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OVERHEATING ASSESSMENT

9.611 – 2-8 DANSON ROAD

17/10/2020 *by AC, reviewed by KM*

EXECUTIVE SUMMARY

An overheating analysis has been conducted for the bedrooms of the proposed development at 2-8 Danson Road, located in the London Borough of Bexley. The purpose of this analysis is to test the existing design and ensure the mitigation of any overheating risk within the occupied rooms. 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.

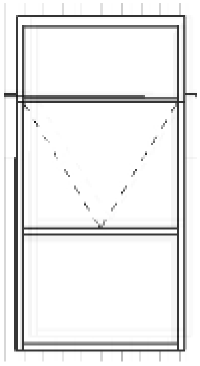
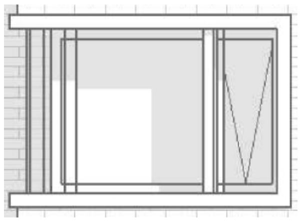
In order to assess the thermal performance of the development, models were constructed within a thermal simulation software. The internal temperature, lighting and ventilation conditions were estimated for all the internal spaces.

With the aim of giving the most robust consideration, performance of the various occupied rooms 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.

A sample of bedrooms, considered to be the worst-case scenario, were considered for the dynamic thermal model. The thermal simulations indicated that the use of natural ventilation with opening Free Areas of 30% as well as solar control glazing with g-value of 0.5 and internal blinds enabled the bedrooms to pass overheating risk criteria under DSY1 2020 high emissions 50 percentile weather file. It is recommended that internal blinds are attached to the window frame so that they don't interfere with the air flow required for natural ventilation.

This indicates that natural ventilation would be possible for the bedrooms based on the method of assessment adopted but if strict control of internal environment is required, then some form of cooling would need to be provided.

On the following page, the table provides summary of the main window sizes and types identified for bedrooms within the scheme. Based on the architect's elevations (received on 09/11/2020 from Ryder), each window type identified throughout the scheme is able to comply with the minimum unobstructed free areas recommended (30%).

	g-value	Minimum Unobstructed Free Area Recommended	Reducing Overheating Further
	0.50	30%	Do not include bottom unopenable pane.
	0.50	30%	Both panes openable.

METHODOLOGY

3D thermal models of the proposed scheme at 2-8 Danson Road have been developed based on the planning architectural drawings received (November, 2020). To give a fair representation of the development, 8 habitable rooms were analysed to provide a representative sample of the space within the development. The rooms were selected based on type, size, location in the building, solar exposure, glazing areas and shading elements.

