 methodology where openable windows are present, habitable spaces can be modelled against the natural ventilation criteria detailed in the previous section of this report.

Both the hotel and the office were modelled as free-running buildings, in order to evaluate overheating risks with passive design measures. Window openings were modelled with different free areas to evaluate the appropriate minimum free area that should be achieved by the design. It is assumed that occupants will open windows when internal dry bulb temperature exceeds 22 °C for occupied hours. The level of exposure and associated coefficients of discharge are set up in accordance to the relative position of each window in relation to the site context and building massing. More details of the different iterations tested can be found in the subsequent section of the report.

RESULTS

This section presents the results summary for each of the tests carried out for the spaces assessed. In terms of hotel areas, 198 habitable spaces were included in the assessment comprising 186 bedrooms and restaurant, kitchen and reception areas. Non-habitable spaces such as bathrooms, storage rooms and circulation areas have been excluded from the assessment; however, their internal gains have been included in the model. Further to the above, the office building spaces were also modelled and the results are presented separately in this section of the report.

Once a baseline simulation is undertaken, a series of potential mitigating strategies are modelled. The purpose of the proposed improvement measures is to minimise the number of rooms that fail the TM52 criteria to the extent feasible, taking into consideration viability, feasibility and other design or design intent constraints.

HOTEL BUILDING

The non-domestic areas of the hotel building were included in the assessment and the results are presented in this subsection in line with CIBSE TM52 methodology, using DSY1, DSY2 and DSY3 weather files (2020s, high emissions, 50% percentile scenario).

The table below shows the number of the modelling iterations undertaken and the sequential improvement measures that are proposed to be incorporated for each iteration.

Table 4: Overheating assessment results for the hotel building.

Design Summer Year DSY1 (2020 High 50s)						
Iteration	**Window F.A.**	**Lighting Bedrooms**	**Auxiliary ventilation**	**Solar control**	**Active cooling**	**No of rooms not meeting TM52 criteria**
1	0%	5.20 W/m^2	13l/s/person	g-value 0.3	No	198 / 198
2	20%	5.20 W/m^2	13l/s/person	g-value 0.3	No	12/ 198
3	0%	5.20 W/m^2	13l/s/person	g-value 0.3	Yes	0/ 198

The following observations can be made from the results:

- The inclusion of some form of natural ventilation combined with solar control glazing enabled most of the spaces to reduce the overheating risk (iteration 2).
- Implementation of comfort cooling to the habitable areas, even with the windows permanently closed, enabled the mitigation of any overheating risk. This iteration is applicable to the hotel building due to the noise-related restrictions that do not allow the building occupants to open any windows.
- Non-domestic spaces have stricter environmental control requirements, so some form of cooling would be recommended to achieve the desirable temperatures, as per iteration 3. Energy efficient lighting and solar control glazing with a maximum g-value of 0.3 would be recommended to reduce overall cooling loads for non-domestic area of the scheme.

The analysis was also undertaken for different design summer year weather files, in line with CIBSE TM52 methodology. As for DSY1, the same observations were made from the results for Design Summer Year 2 and 3, as shown in the following table.

Table 5: Overheating assessment results for the Design Summer Year DSY2 and DSY3.

Design Summer Year DSY2 and DSY3						
Iteration	**Window F.A.**	**Lighting Retail**	**Auxiliary ventilation**	**Solar control**	**Active cooling**	**No of rooms meeting TM52 criteria**
1	0%	5.20 W/m^2	13l/s/person	g-value 0.3	No	198 / 198
2	20%	5.20 W/m^2	13l/s/person	g-value 0.3	No	12/ 198
3	0%	5.20 W/m^2	13l/s/person	g-value 0.3	Yes	0/ 198

Please note these results are for informative purpose only and do not require more measures to be implemented, as compliance with DSY2-High Emissions 50 Percentile and DSY3-High Emissions 50 Percentile is not a strict requirement It should be noted that notable measures have been adopted as far as feasible to reduce risk of overheating for the development under all 3 climate scenarios, taking into account architectural, energy efficiency, daylight and acoustic considerations.

OFFICE BUILDING

The non-domestic areas of the office building were included in the assessment and the results are presented in this subsection in line with CIBSE TM52 methodology, using DSY1, DSY2 and DSY3 weather files.

The table below shows the number of the modelling iterations undertaken and the sequential improvement measures that are proposed to be incorporated for each iteration.

Table 6: Overheating assessment results for the office building.

