

Thermal Comfort Report

Library, Barnsley Better Buildings, Barnsley

Stroma Reference: 09-15-54301 TC2
Date: 15/04/2016
Prepared for: NPS Barnsley

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1. Summary

This thermal comfort assessment has been undertaken in accordance with CIBSE AM11 – *Building Energy and Environmental Modelling* utilising Apache software by Integrated Environmental Solutions (IES). The Apache software provides a full dynamic thermal analysis and hourly output data for assessment against the relevant thermal comfort criteria.

Software version: **IES-VE v2015**

Weather file: **Leeds DSY**

Projected climate change weather file/s: **N/A**


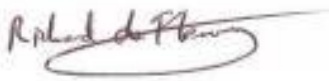
Building conditioning strategy: **Natural ventilation/free running**

Winter comfort criteria: **N/A**

Summer comfort criteria: **CIBSE TM52: 2013**

Results are expressed against the Time out of Range (TOR) metric for each applicable and occupied building area. Results show that four rooms currently fail the criteria set out in CIBSE TM52 these are the 2nd Floor Library, IT room, Meeting room and 1st floor Staff office. The main reason for the non-compliance is combination of solar gain and equipment gains and insufficient ventilation to reduce the internal temperatures to achieve CIBSE TM52 compliance.

Ventilation rates have been increased for all areas failing CIBSE TM52 to a point where compliance is shown to be possible. Due to the ventilation rates required to the IT room it might be more appropriate to introduce mechanical cooling to this area in order to comply with CIBSE TM52.

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Version	Status	Date	Change Summary
S1	Preliminary	08/04/2016	-
S2	First Issue	15/04/2016	Night ventilation amended along with ventilation required for compliance.

2. Development Overview

The development is located in Barnsley within the existing town centre square and has an adjacent café and retail unit as well as being built next to an existing row of buildings on Burlington Arcade. The library is built across 4 floors with full height glazing on the east and north façades from the ground floor to the second floor. The library consists of 3 floors of open plan public library space with meeting rooms, an IT room, staff office and pod spaces. The third floor consists of an event space, used for private functions, along with associated circulation spaces, lifts and toilets. The event space has a roof terrace

This thermal comfort assessment assesses the occupied spaces of the open plan public library, children's library, meeting rooms, pod spaces, staff office, IT room and event space.

