Testing And Balancing: Energy Versus Performance

Arbitrary energy conservation tactics have caused numerous environmental problems in all types of buildings. HVAC testing and adjusting can help solve them

By **FRED C. SCHULZ, P.E.**
President
EnerVation Inc.
Milwaukee

Testing and balancing or, preferably, testing and adjusting, is integral to an effective HVAC system. However, this procedure did not receive due respect until the 1980s when building owners realized it had a positive impact on mechanical operating costs and helped provide an environment satisfactory to most building occupants.

During this period, workmanship was improving, reports were more thoroughly written, and more and better instrumentation was introduced. Certified agencies, such as the National Environmental Balancing Bureau (NEBB), experienced unprecedented growth, and the majority of consultant's specifications demanded *qualified* system adjustments to guarantee satisfactory operation.

Qualified system adjustment, coupled with the vast improvement and increased capabilities of the building automation industry, is a major contributor to keeping this country's thirst for energy within reason. However, demand will continue to increase through the '90s as long as a barrel of OPEC crude remains cheaper than an American barrel and our elected representatives ignore the coming energy crisis—as witnessed by lack of an energy policy.

Impending cost increases

Historically, when world demand absorbs more than 80% of OPEC's production capacity, prices begin to escalate. In addition, relatively small supply interruptions create price explosions. If demand continues to grow as it has since the 1986 price collapse, and if OPEC chooses not to increase production, the 80% mark could be reached somewhere between 1993 and 1995.

The sick building syndrome is primarily a product of overly aggressive energy conservation practices

The result will be another phase of concentrated energy conservation similar to that of the '70s. The "Energy Security White Paper" issued by the American Petroleum Institute, states, "Alarmist rhetoric about the immediate energy future is both inappropriate and counterproductive. But there is a vast difference between falsely 'crying wolf' on the one hand, and ignoring energy trends which are potentially damaging to the country's well being, on the other."

Energy cost escalation (see Figure 1) virtually assures the success and growth of the testing and adjusting industry. Demand for certified technicians to commission mechanical systems will increase in direct proportion to energy cost increases.

Indoor air quality

The '90s also will bring a heightened awareness of indoor air quality and its effect on employee productivity. The "sick building syndrome" is primarily a product of overly aggressive energy conservation practices implemented by owners and their maintenance personnel, principally for saving money. Window and door frames were recaulked, weatherstripping was replaced, vestibules were added to entries, insulation was added everywhere possible and so on. Closing outside air dampers on mechanical systems made the maintenance man an instant hero. Fortunately, state-of-the-art dampers still let in 10% outside air when fully closed.

As a result, today's buildings are suffocating. An improper outside air/exhaust ratio cannot curb the amount of contaminants within the space.

Certainly, increasing outside air intake uses more energy and costs more money, especially in the Snow Belt; but compared to what? Is it more expensive than a 20%

drop in productivity, an increase in employee absenteeism, increased costs of medical treatment or the insidious damage to building structural components?

The American Society of Heating, Refrigerating and Air-Conditioning Engineers' (ASHRAE) Standard 62-1989, "Ventilation for Acceptable Indoor Air Quality," calls for specific minimums for achieving acceptable conditions. In all probability it will be adopted by most state code bodies.

The ASHRAE standard, in itself, will not improve air quality. It does not devote one paragraph to the importance of qualified system adjustments to achieve intended goals. The leadership of NEBB and other agencies should work toward this end. What good are laws without enforcement agencies?

