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SUSTAINABILITY
OVERHEATING ANALYSIS

REVISION 02 – 11 DECEMBER 2019

Audit sheet.

Rev.	Date	Description of change / purpose of issue	Prepared	Reviewed	Authorised
01	09/12/2019	First Issue	JT	RG	KC
02	11/12/2019	Updated to incorporate cooling hierarchy section	JT	RG	KC

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Contents.

Executive summary.

This report has been produced in support of the planning application for renovation of Air Studios, Lyndhurst Hall, Hampstead.

The proposed renovation consists of the renovation of the existing office spaces and the construction of a new café area.

This report outlines the cooling hierarchy approach followed in the project and reviews the overheating risk assessment carried out in line with CIBSE TM52 and CIBSE Guide A (2015). A combination of openable windows, high performance glazing, and mechanical ventilation has been used to evaluating the overheating risk of the occupied spaces. Through these measures, comfortable internal temperatures can be achieved for a majority of the year. In some spaces active cooling will be required in peak summer conditions.

Active cooling will as a minimum be required in the following spaces:

- G.02 Proposed Office
- 1.02 Proposed Dining Area (Glazed)
- 1.04 Meeting Room

Where possible, natural ventilation has been considered to reduce the demand for active cooling.

Full results are included in Section 4 of this report.

1. Introduction.

This report reviews the overheating risk assessment for the occupied spaces of the proposed Air Studios renovation, using dynamic simulation modelling following the guidance detailed in *CIBSE Guide A (2015)* and *CIBSE TM52 Adaptive Thermal Comfort* (2016).

1.1 CIBSE Guide A (2015) & CIBSE TM52 Adaptive Thermal Comfort

CIBSE Guide A (2015) introduces the recommendation of using the adaptive approach (detailed in CIBSE TM52: The limits of thermal comfort) to determine if a building or room is likely to overheat in free running naturally ventilated buildings. This supersedes the single temperature overheating limit approach included in the 2006 version of CIBSE Guide A, which recommended limiting the expected occurrence of operative temperatures above 28°C to 1% of the annual occupied period; setting the maximum acceptable indoor operative temperature to 30°C.

There are a few reasons that support this change in the methodology. According to the 'adaptive' approach to thermal comfort, the temperature at which the majority of people are comfortable 'tracks' the mean indoor temperature as a result of the correlation between indoor and outdoor temperature. This means that comfort temperature varies with outdoor temperature in free-running buildings, as shown in Figure 1.

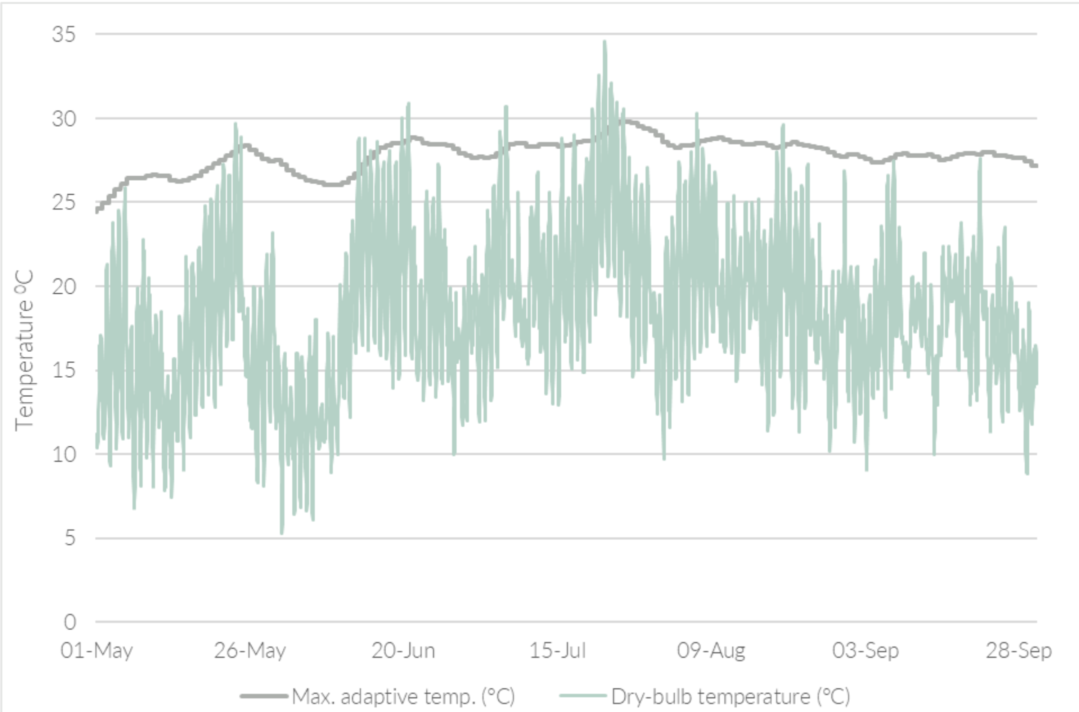


Figure 1: Adaptive Comfort –Maximum acceptable temperature and outside air temperature (based on London LHR DSY1 2020 High 50 weather file)

Initial simulations have been conducted without the use of any active cooling. Under Simulation 1, space 1.01 and 1.02 have been evaluated under TM52. As the remainder of the occupied spaces do not have suitable windows to allows for natural ventilation, they have been assessed under CIBSE Guide A for primarily mechanically ventilated spaces. Simulation 2 has been conducted with active cooling in the 1.02 Proposed Dining Area (Glazed), the space has therefore been excluded from overheating calcs. The remaining spaces have been evaluated as in Simulation 1.

