153 King Henrys Road, London

Cooling Hierarchy Statement and Thermal Comfort Model

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Melin Consultants are accredited to provide a range of calculation, assessment and testing services. They are members of CIBSE Low Carbon Consultants.

Melin Consultants fully check all work prior to completion and a robust audit trail exists to demonstrate accountability.

All information within this document is based on evidence provided in the form of drawings and specifications.

CPD (Continual Professional Development) records are kept and all technical staff are required to complete a minimum 20 hours per year in training activities.

Low Carbon Consultants have the expertise and necessary qualifications to offer advice in a professional capacity on matters relating to Part L of the Building Regulations and sustainability within the construction sector.

This document contains the following information:

- Cooling Hierarchy Statement and Thermal Comfort Model

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Contents

1. Executive Summary

Melin Consultants were appointed to carry out a Cooling Hierarchy Statement and a Dynamic Thermal Comfort Model on 153 King Henrys Road, London. Melin Consultants are CIBSE Low Carbon Consultants and are accredited to carry out Level 3, 4 and 5 commercial assessments as well as residential SAP calculations through Stroma software.

The purpose of the report was to analyse whether 153 King Henrys Road, London has comfort levels in accordance with the criteria set out in CIBSE TM59, to assess the space against the Cooling Hierarchy criteria and to ascertain whether an active cooling system would be required within the space.

A detailed thermal model has been carried out in line with CIBSE AM11 and CIBSE TM59 criteria. IES dynamic simulation software was used to carry out the calculations. The application tools used were Macroflo, Suncast and Apache. Macroflo was used to model the ventilation strategy for the building, Suncast was used to model the solar gains for the building and Apache was used to calculate the internal air temperatures and mean radiant temperatures for the occupied areas.

To calculate the air temperature and radiant temperature of the assessed rooms, the sensible loads and latent gains have been used as set out in CIBSE TM59. These have been outlined in Appendix A.

2. Introduction

The purpose of this report is to consider whether air conditioning units would be suitable at 153 King Henrys Road, London based on the Camden Local Plan Policy CC2 and, the Cooling Hierarchy. To determine whether active cooling units would be feasible all the items in the Cooling Hierarchy must be explored and it must also be demonstrated, using a Dynamic Thermal Model that there is an overheating risk in the space.

2.1 Assessment Criteria

Camden Local Plan (2017) Policy CC2

All new developments will be expected to submit a statement demonstrating how the London Plan's 'cooling hierarchy' has informed the building design. Any development that is likely to be at risk of overheating (for example due to large expanses of south or south west facing glazing) will be required to complete dynamic thermal modelling to demonstrate that any risk of overheating has been mitigated.

Active cooling (air conditioning) will only be permitted where dynamic thermal modelling demonstrates there is a clear need for it after all the preferred measures are incorporated in line with the cooling hierarchy.

The cooling hierarchy includes:

- Minimise internal heat generation through energy efficient design;
- Reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration, insulation and green roofs and walls;
- Manage the heat within the building through exposed internal thermal mass and high ceilings;
- Passive ventilation;
- Mechanical ventilation; and
- Active cooling

CIBSE TM59

The CIBSE TM59 overheating metric is aimed specifically at residential buildings. There are 2 main criterion that need to be achieved to confirm a building will be comfortable for it's occupants. Criterion 1 is for Bedrooms, Living Rooms and Kitchens, Criteria 2 are for bedrooms only. The criterion are outlined below.

- Criterion 1 (hours of exceedance) – *TM59 guide section 4.2 Criterion (a):* - kitchens, living rooms and bedrooms: the number of hours during which ΔT (T_{op}–T_{max}) is greater than or equal to one degree (K) during the period May to September inclusive shall not be more than 3 percent of occupied hours. This is the same as Criterion 1: Hours of exceedance for CIBSE TM52.
- Criterion 2 - *TM59 guide section 4.2 Criterion (b) - bedrooms:* T_{op} in bedrooms from 10pm to 7am shall not exceed 26°C for more than 1% of annual hours. Based on occupied hours of 9 hours per night for 365 days a year, 1% of occupied hours is a total of 33 hours per year.

Bedrooms must pass both criteria above

T_{op} refers to the Operative temperature of the rooms and is calculated using IES software.

2.2 Dynamic Thermal Model Input Data

The following input data has been used to carry out the calculations:

2.2.1 U values:

- Walls – 3.12W/m^{2}K
- Roof - 3.38W/m^{2}K
- Floor – 0.79W/m^{2}K
- Doors – 3.00W/m^{2}K
- Windows – 4.83W/m^{2}K with a default g value of 0.82 throughout

2.2.2 Building Services

To calculate the temperatures within the building, a default system of gas boilers have been used for the Thermal Comfort model, except for the assessment where air conditioning has been trialled.

2.2.3 Ventilation Strategy

A natural ventilation strategy has been used in the space. Windows have been modelled based on drawing number 115 P1. All windows have been modelled as openable, these have been modelled based on Sash windows with a total openable area of 25%. The windows have been modelled with opening hours of 6pm and 11pm, when the temperature in the rooms is above 18°C.

