MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
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FOR BCTRAG	21 FEBRUARY 2020
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SUBJECT	**AIRTIGHT BUILDINGS CAUSING MOISTURE ISSUES**

INTRODUCTION

Buildings are becoming more airtight.

Airtightness increases with better air barriers and thicker insulation, which disrupts the traditional wetting-drying cycle previous buildings have relied upon. Water and water vapour becomes trapped within, or on the building fabric can cause major problems.

Airtightness is not a bad thing; it is actually beneficial. However, if buildings do not adapt properly to their changing constraints, airtightness causes more and different problems. Building methods can adapt by using controlled ventilation, heat recovery, better insulation and heating.

This paper seeks to provide brief background information to support a discussion on the industry view of the risk of airtight buildings causing moisture issues and to seek feedback on potential mitigation measures.

WHAT RISKS ARE WE TRYING TO MANAGE

Issues associated with poor moisture management can lead to failing to achieve a warm, dry, healthy home.

Moisture issues in buildings can lead to deterioration of the building structure and other components as well as significant potential health risks for occupants.

BACKGROUND

There are two ways to manage moisture within in a building and its envelope, either:

1. Accept external and internally generated moisture will penetrate the fabric and concealed spaces and mitigate that by allowing relatively free airflow in, around and through it to enable drying. This is the traditional wetting-drying cycle.
2. Prevent external and internally generated moisture from penetrating the fabric and concealed spaces, and remove excess moisture with drained cavities and controlled ventilation.

Walls and roofs traditionally leaked small amounts of moisture, the natural air movement in and through the envelope dried the structure before any lasting damage or mould growth could occur. Similarly, warm humid air, driven by entropy or carried on air leaks, from inside the building would condense as it travelled through the building envelope toward the colder outside (or vice versa) and the air movement in the envelope would allow it to dry out.

As airtightness increases with air barriers and thicker insulation, the traditional wetting-drying cycle of previous buildings is disrupted. Water and water vapour becoming trapped within or on the building fabric risks causing problems such as:

- Surface condensation on internal walls (and ghosting)
- Interstitial condensation (within the walls)
- Mould, particularly black mould, fungal growth, dust mites and particulates of biological origin.
- Increase in the release of certain chemical compounds from building components and furnishings, including formaldehyde and phthalates

AIR PRESSURE TESTING

Air pressure testing (Blower door) is a relatively simple way of determining how airtight a building is. Openings in the building are blocked and calibrated fans are installed in an external door. When the building is pressurised (or depressurised) to 50 Pascal's, the amount of air moved and the differential pressure is measured. From these measurements, the amount of air leakage in $m^3/(hr.m^2)$ is determined.

The reason airtightness is preferred in modern construction is because, as the wet-dry cycle is compromised for weathertightness and energy efficiency reasons, any air leakage carries orders of magnitude more moisture into the fabric of the building, exacerbating the wetting that occurs (approximately 1600x more). Crucially, this moisture tends to stay in the fabric causing mould, rot, corrosion etc.

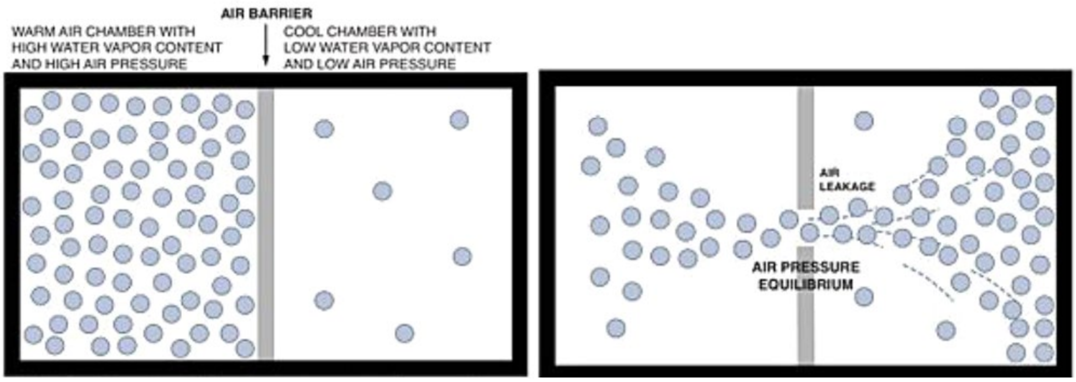

Figure 1 shows the difference between airborne moisture, approx. 1600 times more, (right) and moisture transfer by diffusion (left).

Figure 2 Three examples of interstitial condensation

Air leakage also carries heating (or cooling) energy, reducing the efficiency of a building.