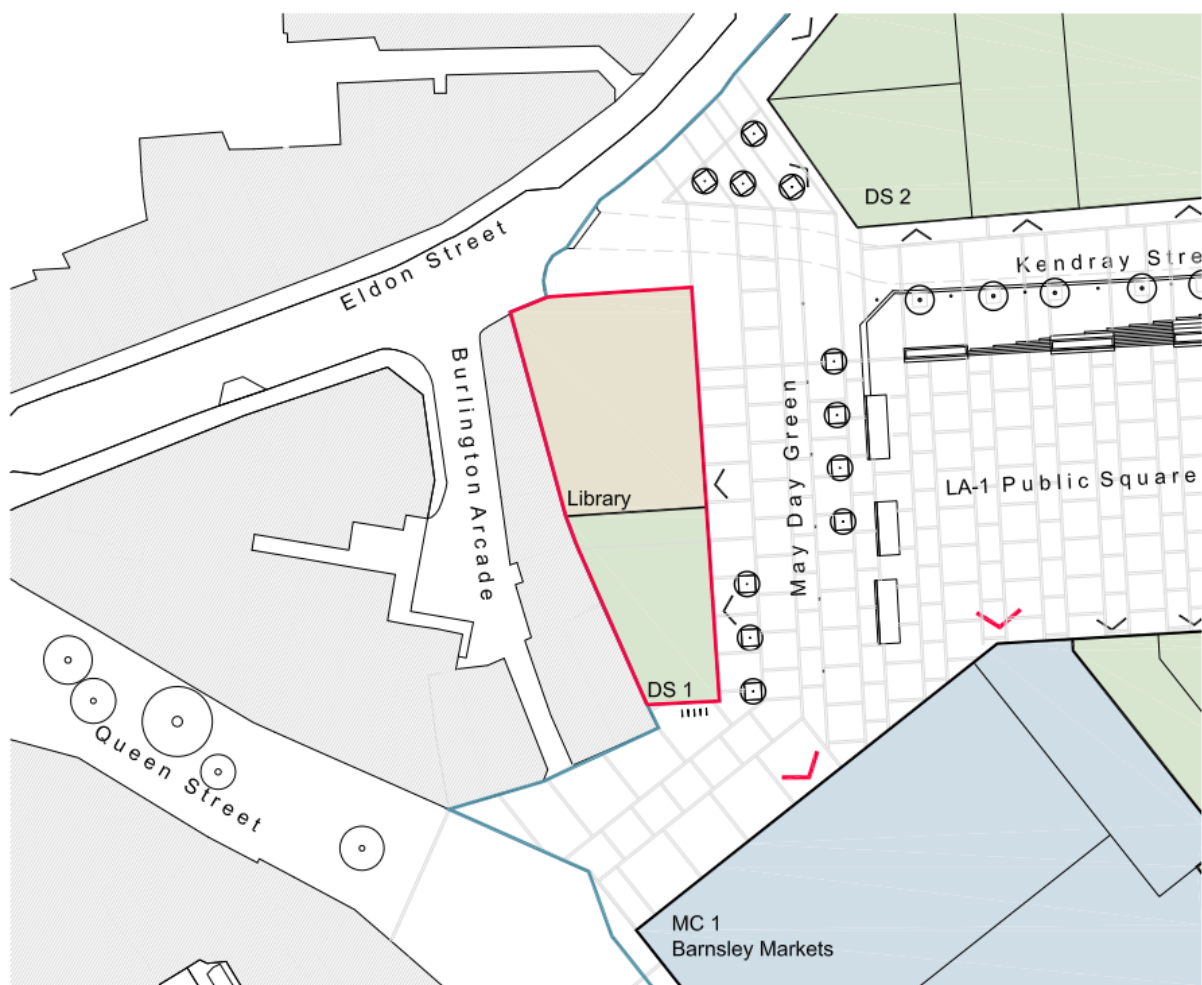


Figure 1. **Development site**

3. Comfort Criteria

3.1. Summer Comfort – CIBSE TM52: 2013

CIBSE TM52: 2013 comprises of three assessment criteria applicable to naturally ventilated or 'free running' buildings. In order to demonstrate compliance, at least 2 of the 3 criteria must be satisfied. This assessment approach accounts for adaptive human behaviour; whereby the requirements for thermal comfort are defined as a function of previous environmental conditions. The maximum acceptable temperature is based upon a running mean analysis of previous days/months.

Predicted operative temperatures are determined through Dynamic Simulation Modelling (DSM) for a full year using the relevant CIBSE Design Summer Year (DSY) weather file.

The compliance criteria are defined as follows:

a) Criteria 1 - Hours of exceedance (He)

The number of hours (He) that ΔT is greater than or equal to one degree (K) during the period May to September inclusive shall not be more than 3%.

b) Criteria 2 – Daily weighted exceedance (We)

To allow for the severity of overheating; the weighted Exceedance (We) shall be less than or equal to 6 in any one day.

c) Criteria 3 - Upper limit temperature (Tupp)

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

ΔT is defined as the operative temperature less the maximum acceptable temperature (rounded to the nearest whole degree). The maximum acceptable temperature is a function of the running mean temperature and the building category.

4. Building Specification

4.1. Thermal Envelope

The following construction information has been provided by Alex Durie of IBI Group.

