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Energy Design Update®

The Monthly Newsletter on Energy-Efficient Housing, from Aspen Publishers

Vol. 25, No. 7 July 2005

INDUSTRY NEWS

Every Failure Holds A Lesson

Less than two years after it was insulated with Icynene, a home in Vermont developed moisture problems so severe that the walls and ceilings had to be opened up in order to dispose of the saturated insulation. The case illustrates the importance of including a vapor retarder in cold-climate Icynene-insulated homes.

In the fall of 2002, homeowners Elizabeth and Matt Moffitt of Warren, Vermont, contracted with a licensed Icynene dealer, Nicholas Krywaka of Environmental Foam of Vermont, to insulate their small prefabricated home. The distributor who supplied the Moffitt house describes the uninsulated model purchased by the Moffitts as a "camping cabin" made by "Pennsylvania Amish craftsmen." Depending upon whom one talks to, the small house is described as "about 12 by 18 feet" or "maybe as large as 14 by 24 feet."

Figure 1. Icynene insulation is an open-cell foam that allows water vapor to pass through it by diffusion. At the Moffitt house, the walls were so wet that water could be squeezed out of the sponge-like Icynene.

The tiny house, framed with 2x4 walls and 2x6 rafters, includes a bedroom, bathroom, and kitchen. After the stud bays and rafter bays were insulated with Icynene (an open-cell foam), tongue-and-groove boards were installed as the finish material on the walls and cathedral ceilings. No vapor retarder was included; according to the homeowners, Krywaka told them that a house insulated with Icynene does not require a vapor retarder.

Saturated Insulation

After the house developed moisture problems, the homeowners contacted a lawyer, John Franco of Burlington, Vermont. "There were problems with mold along the baseboards," says Franco. A building consultant, Henri deMarne of Waitsfield, Vermont, was called in to inspect the home. "The wall was opened up, and the whole thing was soaking wet," says deMarne. "I took a handful of insulation, and squeezed it, and water dripped out of it like a sponge. When the roof was opened up from the outside, the roof insulation was wet as

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Figure 2. The cathedral ceiling of the Moffitt house became so saturated with moisture that the plywood roof sheathing showed signs of delamination and warping.

Figure 3. The stud bays of the Moffitt house were opened up from the exterior in order to remove the wet Icynene insulation. Many of the studs were black with mold.

well" (see Figures 1 and 2). DeMarne concluded that interior moisture was migrating through the insulation by diffusion and condensing on the cold sheathing.

Because of the home's extensive interior finish work, deMarne advised the homeowners to open up the stud bays and rafter bays from the exterior (see Figure 3). According to Franco, it cost the homeowners $25,000 to remove the siding, Thermo-Ply wall sheathing, asphalt shingles, plywood roof sheathing, and Icynene from the building. After the Icynene was deposited in a dumpster, the building was reinsulated with closed-cell polyurethane foam. Acting on the homeowners' behalf, Franco sued Icynene and Environmental Foam of Vermont. The case has not yet been resolved.

Was the Thermo-Ply At Fault?

Gabe Farkas, Icynene's vice president of engineering, told ***EDU***, "I wouldn't call it an Icynene failure. It is the system that failed." Farkas blamed the moisture accumulation on the Thermo-Ply sheathing, which has a vapor permeance of 0.53 to 0.63 perms. "What we have here is a building envelope failure where the vapor barrier is on the cold side," said Farkas.

When it was pointed out to Farkas that the permeance of Thermo-Ply is very close to that of OSB or plywood, and that moisture had accumulated not only in the walls of the Moffitt home, but also in the ceiling, Farkas modified his analysis. "I wouldn't be surprised at moisture condensation on the roof as well as the walls," said Farkas. "It is very climate-dependant. In

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Energy Design Update (ISSN 0741-3629) is published monthly by Aspen Publishers, A WoltersKluwer Company, 111 Eighth Avenue, New York, NY 10011. (212) 771-0600. One-year subscription costs $385. *To subscribe, call 1-800-638-8437. For customer service, call 1-800-234-1660. POSTMASTER: Send address changes to* ***Energy Design Update,*** *Aspen Publishers, 7201 McKinney Circle, Frederick, MD 21704.* *All rights reserved. Duplication in any form without permission, including photocopying and electronic reproduction, is prohibited. Printed in the U.S.A.*

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this case, there should have been a vapor retarder — no question about it." In fact, Icynene recommends that a vapor retarder be installed whenever its foam insulation is installed in a climate with 7,500 or more heating degree days (see ***EDU***, April 2005). That recommendation was not followed at the Moffitt house, which is located in a 9,000-heating-degree-day climate.

Many Icynene dealers, even those located in very cold climates, have been telling their customers for years that vapor retarders are unnecessary in Icynene-insulated homes. "The reality is that in many instances, if you can control air leakage, you can alleviate the need for a vapor barrier," explains Farkas. "But you can get into a gray area. Sometimes people choose to err on the side of — well, I might say, of disaster." Farkas is confident that Icynene's installation guidelines are adequate. "We have our recommendations which are very clear," says Farkas. "The problem is that these are independent installers, and we don't have full control over things. All we can do is advise."

Too Close To The Cliff

Several factors appear to have contributed to moisture problems at the Moffitt house:

- No vapor retarder was installed on the interior side of the Icynene insulation.
- The indoor relative humidity was reportedly much higher than normal, in part because there were as many as three people living in the very small one-bedroom house.
- The installation of Icynene reduced air infiltration to very low levels, compounding the indoor humidity problem.
- The only mechanical ventilation system consisted of a bathroom exhaust fan controlled by the occupants.

In the vocabulary of Terry Brennan, a building science consultant from Westmoreland, New York, the Moffitt house was built "close to the cliff." Brennan often says, "I try to tell people that we need to take steps away from the cliff, not toward the cliff."

If indoor humidity levels at the Moffitt house were, indeed, elevated, the homeowners might have prevented wall and ceiling problems by keeping their bathroom exhaust fan running continuously. If high indoor humidity contributed to the problems, it might be argued that the homeowners' failure to manage their indoor humidity put them at fault. At a 2004 conference, consultant Joseph Lstiburek noted, "If you buy an automobile and choose to drive it at 100 miles per hour with bald tires, it's not the automobile manufacturer's responsibility if you get poor performance. I don't want to design my buildings to deal with your stupidity. Builders should say, 'These are the limitations of use for this product.'" Following Lstiburek's logic, homes may eventually come with warning stickers listing operating parameters and limitations of use.

Others, however, argue that builders and insulation contractors should adopt specifications that ensure that the houses they work on are "further from the cliff." If the integrity of a building's walls and roof depend upon proper operation of a ventilation system, then the house is hanging by a fairly thin thread. No builder is likely to sleep well at night knowing that the flip of a toggle switch can undermine the solidity of his clients' homes.

Launching National Residential Green Standards

The United States Green Building Council (USGBC) is now ready to launch a pilot version of its proposed nationwide program for the certification of green homes (see ***EDU***, March 2003). The program is an outgrowth of the USGBC's successful Leadership in Energy and Environmental Design (LEED) program for commercial and institutional buildings.

There is currently no nationally accepted definition of a green home. Although there are at least 40 residential green building programs nationwide, each has a different set of specifications. The USGBC envisions its residential program, dubbed LEED for Homes, as a way to develop a national consensus defining residential green construction.

