Evaluating Appropriate Residential Ventilation Strategies in Dense Urban Environments and the Challenges for Passive Design

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Background

- Residences are increasingly being built in noisy locations and on challenging plots of land, often resulting in designs for single aspect homes with facades exposed to traffic.

- At the same time, there is often a drive to provide large areas of glazing in new apartments (perceived as desirable for the residential market).

- This response can create ventilation challenges and overheating risk.
Good practice site selection and appraisal of building form

Guidance references:

- CIBSE Guide L (Sustainability), 2007
- Site Layout Planning for Daylight and Sunlight: Guide to Good Practice, BRE, 2011
- Engineering a Low Carbon Built Environment, The Royal Academy of Engineering, 2010
- Overheating in Homes: An introduction for planners, designers and property owners, NHBC 2012

Assessing site opportunities and constraints (Source: CIBSE Guide L – Sustainability)
London planning guidance

Developments should minimise the need for active cooling systems and consider natural means of maintaining comfort (London Plan policy 5.9)

1. Minimise internal heat generation through energy efficient design
2. Reduce summer heat gains: orientation, shading, albedo, fenestration, insulation, green roofs / walls
3. Exposed internal thermal mass and high ceilings
4. Passive ventilation
5. Mechanical ventilation
6. Active cooling systems (selecting the lowest carbon options)
Busy London high street …100 years ago

Camden High Street c.1904

Electrified tram in Camden, c. 1910
The same street…now

Challenges for residential ventilation in urban locations:

- Traffic noise
- Retail activity
- Air conditioning units
- Urban heat island effect / warmer climate
Glazing proportions in modern apartments can be > 50% of the façade
Glazing proportions in older buildings generally < 35% of the facade
Urbanisation increases the density of residential development

Manchester skyline
Traditional apartment design enables cross-flow ventilation
Climate change:
Ranking the hottest years since 1850 shows that most of the hottest years have occurred in the last 10 yrs.

Average temp. changes:

- Approx. 0.5°C increase since 1950s
- Approx. 1.0°C increase since 1850s
Cities in particular, are getting hotter

- Summers are getting drier and warmer
- More extreme weather conditions occur

Figure 4. Surface temperature (°C) in London at 21.43 on 12 July 2006. Source LUCID⁹

Hyde Park in the summer
Future trends in peak temperatures -
Predictions for different emission scenarios

Maximum temperatures could rise by at least 2°C by 2050s

Worst in southern England
Future evening temperatures will reduce opportunities for night cooling

Evening temperatures could increase by 3°C by 2050s
Overheating criteria for residential design

- CIBSE Residential Summer Peak temperatures (CIBSE Guide A)
  Assessed by dynamic thermal model

<table>
<thead>
<tr>
<th>Building type</th>
<th>Benchmark summer peak temp</th>
<th>Overheating criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dwellings - Living Areas</td>
<td>28°C</td>
<td>Not to exceed 28°C operative temp for more than 1% annual occupied hours</td>
</tr>
<tr>
<td>Dwellings - Bedrooms</td>
<td>26°C</td>
<td>Not to exceed 26°C operative temp for more than 1% annual occupied hours</td>
</tr>
</tbody>
</table>

- Passivhaus Overheating Criteria

<table>
<thead>
<tr>
<th>Minimum Acceptable Overheating Criterion</th>
<th>Preferred Overheating Criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not to exceed 25°C air temp for more than 10% of total annual hours</td>
<td>Not to exceed 25°C air temp for more than 5% of total annual hours</td>
</tr>
</tbody>
</table>
Acoustic criteria for residential design

Recommended acoustic criteria for residential design are provided by BS8233 (Sound Insulation and Noise Reduction for Buildings – Code of Practice)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Internal space</th>
<th>07:00 to 23:00</th>
<th>23:00 to 07:00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resting</td>
<td>Living Room</td>
<td>35dB $L_{Aeq,16\text{hour}}$</td>
<td>-</td>
</tr>
<tr>
<td>Dining</td>
<td>Dining Room</td>
<td>40dB $L_{Aeq,16\text{hour}}$</td>
<td>-</td>
</tr>
<tr>
<td>Sleeping (daytime resting)</td>
<td>Bedroom</td>
<td>35dB $L_{Aeq,16\text{hour}}$</td>
<td>30dB $L_{Aeq,8\text{hour}}$</td>
</tr>
</tbody>
</table>

