Thermal Comfort Analysis - CIBSE TM52 as Current Architon Architectural Design

UCL IOE Phase 2 – Level 3&4

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1.0 Executive Summary

This report presents the inputs used, as well as the results, for the thermal comfort checks completed for the UCL IOE Phase 2 development levels 3&4.

This report is based upon current Architon architectural design and is different from the thermal overheating report carried out by Buro Happold (ref 035833 dated 15th January 2021).

Within the Buro Happold report, there was a degree of solar shading to the South elevation and a greater performing roof area, which is now not allowed in the current architectural design. In place of the Greenery Screen used to reduce solar gains, internal blinds have been implemented to the South Façade as per Architon's design.

Given this, having fully evaluated the model the Level 3,4 area achieves the thermal overheating comfort requirement in zone 6 at Level 4.

Thermal comfort has been assessed using CIBSE TM52:2013.

The heating and cooling loads contained in this report were calculated using IES VE 2021.

2.0 Thermal Comfort Criteria

2.1 CIBSE TM52: 2013 Criteria

The CIBSE TM52: 2013 document defines the limits of thermal comfort in order to avoid overheating in European buildings. This criterion is sub-categorised by three criteria:

1. The first criterion sets a limit for the number of hours the operative temperature can exceed the threshold comfort temperature by 1K or more during the occupied hours of a typical non-heating season (1 May to 30 September).

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% of occupied hours.

2. 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. 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 in any one day where:

$$W_e = (\sum h_{ey}) \text{ X } WF$$

Where the weighting factor WF = 0 if $\Delta T \leq 0$ otherwise WF = ΔT, and h_{ey} is the time (h) when WF = y.

3. 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 shall not exceed 4K.

A room that fails any two of the three criteria is classed as overheating.

The weather file used for this analysis is known as the DSY (Design Summer Years). It consists of an actual 1-year sequence of hourly data, selected from the 20-year data sets to represent a year with a hot summer. The selection is based on dry bulb temperatures during the period April–September.

It is important to note that the CIBSE TM52: 2013 guidance provides recommendations for non-air conditioned building to limit the effect of overheating in summertime. Therefore the criteria listed above are not relevant for a mechanically cooled room. Furthermore this good practice criterion is applicable only for occupied rooms.

CIBSE recommends that new buildings, major refurbishments and adaptation strategies should conform to Category II in BS EN 15251 (BSI, 2007), which sets a maximum acceptable

temperature of 3 °C above the comfort temperature for buildings in free-running mode, where the comfort temperature is as follow:

$T_{comf} = 0.33\ T_{rm} + 18.8$

Where T_{rm} (Running Mean Temperature) is as follow:

$T_{rm} = (1 - \alpha)\ (T_{od-1} + \alpha\ T_{od-2} + \alpha^2\ T_{od-3} ....)$

Where α is a constant (<1) and T_{od-1}, T_{od-2}, etc. are the daily mean temperatures for yesterday, the day before, and so on. Please refer to the CIBSE TM52: 2013 guidance for further details.

This methodology is applied to all proposed cooling scenarios to assess their suitability in mitigating overheating in the offices of the development.

3.0 Thermal Modelling

A Dynamic Thermal Model of the design proposal has been constructed to investigate the overheating risks in the UCL IOE Phase 2 Road development.

The simulation has been run using IES VE 2021, a dynamic thermal modelling tool via the following method:

I. Construction of a geometric model of the development proposal (IES – Model IT)
II. Definition of the construction module's fabric performance properties (IES - Apache)
III. Definition of the loads and condition for each zone (IES - Apache)
IV. Solar Shading Analysis (IES – Suncast)
V. Dynamic simulation (IES – ApacheSim) – For overheating analysis

The ApacheSim thermal simulation engine, supported by the Suncast and Macroflo modules, complies with the requirements of CIBSE Application Manual AM11.

4.0 Modelling Information

The following table presents the input data used within the model.

4.1 Weather Data

In line with guidance from the Greater London Authority, the London Weather Centre DSY file has been used as this represents a central London location for a moderately warm year as interpreted in current CIBSE guidance.

4.2 Construction Information

The following construction information has been taken from Architon construction information for new build works, and where existing construction is utilised the information within the Buro Happold report UCL Institute of Education– Phase 2C Overheating Review (January 2021) is utilised.

