PREDICTING OVERHEATING RISK IN HOMES

Susie Diamond – Inkling
Anastasia Mylona – CIBSE
Simulation for Health and Wellbeing
27th June 2016 - CIBSE
About Inkling

• Building Physics Consultancy
  • Susie Diamond
  • Claire Das Bhaumik

• Services
  • Design stage overheating risk assessments
  • Part L2A/CO2 emissions calculations
  • Massing and orientation advice
  • Daylight, sunlight and overshadowing reports
  • EPC predictions
  • Thermal performance and TM54 analyses
  • CFD modelling
Domestic overheating

Using weather data to make buildings climate proof

Climate change means CIBSE's updated weather files are imperative for building energy and overheating risk analysis. Liza Young explains the new data sets and finds out whether the methodology for applying them is up to the task.

Posted in May 2016

Two summers ago, CIBSE Journal received a memorable letter from Ben Cullen about life in his sweltering flat in Milton Keynes. He described how his single-aspect apartment became so hot that the 'killer views' alluded to in the sales brochure were more likely to come from his lack of airing, which consistently breached broadcasting standards. (See 'Tickled pink', CIBSE Journal, September 2014.)

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HOME IS WHERE THE HEAT IS

As global temperatures rise, overheating is becoming an urgent problem for the residential sector. With no government-enforced sanctions on maximum temperatures and little incentive for developers, Liza Young finds out what can be done to keep cool.

The consequences of climate change are not a problem for future generations – they are an immediate threat. Already, there is growing evidence of overheating in homes. According to the Committee on Climate Change (CCC), one fifth of domestic properties could be overheating, even during a cool summer. Flats, which make up 40% of new dwellings, are especially vulnerable.1

By the 2040s, half of all summers are expected to be as hot, if not hotter, than in 2003, when temperatures of up to 38°C led to more than 2,000 excess deaths in the UK. A recent CCC adaptation sub-committee report predicts that annual deaths caused by high UK temperatures will triple to 7,000 on average by the 2050s.2

Yet at the same time, we are designing and building for winter energy efficiency,
Assessing Overheating risk

- Zero Carbon Hub publication
- Co-authored by Inkling and Anastasia Mylona (ARCC and CIBSE)
- Part of report series and ongoing 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
• Large areas of glazing
• Limited ventilation
  • Restricted openings
• City centre locations
  • Noise and/or air pollution limiting natural ventilation
  • UHI effects
• Community heating
Higher overheating risk in city centres

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

- SAP (Appendix P)
  - Single calculation for June, July and August using monthly averages for weather data
  - Single zone model
  - Easy to fudge
- CIBSE Guide A 2015
  - Follows TM52 – adaptive thermal comfort
  - Based on commercial buildings - advice for dwellings is limited
- PHPP
  - Passive House Planning Package
  - Spreadsheet based
  - Uses bespoke internal gains but similar calc to SAP
- Dynamic Thermal Simulation
  - Powerful software, but inconsistent application as no defined methodology
Evidence?
What do we need?

- A stakeholder agreed methodology to follow that is:
  - Reliable
  - Cost-effective
  - Flexible
  - Understandable
- Not as easy as it first appears, but do-able
CIBSE TM52

- Developed for ‘free-running’ commercial buildings
- Provides a definition of overheating and pass/fail criteria
- Based on BS EN Standard 15251:2007
- Sets three criteria against which designs should be assessed:
  - Criterion 1: Hours of Exceedance
  - Criterion 2: Daily Weighted Exceedance
  - Criterion 3: Upper Limit Temperature
TM52 – How it works

1. The first criterion 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 (1 May to 30 September). 3%

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. Weighted exceedance ≤6

3. The third criterion sets an absolute maximum daily temperature for a room, beyond which the level of overheating is unacceptable. It requires the internal operative temperature not to exceed the external running mean by more than 4 degrees. ΔT≤4K
TM52 – variable threshold

- DTM results – Threshold temperature graph

Adaptive Summer Temperatures for London DSY

- $(T_{ed})$ External Dry Bulb
- $(T_{elm})$ External Running Mean
- $(T_{max})$ Comfort Range Max.
- $(T_{upp})$ Absolute Upper Limit
### TM52 – results presentation