It should be noted that high noise levels can cause anxiety and affect sleeping patterns for occupants. (Ref. Overheating evidence review, Zero Carbon Hub, 2015)
MVHR performance gap issues

References highlighting industry problems with MVHR installations and operation:

• Preventing Overheating: Investigating and reporting on the scale of overheating in England, including common causes and an overview of remediation techniques, Good Homes Alliance, 2014

• Overheating in new homes: A review of the evidence, NHBC & ZCH, 2012

Summary of challenges for urban residential developments

**Site location and building form:**
- Homes developed at busy sites with high external noise levels
- Single aspect apartment layouts with no opportunity for cross-flow ventilation
- Small dwelling sizes (solar and internal heat loads can become significant)
- Lightweight construction

**Window configuration:**
- Highly glazed
- Often lack of openable windows, or windows won’t open fully

**Mechanical ventilation / Building services:**
- Increasing dependency on MVHR systems
- MVHR performance gap issues: low air flow rates and poor maintenance
- Internal heat gains from communal heating systems (with corridor distribution 24 hrs/day)
Case study

– Analysis of an apartment block adjacent a busy road
Case study description

- The project is a multi-storey apartment block with two elevations facing busy roads.
- External noise levels measured by acoustic survey: 65 dB(A) to 72 dB(A).
- Due to high external noise levels opening windows for background ventilation and comfort should be kept to a minimum.
- Acoustic implications for apartments facing the streets:
  - Partially open window (10-15 dB reduction) => approx. 50-60 dB inside apartment
  - Closed window (35-40 dB reduction) => 30-35 dB inside apartment
- All apartments designed to have MVHR unit and openable windows for purge ventilation (for Building Regulation Part F compliance and occupant control)
Description of Overheating Assessment

• A CIBSE Guide A overheating assessment was undertaken using dynamic thermal modelling software: TAS (EDSL) v 9.2.1.3. The 2005 CIBSE weather data for London Heathrow Design Summer Year (DSY) was used.

• The baseline scenario includes a standard MVHR unit in the apartments with the flow rates: 18 l/s for small living rooms/bedrooms and 30 l/s for larger living rooms/larger bedrooms.

• In order to assess the opportunity to reduce overheating risk a larger MVHR unit was considered, with higher flow rates: 60 l/s for small living rooms, 100 l/s for larger living rooms and 36 l/s for bedrooms.

• The larger MVHR unit scenario was assessed with and without external shading (The external shading comprised external louvres at 45° angles).
Results - Natural ventilation scenario with standard MVHR units and no external shading

Low overheating risk but opening windows create unreasonable noise levels in the apartments due to external traffic noise.
Results - Larger MVHR scenario with no external shading

Apartments showing some overheating risk
Results - Larger MVHR scenario with external shading added

The addition of the external shading has resulted in fewer apartments showing overheating risk.

Some apartments still show some residual overheating risk. This can be mitigated by further increases in the ventilation rates and other measures.
Conclusions of case study

1. Natural ventilation (using openable windows) is not suitable at the site, given the high levels of traffic noise, although the modelling shows it would be effective in minimise overheating risk.

2. Standard MVHR ventilation rates are insufficient to avoid overheating risk at the site.

3. Higher MVHR ventilation rates reduce overheating risk when combined with external shading.

The recommended solution comprises:

- Large MVHR unit with high ventilation rates
- External shading
- Openable windows for purge ventilation
Lessons from abroad - examples of solar shading techniques
Lessons from abroad – passive construction techniques

Good practice examples from Mediterranean housing:

- Thermal mass
- Reflective surfaces
- Smaller windows
- Optimised building form
Examples of shading in recent UK projects

Timber Wharf, Manchester
Art House, Kings Cross
Hanham Hall, Bristol
Key lessons and future issues

1. An early review of external noise and ventilation strategies will become increasingly important, especially as dwellings are being planned adjacent busy roads and other noisy sites.

2. Natural ventilation strategies may be unacceptable from an acoustic perspective. MVHR is increasingly likely to be the future solution.

3. The use of external shading, light coloured facades, thermal mass and smaller areas of glazing should be evaluated as passive strategies to complement the MVHR system.

4. Dynamic thermal modelling is a useful tool to test the impact of passive measures at the pre-planning stage.

5. MVHR performance gap issues need to be resolved (better installation, testing, commissioning and maintenance etc.)

6. Impact of the future climate conditions, adaptation and microclimate will be increasingly important (including the urban heat island effect)
Thank-you

Any questions?

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