Due to security reasons, any doors have been modelled as non-openable.

2.2.4 Weather data

The London DSY 2020 High 50th percentile weather data file has been used.

3. London Plan Cooling Hierarchy

The Cooling Hierarchy states that active cooling systems must be the last resort. To reduce the need for active cooling, the hierarchy must be explored to reduce the need for cooling. The Cooling Hierarchy is outlined below:

- Minimise internal heat generation through energy efficient design;
- Reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration, insulation and green roofs and walls;
- Manage the heat within the building through exposed internal thermal mass and high ceilings;
- Passive ventilation;
- Mechanical ventilation; and
- Active cooling

The hierarchy, in relation to the development is explored below.

3.1 Minimise Heat Generation Through Energy Efficient Design

As the development is an existing dwelling, the potential to limit heat generation within the dwelling is limited as the layout of the space has already been determined, slight change to the layout may be conceivable, however, this would not likely change the results of the calculations.

3.2 Reduce the Amount of Heat Entering a Building in Summer

As the development is an existing building, the orientation and amount of glazing within the space is already set. The glazing to the front of the dwelling is orientated North, with the glazing to the rear orientated South. Based on the location of the dwelling, it is likely that planning permission would be required for any external shading devices. Internal shading, such as blinds, could be used within the space, although these do not limit the heat entering the space as effectively as external shading systems, such as Brise Soleil.

Planning permission would also be required for green roofs and green walls and based on the location; it may be unlikely that permission would be granted for these measures.

3.3 Manage the Heat Within the Building

Based on the presumed age of the building, it is likely that the assessed space has a high thermal mass, which may help to limit the internal temperature. However, it is unlikely that the building would have any insulation reducing the length of time that the thermal mass would be effective for. An option using blinds has been used to identify whether this could be utilised to reduce internal temperatures.

3.4 Passive Ventilation

The spaces within the dwelling being assessed are single aspect rooms with limited opportunity for cross ventilation. Although the rooms do have openable windows, based on the location of the dwelling noise issues and security may limit the opportunity to open the windows.

3.5 Mechanical Ventilation

As the dwelling is existing, retrofitting a mechanical ventilation system would be costly and may not be feasible depending on floor depths and having suitable locations for the ducts.

3.6 Active Cooling

Based on the possible issues with noise and security in the area, the opportunity to open windows may be reduced. This would impact upon the comfort of the occupants and may mean that the rooms become uncomfortable during spells of warm weather. Active cooling systems could therefore be used to guarantee that the internal comfort levels are maintained within the dwelling.

4. Thermal Model Calculation Results

To assess the current situation, a model has been carried out with the windows as openable and with the current systems in place. The results can be found in Table 1.

Table 1: CIBSE TM59 Criterion 1 Results – As existing with window openings as specified as above

Room Name	Criteria 1 (% hours T_{op} - T_{max} >=1k) (Limit =3)	Criterion 2	Maximum Temperature °C	Pass/Fail
Lounge	1	-	26.71	Pass
Richard's Bedroom	0	0.03%	27.64	Pass
Master Bedroom	1	0.00%	26.32	Pass
Bedroom 3	2	0.03%	28.05	Pass
Bedroom 4	1	0.00%	27.57	Pass

Additional measures have been trialled to see if they reduce the temperatures sufficiently.

Table 2: CIBSE TM59 Criterion 1 Results – As existing with window openings as specified as above with blinds added

Room Name	Criteria 1 (% hours T_{op} - T_{max} >=1k) (Limit =3)	Criterion 2	Maximum Temperature °C	Pass/Fail
Lounge	0	-	26.12	Pass
Richard's Bedroom	0	0.00%	27.21	Pass
Master Bedroom	0	0.00%	26.05	Pass
Bedroom 3	1	0.00%	27.66	Pass
Bedroom 4	0	0.00%	27.03	Pass

Table 3: CIBSE TM59 Criterion 1 Results – As existing with window openings as specified as above with roof insulation added

Room Name	Criteria 1 (% hours T_{op} - T_{max} >=1k) (Limit =3)	Criterion 2	Maximum Temperature °C	Pass/Fail
Lounge	1	-	26.71	Pass
Richard's Bedroom	0	0.03%	27.64	Pass
Master Bedroom	1	0.00%	26.32	Pass
Bedroom 3	1	0.02%	27.99	Pass
Bedroom 4	1	0.00%	27.53	Pass

As opening windows may be problematic, assessments have been carried out with the windows modelled as shut. The results can be found in Table 4.

Table 4: CIBSE TM59 Criterion 1 Results – As existing with windows shut

Room Name	Criteria 1 (% hours T_{op} - T_{max} >=1k) (Limit =3)	Criterion 2	Maximum Temperature °C	Pass/Fail
Lounge	40.3	-	32.05	Fail
Richard's Bedroom	15.1	16.44%	33.07	Fail
Master Bedroom	31.8	17.50%	33.12	Fail
Bedroom 3	24	4.96%	34.67	Fail
Bedroom 4	21.4	4.26%	34.19	Fail

Based on the results of Table 4, blinds were added to see if they will alleviate the problem of overheating. The results can be found in Table 5.