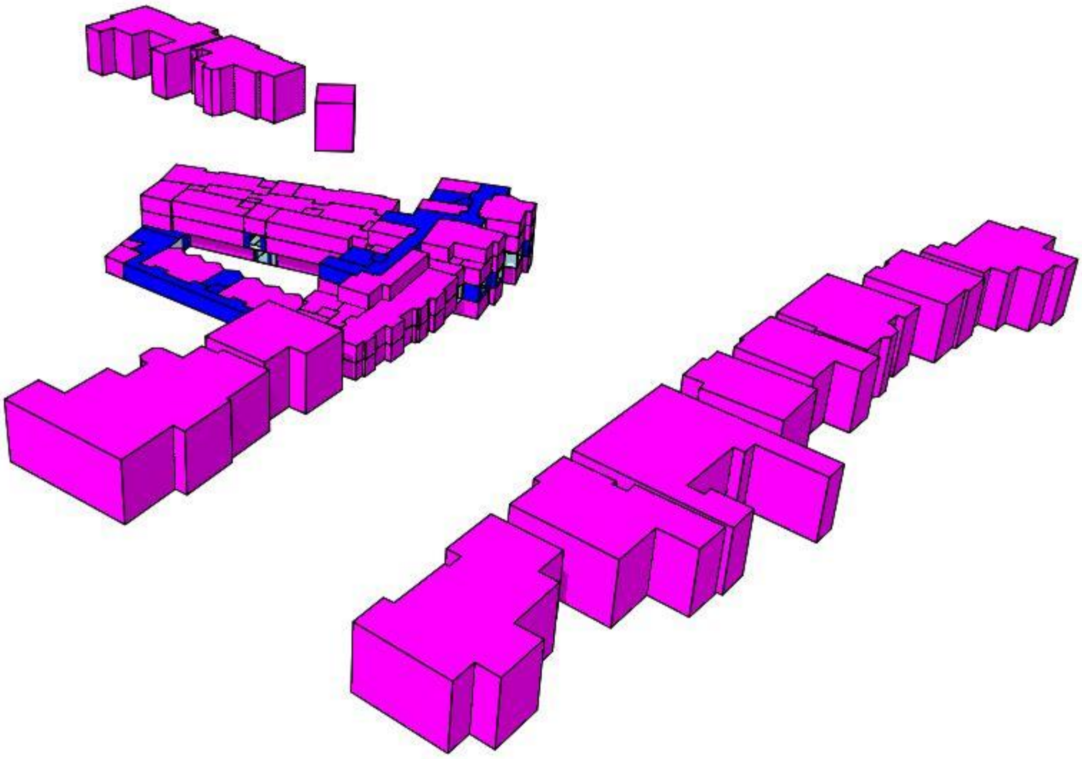


Figure 1: South-east axonometric view of 2-8 Danson Road

The overheating risks of the spaces were assessed for current and future climate scenarios as a worst-case approach. Following the methodology set out in CIBSE TM49 Design Summer Years for London, which was published after CIBSE TM52 guidance, the following three years were selected to form the set of probabilistic design summer years for the future weather scenarios:

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

The first of these years, 2020 (DSY1-High 50 Percentile) represents a moderately warm summer, as is interpreted in current CIBSE guidance. The years 2020 (DSY2-High 50 Percentile) and 2020 (DSY3-High 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 buildings have 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 opening, all aspects of solar and internal gains as well as natural ventilation flows within buildings. Compliance of the design with the CIBSE TM52 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 development.

At least two of the following criteria must be met:

1) **Hours of exceedance (H_e): H_e<3% of occupied hours**
   The first criterion sets a limit for the number of hours that the operative temperature can exceed the threshold comfort temperature by 1°C or more during the occupied hours of a typical non-heating season (1 May to 30 September).
2) **Daily weighted exceedance (W_e): W_e<6**
   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 temperature rise and duration. This criterion sets a daily limit for acceptability.
3) **Upper limit temperature (T_{upp}): T_{op}[1] - T_{max}[2] <4°C**
   The third criterion sets an absolute maximum daily temperature for a room, beyond which the level of overheating is unacceptable.

All the criteria are evaluated in terms of the ΔT, which is the difference between the operative temperature T_{op} and the limiting maximum temperature T_{max}. $\Delta T = T_{op} - T_{max}$.

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.

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

[1] 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.
[2] 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 ASSUMPTIONS

FABRIC PERFORMANCE

The specification of the fabric is summarised in the table below:

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	1.3	0.63
	Air permeability (@50Pa)	
	3.0 $m^3/m^2.h$	

OCCUPANCY

CIBSE does not specify the exact hours that the spaces are occupied, and as a result the BRE estimates that are inherited for the National Calculation Methodology (NCM) are often used as a basis for the prediction of the occupied hours of different areas of occupation in overheating assessment calculations.

Table 3 set out the predicted occupancy patterns for the assessed rooms; these are then programmed into the dynamic software model to calculate the relative occupancy gains for the designated space.

Table 3: Occupancy assumptions for bedrooms

Area	NCM Predicted occupation pattern
Bedroom	As per National Calculation Methodology

INTERNAL GAINS

Similarly to occupancy hours, the BRE estimates that are inherited for the National Calculation Methodology (NCM) are often used as a basis for the prediction of internal gains (lighting, equipment, people), however, when information is available that is specific to the project with regards to internal gains, this is incorporated into the model to give a more accurate representation of the conditions expected in the assessed rooms. In this case, people and equipment gains have been assumed as per the NCM predictions and lighting gains have been based on current assumptions for the lighting specification for the development.

