www.xco2.com
mail@xco2.com
+44 (0)20 7700 1000
56 Kingsway Place, Sans Walk
London, EC1R 0LU

OVERHEATING ASSESSMENT

9.110 – 77 AVENUE ROAD

14/08/2019 *by AF, reviewed by TS*

The overheating assessment carried out for the proposed dwelling at 77 Avenue Road has found that the majority of habitable rooms assessed do not comply with the CIBSE TM59 overheating risk criteria for the DSY1 (2020 High 50 Percentile) data set, when including a combination of natural ventilation and solar control techniques within the design. MVHR and air conditioning cooling methods are recommended to future proof the development from climate change.

EXECUTIVE SUMMARY

An overheating analysis has been conducted for the proposed development at 77 Avenue Road, located in the London Borough of Camden. The purpose of this analysis is to test the design of the proposed scheme and ensure the mitigation of any overheating risk within the occupied zones across the development. This will ensure the comfort of the occupants as well as 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, models were constructed within thermal simulation software. The internal temperature, lighting and ventilation conditions were estimated for all the habitable internal spaces.

With the aim of giving the most robust consideration, performance of the various occupied rooms was compared with CIBSE Technical Memorandum 59[1] 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 beyond which the level of overheating is considered unacceptable. Specifically, for bedrooms, the methodology aims to evaluate comfort during the sleeping hours by setting a maximum number of hours for which the operative temperature can exceed 26°C. TM59 is currently the most appropriate assessment methodology for understanding overheating risk in residential properties in the UK.

A representative sample of the space types of the development were selected for the dynamic thermal model, including all habitable rooms including communal spaces and bedrooms as listed below:

Table 1: Breakdown of rooms assessed

Dwelling	Floor	Area (m^2)	Orientation	Significance
Cinema	Sub-Basement	36.9	SW	Multiple / high occupancy at given times. Underground with no natural ventilation possible.

[1] CIBSE TM59:2017 – Design Methodology for the assessment of overheating risk in homes

Dwelling	Floor	Area (m^2)	Orientation	Significance
Games Room	Sub-Basement	35.6	NW	Multiple / high occupancy at given times. Underground with no natural ventilation possible.
Gym	Basement	28.4	NE	Multiple / high occupancy at given times. Underground with no natural ventilation possible. Active area, likely to have a warmer air temperature.
Salon	Basement	17.3	NW	Multiple / high occupancy at given times. Underground with no natural ventilation possible.
Staff Living	Basement	22.5	SW	Multiple / high occupancy at given times.
Staff Bedroom 1	Basement	13.5	SE	Double bedroom.
Staff Bedroom 2	Basement	21.2	NW	Double bedroom.
Formal Dining Room	Ground	35.3	SE	Multiple / high occupancy at given times.
Kitchen	Ground	33.0	SE	Higher temperature expected due to appliances.
Living room	Ground	71.8	NE	Multiple / high occupancy at given times.
Study	Ground	23.2	NW	Living area.
Master suite	First	54.7	NE	Double bedroom.
Bedroom 1	First	29.6	SE	Double bedroom.
Bedroom 2	First	29.8	NW	Double bedroom.
Bedroom 3	Second	25.9	SW	Double bedroom.
Bedroom 4	Second	38.0	NE	Double bedroom.
Bedroom 5	Second	27.3	SW	Double bedroom.
Play Room	Second	35.8	NE	Occupied by children. Active area, likely to have a warmer air temperature.

The thermal simulations indicate the following:

- The proposed dwellings are expected to fail the overheating risk criteria for the probabilistic Design Summer Year (DSY1) weather data for London Weather Centre, a combination of natural ventilation, improved g-values and solar control strategies can provide some relief but did not result in all living areas and bedrooms meeting the required criteria;
- Although not mandatory for compliance, the inclusion of solar control strategies in the corridors adjacent to bedrooms and in the basement or sub-basement levels is recommended to allow for compliance with the overheating risk criteria for corridors and generally improve the resilience of the dwelling to overheating risk.

Based on the method of assessment adopted, XCO2 recommend the design team to consider incorporating the features that allow compliance with the CIBSE TM59 criteria for the London weather data, which include a combination of natural and mechanical ventilation strategies such as air conditioning and MVHR.

METHODOLOGY

3D thermal models of the proposed scheme have been developed based on the planning architectural drawings. To give a fair representation of the residential development, 18 rooms were analysed due to the scheme being a single house, all communal living areas and bedrooms were modelled within the development.

