HEATING • COOLING • REFRIGERATION • CONTROLS

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Vol. 14 No. 11 November 1997

Engineered Systems®

BNP Business News Publishing Company

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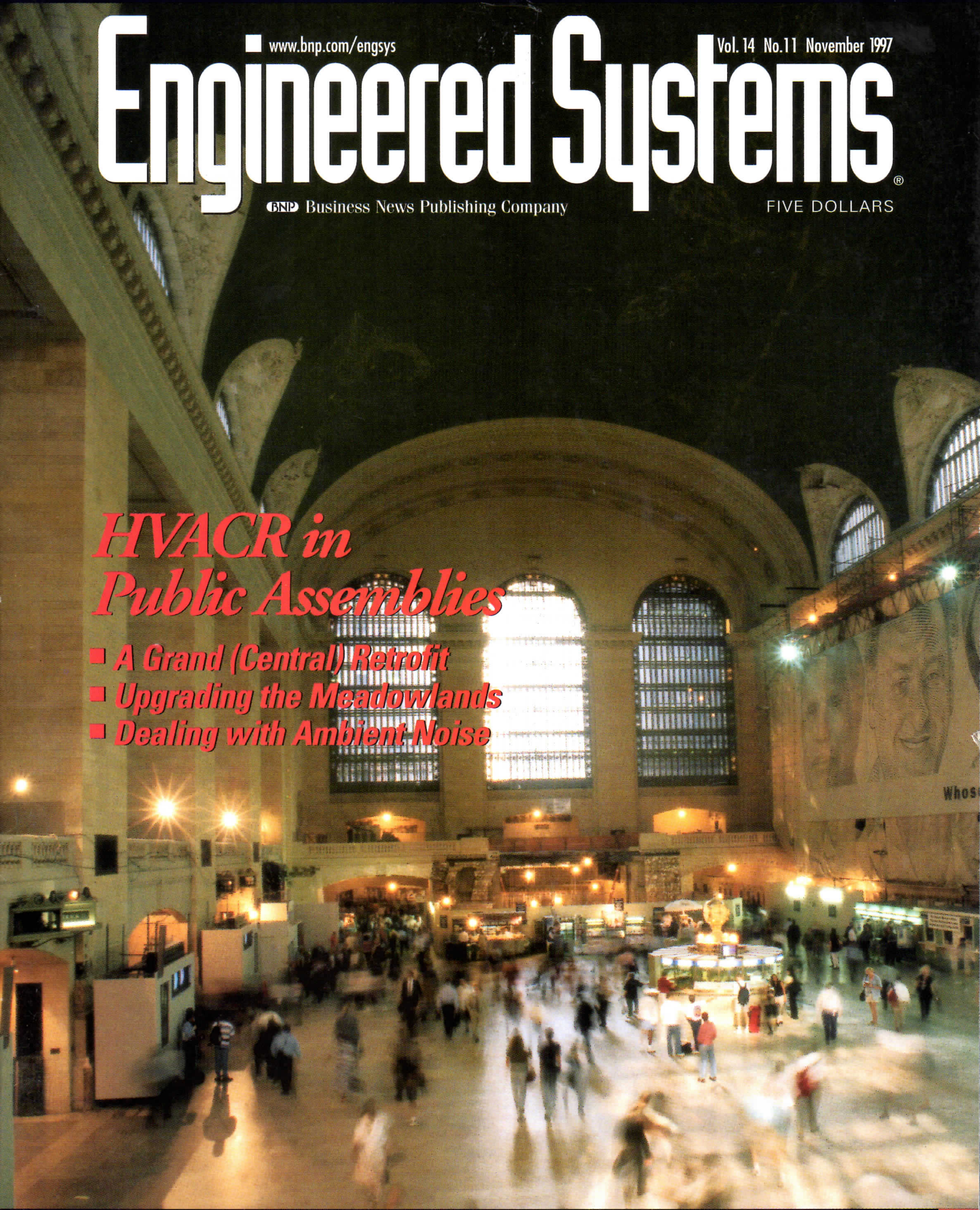

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PRACTICAL APPLICATIONS FOR INNOVATIVE HVACR MECHANICAL SYSTEMS ENGINEERS

CONDENSATE CONTROL

POSITION OF FAN (BLOWER) IN AIR HANDLER

The position of the fan in an air-handling system can be a significant factor in condensate control. It directly affects internal airflow conditions, and can seriously degrade air handler performance.

BY WARREN TRENT, P.E., AND CURTIS TRENT, Ph.D.

