Building Services Engineering
Sustainability Consultants
Low Carbon Design

FLATT

FOR:

Star Land Realty Ltd
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BARNES HOSPITAL SITE

TM:59 OVERHEATING ANALYSIS – BLOCK B

Engineering Sustainability

Revision

Version No	Version Date	Status	Summary of Changes
1	04/08/21	PLANNING	-
2	19/11/21	PLANNING	Red Line Site Amended
3	07/10/22	PLANNING	Aprt mix, Red Line Site & Plans/Elevations Amended
4	21/10/22	PLANNING	Figure 1 Plan Changed

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CONTENT **PAGE NO.**

EXECUTIVE SUMMARY

This report has been prepared by **FLATT** on behalf of **STAR LAND REALTY LTD** to assess the risk of summertime overheating within the apartments on the Barnes Hospital Site, London.

Block B was selected as the most exposed and a good representation for all apartments.

CIBSE Technical Memorandum TM:59 – Design Methodology for the Assessment of Overheating Risk in Homes. TM:59 is a standardised approach to predicting overheating risk for residential building designs (new-build or major refurbishment) using dynamic thermal analysis. It is essentially an updated version of TM:52 specifically for dwellings. The TM:59 methodologies consider the effect of how occupants perceive indoor temperatures and provides limitations on exposure to higher temperatures under certain conditions. Internal communal corridors are also considered, to pass they must not exceed 28°C for 3% of the annual hours.

A 'Dynamic Thermal Simulation Computer Model' of Block B was created to undertake the analysis. The model incorporates the proposed solar control glazing, window reveals, openable areas of windows and doors, balconies and building layout. Internal blinds were not incorporated into the analysis, as not installed as part of the development. The glass specification applied is Suncool 70/40 with a g value of 0.43.

Three 2020 weather files are considered, these are described as follows:

DSY1 – A moderately warm summer.
Summers will have a 1-in-7 chance of being equal or hotter than this DSY.
DSY2 – A summer with a short intense warm spell.
An intense summer with a heat event the same length of that of DSY1, but with a higher intensity.
DSY3 – A summer with a long less intense warm spell.
The heat event is less intense than that of DSY2, but has a higher intensity than DSY1. It has a longer duration than that of DSY1.

The results for DSY2 and DSY3 are for information on the buildings performance in relation to future climate change and whilst they need to be reported they are not mandatory to pass under TM:59. The DSY1 is the standard Climate Change file which forecasts for the period 2020 to 2030 and a pass on this criteria is required.

The results of the analysis are summarised as follows:

DSY1 – All Living/Dining/Kitchens & Bedrooms PASS this analysis
DSY2 - 6 Living/Dining/Kitchens & 20 Bedrooms FAIL this analysis
DSY3 - 18 Living/Dining/Kitchens & All Bedrooms FAIL this analysis

1.0 INTRODUCTION

This report has been prepared by **FLATT** on behalf of **STAR LAND REALTY LTD** to assess the risk of summertime overheating within the apartments at Block B on the Barnes Hospital Site, London.

Block B was selected as the most exposed and a good representation for all apartments.

The developer recognises that overheating in residential accommodation is of concern in modern highly insulated and airtight buildings and the value of undertaking such studies to address overheating.

To assess the likelihood of overheating risk within the residential parts of the development the following assessment is considered:

CIBSE Technical Memorandum TM:59 – Design Methodology for the Assessment of Overheating Risk in Homes.
CIBSE Technical Memorandum TM:48 – CIBSE The Future Weather Years

TM:59 is essentially an updated version of TM:52 specifically for dwellings.

These methodologies consider the effect of how occupants perceive indoor temperatures and provides limitations on exposure to higher temperatures under certain conditions.

This report records the outcome of the overheating analysis was carried out and summarises the results including confirming the glazing specification in terms of solar control.

This approach includes the impact of future global climate change undertaking the TM59 analysis in accordance with TM48: CIBSE The Future Weather Years. The files used are all 2020, High Emissions 50% Percentile (2020High50). The 2020High50 weather files are considered by TM48 as the climate change test files and represent the period from 2020 to 2050. The weather files are summarised below.

DSY1: Moderately warm summer – Standard Test Criteria
DSY2: Short, intense warm spell.
DSY3: Long, less intense warm spell

A minimum requirement for passing the TM:59 analysis is to pass using the DSY1 weather file. For older residents, DSY 2 & 3 should also be considered. However, it is not a requirement to pass the test but may be used to advise to develop a heatwave plan.

2.0 THE DEVELOPMENT

The site is located on Worple Way, Barnes SW14 8SU. The site falls within the London Borough of Richmond. The proposed development consists of the following dwellings: -

Total Apartment Mix

Unit Size	Market		Shared Ownership		Affordable Rent		Total	
	Units	%	Units	%	Units	%	Units	%
Studio	1	1.2%	0	0%	0	0%	**1**	**0.9%**
1-bedroom	29	34.1%	5	100%	7	36.8%	**41**	**37.6%**
2-bedrooms	41	48.2%	0	0%	8	42.1%	**49**	**45%**
3-bedrooms	14	16.5%	0	0%	4	21.1%	**18**	**16.5%**
Total	**85**	**100%**	**5**	**100%**	**19**	**100%**	**109**	**100%**