Minimum Requirements

The LEED for Homes draft standard includes certain minimum requirements for a home to be eligible for any level of certification. At a minimum, a green home would require:

- An Energy Star Homes label (HERS 86);
- Energy Star windows;
- Ventilation meeting ASHRAE Standard 62.2;
- A maximum air leakage rate of 0.35 air changes per hour;
- A comprehensive envelope durability plan;
- Third-party inspection and verification.

The program envisions four levels of participation.

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The lowest level would be called "certified green." Builders interested in achieving higher standards could aim for a silver, gold, or platinum label. Each of these participation levels would require a minimum, but still undetermined, point score. The draft specifications now being circulated include a long list of measures that would qualify for points; a builder could pick and choose among the measures to achieve any desired score. The number of points associated with each measure is still being worked out. Among the measures on the list:

- The home is part of a compact development (that is, is on a small lot or is a multifamily unit);
- The size of the house is below average;
- A pre-drywall insulation inspection had been conducted;
- All ducts are located within conditioned space;
- Duct sealing is above average;
- Wall insulation is at least R-5 above code;
- Hot water pipe system includes a central manifold;
- Heat-pump water heater;
- Instantaneous water heater;
- Solar hot water system;
- An HRV or ERV;
- A photovoltaic system;
- A timer or humidistat controlling the bathroom exhaust fan;
- Toilets using under 1.28 gallon per flush;
- Showerheads using less than 2 gpm;
- No carpeting in the house;
- An Energy Star refrigerator, dishwasher, or clothes washer;
- Air leakage rate of 0.25 ACH or lower;
- A HERS score of 87 or higher;
- An Energy Star with Indoor Air Package label (see ***EDU***, January 2005).

Launching A Pilot

As this issue of ***EDU*** went to press, the draft specifications were being reviewed by builders. "Initially, we want to see if the draft passes the 'laugh test' — to be sure there are no show-stoppers," said Jay Hall, director of research at Building Knowledge, Inc., one of the consultants helping to develop the proposed standard. If all goes according to schedule, builders in a dozen cities will participate in a pilot LEED for Homes program beginning this year. To avoid conflicts with existing green building programs, many of which are sponsored by local Home Builders Associations, the USGBC will launch its pilot in areas of the country where local green building programs do not yet exist.

The USGBC hopes that the pilot will enroll 50 to 100 homes. According to Hall, "The goal of the pilot is to demonstrate that the spec is viable." Hall's supervisor, Jim Hackler at USGBC, notes, "The pilot is really a way to do market testing of the rating system." After digesting lessons learned during the pilot, the USGBC intends to put the green specifications out for public review and comment.

Green Providers and Green Raters

The LEED for Homes proposal would require each home enrolled in the program to receive a third-party inspection from a "green rater." However, a nationwide network of green raters does not yet exist. Working with the Residential Energy Services Network (RESNET), the USGBC has invited Home Energy Rating System (HERS) raters to consider offering green rating services under the umbrella of companies called "LEED for Homes Program Providers."

Since every LEED home would require a HERS rating, a green rating would, in effect, be an enhanced HERS rating. The cost of such a rating would necessarily exceed that of a basic HERS rating. Hall predicts, "The green rating will probably cost under $1,000." According to a "Frequently Asked Questions" document from USGBC, "It is expected that the initial [green] verification tasks will cost from $500 to $2,000 per home." The cost of green verification, though paid by the builder, will of course be passed on the home buyer.

For more information, contact Jim Hackler, United States Green Building Council, 1015 18th Street NW, Suite 805, Washington, DC 20036. Tel: (202) 587-7182; E-mail: jhackler@usgbc.org.

NEWS BRIEFS

A Hydrogen-Fueled Home

SCOTTSDALE, AZ — Arizona engineer Bryan Beaulieu is putting the finishing touches on a new $2 million energy-efficient home at the foot of Troon Mountain in Scottsdale. The unusual 6,000-square-foot home includes several appliances fueled by hydrogen, including the kitchen stove and the fireplace. Beaulieu also uses hydrogen for heating water and generating electricity at night. The hydrogen is produced on-site by a photovoltaic-powered electrolyzer and is stored

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under pressure in carbon-fiber tanks. The home's concrete roof is covered with two feet of soil. The innovative house includes many energy-saving features, including LED lighting and a hydronic cooling system circulating well water. It also includes many green features, including passive solar orientation and a gray-water irrigation system. "In a way, this house is a big exhibit," Beaulieu told a reporter from the *Arizona Republic*. "It's Disneyland and NASA."

Massachusetts Approves Unvented Gas Fireplaces

BOSTON, MA — Massachusetts authorities have approved the use of unvented gas fireplaces in any home equipped with a carbon monoxide detector, as long as the installer obtains two permits: one from the local fire department and one from the local gas inspector. The new regulation, 527 CMR 30.00, has been published in the Regulations of the Massachusetts Board of Fire Prevention. According to the regulation, an unvented gas appliance cannot be used as a building's primary heat source, and cannot be installed under any circumstances in a bedroom or bathroom.

New PV Incentives in Washington State

OLYMPIA, WA — Washington governor Christine Gregoire has signed into law a bill, SB 5101, which establishes a framework for electric utilities to purchase power produced by residential photovoltaic (PV) and wind systems at the favorable rate of 15 cents per kWh, up to a maximum of $2,000 per customer per year. Utilities agreeing to participate in the voluntary program will be eligible for a state tax write-off for expenses equal to the cost of providing the so-called "feed-in credit" to customers. The generous credit would increase to as much as 54 cents per kWh, guaranteed for ten years, to customers using PV components manufactured in Washington state.

Swedish Houses Without Heating Systems Need A Little Heat

LINDÅS, SWEDEN — Swedish researcher Svein Ruud has reported energy-use data collected at housing units built without heating systems in Lindås, Sweden (see ***EDU***, February 2002). Ruud monitored electricity consumption and interior air temperatures at all of the development's 20 rowhouse units. In six of the units he also separately monitored the electrical consumption of the domestic water heaters and heat-recovery ventilators. According to Ruud's data, the mean indoor air temperature in most of the units was at least as high as would be expected in houses with traditional heating systems. However, some of the units had indoor temperature fluctuations that ranged beyond typical levels. The total energy use for the houses, though much lower than that of typical Swedish houses, was still higher than projected, in part because of the need to provide some supplemental heat (provided by electric resistance heaters in the heat-recovery ventilators) during cold winter weather. Total mean electrical energy use per apartment was 8,200 kWh per year, including 1,800 kWh per year for space heating, 700 kWh per year for ventilation, and 1,700 kWh per year for domestic hot water. For more information, contact Svein Ruud, Swedish National Testing and Research Institute, P.O. Box 857, SE-501 15 Borås, Sweden; E-mail: svein.ruud@sp.se.

Senate Bill Promotes Appliance Efficiency

WASHINGTON, DC — Three US Senators — Gordon Smith (R-Oregon), Blanche Lincoln (D-Arkansas), and Charles Grassley (R-Iowa) — have introduced legislation to offer federal tax credits for the purchase of energy-efficient appliances. Senate bill S. 1022, the Resource Efficient Appliance Incentives Act of 2005, would provide tax credits of $50 to $175 for the purchase of energy-efficient clothes washers, refrigerators, or dishwashers. Kateri Callahan, president of the Alliance to Save Energy, noted, "We applaud Senators Smith, Lincoln, and Grassley for this important bill, which will help the most efficient appliances become the most widely-used appliances. Energy efficiency is the quickest, cheapest, and cleanest way to address our critical energy needs, and it should be a cornerstone of our energy policy."