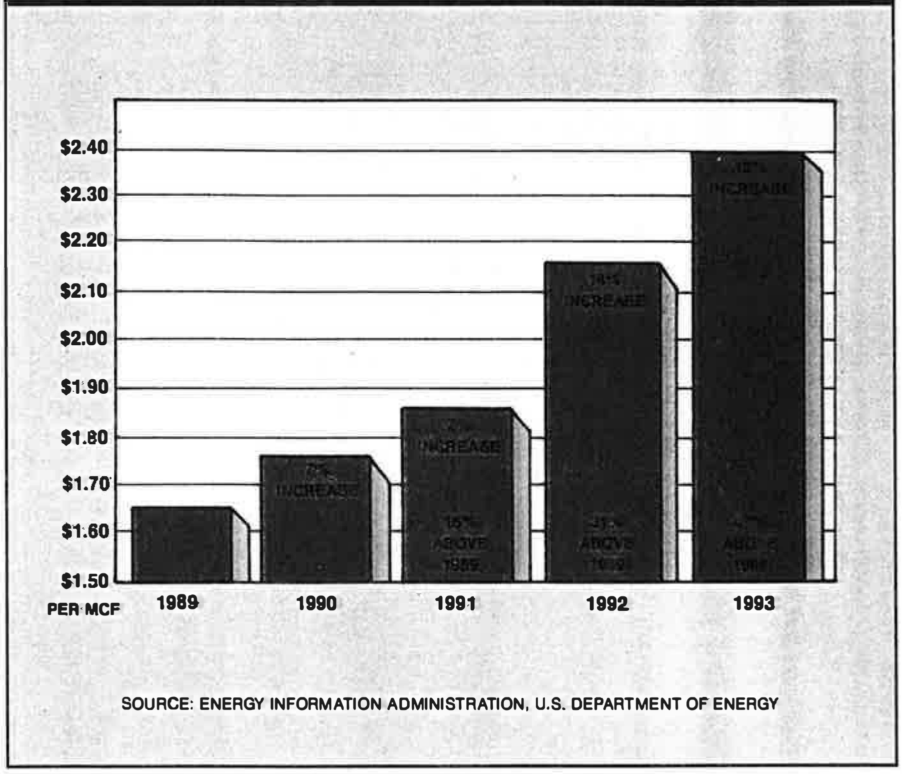
The standard basically recommends an increase in the level of outside air per occupant. Qualified adjustment of the outside air damper minimum position at winter and summer design limits is of critical importance to indoor air quality *and* the owner's pocketbook.

As seen in Figures 2, 3 and 4, slight variations in outside air quantity can have a major impact on utility costs. In a high-occupancy facility, increased outside air quantities could exceed the capacity of primary heating coils in a central air handler and require adding a booster or reheat coils. Conversely, in summer, additional cooling may be required to offset increased outside air quantities. A sampling of ASHRAE recommendations indicates large increases in outside air quantities per occupant:

Area	Cubic feet per minute (cfm) per occupant
Office	20
Conference	20
Cocktail lounges	30
Smoking lounges	60
Beauty parlor	25
Gymnasium	20
Auditoriums	15
Classrooms	15
Operating rooms	30
Patient rooms	25

Most codes presently call for five to 7.5 cfm per occupant. Considering cfm guidelines, it would be to the owner's advantage to make sure these requirements are met, but not exceeded.

FIGURE 1
WELLHEAD PRICE FORECAST (IN 1988 DOLLARS)



Energy costs are expected to increase steadily into the 1990s. Careful system design and attention to testing and adjusting are ways to keep these costs in check.

Radon mitigation

Increasing concern about radon (a colorless, odorless gas produced by decaying radioactive elements in soil) in high-occupancy buildings, such as schools, will create further demand on the testing and adjusting industry in the '90s. If a building is operating under negative pressure, radon enters through all available foundation cracks and openings.

Radon is considered a lung cancer risk. School administrators are especially concerned about it because children have smaller lung volumes and higher breathing rates than adults. Experience indicates large differences in radon levels in classrooms on the same floor, primarily because soil conditions vary and radon entry routes are numerous.

The situation is extremely difficult and expensive to correct. Subslab depressurization—a technique using tubes or ducts inserted through the floor slab and connected to an exhaust fan, creating a negative pressure beneath the slab—is highly unpredictable. Sealing cracks and openings has proven ineffective; sealed routes reopen when buildings settle or expand.

An effective approach to radon mitigation is to properly adjust a building's air distribution and exhaust systems to maintain a continuous positive pressure. Instruments confirm system-operating air

Energy cost escalation virtually assures the success and growth of the testing and adjusting industry

volumes and building static pressures under all conditions of varying outside-air, return-air and exhaust-air dampers.

Buildings with elevated radon levels may run mechanical systems 24 hours a day, every day. Weekend or night shutdown would neutralize building pressure and allow radon levels to increase. Qualified testing and adjusting, along with radon monitoring, plays a crucial role in keeping a building environmentally safe.

