

# Adaptive Thermal Comfort and Predicted Mean Vote (PMV)

JP1



The Performance Requirements of the National Construction Code (NCC) can be met using either a Performance Solution or a Deemed-to-Satisfy (DTS) Solution, or a combination of both solutions. The following demonstrates a performance-based design process, aligning with the ABCB's Development of Performance Solutions guidance document.

## Scenario

The developer of a Class 9b university building is seeking to demonstrate compliance with Performance Requirement JP1 using the Verification Method JV2 Green Star. It is assumed the building complies with, and has the appropriate documentation and reporting to demonstrate compliance with, most requirements of JV2<sup>1</sup>. The building is primarily naturally ventilated, with limited air conditioning controlled by the occupants. JV2 requires the building to achieve a thermal comfort level of between a Predicted Mean Vote (PMV) of -1 to +1 across 95% of the floor area of all occupied zones for 98% of the annual hours of operation of the building. As PMV is only applicable to mechanically ventilated buildings and this building is naturally ventilated, a Performance Solution is required.

## What is PMV?

The PMV index predicts the mean response of a large group of people on a 7-point thermal sensation scale, from +3 (hot) to -3 (cold), where 0 is neutral. The metric is designed for fully mechanically ventilated buildings and is determined in accordance with ANSI/ASHRAE Standard 55. A PMV of -1 to +1 means that 75% of people are satisfied and comfortable.

## What are occupant-controlled naturally conditioned/naturally ventilated spaces?

ANSI/ASHRAE Standard 55, the standard for *Thermal Environmental Conditions for Human Occupancy*, defines an occupant-controlled naturally conditioned space as one where the thermal conditions are regulated primarily by occupant-controlled openings in the envelope.

## What is Adaptive Thermal Comfort and when can it be used?

The Adaptive Thermal Comfort metric relates indoor design temperatures to outdoor temperatures. It is based on the understanding that occupants can adapt to, or even prefer a wider range of conditions. For example, the acceptability criteria under this metric allows for warmer internal conditions (outside the range of typical criteria of 21°C to 24°C), when conditions are very warm outside. The Adaptive Thermal Comfort model can be used if the following conditions are met (as per Section 5.4 of ANSI/ASHRAE Standard 55):

- The space is naturally conditioned/naturally ventilated through occupant control;
- The space has no mechanical cooling system (mechanical ventilation with unconditioned air is allowed);
- No heating system is operated in the space (heating systems can be provided, however the adaptive method does not apply when in operation);
- The occupants in the space are engaged in near-sedentary physical activities (i.e. a sitting or seated position);
- The occupants are free to adapt their clothing to the indoor and outdoor thermal conditions within a range of at least 0.5 to 1.0 clo (clo is a unit used to express the thermal insulation provide by clothing); and
- The prevailing mean outdoor temperature is greater than 10°C and less than 33.5°C.

To achieve a similar level of comfort to those required in Verification Methods JV1, JV2 and JV3, an acceptability limit of more than 80% should be achieved across 95% of the floor area for 98% of the hours of operation (calculated in accordance with ANSI/ASHRAE Standard 55). Note that the 80% acceptability limit relates to the indoor operative temperature. Operative temperature refers to the level of human comfort because of air temperature, mean radiant temperature and air speed.

<sup>1</sup> For more information on using JV2, see the JV2 Verification using Green Star Performance Scenario available from the ABCB website.



## Prepare a performance-based design brief

### What are the design objectives?

To use natural ventilation to maximise occupant control and reduce operating costs.

### Who should be consulted?

Property developer/owner, design team, builder, environmentally sustainable design (ESD) consultant and the Appropriate Authority.

### What is the basis of the Performance Solution?

ANSI/ASHRAE Standard 55, the standard for *Thermal Environmental Conditions for Human Occupancy*.

### What evidence is proposed?

Documentation in line with ANSI/ASHRAE Standard 55 for the achieved acceptability limit including:

- Assumptions for personal factors in each space type, category and season (i.e. summer and winter clothing levels and metabolic rate);
- Verification that each occupant-controlled, naturally conditioned space meets all the criteria of Section 5.4 of ANSI/ASHRAE Standard 55;
- Weather data used for mean monthly outdoor temperature calculations (in line with ANSI/ASHRAE Standard 55 clause 5.4.2.1);
- Any adjustments to the upper operative temperature limit based on increased air speed (as per ANSI/ASHRAE Standard 55 clause 5.4.2.4);
- Verification that the operative temperature is predicted to be within the 80% acceptability limits in Figure 5.4 of ANSI/ASHRAE Standard 55 including adjustment for elevated airspeed;
- Supporting documentation with inputs and results of calculations or simulations; and
- Worst-case design outdoor conditions and predicted indoor conditions for each month.

Note: See ANSI/ASHRAE Standard 55 for a more detailed description of the documentation required.

### Which DTS Provisions are applicable?

None.

### Which Performance Requirement is applicable?

JP1(b) in NCC Volume One Section J — Energy Efficiency.

Note: for brevity, the applicable Performance Requirements and DTS Provisions have been limited. This solution may also impact other Performance Requirements and DTS Provisions and must be considered in accordance with Part A2 of NCC 2019.



## Carry out analysis, modelling or testing

### Which Assessment Methods are the most suitable and where can they be found?

Assessment Methods are listed in A2.2 in Part A2. Any Assessment Method or combination of them may be used to determine that a solution complies with the Performance Requirements. In this scenario, 'evidence of suitability' in accordance with Part A5 is used as the Assessment Method.

### What analysis, modelling or testing is used?

To ensure that the building satisfies the thermal comfort requirements of JV2, the ESD consultant completes the following.

**Step 1:** The ESD consultant seeks the approval of the Appropriate Authority. They confirm the Adaptive Thermal Comfort model can be used in place of PMV as a Performance Solution.

**Step 2:** The Adaptive Thermal Comfort model of the university is checked in the same thermal model used for compliance with the Green Star — Design & As-Built modelling requirements of JV2.



## Collate and evaluate results

Based on the modelling, the ANSI/ASHRAE Standard 55 and 80% acceptability limit acceptance criteria was met for acceptable operative temperature ranges for naturally ventilated conditioned spaces, for more than 95% of the floor area and 98% of the hours of operation of the building. Subsequently, this satisfies JP1(b).

The stakeholder group peer review the modelling and confirm their satisfaction of the outcome.



## Prepare a final report

The ESD consultant compiles documentation in line with ANSI/ASHRAE Standard 55 for the achieved acceptability limit.

The key points for this Performance Solution include:

- Justifying the need for an Adaptive Thermal Comfort Performance Solution (i.e. the building is naturally ventilated through occupant controls); and
- The achieved acceptability limit (at least 80%), as per ANSI/ASHRAE Standard 55's acceptable operative temperature ranges for naturally ventilated conditioned spaces across at least 95% of the floor area of all occupied zones for not less than 98% of the hours of operation of the building.