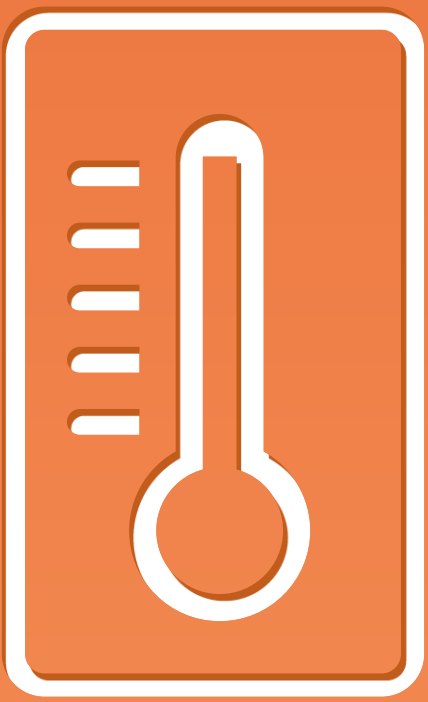
DEFINING OVERHEATING LEAFLET



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OVERHEATING IN HOMES

Overheating has not, historically, been something the UK housing sector has needed to grapple with, but it is a growing problem. Potentially up to 20% of the housing stock in England is already affected and the issue is likely to become more prevalent in future.

"As temperatures rise due to climate change there is an increased risk of overheating in buildings."
ENVIRONMENTAL AUDIT COMMITTEE

WHAT IS OVERHEATING?

Overheating is the term used to describe situations where the temperature inside a person's home becomes uncomfortably or excessively warm. It happens most often during warm weather in the summer, but it can happen in winter months too.

Both sudden spikes in temperature and prolonged periods of excess heat can be difficult for people to cope with, especially if they have an underlying health condition.

PURPOSE OF THIS LEAFLET

Overheating is notoriously difficult to define for all scenarios. Different sectors have developed different definitions and thresholds. The Chartered Institution for Building Services Engineers (CIBSE) provides industry guidance on comfortable indoor temperatures.

In contrast, the health sector tends to think about overheating in terms of the consequences for people's health and to focus on the temperatures at which people start to fall ill or which lead to fatalities.

"Excess heat" is included as a hazard in the Housing Health and Safety Rating System. Environmental Health Officers have legal powers to order housing providers to make properties safe.

This leaflet provides an introduction to the range of overheating definitions and thresholds in use in the Housing sector and also by health professionals.

It is based on work carried out by the Zero Carbon Hub over the past two years as part of a large-scale project on 'Overheating in Homes', and draws specifically the detailed evidence review, 'Defining Overheating' authored by the Chartered Institution of Building Services Engineers (CIBSE), ARCC, University College London (UCL), and the London School of Hygiene and Tropical Medicine (LSHTM).

THE ZERO CARBON HUB'S OVERHEATING PROJECT

At the request of Government, the Zero Carbon Hub formed the project 'Tackling Overheating in Homes' in 2014 to gather evidence and information on the current and possible future extent and impact of overheating in homes. We also looked at the degree to which the housing sector is already gearing up to tackle the issue and what further action could be required to manage the risk of future overheating.

Our 'Overheating in Homes – the Big Picture' baseline evidence report, published in June 2015, presents our findings from:

- Over 400 research papers and reports;
- 6 thematic Evidence Reviews;
- A survey of 75 Housing Providers (representing 207, 728 homes) in partnership with Sustainable Homes;
- 33 in-depth interviews with Housing Providers and other industry experts; and
- Workshops and one-to-one meetings.

All our Overheating publications are available online at **www.zerocarbonhub.org**

The term Housing Provider covers all organisations who build, manage, rent or retrofit domestic properties, for example developers and private and social landlords.

EVIDENCE REVIEWS

As part of the Overheating in Homes project, a series of Evidence Reviews were commissioned from experts on key themes related to overheating.

DEFINING OVERHEATING
by CIBSE, ARCC, UCL, and the LSHTM

ASSESSING OVERHEATING RISK
by Inkling LLP, CIBSE, UCL and ARCC

IMPACTS OF OVERHEATING
by AECOM

OVERHEATING RISK MAPPING
by AECOM

DRIVERS OF CHANGE – OVERHEATING IN HOMES
by the ZCH and AECOM

SOLUTIONS TO OVERHEATING IN HOMES
by BRE

LEAFLETS FOR HOUSING ASSOCIATIONS AND LOCAL AUTHORITIES

MONITORING OVERHEATING – HOUSING ASSOCIATION CASE STUDIES

LOCAL AUTHORITIES – TACKLING OVERHEATING IN HOMES

BUILDINGS AS MODIFIERS OF CLIMATE

People in the UK spend a large proportion of their time indoors. One purpose of buildings, especially homes, is to protect their occupants from the external climate. This means it is not enough to define overheating just in terms of external temperatures.

