TM59 - A METHODOLOGY FOR PREDICTING OVERHEATING RISK IN HOMES

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ANC Conference

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About Inkling

- Building Physics Consultancy
  - Susie Diamond
  - Claire Das Bhaumik
- Services
  - Design stage overheating risk assessments for all building types
  - Thermal performance and TM54 analyses
  - Modelling in support of BREEAM, WELL, LEED
  - Advanced HVAC modelling
  - Part L2A compliance modelling and advice
  - EPC assessments
  - Research

What is overheating?

- No one definition fits all
- Comfort is subjective
- Depends on both environmental and human factors
- Duration/ timing of high temperatures is important
- Very high temperatures > 35°C lead to **Heat stress**
- High bedrooms temperatures (>26°C) can impair sleep

Image from ZCH *Overheating in homes - Where to Start - An introduction for planners, designers and property owners*, 2013

Key overheating risk factors in homes

- Single aspect
  - No cross-ventilation – so openings need to be larger
- Large areas of glazing
  - Greenhouse effects
  - Solar gain has large radiative component which is not removed with ventilation
- Limited ventilation
  - Restricted openings due to:
    - Health and safety concerns (tall buildings)
    - Noise
    - Poor air quality

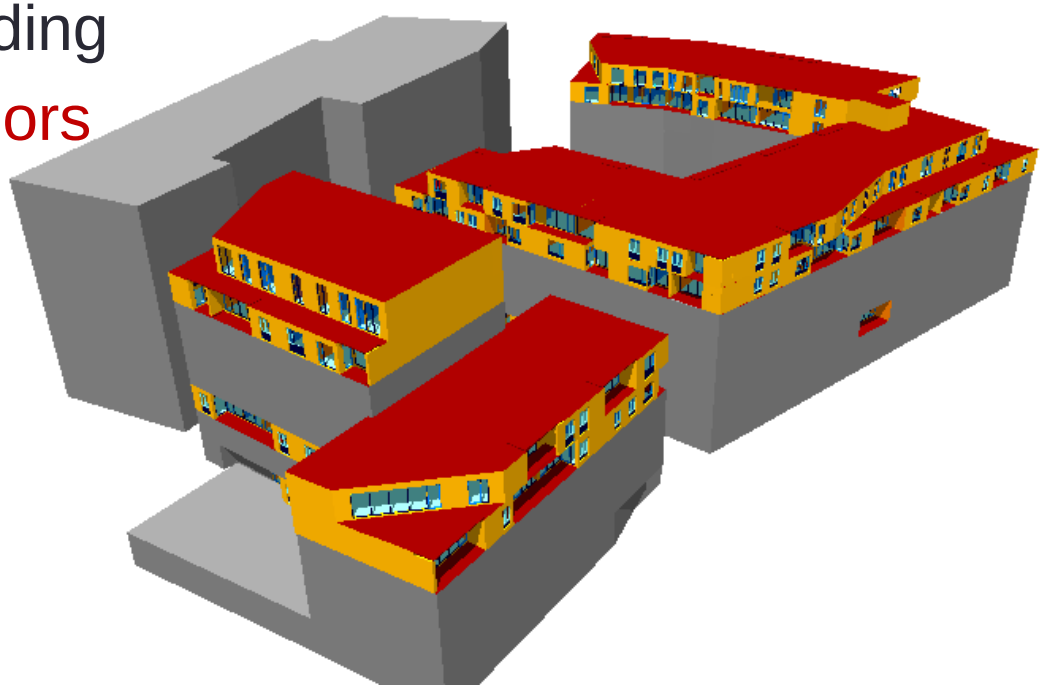
Key overheating risk factors in homes

- City centre locations
  - UHI effects producing warmer night time temperatures
  - Noise and/or air pollution limiting natural ventilation
- Community heating
  - Heat leaching 24/7 from hot pipework
- Locations in the South-East
  - Warmer weather and large UHI in London

Dynamic Thermal Modelling

Inputs include:

- Building location & orientation
- Construction types and thermal properties
- Internal / external shading
- Opening windows / doors
- Mechanical systems
- Internal gains
- Room types
- Occupancy profiles
- Weather files for site



