NT-87-04-2

ZONED AIRFLOW CONTROL

L.J. Bentsen, P.E.
ASHRAE Member

ABSTRACT

The use of zoned airflow control offers opportunities to eliminate building pressurization problems and the effects associated with these problems. This paper discusses control guidelines and options associated with a zoned control approach using either zone dampers or multiple fan systems. Airflow tracking and direct pressure control are compared for zoned control applications. Reference is made to smoke control systems that use zone controls.

INTRODUCTION

New requirements for control of airflow and pressurization in buildings offer challenges to the control system designer. One of these requirements is the integration of smoke control into VAV systems. Smoke control dictates a zoned approach for the smoke control mode, but, typically, the system does not utilize zoning control for normal operation. What are the benefits of zoned control and what are some of the application guidelines?

Figure 1 illustrates a four-story building having a central air handler. The first floor is more porous due to various doors that open to the outside. When doors are opened, space pressurization is essentially lost. The third floor might have a higher cooling load due to a higher density of people and machines. The higher cooling load requires higher supply airflow rates than other building areas. In this example, building pressurization is greatest on the third floor and least on the first floor. Due to these pressure unbalances, airflows containing odors and other air pollutants are circulated within the building rather than directly removed by the return system. Moreover, temperature and humidity control become more difficult due to the interaction between building areas.

The return fan, which plays the primary role in determining average building pressurization, is usually controlled by airflow tracking or by direct building pressure control techniques. With airflow tracking, building pressurization is a function of the differential between supply, return and exhaust airflows and the porosity of the buildings. Areas receiving greater proportions of supply airflow tend to be pressurized higher than areas receiving less proportions of supply airflow. If direct pressure control is used, the area where static pressure is measured is held and other areas are higher or lower depending on supply airflow distribution.

The situation doesn't change much if each floor is separated by barriers and doors. Airflow from the third floor passes through floor and wall penetrations to other floors, especially the first floor. Pressure unbalances will become more significant.

There might be smoke dampers on each floor for supply and return, but they are not functional during the normal mode, as Figure 2 shows. The return damper, used to control return airflow and pressurization of floors or zones during the smoke control mode, can be used for zoned control during the normal mode.

L. J. Bentsen, Principal Application Engineer, Honeywell Inc., Arlington Heights, Illinois.

ZONED AIRFLOW CONTROL

Figure 3 illustrates the zone approach. Control of the return damper on each floor determines the floor's pressurization.

Return damper control can be from airflow tracking or direct pressure control. Airflow tracking is the preferred selection for zoned control on the first floor. Due to sudden static pressure changes that occur whenever doors open to the outside, a direct pressure control technique is difficult to stabilize. Moreover, the high leakage around doors requires pressure control at very low set-point values, which are difficult to measure. On floors above the first, where porosity is tight due to a trend toward better sealing techniques, flow tracking control is not viable. Relatively small differences in flow tracking differentials of tightly sealed zones result in large pressure differentials. Also, all exhaust airflows must be included in the central scheme, which makes the control design more complex. Direct pressure control is the preferred control selection on these floors.

Both airflow tracking and direct space pressure control require accurate sensing. For airflow tracking control, sensors are located in supply and return ducts to sense total airflow. Minimum velocities and location of the airflow sensor relative to any variations from straight duct are critical design considerations. For direct pressure control, the static pressure sensing points must be shielded and free from the effects of velocity. The indoor static pressure sensor should be in the largest open area and not near doors that open to stairways and elevators. The outdoor static pressure sensor should be at least 10 feet above the building (depending on surrounding conditions) and be specifically designed to accommodate multi-directional winds.

For zoned airflow tracking or space pressure control, the return fan control strategy is to hold duct pressure constant at a point about two-thirds of the overall duct length upstream of the return fan, as Figure 4 shows. This control technique is the same as that used to control the supply fan, except the duct pressure is negative relative to the ambient surrounding the duct.

In order to assure a minimum outside airflow, the control scheme in Figure 5 is recommended. The airflow sensor located in the duct providing minimum outside air is needed for control; it also provides valuable information regarding the quantity of minimum outside air. Obviously, an accurate minimum quantity is desirable to optimize the trade-offs between air quality and energy costs. The control modulates the outside air, return air, and exhaust dampers to provide additional outside air if required. Normally the difference between total supply and return airflows, as determined by the zone controls, provides the minimum outside air. Since each zone is set to provide proper pressurization and new buildings tend to be sealed tightly, requiring less outside air for pressurizaton, this control scheme assures minimum outside air. Note that increases in minimum outside airflow do not affect building pressurization.

