#2585

H2585 2105

Local control for vav systems

Alan Fisher reports on VVT — a new name in zone control for smaller commercial buildings.

Variable air volume, vav, is now the recognised industry method for achieving acceptable comfort control with a good degree of internal flexibility in large buildings; but what is the solution for smaller commercial buildings?

Until now, attempting to air condition smaller buildings using single packaged cooling units (or heat pumps) to provide true flexibility and individual zone temperature control, has proved almost impossible.

Various methods have been tried with limited success. Traditionally, attempts have been made by using a single thermostat, averaging by measuring the return temperature air system, or even zone reheaters, each controlled by its own thermostat. Although this latter system does give high standards of control, it is not necessarily cost effective and certainly not energy conscious. Unfortunately, all three methods have proved unsatisfactory because of one fundamental drawback: neither system confronts the essential need for a comfort air conditioning system that can provide control of both the air volume and temperature.

Carrier has now solved this problem by developing and introducing the VVT system which provides both variable volume and variable temperature.

VVT has been designed for use in tandem with Carrier's range of standard packaged or split system constant volume cooling or heating units (whether they be cooling with electric heat or heat pump versions), controlled by the use of microelectronics.

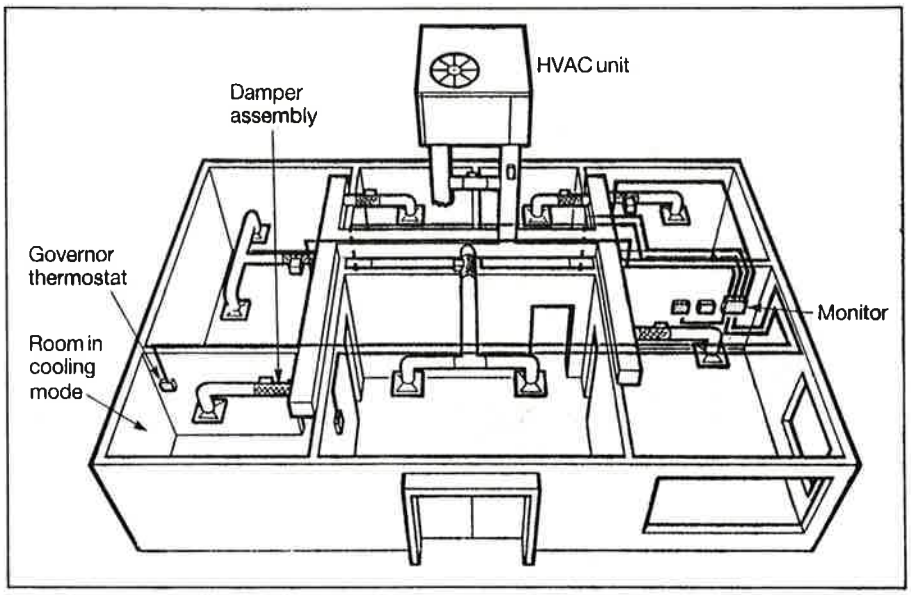
The necessary heating and cooling capacity for a building is calculated on the "block load" method (peak load requirements for the building at a given moment), rather than the "zone load" method (sum total of all peak zone requirements, even though the peaks may occur at different times).

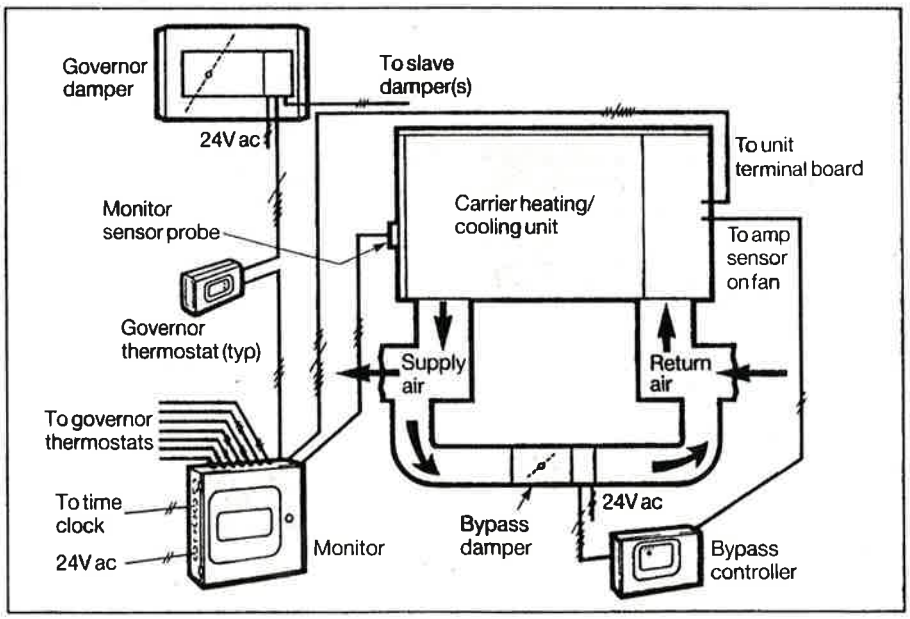
By taking account of diversity the VVT system can often use the next equipment size down, resulting in lower initial and operating costs, and eliminating the need for costly multiple hvac units.

