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Comfort over compliance – designing to maximise outcomes

Only by looking at a building as a whole can optimum performance be achieved, and that means looking beyond compliance.

At a glance

- Buildings work as a system and only by looking at the performance as a whole can we ensure good outcomes.
- Schedule and calculation methods focus on thermal resistance only, so a house that complies with H1/AS1 may have issues with overheating if solar heat gains are not controlled.
- Verification Method H1/VM1 considers other factors such as heat gain and occupant loads. It gives a more reliable understanding of how the building will potentially perform.
- H1/VM1 is still linked to a reference building, which does create some challenges in getting the best from a design.
- Prioritising occupant comfort using computer modelling means compliance with H1 is achieved as part of the process rather than being an afterthought tacked on at the end.

Buildings work as a system. Changing just one aspect – like insulation – can disrupt the balance. Minimum R-value updates in New Zealand Building Code clause H1 in 2023 help reduce heat conduction, keeping the warmth inside in winter and the heat outside in summer. However, a lack of solar control can cause excessive heat gains and lead to overheating. Year-round comfort and energy efficiency can only be achieved when all components, like insulation, ventilation and solar control, are considered alongside each other. To truly deliver comfort and efficiency, we need to look beyond compliance and design for performance.

H1 compliance methods

The Building Code sets out the minimum performance of a residential house. The

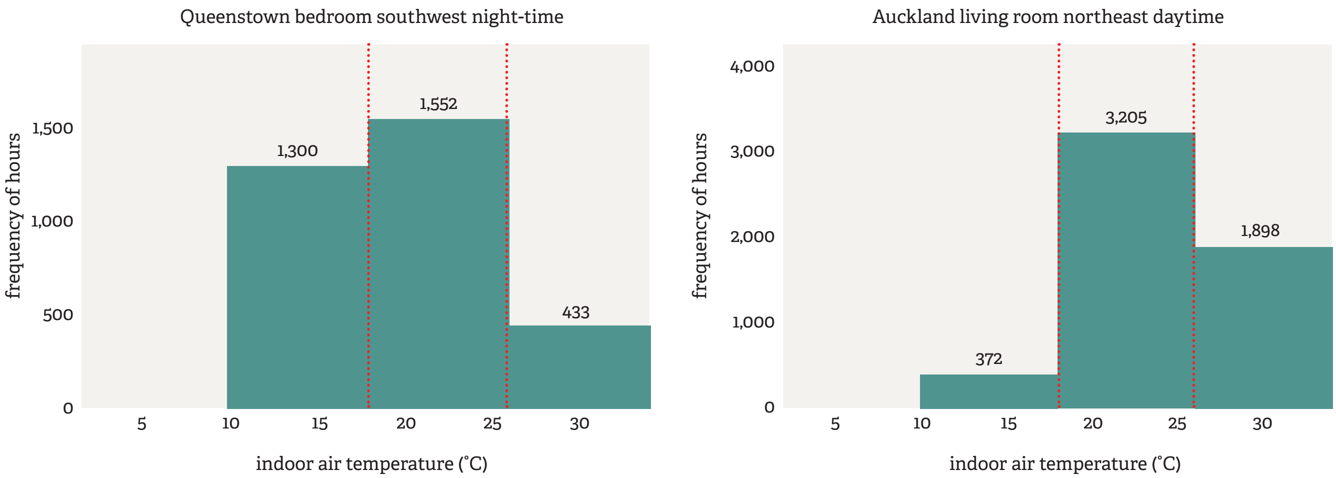

Figure 1: Using the schedule method – overnight (10pm–7am) temperature distribution for Queenstown bedroom (left) and daytime (7am–10pm) temperature distribution for Auckland living room (right).

pathways to achieve the performance are set out in the clauses. In clause H1 *Energy efficiency*, compliance can be demonstrated through one of two Acceptable Solutions or a Verification Method.

Acceptable Solutions are designed to be accessible and cost-effective in all situations. In New Zealand's heating-dominated climate, they work on the basis that increasing insulation reduces heat loss, which leads to warmer indoor temperatures. The schedule method specifies the minimum insulation R-values in each building element based on the location. The calculation method compares the heat transfer coefficient of the proposed building to that of a reference building.

The reference building has the same form, areas and orientation but is calculated with the minimum R-values from the schedule method and up to 30% glazing. These methods don't account for solar heat gains due to radiation through glazing, meaning a house that complies with either Acceptable Solution may experience overheating and have high cooling costs.

On the other hand, H1/VM1 uses computer simulation to calculate the heating and cooling loads considering all variables in a building, including solar heat gains. Much like the calculation method, H1/VM1 achieves compliance when the

