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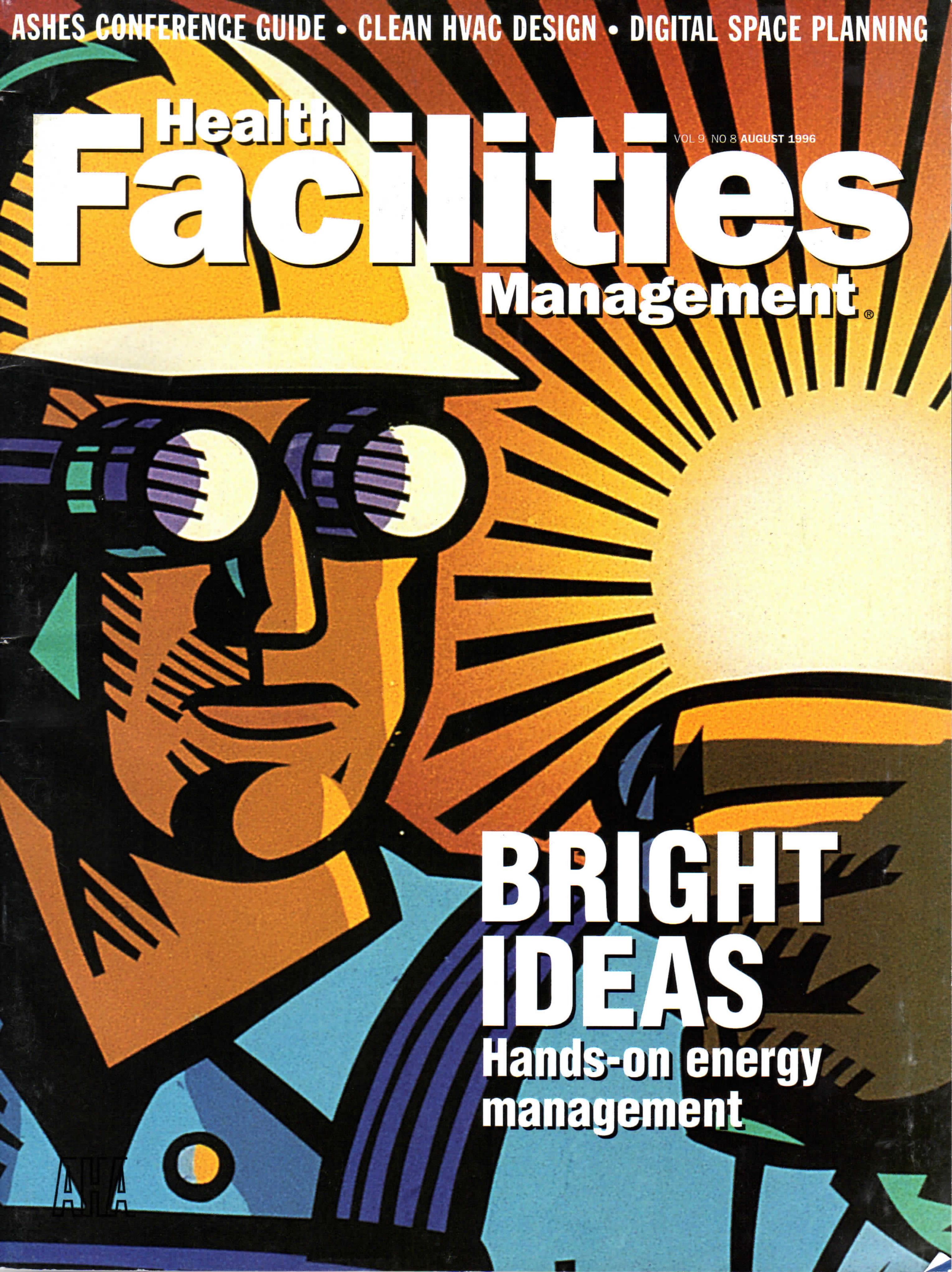

BRIGHT IDEAS

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Designing Clean Air

If your **HVAC** system is acting up, it may need a redesign

by C. Curtis Trent and Warren C. Trent

Every year hospitals spend millions of dollars unnecessarily on excessive maintenance and replacement of heating, ventilating and air conditioning systems. These costs come from service calls, damaged equipment and property, as well as human health and absentee problems.