Figure 1. Site Plan – Block B outline shown in Green

1.2 Block B - Floor Plans

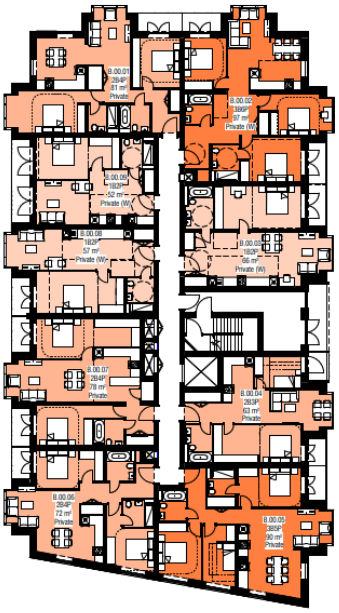


Figure 2. Level 00

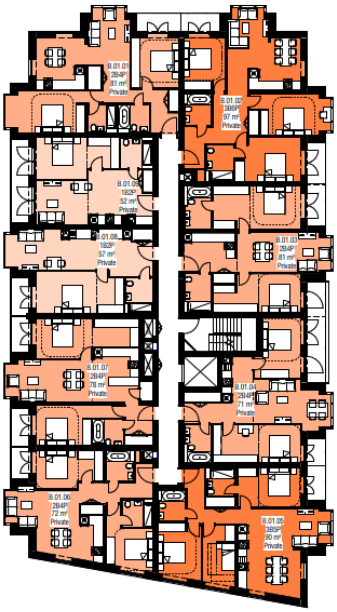


Figure 3. Level 01-02

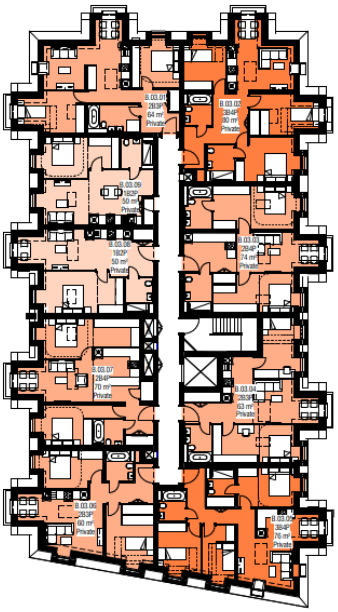


Figure 2. Levels 03

1.2 Block B - Elevations

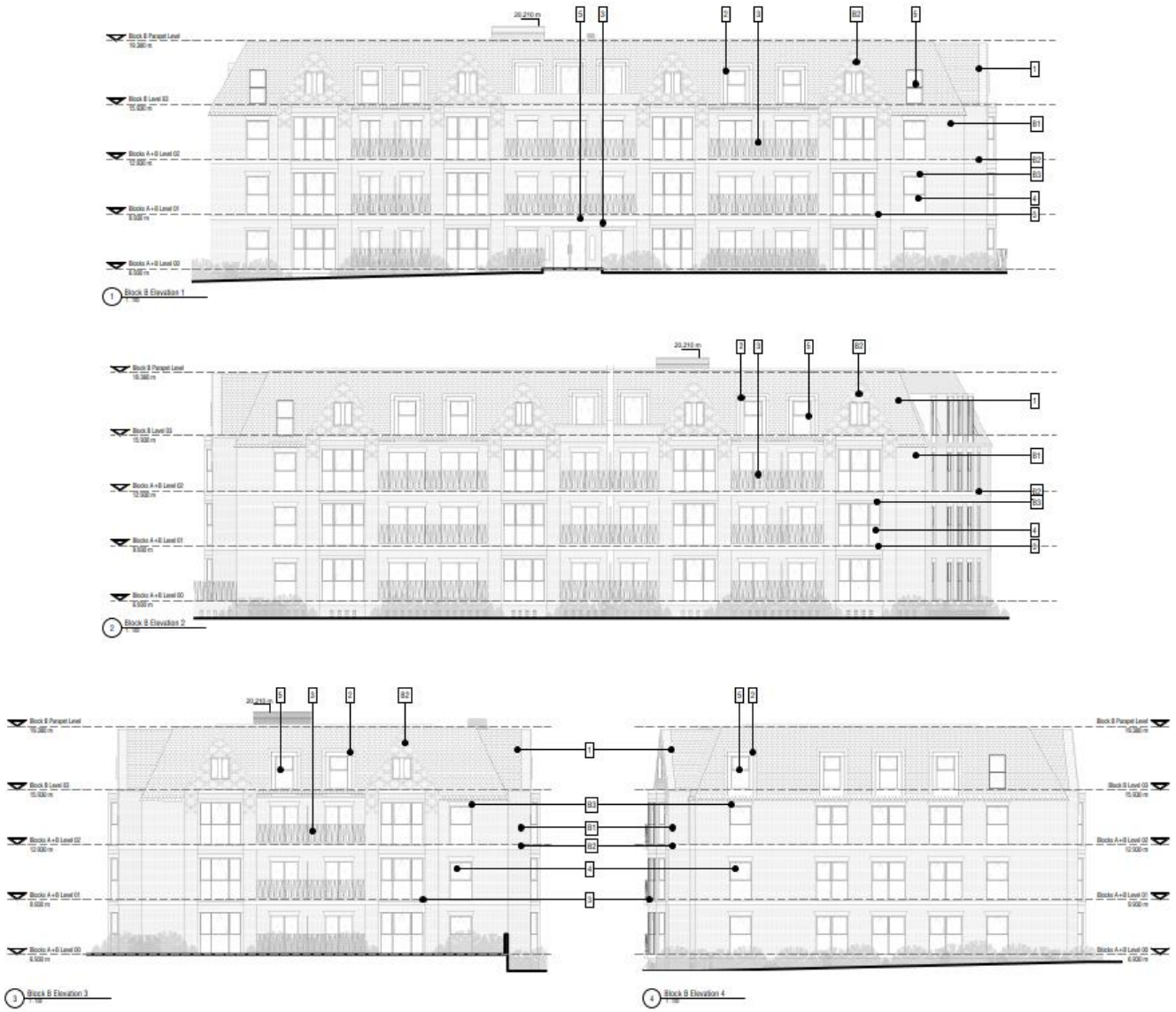


Figure 3. Block B – Elevations

2.0 METHODOLOGY

A dynamic simulation thermal model is created of the building using Virtual Environment (IES-VE) software. The version is VE2021.2.0.0, which was current at time of this report.

For the purpose of this analysis the building has been modelled directly from the Architectural drawings. All apartments were modelled and include all communal and landlord areas.

The modelling incorporates windows, window reveals, balcony doors and external shading from balcony structure.

Blinds were excluded from the analysis, as per TM:59 guidance and methodology, which stipulates that should only be included if they are provided as part of the base build.

Natural ventilation paths are modelled by algorithms that control the window and balcony door openings. Within the apartment's internal doorways between living spaces and bedrooms are incorporated to allow cross ventilation to occur between rooms. However, bedroom doors are only operable outside the TM59 designated occupied period.

The assessment is undertaken in accordance with methodology and criteria contained within CIBSE TM59: Design Methodology for the Assessment of Overheating Risk in Homes (2017) using current Design Summer Year (London_LHR_2020High50.DSY1) weather data. This provides a robust method of assessment and is in line with London Plan guidance, current 'industry' standards and best practice.

The software incorporates the TM52 Adaptive Comfort analysis tool to assess the overheating of buildings based on the criteria outlined in CIBSE Technical Memorandum TM:52 –2013. This is used to assess Criteria 1: Hours of Exceedance as per Chapter 4.2 Par (a) of TM:59 for Living rooms, kitchens and dining rooms (LKD).

The software also incorporates VistaPro, which permits range testing of variables. Such as Operative Temperatures in excess of 26°C between the hours of 10pm to 7am as per Chapter 4.2 Para (b) of TM:59 for bedrooms.

The following images are taken from the thermal models and demonstrate the buildings 'likeness' to the proposed building for construction and provide a visual indication of how the building is exposed to solar gain. Blue areas are the apartments, Magenta areas are adjacent apartments and green areas are local shading such as balconies.

The external shading provided by the balconies (in green) can clearly be seen in the images.