1.2 Compliance Requirements – 'Free Running'

The TM52 thermal comfort criteria are based upon the adaptive comfort model, a variable (adaptive) temperature threshold that is related to the outside running-mean dry-bulb temperature based upon a CIBSE Design Summer Year (DSY) weather file.

For all free-running buildings the values for the maximum acceptable temperature (Tmax) are calculated from the running mean of the outdoor temperature (Trm) as follows:

$$T_{rm} = (\Theta_{ed-1} + \Theta_{ed-2} + \Theta_{ed-3} + \Theta_{ed-4} + \Theta_{ed-5} + \Theta_{ed-6} + \Theta_{ed-7})/3.8$$

Θ_{ed-1} is the daily mean external temperature for the previous day

Θ_{ed-2} is the daily mean external temperature for the day before and so on

The maximum acceptable temperature can be calculated by the following formula:

$$T_{max} = 0.33T_{rm} + 21.8$$

There are three criteria for overheating and at least two of the three criteria must be achieved in order to comply with Adaptive Comfort:

Criterion 1 – Hours of Exceedance (H_e)

The first criterion sets a limit for the number of hours (He) that the operative temperature can exceed the threshold comfort temperature (upper limit of the range of comfort temperature) by 1K or more during the occupied hours of a typical non-heating season (1st May to 30th September). The number of hours (i.e. H_e=hours of exceedance) during which ΔT is greater than or equal to 1K during the period May to September inclusive shall not be more than 3% of occupied hours. ΔT is defined as operative temperature less the maximum acceptable temperature (ΔT= T_{op}-T_{max},). ΔT is rounded to the nearest whole degree.

Criterion 2 – Daily Weighted Exceedance (W_e)

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 its duration. The sum of the weighted exceedance for each degree K above T_{max} (1K, 2K and 3K) shall be less than or equal to 6 in any one day; where W_e = ΣH_e (1,2,3)*(ΔT)(1,2,3) and ΔT (T_{op}-T_{max}), rounded to a whole number.

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. To set an absolute maximum value for the indoor operative temperature the value of ΔT (T_{op}-T_{max}) shall not exceed 4K.

1.3 CIBSE Guide A (2015) and predominantly mechanically ventilated spaces

For spaces where mechanical ventilation is the primary source of ventilation, the conditions of a CIBSE fixed temperature test must be followed, i.e. all occupied rooms should not exceed an operative temperature of 26 °C for more than 3% of the annual occupied annual hours (CIBSE Guide A (2015a)).

2. Cooling hierarchy.

The London Plan Policy 5.9 (Overheating and Cooling) requests that developments should reduce potential overheating risk and reliance on air conditioning systems. A 'cooling hierarchy' is provided and the Proposed Development has sought to follow this hierarchy.

The following cooling hierarchy has been followed to limit the effects of heat gains in summer:

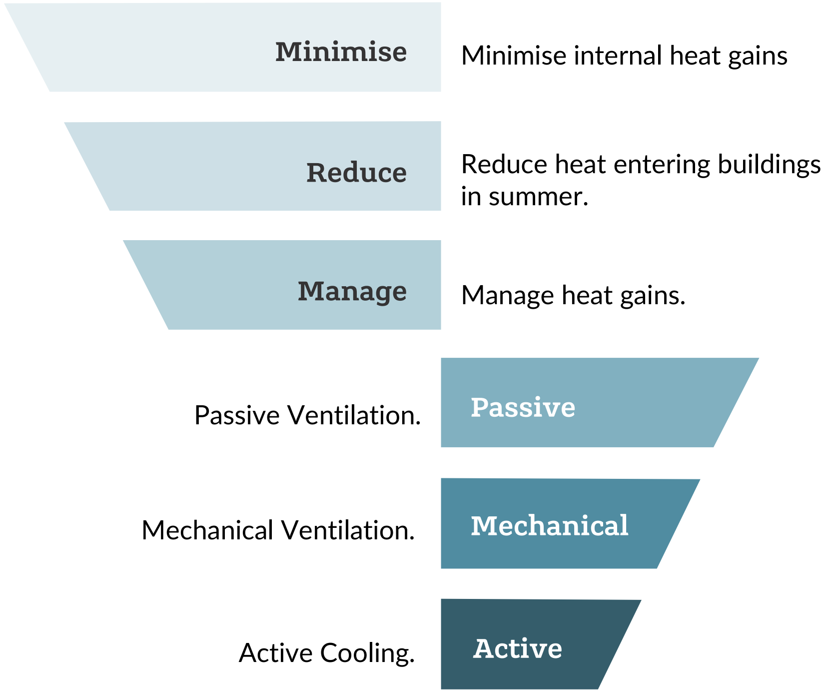


Figure 2: Cooling hierarchy.

2.1 Minimising internal heat generation through energy efficient design

The following mitigation methods will be implemented to minimise the internal heat generation through energy efficient design at the Proposed Development:

- Energy efficient lighting (such as LED or CFL) with low heat output.
- Insulation to heating and hot water pipework and minimisation of dead-legs to avoid standing heat loss from pipework.
- Energy efficient equipment should be specified where appropriate.

2.2 Reducing the amount of heat entering the building in summer

High performance, solar control glazing is proposed to be installed, incorporating very low g-values to minimise solar gains.

2.3 Manage the heat within the building

The existing construction of solid brickwork will provide a degree of thermal mass that will assist in reducing peak temperatures in summer.

2.4 Passive ventilation

Natural ventilation through opening windows is proposed in the rooms with external windows, i.e. 1.01 Proposed office and storage and 1.02 Proposed dining (glazed). All other areas do not have external openings and therefore natural ventilation is not possible.

