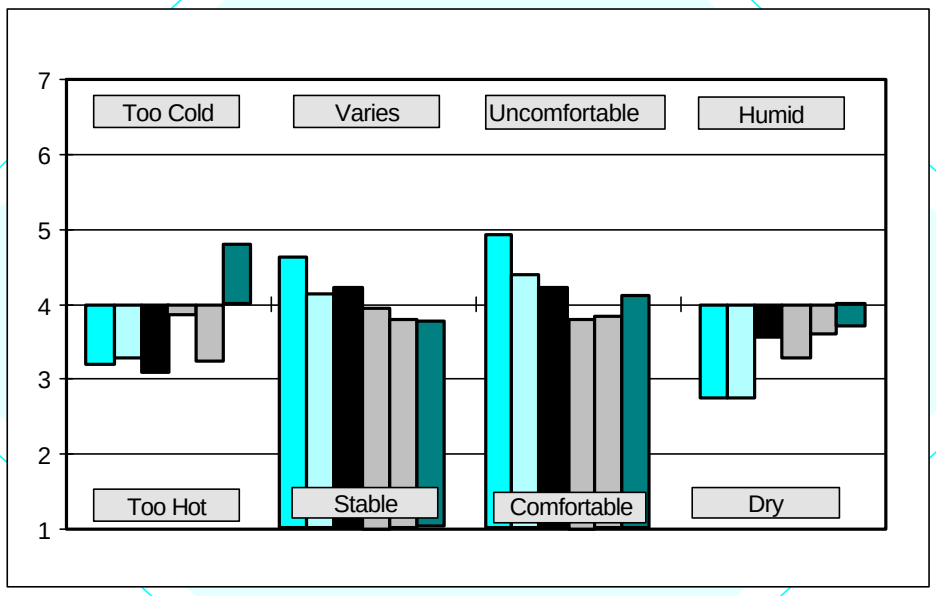
Technical Note TN 3/98

MODERN VENTILATION TECHNIQUES

- Case studies scenario

W B Booth



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EXECUTIVE SUMMARY

In recent years there has been a gradual re-emergence of the use of passive ventilation and cooling techniques with some mechanical ventilation for peak loads (mixed mode). Penetration in the private sector has been relatively low, apparently because clients and developers do not believe such buildings will provide acceptable comfort conditions.

This Technical Note reports on an assessment of three headquarters type buildings which use mixed mode ventilation to determine whether these concerns are valid. The building indoor environment was assessed in a monitoring programme over two two-week periods (one winter, one summer). An occupant questionnaire was distributed (based on the BRE/RSH questionnaire for studies of sick building syndrome.

BRE building sickness index was determined for each building with one building being in the 'cause for concern' category, and one in the 'cause for further investigation' category, and one showing 'minimal problems'.

In these three buildings, we found:

- Occupant well-being levels appear to be unrelated to the type of mixed-mode modern low energy building with both low and high levels of symptoms being reported. There appears to be no simple link between the occurrence of any particular symptom in these buildings and the modern ventilation techniques incorporated into the design.

- Occupants reported low levels of perceived control in all aspects of the indoor environment though the techniques available, such as blind and window usage, seemed under utilised. This may have been in part due to poor occupant understanding of their role in the building's overall performance. The data suggests that higher environmental satisfaction levels tended to occur when perceived control is high.

- The observed summer temperatures were high on occasions but were generally reasonable and accepted by the majority of the occupants. From an occupant perspective, the relative variability of the temperature (inherent in mixed-mode ventilation) appears to add to the dissatisfaction levels with the thermal environment. Predicted mean vote values indicate acceptable thermal comfort levels.

- External weather conditions clearly influence internal conditions on a diurnal and a seasonal basis in each of these buildings. The summer monitoring period in Building 2 showing high internal temperatures, coincided with some days of very high external temperatures.

- Air velocities were generally low i.e. below the mean values traditionally associated with mechanically ventilated spaces. Average air speeds were higher in the summer than the winter though window opening was not extensive. CO_2 levels indicated sufficient fresh air was reaching the occupied space. CO_2 peak levels showed a reduction from winter to summer. The occupants described the air as being 'stuffy' and although this might be expected to be due to high metabolic CO_2 levels, those actually measured appear to be fairly low for occupied buildings.

