6 IEQ 6.5 THERMAL COMFORT

6.5.2 THERMAL COMFORT IN NATURALLY VENTILATED PREMISES

EXCLUSIONS
Buildings that are not designed to utilise natural ventilation.

OBJECTIVE
Promote the application of measures that reduce elevated temperatures caused by external heat gains, and ensure installed air-conditioning units can provide adequate control of indoor temperature.

CREDITS ATTAINABLE
3

PRE-REQUISITES
None

CREDIT REQUIREMENT

a) Performance with natural ventilation
1 credit for demonstrating indoor operative temperatures in occupied/habitable rooms meet the 80% acceptability limits.
2 credits for demonstrating indoor operative temperatures in occupied/habitable rooms meet the 90% acceptability limits.

b) Performance with air-conditioning
1 credit for sustaining the air temperature at the design value within ±1.5°C when the air-conditioning unit is operating at steady state under conditions of zero occupancy.

ASSESSMENT

a) Performance with natural ventilation
The assessment will seek to establish the extent to which the design of the building envelope can mitigate the effects of external heat gains. Based on the output from a suitable thermal simulation model of the building the predicted indoor operative temperature shall be compared with the criteria given in ASHRAE 55 [1] under the ‘Optional Method for Determining Acceptable Thermal Conditions in Naturally Conditioned Spaces’.

Assessment may be confined to the ‘worst case’ scenarios, i.e., for those normally occupied areas of the building most susceptible to external heat gains and/or do not benefit from the prevailing climatic conditions.

The spaces in question must be equipped with operable windows that can be readily opened and adjusted by the occupants. Mechanical cooling for the space shall not be provided, although mechanical ventilation with unconditioned air may be utilized.

The thermal analysis shall be undertaken using dynamic thermal modelling software. The thermal performance within the occupied or habitable space of each type of premises most affected by solar gains shall be determined. The modelling shall be undertaken full annual simulation using standard Hong Kong weather data. The modelling will include the effect of installed solar control features, e.g. glazing, internal or external shading components, fabric and infiltration specifications, and site obstructions. The modelling need not include any internal gains, i.e., simulations for unoccupied premises are required.

Alternatively, compliance may be demonstrated under appropriate summer and winter conditions through the measurement of temperature in suitable locations in a sample of premises most exposed to external heat gains.

The Client shall provide evidence in the form of a report prepared by a suitably qualified person detailing any means used to control the external

(solar) heat gains, the specification and details of the thermal simulation software used in the analysis, and the results of the simulations.

Where compliance is demonstrated by measurements the details of measuring equipment, sampling locations, sampling time, time of measurements, external temperature and prevailing weather conditions shall be provided.

Where it can be demonstrated that the predicted indoor temperature lies within the 80% acceptability limits given in ASHRAE 55-2004 a credit shall be awarded. Where the predicted indoor temperature lies within the 90% acceptability limits both credits shall be awarded.

b) Performance with air-conditioning

The measurement locations shall include at least one representative sample of each type of premises (occupied spaces) as defined by the type of HVAC system used, design occupancy density, nature of usage, zoning, etc. The measurements shall be undertaken with no occupants. The sensors used in the measurement survey shall have an accuracy that complies with ISO 7726 [2] or equivalent. To earn credit the results shall demonstrate compliance with the prescribed design criteria within the prescribed limits, for a minimum of 90% of the prescribed locations.

**BACKGROUND**

Thermal comfort standards such as ISO 7730 [3] and ASHRAE 55 establish relatively tight limits on recommended indoor thermal environments, and do not distinguish between what would be considered thermally acceptable in buildings conditioned with natural ventilation. Derived from laboratory experiments using a thermal-balance model of the human body these standards have attempted to provide an objective criterion for thermal comfort, specifying combinations of personal and environmental factors that will produce interior thermal environments acceptable to at least 80% of a building’s occupants. The heat-balance models, on which the standards are based were developed in tightly controlled conditions. The people involved were considered passive subjects of climate change in artificial settings, and little consideration was given to the broad ways they might naturally adapt to a more wide ranging thermal environments in realistic settings.

Field studies and research has demonstrated that occupants of buildings with centralized HVAC systems become finely tuned to the very narrow range of indoor temperatures provided, developing high expectations for homogeneity and cool temperatures, and soon became critical if thermal conditions do not match these expectations [4,5]. In contrast, occupants of naturally ventilated buildings are more tolerant of a wider range of temperatures. This range extends beyond the comfort zones established for air-conditioned buildings, and may more closely reflect the local patterns of outdoor climate.

Analysis of the available data has established that behavioural adaptations, such as changes in clothing insulation or indoor air speeds, could account for only half the observed variance in thermal preferences of people when in naturally ventilated buildings. Given that physiological adaptation is unlikely to play much of a role; it is suggested that the rest of the variance is attributable to psychological factors [4]. Relaxation of thermal expectations may be due to a combination of higher levels of perceived control and a greater diversity of thermal experiences in a

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naturally ventilated building.

For the purposes of ASHRAE 55-2004, occupant-controlled naturally conditioned spaces are those spaces where the thermal conditions of the space are regulated primarily by the occupants through opening and closing of windows. The ‘Optional Method for Determining Acceptable Thermal Conditions in Naturally Conditioned Spaces’ is intended for such spaces. In order for this optional method to apply, the space in question must be equipped with operable windows that open to the outdoors and that can be readily opened and adjusted by the occupants of the space. Mechanical cooling for the space should not be available, although mechanical ventilation with unconditioned air may be utilized. The method applies only to spaces where the occupants are engaged in near sedentary physical activities, with metabolic rates ranging from 1.0 met to 1.3 met, and may freely adapt their clothing to the indoor and/or outdoor thermal conditions.

Allowable indoor operative temperatures for spaces that meet these criteria may be determined from Figure 5.3 in ASHRAE 55-2004. This figure includes two sets of operative temperature limits—one for 80% acceptability and one for 90% acceptability. The 80% acceptability limits are for typical applications and shall be used when other information is not available. The 90% acceptability limits may be used when a higher standard of thermal comfort is desired.

The allowable operative temperature limits in Figure 5.3 may not be extrapolated to outdoor temperatures above and below the end points of the curves in this figure. If the mean monthly outdoor temperature is less than 10°C or greater than 33.5°C, this option may not be used, and no specific guidance for naturally conditioned spaces is included in this standard. Consequently, for the HK-BEAM assessment, months for which the mean monthly outdoor temperatures are outside these limits can be discounted.

It is most likely that some of the premises within a building development will be subject to higher than average external heat gains, with consequent higher internal temperatures during summer months. Those premises at more exposed facades will suffer from adverse winter conditions. It is appropriate to examine the detailed thermal performance of the most susceptible premises, and based on detailed analysis employ mitigation measures, such as changes in fabric design and other solar control strategies.

When air-conditioning is likely to be installed the type, rating and installation of units should be such as to provide for control over thermal comfort conditions over the range of thermal loads that are likely to arise.

**SIMULATION SOFTWARE**

For the purposes of simulating thermal conditions (and in estimating energy use) previous HK-BEAM assessments have employed the simulation software HTB2 [6]. Any software meeting the requirements of ASHRAE standard 140 [7] would be acceptable.

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