Design Summer Year DSY1						
Iteration	**Window F.A.**	**Lighting Offices**	**Auxiliary ventilation**	**Solar control**	**Comfort cooling**	**No of rooms not meeting TM52 criteria**
1	0%	11.25 W/m^2	13l/s/person	g-value 0.3	No	28 / 28
2	20%	11.25 W/m^2	13l/s/person	g-value 0.3	No	28 / 28
3	20%	7.5 W/m^2	13l/s/person	g-value 0.3	No	28 / 28
4	20%	7.5 W/m^2	18l/s/person	g-value 0.3	No	28 / 28
5	0%	11.25 W/m^2	13l/s/person	g-value 0.3	Yes	0/ 28

The following observations can be made from the results:

- The inclusion of some form of natural ventilation combined with solar control glazing did not enable the areas to reduce the overheating risk (iteration 2).
- Implementing an increase to the mechanical ventilation supply together with a decrease in the lighting gains (from use of energy efficient lighting) was also not found to enable compliance with the criteria (iteration 3 and 4).
- Implementation of comfort cooling to the habitable areas, even with the windows permanently closed enabled the mitigation of any overheating risk. This iteration is also applicable to the office building due to the noise issues that do not allow the building to open any windows.
- Non-domestic spaces have stricter environmental control requirements, so some form of cooling would be recommended to achieve the desirable temperatures, as per iteration 5. Energy efficient lighting and solar control glazing with a maximum g-value of 0.3 would be recommended to reduce overall cooling loads for non-domestic area of the scheme.

The analysis was also undertaken for different design summer year weather files, in line with CIBSE TM52 methodology. As for DSY1, the same observations were made from the results for Design Summer Year 2 and 3, as shown in the following table.

Table 7: Overheating assessment results for the Design Summer Year DSY2 and DSY3.

Design Summer Year DSY2 and DSY3						
Iteration	**Window F.A.**	**Lighting Retail**	**Auxiliary ventilation**	**Solar control**	**Comfort cooling**	**No of rooms meeting TM52 criteria**
2	20%	11.25 W/m^2	13l/s/person	g-value 0.3	No	28 / 28
3	20%	7.5 W/m^2	13l/s/person	g-value 0.3	No	28 / 28
4	20%	7.5 W/m^2	18l/s/person	g-value 0.3	No	28 / 28
5	0%	11.25 W/m^2	13l/s/person	g-value 0.3	Yes	2/ 28

Please note these results are for informative purpose only and do not require more measures to be implemented, as compliance with DSY2-High Emissions 50 Percentile and DSY3-High Emissions 50 Percentile is not a strict requirement It should be noted that notable measures have been adopted as far as feasible to reduce risk of overheating for the development under all 3 climate scenarios, taking into account architectural, energy efficiency, daylight and acoustic considerations.

CONCLUSIONS AND RECOMMENDATIONS

High external temperature combined with solar gain and internal occupant/equipment gains in the spaces are the main contributors to the rise of internal air temperatures. The internal gains for all the habitable spaces analysed are based on CIBSE TM52 and NCM.

The results show that all spaces are likely to achieve compliance with overheating benchmarks, provided that adequate design measures are taken into account. The analysis indicated that some form of cooling would be required to achieve the desirable internal environment due to stricter conditioning requirements for the non-domestic buildings. The use of solar control glazing and energy efficient lighting is recommended to reduce cooling loads.

The following table summarises the recommendations made in line with the GLA guidance.

Table 8: Summary of recommendations.

Measure	Implementation
Minimise internal heat generation through energy efficient design	
High efficiency lighting installations (LED)	Energy efficient lighting installation recommended for the non-domestic spaces.
LTHW pipework design and installations (location, configuration and insulation) to minimise heat losses.	LTHW pipework running areas are proposed to be highly insulated across the development including jackets for valves and junctions.
Reduce the amount of heat entering the building	
Solar control glazing	Solar control glazing with a maximum g-value of 0.3 for non-domestic spaces.
Use of thermal mass to manage heat within the building	
Concrete slab providing thermal mass	Not offering a significant impact.
Passive ventilation	
Natural ventilation opening	Not applicable due to noise restrictions on site.
Mechanical ventilation	
MVHR with summer boost mode	Mechanical engineer to investigate post-planning the optimum balance between fan energy (by increasing mechanical ventilation) and chiller energy (for providing cooling) to the spaces.
Comfort Cooling	
Air-Condition to main habitable areas	Some form of comfort cooling is recommended for all habitable areas. Mechanical engineer to investigate applicable AC system.