Building pressurization

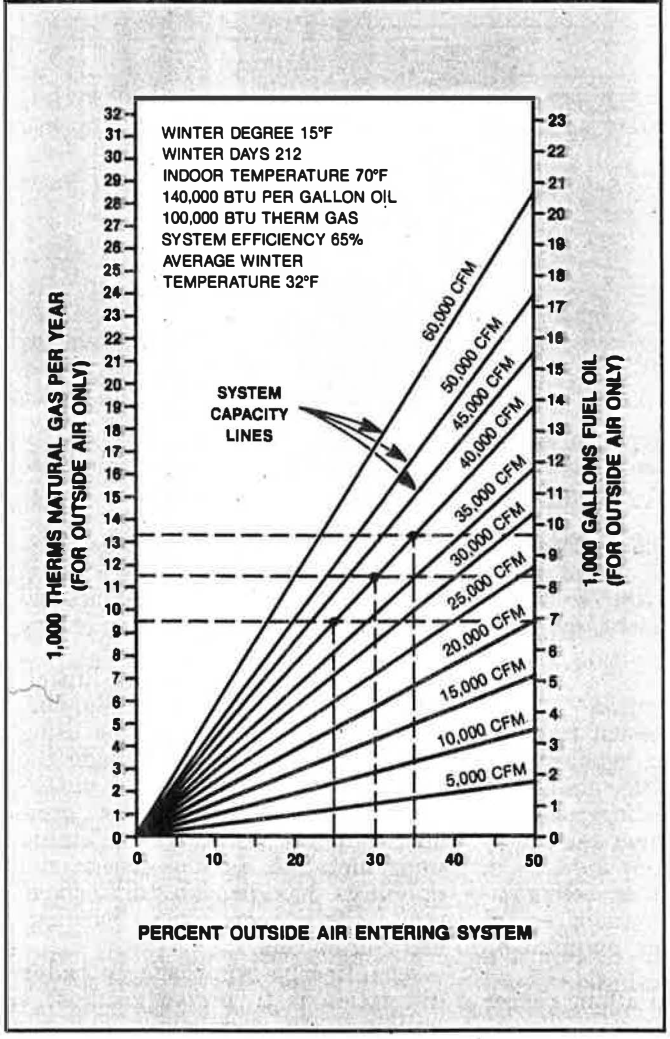
Aside from contributing to radon mitigation, building pressurization provides additional benefits by 1) increasing gas- or oil-fired equipment efficiency, and 2) increasing building structural component life.

Whether a building is under positive or negative pressure is purely a function of the relationship between the amount of outside air brought in and the quantity of air exhausted. If intake exceeds exhaust, the building is under positive pressure. If exhaust exceeds intake, the building is under negative pressure.

Unfortunately, in this era, most buildings are operating under negative pressure conditions. The reason is simple; it costs money to hold a positive condition. It is especially costly to open the outside air damper in the Snow Belt.

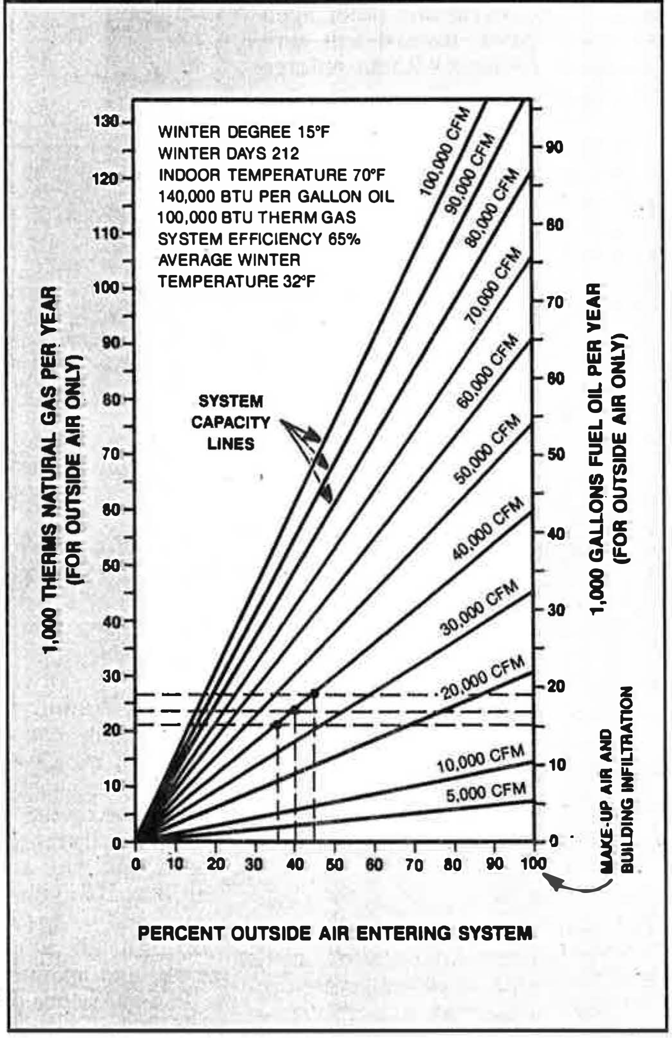
It's easy for the maintenance man to reduce the owner's energy bill; he manually closes the outside air dampers, reducing intake. However, unless the amount of building ex-