- Satisfaction with indoor air quality appears to be heavily influenced by the perception of 'stuffiness'. Perceptions of odour, air movement and humidity seem less significant although these aspects are generally considered to be the primary factors/components of 'stuffiness'. There is scope for a slight increase in air velocities without producing uncomfortable conditions. The overall reported symptoms varied but the building with the highest reported symptoms had the most prevalent perception of stuffiness.

- Whilst perceived light levels are satisfactory, the perceived uneven nature of the light may contribute to a lower overall level of satisfaction with lighting. The noise levels are satisfactory but the intrusive nature of the sounds experienced in these open plan offices detrimentally affects the satisfaction felt with the noise environment.

Based on this research, BSRIA believes it is important that:

- From the outset, the ultimate client understands and accepts the variable internal environmental conditions (diurnal and seasonal) that are intrinsically associated with modern passive low energy buildings.

- The owner/operator embraces the concept and practices of mixed-mode ventilation if he is to achieve low energy usage and effective building operation. During the study, specific points concerning design issues and operational issues were identified.

- Proper design and use of the building should be augmented by training and instruction of occupants. This is necessary to obtain the best out of any building but particularly so in mixed-mode buildings where occupant behaviour (including adopting a more active role) is likely to be a major factor in its overall performance, successful or otherwise.

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This publication is issued with the agreement of the DETR and every opportunity has been taken to incorporate the views of the editorial panel, but final editorial control of this document rests with BSRIA.

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GLOSSARY

AMV	Actual mean value
B1S	Building 1 summer
B1W	Building 1 winter
B2S	Building 2 summer
B2W	Building 2 winter
B3S	Building 3 summer
B3W	Building 3 winter
BMS	Building management system
BRE/RSH	Building Research Establishment/Royal Society of Health
BSI	Building sickness index
CO_2	Carbon dioxide
DB	Dry bulb (temperature)
L_{eq}	Equivalent sound pressure level
NR	Noise rating (curve)
PMVmean	Mean PMV
PMV	Predicted mean vote (see reference 4,5)
PPD	Predicted percentage dissatisfied (see reference 4,5)
PPDmean	Mean PPD
ppm	Parts per million
PSI_5	Personal symptom index (based on 5 possible symptoms)
RAM	Room air movement
RH	Relative humidity
SFQ	Short form questionnaire
Tmean	Mean air temperature (RAM and thermal comfort surveys)
Vmean	Mean air velocity (RAM and thermal comfort surveys)

1 INTRODUCTION

Modern passive low energy buildings are characterised by the use of natural ventilation and night cooling either to fully, or partially, satisfy comfort conditions. Where the latter is the case, use is made of mixed mode techniques which incorporate various forms of mechanical cooling to meet peak loads.

In recent years there has been a gradual re-emergence of the use of these passive ventilation and cooling techniques. Much of this growth to date has been within the public sector building programme, with relatively low market penetration in the private sector. The reason for this appears to be the general assumption among clients and developers that such buildings will not provide acceptable comfort conditions. A similar scepticism is found among property and letting agents.

This Technical Note reports on an assessment of three buildings of this type in order to determine the validity or otherwise of these concerns. This was done by monitoring and evaluating the internal environment of three low-energy buildings incorporating passive and mixed mode techniques, with particular emphasis on assessing occupant comfort.

The three buildings considered as case studies were regional / headquarters-type office buildings using mixed mode ventilation. All three buildings were structured around a central atrium and used exposed floor slabs to stabilise internal temperatures. Details of the buildings and the winter and summer design conditions are tabulated along with descriptions of the building services plant installed.

The building indoor environment was assessed in detail by the monitoring programme undertaken in each building over a two week period in the winter and again in the summer. The occupant questionnaire was based on the BRE/RSH [1] questionnaire for studies of sick building syndrome. This includes demographic data, questions concerning personal well-being and questions relating to the occupants' perception of the environment.