Petaluma Considers Making Residential PV Mandatory

PETALUMA, CA — According to an article in the *Argus Courier*, Petaluma city councilmember Pamela Torliatt has proposed a regulation to require new residential subdivisions in Petaluma to include photovoltaic (PV) systems. The proposal comes on the heels of earlier decisions by the city council to require the developers of three recently permitted subdivisions — Traditions, Washington Creek Village, and Baker Ranch — to include PV systems on 10% of all houses built. The council decided to study the issue further before voting on the proposed regulation.

US Electricity Prices Range From 4.70 to 14.84 cents per kWh

PARK RIDGE, NJ — US electricity prices range from a low of 4.70 to a high of 14.84 cents per kWh, according to a new report by independent consulting company NUS Consulting. Between April 2004 and April 2005, the national average price of electricity rose 5.2%, from 7.56 to 7.95 cents per kWh. The five utilities with the

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highest electricity prices are Consolidated Edison of New York (14.84 cents), Niagara Mohawk of New York (11.97 cents), Southern California Edison (11.45 cents), Pacific Gas and Electric of California (11.31 cents), and Public Service Electric of New Jersey (9.90 cents). The five utilities with the lowest electricity prices are Ohio Power (4.70 cents), Dominion Power of Virginia (5.18 cents), Duke Power of North Carolina (5.28 cents), Alabama Power (5.37 cents), and Ameren UE of Missouri (5.46 cents). For more information, visit *www.nusconsulting.com*.

Quantum Dot Technology May Improve PV Efficiency

GOLDEN, CO — Researchers at the National Renewable Energy Laboratory (NREL) have announced that a new type of photovoltaic cell — one based on nanocrystals, or "quantum dots" — may one day convert sunlight into electricity at an efficiency level of 65%. Currently, the most efficient PV cells are 33% efficient. The NREL researchers, including Arthur Nozik, Randy Ellingson, Matt Beard, Justin Johnson, Pingrong Yu, and Olga Micic, worked with two theorists, Alexander Efros and Andrew Ahavaev of the Naval Research Laboratory in Washington, DC. According to Nozik, "We have shown that solar cells based on quantum dots theoretically could convert more than 65% of the sun's energy into electricity, approximately doubling the efficiency of solar cells." The researchers' work was reported in a paper published in the May issue of *Nano Letters*, a publication of the American Chemical Society.

Raising Thermostat Settings in Japanese Offices

TOKYO, JAPAN — In an effort to achieve Kyoto Protocol targets for the reduction of greenhouse gas emissions, the Japanese government has launched a campaign to raise thermostat settings to 28ºC (82ºF) in all government and private offices during the air conditioning season. To make such temperatures bearable, Japanese men have been urged to show up for work without jackets or ties, beginning June 1st. A *New York Times* article quotes environment minister Yurilo Koike's announcement: "This summer I will not allow anybody with tie or jacket into my office." The campaign is meeting resistance from some Japanese office workers, for whom jackets and ties represent a necessary part of the uniform identifying their social position. According to the *New York Times*, "Bureaucrats mortified by informality can wear pins blaming their casual look on the national drive to meet Kyoto targets: '28 degrees / We are in the summer casual dress campaign to achieve minus 6 percent.'"

US Mayors Commit to Kyoto Targets

SEATTLE, WA — Seattle Mayor Greg Nickels has launched a nationwide campaign to urge US mayors to comply with the Kyoto Protocol, in spite of the Bush administration's rejection of the treaty. So far, 132 mayors, including Mayor Bloomberg of New York City, have made the pledge to reduce their cities' greenhouse gas emissions by 2012 to levels 7% below those of 1990. To comply with the Kyoto goal, the Salt Lake City government has signed contracts to purchase wind power, while New York City is purchasing hybrid gas-electric vehicles to replace aging vehicles in the city's fleet. According to an article in the *New York Times*, "Mr. Nickels said he decided to act when the Kyoto Protocol took effect in February without the support of the United States, the world's largest producer of heat-trapping gases. On that day, he announced he would try to carry out the agreement himself, at least as far as Seattle was concerned, and called on other mayors to join him. … The mayor of low-lying New Orleans, C. Ray Nagin, a Democrat, said he joined the coalition because a projected rise in sea levels 'threatens the very existence of New Orleans.'"

Ancillary Benefits of PV May Be Worth Up To 22¢/kWh

SACRAMENTO, CA — The ancillary benefits of photovoltaic (PV) electric production may be worth up to 22.4 cents per kWh, according to an analysis submitted to the California Public Utilities Commission by Americans for Solar Power, a lobbying group launched by PV manufacturers. The report quantified the benefits as follows: avoided fuel costs for peak-load electricity generation, 3.24 to 9.71 cents per kWh; avoided generation capacity capital costs, 2.73 to 4.0 cents per kWh; avoided distribution costs, 0.19 to 2.95 cents per kWh; and the value of avoided CO_2 emissions, 0.33 to 1.77 cents per kWh. The report also quantified the value of avoided generation capacity maintenance costs, avoided fossil fuel price hedges, and avoided water use. In testimony presented to the commission, economist Lori Smith Schell noted, "The benefits of distributed generation — solar power made locally and used locally — go far beyond the savings on your summer electricity bill."

New Zealand Introduces World's First Carbon Tax

WELLINGTON, NEW ZEALAND — In an effort to reduce the country's greenhouse gas emissions, New Zealand has instituted the world's first carbon tax. The government estimates that the new carbon tax will cost the average New Zealand household about NZ$4

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(US$2.82) per week and will raise a total of NZ$360 million (US$253 million) annually. Pete Hodgson, Convenor of the Ministerial Group on Climate Change, announced, "Tackling climate change is a major global challenge. The New Zealand government is proud to be part of the gathering global effort that is taking the first step." Methane and nitrous oxide emissions produced on farms are specifically excluded from the carbon tax, despite the fact that livestock flatulence is responsible for about half of New Zealand's greenhouse gas emissions.

California House Gets Enormous PV System

RANCHO SANTA FE, CA — A new custom home under construction in southern California includes a $280,000 photovoltaic (PV) system. The massive 35-kilowatt grid-connected PV system is being installed by WorldWater & Power Corp. According to Larry Slominski, a regional manager for WorldWater & Power, the system is expected to offset 100% of the home's electrical use. "The customer has a strong sense of the efficient use of resources, and solar makes more sense to him than using fossil fuels," says Slominski. Since the PV array is too large to be roof-mounted, the modules will be integrated into the landscaping of a south-facing hill.

Quote Without Comment

"I was amazed once to find rather dry conditions inside a house that had a crawlspace which I was assured remained continually flooded. I opened the crawlspace hatch, saw my reflection, measured the wood moisture content, smelled the crawlspace air, and everything indicated drier conditions than should have been. I looked at my reflection once again and saw the faint color effects of an oil film on the water. That explained very well the quite dry conditions above the water. (First aid for a flooded crawlspace until it can be pumped dry: a quart of mineral oil poured on the surface.)" [*Water in Buildings* by William Rose; John Wiley & Sons, Hoboken, New Jersey, 2005.]