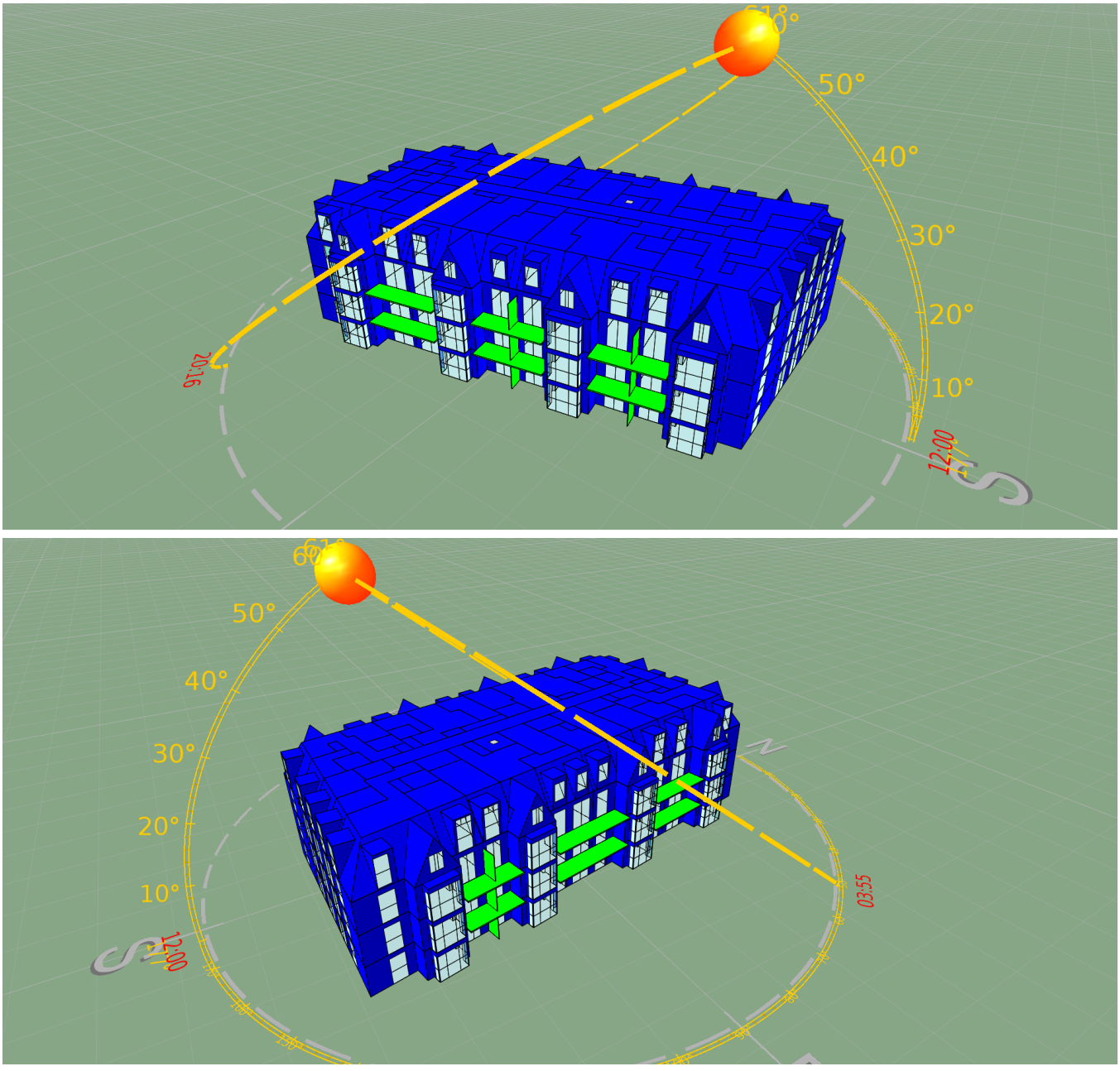


Figure 4. IES-VE Thermal Model Image

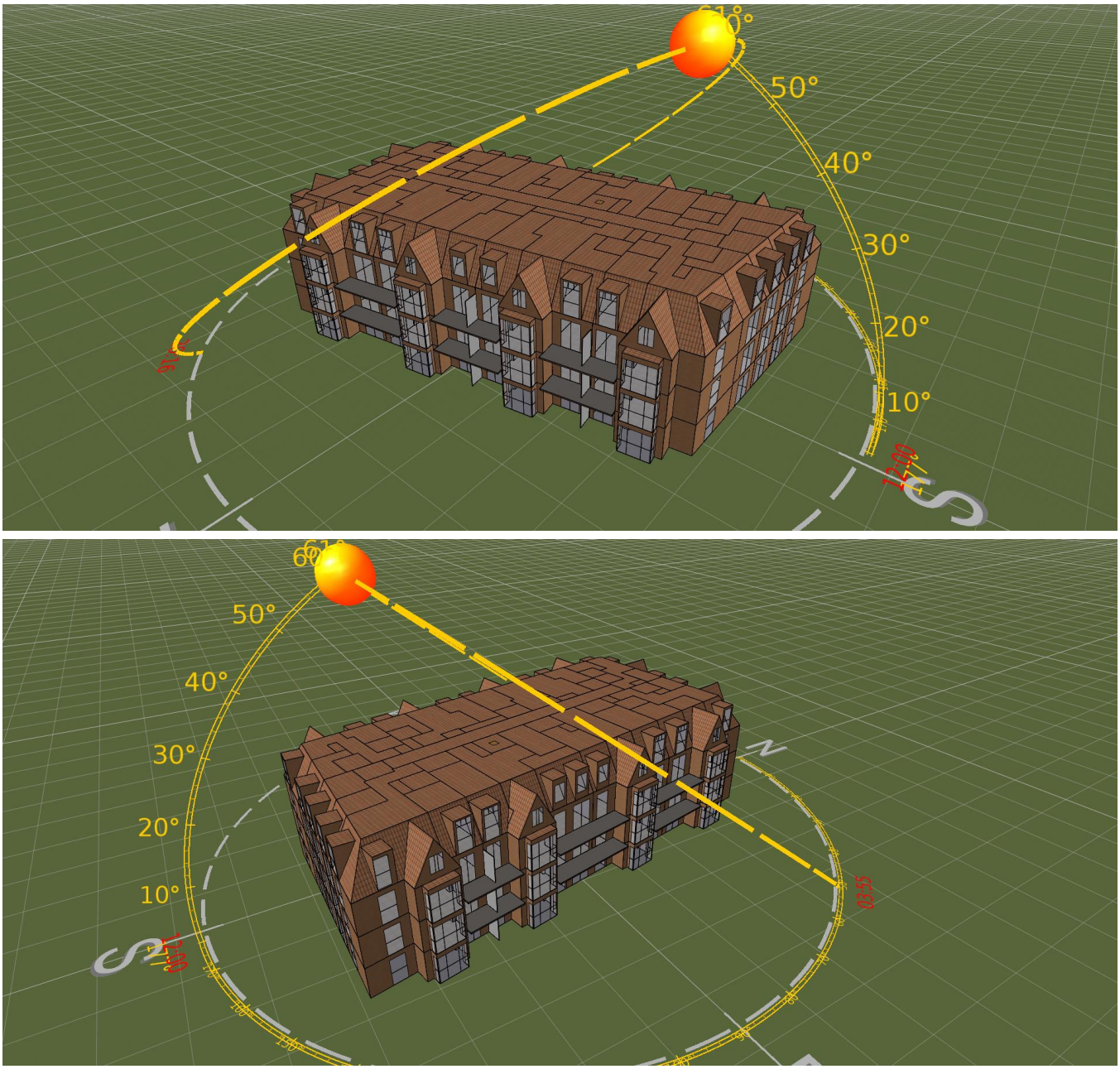


Figure 5. IES-VE Thermal Model Image

The following images provide an indication of the natural air flows through the dwellings, the larger red arrows are indicative of the greater airflow leaving through the balcony doors.