While many in the HVAC industry and government agencies blame these costs on poor HVAC system maintenance, they actually result from system design deficiencies. In fact, some systems are designed so poorly that they are virtually impossible to maintain, regardless of the budget available and the number of maintenance personnel assigned. Many thousands of such systems are now in operation in hospitals—and the numbers are growing.

Besides these excessive costs, a faulty HVAC system can cause severe indoor air-quality deficiencies. Inhalation of microbial contaminants that have entered and bred within an HVAC system can cause allergic reactions that result in inflammation of the nose, the airways and alveolar spaces.

In the May 1990 issue of *Safety and Health* magazine, author K. M. Magon ventured to estimate that nearly 50 percent of the North American workforce suffers from headaches, sore throats or breathing problems, all brought on by polluted indoor air.

A sad state of affairs

During the past two cooling seasons, we examined scores of air conditioning units throughout the Southeastern United States (many in hospitals and nursing homes). We found that most of the units were wet inside. We also found various types of algae growing in the drip pans and unit floors, and buildup of mold, mildew and other fungi on the inside walls and ductwork. We commonly found stagnant water standing in the rusting and deteriorating floors of many units and evidence of frequent overflows.

We were able to trace these conditions to one or more of 11 design deficiencies in the system:

- Excessive airflow
- Deficient airflow
- Inadequate provisions for ventilating the air
- Noninsulated coolant or refrigerant lines in the airflow path
- Improper blower (fan) location

- Inadequate filters and filter holders
- Highly slanted cooling coils
- Unsuitable drip pan drain ports
- Long, undulating and poorly routed condensate drain lines
- Unduly large condensate drip pans
- Inadequate seals on condensate drain lines

The latter was the most flagrant and detrimental of the deficiencies observed, and the industry practice of depending on a condensate trap to provide a drain line seal is the reason for it. Because the trap is so unreliable, most of the draw-through systems that we observed were operating without a seal or with a dysfunctional seal on the condensate drain line.

The condensate drain seal

A primary function of an air conditioner is to remove moisture from the air. During the cooling process, condensate collects on the cooling coil and drips into the catch pan located below. From there, it is, ideally, drained away from the unit to a suitable disposal place.

Unfortunately, draining condensate from a draw-through air conditioner (a common type used in hospitals) is no easy task, particularly if the unit is operating without an adequate seal on the drain pipe (a common condition). Under this scenario, the system can draw in air through the drain pipe at velocities of about 30 miles per hour. The airflow can draw in outside contaminated air and gases, and it can become strong enough to blow condensate into the system and ductwork. This is an ideal condition for the reproduction and growth of harmful microorganisms, which can be spread directly into patient rooms and offices.

This airflow can produce an aerosol mist (the only known mechanism for spreading Legionnaires' disease bacteria). It can also impede the flow of condensate and cause the unit to overflow, causing extensive damage to the air conditioning unit and, again, creating conditions that are conducive to breeding harmful microorganisms. Air filters will not eliminate the growth of bacteria and fungi generated within the HVAC system, and they are located in the wrong place to prevent internally grown microorganisms from being blown into patient rooms and offices.

Conventional water-type P-traps are recognized failures as seals for condensate drain pipes because, more often than not, they are improperly designed, become blocked periodically and cause overflow. Often removed by service personnel, they require extensive maintenance, and if located outside, they tend to freeze and break in cold weather. The solution is to remove the condensate properly and prevent it from blowing into the system and ductwork.