Temperatures inside the home may be higher or lower than the external air temperature, depending upon the construction and use of the building.

Home occupants are also likely to demonstrate a wide distribution of individual heat vulnerability, with certain groups being disproportionately affected by excess temperature exposure.

DON'T BUILDING REGULATIONS ALREADY SET A STANDARD?

Approved Document Part L1A is designed to drive the conservation of fuel and power, rather than set thermal comfort standards. It requires housebuilders to make "reasonable provision to limit heat gains" in dwellings in order to reduce the need for mechanical cooling. Specific criteria or thresholds are not specified. The overheating 'check' in SAP Appendix P provides a means of demonstrating that reasonable provision has been made, but the calculation is not integral to the SAP rating and it is unclear what happens if a development fails the test.

"The dwelling should have appropriate passive control measures to limit the effect of heat gains on indoor temperatures in summer, irrespective of whether the dwelling has mechanical cooling. The guidance given in paragraphs 2.38 to 2.42 of this approved document provides a way of demonstrating reasonable provision."

CRITERION 3, APPROVED DOCUMENT PART L1A

SAP APPENDIX P OVERHEATING CHECK

The Standard Assessment Procedure (SAP) is the Government's procedure for rating the energy performance of homes.

Designers and developers in the UK need to show compliance with SAP for each of the domestic units they are designing. It is not a design tool, but rather a compliance tool intended to produce an energy rating.

SAP Appendix P is a simplified check of whether the home could have an overheating problem. It uses regional average external air temperatures for the months of June, July and August, heat gains and fabric characteristics of the building in order to calculate monthly mean summer internal air temperatures. These are then compared to a table of threshold temperatures. For monthly mean internal temperatures below 20.5°C, overheating risk is predicted to be 'not significant', whereas for temperatures of 23.5°C and above, the risk is 'high'.

"It is too easy to twist the response in SAP to make sure you always get a pass."

HOUSEBUILDER

ISSUES WITH SAP

The temperature inside a home depends on many variables and changes throughout the day. Overheating risk during severe hot weather events cannot be calculated using monthly average temperatures. Neither can the impact of the Urban Heat Island effect or future changes in climate.

Housing Providers and experts consulted by the Zero Carbon Hub raised many concerns with SAP Appendix P. For example, it allows unrealistic assumptions to be included, such as that windows are constantly open, which make it too easy to pass.

Table 1. **SAP 2012 (Appendix P): Levels of threshold temperature corresponding to likelihood of high internal temperature during hot weather.**

Threshold temperatures (°C)	Likelihood of high internal temperatures during hot weather
< 20.5°C	Not significant
20.5°C - 22.0°C	Slight
22.0°C - 23.5°C	Medium
≥ 23.5°C	High

DESIGN STANDARDS FOR THERMAL COMFORT

Within the housing sector, the desire is to design dwellings in which the occupants will experience 'thermal comfort'.

Thermal comfort has been defined as: 'that condition of mind which expresses satisfaction with the thermal environment'. (ISO 7730:2005)

The Chartered Institution of Building Services Engineers (CIBSE) has produced guidance on the temperature thresholds, which if exceeded for certain periods of time, would result in most occupants in buildings feeling uncomfortably warm. In such circumstances the building is considered to have overheated.

Unlike SAP, these standards relate to hourly temperatures for the period during which the home is occupied, so designers need to use dynamic thermal simulation to calculate them.

CIBSE GUIDE A ENVIRONMENTAL DESIGN: 2006 EDITION

CIBSE's previous 2006 edition of Guide A Environmental Design states 25°C as the temperature above which people will start to feel uncomfortably warm in their homes during the day. Overheating occurs, if the living room temperature exceeds 28°C for more than 1% of the time that the room is in use.

High night-time temperatures can lead to disrupted sleep and impair a person's ability to recover from heat stress during the day. A lower peak threshold temperature of 26°C is used to calculate overheating in bedrooms. The summer comfort temperature for bedrooms is 23°C and the Guide suggests that sleep quality may be impaired once indoor temperatures exceed 24°C.

These thresholds use the "operative temperature", which combines the air temperature and the mean radiant temperature in a weighted average.

Table 2. **Temperature thresholds for the design of buildings**

Homes	Acceptable summer comfort temperature	Peak summer temperature	Overheating criterion
Living areas	25°C	28°C	1% annual occupied hours over peak temperature
Bedrooms	23°C	26°C	

Used with permission from CIBSE's Environmental Design Guide A (2006)

CIBSE GUIDE A ENVIRONMENTAL DESIGN: 2015 EDITION

ADAPTIVE THERMAL COMFORT

The absolute thresholds in CIBSE Guide A 2006 are relatively simple to use and understand.