The key to the transformation of a single-zone constant-volume unit into variable volume is the cds (computerised damper system) controls. Variable volume is achieved by using zone dampers to modulate the air flow into the zone in response to a zone thermostat, while variable temperature (cooling or heating) can be achieved in various ways — cooling and electric heating, heat pumps, etc.

As well as a single packaged rooftop or ducted split system, the essential equipment making up the rest of the VVT system — all cds components — comprise the following items:

☐ The governor thermostat is a comfort sensitive micro-computer, located in each zone. Up to eight governor thermostats, one in each zone or room, can be interfaced to their respective eight governor zone dampers in the branch ducts and to the system monitor panel.





Top: typical component layout for a small commercial building; and *above:* wiring schematic for Carrier's VVT air conditioning system.

The governor thermostat monitors temperature and modulates the damper to maintain the temperature selected at the thermostat. It continuously regulates the damper position to maintain the set temperature — ranging from 20 to 27°C. To simplify air balancing, minimum and maximum damper positions are manually adjustable from the thermostat.

Set-point, duct temperature (from associated damper), room temperature, and damper position can be displayed on demand to facilitate system diagnosis. The room set-point button makes user adjustment easy.

Change-over from heating to cooling is carried out automatically. The thermostat permits zones that do not require conditioning to be closed off and automatically resume a 23°C set point if power is off for more than eight hours. It can also control up to six slave dampers.

The governor thermostat micro-computer is interfaced with the hvac unit through the panel monitor control, allowing each zone to demand heating or cooling.

☐ The governor damper regulates the flow of conditioned air into each zone. The damper is activated by the governor thermostat which sets the damper at closed, open or any of 13 000 positions in between, to accurately meter air flow and modulate precise comfort control.

☐ The central monitor control panel is the computerised co-ordinator of the entire system and interfaces with governor thermostats (accepting information from up to eight governor thermostats); collects the required zone information and determines the demand for heating and cooling in all zones.

The monitor control panel evaluates and interrelates input from all the zones and controls the hvac unit to meet the overall zone comfort requirements. This involves selecting the correct hvac mode (heating or cooling) as required by the whole system.

The monitor panel also provides night set back, time guard facility and is connected to a sense probe (located in the supply duct before the bypass) for operational high/low limit protection and off coil temperature control. The set point at all zone thermostats may be locked at the monitor.

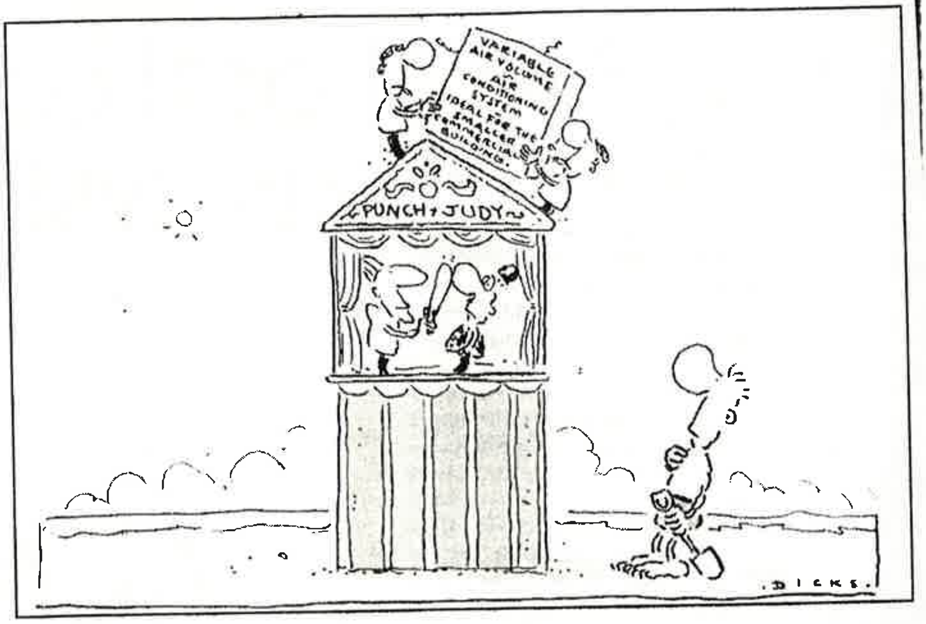
☐ Bypass controller interfaces with one or more bypass dampers between the supply and return air duct. When the bypass controller senses the drop in fan current from the indoor fan motor current sensor, it modulates the bypass damper to offset an increase in system pressure due to the closing of zone dampers as zones are satisfied.

