Congratulations on doing a great job covering the pertinent issues.

Kevin Kelly
Jay-K Independent Lumber Corp.
New Hartford, New York

Editor's Reply

Your point about the relationship between poor indoor air quality, allergies, and asthma is an interesting one. Those who advocate the use of unvented gas appliances like to point out that there have been few, if any, documented deaths since the industry began to equip such appliances with oxygen depletion sensors.

But there's a lot of room for illness and human misery short of death. People who are poisoned by low levels of carbon monoxide and nitrogen dioxide often attribute their symptoms to a cold, flu, or a general decline in health. It's only when they get sick enough to go to the doctor or check into a hospital that the real cause of their illness *might* be diagnosed. We say "might" because doctors sometimes don't think to test the carboxyl hemoglobin level in the patient's blood, which is only way that carbon monoxide poisoning can be medically confirmed.

Recent research establishing a link between low-level exposure to household sources of carbon monoxide and brain damage makes this game of brinkmanship even scarier (see *EDU*, November 1997).

You are correct in stating that unvented gas appliances are outlawed in Canada. When we checked in with W.M. "Tex" McLeod, head of the Canadian Hearth Products Association, he told *EDU* that Canadians are "deeply puzzled" by the ongoing legalization and sale of unvented gas appliances in the US. Perhaps he was putting it kindly.

Don Best

Another Low-Cost Ventilation Strategy to Consider

Dear Editors,

I was interested in the article and letters you published regarding the Habitat for Humanity house's lack of mechanical ventilation. [*EDU*, May, July, September, November 1997.] We all agree it's needed, but at what cost? I know that Habitat homes are on a budget and that an air-to-air heat exchanger would be the solution. However, our company has a simple, low-cost solution for indoor air pollution.

We call it Timed Make-Up Air Control (TMAC) or Timed Ventilation Control (TVC). It is a simple timer control that operates a motorized damper that controls outdoor air entering the central HVAC system. Using the timer, which can be set up to as often as 15-minute intervals, the TMAC (low voltage) or TVC (line voltage) opens the damper and turns on the blower in the HVAC unit, if it's not already on. This draws in outside air through the open damper providing some means of bringing in a small amount of fresh air. Usually, a 6-inch round duct and damper is used. The TMAC and TVC can also bring on the bathroom and/or other exhaust fans in the home to move fresh air through the home.

The installed cost of a TMAC or TVC and motorized round damper can be under $300, well less than the cost of many air-to-air heat exchangers.

Richard Foster, Jr.
President, Trol-A-Temp
Elmwood Park, New Jersey

Editor's Reply,

Thanks for refreshing our memory on the TMAC and TVC. The ventilation strategy you describe is simple and dependable, which are good characteristics to have in *any* kind of housing. While there would be an energy penalty involved in bringing unconditioned air into the HVAC system, it's a lesser evil than subjecting the occupants to contaminated indoor air year after year. The advent of energy-efficient, variable-speed blowers that can quietly circulate fresh air at low flow rates makes this strategy a lot more appealing than it used to be.

Don Best

RESEARCH AND IDEAS

New IBACOS House Tests Vent-Free Attic in Cold Climate

A newly completed house in Pittsburgh, Pennsylvania, combines a number of innovative framing, insulation, and HVAC designs that will be heavily monitored over the year ahead. Included among these innovations is a vent-free attic, a design that's previously been limited to hot climates.

The four-story, 3,200-square-foot house, located on Washington's Landing Island in the Allegheny River, was built by Montgomery & Rust, of Allison Park, Pennsylvania, and designed by Innovative Business and Construction Solutions (IBACOS), one of four R&D consortia working under the

Figure 1 — The IBACOS test house, located at the Village at Washington's Landing, was built by Montgomery & Rust in cooperation with Rubinoff Company, the developer, and the Urban Redevelopment Authority of Pittsburgh.

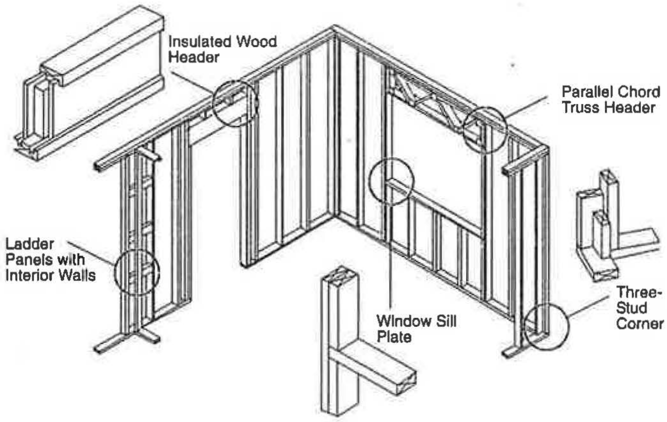

Figure 2 — IBACOS details that save lumber, labor, and energy. 1. Ladder panels, used to attach interior partition walls, are built with 2x4s nailed vertically rather than horizontally, creating a 2-inch deep cavity for insulation. 2. Insulated wood header beefs up a thermal weak spot in the envelope. 3. Parallel-chord truss headers used over extra-wide windows and sliders have a greater load capacity than 2x10s or 2x12s and provide cavities for insulation. 4. Three-stud corner leaves room for insulation and saves lumber. 5. Window framing detail eliminates the "cripple" stud and leaves room for more insulation under the window.