However, healthy people can adapt to recent changes in outdoor temperatures and this will influence their perception of and response to indoor temperatures. Occupants of non air conditioned buildings will also make adjustments in their clothing and their environment to keep cool.

This is the basis of the 'adaptive thermal comfort model', adopted by CIBSE in the latest 2015 edition of Guide A. The underlying British Standard (BS EN) 15251:2007 introduced the concept of acceptable indoor comfort temperature bands for different categories of buildings, depending upon the ability of the occupants to modify and adapt to their environments.

ADAPTIVE THERMAL COMFORT FOR HOMES

The adaptive thermal comfort model is based on extensive field studies, but these were carried out primarily in the non-domestic sector, for example in offices.

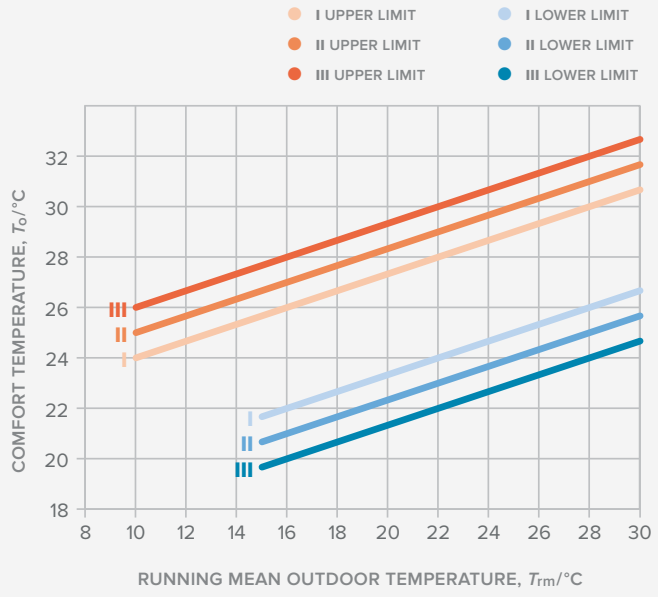
The model needs to be fully road-tested in the domestic sector, in particular, to confirm its applicability to bedroom comfort temperatures during the night. CIBSE Guide A (2015) continues to advise that sleep quality may be compromised when the indoor operative temperature rises above 24°C and recommends that peak bedroom temperatures should not exceed 26°C.

Figure 1.
Indoor comfort temperatures as a function of the running mean outdoor temperature, for three building types.

I. Spaces occupied by very sensitive and fragile persons

II. New buildings and renovations

III. Existing buildings



Used with kind permission from the British Standards Institute

HEALTH THRESHOLDS

There is often a difference between defining the conditions that should be met for acceptable thermal comfort and the temperatures above which there could be significant health impacts for occupants. The people most at risk from the health effects of excess heat may experience those effects at temperatures below the upper thresholds for thermal comfort.

People have different degrees of vulnerability to heat depending on, for example, their age, health and social contacts. Prolonged heat exposure, which can cause serious health problems for vulnerable groups, is also not well accounted for by simple temperature thresholds.

Where health-related research and guidance on temperatures exists, it is usually related to external temperatures.

At present, there are currently no officially established, universally accepted upper internal temperature thresholds for health. In a recent review, Public Health England called for the development of an appropriate indoor heat vulnerability index.

"Indoor thresholds for health are needed as a protective measure against preventable morbidity and mortality."

OVERHEATING IN NEW HOMES. A REVIEW OF THE EVIDENCE (2012), NHBC FOUNDATION

THE HOUSING HEALTH AND SAFETY RATING SYSTEM (HHSRS) 2006

The Housing Health and Safety Rating System was introduced under the Housing Act 2004 and applies to residential properties in England and Wales. This risk-based evaluation tool identifies potential risks and hazards to health and safety from any deficiencies identified in dwellings. One of the 29 hazards is Excess Heat. The HHSRS guidance states that temperatures above 25°C can lead to an increase in strokes and mortality.

Environmental Health Officers have legal powers to order housing providers to make changes to properties so that they comply with the HHSRS and are safe to live in.

"Where do you draw the line between temperatures affecting health versus thermal comfort. Some of us are very comfortable in heat, others aren't. Some groups of people may have their health put at risk by excessive heat."

TRADE BODY

THE HEATWAVE PLAN FOR ENGLAND

The Heatwave Plan for England (Public Health England 2015) defines regional day and night external temperature thresholds based on statistical analysis of summer temperature records and mortality between 1993 and 2006. In connection with this, England has a 'Heat-Health Watch' system. It comprises five main levels (Levels 0-4), from long-term planning for severe heat, through summer and heatwave preparedness, to a major national emergency.