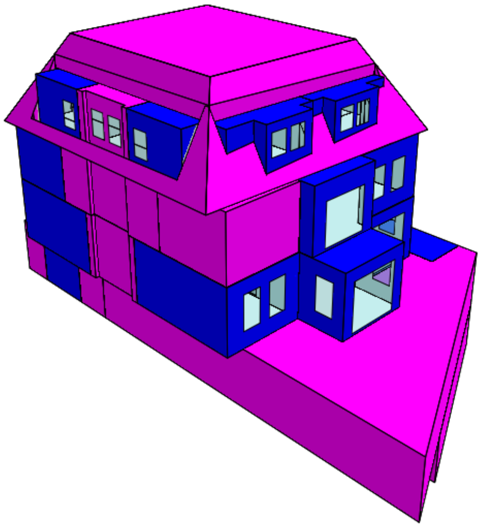

Figure 1: An axonometric view from the West

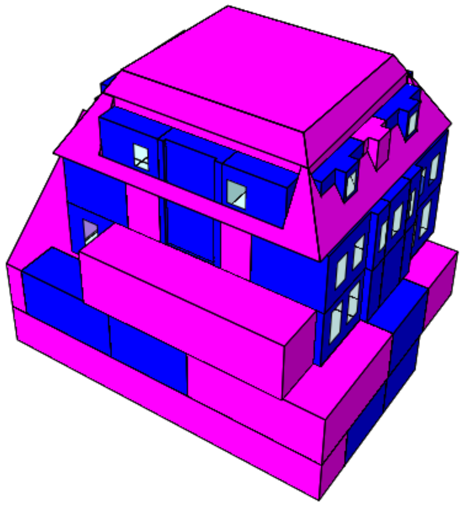

Figure 2: An axonometric view from the East

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 (DSY3High 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 longer period of persistent warmth.

The building 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 buildings. Compliance of the design with the CIBSE TM59 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 TM59 have been used to assess the overheating risk within the proposed development.

Considering the dwelling using natural ventilation as the primary mechanism to mitigate overheating risk, the following two criteria must be met:

1) **For living rooms, kitchens and bedrooms:**
   The number of hours during which ΔT (the difference between operative and threshold comfort temperatures) is greater than or equal to one degree (K), during the period of May to September inclusive, shall not be more than 3 per cent of occupied hours. (CIBSE TM52 Criterion 1: Hours of exceedance).
2) **For bedrooms only:**
   To evaluate 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).

The first criterion is evaluated in terms of the ΔT, which is the difference between the operative temperature T_{op} and the limiting maximum temperature T_{max}, $\Delta T = T_{op}$[2] $- T_{max}$[3]. In order to estimate T_{op}, dynamic thermal modelling is carried out to compute the predicted temperature distribution in the different thermal zones of the building. The maximum acceptable temperature is a function of the outdoor temperature and the design limits, which are shown below. The table details the suggested acceptability in terms of the temperature range of naturally ventilated buildings. For the purpose of the assessment, we have used Category II limits, as recommended within CIBSE TM52.

Table 2: CIBSE TM52 – Suggested applicability of the category and the associated acceptable temperature range for a free running building

Category	Explanation	Acceptable Range (°C)
II	Normal expectation (for new buildings and renovations)	±3

CIBSE TM59 also recommends assessment criteria for overheating risk in corridors based on exceeding an operative temperature of 28°C. Whilst there is no mandatory target, corridors should aim to comply with the following criteria:

1) **For corridors (non-mandatory):**
   If an operative temperature of 28°C is exceeded for more than 3% of total annual hours, this should be flagged as a significant risk within the report.

[2] Operative temperature models the combined effect of convective and radiant heat transfer. It accounts for the combined of the temperature of the air, the temperature of the surfaces and air speed.
[3] T_{max} is the maximum acceptable temperature and is dependent on the outdoor running mean temperature and the building category with each associated acceptability range.

MODELLING ASSUMPTI ONS

FABRIC PERFORMANCE

The specification of the fabric is aligned with the proposals at planning stage as these are outlined in the Energy Statement for the scheme and summarised in Table 3:

Table 3: Building fabric assumptions.

Element	Specification	
	U-value [W/m².K]	
External Walls	0.15	
Ground Floor	0.10	
Roof	0.10	
	U-value [W/m².K]	**g-value**
Window	1.30	Bedrooms, Kitchen, Living rooms and dining rooms = 0.63
	Air permeability (@50Pa)	
	3 $m^3/m^2.h$	

OCCUPANCY

The TM59 methodology specifies the hours during which spaces are anticipated to be occupied and these have been used within the overheating assessment calculations. Table 4 sets out the predicted occupancy patterns for the assessed rooms within the dwellings in line with the TM59 requirements; these are programmed into the dynamic software model to calculate the relative occupancy gains for the designated spaces.