RESEARCH AND IDEAS

Convection Currents In Fiberglass Batts

A Belgian study of the thermal performance of cathedral ceilings has demonstrated that convection currents degrade the effectiveness of fiberglass batt insulation by 9%, even in relatively airtight unventilated roof assemblies. The research revealed that, of all the factors determining the thermal performance of cathedral ceilings, the most important are the effects of air leakage, ventilation, and convection currents.

The research was reported in a paper, "The Impact of Airflow on the Hygrothermal Behavior of Highly Insulated Pitched Roof Systems," authored by Geert Houvenaghel, Arturo Horta, and Hugo Hens. Houvenaghel presented the paper at the Building Envelopes 9 conference in Clearwater Beach, Florida, in December 2004.

Four Different Roof Assemblies

The Belgian researchers monitored the performance of four different roof assemblies in a test building for two years (see Figure 4). During the study's first winter, the average outdoor temperature was 39°F; during the second winter, it was 44°F.

The test building's gable roof has a 12-in-12 pitch. The researchers constructed four different cathedral roof test assemblies, with each assembly having slopes on both sides of the gable roof. The four roof assemblies — with one slope measuring about 6 feet wide and 17 feet long on the northeast roof, and a slope of the same dimensions on the southwest roof — had some common features:

- Roofing consisted of concrete tiles installed over skip sheathing.
- Roofing underlayment was installed between the ship sheathing and the rafters.

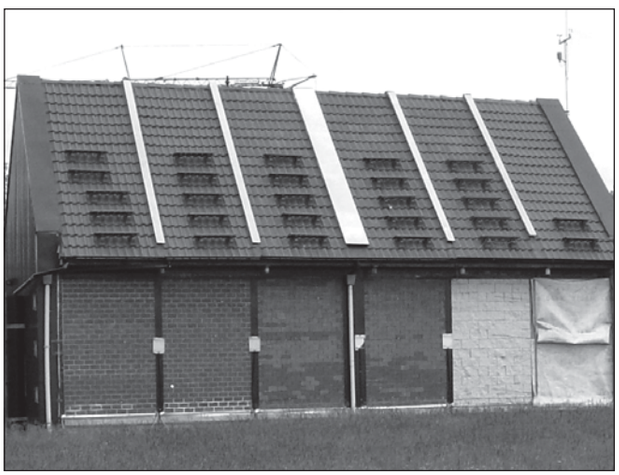

Figure 4. The performance of four different cathedral roof assemblies was monitored for two years at this test building in Belgium.

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- The roof assemblies had identical insulation consisting of 5.9-inch-thick Owens Corning fiberglass batts. (Although the title of the researchers' paper refers to "highly insulated" roof systems, the monitored assemblies were not highly insulated by US standards. The R-value of all four roof assemblies was identical: R-26.)
- The interior finish consisted of painted gypsum drywall installed over 1x3 strapping.
- The vapor retarder membranes, which were installed with care between the ceiling strapping and the rafters, doubled as air barriers.

The four roof assemblies differed from each other in several respects (see Table 1, below):

- Two of the roof assemblies were ventilated, and two were unventilated. In the unventilated assemblies, there was no airspace between the insulation and the roofing underlayment.
- One assembly had asphalt felt underlayment, while three assemblies used Tyvek as the roofing underlayment.
- One assembly included a reinforced polyethylene vapor retarder; two used a semi-permeable (1 to 2 perm) vapor retarder, Tyvek SD2, which is made from spunbonded polypropylene; and one assembly had no vapor retarder other than the painted gypsum drywall.

The indoor temperature was maintained at 73ºF. The roof assemblies were peppered with monitoring sensors, including heat flux transducers, thermocouples, condensation indicators, rafter-mounted moisture pins, pressure tubes, and relative humidity sensors. The outdoor climate was also monitored.

No Condensation Problems

The researchers were interested in studying whether different vapor barrier strategies, different ventilation strategies, or different types of roofing underlayment resulted in different levels of moisture problems or thermal performance. Somewhat surprisingly, they found that, in terms of thermal performance and levels of condensation problems, there were virtually no differences between the four roof assemblies. "None of the roofs show major condensation problems," the researchers wrote. "The moisture control strategy of an airflow-retarding layer at the inside and a vapor-open underlay [roofing underlayment] or a vented underlay works properly."

Although no significant performance differences were found between the ventilated and unventilated roofs, nor between the roofs with high-permeance roofing underlayment and those with low-permeance underlayment, the monitoring data revealed that wind washing and air movement within and around the fiberglass insulation resulted in a significant thermal penalty. "The impact of air transfer shows that traditional thermal performance indicators, such as the conduction related U-factor, no longer have a clear physical meaning," they wrote. "Measurements of the relative humidity fields, the moisture content in the rafters, and the occurrence of condensation confirmed the importance of air flow, not only for thermal but also for hygric performance. … The performance differences between the ventilated and the nonventilated roofs and between the roofs with a vapor-permeable underlay [roof underlayment] and those with a vapor-tight underlay are overshadowed by these air and wind flow effects."

Table 1 — Roof Assemblies Studied by Houvenaghel et al.

	Interior Vapor Retarder	Ventilation	Roofing Underlayment
Roof assembly 1	11 mil reinforced polyethylene	1- to 2-inch cavity between insulation and roof underlayment	Asphalt felt
Roof assembly 2	Tyvek SD2	1- to 2-inch cavity between insulation and roof underlayment	Tyvek housewrap with unsealed seams
Roof assembly 3	None (except paint)	None	Tyvek housewrap with sealed seams
Roof assembly 4	Tyvek SD2	None	Tyvek housewrap with sealed seams

Table 1. Researchers Geert Houvenaghel and Hugo Hens studied the hygrothermal performance of four different cathedral roof assemblies in a test building in Belgium. Tyvek SD2 is a spun-bonded polypropylene vapor retarder membrane available in Europe; its vapor permeance is between 1 and 2 perms.

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Windwashing and Convection Currents

Presenting his paper at the Florida conference, Houvenaghel noted, "It has been shown that there can be a lot of air effects and wind effects in roofs: air looping in insulation, either around or inside the insulation; natural convection from soffit to ridge; wind washing; and, when roofs are not sufficiently airtight, infiltration and exfiltration. Usually a combination of several of these air and wind effects can be seen."

The effects of air movement on the thermal performance of the roof assemblies were picked up by the researchers' data loggers. The researchers monitored heat flux using sensors installed at several locations at the interior drywall, as well as at several locations at the roofing underlayment. These sensors revealed that the thermal performance of the roof assemblies was uneven.

The researchers wrote, "Without infiltration or exfiltration, without air intrusion, and without rotation or wind washing, all measured R_{app} values [apparent local R-values] should be the same, which is clearly not the case." Had the air within the fiberglass insulation been totally still, the performance of the batts would have been uniform. But according to the data, "For the compact [unventilated] roofs, in both the southwest and the northeast pitch, the heat flux at the inner side of the insulation is higher in the middle than at the eaves and ridge. The inside temperature of the insulation in the middle of the southwest pitch, which is the windward pitch most of the time, is significantly lower."