Construction		Information Derived From
Retained Curtain Wall (W/m^2.K)	3.24	Existing Construction based on Buro Happold original study
New Curtain Wall (W/m^2.K)	1.70	Existing Construction based on Buro Happold original study
Internal Walls (W/m^2.K)	0.95-1.53	Based on new/retained walls value as Buro Happold's study
Exposed Floor (W/m^2.K)	0.60	Existing Construction based on Buro Happold original study
Level 4 Roof (W/m^2.K)	0.20	Based on Construction information provided by Architon
New pavilion Roof (W/m^2.K)	0.17	Based on Construction information provided by Architon
Internal Floor/Ceiling (W/m^2.K)	1.54-2.50	Existing Construction based on Buro Happold original study

Single Glazing (W/m^2.K)	5.70	Existing Single Glazing to Front (E) and Rear (W) Facade
- Front Façade (E) Glazing g-Value (%)	73	Existing Glazing based on Buro Happold original study. Blinds as per Architon's Drawings.
- Rear Façade (W) Glazing g-Value (%)	47 **(blinds applied to Zone 6)**	
New Pavilion Glazing (W/m^2.K)	1.50	Based on Cannon Glass information provided for the New Build Elements
- Glazing g-Value (%)	52.8	
New Rooflight (W/m^2.K)	1.81	Construction based on Buro Happold original study, New Build Elements to be provided to this specification
- Rooflight g-Value (%)	25	

4.3 Internal Loads

4.3.1 Internal Temperatures

	Temperatures	
	Summer	**Winter**
Circulation	Not Controlled	Not Controlled
Comms Room	22°Cdb +/- 2°C	22°Cdb +/- 2°C
Meeting Rooms/Teaching Rooms	24°Cdb +/- 2°C	22°Cdb +/- 2°C
Social/ Break out Spaces	Not Controlled	22°Cdb +/- 2°C
Social Café	Not Controlled	22°Cdb +/- 2°C
Stores	Not controlled	Not controlled
Toilet Areas	Not controlled	18°Cdb +/- 2°C
Stairs	Not controlled	Not controlled
Reception	Not controlled	20°Cdb +/- 2°C

Where temperature control is given, these spaces are conditioned locally.

4.3.2 Occupancy

	Occupancy (m^2/person)
Circulation	9
Comms Room	-
Meeting Rooms/Teaching Rooms	Based on number of seats
Social/ Break out Spaces	Based on number of seats
Social Café	Based on number of seats
Stores	-
Toilet Areas	-
Stairs	-
Reception	6.6

Occupancy gain is based on 80-85W sensible and 55-75W latent per person based on mixed male/female occupancy and is also based on the activity level of the space.

A diversity of 0.5 is applied to Break Out and Café Areas, 0.8 to study areas. All other spaces do not have diversity.

4.3.3 Lighting Gains

	Lighting Load (W/m^2)
Circulation	10
Comms Room	-
Meeting Rooms/Teaching Rooms	4
Social/ Break out Spaces	10
Social Café	10
Stores	-
Toilet Areas	5
Stairs	-
Reception	10

4.3.4 Equipment Gains

	Equipment Gain
Circulation	13 W/m^2
Comms Room	50W/m^2
Meeting Rooms/Teaching Rooms	25W/m^2
Social/ Break out Spaces	10W/m^2
Social Café	10W/m^2
Stores	-
Toilet Areas	25W
Stairs	-
Reception	10W/m^2

It should be noted that the social café and breakout areas have had a reduction in equipment loads from 25W/m^2 to 10W/m^2 in order to reflect what is believed to be a more appropriate load for the space type.

4.3.5. Infiltration Rates

0.625 ac/hr.

4.4 Proposed Ventilation Strategies

4.4.1 Natural Ventilation

Night purge ventilation is achieved with top-hung windows operating and controlled by indoor temperature, the panels fully open when internal temperature is greater than 16°C and when internal temperature is greater than outdoor temperature.