Table 4 sets out the assumed internal gains for the assessed bedrooms; these are then programmed into the dynamic software model to calculate the relative internal gains for the designated space.

Table 4: Internal Gains assumptions for bedrooms

Area	Predicted Internal Gains		
	Lighting	**People**	**Equipment**
Bedroom	6.5 W/m^2	9.55 m^2/person at 100 W/person sensible gain and 40 W/person latent gain	3 W/m^2

RESULTS

This section presents the results summary for each of the tests carried out for the bedrooms.

The results are presented in this subsection in line with CIBSE TM52 methodology, using DSY1, DSY2 and DSY3 2020 high emissions 50 percentile 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. The number of rooms that were found to meet at least 2 of the CIBSE TM52 criteria for each of the modelling iterations are also shown in the last column. The following observations can be made from the results:

- The use of natural ventilation alone (iterations 1-2) is not sufficient to mitigate the overheating risk in the bedrooms.
- The use of natural ventilation with free areas up to 30% combined with solar control glazing (g-value of 0.5) was found to have significant effect, resulting in 7 of 8 rooms meeting TM52 criteria (iteration 3).
- The use of natural ventilation (F.A 30%) together with solar control glazing (g-value of 0.5 and internal blinds fixed to the window frame) enabled compliance with TM52 criteria for the south-west facing bedroom located on the top floor (iteration 4).

Table 5: Overheating assessment results for the bedrooms with DSY1

Design Summer Year DSY1 2020 high emissions 50pct				
Iteration	**Window F.A. (occupied hours)**	**Glazing g-value**	**Solar shading**	**No. of spaces meeting 2/3 of TM52 criteria**
1	20%	0.63	-	3 of 8
2	30%	0.63	-	4 of 8
3	30%	0.5	-	7 of 8
4	30%	0.5	Venetian blinds fixed to window panes	8 of 8

The following table shows the results for the DSY2 and DSY3 weather files (2020 High Emissions 50 percentile).

Table 6: Overheating assessment results for the London Weather Centre with DSY2 and DSY3

Design Summer Years DSY2 and DSY3 high emissions 50pct						
Iteration	**Aperture F.A.**	**Glazing g-value**	**Thermal mass**	**Solar shading**	**No. of rooms meeting 2/3 of criteria**	
					DSY2	**DSY3**
5	30%	0.5	-	-	3 of 8	4 of 8
6	30%	0.5	Exposed ceiling	-	3 of 8	4 of 8

The results for Design Summer Year 2 and 3 show that none of the spaces meet TM52 criteria using standard mitigation techniques that suffice for moderately warm summer weather year in the 2020's (2011-2040 period) as presented in iteration 4. The combination of free areas for natural ventilation (30%), reduced g-value (0.5) for glazing, and exposed thermal mass would still not be sufficient to mitigate overheating risks as shown in iterations 5 and 6. This is primarily because these DSY2 and DSY3 weather files are particularly onerous to enable the rooms to achieve compliance with overheating benchmarks. Non-domestic spaces have stricter environmental control requirements, so some form of cooling would be recommended to achieve the desirable temperatures under more extreme summer periods and intense heat waves.

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 analysis for DSY1 showed that the inclusion of openings with Free Areas of 30% and solar control glazing with g-value of 0.5 would enable all bedrooms to achieve compliance with the overheating benchmarks.

The results for DSY2 and DSY3 indicated that some form of cooling would be required for the spaces to achieve the desirable internal environment during more onerous heat waves.

Table 7: Summary of recommendations

Measure	Implementation
Minimise internal heat generation through energy efficient design	
High efficiency lighting installations (e.g. LED)	Energy efficient lighting installation recommended for all 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 four residential blocks will be vertical rather than horizontal to reduce pipe lengths.
Reduce the amount of heat entering the building	
Solar control glazing	Application of double-glazing with a maximum g-value of 0.4 for all windows exposed to solar radiation.
Use of thermal mass to manage heat within the building	
Concrete slab providing thermal mass	Exposed thermal mass in the ceiling could help reduce some peak summer temperatures.
Passive ventilation	
Natural ventilation opening	Openable windows with 30% free area for natural ventilation.