Table 4: Occupancy assumptions for each dwelling room type assessed.

Area	TM59 Predicted occupation pattern
Double Bedroom	24 hours a day
Single Bedroom	24 hours a day
Kitchen/living/dining area	09:00 – 22:00

INTERNAL GAINS

Similar to the predicted occupancy hours, the internal gains (lighting, equipment, people) for occupied areas are incorporated within the model in line with the guidance set out in TM59. Table 5 sets out the various internal gains for the assessed rooms within the dwellings. Non-occupied spaces such as circulation, bathrooms and storage were modelled based on the typical internal gains specified within the TM59 methodology.

Due to the nature of the development as a single house, with 6 double bedrooms (excluding 2 staff bedrooms), thermal templates noted below were implemented with adjusted occupancy settings of 4 to 12 people. The games room, cinema, gym, salon and study were modelled as living areas with adjusted occupancy.

Table 5: Internal Gains modelled for each room type assessed.

Area	Predicted Internal Gains		
	Lighting [W/m²]	People [peak W]	Equipment [peak W]
Double Bedroom	2.0 W/m²	150 W sensible, 110 W latent	80 W
Single Bedroom	2.0 W/m²	75 W sensible, 55 W latent	80 W
2 Bed living area	2.0 W/m²	150 W sensible, 110 W latent	450 W
3 Bed Kitchen	2.0 W/m²	375 W sensible, 275 W latent	450 W
3 Bed living area	2.0 W/m2	375 W sensible, 275 W latent	450 W

Although TM59 only requires the inclusion of corridors in the overheating analysis where community heating pipework runs through them, the circulation areas have been included in the assessment to verify the compliance with TM59 guidance, to ensure the design is robust and overheating risk is mitigated in all areas of the dwelling.

Table 6: Internal Gains modelled for corridor areas.

Area	Predicted Internal Gains		
	Lighting [W/m²]	People [peak W]	Equipment [peak W]
Corridor	2.0 W/m²	-	10 W

VENTILATION

The modelled ventilation strategy for the development entails the use of natural ventilation for the whole year, utilising mechanical extract ventilation in the kitchens and bathrooms. This was done to determine whether MVHR or other alternatives would be required. Therefore, the estimated ventilation flow rates have been included in the model in line with Part F requirements for ventilation to provide a conservative baseline for assessment.

Natural ventilation was modelled using free areas calculated from the window openings detailed in the architectural drawings received from Wolff Architects, drawings 300-334 and received on 16/02/18. An improved g-value was assessed in Type 3 in order to determine the possible impact of an improvement in solar gains. 31 windows were assessed and three window types were calculated, with the following free areas incorporated into the calculations:

- Type 1: All windows to be capable of opening at least 30% unobstructed free area with a g-value of 0.63.
- Type 2: All windows to be capable of opening 30% unobstructed free area with the addition of venetian blinds.
- Type 3: All windows be capable of opening at least 30% unobstructed free area with a g-value of 0.50.

It is assumed that occupants will open windows when internal dry bulb temperature exceeds 22 °C for occupied hours, in line with TM59 guidance. The level of exposure and associated coefficients of discharge are set up in accordance to the relative position of each window in relation to building massing.

Internal doors have been included and assumed to be open during daytime but closed when occupants are sleeping. Doors to the cinema, study and salon have been assumed to be closed due to the nature of the room's use.

RESULTS

This section presents the results summary for each of the tests carried out for the proposed development. In total 18 habitable spaces were included in the assessment specifically the kitchen, 2 living areas, dining room, 8 double bedrooms and 6 other living spaces (gym, games room, cinema, study etc). Non-habitable spaces such as bathrooms, storage rooms and circulation areas have also been included in the assessment model, and their internal gains have been accounted for in the model.

Table 7 shows the modelling iterations undertaken under for London Weather Centre DSY1 High Emissions 50 Percentile weather data, the sequential improvement measures that are proposed to be incorporated for each iteration and the number of rooms that were not found to meet the CIBSE TM59 criteria for each of the modelling iterations.

The purpose of the improvement measures proposed is to minimise the number of rooms that fail the TM59 criteria to the extent possible, taking into consideration viability, feasibility and other design constraints.

Table 7: Overheating assessment results for London Weather Centre DSY1 High Emissions 50 Percentile.