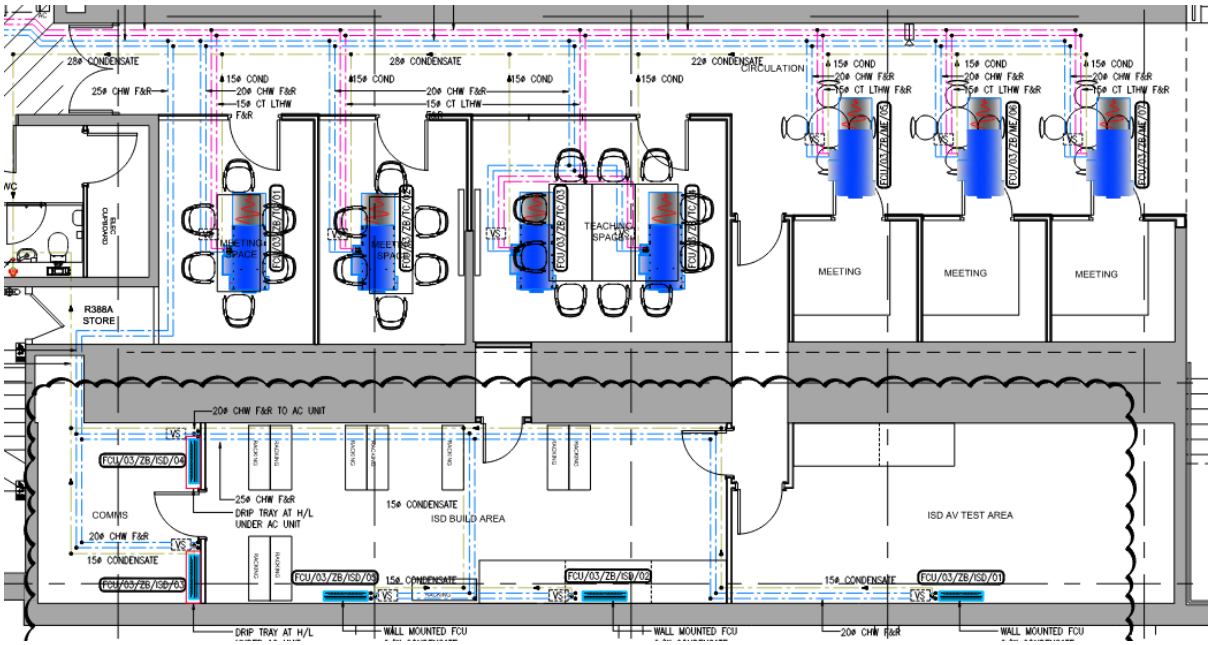
During the daytime the top hung window opening profile is set controlled by indoor temperature, it opens above 22°C and fully opens above 24°C.

Level 4 openable rooflight opens to a maximum of 10° controlled to open between 9am and 8pm when internal temperatures exceed 22°C and internal temperatures are greater than external air temperatures. Night purge ventilation is controlled by indoor temperature, the rooflights fully open when internal temperature is greater than 16°C and when internal temperature is greater than outdoor temperature.

Circular Entrance doors are openable and linked to BMS to open fully. Doors are controlled to open between 9am and 8pm when internal temperatures exceed 22°C and internal temperatures are greater than external air temperatures.

4.4.2 Cooling

The only fully cooled spaces are the ISD Build Area, Teaching spaces, Meeting Spaces, and ISD AV Test Area on Level 3. This is allowed for within the model as the cooled spaces have a marginal effect on the surrounding areas.



5.0 CIBSE TM52:2013 Results

The results for the CIBSE TM52:2013 test for the UCL naturally ventilated spaces are shown below.

The results below reflect the proposed design, accounting for the modelling information contained in Section 4.

5.1 – CIBSE TM52:2013 Results

Room Name	Criteria 1 ≤3.0%	Criteria 2 W_e≤6	Criteria 3 ΔT ≤4	TM52: 2013 Compliance
% of Spaces Pass	100	37	100	PASS
% of Spaces Fail	0	63	0	

The results above demonstrate that a natural ventilation solution will allow the relevant spaces at UCL IOE Phase 2 Road development to comply with the thermal comfort requirements of CIBSE TM52:2013. The full set of results is contained in Appendix A.