Criteria for proper HVAC design

The heating and air conditioning industry is aware of the maintenance, property damage and pollution problems caused by draw-through HVAC systems. But since there is little demand that the industry take steps to correct the situation, facility managers must take the initiative to ensure that their HVAC systems meet the following provisions:

1. The velocity of the airflow through the cooling coil is not high enough to blow condensate from the cooling coil into the unit and duct system.
2. The velocity of the airflow through the cooling coil is not so low that moisture will form on the supply grills in hospital rooms.
3. Internal coolant lines in the airflow path are insulated to the extent that moisture will not form on them and be blown into the system and ductwork or drip onto the floor of the unit.
4. The blower (fan) is positioned properly within the unit, so that the airflow does not create vortices, or "little hurricanes," that feed water into the system.
5. Adequate provisions are made for ventilating air and for controlling relative humidity, under all operating conditions.
6. Filter holders are snug and don't let air be drawn in around the filter sides.
7. Filters have a dust-spot efficiency of at least 25 percent to prevent dust from adversely affecting the cooling coil.
8. Drain ports are flush with the lowest point in the bottom of the drip pan. The pan is slanted toward the drain port or the unit is tilted toward the drain exit.
9. The drip pan is no larger than neces-

Know the standard mechanical code

304.8 Evaporators and Cooling Coils

304.8.1 General. Condensate drain systems shall be provided for equipment containing evaporators or cooling coils. Condensate drain systems shall be designed, constructed and installed in accordance with this section.

304.8.2 Seal. The condensate drain system shall provide a seal that prevents ingestion of air or other gas, through the condensate drip pan drain and overflow connections, from all outside sources, including the condensate disposal place, during all operating conditions. . . .

sary, providing minimal space for water to stand. Standing water is a growth haven for algae and other organisms.

10. The base for the unit is high enough to allow a slope on the drain line of at least one-eighth inch per linear foot.

11. The condensate drain lines are properly supported and secured, so that no dips are formed to trap water and debris, and have a slope of at least one-eighth inch per linear foot.

12. There is a good seal on the primary drip pan drain lines and secondary drain lines of draw-through units that will:

- Prevent polluted air from being drawn into the system through the condensate drain pipe, during both heating and cooling operations
- Prevent condensate in the drip pan from blowing into the unit and ductwork
- Prevent an aerosol mist
- Eliminate condensate overflow caused by drain blockage and negative pressure inside the system
- Prevent condensate from standing more than one-forth inch in the drip pan
- Not be affected by evaporation
- Prevent damage caused by freezing temperatures
- Have no moving parts
- Be self-cleaning and self-regulating

The conventional condensate P-trap doesn't meet these provisions, but other technologies exist to meet all these provisions as well as the requirements of the 1994 standard mechanical code.

Important provisions of ASHRAE standard 62-89

1. Specific outside air ventilation rates
2. No standing water in condensate pans (self-drainage)
3. Provisions for in-place cleaning of cooling coil and condensate pan
4. Easy accessibility for inspection of fan and cooling coil
5. Relative humidity in air ducts and air plenums: less than 70 percent
6. Make-up air inlets and exhaust air outlets away from polluting sources

The right system

An HVAC system that has been designed with the above provisions will meet the following operating criteria. It will:

- Remain dry inside (except the cooling coil and a small drip pan) during all operating conditions
- Prevent outside air and contaminated gases from being drawn into the system through the condensate drain line, under all operating conditions
- Be capable of controlling temperature and relative humidity of the occupied space within the human comfort zone (established by the ASHRAE *1993 Handbook-Fundamentals*, page 8.13, figure 5) under all operating conditions
- Maintain a positive pressure, within buildings, of between 2 and 10 pascals during normal operating conditions (hot and humid)
- Meet or exceed the requirements identified in ASHRAE standard 62-89 (see box above)
- Comply with building mechanical (see page 43) and plumbing codes

Adhering to these criteria is neither difficult nor expensive. It requires only that designers use current technology and engineering practices. If managers demand that system designers adhere to these criteria, they will not only avoid the exorbitant costs of excessive maintenance, property damage, early equipment replacement, and absenteeism, but they will find themselves less vulnerable if there is ever litigation. ■

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