2.5 Mechanical ventilation

Mechanical ventilation is proposed to be installed in the occupied areas with a minimum flowrate of 10l/s/person in line with Building Regulations Part F requirements. The results of the dynamic simulation modelling, included in Section 4 of this report, suggest that comfortable conditions are expected to be maintained for the majority of the year with a combination of mechanical ventilation and natural ventilation in the areas with external openings.

2.6 Active cooling

Following the dynamic thermal modelling simulations carried out the assess the overheating risk, it is recommended to provide active cooling to some rooms in order to provide thermal comfort during peak summer conditions. Full details of the analysis are included in sections 3 and 4 of this report.

3. Input Criteria & Assumptions.

3.1 Profile templates & internal gains

The occupancy profiles have been provided by Brightspace Architects on 27.11.2018. Full variance profiles can be found in Appendix A

3.2 Geometry

The thermal model (Figure 3 and Figure 4) has been based on the drawings received from Brightspace Architects on the 27.11.2018. This report considers the shading provided by the rest of the building.

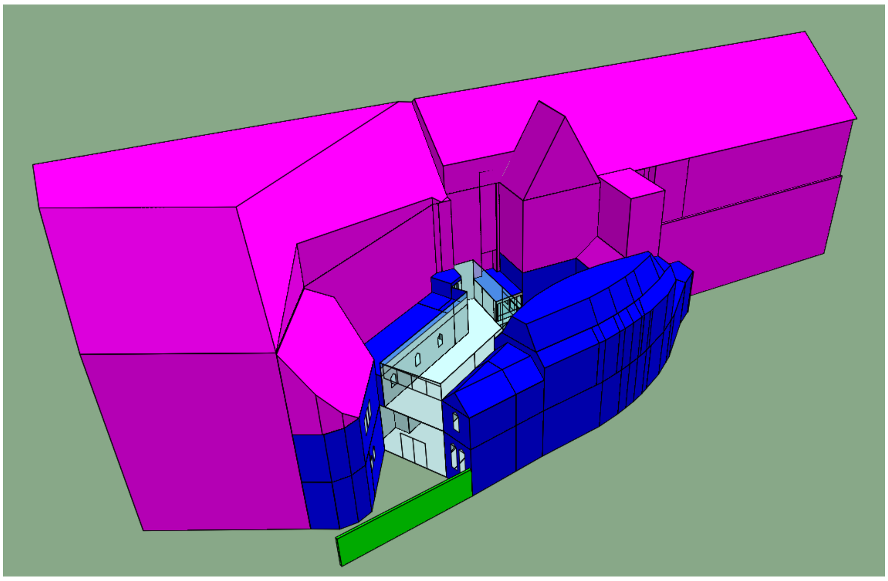


Figure 3: Thermal Model - North view.

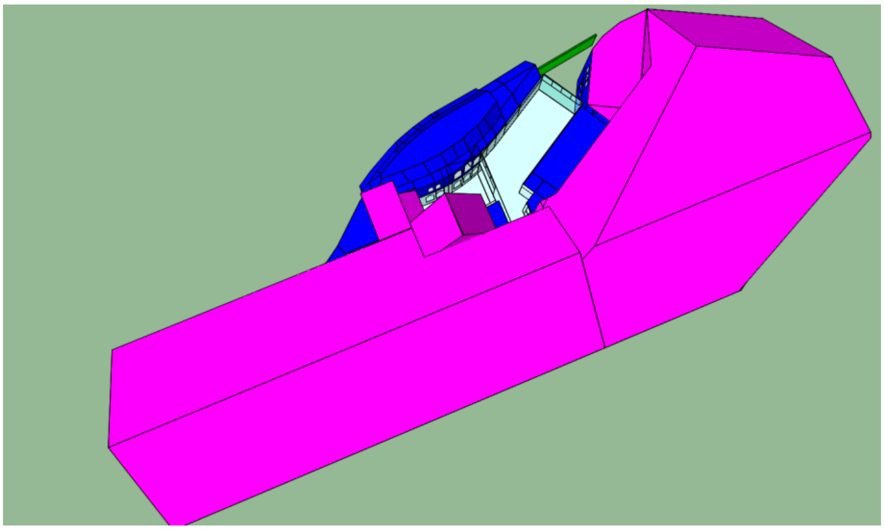


Figure 4: Thermal Model – South View

3.3 Assessed spaces

All occupied spaces without active cooling have been included in this overheating assessment. These spaces have a range of orientations and adjacent shade. Full mark-ups can be found in Appendix C.

3.4 Weather file

The weather file used for this analysis is the nearest CIBSE DSY1 (Design Summer Year) for the 2020s high emissions, 50% percentile scenario (i.e. London Heathrow DSY1 2020 High50). This is in line with current industry recommendations for overheating risk assessments.

3.5 Gains

Internal gains have been included in the simulations following the guidance in CIBSE TM52, as detailed in Table 1 below.

	Occupancy	Lighting	Small Power
G.01 Reception and Security	2 person*	$10W/m^2$	$15W/m^2$
G.02 Proposed Office	8 person*	$10W/m^2$	$15W/m^2$
G.03 Proposed Office (Accounts)	3 person*	$10W/m^2$	$15W/m^2$
G.04 Proposed Office (Meeting)	3 person*	$10W/m^2$	$15W/m^2$
1.01 Proposed Office and Storage	2 person*	$10W/m^2$	$15W/m^2$
1.02 Proposed Dining Area (Glazed)	46 person*	$10W/m^2$	$0W/m^2$
1.03 Proposed dining Area (Small)	8 person*	$10W/m^2$	$15W/m^2$
1.04 Meeting Room	10 person*	$10W/m^2$	100W

*75W (sensible) & 55W (latent) per person

Table 1: Internal gains

3.6 Fabric & Constructions

All assigned fabric constructions and U-Values have been assumed based on typical values for existing construction and best practice for newly constructed elements and are detailed in Table 2 below. High performance glazing is particular important in reducing solar gains.

