# The natural solution in refurbishment

Natural ventilation has been claimed as suitable for 9 out of 10 offices not severely affected by noise or pollution, claims Andrew Martin

IT IS POSSIBLE to provide high class office accommodation in refurbished buildings despite their inherent constraints, and viability is improving as office technology advances.

Equipment and lighting are more efficient and contribute less heat to their surroundings, thus reducing the need for environmental services to keep conditions comfortable. Flexible systems, use of structured cabling, and less strict specifications demanded by the British Council for Offices (for example, floor loadings) are also contributing to the increasing possibilities for refurbishment.

The benefits of natural ventilation include lower running and maintenance costs, possibly less capital outlay, increased useable/lettable area with reduced space requirements for plant rooms, and increased occupant satisfaction when given local control over conditions. The link between air conditioning and sick building syndrome is not proven, but a naturally ventilated solution will certainly result in a more robust building, less susceptible to deficiencies in maintenance. Different building types will present different challenges when refurbishing for natural ventilation, some of which are summarised in Table 1.

However variable natural ventilation may be in theory, the final decision is commercial and, currently premium rents are payable for the perceived prestige of air conditioned office space. It remains to be seen whether increasing concerns over high service charges, running costs, and that state of the environment, will translate into a demand for high class naturally ventilated office accommodation, with corresponding premium rents.

**TABLE 1: REFURBISHMENT OF DIFFERENT BUILDING TYPES FOR NATURAL VENTILATION**

| Period/description | Construction | Advantages for natural ventilation | Disadvantages for natural ventilation |
|---|---|---|---|
| Pre 1900 Commercial | Masonry | High ceilings<br>Tall windows<br>Good natural light<br>High thermal mass | May be listed building<br>Structural partitions - inflexible space, poor circulation |
| Pre WWII Commercial | Masonry, concrete or steel frame | May have high ceiling<br>Narrow floor plate | |
| Late 1950's/ 1960's office building | Steel frame or reinforced concrete, curtain wall | Narrow floor plate<br>Open plan layout | Low floor-floor height<br>Large glazed area<br>Low floor loading<br>Relatively lightweight |
| 1970' s office development | Steel frame or reinforced concrete | Larger floor-floor height than 1960ís (for services)<br>Open plan layout | Deep plan<br>Lightweight construction |

## Costs

■ Different levels of refurbishment are classified in Table 2 and it provides typical costs associated with each. These indicative costs are based on a consen-

"Natural solutions need more design consideration"

**TABLE 2: TYPICAL COSTS OF VARIOUS LEVELS OF REFURBISHMENT**

| Heat Gain (W/m2) | Level of Refurbishment | Cost £/m 2 gfn |
|---|---|---|
| 15-20 | Level 1: opening windows, install modern blinds, repaint interior, redesign layout | 170-210 |
| 20-25 | Level 2: opening windows, install modern blinds (possibly exterior louvres), renew lighting, repaint interior, remove false ceiling to expose thermal capacity and raise ceiling height. | 300-460 |
| 25-35 | Level 3: opening windows, install modern blinds (possibly exterior louvres), renew lighting, repaint interior, remove false ceiling to expose thermal capacity and raise ceiling height, use stair as stacks, BMS-controlled | 410-600 |
| 35-45 | Level 4: opening windows, install modern blinds (possibly exterior louvres), renew lighting, repaint interior, remove false ceiling to expose thermal capacity and raise ceiling height, use stair cores as stacks, BMS-controlled night cooling with motorised window/vent opening. Radical change to air flow path, for example by addition of a central atrium to decrease plan depth or use of a double facade to drive stack ventilation | 650-1000 |

sus obtained from quantity surveying practices in London.