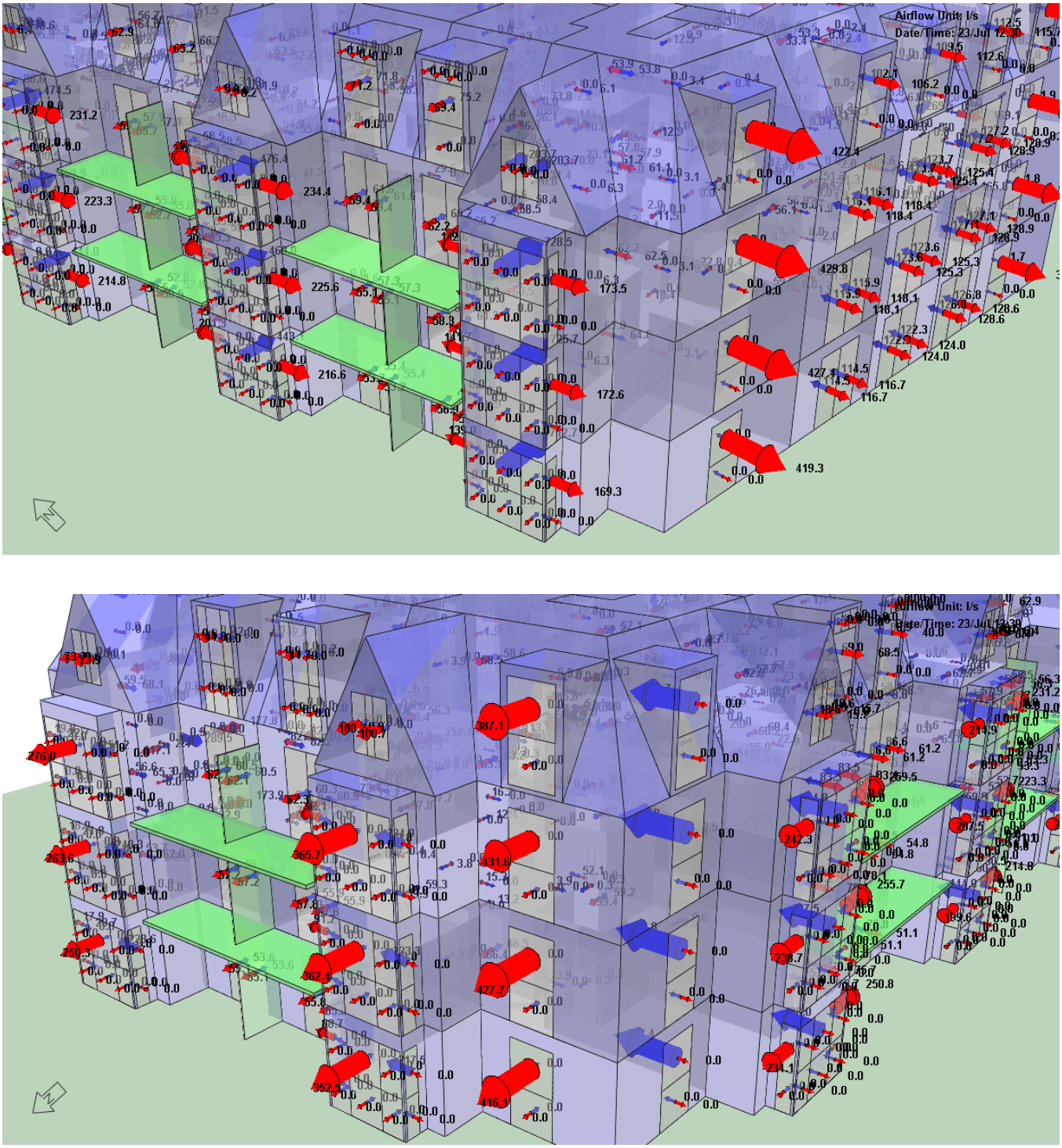


Figure 6. IES-VE Thermal Model - MacroFlo Natural Ventilation

2.1 TM:52 Adaptive Comfort Criteria

The following three criteria are used to assess the risk of overheating of buildings in the UK and Europe.

If a room or building fails any two of the three criteria it is classed as overheating and fails TM:52 as a consequence. TM:59 only uses Criterion 1 for the Living Rooms, Kitchens and Dining Rooms but applies a different data set for occupancy profiles and internal gains.

Criterion 1.
This 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).

Criterion 2.
This 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 its duration.
This criterion sets a daily limit for acceptability.

Criterion 3.
This sets an absolute maximum daily temperature for a room, beyond which the level of overheating is unacceptable.

Further information on these criteria can be found in TM52 – 2013, section 6.1.2.

2.1.1 Criterion 1 - Hours of Exceedance – For Living/Dining/Kitchens only.

The number of hours during which the temperature difference (ΔT) is greater than or equal to one degree (°K), during the period May to September inclusive, this period shall not be more than 3% of occupied hours.

The ΔT is defined as operative temperature less the maximum acceptable temperature and is rounded to the nearest whole degree.

2.1.2 Criterion 2 - Daily Weighted Exceedance – Not Required for TM:59

To allow for the severity of overheating, the weighted exceedance shall be less than or equal to 6°K in any one day.

2.1.3 Criterion 3 - Upper Limit Temperature – Not Required for TM:59

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

2.2 TM:59 Criteria for Homes Predominantly Naturally Ventilated

This includes homes which have MVHR with good opportunities for natural ventilation. Compliance is based on passing both of the following two criteria:

a) For living rooms, kitchens and bedrooms: the number of hours 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 percent of occupied hours. (CIBSE TM52 Criterion 1:Hours of exceedance).

b) For bedrooms only: to guarantee 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).

Criteria 2 and 3 of CIBSE TM52 may not be met, but both (a) and (b) above must be passed for all relevant rooms.

2.2.1 Communal Corridors

Corridor ventilation should be included in the analysis as designed. Whilst there is no mandatory target to meet, if an operative temperature of 28 °C is exceeded for more than 3% of the total annual hours, then this should be identified as a significant risk within the report.

2.3 TM:59 Internal Loads, Occupancy and Equipment Data Sets

TM:59 provides a schedule of room data sets for the domestic apartments. CIBSE technical memorandum recognises that NCM room templates, profiles and schedules may not be appropriate for residential properties and has thus assigned a set of room data sets which more realistically represent domestic properties. All rooms have been assigned the appropriate data set in accordance with Table 2 TM:59.

Communal corridors have been assigned an internal gain of 171W based upon an assessment of the quantity of LTHW distribution pipework. This has been undertaken in accordance with Table 1 TM:59.

A manufacturer declared heat loss of 2W for the HIU units has been included for within each apartment.

2.4 Design Summer Year (DSY) Weather File

The weather file applied, is the current DSY for London. The results presented within this document are presented in brief terms rather than the full output documents. It is a requirement of TM:59 that the most appropriate location file is used for the 2020's High Emissions, 50% percentile scenario.

The most appropriate DSY weather file is London_LWC_DSY1_2020High50. This was used to calculate the Exponentially Weighted Running Mean of the Daily Outdoor Air Temperature. This temperature noted within TM52 as T_{RM} is used to calculate ΔT (temperature difference) for the TM:52 analysis.