FIGURE 2
SCHOOLS, OFFICE, INDUSTRIAL
(50 HOURS PER WEEK)



Increased outside air quantities applied to a facility with high occupancy could exceed the capacity of primary heating coils.

FIGURE 3
INDUSTRIAL
(80 HOURS PER WEEK)



A slight variation in outside air quantity can have a major impact on utility costs.

An improper outside air/exhaust ratio cannot curb the amount of contaminants within a space

FIGURE 4
INSTITUTIONAL AND INDUSTRIAL
(24 HOUR PER DAY)

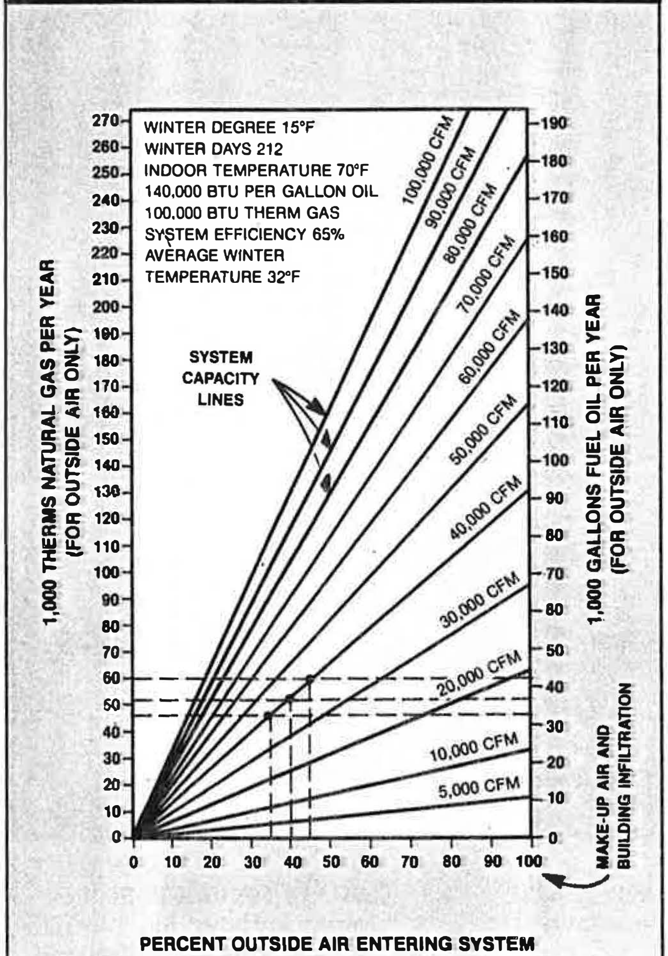
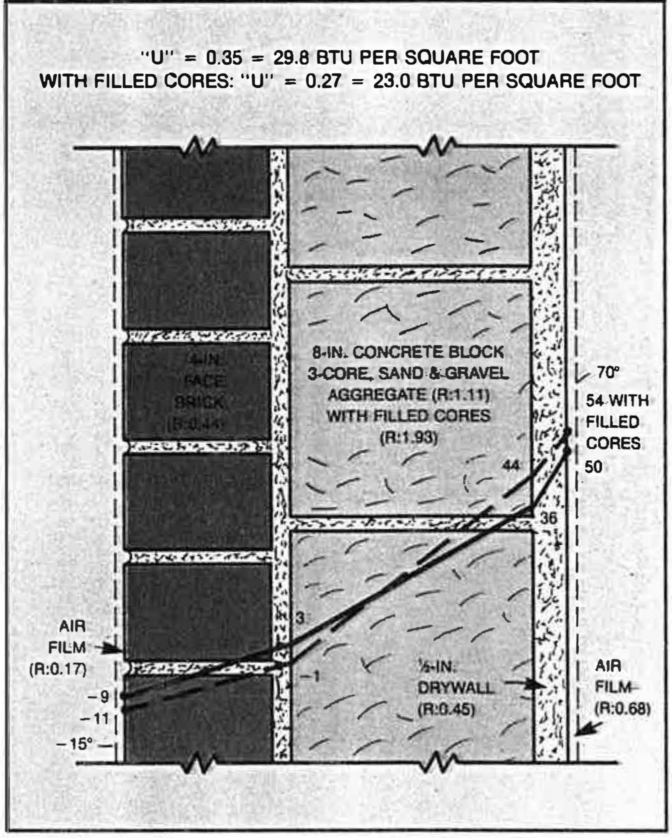