Construction element	U-value
Existing Wall U-value	$1.69 W/m^2.K$
Existing Roof U-value	$1.00 W/m^2.K$
Existing Window U-value (including frame)	$5.59 W/m^2.K$
Existing Floor U-value	$0.45 W/m^2.K$
New Window U-value (including frame)	$1.4 W/m^2.K$
New Rooflight U-value (including frame)	$1.6 W/m^2.K$
New Roof U-value (walkway)	$0.18 W/m^2.K$
Glazing G-value	0.20 – Rooflight, 0.35 – Vertical Glazing, 0.8 Existing glazing.
Thermal mass	Low
Infiltration	0.10ach

Table 2: Fabric performance

3.7 Mechanical ventilation

Mechanical ventilation has been included in the occupied areas. The minimum ventilation requirements of 10 l/s/person as defined in Building Regulations Part F has been used for the purpose of this simulation. The mechanical ventilation has been assumed to active from 08:00 to 18:00 when the internal air temperature is higher than 22 °C and active in all other hours when the internal air temperature is higher than 18 °C. Details can be found in Appendix B.

3.8 Opening windows

The 1st floor glazed dining area has been evaluated using openable windows. To encourage cross ventilation openable glazing has been placed on both the North and South facades as demonstrated in Figure 4 below.

Both facades have been evaluated with an equivalent free area of 2.5 m^2 respectively.

The 3D site survey demonstrates that the window in 1.01 Proposed Office and Storage. This has been assumed to be openable with an equivalent free area of 0.23 m^2.

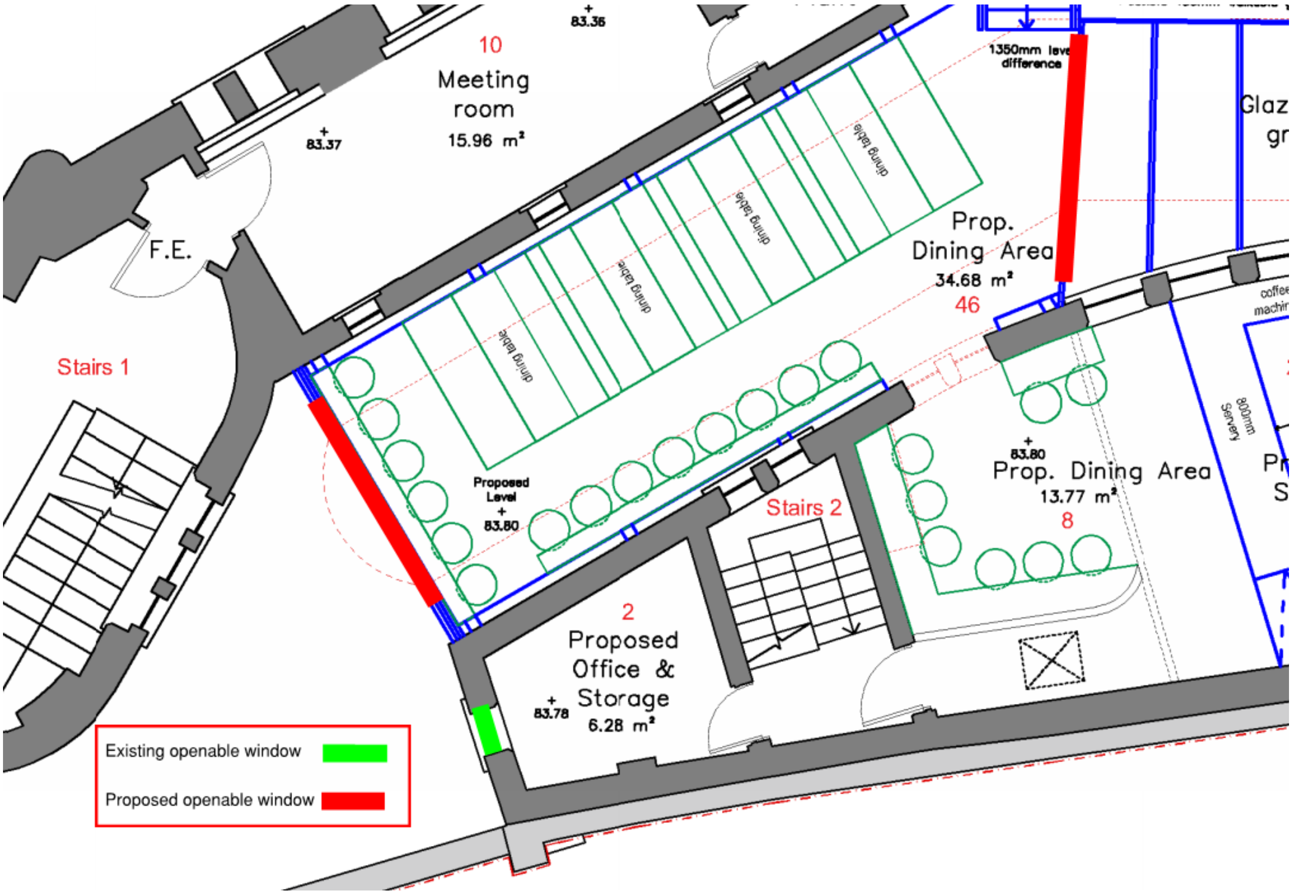


Figure 5: Openable windows mark up.