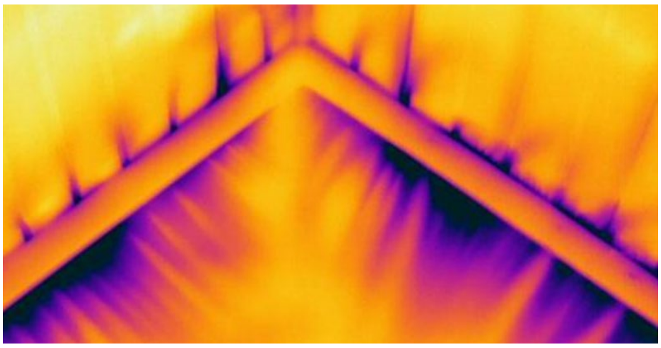

Figure 3 thermal image of air leaks.

Belgium, Czech Republic, Denmark, Estonia, France, Germany, Ireland, Italy, the Netherlands, Norway, Portugal and many states un the U.S. use air pressure testing as a means of assessing the energy efficiency and health of a building. Air pressure testing will become mandatory in Britain this year.

The ABCB (Australia Building Code Board) implemented a number of actions following their acknowledgement of the major condensation problems they are currently experiencing in their building stock. The ABCB has introduced an optional compliance pathway JV4 which uses air pressure testing as a means of gathering data about the building stock. The Australian Government and the ATTMA (air tightness testing and measuring association) are also embarking on a pilot scheme in Canberra with non-mandatory limits with the similar objective of collecting data to establish just how inefficient and condensation prone their housing stock is. Initial indications are that Australian buildings are approximately 2 times leakier than the Florida state code and 5 times leakier that the New York State code.

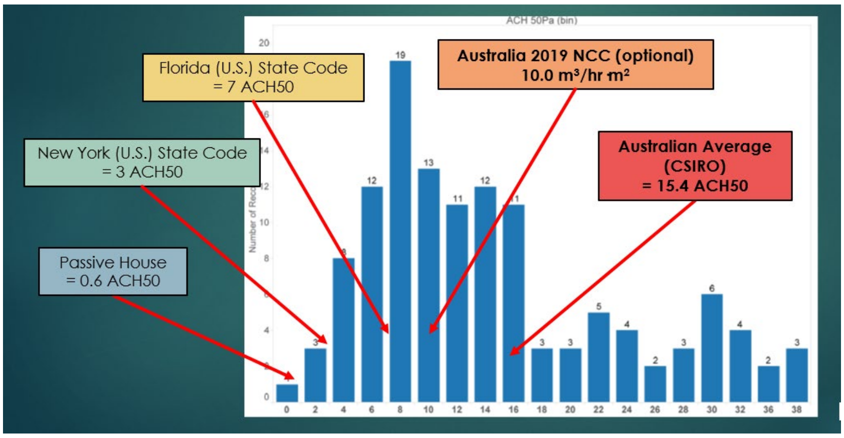

Figure 4 air leakage rates shown horizontally.

The Australian approach is to implement airtightness into regulation relatively gently. A non-mandatory and easily achievable limit of 10 $m^3/(hr.m^2)$ has been set. As the skill of the industry increases, the intention is that the limits will gradually tighten.

There is currently no data available on the airtightness of the New Zealand building stock. BRANZ have however identified that 49% of New Zealand buildings have visible black mould growth – a good indicator for hidden interstitial mould.

For discussion:

- **Does the BCTRAG have advice on the risk of condensation issues associated with airtightness occurring in;**
  - **a) New code compliant buildings?**
  - **b) Existing building stock?**

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BALANCING THE VENTILATION, INSULATION AND HEATING TRIAD

As previously, identified, controlled ventilation is the best option to mitigate high internal humidity and condensation risk. Although it may appear that the occupant is throwing heated (or cooled) air away, humid air has more mass and therefore requires more energy to heat. When coupled with effective heat recovery, controlled ventilation is a very efficient means of providing a warm, dry and healthy home.

Many New Zealand homes have extraction fans in bathrooms and range hoods over stoves to reduce moisture at the largest sources, although these are intermittent and are typically turned off the moment the shower or cooking has finished, leaving residual moisture (this can be resolved by using continuous low volume ventilation or timers) . There are also multiple other moisture sources within a house as shown below. BRANZ research has found that 40l/day can evaporate from the ground beneath an average house, causing elevated humidity.

