Report of the workshop
Blowing Hot and Cold at Home

London, 25th March 2011

Convened by the Extreme Events and Health Protection Section with
Air Pollution Unit, Health Protection Agency
and the Department of Health

In association with the National House Building Council Foundation and
the Building Research Establishment (BRE)

This document is available on the internet at: www.hpa.org.uk
1 Introduction

1.1 Background to the workshop

The NHBC Foundation has recently provided research funding for BRE to conduct a review on the subject of overheating in homes in the UK. The six month project commenced in early February 2011 and will involve reviews of literature and case studies, as well as consultation with a range of stakeholders - including people from the medical sector, construction industry, developers and housing groups, policy makers and academics.

Before the inception of the project, BRE had approached Virginia Murray at the HPA to take part in certain work items, primarily with respect to a literature study on the medical effects of overheating on humans - at which time discussions on a workshop commenced. The HPA Extreme Events Unit wished to convene a follow up to the HPA workshop ‘Homes, health and climate change’ held in November 2008, which led to a publication entitled ‘Will drivers for home energy efficiency harm occupant health?’

With BRE’s wish to consideration of the causes and effects of overheating in homes from a medical and health and wellbeing point of view, and HPA’s wish to also cover the causes and effects of over-cold in homes, as well as the Department of Health’s existing heat-wave plan and new draft cold weather plan, it was agreed that a whole day workshop would be held at HPA, during which both heat and cold were to be considered. The workshop was given the name ‘Blowing Hot and Cold at Home’, with the overheating component of the day’s proceedings to form part of the NHBC Foundation review project mentioned above.

Hot

At present there is no rigorous definition of what constitutes overheating in dwellings. However there is documented evidence that current temperatures in some existing dwellings are harmful to occupant health and wellbeing. It is also evident that some dwelling designs currently passing planning and building control exhibit the same characteristics as existing dwellings which overheat.

The factors that contribute to overheating in dwellings include urbanisation, occupant behaviour/interventions, orientation, aspect, thermal mass, glazing, internal gains, changes in building design (including the drive for energy efficiency, leading to highly insulated and airtight dwellings), pollution, noise and security. Previous assessments and research into the subject have tended to make the assumption that window opening is an available option when occupants become hot but, particularly in urban
locations, window opening is not always appropriate or safe for occupants, or is limited in its effectiveness. The Building Regulations currently make simplistic assumptions about ventilation, and this is applied uniformly across the housing stock. Alternative means of assessing the risk are required in order to capture this very wide range of independent contributing factors.

Cold

On average, over 25,000 additional people die in England over the winter months because of cold weather than during other times of the year.\textsuperscript{2} This figure can be substantially increased when winter weather is severe: over 45,000 ‘excess’ deaths during the winter of 1999/2000 and over 36,000 in 2008/09. Deaths occur from heart attacks, strokes and respiratory illnesses, although there are other non-fatal health related endpoints thought to be caused by the cold. The annual cost to the NHS of treating winter-related disease is £859 million.\textsuperscript{3} This does not include additional spending by social services, or economic losses through missed work. A recent study showed that investing £1 in keeping homes warm saved the NHS up to 42 pence in health costs.\textsuperscript{3}

Although there have been significant improvements to building regulations over the last decade, and a push to improve the energy efficiency of older homes, there are still many homes in England that fall well below modern standards of insulation and heating. Additionally, from a health perspective, it is important to ensure that as houses are improved, adequate ventilation ensures adequate air changes to prevent other health problems. Furthermore, the older you are, and the more likely to be at risk of ill health from a cold, damp home, the more likely you are to be living in a less energy efficient home (see below).

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figures}
\caption{Percentage of households with Central Heating by Age of Occupant(s)}
\end{figure}

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figures}
\caption{Percentage of Houses failing Decent Homes standards by Age of occupant(s)}
\end{figure}

Source: English House Condition Survey, 2001
2 Objectives and key questions

The interactive workshop brought together a range of experts from the academic community and policy-makers from the UK to explore various facets of the issues surrounding overheating and over-cold in homes.

To enable discussion the number of participants was restricted to approximately 25. A list of the participants is attached as Annex 1.