All windows have been assumed to be opened when the internal temperature is higher than 22 °C (See Appendix B).

4. Results.

The first simulation has been run with no cooling in 1.02 Proposed dining area (Glazed). The second simulation has included active cooling in this space

4.1 Simulation 1 – No active cooling.

	Criterion 1 (%Hrs Top-Tmax>=1K) (Max value = 3)	Criterion 2 (Max. Daily Deg.Hrs) (Max value = 6)	Criterion 3 (Max. DeltaT) (Max value = 4)	Compliance with TM52
1.01 Proposed Office and Storage	0.3	5	1	Pass
1.02 Proposed Dining Area (Glazed)	5.5	51	7	Fail

Table 3: TM52 Results – Simulation 1.

	Dry resultant temperature (°C) - % hours > 26 °C (Target is <3%)	Compliance with CIBSE Guide A
G.01 Reception & security	3.2	Fail
G.02 Proposed office	4.8	Fail
G.03 Proposed office (Accounts)	3.3	Fail
G.04 Proposed Office (Meeting)	2.4	Pass
1.03 Prop. Dining area (small)	4.2	Fail
1.04 Meeting room	5.2	Fail

Table 4: CIBSE Guide A Results – Simulation 1.

Under Simulation 1 the majority of occupied spaces exceed the relevant overheating criterion. The openable windows significantly help to reduce the internal temperatures in space 1.02 below 26 degrees – as seen in Figure 5. However, during peak conditions the internal temperatures still reach high levels.

This simulation demonstrated that due to the large amount of glazing and the high expected occupancy in the 1.02 Proposed dining area (Glazed), active cooling will be needed to maintain comfortable temperatures in this space during the summer. Simulation 2 has been evaluated with active cooling in this area. This space is therefore excluded from the overheating analysis in Simulation 2.

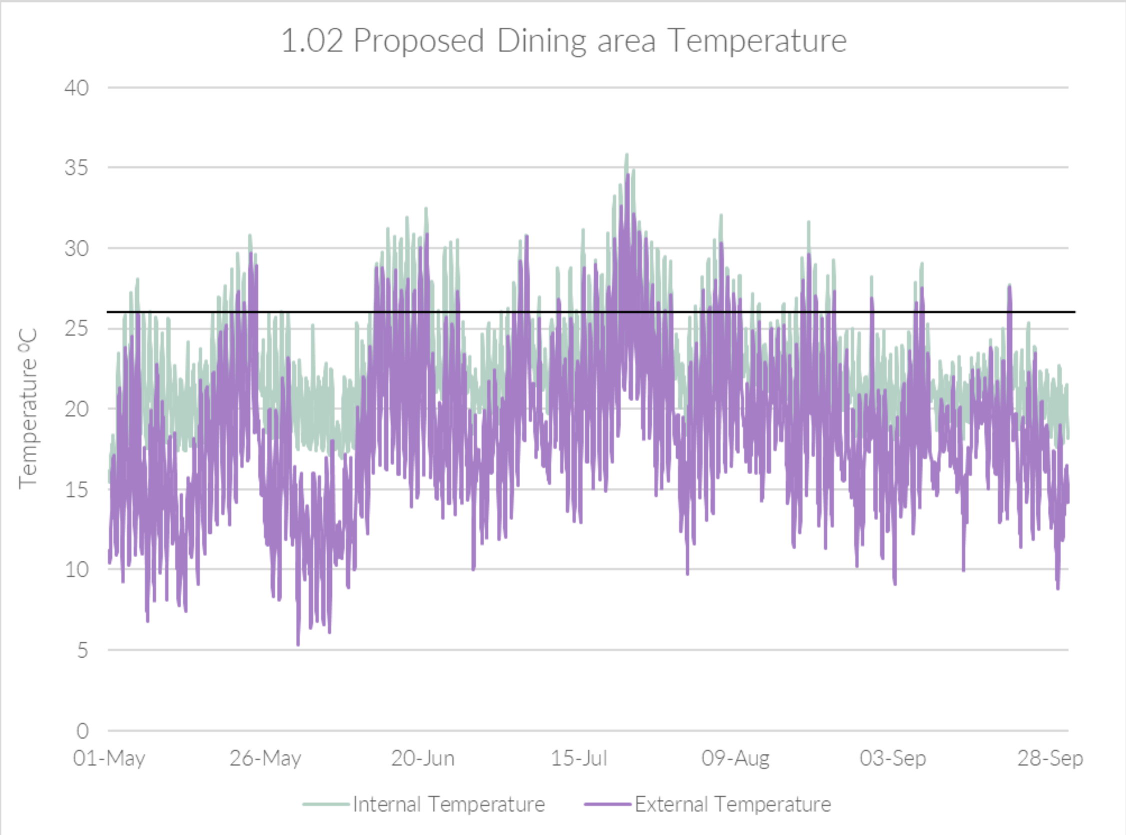


Figure 6: Internal Vs External temperature - 1.02.

4.2 Simulation 2 – Active Cooling.

With the inclusion of cooling in space 1.02, the remaining spaces all achieve reductions in their internal temperatures due to less heat transfer between rooms. As space 1.02 is actively cooled it has not been included in these results.