Since the same controls, including return zone dampers, are utilized during the smoke control mode, there is greater control system confidence than with a separate smoke control system that is tested only periodically.

MULTIPLE FAN SYSTEMS

Multiple fan systems are a form of zoned tracking and need to be included in this discussion. The same concepts for zone pressurization utilizing airflow tracking or direct space pressure control techniques apply for multiple fan systems as in Figure 6. A return fan is modulated instead of the zone return damper for zone pressurization.

CONCLUSIONS

1. Zoned airflow control can minimize the undesired migration of odors and pollutants throughout the building.

2. Zoned airflow control can improve the reliability of smoke control systems by utilizing and operating the same control elements.

3. Accurate quantities of minimum outside air can be provided without increasing building pressurization.

4. Various zones within a building can use different pressurization control techniques to achieve optimum results.

5. Airflow tracking should be used in zones with high leakage and zones lacking containment.

6. Direct pressure control is best suited for tightly sealed, contained zones.

BIBLIOGRAPHY

1. Shavit, G., "Smoke Control with Feedback," ASHRAE Transactions 1983, V.89, Pt.1.

2. Trane Air Conditioning Applications Engineering Manual, AM-CON 17 (882), Building Pressurization Control, The Trane Company, LaCrosse, Wisconsin, 1982.