ID	Bedrooms	Other rooms	Solar Control	Bedrooms TM59 night-time 26°C criterion	Bedrooms TM52 Criterion 1	KLD Rooms TM52 Criterion 1	Other Rooms TM52 Criterion 1
	Window opening profile and solar control			No. of rooms not meeting criteria			
1	10%: Open 24h	10%: Open 9am - 10pm	g = 0.63	8/8	2/8	4/4	6/6
2	20%: Open 24h	20%: Open 9am - 10pm	g = 0.63	8/8	2/8	3/4	6/6
3	30%: Open 24h	30%: Open 9am - 10pm	g = 0.63	2/8	2/8	3/4	6/6
4	40%: Open 24h	40%: Open 9am - 10pm	g = 0.63	2/8	2/8	3/4	6/6
5	10%: Open 24h	10%: Open 9am - 10pm	g = 0.63 Venetian blinds	8/8	6/8	4/4	6/6
6	20%: Open 24h	20%: Open 9am - 10pm	g = 0.63 Venetian blinds	8/8	2/8	3/4	6/6
7	30%: Open 24h	30%: Open 9am - 10pm	g = 0.63	3/8	2/8	3/4	6/6
8	40%: Open 24h	40%: Open 9am - 10pm	Venetian blinds g = 0.63	2/8	2/8	3/4	6/6
9	30%: Open 24h	30%: Open 9am - 10pm	g = 0.50	2/8	2/8	3/4	5/6

The following observations can be made from the results:

- All communal activity rooms (other rooms) such as the gym, study and cinema were found to fail the overheating Criterion 1. Four of the rooms that failed (the gym, salon, cinema and games room) are located in basement areas and are windowless;
- At least 75% of KLD rooms failed Criterion 1 for all runs conducted, even at a maximum possible window opening of 40%;
- Between 25%-75% of bedrooms fail Criterion 1 for the opening range of 10-40%;
- For windows open less than 30%, all rooms fail the TM59 night time criteria; and
- Improving the g-value by 20% (from 0.63 to 0.50) showed minimal improvement in overheating performance.

Finally, the last iteration was applied with DSY2 and DSY3 weather files, which are more severe weather types. The results for these years are shown in the table below.

Table 8: Overheating assessment results for the London Weather Centre 2020 High Emissions 50 Percentile

Future Weather File for London Weather Centre					
Iteration	Glazing g-value	Glazing percentage	Solar Control	No. of rooms not meeting criteria	
				2003 (DSY2)	1976 (DSY3)
1	0.63 all windows	35%	No Blinds	18/18	18/18 (2 Bedrooms pass Criterion 1, but not the night time criteria)
2	0.5 all windows	35%	No Blinds	18/18	18/18 (2 Bedrooms pass Criterion 1, but not the night time criteria)

Please note these results are for informative purpose only and do not require more measures to be implemented, as compliance with DSY2 and DSY3 is not a strict requirement for TM59.

CONCLUSIONS AND RECOMMENDATIONS

The following conclusions can be drawn;

- All areas at basement and sub-basement levels fail Criterion 1;
- A 20% improvement of the g-value resulted in only one additional non-bedroom passing Criterion 1;
- The incorporation of venetian blinds did not decrease the amount of rooms that failed the overheating criteria;
- For windows open less than 30%, all bedrooms fail the night time hours above 26°C criterion; and
- Calculated maximum opening area was found to be 35%, with 25% of bedroom windows failing the night time hours above 26°C criterion.

The results show that a number of occupied areas fail compliance with CIBSE TM59 overheating risk criteria for London Weather Centre, London DSY1 weather data. Design considerations and further mitigation such as MVHR systems with a combination of air conditioning should be considered.

The results detailed on the previous page demonstrate that solar control strategies are essential, but not sufficient for compliance with the overheating risk criteria.

The table below summarises the design recommendations that contribute to reducing overheating risk.

Table 9: Summary of recommendations for the proposed development.

Measure	Implementation
Minimise internal heat generation through energy efficient design	
High efficiency lighting installations (LED)	All residential spaces
LTHW pipework design and installations (location, configuration and insulation) to minimise heat losses.	LTHW pipework running in corridors and circulation areas to be highly insulated across the whole length; including jackets for valves and junctions. Primary distribution within the building will be vertical rather than horizontal to reduce pipe lengths.
Reduce the amount of heat entering the building	
External shade from balconies and overhangs	Slight recesses included within windows across site and balconies where present
Solar control glazing (g value <=0.63)	Option for applying solar control glazing to achieve g-value = 0.50 or less for nominal affect, this is not considered a high value recommendation due to the limited improvement achieved.
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	Openable windows allowing at least 30% free area for natural ventilation. Ground floor windows to allow for the greatest feasible free-area as is deemed feasible (Secure by Design compliant). The results of the overheating analysis indicate that natural ventilation is insufficient. MVHR and air conditioning is recommended for living spaces and bedrooms in order to achieve the required TM59 criteria.