156 West End Lane

a2dominion

Overheating Assessment Report

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A2Dominion Developments Limited

156 West End Lane, Camden

Overheating Assessment Report

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3				

Disclaimer

Contents

Executive Summary

This report has been produced by Silver to outline how the development at 156 West End Lane follows the London Plan Policy 5.9 Overheating and Cooling. The development has been reviewed against the performance criteria of this policy from an early stage.

The study adopted a number of reasonable assumptions as some significant details for the assessment will be decided during the detailed design stages. However, this assessment should be used as a guidance for the later selection of materials and decision of ventilation strategies.

The results of the 13 representative flats' habitable rooms and the assumed scenario are tabulated below.

Passed:	35 rooms			
Room Name	**Criteria 1** (%Hours Top-Tmax>=1K)	**Criteria 2** (Max. Daily Deg.Hrs)	**Criteria 3** (Max. ΔT)	**Compliance**
Upper Limit	**3%**	**6h**	**4K**	
Plot E-1.01 - Bedroom 1	0.2	2	1	✓
Plot E-1.01 - Liv/Din Room	0.2	6	2	✓
Plot E-1.09 - Bedroom 1	0.1	1	1	✓
Plot E-1.09 - Living Room	0	0	0	✓
Plot E0.01 - Bedroom 1	0.1	1	1	✓
Plot E0.01 - Bedroom 2	0	0	0	✓
Plot E0.01 - Liv/Din Room	0.1	4	3	✓
Plot E1.01 - Bedroom 1	0	0	0	✓
Plot E1.01 - Liv/Din Room	0.1	3	2	✓
Plot E1.02 - Bedroom 1	0	0	0	✓
Plot E1.02 - Liv/Din Room	0	0	0	✓
Plot E1.16 - Bedroom 1	0	0	0	✓
Plot E1.16 - Living Room	0	0	0	✓
Plot E1.17 - Bedroom 1	0	0	0	✓
Plot E1.17 - Liv/Din Room	0.8	11	3	✓
Plot E4.05 - Bedroom 1	0	0	0	✓
Plot E4.05 - Liv/Din Room	0	0	0	✓
Plot E4.06 - Bedroom 1	0	0	0	✓
Plot E4.06 - Liv/Din Room	0	0	0	✓
Plot W4.01 - Bedroom 1	0	0	0	✓
Plot W4.01 - Bedroom 2	0	0	0	✓
Plot W4.01 - Bedroom 3	0	0	0	✓
Plot W4.01 - Bedroom 4	0.7	9	3	✓
Plot W4.01 - Liv/Din Room	0	0	0	✓
Plot E5.01 - Bedroom 1	0	0	0	✓
Plot E5.01 - Bedroom 2	0	0	0	✓
Plot E5.01 - Liv/Din Room	0	0	0	✓
Plot E5.02 - Bedroom 1	0	0	0	✓
Plot E5.02 - Bedroom 2	0.1	1	1	✓
Plot E5.02 - Liv/Din Room	0.1	1	1	✓
Plot E5.03 - Bedroom 2	0	0	0	✓
Plot E5.03 - Bedroom 1	0	0	0	✓
Plot E5.03 - Liv/Din Room	0.1	1	1	✓

The results of the modelling showed that if the proposed strategies and assumptions are adopted the building can meet the TM52 Adaptive Overheating criteria without the use of active cooling and as a result, can comply with the Cooling hierarchy of London Plan Policy 5.9.

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1. Introduction

1.1 Background

Silver has been instructed by A2Dominion Developments Limited (A2Dominion) to carry out an overheating analysis for the redevelopment of 156 West End Lane, Camden.

This document presents how the development deals with London Plan Policy 5.9 Overheating and Cooling. The suitable commercially viable measures to prevent overheating have been investigated and implemented according to the cooling hierarchy. These options have been considered in this report at a strategic level.

1.2 Description of the site

The proposals are for demolition of all existing buildings and redevelopment of the site to provide 163 mixed-tenure homes (Use Class C3), new floor space for town centre uses (Use Classes A1, A2, A3, D1 or D2), new employment floor space (including four dedicated units for start-up businesses) (Use Class B1), a community meeting room and new and improved public open spaces, together with associated new landscaping, on-site access, servicing and disabled car parking.

The residential element proposes 163 mixed tenure units, with 50% of the residential floor area allocated for affordable housing, with a mix of affordable rent and shared ownership. The affordable rented element includes a high proportion of family units.

2. Planning Policy Requirements

This section summarises the relevant overheating policy context.

2.1 The London Plan

London Plan Policy 5.9 seeks to reduce the impact of the urban heat island effect in London and encourages the design of places and spaces to avoid overheating due to excessive heat generation, and to reduce overheating due to the impacts of climate change and the urban heat island effect on an area wide basis.

In order to reduce potential overheating and reliance on air conditioning systems the following cooling hierarchy should be followed:

1. **Minimising internal heat generation through energy efficient design:** For example, heat distribution infrastructure within buildings should be designed to minimise pipe lengths, particularly lateral pipework in corridors of apartment blocks, and adopting pipe configurations which minimise heat loss e.g. twin pipes.
2. **Reducing the amount of heat entering the building in summer:** For example, through the use of carefully designed shading measures, including balconies, louvres, internal or external blinds, shutters, trees and vegetation.
3. **Use of thermal mass and high ceilings to manage the heat within the building:** Increasing the amount of exposed thermal mass can help to absorb excess heat within the building.
4. **Passive ventilation:** For example, through the use of openable windows, shallow floorplates, dual aspect units, designing in the 'stack effect'.
5. **Mechanical ventilation:** Mechanical ventilation can be used to make use of 'free cooling' where the outside air temperature is below that in the building during summer months. This will require a by-pass on the heat recovery system for summer mode operation.
6. **Active cooling systems:** Ensuring the systems used are the lowest carbon options.

2.2 CIBSE TM52:2013 Overheating Criteria

CIBSE TM52:2013 suggests that discomfort is not a function of solely the temperature, but the deviation from a set comfort temperature.

To help with the definition of whether and when a building overheats, CIBSE recommends that a running mean is utilised to describe the external temperature. The running mean gives more weight to the days closer to present.

By its nature overheating is a very subjective issue, as the extent to which a person experiences overheating is affected by physical elements, such as temperature, humidity and air movement, but also by the individual's characteristics such as clothing, metabolic rate, susceptibility to heat and ability or willingness to adjust.

The following three criteria set by CIBSE, taken together, are used to assess 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.

- **Criterion 1: Hours of exceedance (He)**

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 1 K or more during the occupied hours of a typical non-heating season (1st May to 30th September).

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.

- **Criterion 2: Daily weighted exceedance (W_e)**

The second criterion deals with the severity of overheating within any single day, which can be as important as its frequency, the level of which is a function of both temperature rise and its duration (degree hours). This criterion sets a daily limit for acceptability.

To allow for the severity of overheating the weighted exceedance (W_e) shall be less than or equal to 6 degree hours in any given day.

- **Criterion 3: Upper limit temperature (T_{upp})**

The third criterion sets an absolute maximum daily temperature for a room, beyond which the level of overheating is unacceptable regardless.

To set an absolute maximum value for the indoor operative temperature the value of ΔT shall not exceed 4 K.

3. Overheating Risk Analysis

3.1 Cooling Hierarchy and Design Measures

This section summarises how the design of the development follows the Cooling Hierarchy as set out in London Plan Policy 5.9.