3. Honeywell Fundamentals 77-7013, Zone Airflow Tracking Control, Honeywell Inc., Minneapolis, Minnesota, 1985.

4. Honeywell Principles 77-5065, Airflow Control Systems, Honeywell Inc., Minneapolis, Minnesota, 1985.

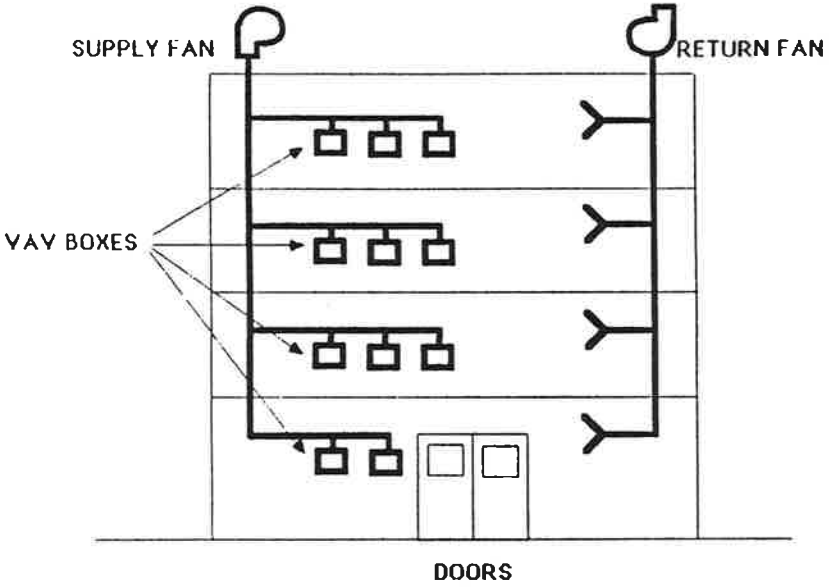

Figure 1. Central VAV system

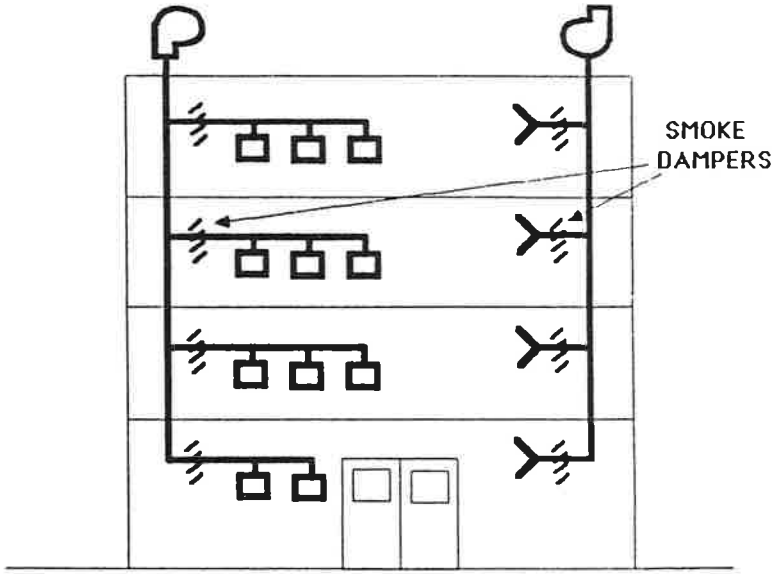