2.1 Hot

Aim

Given the current carbon compliance agenda, a concerted research programme is required in order to establish the level of risk associated with building new homes which will be susceptible to overheating. It is hoped that a major research programme can be undertaken to provide guidance in time for the next major revision of the Building Regulations and to help all stakeholders to manage the risk of overheating.

A robust and recognised definition of overheating could be used to predict and mitigate for the risk of overheating. It would be used by designers, assessors and surveyors and would also alert and inform the whole construction industry of this issue. The health fraternity would also benefit from such information.

Key questions were devised by the organisers to help define important issues for discussion:

Four broad questions:

1. What is overheating – short-term/long-term?
2. Who are the susceptible groups and what are the effects on them?
3. What are the causes, and what can be done by way of mitigation or adaptation?
4. What should be the thresholds/trigger values for intervention?

Breakdown of questions:

1. Definition of overheating
   - Is there a problem with overheating in domestic buildings?
   - How do we know we have a problem?
2. Susceptible groups

- What are the susceptible groups?
- Is there evidence which points to a sub-group of greater susceptibility?
- What percentage of people are vulnerable, i.e. how big is the problem?

3. Causes

- Where is the problem?
- What causes the problem?
- Will the problem be solved by adaptation?
  - Can we learn anything from other countries?
- Will the problem be solved by mitigation?
- Is there any work required that will help answer these questions
  - Short-term
  - Long-term

4. Thresholds for intervention

- Do we have a threshold?
- Is there one figure or a graduation of figures which could be used for different intervention techniques to be employed?

Research:

- What research needs to be put in hand to answer these questions?
- What research do we need to do to be able to calculate the benefits to health of reducing exposure to overheating?
- Is there any new evidence due to appear which might help with answering any of these questions?

2.2 Cold

Aim

Keeping warm indoors is important and although heating and insulation are not the only considerations for a healthy indoor domestic environment, improving the energy efficiency of older dwellings is clearly an issue for both health and mitigation of the effects of climate change. Our understanding of the risk of cold for different sectors of the population needs to be taken further forward, helped by the Department of Health’s/Health Protection Agency’s preparation of a cold weather plan. It is important to determine the level of risk associated with not adequately improving older housing stock, and to produce guidance for the improvement of dwellings using health based and scientific criteria.
A robust and recognised definition of cold could be used to predict and mitigate for the risk of cold in dwellings. This would be used by designers, assessors and surveyors and the health fraternity.

Key questions were devised by the organisers to help define important issues for discussion:

Four broad questions:

1. What is cold?
2. Who are the susceptible groups and what are the effects on them?
3. What are the causes, and what can be done by way of mitigation or adaptation?
4. What should be the thresholds/trigger values for intervention?

More focused questions:

1. Definition of cold
   - Is there a problem with cold in domestic buildings?
   - How do we know we have a problem?
   - In what situations/building types is there a problem?

2. Susceptible groups
   - What are the susceptible groups?
   - Is there evidence which points to a sub-group of greater susceptibility?
   - Is susceptibility associated with building type?
   - What percentage of people are vulnerable, i.e. how big is the problem?

3. Causes
   - Where is the problem?
   - What causes the problem?
   - Will the problem be solved by adaptation?
     - Can we learn anything from other countries?
   - Will the problem be solved by mitigation?
   - Is there any work required that will help answer these questions
     - Short-term
     - Long-term

4. Thresholds for intervention
   - Is there a threshold figure?
   - Is there one figure or a graduation of figures which could be used for different intervention techniques to be employed?
Research:

- What research needs to be put in hand to answer these questions?
- What research do we need to do to be able to calculate the benefits to health of reducing exposure to over-cold?
- Is there any new evidence due to appear which might help with answering any of these questions?

3 Agenda & presentations

The agenda, attached as Annex 2, was divided into a series of 15-minute presentations, with time allocated for corresponding discussion.

This section provides a record of the key points which emerged during and after the presentations.