6.0 Conclusion

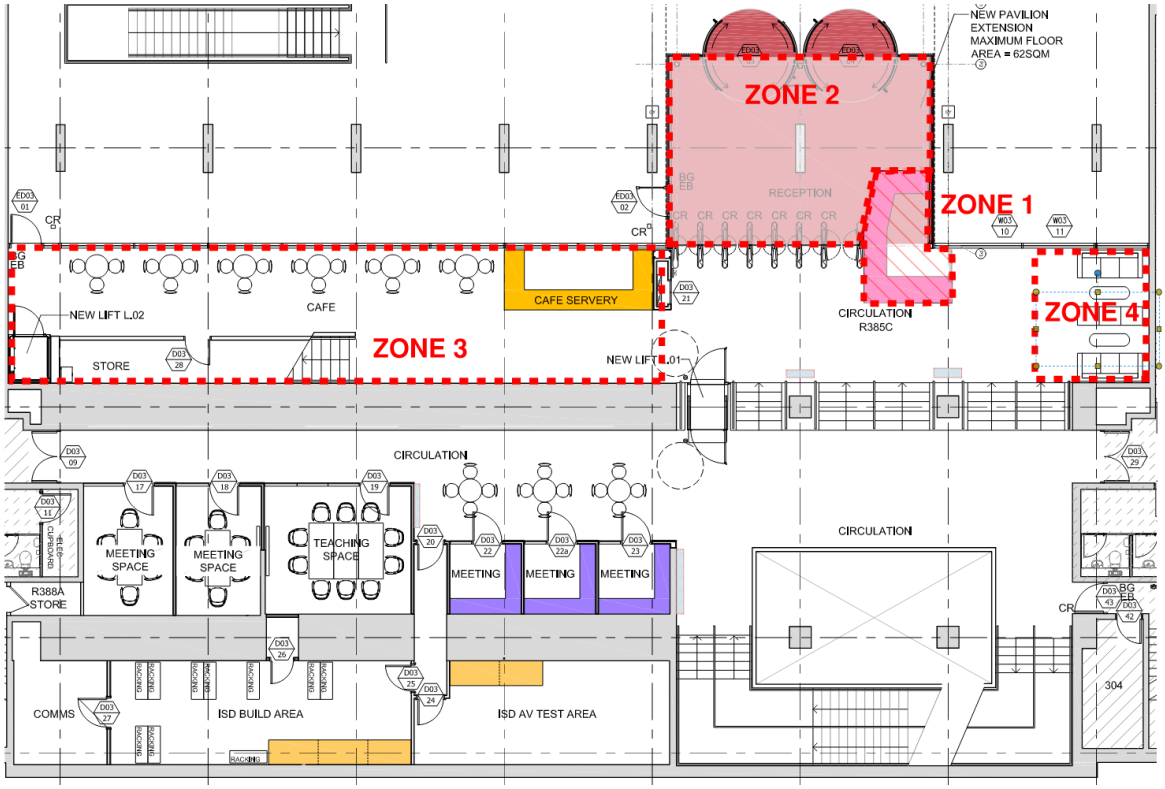
The results contained in Section 5 of this report demonstrate that the UCL IOE Phase 2 Road development offices comply with the requirements of CIBSE TM52: 2013.

7.0 Appendix A – CIBSE TM52: 2013 Results

Room Name	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing
L03_Zone 3Cafe Zone 1	1	14	2	2
L03_Auditorium	0.6	6	1	-
L03_Auditorium	0.4	5	1	-
L03_Cafe Servery	0.9	13	2	2
L03_Circulation adj Teaching Spaces	0.3	5	1	-
L03_Circulation between Teaching Spaces	0	0	0	-
L03_Core A_Circulation R382	0	0	0	-
L03_ISD AV Test Area	0	0	0	-
L03_ISD Build Area	0	0	0	-
L03_Meeting Space_FCU/03/ZB/TC/01 and 02	0	0	0	-
L03_Meeting Space_FCU/03/ZB/TC/01 and 02	0	0	0	-
L03_Meeting Space_FCU/03/ZB/TC/05 and 06	0	0	0	-
L03_Meeting Space_FCU/03/ZB/TC/05 and 06	0	0	0	-
L03_Meeting Space_FCU/03/ZB/TC/05 and 06	0	0	0	-
L03_Teaching Space_FCU/03/ZB/TC/03 and 04	0	0	0	-
L03_Zone 1 New Pavillion	1	13	2	2
L03_Zone 1 New Reception	0.8	9	2	2
L03_Zone 3Cafe zone 2	1	13	2	2
L03_Zone 3Cafe Zone 3	0.9	13	2	2
L04_Circulation	1	15	2	2
L04_Circulation	0.9	11	2	2
L04_Circulation	1.1	18	3	2
L04_Circulation 1	0.9	11	2	2
L04_Circulation 4	1	11	2	2
L04_Circulation 7	1	14	2	2
L04_Circulation 8	1	15	2	2
L04_Circulation R486B	1	15	2	2
L04_Entrance Lobby	1.5	23	3	2
L04_Reception Waiting	1.8	22	3	2
L04_Zone 5 Central Study Zone 1	1	12	2	2
L04_Zone 5 Central Study Zone 2	1.1	13	2	2
L04_Zone 5 Central Study Zone 3	1	12	2	2
L04_Zone 5 Central Study Zone 4	1	12	2	2
L04_Zone 6 Break Out_FCU/04/RC/BO/01	1.6	24	4	2
L04_Zone 7 Rear Reception	1.6	21	3	2

8.0 Appendix B – Zone Layouts

Level 2 & 3



Level 4