2.5 Building Classification

The following building classifications are stipulated with Table 2 CIBSE TM:52. These classifications determine the benchmark values within each criterion that the building must be seen to meet or better. Depending on the classification a greater or lesser benchmark is set with corresponding level of expectation.

Category	Explanation	Suggested Acceptable Range (°K)
Category I	High level of expectation only used for spaces occupied by very sensitive and fragile persons	2
Category II	Normal expectation (for new buildings and renovations)	3
Category III	A moderate expectation (used for existing buildings)	4

Figure 7. TM:52 Building Classification

In line with the recommendations within Table 2 CIBSE TM:52, the classification for this building has been applied as Category II.

2.6 Openable Windows and Doors

Combined living room, dining room and kitchen (LDK's) tend to have a greater glazed area than bedrooms as well as an occupancy and load profile which presents a more onerous overheating risk when compared to bedrooms. They are also principally occupied during the day when solar gain is stronger, therefore, the LDK's are subject to a greater overheating risk than bedrooms.

Where large balcony double doors are provided very high air change rates can be experienced. Bulk air movement rates greater than 25 ACH, i.e. mean room air velocities greater than 0.18m/s, are deemed to be excessive and therefore unlikely to be seen under normal operation as occupants would partially close the window/door. The natural ventilation modelling automatically adjusts the door/window opening size to prevent these high air change rates from being experienced on a continual basis.

To mimic how occupants, react to rising room temperatures the modelling incorporates an algorithm that opens windows and doors when the internal operative temperature exceeds 22°C. If high temperatures prevail during the night-time, the windows/doors will remain open at a minimum setting

to provide natural ventilation to alleviate temperature build up. All algorithms are based upon the requirements directed by the Limits on CIBSE TM59 modelling, which is introduced to the new Approved Document Part L2 Jan 2021 which is still in consultation.

By incorporating internal doors into the building model cross flow ventilation between rooms is encouraged, this is acceptable as per the SAP2012 conventions. However, bedroom doors remain closed during occupancy as per TM:59 guidance.

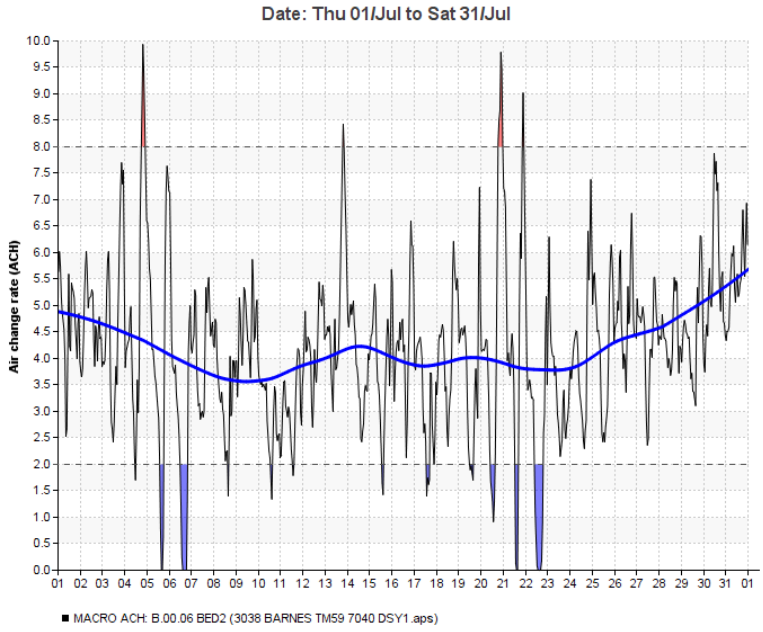


Figure 8. Natural Ventilation Bulk Air Movement, Typical Bedroom

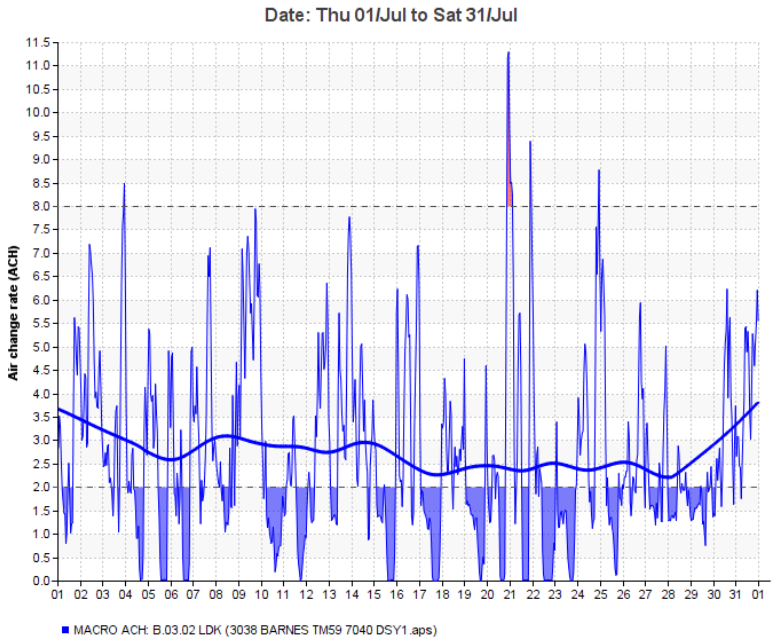


Figure 9. Natural Ventilation Bulk Air Movement, Typical LDK

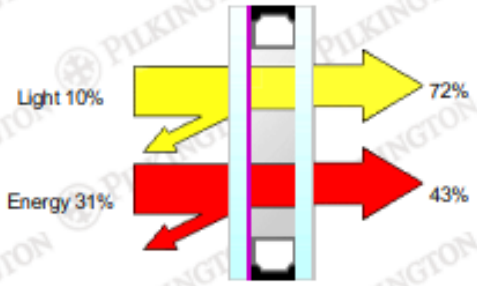
2.7 Glazing – Block B

The specifications of glazing modelled:

- Pilkington 70/40 g value = 0.43 Colour/Tint = Clear/Neutral

The g value being the proportion of solar gain that enters the space through the glazing.

PILKINGTON NSG GROUP



DESCRIPTION

Position	Product	Process	Thickness (nominal) mm	Weight kg/m²
Pilkington **Insulight™** Sun				
Glass 1	Pilkington **Suncool™** 70/40	Annealed	6.0	
Cavity 1	Argon (90%)		16.0	
Glass 2	Pilkington **Optifloat™** Clear	Annealed	6.0	
Product Code	6C(74)-16Ar-6		28.0	30.00

PERFORMANCE

Light		
Transmittance	LT	72%
	UV %	19%
Reflectance Out	LR out	10%
Reflectance In	LR in	11%
Performance Code		
U_g-value/Light/Energy		1.1 / 72 / 43
Ra		94
The values of some of characteristics are displayed as NPD. This stands for No Performance Determined.		