As Houvenaghel explained at the Florida conference, "Something is going on in these roofs." The researchers concluded that the most likely cause of the thermal irregularities in the unventilated roofs was internal convection within the insulation: "Since all gaps [seams] of the underlay [roofing underlayment] are sealed in the compact [unventilated] roof, the major reason for the remarkable temperature and heat flux distribution may be rotational air flow in the insulation."

The Advantage of Denser Insulation

In their paper, the Belgian researchers refer to earlier research (A. Janssens, W. Depraetere, A. Morel, Hugo Hens, 1998, "Third Annual Report On the Vliet Test Building") that showed that unventilated cathedral ceilings perform better thermally than ventilated cathedral ceilings, as long as the insulation used is relatively dense. "Janssens et al. (1998) showed that the energy performance of compact [unventilated] roofs is better than that of vented roofs due to less air intrusion and wind washing effects when mineral wool with a higher density (1.15 pounds per cubic foot) is used." The fiberglass batts installed by the Belgian researchers were similar to standard batts sold in the US; they had a density of only 0.56 pounds per cubic foot. (For comparison, CertainTeed's "high density" R-30 8.25-inch-thick fiberglass batts have a density of 0.71 pounds per cubic foot; cellulose insulation has a density of 2.3 to 3.0 pounds per cubic foot.)

The surprising fact that the convection loops in the unventilated roofs caused just as high a thermal penalty as did the wind washing and air flow through the insulation in the ventilated roofs is due, according to the researchers, to the low density of the fiberglass batts. "The fact that both the vented and compact roof have more or less the same overall thermal performance is due to wind and air flow and [is] strongly related to the low density of the mineral fiber insulation used. … From a thermal point of view, compact roofs are to be preferred since the impact of wind washing is lower than in vented roofs. This, however, is only fully true if the mineral fiber thermal insulation has a high enough density (greater than 18 kg. per cubic meter [about 1.15 pounds per cubic foot])."

Thermal Penalty

The Belgian researchers calculated that air flow effects in all four monitored roof assemblies degraded the overall averaged thermal performance of the fiberglass insulation by 9%. The researchers wrote, "The measured heat fluxes show that air flow plays an important role in both [ventilated and unventilated] roofs: in the vented roofs, air intrusion and wind washing are major effects, while in the compact roofs, internal air rotation is the dominant phenomenon. These air and wind influences lower the apparent thermal resistance over a heating season by 9% from what is theoretically expected. There is no significant difference in overall average energy performance measured between the vented and the compact [unvented] roofs."

Although several previous studies have quantified the effect of convection loops in, around, or through fiberglass insulation (see ***EDU***, October 1991 and June 1993), the Houvenaghel study is probably the first to quantify the thermal penalty of convection loops in carefully installed fiberglass batts in unventilated cathedral ceilings.

For more information, contact Geert Houvenaghel, Catholic University of Leuven, Laboratory for Building Physics, Kasteelpark Arenberg 40, 3001 Heverlee, Belgium. E-mail: geert.houvenaghel@bwk.kuleuven.ac.be.

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NEW PRODUCTS

Two New ERVs

An energy-recovery ventilator (ERV) is a type of heat-recovery ventilator that transfers moisture as well as heat from one airstream to another. Recently, two ERV manufacturers introduced new models exhibiting opposing trends in the ERV industry.

RenewAire Breeze

The Breeze ERV from RenewAire (see Figure 5) has been developed with one goal in mind: ease of installation. While most ERVs require the installation of four ducts (outside air intake, fresh air delivery from ERV to rooms, exhaust air from rooms to ERV, and exhaust air to outside), the Breeze requires only two ducts (outside air intake and exhaust air to outside). This feat is accomplished by hanging the ERV from the main return duct of a home's existing forced-air system.

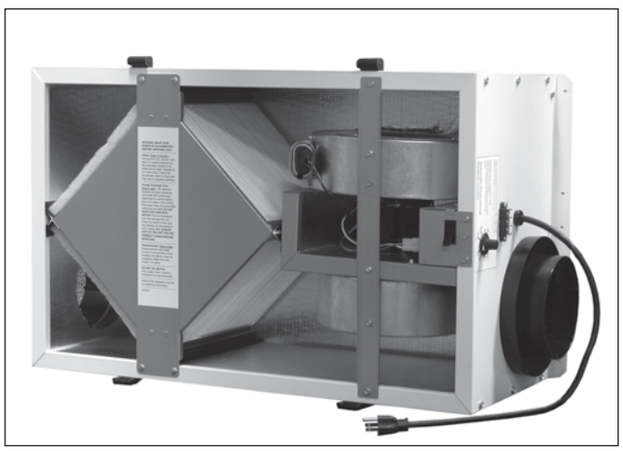

Figure 5. The RenewAire Breeze is an ERV designed for fast and easy installation.

When the unit is installed, two holes are cut into the main return duct. Through one of these holes, the ERV sucks a portion of the passing airstream into the unit. Fresh outdoor air is blown from the unit into the second hole, slightly downstream.

An ERV installed on the return duct of an HVAC system differs significantly from an ERV with dedicated ventilation ductwork. For one thing, such a system cannot draw its exhaust air from humid or smelly locations like bathrooms. Moreover, for the ERV to function properly, the home's furnace fan must be operating. "The two holes are only a foot apart," explains Duane Amundson, RenewAire's residential product manager. "If you hook it to the duct, with air moving by at 1,000 to 1,500 cfm, then it works. Without the strong airflow going by, it's not possible—the air would just short-circuit between the two holes."

Since most US furnaces have power-hungry blowers using 500 to 700 watts, use of the RenewAire Breeze usually incurs a fairly steep energy penalty (see ***EDU***, June 2005). "The only reason we have this is to speed up the installation," explains Amundson. "I know an installer who can put in a Breeze 70 in just two hours. So in two hours he can double his money—all he needs is $40 worth of accessories. For the customer, it's like that oil filter commercial on TV—you can pay now or pay later. You can have a lower-cost installation, but your operating costs may be higher."

The RenewAire Breeze is available in two models, the BR70 (30 to 80 cfm) and the BR130 (35 to 140 cfm). On the Web, the BR70 sells for $574, and the BR130 sells for $672.

UltimateAir RecoupAerator 200DX

While the RenewAire Breeze sacrifices energy efficiency for ease of installation, the UltimateAir RecoupAerator 200DX, an ERV introduced in April 2004 by Stirling Technology, is engineered with energy efficiency in mind (see Figure 6).

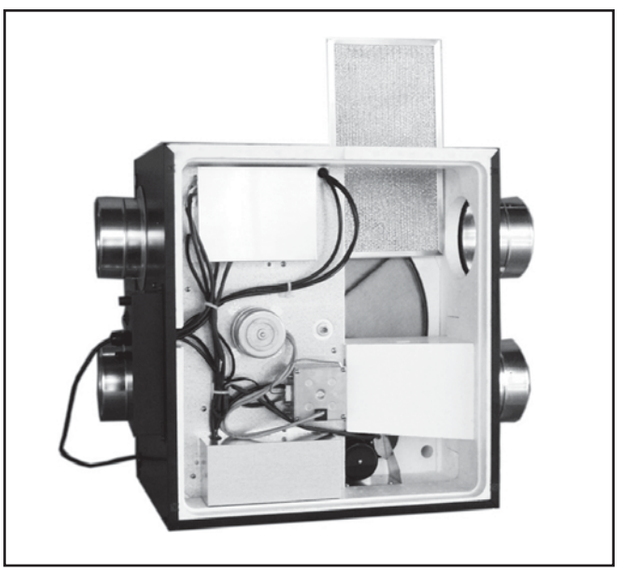

Figure 6. The fan motors in the RecoupAerator 200 DX, an ERV from Stirling Technology, are both electronically commutated motors (ECMs).