3.1 HOT

3.1.1 Note on consideration of health & wellbeing of occupants
In order to consider the causes and effects of overheating and of cold, and to arrive at a working definition, it is important to approach the issue from a medical/health standpoint as well as from the point of view of construction and energy issues. Existing guidance and temperature thresholds for overheating and cold tend to have been developed in work place settings where drivers will to a large extent be about productivity (and mainly during the daytime) and to some extent the physiological effects of cold on the human body have been studied. During this workshop we sought to explore the causes and effects of overheating and cold regarding the health and well being of occupants in domestic settings (throughout the day and night) and to discuss the ways in which potential harm to occupants may be lessened, and a basis by which overheating and cold thresholds or trigger values for intervention could be set.

3.1.2 Presentation No. 1

Buildings and the new codes – the health implications of air tight enclosures

Andy Dengel (BRE) identified the following research needs:

- Better understanding of causes & effects
  - including cost to “UK plc” – e.g. the NHS
- Inform design, mitigation and adaptation by:
  - providing a definition of overheating for designers
  - undertaking physical monitoring throughout a large sample of UK housing stock (especially urban)
  - informing changes to Regulations
- Set realistic & robust thresholds for intervention.
• Enable stakeholders to better assess risks and/or take action (HA’s, EHO’s, householders, etc.)

3.1.3 Presentation No. 2

Overheating case studies

Michael Swainson (BRE) showed that preventing dwelling overheating requires:

• A working definition of overheating that can be used by:
  – Designers to allow risk to be assessed early in the design stage.
  – Local Authorities to allow assessment of design robustness.
  – Landlords, EHO’s, etc. to allow assessments of cases of claimed overheating.
• The definition must be based on the risk to health – minimising the risk to occupants and the developing liability for the NHS.
• Guidance on how to assess the risk – validated modelling?

3.1.4 Presentation No. 3

Hot weather plan

Graham Bickler (HPA) summarised by stating that heat and cold can kill.

Heat-waves are very dangerous and CVD, respiratory and other deaths increase, the vulnerable are greater risk, with hospital impacts confusing, but impact on respiratory admissions. Heat-waves are increasing in frequency and intensity with the annual risk of 9 day heat wave averaging 27°C in SE England one in forty by 2012; but the effects should be preventable. GH provided the thresholds used by the hot weather plan:

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<tr>
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<th>Day</th>
<th>Night</th>
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</thead>
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<tr>
<td>North West</td>
<td>30</td>
<td>15</td>
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<tr>
<td>Yorkshire and Humber</td>
<td>29</td>
<td>15</td>
</tr>
<tr>
<td>North East</td>
<td>28</td>
<td>15</td>
</tr>
</tbody>
</table>
3.1.5 Presentation No. 4

Vulnerabilities in the Heat

**Prof. George Havenith, Environmental Ergonomics Research Centre, Loughborough University** summarised indoor versus outdoor heat:

- Cities act as heat islands.
- Urban heat islands magnify night time temperatures.
- High night temperature affects sleep quality.
- Increased physiological risk with age.
- Older people and their indoor environments.
  - Poor quality homes.
  - Lack of air conditioning.
  - Immobility.
  - Fear of crime.
  - Isolation.

More research is needed (case histories). Prof. Havenith identified a range of knowledge gaps:
- Though causes for exertional heat stroke are well understood, the causes for the population mortality increase in the heat are less clear; more in depth case studies are needed.
- Knowledge of behavioural aspects of heat exposure is often anecdotal and deserves more attention.
- Suggestions for alternative building design need to be evaluated in particular for occupation by the elderly.

In summary he stated that the failure to maintain heat balance with increased body heat content and core temperatures lead to:

- Blunted thermal perception, reducing capacity for behavioural responses.
- Impaired vasodilatory mechanisms, decreasing cutaneous heat losses.
- Reduced sweating capacity.

3.2 COLD

3.2.1 Presentation No. 5

Where are we now?

**Professor Virginia Murray HPA** (on behalf of Dr Yvonne Doyle DH) with reference to the CMO annual report from 2009 [http://www.dh.gov.uk/prod_consum_dh/groups/dh_digitalassets/@dh/@en/@ps/documents/digitalasset/dh_114012.pdf](http://www.dh.gov.uk/prod_consum_dh/groups/dh_digitalassets/@dh/@en/@ps/documents/digitalasset/dh_114012.pdf) showed that:

- England’s annual winter death toll averages over 30,000 people.
- This death rate is far higher than that in comparable countries.
• With better preparation for cold weather, thousands of lives could be saved each year.