Department of Energy's Building America Program (see Figure 1).

By using panelized 2x4 walls, stack framing, and other material- and labor-saving techniques (see Figure 2), IBACOS designers were able to reduce the framing factor (total materials and labor) by 20%. Stack framing aligns the floor trusses and studs so that loads are transferred directly from the roof to the foundation, eliminating the need for double top plates. Using single 2x4 plates on each floor saved lumber and left room in the wall for an extra 1½ inches of insulation.

IBACOS used savings achieved in the framing to pay for upgraded Pella ProLine windows with argon-filled, multi-layer, low-E coated glass.

The builders fitted the grade beam foundation with perimeter and under-slab edge insulation. Brownfield soil conditions prevented the use of the insulated pre-cast concrete foundation system that IBACOS has favored in the past (see *EDU*, August 1997).

In a departure from conventional practice, IBACOS decided to hire two insulation contractors for the job. The first sprayed Icynene foam insulation into the band joist area, roof framing, and pipe and wire chases. The second contractor insulated the walls with R-5.2 blue-board sheathing and R-13 fiberglass batts, yielding a nominal R-19 and an actual R-15.2. He also added six inches of fiberglass batt to the roof, which, combined with the Icynene, produced R-30.

"By using rubber gaskets on the framing joints, carefully taping the foam insulation, and sealing the band joist and roof with Icynene, this turned out to be the tightest of the eight houses that IBACOS has designed to date," says Glenn Cottrell, IBACOS' s director of information technology. Cottrell tells *EDU* that a blower door test run after the Icynene was installed, but before the fiberglass and drywall went in, showed only 0.13 ACH. The final blower door test, run after the walls were closed in and the plumbing vents, bathroom fan vents, dryer vent, and rangehood vent were installed, came in at 0.18 ACH.

The optimized thermal shell enabled designers to downsize the furnace and central air conditioner, which will save the homeowners an estimated 40% on their heating and cooling bills.

A Vent-Free Attic in Chilly Pittsburgh?

By placing the Icynene and fiberglass up flush against the roof decking, the designers converted the fourth floor attic into a livable loft and eliminated all soffit, ridge, and gable vents, and their associated costs. The ductwork, concealed inside the loft's knee walls, is entirely within the conditioned space, saving an estimated 20% on heating and cooling through avoided duct losses.

As reported earlier (see *EDU*, November and December 1997), vent-free attics have recently gained a toe-hold in hot weather climates like Las Vegas and

Houston, but not in cold climates, for fear of ice dam problems.

"Our purpose in using the Icynene and fiberglass in the roof was to eliminate the passage of heat and moisture to the underside of the roof decking, so that ice dams won't form," says Cottrell. "Nonetheless, we're going to observe the roof through a number of freeze-thaw cycles this winter to see how it performs, and have placed moisture and temperature sensors under the roof paper, on the inside of the sheathing, and at various depths through the Icynene and fiberglass so that we can monitor what's happening." Cottrell says that the house will not be put on the market until late spring, at the earliest, and that the National Renewable Energy Laboratory will continue to collect data and analyze the house for a full year.

Five Ventilation Strategies to Be Assessed

The house at Washington's Landing is also serving as a laboratory to test five tight-house ventilation strategies, which will be switched in and out over the coming months as the seasons change.

1. Negative pressurization — By continuously running the central exhaust fan that serves the bathrooms, the house is kept under slightly negative pressure, drawing fresh air in through cracks in the envelope (1A) or a dedicated supply duct (1B).
2. Carrier heat recovery ventilator.
3. Positive pressurization — Fresh air is mechanically drawn into the house to keep it slightly pressurized, pushing stale air out through the walls (3A) or through a dedicated exhaust port ducted to the bathrooms (3B). Designers John Holton, of Burt Hill Kosar Rittelman Associates, and Al Sain, of IBACOS, recognize that pressurization is not a viable ventilation strategy for a cold climate like Pittsburgh, because it would drive warm moist air into the walls and cause condensation problems. But the method will be tested over the short run to evaluate it for use in other climates.