Energy		
Direct Transmittance	ET	39%
Reflectance	ER	31%
Absorptance	EA	31%
Total Transmittance	g	43%
Shading Coefficient Total		0.49
Shading Coefficient Shortwave		0.45
Sound Reduction	R_w (C;C_{tr}) dB	31 (-1; -4)
Thermal Transmittance	W/m²K	1.1

Figure 10. Suncool 70/40

3.0 ANALYSIS RESULTS – OPENABLE WINDOWS/NAT VENTILATION

The full analysis results for the LKD's are tabulated respectively, for each of the following criteria:

Criteria 1 The % hours that T_{op} - T_{max} >=1K, shall be not more than 3%.
Criteria 2 The maximum daily degree hours, shall be < or = to 6^0K.
Criteria 3 The maximum temperature difference for T_{op} shall not exceed 4^0K.

LDK's need only pass Criteria 1 to meet the requirements of TM:59, however it should be stated that the other two criteria, and namely Criteria 3 in particular, should be taken as advisory. Criteria 2 for naturally ventilated homes would be almost impossible to meet.

3.1 TM:59 Living/Dining/Kitchen Results

3.1.1 DSY1 Weather File

The results tabulated below demonstrate that all the apartment LDK's all Pass Criterion 1 of TM:52 with DSY1 2020 High percentile 50% and Suncool 70/40 with a Solar g-value of 0.43.

Room Name	Occupied days (%)	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing
B.00.01 LDK	100	1	13	3	2
B.00.02 LDK	100	0.5	5	2	-
B.00.03 LDK	100	0.4	4	1	-
B.00.04 LDK	100	0.6	4	1	-
B.00.05 LDK	100	1.5	12	2	2
B.00.06 LDK	100	2.4	15	3	2
B.00.07 LDK	100	1.5	14	3	2
B.00.08 LDK	100	1.4	14	3	2
B.00.09 LDK	100	1.2	11	3	2
B.01.01 LDK	100	1.3	13	3	2
B.01.02 LDK	100	0.7	9	2	2
B.01.03 LDK	100	0.6	6	2	-
B.01.04 LDK	100	0.7	7	2	2
B.01.05 LDK	100	1.9	17	3	2
B.01.06 LDK	100	2.6	18	3	2
B.01.07 LDK	100	1.9	15	3	2
B.01.08 LDK	100	1.9	15	3	2
B.01.09 LDK	100	1.2	13	3	2
B.02.01 LDK	100	1.4	13	3	2
B.02.02 LDK	100	0.7	9	2	2
B.02.03 LDK	100	0.8	9	2	2
B.02.04 LDK	100	0.9	9	2	2
B.02.05 LDK	100	2	20	3	2
B.02.06 LDK	100	2.7	18	3	2
B.02.07 LDK	100	2.2	17	3	2

Room Name	Occupied days (%)	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing
B.02.08 LDK	100	2.2	16	3	2
B.02.09 LDK	100	2	16	3	2
B.03.01 LDK	100	0.2	5	2	-
B.03.02 LDK	100	0.2	3	1	-
B.03.03 LDK	100	0.3	3	1	-
B.03.04 LDK	100	0.4	4	1	-
B.03.05 LDK	100	0.5	4	1	-
B.03.06 LDK	100	0.5	7	2	2
B.03.07 LDK	100	0.6	7	2	2
B.03.08 LDK	100	0.4	4	1	-
B.03.09 LDK	100	0.9	9	2	2

The above table indicates that all LDK's PASS the DSY1 TM:59 analysis.

3.1.2 DSY2 Weather File

The results tabulated below demonstrate that some apartments LDK's Fail Criterion 1 of TM:52 with DSY2 2020 High percentile 50% and Suncool 70/40 with a Solar g-value of 0.43. The failures are modest, equating to an additional 0.8% of the annual occupied hours exceedance for the highest case.

Room Name	Occupied days (%)	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing
B.00.01 LDK	100	1.9	14	3	2
B.00.02 LDK	100	1.5	13	3	2
B.00.03 LDK	100	1.4	17	3	2
B.00.04 LDK	100	1.8	18	3	2
B.00.05 LDK	100	3.4	30	4	1 & 2
B.00.06 LDK	100	3.5	29	5	1 & 2 & 3
B.00.07 LDK	100	2.4	19	4	2
B.00.08 LDK	100	2.4	17	4	2
B.00.09 LDK	100	2.1	16	3	2
B.01.01 LDK	100	2.2	16	3	2
B.01.02 LDK	100	1.8	15	3	2
B.01.03 LDK	100	2	19	3	2
B.01.04 LDK	100	2.1	21	3	2
B.01.05 LDK	100	3.8	33	4	1 & 2
B.01.06 LDK	100	3.7	31	5	1 & 2 & 3
B.01.07 LDK	100	2.7	22	4	2
B.01.08 LDK	100	2.6	22	4	2
B.01.09 LDK	100	2.5	19	4	2
B.02.01 LDK	100	2.2	16	3	2
B.02.02 LDK	100	1.9	17	3	2
B.02.03 LDK	100	2.2	23	3	2
B.02.04 LDK	100	2.2	23	3	2
B.02.05 LDK	100	3.8	35	5	1 & 2 & 3
B.02.06 LDK	100	3.7	31	5	1 & 2 & 3

Room Name	Occupied days (%)	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing
B.02.07 LDK	100	2.9	22	4	2
B.02.08 LDK	100	2.8	22	4	2
B.02.09 LDK	100	2.7	20	4	2
B.03.01 LDK	100	1	8	2	2
B.03.02 LDK	100	0.7	8	2	2
B.03.03 LDK	100	1.1	13	3	2
B.03.04 LDK	100	1.1	14	3	2
B.03.05 LDK	100	1.8	20	3	2
B.03.06 LDK	100	1.9	19	3	2
B.03.07 LDK	100	1.6	13	3	2
B.03.08 LDK	100	1.2	10	2	2
B.03.09 LDK	100	2	16	3	2

The above table indicates that 6 LDK's FAIL the DSY2 TM:59 analysis.

3.1.3 DSY3 Weather File

The results tabulated below demonstrate that all apartment LDK's Fail Criterion 1 of TM:52 with DSY3 2020 High percentile 50% and Suncool 70/40 with a Solar g-value of 0.43. However, 17 LDK's fail the analysis, with an additional 2.4% hours of occupancy exceedance in the highest case.