3.1.1 Minimise internal heat generation

The following efficient design measures have been integrated in the design to reduce internal heat generation:

- 100% energy efficient lighting and appropriate controls
- Variable flow rate heating system with high delta T and low return temperatures
- High efficiency motors and variable speed pumps for heating
- Energy efficient mechanical ventilation system with heat recovery
- Instantaneous highly insulated HIUs (no water storage cylinders in flats)
- Appropriate temperature and time zoning
- Enhanced insulation of heating pipework and valves
- Appropriate smart energy metering and monitoring

3.1.2 Reducing the amount of heat entering the building in summer

The development will incorporate a number of passive solar design measures, presented below. The facades will be fabric energy efficient with appropriate proportions of glazing. The building incorporates balconies and different shapes protruding from it which help to provide shading, and therefore minimising the risk of overheating to the units. The proposed windows glazing shading coefficients aim to maximise daylight and again minimise overheating. The glazing specification will be selected to provide a balance of solar control and access to passive solar gain.

The inclusion of green roofs in the development can enhance biodiversity, absorb rainfall, improve the performance of the building, reduce the urban heat island effect and improve the appearance of a development. All the above, contribute to the greening of the infrastructure and have similar cooling effects on the air surrounding the buildings.

The installation of internal blinds will allow the reduction of the direct sunlight entering the rooms and provide an adaptive approach to controlling the internal environment which will increase occupants' tolerance of overheating.

3.1.3 Manage the heat within the building

The residential nature of the development does not allow for high proportion of exposed internal thermal mass due to the need to conceal services. Ceiling heights have been maximised within the planning constraints.

3.1.4 Passive Ventilation

The majority of the units are dual aspect which will allow for the use of cross-ventilation. Openable windows are proposed despite the fact that they will not be essential in providing the essential fresh air supply to the rooms to maintain the required Indoor Air Quality (IAQ). They will, however, provide some further allowance to residents and occupiers to control their environment during spring and summer and thus, increase their adaptive approach to comfort. The openable windows will also be used for purge natural ventilation during summer to reduce the risk of overheating.

3.1.5 Mechanical Ventilation

Taking into consideration building fabric and low carbon energy proposals, it is assumed that an appropriate mechanical ventilation strategy with heat recovery (MVHR) will likely be provided as continuous background ventilation to ensure compliance with Part F Building Regulations. Natural ventilation in order to provide the desired Indoor Air Quality (IAQ) to the dwelling has been considered but due to the high energy efficiency requirements and CO_2 reduction targets as well as noise sources arising from the surroundings, it may be difficult to implement this strategy throughout the year.

3.1.6 Active Cooling Systems

The simulation demonstrated that they are not essential for the development to mitigate the risk of overheating.

3.2 Overheating Assessment Methodology

Thirteen flats were selected to undergo a full dynamic thermal analysis to define how the developments performs in regards to overheating. The software used for the dynamic thermal simulation is the approved IES Virtual Environment 2015 Dynamic Simulation Modelling (DSM) software, a computer package software which allows the user to create and analyse a detailed thermal model of the building. It is capable of simulating to a satisfactory accuracy what the internal and external thermal conditions in the areas of interest will be.

The thermal dynamic simulations have been carried out using the London DSY weather file as required by CIBSE Guide A.

Limitations

Measures that are located externally to the envelope of the building cannot be effectively accounted for in an IES model. Thus, the green landscape provided at the development and the green roofs that could have cooling effects on the air surrounding the buildings could not be taken into account.

3.3 Model dwelling selection and geometry

Figures 3.1 - 3.4 present four of the thirteen selected dwellings as a true representation of the development. Table 3.1 shows the flats Plot E-1.01, E-1.09, E0.01, E1.01, E1.02, E1.16, E1.17, E4.05, E4.06, W4.01, E5.01, E5.02 and E5.03 that were selected as they comprise all the different alternative options of configuration and size (one to four bedrooms), placement (ground, mid and top floor) and type of ventilation (single and double aspect). Furthermore, figures 3.5 and 3.6 further below present two snapshots of the IES model.

Figure 3.1 PLOT E-1.01

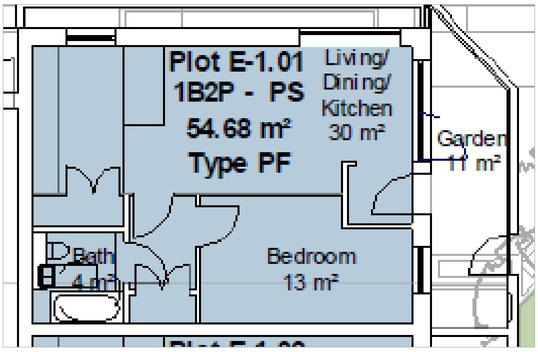


Figure 3.2 PLOT E-1.09

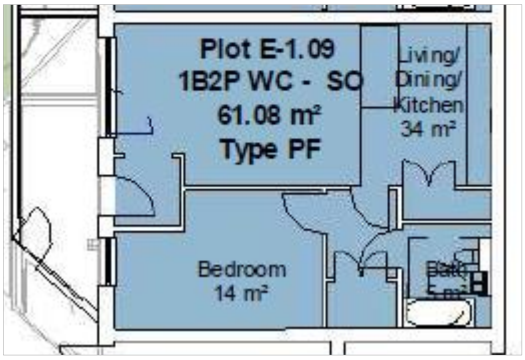


Figure 3.3 PLOT E-1.04

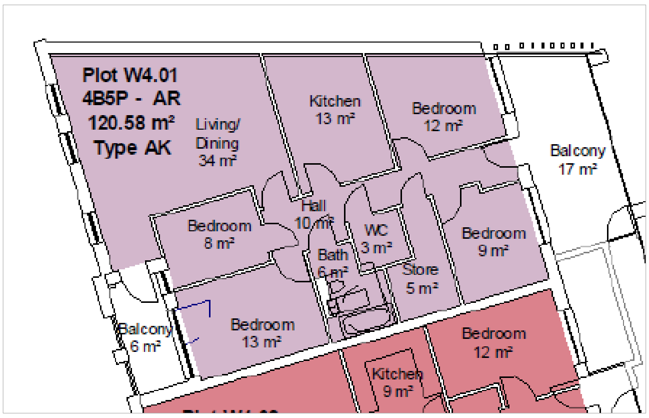


Figure 3.4 PLOT E0.01

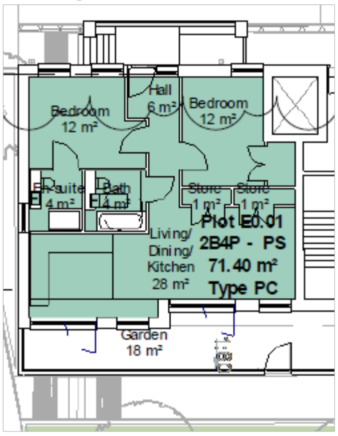
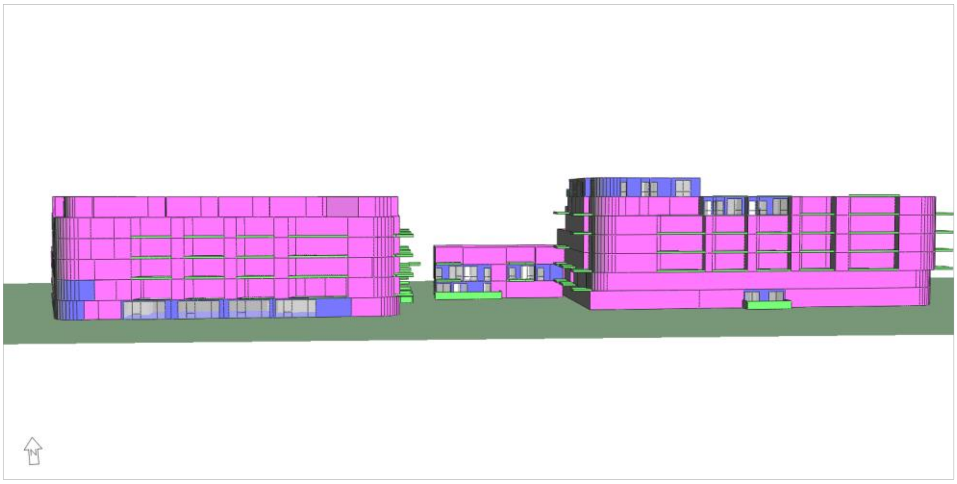