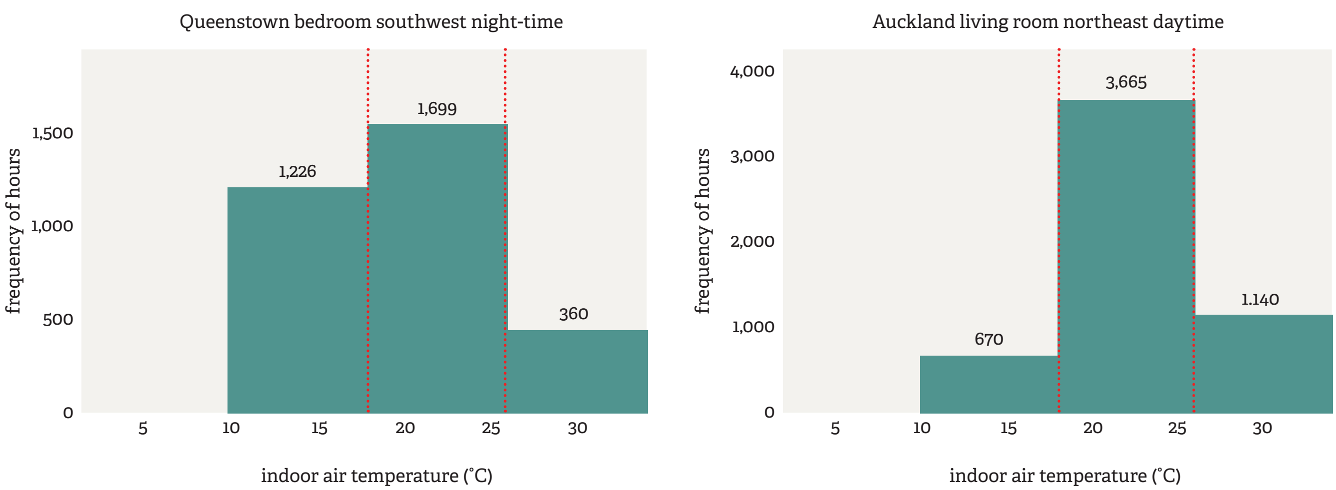

Figure 2: Using H1/VM1 – overnight (10pm–7am) temperature distribution for Queenstown bedroom (left) and daytime (7am–10pm) temperature distribution for Auckland living room (right).

proposed building performance exceeds the reference building – but in terms of energy demand rather than heat transfer.

Focusing on occupant outcomes

Along with energy demand, H1/VM1 tools can calculate the internal conditions, allowing occupant comfort to be a design factor. While not specifically a requirement of H1/VM1, once a building is modelled, designers can go beyond compliance to assess the risk of underheating and overheating and mitigate potential moisture accumulation issues. This sort of efficient design can reduce both installation and running costs while also demonstrating compliance with clauses E3 and G4.

The idea of designing to maximise occupant outcomes is explored here in the climates of Queenstown and Auckland. These models follow the methodology from H1/VM1, including the standardised assumptions about occupancy and plug loads/schedules and infiltration. Instead of conditioning the buildings, the models are free running, meaning they have no ventilation or space conditioning.

Minimum R-values from H1/AS1 are used in the schedule method building, which becomes the reference building. The calculation method building has lower R-values, while the H1/VM1 building uses a combination of insulation, glazing and shading to optimise performance.

In Queenstown's colder climate, the schedule method demands higher R-values in the floor and windows to reduce heat loss. Conversely, the warmer climate in Auckland means lower minimum R-values and a greater risk of overheating, which is not mentioned in the clause.

Results

The air temperature from three zones in the house was calculated. Figures 1 and 2 show the frequency of hours that fall within the specified temperature range, where 18–26°C is considered comfortable. Graphs compare the overnight hours (10pm to 7am) in a Queenstown bedroom and daytime hours (7am to 10pm) in an Auckland living room using the schedule method and H1/VM1.

In Queenstown, the need for heating in the schedule method building is high, with around 35–40% of the occupied hours below the 18°C minimum. In Auckland, the problem lies in overheating, with 30–35% of the occupied hours greater than 26°C. However, results show the houses also have issues with uncomfortable hours on the other end of the spectrum.

Using a reference building with 30% glazing, the calculation method allows for the R-values of building components to be lower than the schedule method. In Queenstown, this increases the problem of underheating. However, in Auckland, it appears to have a positive impact as it reduces the overheating hours. Although this sounds ideal, the number of comfortable hours remains largely unchanged.

Using the Verification Method, the houses in Queenstown and Auckland are optimised with ideal insulation levels, solar shading and low-E glazing. The impact on the number of underheating and overheating hours differs throughout the rooms. However, the result consistently shows an increase in the number of comfortable hours.

In some cases – for example, in the Auckland living room – the underheating hours increase when using the Verification Method. However, the significant decrease to the overheating hours and improvement to the total number of comfortable hours makes up for this.

With an optimised design, there is a reduced reliance on both heating and cooling systems as the house can passively maintain comfortable conditions, meaning compliance is demonstrated. However, this shows that better outcomes cannot be achieved without considering the building as a system, specifically the solar heat gains.

In summary

Acceptable Solutions limit the heat transfer between inside and outside using insulation, with the assumption that higher R-value insulation leads to warmer temperatures indoors. However, ignoring solar heat gains can lead to overheating.

H1/VM1 requires the modeller to not only limit the heating energy but also cooling energy. It asks the modeller to assess the building as a whole and implement strategies other than just insulation to reduce energy use. Once the building has been modelled in a simulation, there is an opportunity to take the design further by assessing occupant comfort.

Rather than relying on standardised Acceptable Solutions, H1/VM1 enables a reliable assessment to optimise the design. This could lead to a building with less insulation than the schedule method minimum but with strategically placed external shading and a low-E coating on the glazing.

On the other hand, the building fabric and glazing placement could be optimised to deliver a better-performing building at the same cost. Using computer modelling allows the designer to understand how certain decisions can affect performance and occupant comfort. By prioritising occupant comfort, it delivers better outcomes and naturally achieves compliance.

Only by considering the house as a system can the optimum balance between solar radiation heat gain and opaque conduction heat loss be identified. Insulation alone cannot solve all the issues – it needs to be considered alongside building orientation, glazing and ventilation. These interconnected factors need to be considered together to optimise comfort and reduce energy demand.

Ideally, future updates to H1/VM1 should move towards an absolute performance goal rather than the reference building. An absolute rather than relative target sets a clear and measurable goal that promotes innovation and ensures all homes meet a consistent standard of efficiency and comfort.