Room Name	Occupied days (%)	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing
B.00.01 LDK	100	3.1	24	4	1 & 2
B.00.02 LDK	100	2.2	18	3	2
B.00.03 LDK	100	2.1	20	3	2
B.00.04 LDK	100	2.5	22	4	2
B.00.05 LDK	100	4.8	31	4	1 & 2
B.00.06 LDK	100	5.2	32	5	1 & 2 & 3
B.00.07 LDK	100	3.9	23	4	1 & 2
B.00.08 LDK	100	3.8	23	4	1 & 2
B.00.09 LDK	100	3.4	19	4	1 & 2
B.01.01 LDK	100	3.3	27	5	1 & 2 & 3
B.01.02 LDK	100	2.4	25	4	2
B.01.03 LDK	100	2.6	25	4	2
B.01.04 LDK	100	2.6	25	4	2
B.01.05 LDK	100	5.3	38	5	1 & 2 & 3
B.01.06 LDK	100	5.3	37	5	1 & 2 & 3
B.01.07 LDK	100	4.1	28	5	1 & 2 & 3
B.01.08 LDK	100	4.1	28	5	1 & 2 & 3
B.01.09 LDK	100	3.6	22	5	1 & 2 & 3
B.02.01 LDK	100	3.5	27	5	1 & 2 & 3
B.02.02 LDK	100	2.6	25	4	2
B.02.03 LDK	100	2.8	27	4	2
B.02.04 LDK	100	2.9	27	4	2
B.02.05 LDK	100	5.5	40	5	1 & 2 & 3

Room Name	Occupied days (%)	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing
B.02.06 LDK	100	5.3	37	5	1 & 2 & 3
B.02.07 LDK	100	4.5	30	5	1 & 2 & 3
B.02.08 LDK	100	4.5	29	5	1 & 2 & 3
B.02.09 LDK	100	4.4	28	5	1 & 2 & 3
B.03.01 LDK	100	1.3	14	3	2
B.03.02 LDK	100	0.9	12	3	2
B.03.03 LDK	100	1.5	16	3	2
B.03.04 LDK	100	1.6	18	3	2
B.03.05 LDK	100	2	24	3	2
B.03.06 LDK	100	1.8	19	3	2
B.03.07 LDK	100	2.1	17	3	2
B.03.08 LDK	100	1.7	14	3	2
B.03.09 LDK	100	2.9	19	3	2

The above table indicates that 17 LDK's FAIL the DSY3 TM:59 analysis.

3.1.4 LDK TM:59 Result Analysis

The LDK's Pass the TM59 analysis comfortably under the DSY1 file. However, both the DSY2 & DSY3 show some moderate failures. Under Criterion 1, the Hours of Exceedance should not exceed 3% of the occupied hours. Under DSY2 this extends to 3.8% (worst case) of the occupied hours and under DSY3 this extends to 5.4% (worst case) of the occupied hours.

In terms of hours, Criterion 3 must be less than 60hrs per annum. The DSY2 fail shows 76hrs, an additional 16hrs per annum. DSY3 shows 108hrs, an additional 48hrs per annum. Thus, under the more extreme DSY2 & 3 climate change heat wave scenarios, there is some moderate risk of overheating in some apartments. However, under normal climate change forecast scenario, the apartments perform well.

3.2 TM:59 Bedroom Results

3.2.1 DSY1 Weather File

The internal operative temperature for the bedrooms must not exceed 26°C for more than **33** annual hours in total. The following table summarises the results for the test.

Location	Operative temperature (TM 52/CIBSE) (°C) - hours in range > 26.00
B.00.01 BED1	17
B.00.01 BED2	17
B.00.02 BED1	17
B.00.02 BED2	15
B.00.02 BED3	16
B.00.03 BED1	15
B.00.04 BED1	16
B.00.04 BED2	20
B.00.05 BED1	18
B.00.05 BED2	20
B.00.05 BED3	18
B.00.06 BED1	19
B.00.06 BED2	21
B.00.07 BED1	19
B.00.07 BED2	21
B.00.08 BED1	17
B.00.09 BED1	17
B.01.01 BED1	19
B.01.01 BED2	18
B.01.02 BED1	18
B.01.02 BED2	15
B.01.02 BED3	17
B.01.03 BED1	16
B.01.03 BED2	19
B.01.04 BED1	19
B.01.04 BED2	20
B.01.05 BED1	21
B.01.05 BED2	20
B.01.05 BED3	20
B.01.06 BED1	21
B.01.06 BED2	22
B.01.07 BED1	21
B.01.07 BED2	21
B.01.08 BED1	21
B.01.09 BED1	19
B.02.01 BED1	18
B.02.01 BED2	18
B.02.02 BED1	19
B.02.02 BED2	15
B.02.02 BED3	17

Location	Operative temperature (TM 52/CIBSE) (°C) - hours in range > 26.00
B.02.03 BED1	17
B.02.03 BED2	19
B.02.04 BED1	20
B.02.04 BED2	20
B.02.05 BED1	21
B.02.05 BED2	20
B.02.05 BED3	19
B.02.06 BED1	21
B.02.06 BED2	22
B.02.07 BED1	21
B.02.07 BED2	22
B.02.08 BED1	21
B.02.09 BED1	20
B.03.01 BED1	26
B.03.01 BED2	29
B.03.02 BED1	26
B.03.02 BED2	27
B.03.02 BED3	26
B.03.03 BED1	26
B.03.03 BED2	22
B.03.04 BED1	28
B.03.04 BED2	17
B.03.05 BED1	27
B.03.05 BED2	25
B.03.05 BED3	23
B.03.06 BED1	26
B.03.06 BED2	27
B.03.07 BED1	25
B.03.07 BED2	31
B.03.08 BED1	21
B.03.09 BED1	28

The above table records the average hours the bedrooms exceed 26°C, as can be seen, all bedrooms **PASS** the analysis under this test condition.

3.2.2 DSY2 Weather File

The internal operative temperature for the bedrooms must not exceed 26°C for more than **33** annual hours in total. The following table summarises the results for the test.

Location	Operative temperature (TM 52/CIBSE) (°C) - hours in range > 26.00
B.00.01 BED1	22
B.00.01 BED2	24
B.00.02 BED1	25
B.00.02 BED2	22
B.00.02 BED3	22
B.00.03 BED1	27
B.00.04 BED1	28
B.00.04 BED2	27
B.00.05 BED1	29
B.00.05 BED2	30
B.00.05 BED3	25
B.00.06 BED1	30
B.00.06 BED2	30
B.00.07 BED1	28
B.00.07 BED2	30
B.00.08 BED1	28
B.00.09 BED1	26
B.01.01 BED1	25
B.01.01 BED2	26
B.01.02 BED1	26
B.01.02 BED2	22
B.01.02 BED3	23
B.01.03 BED1	28
B.01.03 BED2	29
B.01.04 BED1	32
B.01.04 BED2	29
B.01.05 BED1	31
B.01.05 BED2	31
B.01.05 BED3	26
B.01.06 BED1	32
B.01.06 BED2	32
B.01.07 BED1	32
B.01.07 BED2	31
B.01.08 BED1	30
B.01.09 BED1	30
B.02.01 BED1	23
B.02.01 BED2	28
B.02.02 BED1	27
B.02.02 BED2	22
B.02.02 BED3	23
B.02.03 BED1	28
B.02.03 BED2	29
B.02.04 BED1	33

Location	Operative temperature (TM 52/CIBSE) (°C) - hours in range > 26.00
B.02.04 BED2	29
B.02.05 BED1	34
B.02.05 BED2	31
B.02.05 BED3	26
B.02.06 BED1	31
B.02.06 BED2	32
B.02.07 BED1	34
B.02.07 BED2	32
B.02.08 BED1	30
B.02.09 BED1	30
B.03.01 BED1	52
B.03.01 BED2	48
B.03.02 BED1	44
B.03.02 BED2	51
B.03.02 BED3	43
B.03.03 BED1	47
B.03.03 BED2	40
B.03.04 BED1	48
B.03.04 BED2	30
B.03.05 BED1	44
B.03.05 BED2	43
B.03.05 BED3	35
B.03.06 BED1	40
B.03.06 BED2	44
B.03.07 BED1	43
B.03.07 BED2	49
B.03.08 BED1	39
B.03.09 BED1	47

The above table records the average hours the bedrooms exceed 26°C, as can be seen, 20 bedrooms **Fail** the analysis under this test condition. The highest failure illustrating an additional 16hrs.