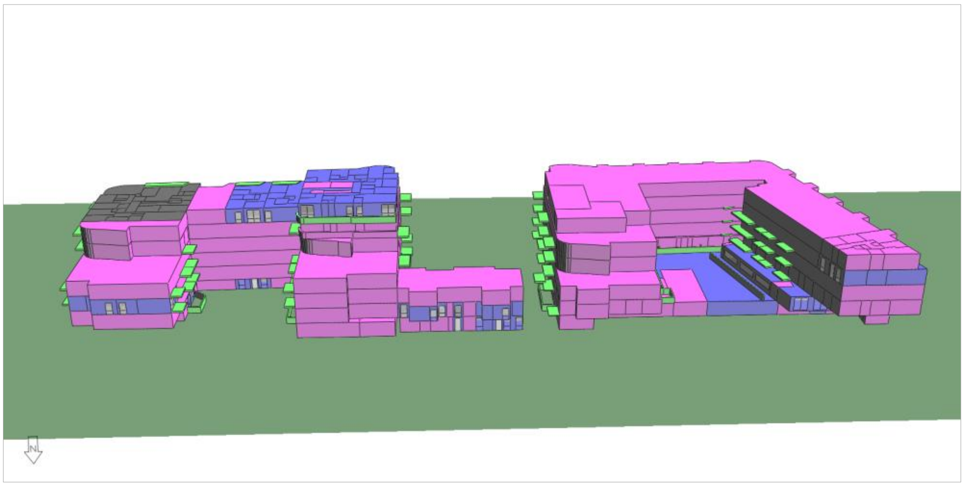
Table 3.1 Dwelling types modelled

Dwelling Ref.	Location in building / flat aspect DA= Double aspect SA= Single aspect	Orientation of majority of living room windows	Floor Area (m^2)	Size / Type PS = Private Sale , SO = Shared Ownership, AR = Affordable Rent
E-1.01	Lower GF / DA	North - East	54.68	1B2P - PS
E-1.09	Lower GF / DA	West	61.08	1B2P - SO Wheelchair
E0.01	GF / DA	South	71.40	2B4P - PS
E1.01	FF / DA	South	74.76	2B4P - PS
E1.02	FF / DA	South	74.43	2B4P - PS
E1.16	FF / DA	East	50.65	1B2P - PS
E1.17	FF / DA	West	50.47	1B2P - PS
E4.05	4F / SA	South	59.57	1B2P - PS
E4.06	4F / SA	South	79.00	2B4P - PS
W4.01	4F / DA	West	120.58	4B5P - AR

E5.01	5F / DA	North	84.33	2B4P - PS
E5.02	5F / DA	South - West	78.91	2B4P - PS
E5.03	5F / SA	South	75.66	2B4P - PS

Figure 3.4 IES VE 2015 Model Screenshot





3.4 Building Fabric

The use of good fabric standards for developments is one of the most cost-effective measures to reduce the risk of overheating. Table 4.1 presents the fabric specification proposed for the development.

Table 4.1 Proposed fabric energy efficiency targets for individual building elements

Element	**U-values W/m²K**	
	Part L1A 2013 minimum fabric requirements	**Proposed specification for the development**
External walls	0.30	0.18

Element	U-values W/m^2K	
	Part L1A 2013 minimum fabric requirements	Proposed specification for the development
Roof	0.20	0.15
Ground floor	0.25	0.15
Windows [1]	2.00	1.30
Airtightness	10 ($m^3/(hm^2)$) at 50 Pa)	4 ($m^3/s/m^2$ @50pa)
y - value	0.15	0.08 [2]

[1] Glazing performance will need to be reviewed alongside acoustic performance as the design is developed. Frame proportion assumed: 10%, Windows' g-value assumed: 0.64

[2] Target value. The actual y-value to be calculated using the lengths of junctions in the actual dwelling and the PSI values

The suggested/simulated elaborate construction details can be found in Appendix A. The proposed specification should be viewed as guidance and will be subject to change as the design progresses.

3.5 Heat Gains

The heat gains are divided in external and internal heat gains.

3.5.1 External Heat Gains

The external heat gains comprise of the solar (radiation) heat gains and the outside air heat gain. Solar radiation acts as a heat source for a building through direct, diffuse and reflected radiation. Outside air acts as a heat source when it is warmer than circa 24ºC.

3.5.2 Internal Heat Gains

Internal heat gains include people, equipment and lighting gains. These gains can have a significant effect on the dwelling overheating as each and all of them plays a crucial role in the resulting internal temperature.

For this overheating study, the NCM methodology internal gains in conjunction with the internal gains utilised by the GLA study 'Creating benchmarks for cooling demand in new residential developments' have been used for all types of internal gains.

Detailed internal gains specified to the model can be found in Appendix B.

3.6 Occupancy-Systems Profiles

The detailed occupancy and systems profiles that have been used in this overheating study are demonstrated in Appendix C. It should be noted that the NCM methodology profiles have been used for this overheating analysis with the exception of occupancy patterns as CIBSE TM52:2013 and IES VE 2015 suggest that NCM occupancy profiles might be proved inappropriate due to their prolonged unoccupied periods during the day.

Hence, in order to reflect the worst case scenario of a vulnerable person being at home all day, the living rooms have been assumed to accommodate one or two occupants from 09 in the morning until

21:00 in the evening. Each bedroom is assumed to be occupied by one or two people for the rest of the day.

3.7 Infiltration

An infiltration rate of 0.30 air changes per hour has been utilised for the model derived by CIBSE Guide A, Table 4.24 through linear interpolation.

3.8 Mechanical Ventilation

Since the units will be equipped with mechanical ventilation with heat recovery (MVHR) 0.5 air changes per hour have been utilised based on current building regulation guidance in the form of BRE digest 398 and the GLA Cooling Benchmark's study.

3.9 Natural Ventilation

Several natural ventilation scenarios have been assessed and reviewed with IES to discover the best strategy to mitigate the overheating risk. As a conclusion, the results proved that the following measures-actions should be utilised:

- Evening - Night Purge Ventilation: Windows should be kept open on the restrictor during the night to cool the thermal mass and wash away the heat gains of the day.
- Early morning Ventilation: In the early morning hours the windows should be kept open for the same reason as above.
- Closed Windows during the day to prevent the heat from entering the dwellings.

As the window effective openable area was not known at this stage of the design, openable windows were assumed as top-hung, opened in 100mm restrictor (20% openable area). Detailed window profiles are presented in Appendix D.

To allow for better circulation of air within the apartments the internal doors of the flats have been set to be left open continuously.

3.10 Shading

External shading is achieved through the buildings' layout and U-shapes which also incorporate balconies that help to reduce the direct sunlight that reaches the glazing area of the development.

The dynamic thermal analysis demonstrated that internal shading should also be utilised during the day to avoid excess heat transfer due to direct sunlight. Venetian blinds have been assumed to be operating during the day. It has been estimated that the shading coefficient of the blinds would equal 0.7, assuming 45 degree blades.

4. Simulation Results

Table 4.1 presents the results of the overheating assessment for the inputs described in section 3. The following values were assumed to employ TM52 adaptive comfort analysis. The nominal design air speed was selected at 0.15 m/s and the summer elevated speed at 0.8m/s. The activity level assumed (93.1 W/m^2) reflects the heat produced by light occupant work, according to Table 1.4, CIBSE Guide A. The clothing level (Table 1.2, CIBSE Guide A) was assumed as 0.7 clo. The building belongs to the significance Category II as set out in CIBSE TM52.