CIBSE TM59 – pass/fail criteria

- Where predominantly Naturally Ventilated
- Draws from TM52 AND CIBSE Guide A
  - **Criterion 1**: Max limit of 3% of occupied hours where DT is >=1K **(CIBSE TM52 Hours of exceedance)**
  - **Criterion 2**: For bedrooms only: Limit of 1% annual hours (33 hrs) where T_{op} >26°C
  - Bedrooms must pass both requirements

Key Points

- Applies to naturally ventilated (free running) homes
  - Openable windows with min free areas (Based on Part F purge criteria, usually 1/20th of room floor area)
  - Potential for occupants to experience breeze
  - Can be augmented by MVHR or MEV systems
  - Are acoustically attenuated vents acceptable?
  - Draft BB101 classifies mechanical vent as ‘free-running’ in the absence of mechanical cooling or close temperature control
- Criteria for predominantly mechanically ventilated homes (where opening windows cannot be used for cooling):
  - Operative temps should not exceed 26°C for more than 3% of occupied hours
  - Refer to CIBSE Guide A (2015a)

CIBSE TM59 – gain profiles

- Gain profiles for occupancy, lights and equipment
- 24/7 occupancy of bedrooms (worst case)
- Daytime (10am-10pm) occupancy of living rooms and kitchens

		Peak Load		Time period																							
				0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-21	21-22	22-23	23-24
Peak / No of People	Hour	Sensible (W)	Latent (W)	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00	19.00	20.00	21.00	22.00	23.00	24.00
1	Single Bedroom Occupancy	75	55	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.7
2	Double Bedroom Occupancy	150	110	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.7
2	Studio Occupancy	150	110	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1 Bed Living/Kitchen Occupancy	75	55	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
1	1 Bed Living Occupancy	75	55	0	0	0	0	0	0	0	0	0	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0	0
1	1 Bed Kitchen Occupancy	75	55	0	0	0	0	0	0	0	0	0	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0	0
2	2 Bed Living/Kitchen Occupancy	150	110	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
2	2 Bed Living Occupancy	150	110	0	0	0	0	0	0	0	0	0	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0	0
2	2 Bed Kitchen Occupancy	150	110	0	0	0	0	0	0	0	0	0	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0	0
3	3 Bed Living/Kitchen Occupancy	225	165	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
3	3 Bed Living Occupancy	225	165	0	0	0	0	0	0	0	0	0	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0	0
3	3 Bed Kitchen Occupancy	225	165	0	0	0	0	0	0	0	0	0	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0	0
	Single Bedroom Equipment	80		0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.13
	Double Bedroom Equipment	80		0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.13
	Studio Equipment	450		0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	1	1	0.44	0.44	0.24	0.24
	Living/Kitchen Equipment	450		0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	1	1	0.44	0.44	0.24	0.24
	Living Equipment	150		0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	1	1	1	1	0.4	0.4
	Kitchen Equipment	300		0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	1	1	0.17	0.17	0.17	0.17