The provision of a naturally ventilated solution for a building often requires more design consideration than an equivalent air conditioned building. This is particularly so when natural ventilation is being provided as part of the refurbishment of a building that was previously air conditioned. Current and planned industry guidance regarding the provision of natural ventilation concentrates on new build. BSRIA is currently producing guidance and source material to complement this existing material, in order to steer designers through a refurbishment for natural ventilation. A methodology for assessing whether natural ventilation is feasible will be provided together with comparatory performance and cost data for different options and case study material. Particular areas to be covered include: reduction of heat gains, window design, the use of stairwells and atria to promote stack ventilation, double facades, mixed mode systems, exposing thermal mass/night cooling, and noise attenuation measures.

The guidance is to be published in Autumn 1997. ■

> "It will result in a more robust building"

** Mr Martin, who works for the Building Services Research and Information Association, was speaking at the CIBSE Natural Ventilation seminar at the Building Services Engineering Centre, London.*



# The issue of air quality

Natural ventilation as a strategy for achieving acceptable IAQ is essentially based on the supply of air to a space and by dilution to reduce the concentration of pollutants. Maria Kolokotroni and Brian Webb explain that keeping the air flow rates in a certain range is very important

NO FAN ENERGY is needed (unless mechanical extract is supplied) with natural ventilation, but during the heating season energy is needed for heating the air. The natural air flow rates vary as a function of time and depend on wind and temperature conditions. Likewise the user can have a substantial impact by window use. Therefore, optimisation is essential so that good indoor air quality and a low energy demand can be combined.

Research at the Building Research Establishment has been carried out in support of the Building Regulations, Part F1 (Ventilation) on methods for providing the required background ventilation to occupiable rooms in non-domestic buildings. Trickle ventilators have been identified as an option for this provision for new buildings. However, they are also suitable for office refurbishment. Trickle ventilators have been used in some refurbished offices including the DTI building.

Several studies, using a combination of computer analysis, laboratory tests and field measurements have been carried out at BRE to confirm the effectiveness of trickle ventilators in providing adequate background ventilation in offices during the heating season.

## In summary:

a) Trickle ventilators with a minimum openable area of 400mm2 per m2 of office floor area can provide adequate fresh air during winter in a typical office room with maximum occupancy density of 8m$^2$ floor area per person. However, for effective trickle ventilator performance, internal doors should be provided with air transfer grills or should be kept open.

b) Cold draughts do not appear to be a problem either at desik or head levels even at distances up to 2m from the windows with the ventilators. Measured

CONTINUED ON PAGE 28

CONTINUED FROM PAGE 27

**velocities in occupied offices were well below the accepted threshold of 0.2m/s for discomfort.**

**c) Maximum metabolic CO2 levels can be maintained on average below 1000ppm when the occupancy of the office is one person with the ventilator open, thus indicating a fresh air ventilation rate of about 51/s per person. Transient increased occupancy increases this level but quickly returns to normal levels when normal occupancy is resumed.**

**d) Measurements confirmed that trickle ventilators do enhance the ventilation in a space so that the internal environment can be controlled by occupants according to their needs.**

**e) Occupants of offices do make regular use of trickle ventilators to control their environment provided they are familiar with their operation.**

However, the air flow does depend on the external conditions and this may lead to oversizing of the openings to ensure provision of minimum ventilation. Issues such as draught problems under certain external conditions and energy wastage in heating the additional incoming air may occur. To address these, controlled air flow inlets have been available for some years. The type of inlets available are controlled by either:

- **Pressure:** These have been mainly used in offices. There exist various designs with differences in:
  - ⇒ Flow rate/capacity or size
  - ⇒ response pressure level (1,5,20 Pa or even peak closing only in stormy weather)
  - ⇒ response time
  - ⇒ control possibilities (passive/active)

- **Humidity:** These have been used almost exclusivly in dwellings and are somewhat limited in scope for application to office buildings (since moisture is not the dominating pollutant in the latter case)
- **Pollutant (CO2/CO/smoke):** These have been mainly used in schools, theatres, shopping malls, meeting rooms, parking lots and occasionally in houses. Future application to offices is debatable as there is no dominating pollutant (expect CO2 in which case considerable drifts have been reported). However, they might have some application for controlling the incoming air in cases with high external intermittent pollution.