Table 5: CIBSE TM59 Criterion 1 Results – As existing with windows shut but blinds added

Room Name	Criteria 1 (% hours T_{op} - T_{max} >=1k) (Limit =3)	Criterion 2	Maximum Temperature °C	Pass/Fail
Lounge	32.1	-	30.99	Fail
Richard's Bedroom	12.4	10.77%	31.04	Fail
Master Bedroom	27.5	12.71%	31.86	Fail
Bedroom 3	18.1	3.24%	32.51	Fail
Bedroom 4	17.3	3.01%	32.13	Fail

As the building is likely to overheat with the windows shut, air conditioning has been added to assess whether this will alleviate the problem.

Table 6: CIBSE TM59 Criterion 1 Results – As existing with window openings as specified as above with roof insulation added

Room Name	Criteria 1 (% hours T_{op} - T_{max} >=1k) (Limit =3)	Criterion 2	Maximum Temperature °C	Pass/Fail
Lounge	0	-	23.92	Pass
Richard's Bedroom	0	0.00%	23.54	Pass
Master Bedroom	0	0.00%	24.65	Pass
Bedroom 3	0	0.00%	24.12	Pass
Bedroom 4	0	0.00%	24.01	Pass

5. Summary of Results

Section 3 above outlines the requirements of the Cooling Hierarchy and how this relates to the assessed spaces. The results of the cooling hierarchy assessment conclude that as the building is existing, the orientation and amount of glazing are fixed and are out of control of the design team. In addition, based on the location of the dwelling it is likely that external changes to the building, such as the installation of external shading systems would not be feasible.

However, based on the age of the building it is likely that the dwelling would have a high thermal mass. Also, based on the layout of the windows, cross ventilation would be achievable, which would decrease the temperatures within the space.

Within Section 4 of the report the results of the Thermal Model have been outlined. The results show that the space complies with the requirements of CISBE TM59, with a maximum temperature that is within the requirements. However, the windows have been modelled as openable, however, this may not be possible based on external influences such as noise and potential issues with security. This may limit the opportunity to open windows and could mean that rooms become uncomfortable.

Option 2 has blinds added to the windows, although these do reduce the temperature in the room, they do not reduce the temperatures in the rooms significantly. Using blinds with openable windows can cause issues with noise and can damage blinds with the blinds moving in the breeze, especially when wind speeds are higher.

Option 3 has roof insulation added with no blinds. The temperatures are reduced slightly in the top floor rooms but has no significant impact to overall results.

As the opening the windows may not always be possible, an assessment of the building with all the windows shut has been undertaken, this is outlined in Table 4, this building shows that there is a risk of overheating. Table 5 is an assessment of the building with the windows shut, but with blinds added to try and reduce the temperatures, this shows that the building is still susceptible to overheating.

As the building is still susceptible to overheating, air conditioning has been added, these calculations show that the assessed rooms will not be likely to overheat and will be in line with the requirements of TM59.

6. Conclusion

As summarised in the Summary of Results above, the results show that due to the dwelling being existing, aspects of the Cooling Hierarchy cannot be implemented, the windows have been modelled as openable, although based on noise and security issues this may not always be possible, limiting the opportunity to open windows. Blinds have been added, but they do not have a significant impact n the temperatures or results, the same applies with the addition of roof insulation.

The results of the Thermal Comfort model show that the assessed spaces are within the requirements of CIBSE TM59 when the windows are modelled as openable. However, the results are based on the assumptions made, which may be affected by external influences such as noise and issues with security. Therefore, further models have been carried out with the windows shut, to assess whether this would cause issues. It is confirmed that this would be an issue with the windows closed. Based on this active cooling could be used to limit internal temperatures and effectively control the internal temperatures.

Appendix A: Heat Loads and Gains

The internal heat gains that have been used in the calculations are outlined below:

Occupancy, equipment and lighting gains/profiles are fixed and defined in TM59 for different types of rooms such as bedrooms, living rooms, kitchens etc. The specific set-up is outlined below.

Kitchen\Living Rooms

- Occupancy set at 2 people for 75% gains between 9am and 10pm; room is defined as unoccupied for remainder of day.
- Equipment peak load of 450W from 6pm to 10pm
- Equipment Load of 60W from 9am to 6pm and from 10pm to 12pm
- Base equipment load of 35W for rest of day

Bedrooms

- Bedrooms are set with 24 hr occupancy (1 person in daytime,1 person in single bedroom at night, 2 people in double bedroom at night).
- Occupancy set at
    - 2 people at 70% gains from 11pm to 8am
    - 2 people at full gains from 8am to 9am and from 10pm to 11pm
    - 1 person at full gains in the bedroom from 9am to 10pm
- Occupant gains: 75 W/person (sensible), 55 W/person (latent); 30% reduction when sleeping
- Lighting gains: 2 W/m^2 between 6pm and 11 pm for efficient new builds. Higher values should be used for existing buildings or specialist designs

Appendix B: 3D model Outputs