Opaque element	Construction (type and insulation)	U-value (W/m ² .K)	Calculation provided		Assumption
Ground Floor	Concrete, insulation, concrete, screed	0.2		NO	<input type="checkbox"/>
External Wall	Aluminium, insulation, aluminium, concrete	0.15		NO	<input type="checkbox"/>
External Wall TF	Aluminium, insulation, concrete, plasterboard	0.15		NO	<input type="checkbox"/>
Internal Wall to adjacent building	Concrete block, insulation, concrete block, cavity, plasterboard	0.15		NO	<input checked="" type="checkbox"/>
Terraced Roof	Screed, insulation, membrane, concrete deck	0.21		NO	<input type="checkbox"/>
Roof	Insulation, membrane, concrete deck	0.21		NO	<input type="checkbox"/>

Table 1. Opaque building elements

Translucent element	Construction type	Overall U-value (W/m ² .K)	Solar g-value	Light trans.	Assumption
Windows	Okatech solar control glass	1.8	0.22	34%	<input type="checkbox"/>
Glazed doors	Okatech solar control glass	1.8	0.22	34%	<input type="checkbox"/>
Rooflights	Double Glazed LowE	1.8	0.5	60%	<input checked="" type="checkbox"/>

Table 2. Transparent building elements

Air permeability (m ³ /h.m ² @ 50 Pa)	Air Changes per Hour (ach)	Assumption
10.0	0.45	<input checked="" type="checkbox"/>

Table 3. Air infiltration

4.2. Servicing Strategy

M&E information has been provided by Christopher Phillips of NPS Barnsley. Details have only been tabulated for occupied areas, relevant to this thermal comfort assessment.

4.2.1.Space Heating

Building Zones/Area Type	Heat Source	Emitter Type	Setpoint Temp. (°C)	Profile
All Areas	LTHW boiler	Radiator	n/a	Off in summer

Table 1. Summary of heating strategy

4.2.2.Mechanical Ventilation

Building Zones/Area Type	Ventilation strategy	Flow Rate	Control	Profile
Library Areas	Central supply and extract	10 l/s/person	None	Constant when occupied. Night ventilation at 50%

Table 2. Summary of mechanical ventilation strategy

4.2.3.Natural Ventilation

Building Zones/Area Type	Ventilator Type	Openable area (%)	Max. Open Angle (°)	Operating Conditions
Event Area	Window/door - side hung	95	90	22° +/- 3°

Table 3. Summary of natural ventilation strategy

4.3. Internal Heat Gains

Internal heat gains are summarised in the below tables. Occupancy for each area has been based on maximum total floor occupancies supplied by Chris Phillips of NPS Barnsley.