A ventilation system using negative pressurization and a dedicated fresh air supply duct offers strong advantages in this particular house, since fresh air can be distributed through the zoned duct system using the variable-speed air handler. "One of the things we learned from earlier IBACOS projects was the tremendous efficiency of these variable-speed motors on air handling equipment," says John Holton. "They are very efficient at moving ventilation air around the house at low cfms."

Taking It to the Market

The IBACOS designers had hoped to incorporate all of the above-mentioned changes, plus those listed in the "Other Features" box, without adding any cost to the house. "We were much more market-focused

Other Features of the IBACOS House

- Open-web floor trusses provide pathways for ducts, plumbing, and wiring, "disentangling" the structural shell of the house from the infill of interior and service systems (see *EDU*, August 1997).
- Pella ProLine windows: argon-filled, multi-layer, low-E coated insulating glass (U-value: 0.35; shading coefficient: 0.48).
- Locating mechanical room in prime, third-floor location reduces duct lengths by 40%.
- Carrier WeatherMaker Infinity Furnace 58MVP (97 AFUE; variable speed).
- Carrier 38TXA air conditioner (SEER 13; chlorine-free refrigerant R-410A).
- 5-zone Carrier Comfort Zone II zoning system with humidity control (see *EDU*, June 1997).
- Carrier Comfort Ventilator heat recovery ventilator (84% efficient).
- Centerline duct system with short branch lines; diffusers located along the center of the house, throwing to the outer walls (see *EDU*, August 1997).
- Owens Corning EnDuraCoat fiberglass ducts (see sidebar).
- Radiant hydronic in-floor heating used in garage and entryway; hot water supplied by a 0.62 EF water heater.
- Majestic direct-vent fireplace.
- Owens Corning QuietZone acoustic batts used in office and furnace room walls.

Antimicrobial Ductwork

The forced-air heating and cooling system in the IBACOS house features a relatively new type of fiberglass duct system — called EnDuraCoat — that's coated on the inside with an antimicrobial acrylic coating to resist the growth of fungi and bacteria. According to Owens Corning, the Toledo, Ohio-based firm that manufactures the duct board, the biocide used in the coating is approved for such use by the US Environmental Protection Agency.

The company points out that the acrylic coating also makes EnDuraCoat easier to clean, should that ever become necessary.

Apart from the duct's antimicrobial properties, IBACOS designers liked the fact that fiberglass ducts in general produce a lot less noise than (unlined) metal ducts, which have a reputation for vibrating and whistling. According to Mala Nanda, Owens Corning's business manager for air handling products, 1½-inch-thick fiberglass duct eliminates 85% of the noise that you'd get from metal duct.

Ironically, IBACOS designers weren't much interested in the intrinsic insulating properties of fiberglass duct (R-4.3 for 1-inch board; R-6.5 for 1½-inch board) since all of the ductwork at Washington's Landing is enclosed in the conditioned space.

Glenn Cottrell, IBACOS' s director of information technology, says that the duct installation work went considerably slower than usual because the HVAC crew had never worked with fiberglass duct before. "Once they got some on-site training, the connecting and sealing work went pretty well," he says. "And the Duct Blaster test we ran afterwards showed that there was virtually no leakage in the ducts." (A final test did reveal sizable "boot" leaks where the ducts connected to air diffusers. These were sealed with mastic.)

Owen's Corning's Nanda tells *EDU* that once HVAC contractors become familiar with fiberglass duct, installation is considerably faster and less expensive than using metal ducts. She also claims that fiberglass ductwork is inherently tighter than metal ductwork because the closure system for fiberglass is an integral part of the installation, not something that's done as a secondary or remedial measure afterwards (e.g., applying mastic). While EnDuraCoat costs more than ordinary fiberglass duct, it would still cost less than sheet metal, she says.

Though fiberglass duct has been around for 30 years without causing any documented health problems, some contractors avoid it because they or their clients believe the board provides nutrients for microorganisms or that fiberglass particles are swept off the surface into the air stream.

But new studies done at the Harvard School of Occupational Health and Duke University conclude that the fiberglass and binder used to make duct board contain no nutrient value for microorganisms and that mold, mildew, and bacteria will grow equally well on metal and fiberglass when sufficient moisture and nutrients (dirt) are available. (When Harvard formally releases its study in a few weeks, *EDU* will take a closer look at the research.)

With regard to fiberglass erosion off the surface, Owen Corning's John Hulse tells *EDU* that the company tests its ductboard to 6,000 cubic feet per minute (cfm), with no evidence of erosion of fiberglass particles. A typical residential forced-air system might run at 900 cfm, he notes.

For more information, contact Mala Nanda, Owens Corning World Headquarters, One Owens Corning Parkway, Toledo, OH 43659; (419) 248-7817, Fax: (419) 248-7461, E-mail: mala.nanda@owenscorning.com, Web site: www.owenscorning.com.