Alert levels 1 to 4 operate from 1st June to 15th September each year. Alert Level 2 (alert and readiness) is triggered when the Met Office forecasts a 60% chance of thresholds being exceeded on at least two consecutive days. Alert Level 3 (heatwave action) is triggered as soon as the Met Office confirms that threshold temperatures have been reached in any region.

OUTDOOR TEMPERATURE THRESHOLDS

Statistical analysis shows that maximum daytime outdoor temperatures are a predictor of heat-related mortality.

In London, mortality starts to rise when the maximum daily external air temperature goes above 24.7°C, and has been estimated to rise by approximately 3% for every further 1°C increase in external temperature. In other regions, the thresholds at which mortality starts to rise are lower. For example, the threshold for the North East of England is 20.9°C.

INDOOR TEMPERATURES IN THE HEATWAVE PLAN

The Heatwave Plan thresholds are based on external temperatures. But there are many variables that affect how warm the building really is inside, for example, heat gains from appliances, the materials the building is constructed from and the level of solar gains.

The Heatwave Plan for England (2015) contains advice related to internal temperatures in dwellings:

- Cool rooms, maintained at temperatures below 26°C, should be provided in hospitals, care/nursing homes and other residential environments occupied by vulnerable' individuals; and
- Fans should not be used if indoor air temperatures are greater than 35°C. Blowing air which is close to or above body temperature will heat people up rather than cool them down.

Table 3. **Heatwave Plan Regional Threshold Temperatures for Heat-Health Watch Alert Levels 2-4.**

Region	Day	Night
London	32°C	18°C
South East	31°C	16°C
South West	30°C	15°C
Eastern	30°C	15°C
West Midlands	30°C	15°C
East Midlands	30°C	15°C
North West	30°C	15°C
Yorkshire and Humber	29°C	15°C
North East	28°C	15°C

OTHER THRESHOLDS

PRODUCTIVITY

Existing occupational heat stress metrics, such as the Wet Bulb Globe Temperature, were generally developed for manual outdoor work in climates hotter than the UK.

Nonetheless, the cumulative effects of night-time discomfort, sleep disruption and sleep deprivation, caused by overheating in homes are likely to have an impact on the ability of individuals to concentrate and perform both physical and mental activities. Especially if they are combined with sustained heat exposure in the workplace during the day.

More research is needed to quantify the impact of overheating in homes upon economic productivity.

INFRASTRUCTURE RESILIENCE THRESHOLDS

The use of air conditioning is currently very low across the residential sector. In 2013 less than 3% of English households were using a fixed or portable air conditioning unit during the summer.

But there is concern that the demand for cooling will increase, increasing peak electricity demand. This could put a strain on the electricity grid. Blackout risk temperature thresholds are largely context-specific. Given the lack of historical data, it is particularly challenging to provide an estimate of external air temperature thresholds above which the likelihood of power outages may increase in the UK.

DEFINITIONS IN USE

"We're finding increasingly that the local environmental health officers have a view and they're potentially at odds with their building control colleagues."
HOUSING ASSOCIATION

WHAT DEFINITIONS IS THE HOUSING SECTOR USING?

The Zero Carbon Hub overheating survey asked "How does your organisation define 'overheating' in residential properties?"

- Approximately two thirds of the 70 respondents defined overheating in general terms related to the thermal comfort of occupants.
- 8 organisations referenced SAP Appendix P as their definition.
- The remainder defined overheating using quantified criteria including CIBSE Guide A (2006), or criteria developed specifically for Passivhaus designs.

ISSUES

Stakeholders engaging with the Zero Carbon Hub have reported that the range of different definitions, and the lack of an agreed method, is creating issues. For example, if Environmental Health Officers seek to enforce health and safety standards which the dwelling was not designed to deliver, protracted disputes can arise. The lack of clarity created by the absence of a standard for domestic properties is leading to uncertainty over whether organisations have 'done enough' to meet legal requirements.

AGREEING A DEFINITION

The Committee on Climate Change's Adaptation Sub-Committee recently called for a Standard on overheating, and the Government's response, published on 15 October 2015, acknowledged the issue of the lack of an agreed definition.

The Zero Carbon Hub is working with the industry to produce a paper, by Spring 2016, providing preliminary recommendations on the type of "definition" which could be effective and workable. The Zero Carbon Hub is also helping CIBSE and Arup to develop improved overheating modelling protocols.

Since our formation in 2008, the Zero Carbon Hub continues to work with Government and industry to identify risks, remove barriers to innovation and help demonstrate that energy efficient, healthy new homes can be delivered by the mainstream house building industry.

Get in touch to find out how we can assist you

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