4.3.1. Occupant

Building Area	No of People	Gain	Profile		
			Weekdays	Saturdays	Sundays
Library Areas	GF - 48 FF - 56 SF - 49	Sensible Gain - 75 W Latent Gain - 55 W	8-9am - 25% 9-10am - 75% 10-12pm - 100% 12-2pm - 75% 2-5pm - 100%	8-9am - 25% 9-10am - 75% 10-12pm - 100% 12-2pm - 75% 2-5pm - 100%	10-11am - 25% 11-12pm - 100% 12-2pm - 75% 2-3pm - 100%
Children's Library	13	Sensible Gain - 52.5 W Latent Gain - 33.75 W	5-6pm - 75% 6-8pm - 25% 8pm-8am - closed	5-6pm - 25% 8pm-10am - closed	4pm-8am - closed
Meeting Rooms	GF- 8 FF - 8 SF - 8	Sensible Gain - 70 W Latent Gain - 45 W	8am-8pm - 100%	8am-6pm - 100%	10am-4pm - 100%
Pods	4	Sensible Gain - 70 W Latent Gain - 45 W	8am-8pm - 100%	8am-6pm - 100%	10am-4pm - 100%
Staff Office ¹	8	Sensible Gain - 70 W Latent Gain - 45 W	8am-8pm - 100%	8am-6pm - 100%	10am-4pm - 100%
IT Room ²	13	Sensible Gain - 70 W Latent Gain - 45 W	8-9am - 25% 9-10am - 75% 10-12pm - 100% 12-2pm - 75% 2-5pm - 100% 5-6pm - 75% 6-8pm - 25% 8pm-8am - closed	8-9am - 25% 9-10am - 75% 10-12pm - 100% 12-2pm - 75% 2-5pm - 100% 5-6pm - 25% 8pm-10am - closed	10-11am - 25% 11-12pm - 100% 12-2pm - 75% 2-3pm - 100% 4pm-8am - closed
Event Space	40	Sensible Gain - 75 W Latent Gain - 55 W	8-9am 25% 9-5pm 100% 5-7pm - 25% 7-10 pm - 100% 10pm-8am closed	8am-2pm 25% 2pm-12am - 100% 12am-10 am closed	10am-2pm 25% 2pm-10pm - 100% 10pm-8am closed
Café Servery ³	3	Sensible Gain - 75 W Latent Gain - 55 W	8am-8pm - 100% 8pm-8am - closed	8am-8pm - 100% 8pm-8am - closed	10am-4pm - 100% 4pm-8am - closed
Cafe ⁴	21	Sensible Gain - 75 W Latent Gain - 55 W	8-9am -100% 9-12pm - 75% 12-2pm - 100% 2-5pm - 75% 5-8pm - 100% 8pm-8am - closed	8-9am -100% 9-12pm - 75% 12-2pm - 100% 2-5pm - 75% 5-8pm - 100% 8pm-8am - closed	10-12pm - 75% 12-2pm - 100% 2-4pm - 75% 4pm-8am - closed
Total⁵	255	-	-	-	-

Table 4. Internal gains – occupant

¹ 25% diversity applied

² 50% diversity applied

³ Included as adjacent space but not included in CIBSE TM52 analysis

⁴ Included as adjacent space but not included in CIBSE TM52 analysis

⁵ Occupancy doesn't include the Cafe

4.3.2. Lighting

Building Area	Gain	Profile		
		Weekdays	Saturdays	Sundays
Library Areas	8 W/m ²	8am-8pm	8am-6pm	10am-4pm
Children's Library	8 W/m ²			
Meeting Rooms	8 W/m ²	8am-8pm	8am-6pm	10am-4pm
Pods	8 W/m ²	8am-8pm	8am-6pm	10am-4pm
Staff Office	8 W/m ²	8am-8pm	8am-6pm	10am-4pm
IT Room	8 W/m ²	8am-8pm	8am-6pm	10am-4pm
Event Space	8 W/m ²	8am-10pm	8am-12am	10am-10pm

Table 5. Internal gains – lighting

4.3.3. Small Power

Building Area	Gain	Profile		
		Weekdays	Saturdays	Sundays
Library Areas	None	None	None	None
Children's Library	None			
Meeting Rooms	None	None	None	None
Pods	None	None	None	None
Staff Office ⁶	8 Laptops – 288 W 8 Monitors – 720 W 1 Printer – 550 W Total = 1558 W	8am-8pm	8am-6pm	10am-4pm
IT Room	13 Desktop PC's – 949 W 13 Monitors – 1170 W 1 Printer – 550 W Total = 2669 W	8am-8pm	8am-6pm	10am-4pm
Event Space	None	None	None	None

Table 6. Internal gains – small power

⁶ 25% diversity applied

5. Thermal Model

A thermal model has been produced within IES software from the architectural drawings provided and specification outlined within Section 4 of this report. A dynamic simulation has been carried out for the required duration against the CIBSE DSY weather file for Leeds.