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The RecoupAerator's two motors (one for fresh air supply, one for exhaust) are both electronically commutated motors (ECMs) from General Electric. These variable-speed, brushless DC motors are self-sensing and programmable, and therefore capable of maintaining a steady air delivery rate under conditions of changing static pressure (for example, changes due to a gradually clogging filter). "The ERV comes from the factory programmed for balanced airflow," says Jason Morosko, vice president of engineering at Stirling Technology. "It can maintain constant airflow independently on the supply and return sides. If there is a duct restriction on one side, it will push harder on that duct to achieve constant airflow."

The RecoupAerator 200DX is rated at 50 to 200 cfm, and comes with four duct collars designed for 6-inch-round ductwork. At minimal static pressure, the unit draws about 40 watts at 70 cfm, or about 193 to 275 watts at 200 cfm. The RecoupAerator 200DX has achieved the highest possible energy efficiency rating from the state of Oregon, which rates HRVs and ERVs as part of an incentive program. (For more information on Oregon's ERV efficiency ratings, visit *http://egov.oregon.gov/ENERGY/CONS/RES/tax/HRVList.shtml.)*

The RecoupAerator 200DX can be ordered with two very desirable options, EconoCool and PressureGuard.

Nighttime Ventilation Cooling Option

The EconoCool option allows the RecoupAeraor to provide summer nighttime cooling, like a smaller version of the NightBreeze (see ***EDU***, September 2004). The feature is controlled by a switch accessible to the homeowner. When the EconoCool option is turned on, a temperature sensor in the incoming fresh airstream will stop energy recovery when the air reaches a preset temperature, usually between 55˚ and 70˚ F. As long as the incoming air is cool enough, it will be distributed to the home untempered.

The major limitation of the EconoCool feature is low airflow. With a maximum rating of 200 cfm, the RecoupAerator provides significantly less nighttime cooling than the 2,200-cfm NightBreeze.

Correcting for Pressure Imbalances

The RecoupAerator PressureGuard option includes both an interior pressure sensor and a remote pressure sensor designed for exterior mounting. At five-minute intervals, the ERV compares the indoor and outdoor pressures to determine whether the house is at a neutral pressure with respect to the outdoors, whether it is pressurized, or whether it is depressurized.

A variety of factors can influence this pressure differential. Conditions can change when the wind shifts, when a window is opened, when a range hood or clothes dryer is turned on, or when an atmospherically vented combustion appliance is fired up. The ERV can be programmed several ways at the time of installation: it can be set for balanced airflow, for slight pressurization of the house, or for slight depressurization. Once this parameter is set, the PressureGuard option does its best to maintain the setting, compensating for competing appliances or envelope changes.

For those worried about house pressurization or depressurization, the PressureGuard-equipped RecoupAerator may sound like the Holy-Grail appliance. Although it comes close, it has limitations, the most important of which is its limited airflow rating. "There are two pressure sensors, and it makes a comparison between the two, and adjusts the exhaust airflow relative to the incoming airflow," says Morosko. "The software is able to adjust both airflows if necessary. Our 210-cfm unit can offset airstreams up to about 120 cfm. But that is where our capacity stops, since the unit still needs to perform heat exchange—we don't want to shut one of the fans off."

So a home equipped with an 800-cfm range hood cannot depend upon a RecoupAerator to prevent combustion gases from backdrafting—at least not yet. According to Morosko, however, Stirling Technology is now working on the development of the true Holy Grail—a PressureGuard-equipped ERV with a higher airflow rating.

The UltimateAir RecoupAerator 200DX sells for $1,099 on the Web; the trade price is $779. The upcharge for the EconoCool option is about $25 (trade price), while the upcharge for the PressureGuard option is $375 (trade price).

For more information, contact:

RenewAire, 2201 Advance Road, Madison, WI 53718. Tel: (800) 627-4499 or (608) 221-4499; Fax: (608) 221-2824; Web site: *www.renewaire.com*.

Stirling Technology, 178 Mill Street, Athens, OH 45701. Tel: (800) 535-3448 or (740) 594-2277; Fax: (740) 592-1499; Web site: *www.ultimateair.com*.

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INFORMATION RESOURCES

Water In Buildings

William Rose, a research architect at the Building Research Council at the University of Illinois, has released an ambitious new introduction to building science called *Water In Buildings* (see Figure 7). Rose is a member of the very small community of US building scientists, currently the orphans of the academic world. As Rose notes, "Presently in the United States there are no degrees, curricula, courses, or for that matter, textbooks in building science." Rose's new book is a major contribution toward filling the textbook gap; he calls his book "a precursor to a textbook in building science or building hygrothermal studies."

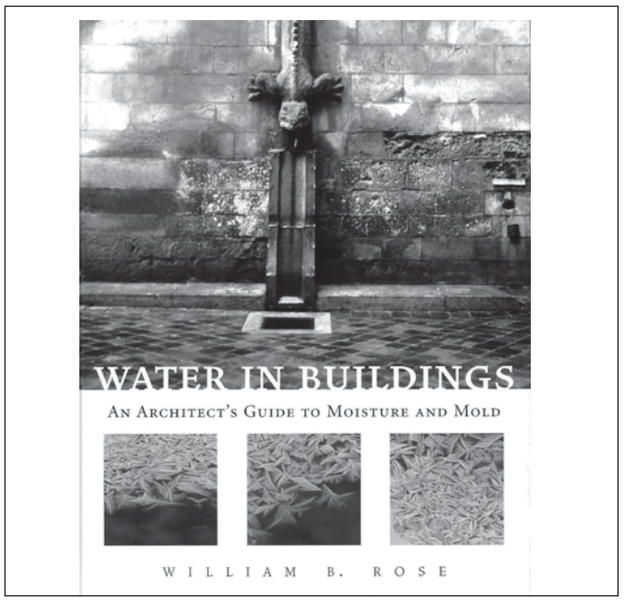

Figure 7. Author William Rose describes *Water In Buildings* as "a precursor to a textbook in building science or building hygrothermal studies."

Rose looks forward to the day when architects will handle moisture management as an engineering issue. "The approach presented here may be termed *moisture engineering*," Rose writes. "It uses a definition, or at least a discussion, of loads, analysis, and criteria that can lead to design decisions. This is the approach that is being adopted by a proposed ASHRAE Standard 160P, 'Design Criteria for the Prevention of Moisture Problems in Buildings.'"

Although *Water In Buildings* is written with the architect in mind — its subtitle is *An Architect's Guide to Moisture and Mold* — many non-architects will find the volume instructive. The book is written at a college level; to get the most out of the book, readers should be familiar with methods of construction and should, ideally, have retained a solid memory of the material covered in their high school physics and chemistry classes. Fortunately, even those with a shaky grasp of physics are likely to find much of value in Rose's book.