3.2.3 DSY3 Weather File

The internal operative temperature for the bedrooms must not exceed 26°C for more than **32** annual hours in total. The following table summarises the results for the test.

Location	Operative temperature (TM 52/CIBSE) (°C) - hours in range > 26.00
B.00.01 BED1	42
B.00.01 BED2	42
B.00.02 BED1	40
B.00.02 BED2	36
B.00.02 BED3	37
B.00.03 BED1	39

Location	Operative temperature (TM 52/CIBSE) (°C) - hours in range > 26.00
B.00.04 BED1	44
B.00.04 BED2	43
B.00.05 BED1	46
B.00.05 BED2	43
B.00.05 BED3	40
B.00.06 BED1	44
B.00.06 BED2	44
B.00.07 BED1	47
B.00.07 BED2	45
B.00.08 BED1	45
B.00.09 BED1	44
B.01.01 BED1	45
B.01.01 BED2	43
B.01.02 BED1	43
B.01.02 BED2	38
B.01.02 BED3	40
B.01.03 BED1	42
B.01.03 BED2	47
B.01.04 BED1	49
B.01.04 BED2	45
B.01.05 BED1	48
B.01.05 BED2	43
B.01.05 BED3	40
B.01.06 BED1	45
B.01.06 BED2	46
B.01.07 BED1	50
B.01.07 BED2	47
B.01.08 BED1	48
B.01.09 BED1	44
B.02.01 BED1	45
B.02.01 BED2	44
B.02.02 BED1	43
B.02.02 BED2	38
B.02.02 BED3	40
B.02.03 BED1	44
B.02.03 BED2	47
B.02.04 BED1	50
B.02.04 BED2	45
B.02.05 BED1	48

Location	Operative temperature (TM 52/CIBSE) (°C) - hours in range > 26.00
B.02.05 BED2	43
B.02.05 BED3	40
B.02.06 BED1	44
B.02.06 BED2	47
B.02.07 BED1	50
B.02.07 BED2	48
B.02.08 BED1	48
B.02.09 BED1	44
B.03.01 BED1	77
B.03.01 BED2	72
B.03.02 BED1	66
B.03.02 BED2	72
B.03.02 BED3	66
B.03.03 BED1	68
B.03.03 BED2	60
B.03.04 BED1	73
B.03.04 BED2	47
B.03.05 BED1	63
B.03.05 BED2	59
B.03.05 BED3	53
B.03.06 BED1	62
B.03.06 BED2	66
B.03.07 BED1	65
B.03.07 BED2	73
B.03.08 BED1	63
B.03.09 BED1	72

The above table records the average hours the bedrooms exceed 26°C, as can be seen, all bedrooms **Fail** the analysis under this test condition. The highest failure illustrating an additional 45hrs.

3.2.4 Bedroom TM:59 Result Analysis

The bedrooms all comfortably Pass the TM:59 analysis under all DSY1 weather file. Under the DSY2 weather file, the greatest exceedance is 48hrs, an additional 16hrs of the annual occupied hours. Under the DSY3 weather file, all bedrooms failed; with the greatest exceedance an additional 45hrs of the annual occupied period.

3.3 Communal Corridors – DSY1, DSY2 & DSY3

The methodology requires that internal communal corridors are also considered. To pass they must not exceed 28°C for 3% of the annual hours.

DSY1.aps Location	Operative temperature (TM 52/CIBSE) (°C) - % hours in range > 28.00
00.COMM CORRIDOR	0.2
00.ENT LOBBY	0
01.COMM CORRIDOR	0.2
02.COMM CORRIDOR	0.3
03.COMM CORRIDOR	0.4

DSY2.aps Location	Operative temperature (TM 52/CIBSE) (°C) - % hours in range > 28.00
00.COMM CORRIDOR	0.4
00.ENT LOBBY	0.1
01.COMM CORRIDOR	0.5
02.COMM CORRIDOR	0.7
03.COMM CORRIDOR	1.1

DSY3.aps Location	Operative temperature (TM 52/CIBSE) (°C) - % hours in range > 28.00
00.COMM CORRIDOR	0.6
00.ENT LOBBY	0.3
01.COMM CORRIDOR	0.8
02.COMM CORRIDOR	0.9
03.COMM CORRIDOR	1.4

Under all 3 weather files the communal corridors modelled all passed TM:59.

4.0 CONCLUSION

Three 2020 weather files are considered, these are described as follows:

- **DSY1 – A moderately warm summer.**
  Summers will have a 1-in-7 chance of being equal or hotter than this DSY.
- **DSY2 – A summer with a short intense warm spell.**
  An intense summer with a heat event the same length of that of DSY1, but with a higher intensity.
- **DSY3 – A summer with a long less intense warm spell.**
  The heat event is less intense than that of DSY2 but has a higher intensity than DSY1. It has a longer duration than that of DSY1.

The results for DSY2 and DSY3 are for information on the buildings performance in relation to future climate change and whilst they need to be reported they are not mandatory to pass under TM:59.
The results of the analysis are summarised as follows:

- **LDK's**
  - DSY1 – All LDKs PASS TM:59
  - DSY2 – Some LDK's modestly FAIL TM:59
  - DSY3– Some LDK's modestly FAIL TM:59
- **Bedrooms**
  - DSY1 – All Bedrooms PASS TM:59
  - DSY2 – 20 Bedrooms modestly FAIL TM:59
  - DSY3 – All Bedrooms modestly FAIL TM:59

APPENDIX A

DESIGN CRITERIA

IES-VE Design Criteria and Input Data

Data:			
Building category:	Category II (new builds.)		
Weather file:	London_LHR_DSY1_2020High50.epw		
Days data=	364	01-Jan	30-Dec
Days (summer)=	153	01-May	30-Sep
Data OK?	OK	Full summer	

- Occupancy -
  - As per TM:59 Table 2 (Inc corrigenda)
- Lighting –
  - As per TM:59 Table 2 (Inc corrigenda)
- Small Power -
  - As per TM:59 Table 2 (Inc corrigenda)
- Infiltration – 0.25ACH constant infiltration rate
- Ventilation –
  - Bedrooms – Natural Only
  - Living/Dining/Kitchen Areas – Natural Only
- Weather File –
  - London_LHR_DSY1_2020High50.epw
  - London_LHR_DSY2_2020High50.epw
  - London_LHR_DSY3_2020High50.epw

Building Fabric	U-Values
Windows	DG 1.40 W/m^2.K, g-value = 0.43
External Wall	0.15 W/m^2 ^{o}K
Ground Floor	0.12 W/m^2 ^{o}K
Roof	0.12 W/m^2 ^{o}K
Space Heating Source	Air Source Heat Pump (AGSHP) – sCOP = 2.5
Ventilation System Type	Mechanical Ventilation with Heat Recovery (MVHR)
Air Tightness	3.0 m^3/h/m^2@ 50Pa