- **Temperature:** They are mainly used in situations where thermal buoyancy is dominant, such as cold countries and high rise buildings, and in these cases considerable energy savings are possible.

In the summer, natural ventilation to provide thermal comfort can be applied at daytime and especially at night-time when the outdoor air is relatively cold. The aim then is to have a maximum exchange of heat between the building structure and the outside air. This is achieved by creating large openings in the building envelope to provide high air flow rates.

## Pollution

■ Whereas for IAQ control, the resulting indoor air quality is linked in a rather simple way to the pollution source strength and the air flow rate, a much more complex relation is found for temperature control in summer. Influencing parameters are the thermal gains (internal and solar gains), the building characteristics (especially thermal mass and insulation level), the use of the building and the rate of natural ventilation provided. Control of the air flow rates is itself not important so long as this does not give unacceptable conditions e.g. draught problems or undercooling in the early morning hours. The required air flow rates for IAQ control are of a totally different order of magnitude to the air flow rates for contributing to better thermal comfort conditions in summer time. As a result, the openings are also of a totally different size.

> "Control of air flow rates is itself not important"

BRE together with WILLAN Building Services and Oscar Faber Applied Research is investigating this requirement, related in particular to night cooling ventilation. The work is carried out under the Department of the Environment Partners In Technology programme. As part of this project, field measurements were carried out on the night cooling achieved in a naturally ventilated office building during the summer of 1995. The findings of the study showed that by using a night cooling strategy in the building, the internal office temperature was reduced by up to 4°C at the start of the working day.

The building had bottom-hung ventilators installed at floor level around its perimeter. Security of the building and weather protection was maintained by the ventilators having mesh screens and perforated external louvres. The ventilators were opened or closed manually each evening Monday through to Friday for the duration of the study. At the end of the study the office managers and staff had appreciated the benefits offered by night cooling. Security was obviously a major concern, and the office managers initially had to be convinced that the ventilators provided adequate security and weather protection.

In conjunction with these measurements, combined thermal and air flow modeling of a 'typical' office was carried out to determine the possible level of cooling available using a range of strategies and ventilator configurations.

## Conclusions:

**a) For the no wind case with a stack equivalent to one floor, flowrates of between 4 and 5 air changes per hour (ach) can be achieved with an inlet area of about 8,300mm2/m2 for most practical outlet sizes. This represents an area of approximately 20 times the minimum required for background ventilation by the current Building Regulations. To maintain the same flowrate on each floor of a building, the opening area must increase with decreasing stack height.**

**b) For high wind pressures, very high ventilation rates can be achieved, up to 48ach for the cases investigated in this work. These are excessive, especially in**

CONTINUED ON PAGE 33

**The Barbican Estate in London is undergoing a thorough refurbishment and cleaning of its entire mechanical ventilation system after a survey by NIFES consulting engineers. Argent has been appointed to carry out the work including upgrading of the extract plant in the three 43 storey tower blocks.**

CONTINUED FROM PAGE 28

**the light of the small differences in temperature achieved, and therefore, some form of control is necessary to ensure that this does not occur.**

**c) Despite the large variations in ventilation rate achieved, there is a relatively small variation in peak comfort temperatures. As the ventilation rate increases beyond 5ach the reduction in temperature achieved decreases.**

**d) It is very important to consider temperatures at the start of the occupied day. If these are too low then occupants are likely to either require heating or feel uncomfortable. If no control is placed on the night ventilators, an analysis of comfort temperatures during occupied hours indicates that the office will be too cold, below a comfort temperature of 18°C, for around 21% of the time for the Kew weather data (typically used in modelling) and around 17% of the time for the Heathrow weather data (warmer summer).**

From the measurements and modeling result, it was evident that in designing a night cooling ventilator one needs to consider both the performance and non-performance features. The performance features or importance are:

- adequate airflow
- weather resistances, especially from rain.
- resistance to the ingress of insects.
- maintaining building security.
- durability and low maintenance.
- capability for daytime ventilation.
- controllability.