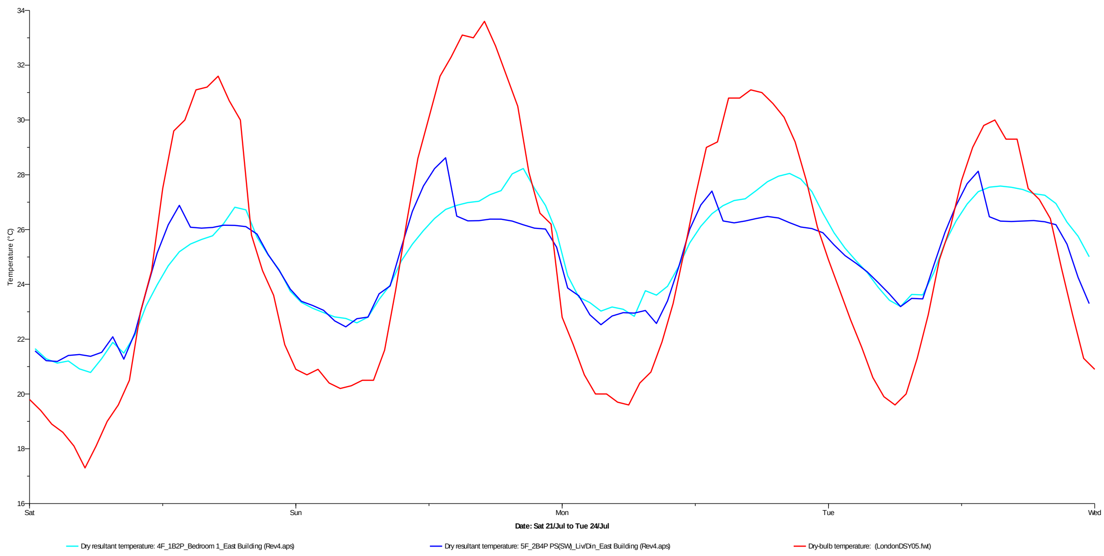
Table 4.1 TM52 Overheating Assessment Results

Passed:	35 rooms			
Room Name	Criteria 1 (%Hours Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. ΔT)	Compliance
Upper Limit	**3%**	**6h**	**4K**	
Plot E-1.01 - Bedroom 1	0.2	2	1	✓
Plot E-1.01 - Liv/Din Room	0.2	6	2	✓
Plot E-1.09 - Bedroom 1	0.1	1	1	✓
Plot E-1.09 - Living Room	0	0	0	✓
Plot E0.01 - Bedroom 1	0.1	1	1	✓
Plot E0.01 - Bedroom 2	0	0	0	✓
Plot E0.01 - Liv/Din Room	0.1	4	3	✓
Plot E1.01 - Bedroom 1	0	0	0	✓
Plot E1.01 - Liv/Din Room	0.1	3	2	✓
Plot E1.02 - Bedroom 1	0	0	0	✓
Plot E1.02 - Liv/Din Room	0	0	0	✓
Plot E1.16 - Bedroom 1	0	0	0	✓
Plot E1.16 - Living Room	0	0	0	✓
Plot E1.17 - Bedroom 1	0	0	0	✓
Plot E1.17 - Liv/Din Room	0.8	11	3	✓
Plot E4.05 - Bedroom 1	0	0	0	✓
Plot E4.05 - Liv/Din Room	0	0	0	✓
Plot E4.06 - Bedroom 1	0	0	0	✓
Plot E4.06 - Liv/Din Room	0	0	0	✓
Plot W4.01 - Bedroom 1	0	0	0	✓
Plot W4.01 - Bedroom 2	0	0	0	✓
Plot W4.01 - Bedroom 3	0	0	0	✓
Plot W4.01 - Bedroom 4	0.7	9	3	✓
Plot W4.01 - Liv/Din Room	0	0	0	✓
Plot E5.01 - Bedroom 1	0	0	0	✓
Plot E5.01 - Bedroom 2	0	0	0	✓
Plot E5.01 - Liv/Din Room	0	0	0	✓
Plot E5.02 - Bedroom 1	0	0	0	✓
Plot E5.02 - Bedroom 2	0.1	1	1	✓
Plot E5.02 - Liv/Din Room	0.1	1	1	✓
Plot E5.03 - Bedroom 2	0	0	0	✓
Plot E5.03 - Bedroom 1	0	0	0	✓
Plot E5.03 - Liv/Din Room	0.1	1	1	✓

The results demonstrate that despite the fact that the worst case scenario of occupancy and ventilation openable areas were employed the development meets the overheating TM52 criteria, as no habitable room fails in simultaneously two of the three criteria.

To provide a more elaborate insight of the thermal performance of the dwellings the internal temperature profile for four consecutive days, including the hottest day of the year, is illustrated in figure 4.1 for the living room of flat Plot E5.02(blue) and bedroom of flat Plot E4.02(cyan) against the respective external temperature(red).

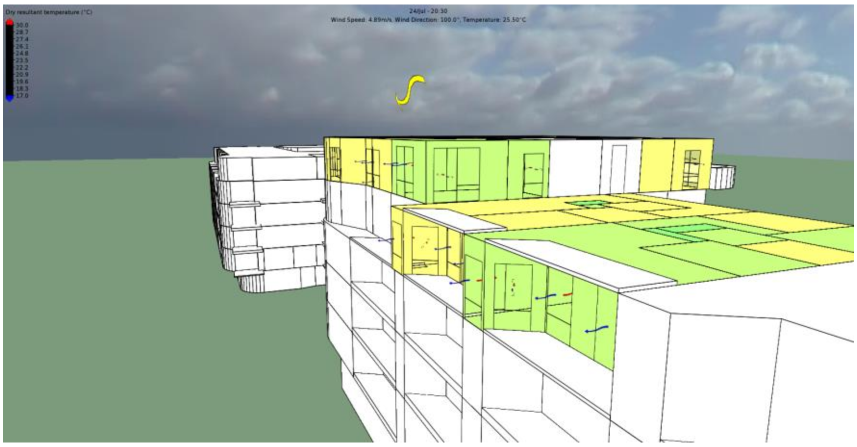
Figure 4.1 - Dry-resultant temperature of one living room and one bedroom against external temperature



The figure above evidences that albeit the temperature in the living room and bedroom generally follows the pattern of the external temperature; the conditioning of the places with the exposed thermal mass and the ventilation strategy allows for the necessitated time lag and smoothening of the peaks and troughs which prevent each space from overheating.

Figure 4.2 illustrates the performance of the ventilation at 20:30 of the 24th July and external temperature of 25.5ºC.

Figure 4.2 Coloured 3D illustration of the temperature inside the rooms and the ventilation arrows at 20:30 of the 24th July



5. Summary and Conclusions

An overheating assessment has been carried out to present how the development at 156 West End Lane minimises the risk of overheating following the cooling hierarchy of Policy 5.9 of the London Plan.

The overheating study investigated the proposed design by producing a dynamic thermal model in IES VE 2015. The model was created comprising a number of assumptions and the results were examined against the TM52 Overheating criteria.

The results of the modelling after the iterative optimisation process of the ventilation strategy and internal shading showed that if the proposed strategies and assumptions are adopted the building can meet the TM52 Adaptive Overheating criteria without the use of active cooling and as a result can comply with the Cooling hierarchy of London Plan Policy 5.9.