- **DTM results – zones results for each criteria**

#### Results

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<th>Zone Name</th>
<th>Occupied Summer Hours</th>
<th>Max. Exceedable Hours (3%)</th>
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Adapting TM52 for homes

- Occupancy profiles are required (not easy)
  - Domestic occupancy very variable
  - To test design need ‘worst case’ scenario, but too ‘worst case’ is excessive and might force mechanical cooling
  - Focusing on occupied hours for bedrooms can have unintended consequences
  - More robust to include all hours i.e. 24/7
- TM52 thresholds – are these suitable for homes where occupancy hours are longer?
  Do we need to adapt them?
Domestic profiles

- Inkling working with Arup and CIBSE to compile profiles based on suggestions from range of sources
- Lighting and equipment gains linked back to annual electrical consumption for homes

This image shows the collated profile for living room occupancy gains. There is significant correlation, but also variation.
Limitations

• Cannot guarantee that people will always be comfortable, regardless of how they act
• Will need to consider different sizes of unit
• Exceptions - should DTM be required on low risk units?
Guidance needed

Advice will be required to cover:

• Recommended sample size
• Choice of sample - aim for worst case or a varied selection?
• Weather file selection including when/how to use future weather
• Use of blinds
• Modelling window openings
Start somewhere

“IF YOU DON’T START SOMEWHERE, YOU’RE GONNA GO NOWHERE.” - BOB MARLEY
CIBSE Weather datasets

- Dynamic thermal simulation building models require external climate inputs.
- Annual observed weather data at hourly intervals supplied from the Met Office.
- Weather variables include air temperature, solar radiation and wind.
- Formats available EPW, TAS, .csv

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Missing Data: see accompanying documentation for description

Model parameters

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TRYs and DSYs

Test Reference Years (TRYs)

- The TRY weather file represents a typical year and is used to determine average energy use within buildings.
- It consists of average months selected from an historical baseline.
- Previous release in 2006 used a baseline from 1984 to 2004.

Design Summer Years (DSYs)

- The DSY represents a warmer than typical year and is used to evaluate overheating risk within buildings.
- The previous methodology for selecting the DSY released in 2006 involved calculating the mean temperature over the period April to September for each year in an observational dataset.
- The DSY was then chosen as the third hottest year.
- Previous release in 2006 used a baseline from 1984 to 2004.
New TRYs and DSYs

Baseline dataset is being updated, both TRY and DSY are selected from 1984 – 2013 baselines.

TRY – same methodology, but with updated baseline, any effects of observed changes in climate are now included.

DSY – methodology for selecting candidate years has changed, based on that used in TM49:

• New files are selected using new metrics based on interrelations between external temperatures and internal comfort temperatures.
• Better description of overheating events, their relative severity and their expected frequency.
New TRYs and DSYs

Available for 14 locations. For each of 14 locations there are:

- Current TRY
- Current DSY1 – featuring moderately warm summer
- Current DSY2 – featuring short intense warm spell
- Current DSY3 – featuring long, less intense warm spell

Note: three new DSYs to replace the single old one per location.
London DSYs

The set also includes the TM49 data made available for London last year with three different London locations:

- London Gatwick (rural) – LGW
- London Heathrow (sub-urban) – LHR
- London Weather station (inner urban) – LWC

Including these three sites allows for different degrees of urban heat island (UHI) effect to be included within the data. This effect is known to increase night-time temperatures significantly in built up areas. The advice is to use the data most appropriate to the project site.
New Future TRYs and DSYs

The future weather files have been morphed based on the UKCIP09 projections and include the following options for each location:

> Future TRY
v Future DSY
   > DSY1
   > DSY2
v DSY3
   > 2020s (only for high)
   > 2050s (only for medium and high)
   v 2080s
      > Low emissions scenario
      > Medium emissions scenario
      v High emissions scenario

10th percentile
50th percentile
90th percentile

x 14 UK wide locations from a 25km grid
Probabilistic Climate Profiles

The Probabilistic Climate Profiles (or ProCliPs) were developed by CIBSE to assist the selection of future files appropriate for each project. These charts, available for all 14 locations, are available for free on the CIBSE Knowledge Portal.

Seasonal mean air temperature (Winter, Spring, Summer Autumn)
Daily minimum temperatures for winter
Daily maximum temperatures for summer
Seasonal daily precipitation (Winter, Spring, Summer Autumn)
The End

Thank you for listening!

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