FIGURE 5
WALL CONSTRUCTION



Internal construction temperatures can be predicted under static conditions (no infiltration or exfiltration). Surface temperatures are actually dewpoint temperatures and represent the point at which condensation begins.

In summer, additional cooling may be required to offset increased outside air quantities.

haust also is reduced equally, savings are minimal. The maintenance man actually has increased the negative pressure and merely "relocated" the outside air intake to every door and window. The simple fact is, for every cubic foot of air exhausted, a cubic foot of outside air enters the building.

With today's use of weatherstripping, caulking and sealing, chimneys and vents have become the new outside air intakes in negatively pressurized buildings. Consider the effect on burner combustion efficiency when the chimney has a strong downdraft. Consider the effect on domestic water heaters and standing pilot lights when a strong downdraft exists. And, consider the effect on indoor air quality when stack downdraft forces combustion products into the occupied space instead of allowing fumes to be vented.

As mentioned previously, one cfm of exhaust is equal to one cfm of outside air intake. If outside air dampers on the air handling apparatus are closed tightly, and the building switches to a negative-pressure mode, outside air enters at every available leakage point. It is a proven fact that a masonry wall permits infiltration, minutely but surely.

Pure logic, therefore, says that the temperature of each component within a wall, roof, window frame, etc. is reduced considerably in a negative-pressure building because of infiltration. In a positively pressurized building, exfiltration has a warming effect on all structural components.

The potential for developing condensation within walls and roofs is considerably higher in a negative-pressure building than a positive-pressure building. With interior vapor pressure forcing its way through a wall or roof (there is no such thing as a 100% effective vapor barrier) and

Slight variations in outside air quantity can have a major impact on utility costs

TABLE
SURFACE CONDENSATION TEMPERATURES (DEGREES FAHRENHEIT)

Room temperature	RELATIVE HUMIDITY 10%	20%	30%	40%	50%	60%	70%
70°	15°	28°	37°	44°	51°	56°	60°
71°	15°	28°	38°	45°	52°	57°	61°
72°	16°	29°	38°	46°	52°	58°	62°
73°	17°	30°	40°	47°	53°	58°	63°
74°	17°	30°	41°	48°	55°	59°	64°
75°	18°	31°	42°	49°	55°	60°	64°
76°	18°	32°	43°	50°	56°	61°	65°
77°	19°	33°	43°	51°	57°	62°	66°
78°	19°	34°	44°	52°	58°	63°	67°
79°	20°	35°	45°	53°	58°	64°	68°
80°	20°	35°	46°	54°	59°	65°	69°

structural components being subcooled by infiltration, moisture development is a common occurrence.

Unfortunately, it is an internal problem and is not immediately noticeable to building occupants until spalling, chipping and cracking is visible on finished surfaces. At this point, it is too late, and expensive repairs are required.

As seen in Figure 5, internal construction temperatures can be predicted under static conditions; that is, no infiltration or exfiltration. These surface temperatures actually are dewpoint temperatures and represent the point at which condensation begins.

In Figure 5, the surface temperature on the backside of the ½-inch drywall is 36°F, when the outdoor temperature is −15°F and the room is at 70°F. Referring to the Table, every room temperature and humidity combination with a surface condensation temperature above 36°F produces moisture within the construction.

It is important to maintain a slightly positive building pressurize under all occupancy conditions. Only qualified testing and adjusting personnel can properly adjust the air intake and exhaust ratio and accurately measure the degree of pressurization.

In the '90s, testing and adjusting will assume its role as the most critical phase of mechanical system commissioning. Qualified, certified firms throughout the country will be called on to fine-tune a variety of complex systems and to resolve an ever-increasing number of environmental problems. □

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