Appendix A - Suggested/ Simulated Construction Details

Figure A1 – External Wall

Description: West End Lane External Walls

Performance: EN-ISO

U-value: 0.1805 W/m²·K | Thickness: 430.000 mm | Thermal mass Cm: 9.4500 kJ/(m²·K)

Total R-value: 5.3688 m²K/W | Mass: 280.8750 kg/m² | Very lightweight

Surfaces | Functional Settings | Regulations

Outside — Emissivity: 0.900; Solar Absorptance: 0.550; Resistance (m²K/W): 0.0400; Default ☑

Inside — Emissivity: 0.900; Solar Absorptance: 0.550; Resistance (m²K/W): 0.1300; Default ☑

Construction Layers (Outside To Inside)

Material	Thickness mm	Conductivity W/(m·K)	Density kg/m³	Specific Heat Capacity J/(kg·K)	Resistance m²K/W	Vapour Resistivity GN·s/(kg·m)	Category
[NCMCBM10] Brick- outer leaf- 105mm [AD-L2 (2002)]	105.0	0.7700	1700.0	840.0	0.1364	-	Brick & Blockwork
Cavity	50.0	-	-	-	0.1800	-	-
[STD_USP] Cement bonded particle board	70.0	0.2300	1100.0	1000.0	0.3043	0.000	Boards, Sheets & Decking
[NCMCBM25] 177Mineral wool batt- 100mm [AD-L2 (2002)]	175.0	0.0380	25.0	1030.0	4.6053	-	Insulating Materials
[STD_USP1] Plasterboard	15.0	0.2100	700.0	450.0	0.0714	0.000	Boards, Sheets & Decking
[STD_USP1] Plasterboard	15.0	0.2100	700.0	450.0	0.0714	0.000	Boards, Sheets & Decking

Figure A2 – Party Wall

Project Construction (Opaque: Internal Partition)

Description: WEL Party Wall

Performance: EN-ISO

U-value: 0.1694 W/m²·K | Thickness: 250.000 mm | Thermal mass Cm: 10.5000 kJ/(m²·K)

Total R-value: 5.6429 m²K/W | Mass: 23.6400 kg/m² | Very lightweight

Surfaces | Regulations

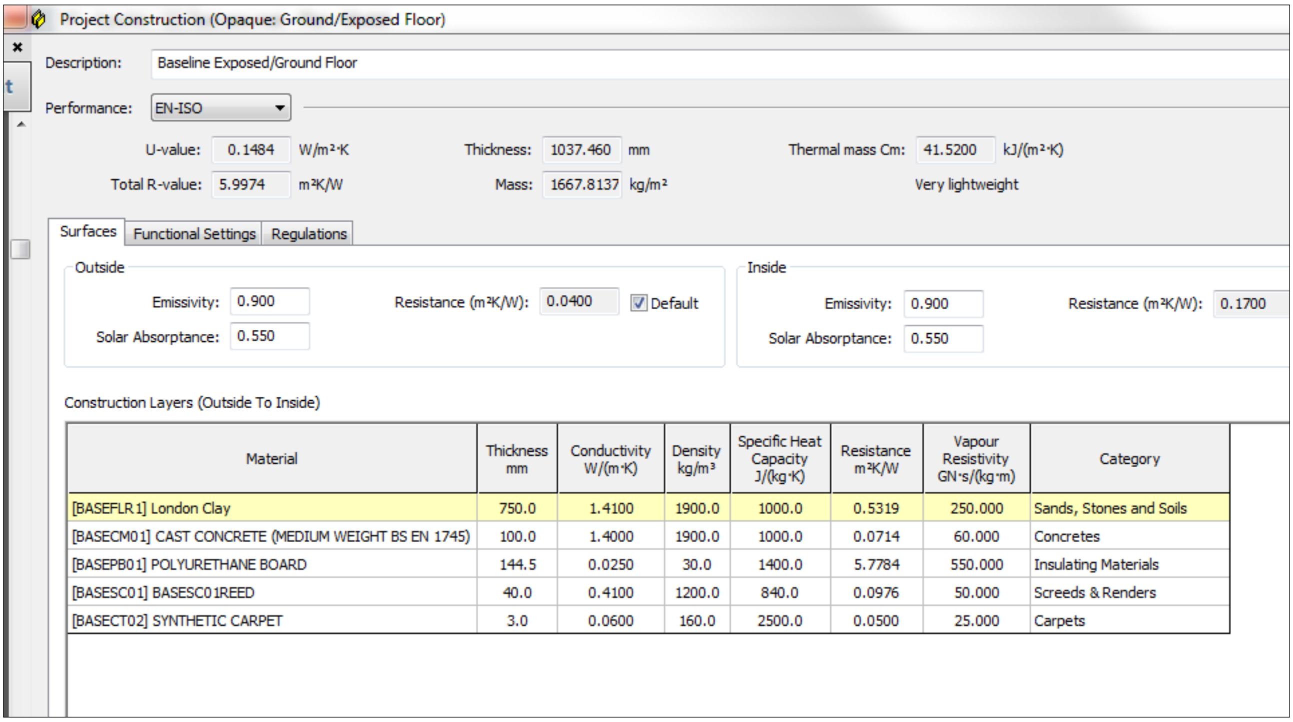
Outside — Emissivity: 0.900; Solar Absorptance: 0.550; Resistance (m²K/W): 0.1300; Default ☑

Inside — Emissivity: 0.900; Solar Absorptance: 0.550; Resistance (m²K/W): 0.1300

Construction Layers (Outside To Inside)

Material	Thickness mm	Conductivity W/(m·K)	Density kg/m³	Specific Heat Capacity J/(kg·K)	Resistance m²K/W	Vapour Resistivity GN·s/(kg·m)	Category
[STD_US2] Plasterboard	15.0	0.2100	700.0	1000.0	0.0714	0.000	Plaster
[NCMCBM15] Min wool quilt- 60 mm	220.0	0.0400	12.0	1030.0	5.5000	-	Insulating Materials
[STD_US3] Plasterboard	15.0	0.2100	700.0	1000.0	0.0714	0.000	Plaster

Figure A3 – Ground Floor


Project Construction (Opaque: Ground/Exposed Floor)

Description: Baseline Exposed/Ground Floor

Performance: EN-ISO

U-value: 0.1484 W/m²·K | Thickness: 1037.460 mm | Thermal mass Cm: 41.5200 kJ/(m²·K)

Total R-value: 5.9974 m²K/W | Mass: 1667.8137 kg/m² | Very lightweight

Surfaces | Functional Settings | Regulations

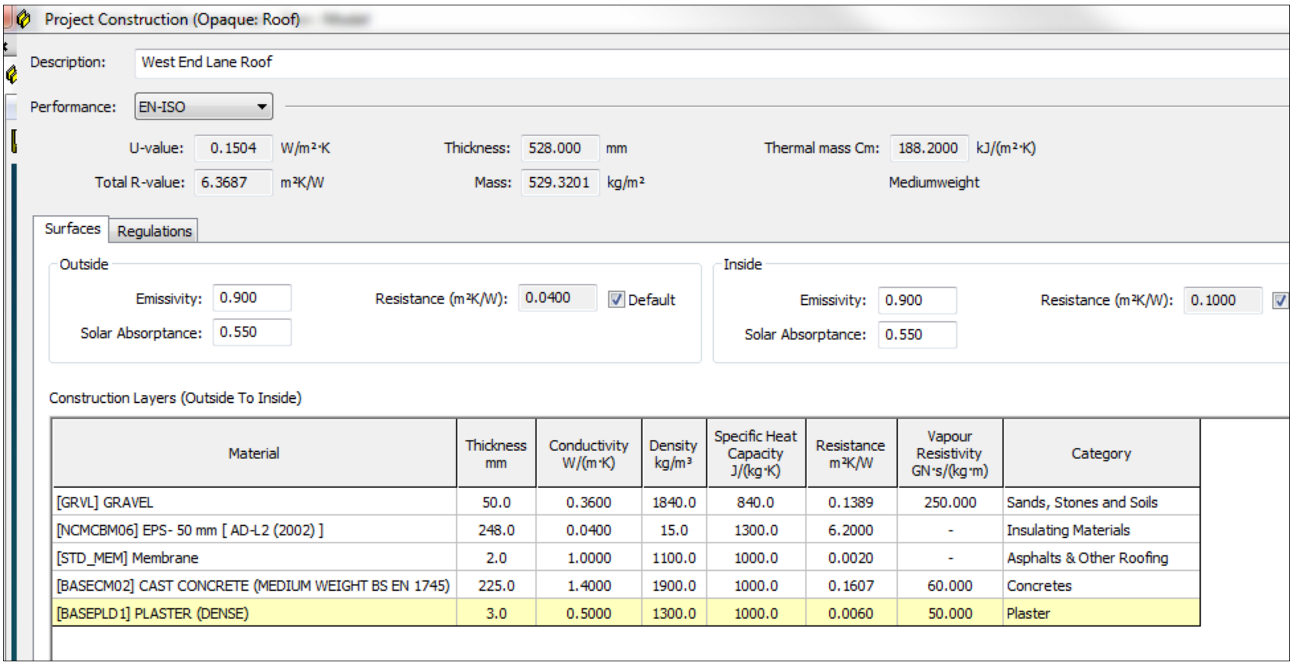
Outside — Emissivity: 0.900; Solar Absorptance: 0.550; Resistance (m²K/W): 0.0400; Default