CIBSE TM59 – weather file

- Requires
  - Local to site
  - 2020s
  - High emissions, 50th %ile
  - DSY1

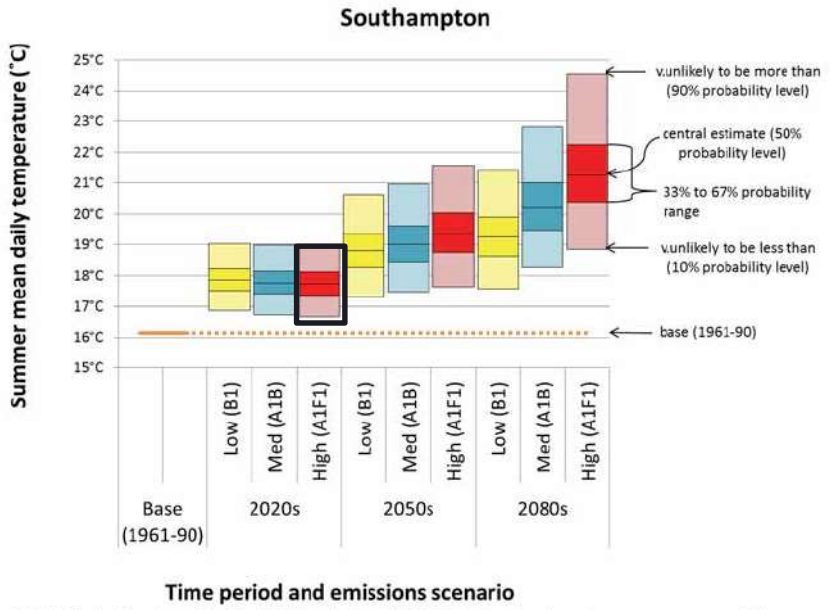


Figure: Probabilistic climate profile (ProCliP) graph from UKCP09 data - Southampton summer mean daily temperature (°C)

- Recommendation to run for DSY2/3 or 2050/2080s data but not required to pass

Including Blinds

- If blinds form part of the mitigation strategy then these must be included in the base build
- Results without blinds must be included in the report
- Blinds should not interfere with the free area of opening windows, or of they do this reduction should be taken into account

Ventilation

Window opening

- Open (free) areas should include any restrictors, and take into account any security, noise or air quality issues which reduce opening area
- Windows should only be modelled as open when rooms are scheduled to be occupied, unless secure openings are provided

- Internal doors can be included and open as modelled as open during waking hours to improve cross-ventilation

Presenting results

Example results

Zone Name	Room Use	Occupied Summer Hours	Max. Exceedable Hours	Criterion 1: #Hours Exceeding Comfort Range	Annual Night Occupied Hours for Bedroom	Max Exceedable Night Hours	Criterion 2: Number of Night Hours Exceeding 26 °C for Bedrooms.	Result
A3_Bed1	Bedroom	3672	110	34	3285	32	27	Pass
A3_Bed2	Bedroom	3672	110	34	3285	32	28	Pass
A3_Kitchen/Living	Living Room / Kitchen	1989	59	71	N/A	N/A	N/A	Fail
A4_Bed1	Bedroom	3672	110	44	3285	32	38	Fail
A4_Bed2	Bedroom	3672	110	41	3285	32	38	Fail
A4_Kitchen/Living	Living Room / Kitchen	1989	59	167	N/A	N/A	N/A	Fail
B21_Bed1	Bedroom	3672	110	78	3285	32	26	Pass
B21_Kitchen	Living Room / Kitchen	1989	59	40	N/A	N/A	N/A	Pass
B21_Living	Living Room / Kitchen	1989	59	149	N/A	N/A	N/A	Fail
B22_Bed1	Bedroom	3672	110	45	3285	32	37	Fail
B22_Bed2	Bedroom	3672	110	68	3285	32	38	Fail
B22_Bed3_single	Bedroom	3672	110	72	3285	32	32	Pass
B22_Kitchen/Living	Living Room / Kitchen	1989	59	80	N/A	N/A	N/A	Fail

Improving Results

Reduce solar gain

- Reducing any very large areas of glazing
- Improving glazing specification (lower g-value)
- External shading devices
- Blinds (must be installed with base build)

Increase ventilation

- Increase window openings
- Add fans/mechanical ventilation

Thermal mass

- Helps daytime spaces, but not bedrooms. Harder to manage purge in homes

Add Mechanical cooling

Useful to explore a few iterations, and test sensitivities – thermal modelling fee should allow for this (within reason)

Reporting Requirements

- Site location and orientation.
- Images of the model and internal layouts
- Construction types including U- and g- values and thermal mass
- Ventilation strategy - including details of window openings, infiltration rates and any mechanical flow rates
- The weather file(s) used
- The results of the analysis

Limitations of TM59

- Cannot guarantee that people will always be comfortable, regardless of how they act
- Modellers will need to use common sense and professionalism
- Continued testing and feedback from monitoring will feed into future updates

Tension

Balancing the tension between

- Overheating risk
- Acoustic constraints
- Daylighting requirements
- FEEs (Part L1A)

Is challenging

The End

Thank you for listening!

Susie Diamond

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