Non-performance aspects needed are:

- 'looks' i.e. does it blend in with the building design.
- relatively low cost.
- easy to install.

A night cooling ventilator can be incorporated in both new build and refurbished buildings. Invariably refurbished buildings include the fitting of new windows so that a large ventilator can easily be fitted into the window opening area. The ventilator would ideally be located at high level to reduce draughts during the daytime. Window blinds would then need to be fixed underneath the ventilator. There will be some reduction in the glazing area and in the amount of daylight entering the office.

A prototype night cooling ventilator has been built and is to be tested in an office during this summer. It has openable louvres on the inside and for protection and keeping out insects, the external opening is located facing downwards with an integral insect screen. The louvres are opened or closed by a 24volt actuator motor.

## Monitoring

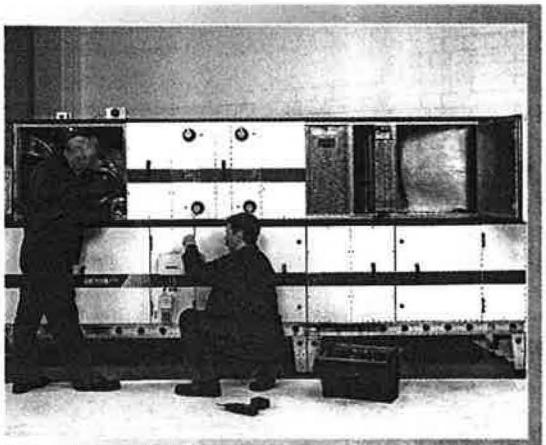
■ A 1960's four storey office building of heavyweight construction will be used for monitoring the performance of the night cooling ventilators. A large open plan office on the second floor (with cross ventilation) has been chosen for the study. Four ventilators are to be installed in the North facade and five in the South facade of the building. It has been decided to install the ventilators at window cill level rather than at the top because of problems with the window design. This does not matter since the ventilators will only be temporarily installed in the building.

Data to be collected during the monitoring period will be internal air temperatures, globe temperatures, surface temperatures, external temperature, wind speed and direction, solar intensity, and wind pressure. At the start of the monitoring period the ventilators will be manually controlled but at a later date an automatic control system will be installed.

Ventilation measurements of the office will also be carried out during the evenings when the office is unoccupied to determine the airflow rate through the ventilators. The results from this study will be published at a later date. ■

** Maria Kolokotroni and Brian Webb work for the Building Research Establishment.*





**▲ The integrated framework and interlinked panel construction of GEA Happel's modular air handling units allows them to be broken down into components and reassembled more quickly than was possible with earlier models, the company claims. The casings are made from galvanised steel with a powder coated finish.**



By controlling the ventilation rate of a building using a pressurised heating system, not only do we avoid the build up of stagnant $CO_2$ laden air, but begin to eliminate infiltration of particulate matter and cold external air through building leakage, explains P.J. Cartwright

# Putting people first

All too often consideration is given only to 'providing acceptable temperature levels' during the heating season and none to 'excessively hot conditions' arising during the summer months. When asked to address this problem most employers would never agree to meeting the capital outlay, or operating cost, of air conditioning. The effectiveness of air movement in creating the effect of cooling is well known.

The effectiveness of this is maximised by the use of fresh air, rather than recirculated air.

This precise control of building conditions makes for an extremely comfortable working environment, with uniform lateral and vertical temperatures. These improved conditions help to eliminate fatigue and sickness and improve general staff morale through the knowledge that their employers are striving to ensure the best environmental conditions possible.

It is now commercially viable to control the environment in large industrial spaces, whether it be heavy or light engineering, retail or warehousing, without massive increases in operating costs.

At a time when better conditions are being demanded technology has found the solution to these demanding times. ■

** P.J. Cartwright is managing director of Nordair Systems.*