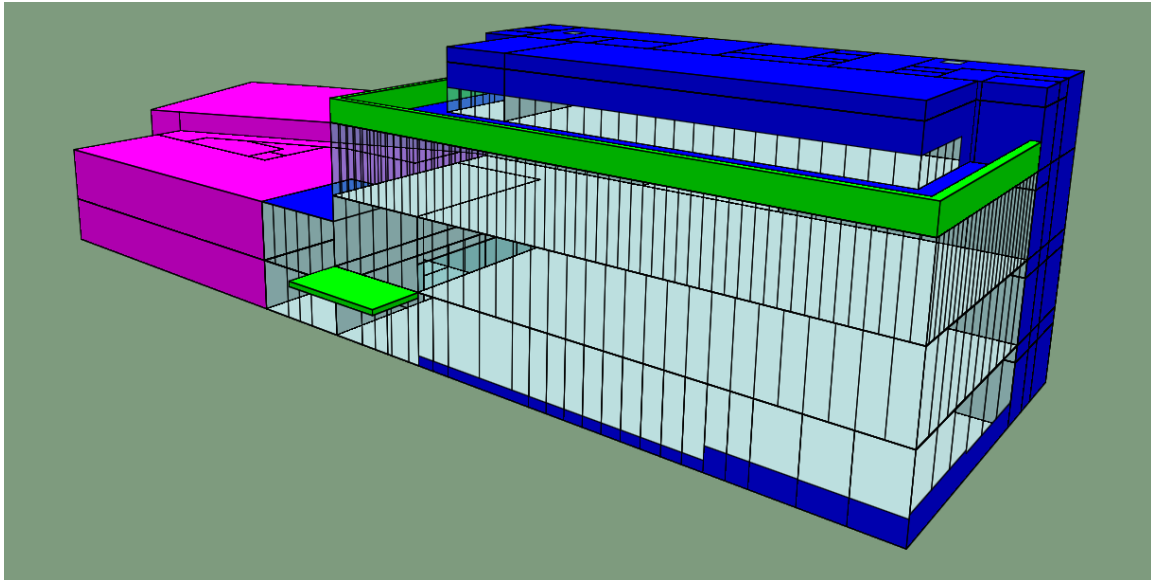


Figure 1. IES thermal model – North and East Elevations

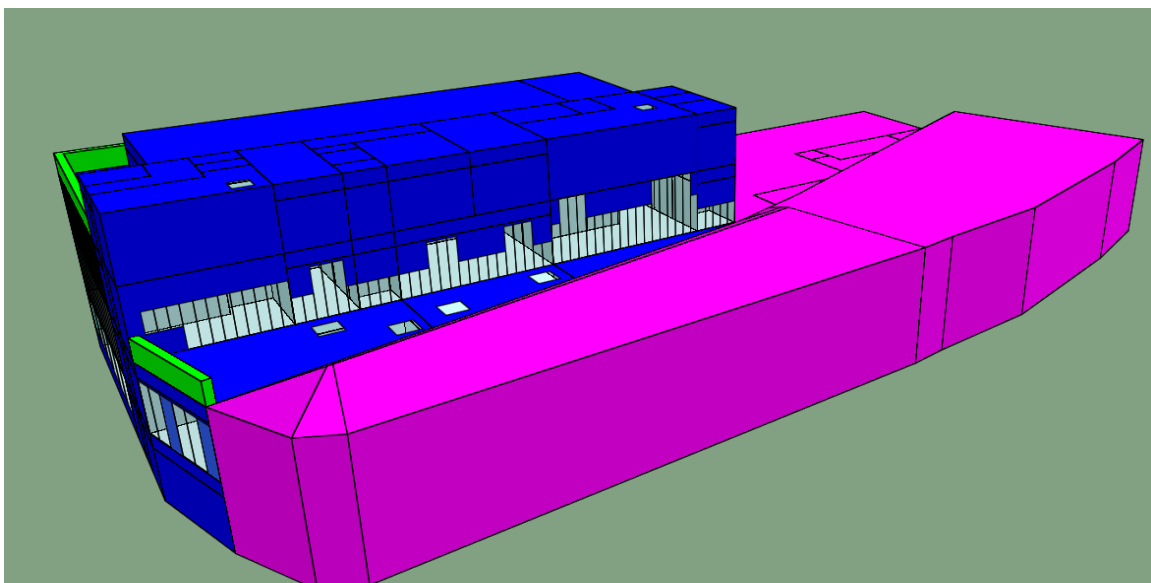


Figure 2. IES thermal model – West Elevation

6. Results

6.1. Time out of Range (TOR) – Initial Ventilation

6.1.1. Summer

Passed:	10 Rooms					
Room Name	Occupied days (%)	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing	CIBSE TM52 Pass
Z00-L-Pod	100	0	0	0	-	Yes
Z00-L-Pod	100	0	0	0	-	Yes
Z00-L-Pod	100	0.1	2	1	-	Yes
Z00-L-Pod	100	0.1	2	1	-	Yes
Z00-L-Meeting Room	100	0.7	4	1	-	Yes
Z01-L-Meeting Room	100	1.1	5	1	-	Yes
Z01-L-Library	100	1.3	5	1	-	Yes
Z01-L-Childrens Library	100	0.8	4	1	-	Yes
Z00-L-Library	100	0.4	4	1	-	Yes
Z03-L-Event Space	100	1.1	6	1	-	Yes

Table 7. **Passing Rooms**

Failed:	4 Rooms					
Room Name	Occupied days (%)	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing	CIBSE TM52 Pass
Z02-L-Meeting Room	100	4.2	15	2	1 & 2	No
Z02-L-Library	100	3.4	14	2	1 & 2	No
Z02-L-IT Room	100	5	19	3	1 & 2	No
Z01-L-Staff Office	100	3.3	12	2	1 & 2	No

Table 8. **Failing Rooms**

6.2. Analysis

Of the rooms that fail CIBSE TM52, the below figures shows that in both situations the internal temperature cannot be reduced by the current proposed ventilation rates. The main issue with the 2nd Floor is solar and internal gains causing the predicted internal temperature to increase beyond 27°C. The increase in the amount of glazing on the 2nd floor increases the solar gain by around 3 kW compared with the ground and first floor library areas.

The IT room's main issue is a predicted internal temperature of over 27°C driven by the internal equipment gain and again the ventilation rates proposed currently aren't sufficient to reduce the internal temperature