Inside — Emissivity: 0.900; Solar Absorptance: 0.550; Resistance (m²K/W): 0.1700

Construction Layers (Outside To Inside)

Material	Thickness mm	Conductivity W/(m·K)	Density kg/m³	Specific Heat Capacity J/(kg·K)	Resistance m²K/W	Vapour Resistivity GN·s/(kg·m)	Category
[BASEFLR1] London Clay	750.0	1.4100	1900.0	1000.0	0.5319	250.000	Sands, Stones and Soils
[BASECM01] CAST CONCRETE (MEDIUM WEIGHT BS EN 1745)	100.0	1.4000	1900.0	1000.0	0.0714	60.000	Concretes
[BASEPB01] POLYURETHANE BOARD	144.5	0.0250	30.0	1400.0	5.7784	550.000	Insulating Materials
[BASESC01] BASESC01REED	40.0	0.4100	1200.0	840.0	0.0976	50.000	Screeds & Renders
[BASECT02] SYNTHETIC CARPET	3.0	0.0600	160.0	2500.0	0.0500	25.000	Carpets

Figure A4 – Roof


Project Construction (Opaque: Roof)

Description: West End Lane Roof

Performance: EN-ISO

U-value: 0.1504 W/m²·K | Thickness: 528.000 mm | Thermal mass Cm: 188.2000 kJ/(m²·K)

Total R-value: 6.3687 m²K/W | Mass: 529.3201 kg/m² | Mediumweight

Surfaces | Regulations

Outside — Emissivity: 0.900; Solar Absorptance: 0.550; Resistance (m²K/W): 0.0400; Default

Inside — Emissivity: 0.900; Solar Absorptance: 0.550; Resistance (m²K/W): 0.1000

Construction Layers (Outside To Inside)

Material	Thickness mm	Conductivity W/(m·K)	Density kg/m³	Specific Heat Capacity J/(kg·K)	Resistance m²K/W	Vapour Resistivity GN·s/(kg·m)	Category
[GRVL] GRAVEL	50.0	0.3600	1840.0	840.0	0.1389	250.000	Sands, Stones and Soils
[NCMCBM06] EPS- 50 mm [AD-L2 (2002)]	248.0	0.0400	15.0	1300.0	6.2000	-	Insulating Materials
[STD_MEM] Membrane	2.0	1.0000	1100.0	1000.0	0.0020	-	Asphalts & Other Roofing
[BASECM02] CAST CONCRETE (MEDIUM WEIGHT BS EN 1745)	225.0	1.4000	1900.0	1000.0	0.1607	60.000	Concretes
[BASEPLD1] PLASTER (DENSE)	3.0	0.5000	1300.0	1000.0	0.0060	50.000	Plaster

Appendix B - Internal gains

The internal gains were based on SAP assumptions, CIBSE Guide A recommendations and, mainly, on the study 'Creating benchmarks for cooling demand in new residential developments' prepared for GLA. The latent and sensible occupancy gain figures were based on NCM figures.

Table B1 – Internal gains

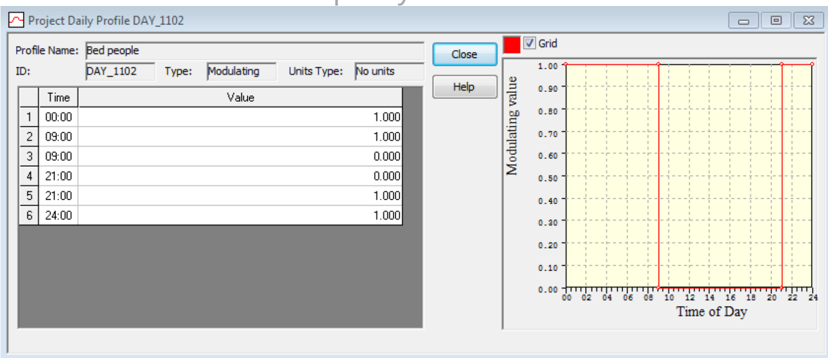
Room Type	Lighting gain (W/m^2)	Equipment gain (W/m^2)	Occupancy density (m^2/person)	Maximum Occupancy gain (Sensible/Latent) (W/person)
Open plan ling room	0.43 Radiant fraction: 0.45	11.95 Radiant fraction: 0.2	12.8	67.1 / 42.9
Bedroom			12.8	67.5 / 22.5
Circulation			26.8	90 / 90
Bathroom / Ensuite			26.8	60 / 60

Table B2 – Infiltration details

	Permeability Based Infiltration
Type	Infiltration
Variation Profile	On continuously
Adjacent Condition	External air
Max A/C Rate	0.30 ach

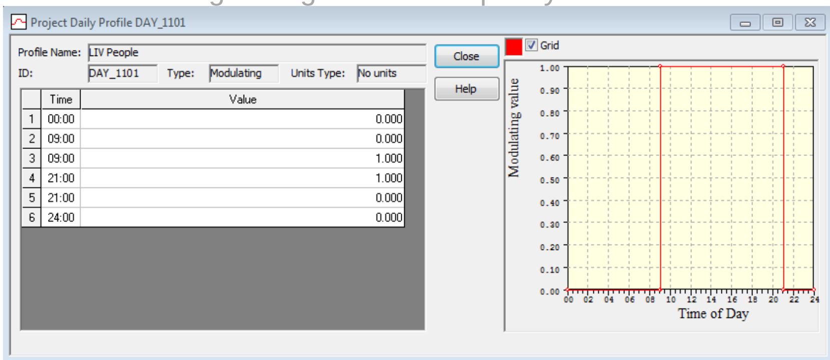
Appendix C - Occupancy Profiles

Table C1 - Bedroom Occupancy Profiles



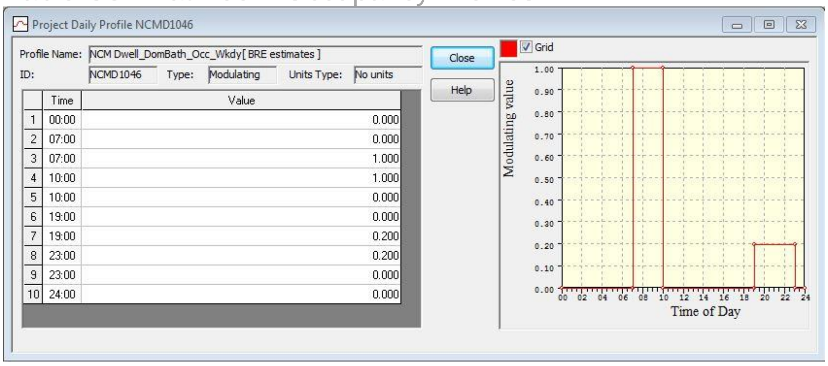
	Time	Value
1	00:00	1.000
2	09:00	1.000
3	09:00	0.000
4	21:00	0.000
5	21:00	1.000
6	24:00	1.000