☐ Sub-zoning can be achieved by using cds controls. The damper and thermostat can be used separately as a stand alone control for small sub-zones fed from the hvac unit. In this situation the governor thermostat does not control the hvac plant, which has its own control. Instead, the damper and thermostat prevent over conditioning in the small sub-zones by varying the volumes of air in relation to room temperature.

The only limitation placed on sub-zoning is that control of more than 10% of the hvac unit's total air volume in the sub-zone should not be attempted. Excess noise and air flow is then prevented from affecting the main area when the sub-zone damper is closed.

Other limitations of the VVT system (because like any system it has its limitations) include areas to be avoided such as high pressure ductwork systems (and governor dampers being rated up to an inlet pressure of 25 mm wg maximum). Also worth noting is that the bypass system can only operate with forward curved fans.

VVT systems should not be applied to buildings where one or more zones have a cooling load on a "design heating day" eg a computer room in the central core of a building.



The VVT system is designed to cope with simultaneous heating and cooling loads and will change from one mode to the other to satisfy zone requirements. There is a facility to bias the system towards heating or cooling. The hvac equipment is selected for peak summer and winter design. At other times of the year excess capacity is available and individual zone requirements can be satisfied quickly.

It is worth emphasising that as the system employs a variable volume, good air distribution techniques must be used to avoid "dumping" at low air volume.

In Hove, at the headquarters of lense manufacturer Rayner Intraocular Lense, the largest VVT system installation to date in the UK (up to its maximum in terms of capacity) has just been successfully completed and commissioned.

Designed by Peter Morrison of Hove, the VVT system serves a first floor office area of 475 m^2. A split system was selected for the hvac plant. Located outdoors on ground level are two Carrier heat pumps — one 38 AQ 012 and one 38 AQ 016. Coupled to these, in the plant room adjacent to the first floor, is a 40 RR 028 indoor fan coil unit.

The computerised damper system comprises eight governor controlled zones plus an extra "floater". They serve the drawing office, lecture room, boardroom, open plan area and individual offices, all on the first floor. Three bypass dampers are included. The total number of boot diffusers in the office areas is 44.

The VVT system has been designed for a summer ambient of 30°C outside and 21°C inside. In winter conditions the system can handle an external temperature down to −5°C to maintain 21°C. The design evaporator duties incorporated mean that the heating duty on the VVT system is 44 kW, while the cooling duty is around 65 kW. The total air flow being handled by the 40 RR unit, within the VVT system, is 3780 l/sec. Of that, 10% (378 l/sec) is accounted for by fresh air make up. To establish occupancy level 378 was divided by 8 l/sec.

In the Rayner building, the VVT system has been designed to cope with full height glass facing west (single glazed with awnings), the worst situation for both hot or cold temperatures. Due to this, good air distribution is required close to the windows on the west face.

As this building is well insulated the VVT system is set on a cooling load priority. In buildings which are poorly insulated or worse still, uninsulated, heating might well be the priority; it all depends on the nature of the building.

As it is currently set-up, it takes just three zones on demand to obtain mechanical cooling. As the Rayners building is a highly insulated structure there is a low heat-loss time factor. If the system switches to give cooling to other areas the penalties of rapid temperature cool off are not suffered when cooling is applied to those areas demanding cooling.

So, why was VVT right for this firm? Obviously, the prime reason was the client's wish for individually controlled zones. The budget was also sufficient to achieve this sophistication of air conditioning and control, but not that of a full vav perimeter heat system.

An alternative would have been to opt for a fan coil system. This was unacceptable to the client for one very good reason. When it came to maintenance this would have meant that access panels to individual units would have been needed, with the resulting inconvenience and disturbance to occupants.

It is worth remembering that VVT systems are not a replacement for vav systems. Instead, VVT provides a solution for comfort conditioning smaller multizone buildings that use packaged or split ducted hvac equipment, achieving a higher level of comfort than was previously possible.

Alan Fisher works for Carrier Distribution Limited