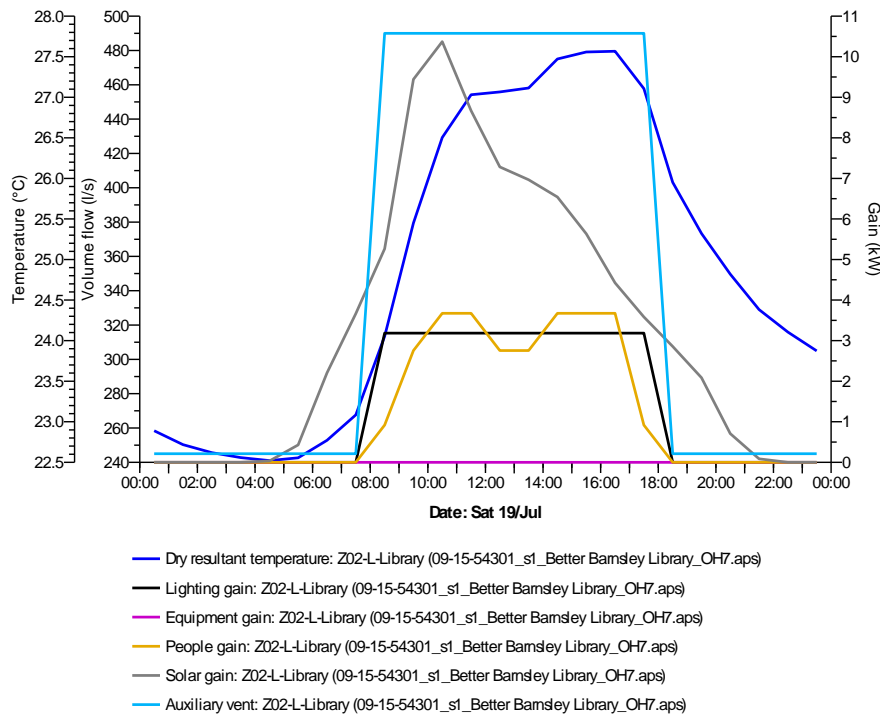


Figure 3. 2nd Floor Library internal temperatures and gains for Sat July 19th

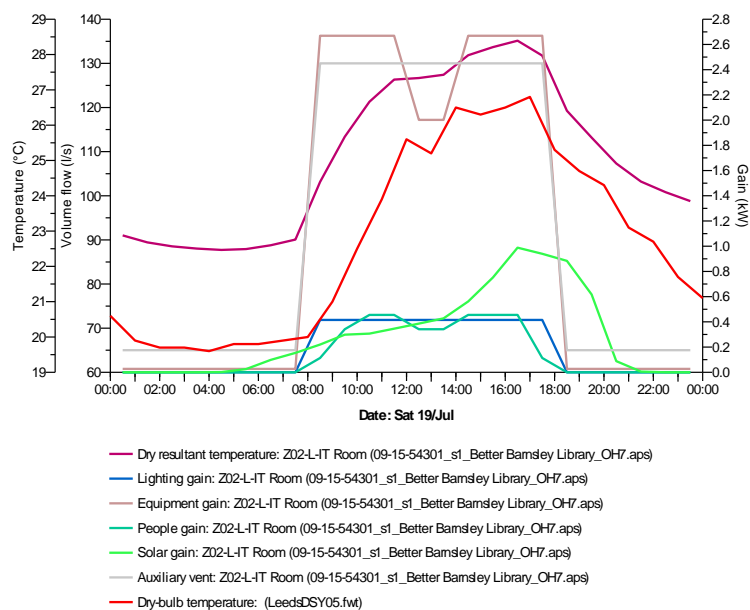


Figure 4. 2nd Floor IT Room internal temperatures and gains for Sat July 19th

6.3. Time out of Range (TOR) – Increased Ventilation

In order to comply with CIBSE TM52, the ventilation supply will need to be increased as per the below table, this has been based on increasing ventilation rates to all areas. Please note that due to the increase in ventilation it might be more appropriate to introduce mechanical cooling to the IT Room in order to comply with CIBSE TM52.

Building Zones/Area Type	Ventilation strategy	Flow Rate	Total Supply Rate
Library Areas	Central supply and extract	20 l/s/person	960-1120 l/s
Staff Room	Central supply and extract	20 l/s/person	160 l/s
Meeting Rooms	Central supply and extract	20 l/s/person	160 l/s
IT Room	Central supply and extract	80 l/s/person	1040 l/s

Table 9. **Proposed Ventilation Rates to comply with CIBSE TM52**

6.3.1. Summer

Passed:	14 Rooms					
Room Name	Occupied days (%)	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing	CIBSE TM52 Pass
Z00-L-Pod	100	0	0	0	-	Yes
Z00-L-Pod	100	0	0	0	-	Yes
Z00-L-Pod	100	0	0	0	-	Yes
Z00-L-Pod	100	0	0	0	-	Yes
Z00-L-Meeting Room	100	0	0	0	-	Yes
Z01-L-Meeting Room	100	0	0	0	-	Yes
Z01-L-Library	100	0.1	2	1	-	Yes
Z02-L-Meeting Room	100	1.2	6	1	-	Yes
Z02-L-Library	100	1.5	6	2	-	Yes
Z02-L-IT Room	100	2.8	10	2	2	Yes
Z01-L-Staff Office	100	2.8	11	2	2	Yes
Z01-L-Childrens Library	100	0	0	0	-	Yes
Z00-L-Library	100	0	0	0	-	Yes
Z03-L-Event Space	100	0.9	5	1	-	Yes

Table 10. **Passing Rooms with increased ventilation**