THERMAL COMFORT AND BEHAVIOURAL STRATEGIES IN OFFICE BUILDINGS LOCATED IN A HOT-ARID CLIMATE

K. Cena and R.J. de Dear, Murdoch University, Perth and Macquarie University, Sydney, Australia

This paper discusses the main results of a large field study (Cena and de Dear, 1999) conducted in Kalgoorlie-Boulder, located in a hot-arid region of Western Australia, and focuses on the effects of indoor climates on thermal perceptions and adaptive behaviour of office workers. The study protocol followed the procedures for a series of large-scale ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) sponsored thermal comfort field surveys and included precise measurements of indoor climates with laboratory-grade instrumentation. Twenty two of the largest office buildings in Kalgoorlie-Boulder were chosen for the study. Sample sizes of 640 and 589 subjects were achieved in winter and summer surveys, respectively. This total of 1,229 sets of data was provided by 935 respondents, of whom 294 were interviewed in both seasons. Female subjects represented 48% of the sample. The average age of all subjects was 35 years. Clothing insulation levels were 0.5 clo in summer and 0.7 in winter. Office chairs were estimated to add 0.15 clo to the clothing insulation. Metabolic rates were estimated to be on average 77 W/m^2 or 1.3 met for both seasons and for both sexes. Thermal neutrality, according to responses on the ASHRAE seven-point sensation scale, occurred at 20.3°C in winter and at 23.3°C in summer. Preferred temperature, defined as a minimum of subjects requesting temperature change, was 22.2°C for both seasons. Thermal acceptability showed little or no systematic relationship with the thermal environmental conditions. After the effect of chair insulation was accounted for, the PMV (Predicted Mean Vote) index adequately predicted optimum summer-time temperatures for the subjects, whether defined in terms of thermal neutrality, thermal acceptability or thermal preference. PMV overestimated neutrality by one and three degrees (C) in summer and winter respectively. On the basis of the adaptive model of thermal comfort one might have predicted that acclimatization to Kalgoorlie's hot and dry climate, especially during the summer season, would push the actual neutrality *warmer* than that predicted on the basis of PMV. One possible explanation for this counterintuitive outcome is that the occupants of air-conditioned buildings actually *adapt* to those indoor climates. There was little difference (particularly in summer) between the sexes in terms of thermal sensations, although there were significantly more expressions of thermal dissatisfaction from the females. The effects of Kalgoorlie-Boulder hot-dry/cool-dry seasonality on thermal comfort responses of office workers was significant, amounting to a 3°C shift in neutrality and was within the range expected on the basis of the clothing insulation differences of approximately 0.2 clo between seasons. Future research into how the overcooling of office buildings in hot-dry climates can be reduced without disrupting the comfort and productivity of their occupants is called for.

Cena, K., de Dear, R.J., 1999. Field study of occupant comfort and office thermal environments in a hot, arid climate. ASHRAE Trans. 105, 204-217.

cena@essun1.murdoch.edu.au