Figure 2. Zone smoke control

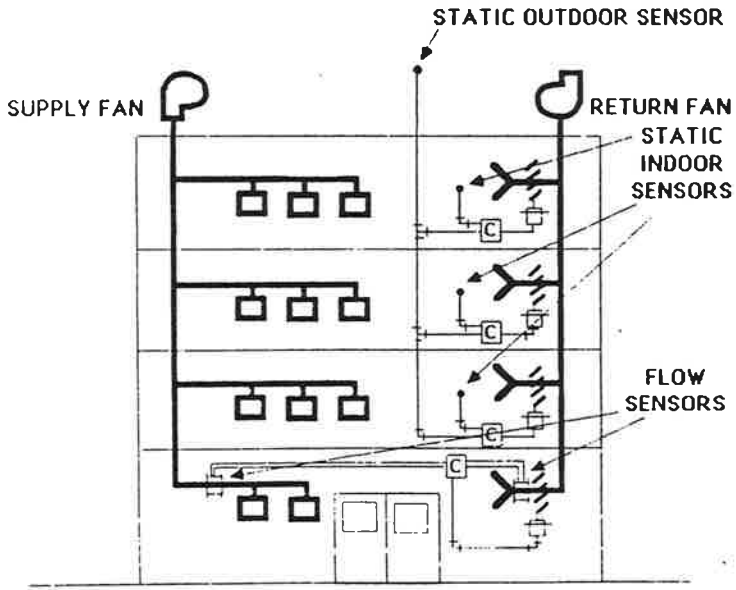

Figure 3. Zone damper airflow control

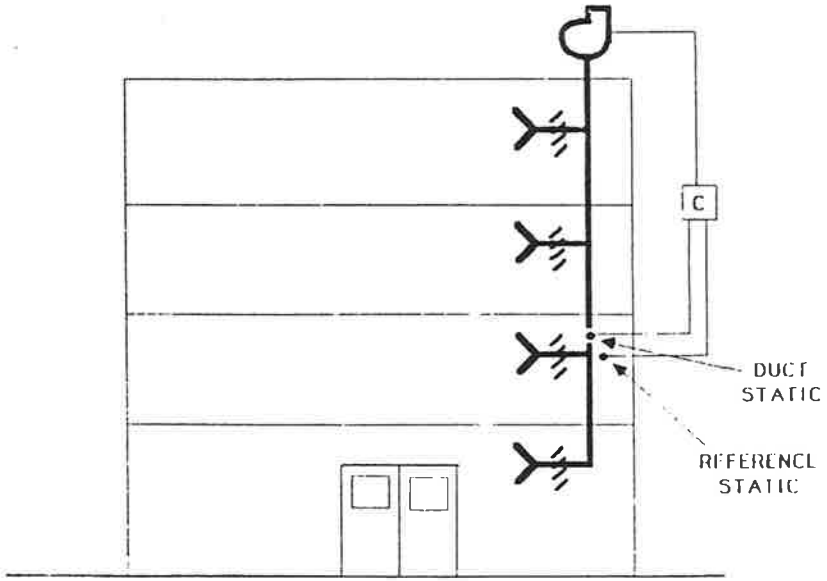

Figure 4. Return fan control

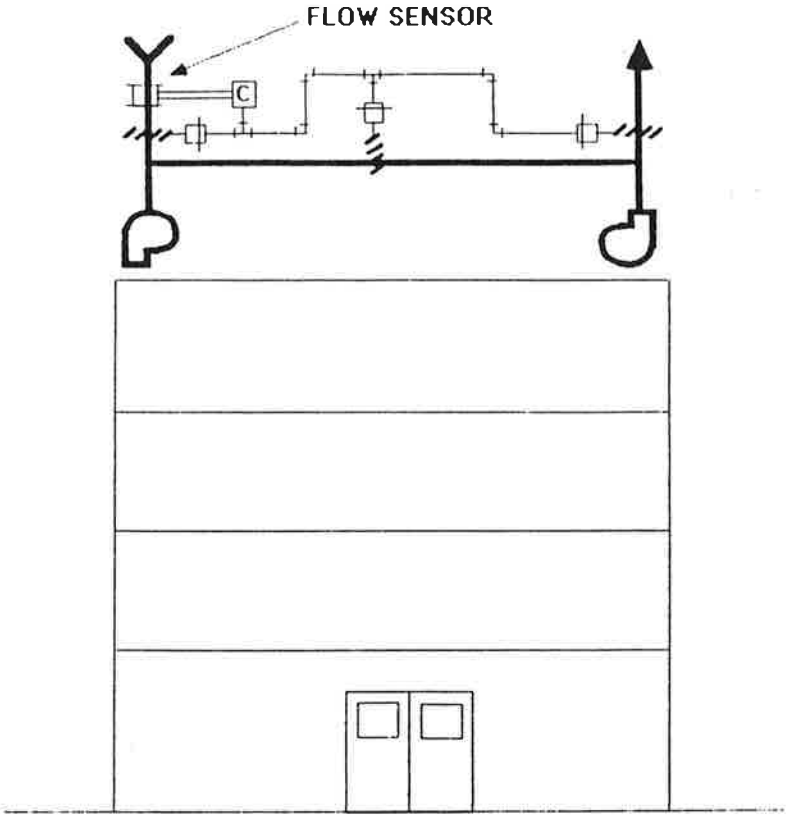

Figure 5. Minimum outside air control

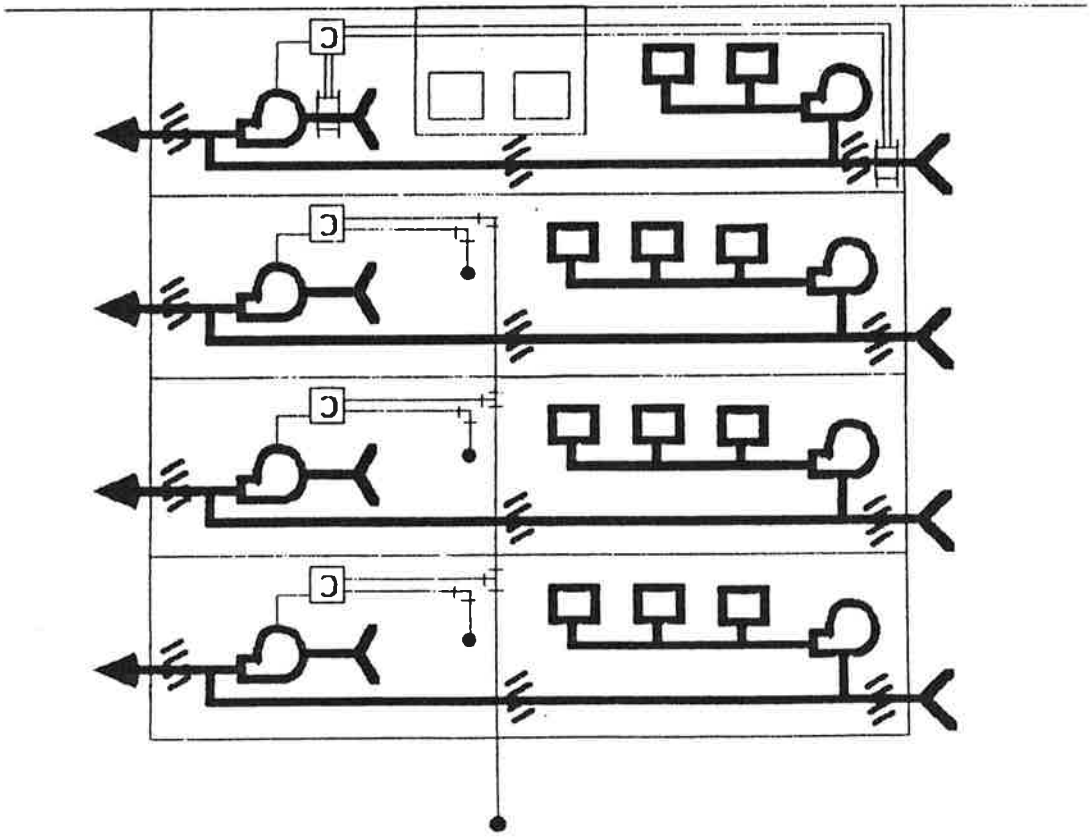

Figure 6. Zone multiple fan airflow control