CMO’s recommendations included:

• A national cold weather plan should be developed to prevent and deal with health consequences of cold weather.
• Healthcare providers should identify people vulnerable to harm from cold weather and refer them for appropriate help.
• Further research should be conducted into the risk factors for winter mortality and how it might be prevented.

In conclusion - a Cold Weather Plan for England has been drafted and piloted over the winter of 2010/11 on a limited basis. Subject to evaluation, it is planned to launch this more widely over the winter of 2011/12. It will continue to develop.

3.2.2 Presentation No. 6

The Draft Cold Weather Plan

Damian Basher, Department of Health reported on the draft Cold Weather Plan for England. He described the thresholds and levels and actions recommended. He pointed to the need for:

• Clarity in developing thresholds.
• Coverage: currently England but to cover all UK countries?
• Where does the plan sit/who leads (Health?)
• Links to other Government Departments: CC adaptation work, other Departments’ plans & standards.
• Delivery of Services and Support: increased demand, coordination across new providers, time-lag of health impacts.
• ‘Big Society’ and personal responsibility for health: voluntary support to vulnerable, reducing personal risk behaviour in cold weather.
• Ongoing communications response to messages, uptake of advice, new media.
• Research.

3.3.3 Presentation No. 7

Housing in England – vulnerabilities and case studies

Maggie Davidson, BRE Housing summarised the issues by suggesting that:

• The primary focus must be on the existing stock – new building won’t solve the problem.
• We need to tackle private sector housing
• Previous and existing initiatives have focussed on ‘low hanging fruit’ – we are left with the problematic/expensive cases.
• Inadequate heating and insulation are linked to and can directly cause other problems.
• We need a better understanding of the impact of cold homes on long term and chronic conditions.
• We need additional and more up to date data and statistics to develop more reliable and persuasive cost benefit models.

4 Outputs from workshops

4.1 HOT Workshop

The reports back from the break-out groups and subsequent discussion between the whole group identified the following HOT issues:

• We need to feed as much real data to assist in validation of models used in guidance to assess risk.
• Must be careful with threshold settings - not too high, not too low (false positives).
• Threshold temperatures - vary regionally (cold) have threshold but only one, not adapted regionally (although this temperature is to do with health, so would not necessarily expect regional variances).
• Is there a need to have thresholds for different areas of the home (e.g. living room, kitchen, bedroom) or does this introduce too much complexity?
• For an extreme event trigger it was agreed that external temperature is appropriate, but we are looking at building design therefore need to consider internal air temperature.
• In some ways indoor temperature is the domain of the building sector, whereas outdoor temperature is the domain of the health sector – what links can we establish here?
• What part (if any) do other factors play (e.g. humidity, ventilation rate), especially in locations where these might play a greater party, for instance in coastal areas.
• There are misleading assumptions in SAP (e.g. ability to be able to or be prepared to open windows) which require correction, but this will not be easy due to the differing micro-environments found in real life (e.g. ‘boundary layers’ near windows).
• Need more case studies to help research (see research gaps in George Havenith’s presentation and from evaluation sheets).
• Scientific evidence base relating to health and indoor temperature is very small. All data presented appeared to be for heat stress due to exercise i.e. sport or HSW Act driven. Nothing robust presented for living – e.g. no studies on people in homes doing nothing.
• Reporting of overheating to EHO’s consists not of a number, but due to experiences from occupants and their requests for assistance.
• 25°C value: originates from WHO, but is it outdated and not sufficient?
• Large susceptible group – the aged - we know of sub-groups, but would not pick a sub group to target as not enough power in data on individual health conditions - therefore targeting elderly is best option. Numbers are great enough if conduct studies using age rather than any further breakdown. Plus findings can be replicated.

• List of other sub-groups includes: those on antipsychotic drugs, socially isolated, with chronic disease, overweight (not exhaustive list).