Water In Buildings attempts to address how water affects all important building components other than finish materials. The book is divided into nine chapters covering building science, water, water and building materials, roofs and façades, soils and foundations, walls, attics, mechanical systems, and rot and mold.

Sorption, Not Condensation

Water In Buildings also gives a technical introduction to the science of moisture, laying the groundwork for understanding fundamental building science principles. For example, Rose explains that moisture in buildings can occur in four phases — the three common ones (ice, liquid water, and water vapor), as well as a fourth phase, bound water. An example of bound water is the water absorbed by such materials as gypsum drywall or framing lumber. Rose defines bound water as "water of sorption in porous and hygroscopic materials."

When builders talk about "condensation" in walls, they usually imagine a process similar to the formation of sweat on the outside of a bottle of beer. In fact, such condensation almost never occurs in a wall; what actually happens is sorption. Rose writes, "Condensation — the phenomenological formation of water droplets — does not occur on the surfaces of porous and hygroscopic materials." He elaborates, "The conversion of water from vapor to sorbed water is not condensation. *Sorption* is a better term, covering adsorption and absorption. Where the accumulation of water on a mirror or a highball glass occurs rarely and only at a discrete set of surface temperature and air humidity conditions, sorption (i.e., *adsorption* or *absorption*, meaning the takeup of water) occurs just about half the time. The other half of the time materials are *desorbing*, giving off moisture. … Nonsorptive materials may require a coaster; sorptive materials often *are* coasters."

Historical Research

In the fledgling US building science community, Bill Rose plays a pivotal role. Although the community includes

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several engineers, physicists, and architects, Rose is, uniquely, the community's scholar and historian.

Among the most valuable of Rose's accomplishments has been his historical research into the development of code requirements for vapor retarders, crawlspace ventilation, and attic ventilation. As Rose's research has shown, "In the short period form 1937 to 1942, the building industry in the United States, prompted by insulation manufacturers, developed the practices of moisture control that have been in use, for better or worse, until the present day." In *Water In Buildings*, Rose summarizes the findings of early building science researchers and explains some of the political and economic forces, as well as a few arbitrary decisions, that led to the adoption of key building code requirements.

Rose explains that vapor barrier requirements were mandated because of a misapplication of the dew point (or profile) method of determining where condensation can occur in a wall. Rose writes, "Requirements for vapor retarders are predicated on the condensation shortcut of the profile method, and that is certainly out of date." He further explains, "The principal criticism of the profile method is this: It cannot detect types of moisture problems other than those related to diffusion. A very informal survey among building science colleagues seems to indicate that diffusion-related moisture problems account for less than 1% of the moisture problems found in buildings. We have been seriously sidetracked by the emphasis the profile method has received in the last 50 years."

According to Rose, code requirements for crawlspace venting, like code requirements for vapor retarders, are based on neither experimental findings nor scientific theory. He writes, "Why are vents the focus of current crawlspace regulation? Probably because they are verifiable and code enforceable, whereas other, more important factors, such as downspouts, rainwater discharge, soil slope, and ground cover, are not."

Debunking Attic Venting

Rose is skeptical of the usefulness of attic venting requirements, which, like crawlspace venting requirements, are arbitrary. "The current universal requirement in the United States for ventilation of all attics and cathedral ceilings in all climatic regions is long overdue for review," he writes. Elsewhere he notes, "Attics are strongly affected by sun, so they tend to be dry. If there are moisture problems in attics, we may consider that they are due to a strong excess moisture load, a lack of sunlight, or both. Of all the parts of a building, the easiest to keep dry is the attic."

In humid climates, moreover, attic venting can be deleterious. "No claims have ever been made that attic ventilation is needed for moisture control in warm, humid climates," Rose writes. "In such climates attic venting tends to increase rather than reduce moisture levels in the attic."

Asphalt shingle manufacturers have long maintained, with little evidence, that a lack of attic venting can shorten shingle life. "Does ventilation significantly reduce shingle temperatures? The short answer is no, not significantly," writes Rose. "Attic ventilation does not deserve the attention it has received in relation to shingle durability."

In Praise of Rose's Prose

Rose's technical writing is refreshingly direct and clear, with flashes of elegance and wit. Many of his sentences are finely crafted, as when he notes, "When water comes in the buildings, it may be argued, it comes in through the crack between the design and the construction professions." Rose manages to stake out a clear position where other authors waffle. Among his pithy statements:

- "Needless to say, the vent should not admit water into the crawlspace. This is a very common problem. It occurs because homes in the United States are expected to show little more than 8 inches of exposed foundation … With only 8 inches of exposed foundation, clearly the bottom of the vent opening will be at grade. The term *vent* should be changed to *sluice* or *weir*."
- "If the soil is well drained, either by good pitch on the surface or by granular soil type, frost heave is unlikely."
- "Water from outdoors (and perhaps from the soil) is the principal water source for building walls. … Wetting occurs from outside."
- "Moisture problems in attics arise simply because of the unwanted movement of humid air from beneath up into the attic."

With *Water In Buildings*, Rose has managed a significant achievement. The text is likely to endure as one of the foundation documents of American building science.

Water in Buildings: An Architect's Guide to Moisture and Mold by William Rose (ISBN #0-471-46850-9) is available for $80 from John Wiley and Sons, 10475 Crosspoint Boulevard, Indianapolis, IN 46256. Tel: (877) 762-2974; Fax: (800) 597-3299; E-mail: customer@wiley.com; Web site: *www.wiley.com*.

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READERS' FORUM

How Long Does Foil Tape Remain Waterproof?

Dear Editor,
Concerning the June 2005 review of Water Out head flashing: in the third paragraph, where it talks about the foil tape, we would like it known that the foil tape is underneath, so that it will not be shown. The article states, "such a seam might eventually lead to leaks." Why would you assume that it would leak?

Jim Montague, marketing and sales manager
Water Out Flashing
Charlotte, North Carolina

Editor's Reply

It is difficult to ascertain which types of tape, if any, can be depended upon to keep a seam waterproof over the life of a building — that is, for 50 to 100 years. Butyl tapes — including some of the foil-faced tapes carrying the Nashua brand, the brand recommended by the manufacturer of Water Out head flashing — are relatively long-lived and are waterproof when carefully installed. How long butyl tape can maintain a waterproof seal when joining two pieces of rigid polypropylene, however, is unknown.

Nashua foil-faced tapes are manufactured by Tyco Adhesives. Ben Cross, a Tyco marketing manager, recommends using their 20-mil butyl tape, Nashua OptiFlash 626-20, for sealing seams in polypropylene flashing. Cross warned ***EDU*** that similar-looking tapes, including Nashua 322 foil tape, have only "a thin coating of butyl rubber" and might not perform as well as Nashua 626-20.

A June 2001 article on flexible tapes and flashings in *The Journal of Light Construction* included the following advice from building consultant Joseph Lstiburek: "Don't rely on the adhesive property [of tapes or membranes] for waterproofing." The article reported the results of a test in which half of a group of 21 peel-and-stick flashing products failed to maintain a waterproof seal when bonded to wood.

To create long-lived flashing details for walls, it helps to think like a roofer. Most construction experts agree that details that rely on gravity — that is, details incorporating shingle-style overlaps — are likely to last longer than details that rely upon adhesive chemistry.