Table C2 - Living/Dining Room Occupancy Profiles



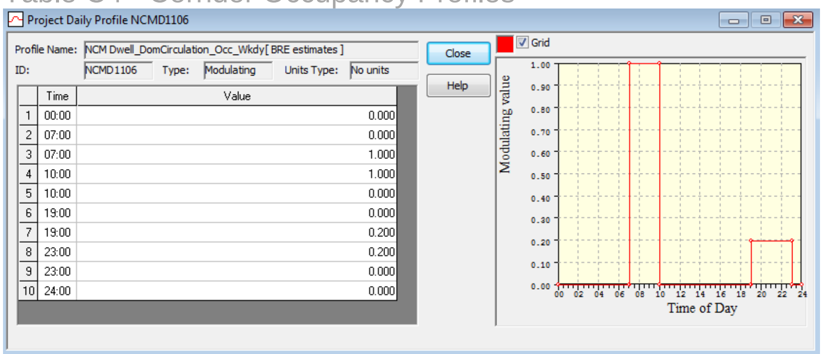
	Time	Value
1	00:00	0.000
2	09:00	0.000
3	09:00	1.000
4	21:00	1.000
5	21:00	0.000
6	24:00	0.000

Table C3 - Bathroom Occupancy Profiles



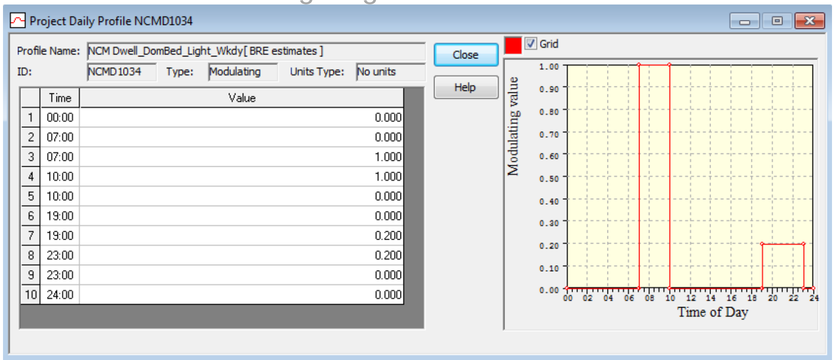
	Time	Value
1	00:00	0.000
2	07:00	0.000
3	07:00	1.000
4	10:00	1.000
5	10:00	0.000
6	19:00	0.000
7	19:00	0.200
8	23:00	0.200
9	23:00	0.000
10	24:00	0.000

Table C4 - Corridor Occupancy Profiles



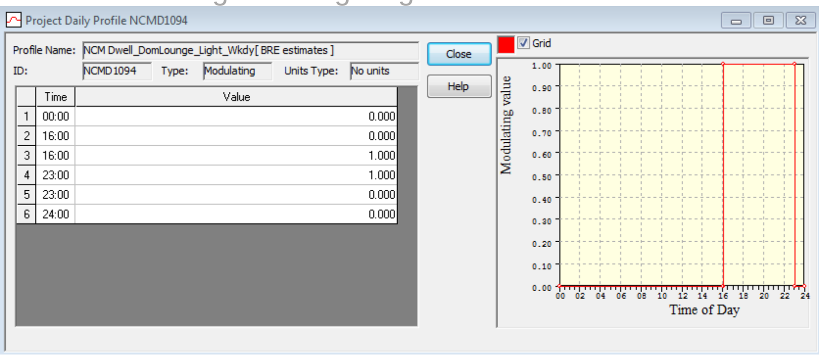
	Time	Value
1	00:00	0.000
2	07:00	0.000
3	07:00	1.000
4	10:00	1.000
5	10:00	0.000
6	19:00	0.000
7	19:00	0.200
8	23:00	0.200
9	23:00	0.000
10	24:00	0.000

Table C5 - Bedroom Lighting Profiles



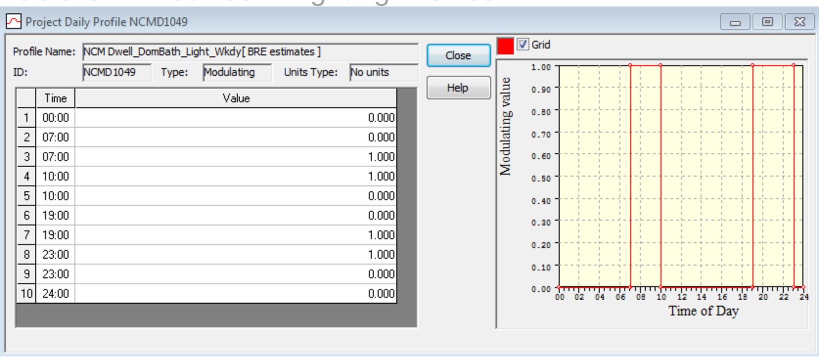
	Time	Value
1	00:00	0.000
2	07:00	0.000
3	07:00	1.000
4	10:00	1.000
5	10:00	0.000
6	19:00	0.000
7	19:00	0.200
8	23:00	0.200
9	23:00	0.000
10	24:00	0.000

Table C6 – Living room Lighting Profiles



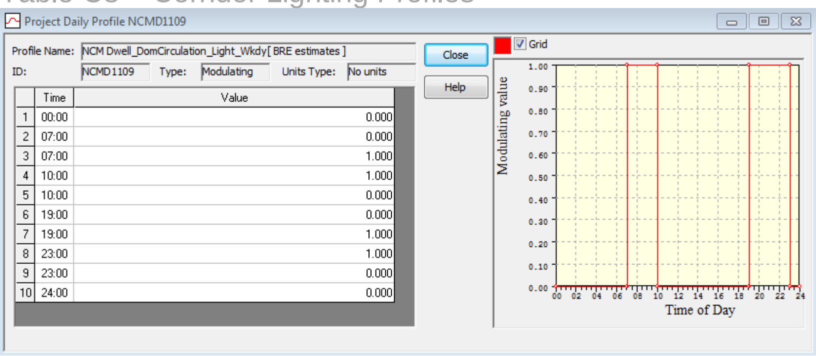
	Time	Value
1	00:00	0.000
2	16:00	0.000
3	16:00	1.000
4	23:00	1.000
5	23:00	0.000
6	24:00	0.000

Table C7 – Bathroom Lighting Profiles



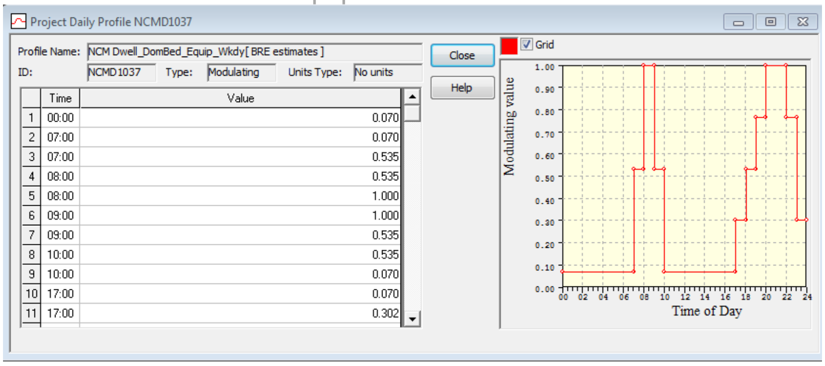
	Time	Value
1	00:00	0.000
2	07:00	0.000
3	07:00	1.000
4	10:00	1.000
5	10:00	0.000
6	19:00	0.000
7	19:00	1.000
8	23:00	1.000
9	23:00	0.000
10	24:00	0.000