• Should look at educating the support networks around vulnerable groups.

• Look at using EU SES data rather than just UK.

• There seems to be a problem with the models we comply with - where buildings are concerned the regulations actually allow us to build 'unfit' buildings.

• Consensus seemed to be that it is better to get design right the first time and then to build to intent, as need for mitigation and/or adaptation later on will cost more. However, how do we best close the design/as-built performance gap? Also, the concept of ‘Lifetime Homes’ has fallen by the wayside of late - largely due to other things moving up the agenda; so how can we reinforce & reinvigorate such long-term concepts?

• As far as heat-waves are concerned, there are different types – e.g. hot/dry or hot/humid; early in summer or late in summer (adaptation issues).

4.2 COLD Workshop

The reports back from the break-out groups and subsequent discussion between the whole group identified the following COLD issues:

• Converted flats pose the biggest problem (e.g. attic conversions).

• A lot of the housing stock is ‘untreatable’ (e.g. pre-1919 houses).

• Below 18°C indoors is a good level at which to define cold for health purposes (though it should be noted that DH recommend 17-21°C as suitable room temp for babies).

• We don’t have intervention studies in this country – need decent longitudinal study.

• Confusion exists with different thresholds used across government departments (e.g. those used to trigger cold weather payments vs. those in cold weather plan).

• Different thresholds for different parts of building and within rooms.

• Where does the 2°C level for alerting come from?

4.3 Overarching comments from HOT and COLD

• Hot lag effect is quite quick, cold effect is slower. Rate of increase could be very steep – little data to back up apparent trend as ambient temperature rises well above 20°C.

• Medication has effect on systems which respond to heat and cold. Any links between the effects of medication, temperature and mental health issues should not be dismissed.

• Also, what are the links with suicide rates, mental health issues, civil disturbances, etc.
• Problem is that UK climate is temperate, so we have not adapted to either extreme.
• We haven't looked at depth into mental health and change in behaviour.
• HHSRS is now out of date. All are keen to update this. (Although note that talking with DO and from information from RS, an update would be better done of the HHSRS on a regional level).
• We need to ensure that measures put in to mitigate overheating do not exacerbate over-cold, and vice versa.
• Existing building stock is very poor for cold – new designs are leading to the potential for increasing impact of hot.
• Whatever we prescribe in terms of occupant behaviour, our culture may largely preclude compliance with instructions on how to control temperature, ventilation etc in the home (example was given of the converse in Germany, where people would tend to obey instructions on how long to keep windows open for example).
• We need cross-disciplinary and large scale research and monitoring (for heat and cold, plus IAQ etc).
• Make sure that we get best value by monitoring (physical & occupant) for as much as possible once sample of households is identified. Can we ‘piggy-back’ on existing monitoring/questionnaire campaigns?
• Overheating (unlike cold) is very relevant to new-build (especially in low carbon homes) – i.e. although there is potential for some older properties to overheat (e.g. attic conversions) it is mainly the newer homes built to the ‘air tightness agenda’ which pose a risk.
• What tools can we use to establish the link between excess deaths and impacts on “UK plc”? (e.g. costs to the NHS).
• When looking for how to set and implement thresholds for intervention, could we use the model used for the Hot Weather Plan, i.e. use INDICATORS (e.g. Levels 1-4) to advise when caution or action may be required. At higher levels, robust thresholds would be used for urgent intervention.
• There should be far more emphasis put on health & wellbeing in questionnaire campaigns, focus group work etc (e.g. EFUS). This would tease out problems with heat/cold (both existing and feared in future).
• Could the condition of housing stock (and in particular its potential to harm occupants by propensity for overheating and/or over-cold) be looked at for vulnerable groups by means of health professional/social services visits (e.g. GP’s, district nurses, etc)? For instance, under the Quality of Outcomes framework, GP practices currently earn ‘QOF’ points for gathering information on patients’ smoking habits, risk of cardio-vascular/cerebro-vascular disease, etc.
• Research maps (hot and colds) are of paramount importance. Need to match medical evidence/knowledge with data on housing stock (EHS, etc).