Minimum Code R-Values for Walls

Dear Editor,
The International Code Council has scheduled its final action vote on proposed code changes to the International Energy Conservation Code (IECC) regarding R-value requirements in wood-frame wall assemblies for September 2005 [see "News Briefs," April 2005 ***EDU***]. Recognizing that your readership is interested in positive stories surrounding promotion of energy efficiency, I wanted to provide some background on the limitations of energy efficiency efforts focused on R-value.

From an energy-efficiency perspective, the proposed R-value increases cannot deliver savings that will help homeowners offset rising energy costs.

The proposed adjustments to R-values are intended to protect homeowners from rising heating and cooling costs, but physical laws governing heat flow in and out of buildings show they will have minimal impact. Air leakage or convection (which contributes up to 50% of energy loss in a building according to the US Department of Energy's Oak Ridge National Laboratory) is far more important than small reductions in conductive heat flow (measured by R-value) in driving energy efficiency. Consider that most (93%) conductive heat flow is already stopped with R-12 insulation. According to Fourier's Law of Thermodynamics, increases in R-value beyond R-12 offer minimal and diminishing returns. For instance, going from R-12 to R-32 insulation offers only an additional 4% reduction in conductive heat flow, yet can double the cost of insulation.

As you know, R-value is a laboratory measurement, and insulation R-values can be compromised after installation by factors such as moisture, installation technique and settling.

The IECC clearly states that the use of specific building products can be disapproved only for health or safety reasons. In fact, section 101.3 of the IECC 2004 goes even further, stating that the intent of the code is "to permit the use of innovative approaches and techniques to achieve the effective use of energy." Yet the proposed R-value increases could exclude products from the marketplace that deliver significant energy savings and contribute to overall building health.

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That said, it might be of value to your readers to focus on the positive energy efficiency advantages of creating a continuous air barrier, which can save up to 50% in energy costs by reducing air leakage, while delivering faster payback. If a new homeowner financed the cost of creating a continuous air barrier, the monthly energy costs savings would likely outweigh any monthly cost of financing almost immediately. There are obvious other associated benefits offered by air sealing including reduction of outdoor pollutants (in combination with mechanical ventilation) and moisture control. Research in building envelope performance concludes that 98% of moisture control is achieved through air leakage control to prevent condensation (Office of Energy Efficiency and Renewable Energy, US Department of Energy).

Peter Boyce
Harbinger Communications
Toronto, Ontario, Canada

[Editor's Note: Peter Boyce is a senior counselor at Harbinger Communications, a public relations firm under contract with Icynene, Inc. Icynene, a manufacturer of open-cell foam insulation, has joined with the National Association of Home Builders to lobby the IECC Development Committee to lower wall insulation requirements from R-15 to R-13 in climate zones 3 and 4. ***EDU*** asked William Prindle, vice president of the American Council for an Energy-Efficient Economy, to respond to Mr. Boyce's letter.]

William Prindle Responds

Mr. Boyce's letter implicitly challenges the value of wall efficiency improvements that were made to the 2004 IECC supplement. Our analysis shows that on a national basis, these modest improvements will save consumers $7 billion in energy bills over 30 years, saving the nation over 500 Trillion Btu in that same period. Building solutions that comply with the code have also been found, by our analysis and that of the Department of Energy, to be cost-effective on a life-cycle basis. At a time when home heating fuel prices have doubled and are predicted to stay well above past levels, this modest cost-saving step is the least that the IECC can do for American homebuyers.

The letter also makes a false presumption that the IECC wall improvements are a mandatory prescriptive requirement. Meeting the increased efficiency criteria can be done in several ways:

1. Through any combination of cavity and sheathing materials that meet the overall R-value criteria. Many builders will elect to comply by adding insulation sheathing, leaving cavity insulation unchanged. This will allow Icynene, cellulose, other foams, and fiberglass products to be used just as they are today.
2. Through a U_O tradeoff. Many builders use simple, free software tools like ResCheck to trade off various envelope components (see *www.energycodes.gov/rescheck*). The increased wall requirements can be traded off against better windows, increased basement or ceiling insulation, or other envelope components.
3. Through a performance approach. Chapter 4 of the IECC allows a performance-based tradeoff method in which wall criteria can be traded against any other component or system, including air infiltration reduction, duct air sealing, and heating/cooling equipment efficiency. Many builders currently use these methods.

This compliance flexibility means that the IECC does not ban any products, as the letter implies. In states like Oregon, whose code requirements closely mirror those in the 2004 IECC, the state energy office reports that Icynene, cellulose, other foams, and many other wall solutions are doing just fine in the marketplace. There is thus no basis to the claims made by Icynene and others that this code requirement will force products off the market.

Finally, the letter suggests that [addressing] air infiltration would be a more appropriate way to save energy in homes. We strongly support air infiltration reduction, along with duct air sealing and other cost-effective measures. However, attempts to make such measures mandatory via code have been unsuccessful. The IECC wall criteria will in fact help to promote use of these measures, since they can be used in a performance approach. Also, to the extent that the new R-values will increase use of insulating sheathing, this can serve to reduce air infiltration. Taped sheathing is already widely used as an alternative to housewrap air barriers, with zero incremental cost.

In summary, no insulation manufacturer need worry that their product will be disadvantaged by the new IECC. Given the challenges we face in soaring energy prices and major environmental challenges, this IECC upgrade is a modest step towards more sustainable housing.

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BACK PAGE

Calculating Cost-Effectiveness With The Planet At Risk

This spring, in its April 25, May 2, and May 9 issues, *The New Yorker* magazine published an extraordinary three-part series of articles on global warming by Elizabeth Kolbert. Even ***EDU*** readers, most of whom work in fields directly related to energy efficiency, are likely to be startled by Kolbert's stark perspective of the risks ahead for the human race. She quotes Pieter van Geel, the Netherlands state secretary for the environment, who notes, "We have only a few years, and not ten years but less, to do something."

Most US efforts to promote energy efficiency have their roots in the 1973 oil shock. Since then, the usual justifications for efficiency improvements have included reducing US dependence on imported oil and lowering energy costs. But the potential catastrophes resulting from global climate change are so serious that they entirely trump ordinary calculations of the cost-effectiveness of energy upgrades.

In an interview posted on *The New Yorker* Web site, Kolbert notes, "I think there is a surprisingly large — you might even say frighteningly large — gap between the scientific community and the lay community's opinions on global warming. … I spoke to many very sober-minded, coolly analytical scientists who, in essence, warned of the end of the world as we know it. I think there are a few reasons why their message hasn't really got out. One is that scientists tend, as a group, to interact more with each other than with the general public. Another is that there has been a very well-financed disinformation campaign designed to convince people that there is still scientific disagreement about the problem, when, as I mentioned before, there really is quite broad agreement. … My oldest son is ten years old and, for his sake, I would very much like to think that we will be able to cope with this challenge. It's hard for me to be optimistic, though. Scientists have been warning about the dangers of global warming for more than twenty-five years now, and in that time we have increased our energy usage — and, with it, our production of greenhouse gases — quite dramatically."

Kolbert closes her article with the following observation: "It may seem impossible to imagine that a technologically advanced society could choose, in essence, to destroy itself, but that is what we are now in the process of doing."

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