Table C8 – Corridor Lighting Profiles



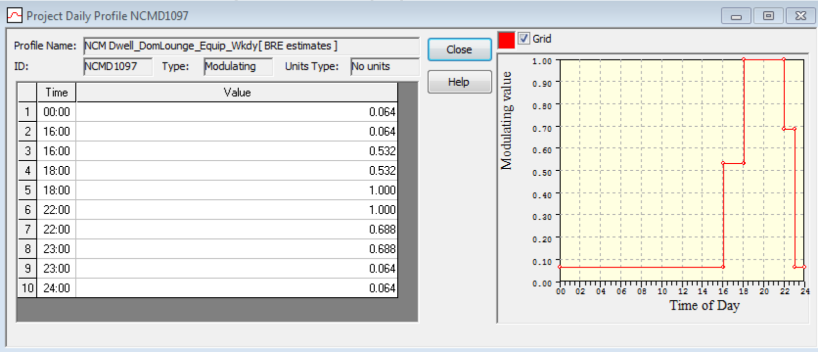
	Time	Value
1	00:00	0.000
2	07:00	0.000
3	07:00	1.000
4	10:00	1.000
5	10:00	0.000
6	19:00	0.000
7	19:00	1.000
8	23:00	1.000
9	23:00	0.000
10	24:00	0.000

Table C9 – Bedroom Equipment Profiles



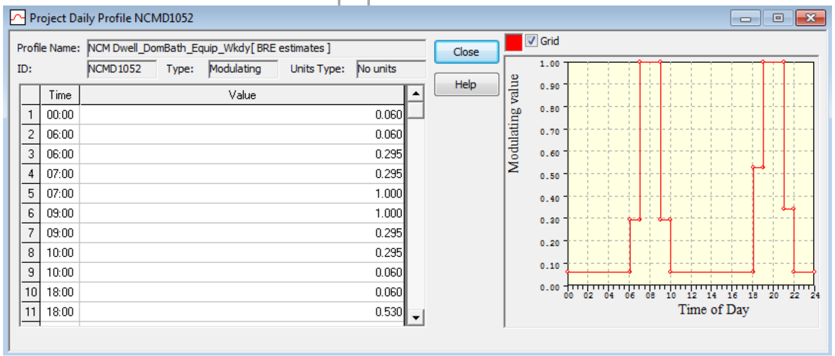
	Time	Value
1	00:00	0.070
2	07:00	0.070
3	07:00	0.535
4	08:00	0.535
5	08:00	1.000
6	09:00	1.000
7	09:00	0.535
8	10:00	0.535
9	10:00	0.070
10	17:00	0.070
11	17:00	0.302

Table C10 – Living Room Equipment Profiles



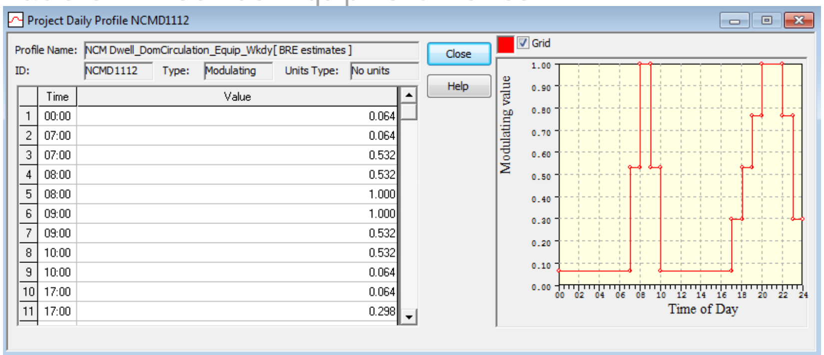
	Time	Value
1	00:00	0.064
2	16:00	0.064
3	16:00	0.532
4	18:00	0.532
5	18:00	1.000
6	22:00	1.000
7	22:00	0.688
8	23:00	0.688
9	23:00	0.064
10	24:00	0.064

Table C11 – Bathroom Equipment Profiles



	Time	Value
1	00:00	0.060
2	06:00	0.060
3	06:00	0.295
4	07:00	0.295
5	07:00	1.000
6	09:00	1.000
7	09:00	0.295
8	10:00	0.295
9	10:00	0.060
10	18:00	0.060
11	18:00	0.530

Table C12 – Corridor Equipment Profiles

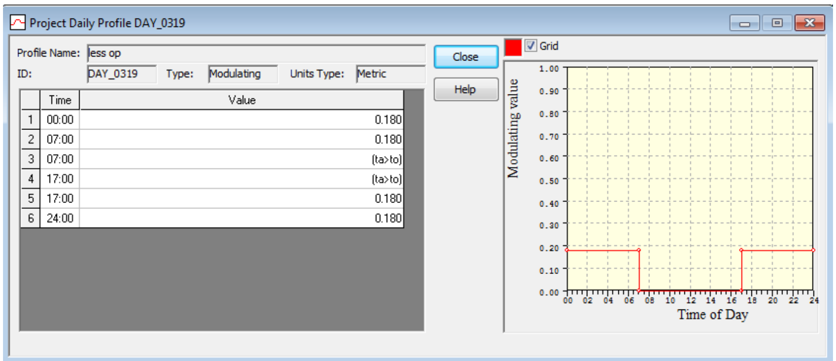


	Time	Value
1	00:00	0.064
2	07:00	0.064
3	07:00	0.532
4	08:00	0.532
5	08:00	1.000
6	09:00	1.000
7	09:00	0.532
8	10:00	0.532
9	10:00	0.064
10	17:00	0.064
11	17:00	0.298

![silver logo]

Appendix D - Windows' opening profiles-blinds specification

Table D1 - Windows operation profile



	Time	Value
1	00:00	0.180
2	07:00	0.180
3	07:00	(ta>to)
4	17:00	(ta>to)
5	17:00	0.180
6	24:00	0.180

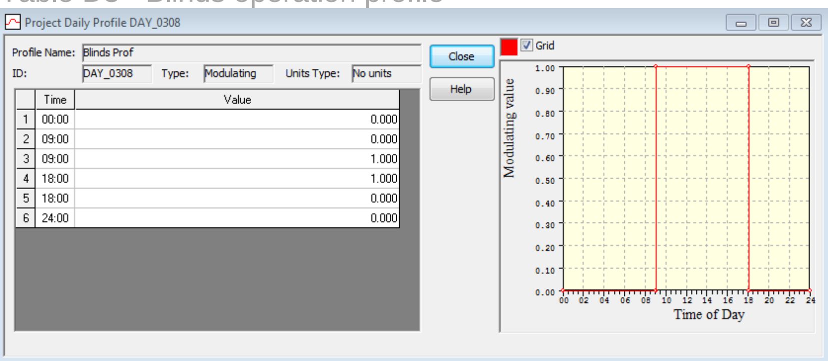
Formula explanation:
(ta>to) indicates that the windows will open <u>only if</u> the external temperature is lower than the internal temperature to avoid creating a greenhouse effect

Table D2 - Blinds Specification

Type	Venetian Blind
Angle of blades	45º
Shading Coefficient	0.7*

Due to lack of bibliography/technical specifications for 45º venetian blinds the shading coefficient used is an approximation based on the IES VE Apache Tables user guide. The user guide specifies that open venetian blinds have shading coefficients of 0.83 whereas closed ones have a shading coefficient of 0.56. To represent the 45º blade, a shading coefficient of 0.7 has been assumed.

Table D3 - Blinds operation profile



	Time	Value
1	00:00	0.000
2	09:00	0.000
3	09:00	1.000
4	18:00	1.000
5	18:00	0.000
6	24:00	0.000