EDITOR'S NOTE: *This is the fifth of a six-part series of articles dedicated to the design of hvac systems that are free of health-threatening and property-damaging problems. This article is adopted from "Condensate Control," by authors Warren and Curtis Trent, in the* HVAC Systems and Components Handbook, *Second Edition, published by The McGraw-Hill Companies (Copyright 1998). This is being reprinted with permission of The McGraw-Hill Companies.*

The flow condition of the air approaching the fan inlet is critical, as is the condition of the air leaving the fan exit.

Airflow conditions at the fan inlet are influenced by (a) the direction at which air enters the fan compartment, (b) hardware located in the airstream that can alter flow direction, and (c) how the approaching air interacts with the rotating fan blades. The airstream may be simply distorted, or it may contain highly harmful vortices.

Vortices may be initiated by (a) fan blades and swirling flow at the inlet, (b) flow disturbances caused by obstructing hardware, or by (c) interactions between airstreams of different velocities. These conditions degrade fan efficiency.

The interactions are complex, but in some cases their effects can be approximated using information from the Air Movement and Control Association.[1] The lower fan efficiency caused by these conditions may be acceptable, in some cases. However, any combination of conditions that allows condensate to be entrained and spread into the hvac system cannot be tolerated.

Failure to provide a suitable diffuser not only results in reduced efficiency, it can introduce unacceptable local air velocities that entrain condensate and spread it to components inside the hvac system.

Air discharged from the fan exits at a high velocity, with a greatly distorted velocity profile. In order to avoid excessive losses in fan system efficiency and achieve a reasonably uniform flow condition, a suitable extension to the exit duct must be provided.

Failure to provide a suitable diffuser not only results in reduced efficiency, it can introduce unacceptable local air velocities that entrain condensate and spread it to components inside the hvac system.

CRITICAL DESIGN FACTORS

The factors that influence fan efficiency affect all types of air handlers in a similar way. Their effects on condensate problems, however, differ depending upon whether the air handler is a draw-through or a blow-through type unit.

In the draw-through unit, only those conditions ahead of the fan inlet are important to condensate control.

In the blow-through unit, the extreme air velocity profile at the fan exit is the primary cause of serious condensate problems.

- **Draw-through air handler:**

In a draw-through air handler, air is drawn through the cooling coil into the compartment that houses the fan and its inlet. Condensate is precipitated by the coil and collected in a pan inside the fan compartment. Thus, air entering the fan compartment is exposed to condensate both in the coil and in the condensate pan.

Generally, the average velocity of the air passing into and through this

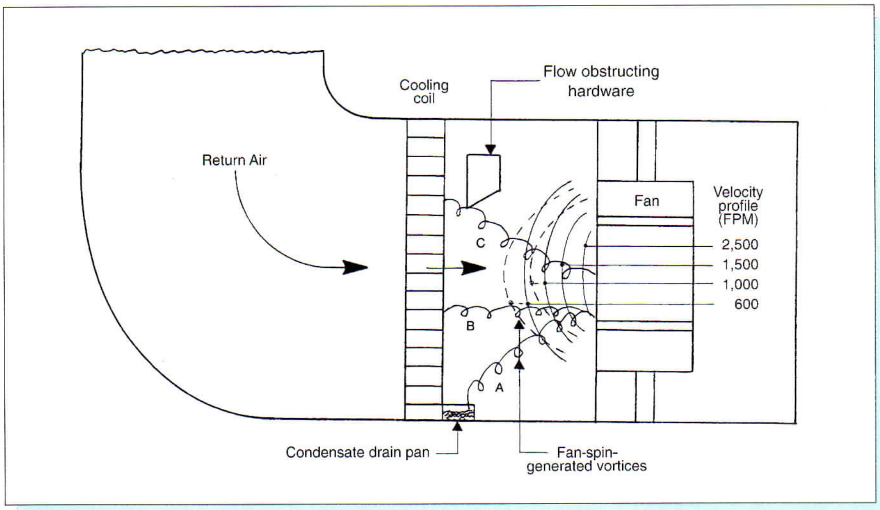

FIGURE 1: Airflow conditions that distort local flow velocities, including detrimental vortices (draw-through unit).

compartment is too low to entrain condensate. However, certain fan and surrounding hardware arrangements can distort flow conditions and create local air velocities high enough to entrain condensate and propel it into the fan inlet.

Published data and analytical techniques available to designers are not adequate to ensure that a selected fan position and adjacent hardware arrangements will be free of condensate entrainment and associated problems. Thus, successful design requires a considerable appreciation of the flow conditions that cause distorted airflow, along with good judgment.

In some designs, full-scale or model testing may be necessary.

Some of the various airflow conditions that create distorted local flow velocities are illustrated in Figure 1, which shows a centrifugal fan with the inlet facing the cooling coil. Changing the position of the fan 90 degrees presents a different airflow pattern, but the fundamental considerations remain the same.