Figure 3 — On-site training helped familiarize the HVAC crew with Owens Corning's EnDuraCoat fiberglass duct board.

on this project than in some of our earlier projects," says Cottrell. "We wanted to demonstrate that you can achieve 40% savings on energy consumption without dramatically increasing your cost."

Though the final cost of the house was about $400,000 — about $20,000 more than it would have cost to build without the IBACOS innovations — Cottrell tells ***EDU*** that the overrun was due to "learning curve" costs that wouldn't be incurred in subsequent projects. More specifically, the HVAC contractor, who was used to installing metal ductwork, had to be trained to install fiberglass duct board (see sidebar and Figure 3) and had to come up to speed on the Carrier Comfort Zone II zoning system (see ***EDU***, June 1997). Some additional cost overrun was attributed to the fact that the Icynene contractor lived more than two hours away from the work site.

The IBACOS consortium is composed of nine corporate members, including Burt Hill Kosar Rittelman Associates, Carrier Corp., GE Appliances, GE Capital Mortgage, GE Plastics, Molex, Owens Corning, Pella Corp., and US Gypsum.

For more information, contact: Glenn Cottrell, IBACOS, 2214 Liberty Avenue, Pittsburgh, PA 15222-4502; (412) 765-3664, Fax: (412) 765-3738, E-mail: cottrell@ibacos.com.

UNLV Study Highlights the Benefits of Radiant Barriers

Various research studies have put the annual energy savings for radiant barriers (RBs) in hot climates at between 5% and 15%, with the exact amount somewhat dependent on the amount of attic insulation in the house. (The better insulated the attic, the lower the savings.) In hot weather, approximately 75% of heat transferring into a residential structure does so by radiation. In the past, it was commonly believed that most of this radiation entered the living space through the attic ceiling, and therefore that the primary job of a radiant barrier was to keep heat away from the ceiling.

But while ceiling heat gain is a real problem, evidence has been growing that a major benefit of radiant barriers is keeping heat away from cooling ducts that run through the attic. A short-term comparison of two homes in Austin, Texas, showed that radiant barrier sheathing — roof sheathing with a radiant barrier laminated to its bottom surface — could reduce cooling energy consumption as much as 14% during the summer, with most of the savings coming from reduced duct heat gain (see ***EDU***, July 1996).

Now two researchers at the University of Nevada, Las Vegas, have developed a computer simulation to gauge savings from radiant barriers over any specified period of time. Simulating a typical house for a representative five-day summer period, Professors Samir Moujaes and Richard Brickman conclude that an RB could reduce cooling requirements 9% to 30%.

Compared to other studies, this estimate is a bit on the high side. One reason for this, says Moujaes, is the simple fact that radiative heat is a larger component of the air conditioning (AC) load in Las Vegas than in other parts of the country (the low humidity in Las Vegas results in a low latent heat load). But another probable reason is that past research tended to slight the savings from blocking radiative heat transfer to HVAC ducts in the attic.

The simulation used specially written code run on computers at the National Supercomputing Center for Energy and the Environment, located on the UNLV campus. The researchers simulated a typical 30-foot by 60-foot Las Vegas tract home: 2x4 stick-framed with R-11 walls, R-30 ceilings, and a 4/12 roof slope. The house was oriented so that its long sides faced east and west. According to Moujaes, such a home can have a peak afternoon grand sensible cooling load of 40,000 btu/hour. (Grand sensible load takes air leakage from ducts and other envelope components into account.) If the home has more than the average amount of window area or has minor construction flaws (not enough insulation, a leaky building shell), cooling loads can be higher.

The simulations, which were run for 12-hour and 5-day time periods, confirmed that a significant amount of the load reduction (energy savings) comes

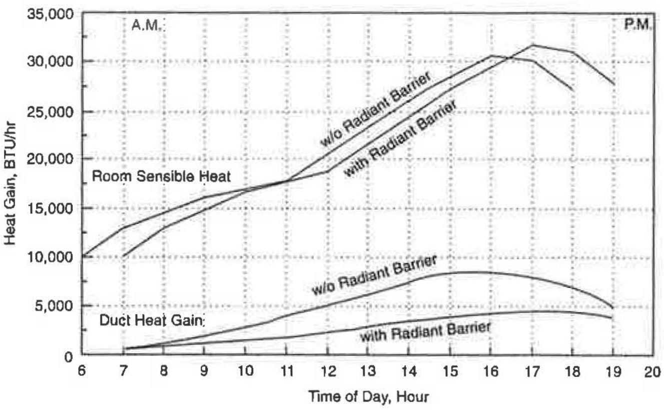

Figure 1 — Room sensible and HVAC duct heat gains with and without radiant barrier sheathing.