How Tight Is Too Tight?

We've figured out how to build tight houses. Now how do we make them livable?

by William Rose

"How Tight is Too Tight?" was the title of a paper delivered at the BTECC conference held in Fort Worth, Texas, in December. At past conferences, the problem was how to make buildings airtight. Now that the experts have mastered that, conference attendees were asking—what do we do now? The bear went over the mountain, the bear went over the mountain...

Most researchers of building performance network through BTECC (the Building Thermal Energy Coordinating Council). These researchers write standards, product literature, and codes, They initiate energy-conservation programs and evaluate the results. They monitor existing buildings, they consult, and they troubleshoot; they build better mousetraps.

The fruits of research generally filter slowly into building practice. Perhaps that's all right: research needs to be reviewed, and results can be interpreted carelessly.

But Canadian research finds its way more quickly into practice than in the U.S., which looks plodding in comparison. In fact, Canadians, who were heavily represented at the conference, wrote the book on tight construction *(Air-Vapour Barriers,* by the Saskatchewan Research Council, 1983). According to one speaker, Canadians know how to install the barrier even if they can't spell it correctly.

Some of the new airtightness questions run like this:

• How tight is *too* tight? Most of the conference attendees accepted the ASHRAE Standard 62-81 as a baseline for minimum ventilation in residences: 10 cfm of fresh air for each room, and a provision for 50 cfm in bathrooms and 100 cfm in kitchens. A paper by Gray Robertson showed that allergenic fungi and bacteria inhabit the ductwork in some 50 percent of commercial buildings—including hospitals—that meet minimum ventilation requirements. More ventilation would help, he concluded, but keeping ducts and filters clean counts for more.

• What about radon? Radon is the new joker in the deck. In tight houses, we can usually count on the ventilation rate to largely control the levels of humidity, carbon monoxide, and formaldehyde. But radon concentrations depend much more on the source strength and on the driving forces than on air exchange, so high concentrations cannot be readily ventilated away.

• Combustion products? The back-drafting of combustion appliances is a *big* problem in tight houses. Without make-up air, flue gases have a hard time shimmying up the flue.

• Do occupants cooperate? Occupants turn mischievous. The temptation to turn off mechanical ventilation to save energy or reduce noise is often too great for them. Steve Wegman, who directs a housing program in South Dakota that incorporates airtightness and mechanical ventilation, has seen all the tricks. Even after the mechanical ventilation is hot-wired to the circuit breaker that runs the house refrigerator, occupants have learned that they can set the dial halfway between high and low ventilation, and skip the contact points.

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• Is "adequate" ventilation adequate? Discussion focused on ventilation efficiency: how well the fresh air is distributed to where it is needed around the house. A method that works well is the "sweep," where air is exhausted from baths and kitchens, and make-up air is provided at inlets in all the rooms. When the inlets are installed near the ceiling, the occupants don't feel local cold spots.

• Who gets airtight houses? We heard mainly from government-agency programs. John Archer, of Canada's R-2000 Home Program, said that the houses in the program are yuppie homes. He wasn't apologizing. As he pointed out, Chevrolet got its technology from BMW.

• Should airtightness standards be *performance* or *prescriptive* standards? With the R-2000 program's *performance* standard, a builder can build and seal any way he or she pleases. But before the drywall goes up, a blower-door test is done, and the house must have a leakage area of no greater than 0.7 sq cm/sq m. That's performance. A prescriptive standard says: Put this right here, just like this, and put that there. But there's no guarantee that a house that meets prescriptive standards will really work.

• Does polyethylene last? Al Houston, of the Canadian Mortgage and Housing Corporation, showed some disturbing results. Eight out of 22 poly samples failed within five years. He recommended stronger standards for the manufacture of polyethylene as a vapor barrier. Six-mil poly definitely lasts longer than 4 mil, and buyers should beware of recycled material and demand "virgin" ingredients.

The modelers have been hard at work. Modeling involves predicting building performance using large equations—often by computer. Modelers are always tweaking the *big* equation to get "real world" results. This year, George Tsongas, from Portland, Ore., showed that making tight homes a little tighter can cause dramatic increases in indoor relative humidity. Another researcher, Jack Vershoor, looked at the effects of moisture storage and showed that office furnishings in a single office can gain 13.4 pounds as relative humidity goes from 40 to 90 percent.

There were some helpful and practical results, too:

Sticky stuff: Acoustical sealant isn't the only polyethylene sealant. Tremco has a line of gun-applied adhesives that are cheaper, perform as well, and don't make nearly the mess of acoustical sealant (black death).

Commercial envelopes: Curtain-wall construction, when the inside skin must be detailed as airtight, is an uphill battle. How do you finish drywall when an 18-inch-deep spandrel beam is just inside the envelope? And, for that matter, how do you fireproof the spandrel beam? Robert Kudder, from Chicago, pointed out this common problem which, he said, is one of impossible design and poor coordination of trades.

Flat roofs: A framed flat roof with a cavity over the insulation is troublesome from the word go. A "compact" roof system, where the insulation is above the deck and sandwiched between the deck and the membrane, is better. Old frame roofs can be safely retrofitted with a compact system above the frame. Just remember to close the vents.

Air cavities: Don't believe the ASHRAE Fundamentals insulation value for a still-air space. Ronald Raab, of Manville Corporation, showed that a still-air space is a dream, and that convective loops in any space will negate its insulating effects. Along these lines, a speaker from Dow showed that rigid foams in masonry cavity walls must be fastened directly to the inner wall, or thermal performance will nose-dive due to convection around the foam.

Crawl spaces: Maybe you've heard about ceiling-truss rise? Now there's floor-truss drop. Steve Wegman reported that some open-web flat trusses used over crawl spaces have been sagging in the center of the span. The floor-truss cavities are insulated and enclosed on the bottom with Tyvek. The downward arch in the trusses is blamed on the top chord of the truss being warmer and drier than the bottom chord, causing differential shrinkage.

Also regarding crawl spaces, Princeton's David Harrje demonstrated that crawl spaces *must* have ground covers to keep moisture out of the house. Harrje's research showed that with ground covers installed, crawl spaces can be insulated and left unvented. The moisture content in framing members actually goes *down.* Although the vents can be left closed and insulated, you should still install them for the occasional leak or flood.

Every few years, a report is given on *dynamic insulation.* It's a lovely idea. You start with a typical leaky vapor barrier on the inside. Fill the cavity with loose batts and sheathe the outside with an air-permeable fiberglass panel, covered with Tyvek. Keep the building's interior under negative pressure (with an exhaust fan) in the winter, and positive pressure in summer. The air that is constantly drawn inward through the entire wall surface in the winter carries the heat that would normally be lost through the wall so that—get this—the heat loss through the wall is almost *zero.*

J. Timusk, from Vancouver, monitored a house like this and showed with thermographs that the exterior surface temperature went way down, indicating reduced heat loss. Not bad, but who changes the filter—the Tyvek? Who gets mad when somebody opens the window? And why don't we hear about all the heat that left the building in the exhaust air?

There was much talk of the future. Donna Fitzpatrick, of the DOE, said that *something* is bound to shake up the energy picture in the next ten years—a nuclear accident, a major recession, or stiff acid-rain legislation. Perhaps the gas glut will end, or overcapacity will become under-capacity with the decommissioning of production plants. Or maybe we'll find that low-level electric fields are unsafe, so transmission lines will have to be mothballed. These scenarios are all possible, and when you add them up, "something" becomes probable.

Nothing at the conference showed what construction will be like 20 years from now. We're all watching to see where the conservation/air-quality pendulum comes to rest. ■

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