In this illustration, air enters the fan inlet at 2,500 fpm and the effect extends upstream from the inlet. The lines of constant velocities shown were computed based on still air surrounding the fan, assuming no upstream flow distortion.[2]

These values are somewhat lower than what will be experienced in practice, because the system airflow adds a velocity component. This component increases the peak velocity and distorts the profile, as indicated by the dashed line in Figure 1, for velocities of 600 and 1,000 fpm.

Although less than precise, these results provide useful information for the designer. For example, if the cooling coil is placed closer than about 0.80 diameters of the inlet, the coil may be exposed to an air velocity of 600 fpm, which will likely cause condensate entrainment and carryover.

On the other hand, at a distance greater than 1.5 diameters, condensate carryover (due to the fan alone) is unlikely to occur.

Vortices can create an even more serious problem.

The spiral lines symbolize vortices and show how condensate can be entrained by the air and ingested into the fan inlet. Lines A and B indicate vortices generated by fan blades and externally induced spin or swirl (distortion). Line C indicates how a vortex may be created by obstructing hardware in the airstream.

Eliminating airflow distortion, whether caused by obstructing hardware, unequal entering velocities, or other conditions, can essentially negate the possibility of damaging vortices.

• Blow-through air handler:

The highly distorted velocity profile of air discharged from the fan of a blow-through air handler imposes significant constraints on the position of the fan relative to the cooling coil.

The distance between the fan and coil must be adequate to eliminate flow distortion and reduce the air velocity sufficiently to avoid condensate entrainment and carryover. As indicated in Figure 2, the required distance between a centrifugal fan and the coil may be 2 to 5 equivalent duct diameters.

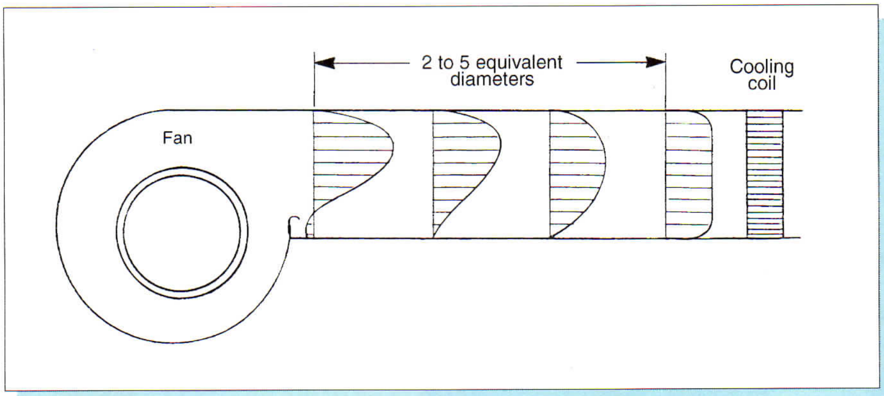

FIGURE 2: Velocity profiles at fan discharge and at cooling coil entry (blow-through unit).

Shorter diffuser duct lengths introduce undesired duct losses and unfavorable velocity profiles, and cause condensate carryover. Baffles used to reduce flow distortion often introduce unacceptable pressure losses and low fan system efficiencies.

• Economic factors:

A fan positioned in an air handler so that it entrains condensate and propels it into the hvac system creates a costly situation for the building owner-user.

The cost of service calls, maintenance, shortened equipment life, and property damage can be excessive; so can health problems that result from contamination caused by condensate entrained and deposited on internal surfaces of the system.

The extra cost of ensuring that an air handler is free of fan-induced condensate problems is due primarily to loss in fan system efficiency, and the designer's use of precautionary design features.

Fan efficiency, for example, may be compromised by adding baffles to reduce flow distortion, particularly in the fan-discharge airstream.

Also, flow distortion caused by complex interactions of the airstream with internal components cannot be precisely defined.

Thus, the designer may add space and distance, with walls, floor, and ceiling, that may not be needed, in order to ensure that high-velocity air and condensate entrainment are avoided.

Whatever this cost is, however, it is minimal compared to the costs incurred when condensate is entrained by the airstream and deposited on the internal components.

SUMMARY

Here is a suggestion for specifications:

The fan shall be positioned in the air handler so that local air velocities and induced vortices do not entrain condensate and propel it onto components in the hvac system.

Next month: *In the final installment (and the last link of the condensate-removal system), the authors discuss condensate drain lines, which can be a source of serious condensate problems.* **ES**

References

[1] Fans and Systems, AMCA publication 201-90; Air Movement and Control Association, Arlington Heights, IL; 1990; p. 47.

[2] *Industrial Ventilation,* A Manual of Recommended Edition; American Conference of Governmental Industrial Hygienists, USA; 1995; pp. 3-6.

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