Note

The comments received on the Event Evaluation Sheets received from delegates are listed as Annex 3.
5 Further actions agreed

- Build a first draft research map and share by two e-mails – one requesting data, a second sharing the cumulated information.
- If DH agree, share the cold weather plan.
- Hold another workshop in October 2012 - with the specific aim of bringing issues to the table which will influence future Building Regulations updates.
6 References


## Annex 1: List of Participants

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<thead>
<tr>
<th>Surname</th>
<th>Forenames</th>
<th>Company</th>
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<tbody>
<tr>
<td>Basher</td>
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<td>Bickler</td>
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<tr>
<td>Davidson</td>
<td>Maggie</td>
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<td>Emanuel</td>
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<tr>
<td>Wells</td>
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# Annex 2: The Agenda

**25th March 2011**

**Health Protection Agency, Victoria, London**

**Blowing Hot and Cold at Home**

HPA / DH workshop in association with the NHBC Foundation & BRE

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
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<td>Introduction to the workshop</td>
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<td>Andy Dengel (BRE)</td>
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<td><strong>HOT HOMES</strong></td>
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<td>10.10</td>
<td>Domestic overheating – why?</td>
<td>Andy Dengel</td>
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<td>Overheating case studies</td>
<td>Michael Swainson (BRE)</td>
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<td>Hot weather plan</td>
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<td>10.55</td>
<td>Vulnerabilities and gaps in knowledge</td>
<td>George Havenith (Loughborough Uni)</td>
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<td>11.10</td>
<td>Coffee</td>
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<td>11.20</td>
<td>Working groups to address</td>
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<td></td>
<td>All</td>
<td>a) Definition of overheating</td>
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<td></td>
<td>Blue Group</td>
<td>b) Susceptible groups and effects</td>
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<td></td>
<td>Red Group</td>
<td>c) Causes, and mitigation or adaptation</td>
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<td>All</td>
<td>d) Thresholds for intervention</td>
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<td>12.20</td>
<td>Feedback from all four groups and discussion</td>
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<td>Where are we now?</td>
<td>Virginia Murray</td>
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<td>13.45</td>
<td>Cold weather Plan</td>
<td>Damian Basher (DH)</td>
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<td>14.00</td>
<td>Vulnerabilities and Case studies</td>
<td>Maggie Davidson (BRE)</td>
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14.25 Working groups to address
   All       a) Definition of over cold
   Blue Group  b) Susceptible groups and effects
   Red Group   c) Causes and mitigation or adaptation
   All       d) Thresholds for intervention
15.30 Feedback from all four groups and discussion
16.00 Final comments and close

Virginia Murray
Annex 3: Comments from Evaluation of Workshop

Evaluation Comments

- Behavioural research on how people behave in buildings.
- Would welcome research mapping.
- More work on threshold temperature for heat-wave health problems (inside dwellings).
- Need for interdisciplinary programme bringing together health, buildings and environment.
- Research map would be a useful start.
- Need to link health, indoor temps and outdoor temperatures.
- Deeper analysis of existing and forthcoming data (especially EHS, energy follow up, LARES).
- Small area/LA study linking health/mortality to dwellings.
- Joined up research - which gives the best 'bang for bucks' by monitoring as much as possible and talking to householders about as much as possible.
- Physiology of sleep and heat, link to urban heat island.
- Involvement of DECC to integrate energy considerations into housing and health; consideration of how the Green Deal roll out will deliver warmer homes.
- Modelling future climate in relation to heat and cold.
- Perceived comfort-range for different people, and links with vulnerability and temperature overheating in common areas of housing and links with distributed hot water – future risks with increase in district heating.
- Cohort studies on cold/heat related mortality and morbidity.
- Quantitative evaluation of intervention studies (improved housing).
- Indirect health effects.
- Time/temperature relationship for overheating.
- Steady state versus heat-wave.
- Relationship of indoor and outdoor temperatures
- How to promote behaviour change in cold weather ‘low-risk’.
• More research is required to determine the relevance of internal dwelling temperatures on health effects of hot and cold.

• Update the principles, etc. that form the basis of HHSRS, as they are acknowledged to be out of date.