	Criterion 1 (%Hrs Top-Tmax>=1K) (Max value = 3)	Criterion 2 (Max. Daily Deg.Hrs) (Max value = 6)	Criterion 3 (Max. DeltaT) (Max value = 4)	Compliance with TM52
1.01 Proposed Office and Storage	0.3	5	1	Pass

Table 5: CIBSE TM52 Results - Simulation 2.

	Dry resultant temperature (°C) - % hours > 26 °C (Target is <3%)	Compliance with CIBSE Guide A
G.01 Reception & security	0.7	Pass
G.02 Proposed office	3.5	Fail
G.03 Proposed office (Accounts)	2.4	Pass
G.04 Proposed Office (Meeting)	2.0	Pass
1.03 Prop. Dining area (small)	0.5	Pass
1.04 Meeting room	4.1	Fail

Table 6: CIBSE Guide A Results - Simulation 2.

While the majority of spaces now achieve complinace with the relevent thermal comfort criteria, spaces G.02 and 1.04 will require active cooling along with space 1.02.

4.3 Assessment of more extreme weather scenarios

In line with GLA guidance, dynamic simulations have also been carried out using the more extreme DSY2 and DSY3 weather files, for a 2020 high emissions scenario. While compliance with the CIBSE thermal comfort criteria under these weather files is not mandatory, the results highlight areas where overheating risk could be increased under these more extreme summer scenarios.

DSY2	Criterion 1 (%Hrs Top-Tmax>=1K) (Max value = 3)	Criterion 2 (Max. Daily Deg.Hrs) (Max value = 6)	Criterion 3 (Max. DeltaT) (Max value = 4)	Compliance with TM52
1.01 Proposed Office and Storage	1.1	17	3	Pass

Table 7: CIBSE TM52 Results - Simulation 2 (with LHR DSY2 2020 High50 weather file).

DSY2	Dry resultant temperature (°C) - % hours > 26 °C (Target is <3%)	Compliance with CIBSE Guide A
G.01 Reception & security	2.2	Pass
G.02 Proposed office	4.7	Fail
G.03 Proposed office (Accounts)	3.8	Fail
G.04 Proposed Office (Meeting)	3.5	Fail
1.03 Prop. Dining area (small)	1.4	Pass
1.04 Meeting room	5.3	Fail

Table 8: CIBSE Guide A Results - Simulation 2 (with LHR DSY2 2020 High50 weather file).

DSY3	Criterion 1 (%Hrs Top-Tmax>=1K) (Max value = 3)	Criterion 2 (Max. Daily Deg.Hrs) (Max value = 6)	Criterion 3 (Max. DeltaT) (Max value = 4)	Compliance with TM52
1.01 Proposed Office and Storage	1	16	2	Pass

Table 9: CIBSE TM52 Results - Simulation 2 (with LHR DSY3 2020 High50 weather file).

DSY3	Dry resultant temperature (°C) - % hours > 26 °C (Target is <3%)	Compliance with CIBSE Guide A
G.01 Reception & security	3.3	Fail
G.02 Proposed office	6.7	Fail
G.03 Proposed office (Accounts)	5.5	Fail
G.04 Proposed Office (Meeting)	5.5	Fail
1.03 Prop. Dining area (small)	1.9	Pass
1.04 Meeting room	6.7	Fail

Table 10: CIBSE Guide A Results - Simulation 2 (with LHR DSY3 2020 High50 weather file).

5. Conclusion.

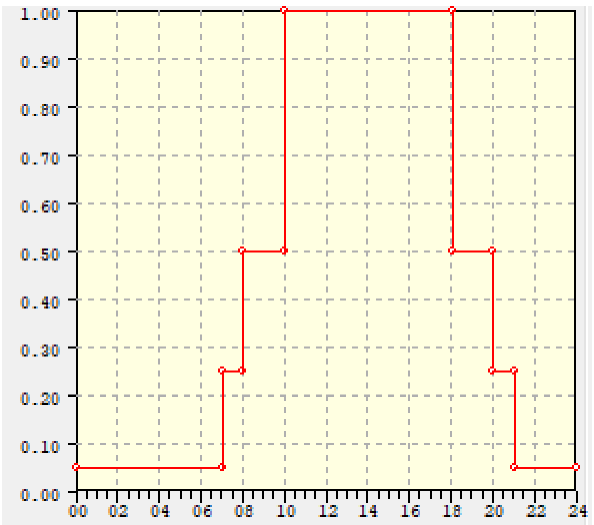
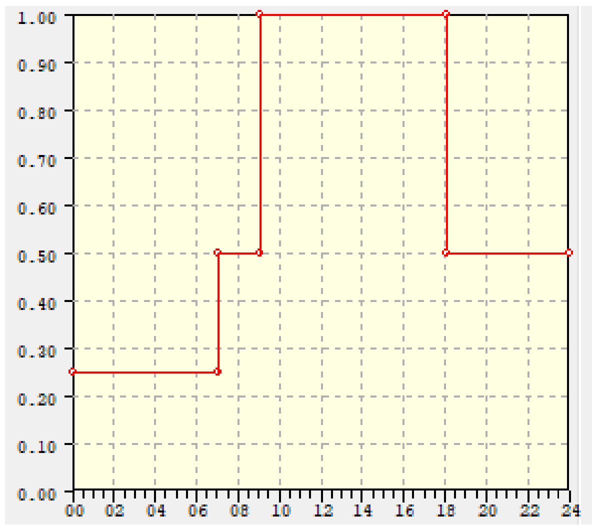
Through a combination of openable windows, high performance glazing, and mechanical ventilation comfortable internal temperatures can be achieved for a majority of the year. In some spaces active cooling will be required in peak summer conditions