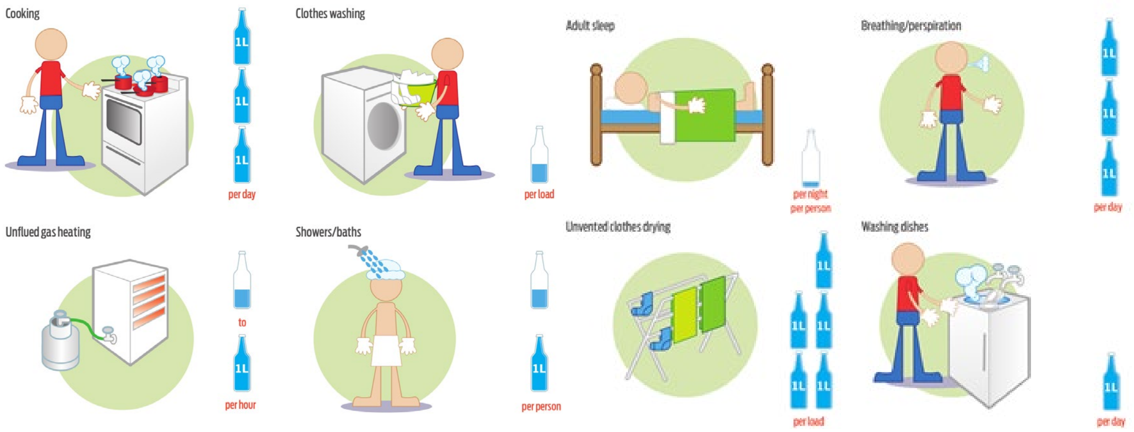

Figure 8. Moisture sources within a house (source BRANZ)

The key is getting the balance right. As insulation gets thicker and the building becomes more airtight, better mechanical ventilation is required.

For discussion:

- **Does the BCTRAG believe there is suitable risk to justify prioritising research into the settings for continuous low volume or time lag mechanical ventilation?**

COLD ROOF PASSIVE VENTILATION

Typical New Zealand house construction uses a cold roof - a roof where the insulation is on the inside of the structure. As seen from the diagram below, a large majority of warm wet air enters the roof space from the internal living area.

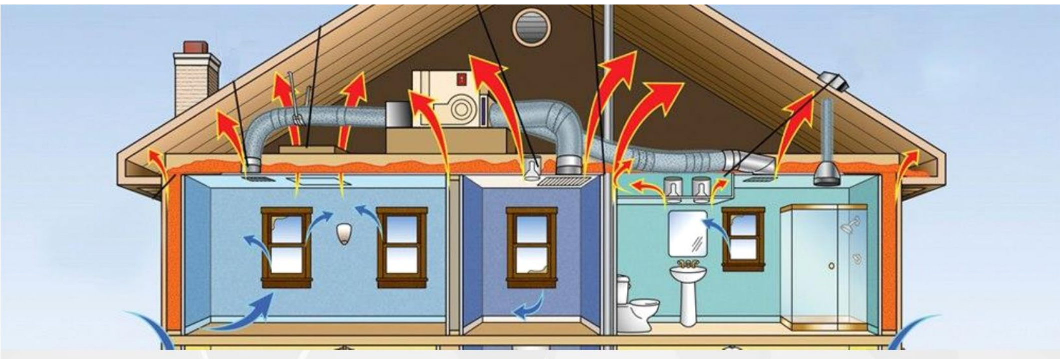

Figure 5. Examples of warm moist air entering a roof space

Once in the roof space, warm and moist air will cool and condense onto the nearest cold surface, typically the underside of the roof (ideally above the underlay) but also fixings, nail plates, steel framing and timber. The effects of black body radiation on a roof at night mean the roof cladding can drop to more than 10°below the ambient temperature, which causes excessive moisture build up.

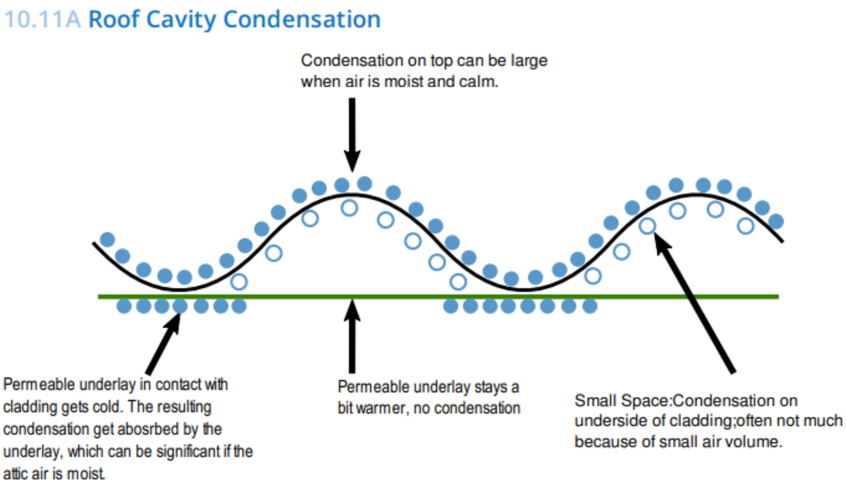

Figure 6. An example of thermal bridging causing moisture on the inside of the underlay.

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Figure 7. Two common examples of damage caused moisture build-up in an insufficiently vented roof space.

Not every cold roof has moisture problems and many have enough passive ventilation by way of their construction. Some roof spaces are be highly susceptible to corrosion from geothermal or salt laden air and would be best with less ventilation.

Currently the NZBC compliance documents have no requirements for where, when and how much passive ventilation is required.

For discussion:

- **Does the BCTRAG believe there is suitable risk to justify prioritising research into the settings for passive ventilation of cold roof spaces?**