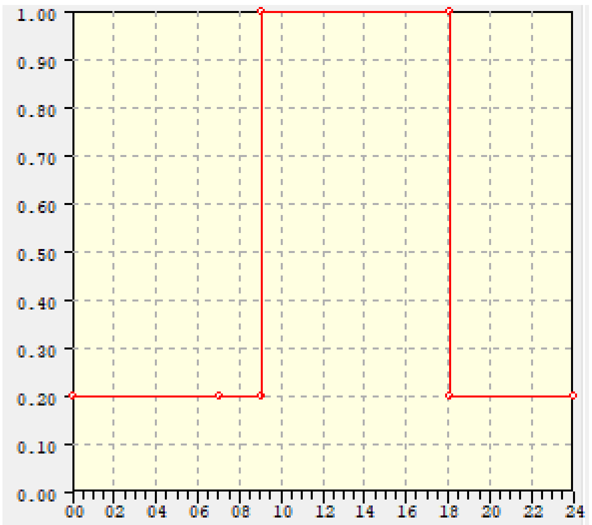
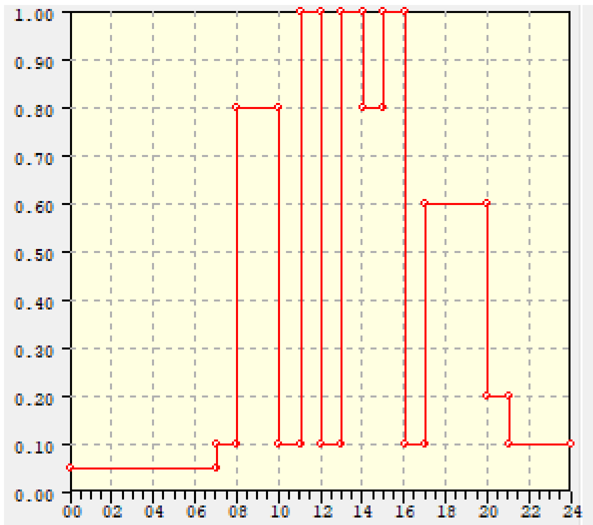
Initial simulations have identified that the space "1.02 Proposed dining area (Glazed)" will require active cooling to maintain comfortable internal conditions during peak summer conditions. The openable windows detailed in Section 3.8 contribute to a passive cooling capacity for the space, however active cooling will be need in peak scenarios.

When active cooling was included (Simulation 2), there is a measurable improved in all other occupied spaces as the internal conduction gains are decreased. While the inclusion of the cooling improves the overall performance the internal temperature of 2 spaces, as detailed in Table 6, exceeds 26 ^{0}C for more than 3% of the occupied hours.

To achieve compliance with the CIBSE Guide A thermal comfort criteria, it is recommended that active cooling be installed in spaces G.02, 1.02, and 1.04 as a minimum.

Appendix A – Internal gain profiles

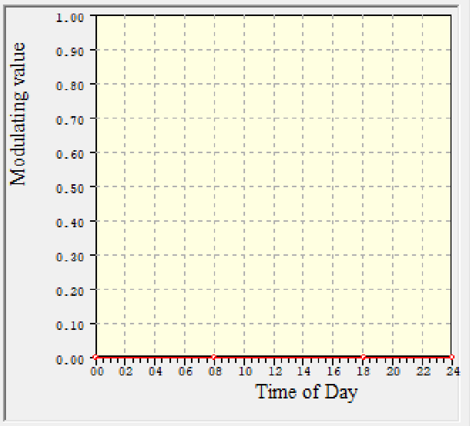
Space Profile	Office	Reception
Occupancy		

Space Profile	Meeting Room	Dining Room
Occupancy		

Appendix B - Ventilation profiles

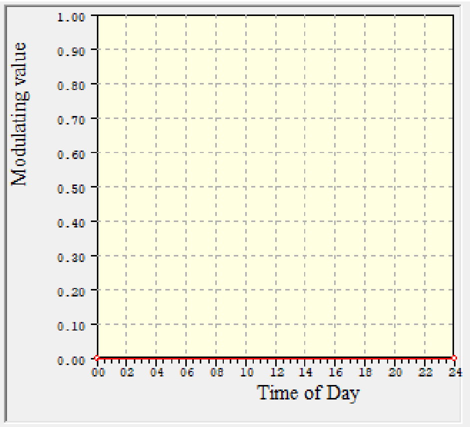
Mech Ventilation	All Occupied Spaces
Operation	

	Time	Value
1	00:00	(ta>18) & (ta>to)
2	08:00	(ta>22) & (ta>to)
3	18:00	(ta>22) & (ta>to)
4	24:00	(ta>18) & (ta>to)



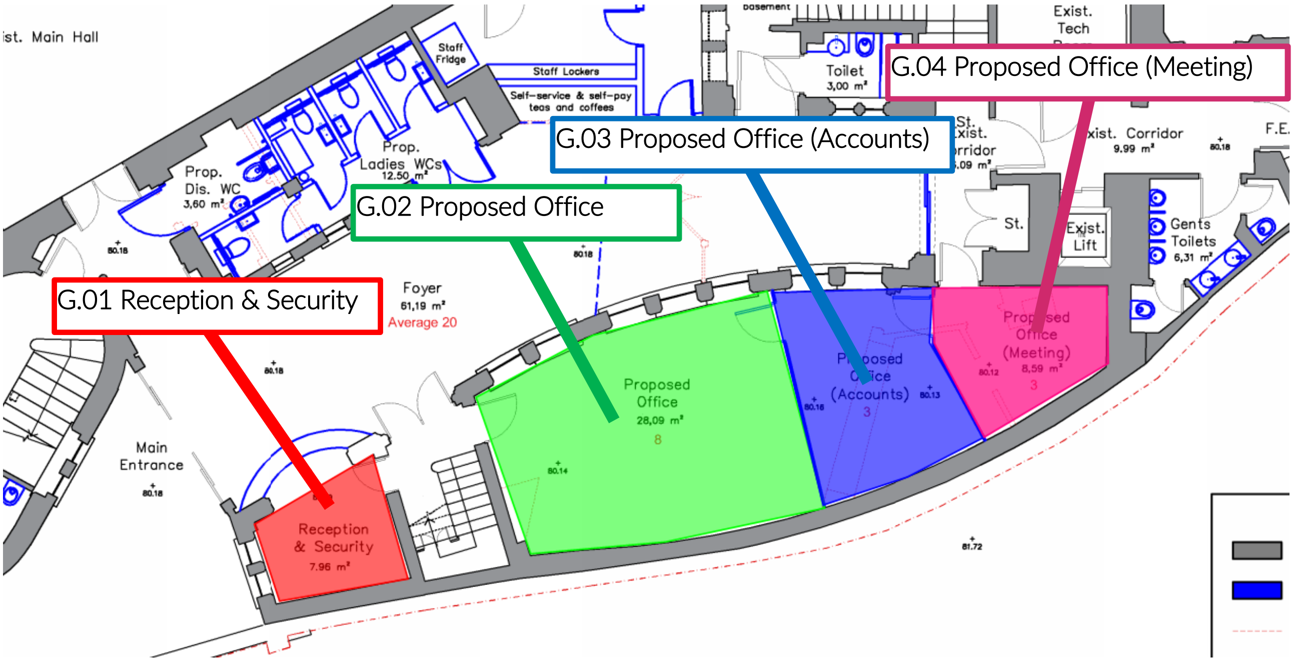
Nat Ventilation	Openable Windows
Operation	

	Time	Value
1	00:00	(ta>22)
2	24:00	(ta>22)

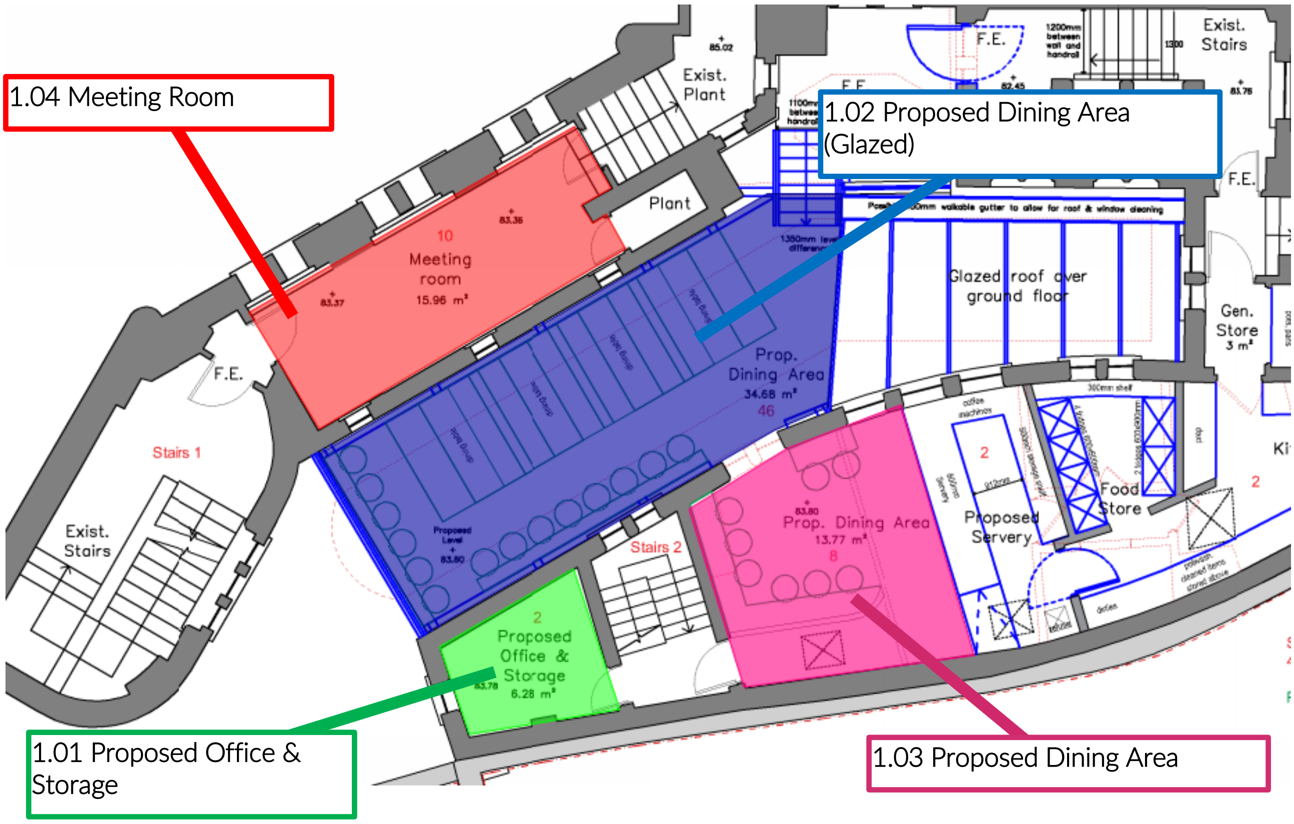


Appendix C – Space Mark-ups

Ground Floor



First Floor



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