

Energy Design Update®

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INDUSTRY NEWS

Roofing With Foam

In most areas of the country, spray polyurethane foam (SPF) is used chiefly as an air barrier and insulation material. Relatively few builders realize that for over 30 years, SPF has also been used as roofing. Although a one-inch layer of high-density SPF is waterproof, it can be applied more thickly if desired. (SPF roofing has an aged R-value of 6 to 6.8 per inch.) Moreover, by varying the thickness at which it is applied, roofers can create a slope to improve drainage in flat roofs.

Not all types of SPF insulation can be used for roofing. Open-cell polyisocyanurate insulations like Icynene are not waterproof enough for roofing applications. In fact, even most types of closed-cell spray polyurethane foam — including Corbond, which has a density of only 1.8 to 2.0 pounds per cubic foot — are not dense enough

for use as roofing. Manufacturers of SPF for roofing — including BASF, Foam Enterprises, North Carolina Foam Industries, and SWD Urethane Company — use formulations resulting in cured foam with a density of 2.5 to 3.0 pounds per cubic foot. High-density roofing foam is not only waterproof, but is able to withstand a fair amount of foot traffic.

Spray polyurethane foam is fairly flexible, accommodating ordinary thermal expansion and contraction of the substrates to which it is adhered. Because it clings tenaciously to a wide variety of materials — including lumber, plywood, OSB, concrete, asphalt shingles, and metal roofing — it does not require any metal flashing at penetrations, transitions, or terminations. “If the roof has a lot of complexity, that tends to favor foam roofing, since there is no additional cost for doing a complicated roof,” says Roger Morrison, a production manager at North Carolina Foam Industries in Mount Airy, North Carolina. “It conforms to all sorts of odd shapes and configurations and sizes.”

For re-roof jobs, SPF can be installed over almost anything, without tearing off the existing roofing. “On retrofit roofs, foam is such a fix-all,” says Ron Whipple, marketing director for Arizona Foam and Spray in Mesa, Arizona. “You can take a roof that is the biggest mess you ever saw, and you can clean it up and foam over it so that it works, and all the mistakes are gone.”

Since sunlight degrades SPF, it must be protected by a layer of crushed stone or an elastomeric coating. But it is the foam, not the coating, which creates the water-tight layer.

Energy Performance

In the Southwestern US, where residential architecture often mimics the look of traditional flat-roofed adobe

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buildings, some energy-conscious builders are capping the homes they build with a thick layer of SPF roofing (see Figure 1). "Right now, a lot of customers just want the cheapest pricing," says Bruce Schenke, technical applications manager for BASF in Cartersville, Georgia. "But as energy prices escalate, I think more people will start to say, 'I want the energy savings.' The energy performance of these roofs is phenomenal. In the Southwest, where there is a lot of residential foam roofing being done, people are saving a lot of money on their energy bills. The more we are able to market on that, the more people will choose more insulation."

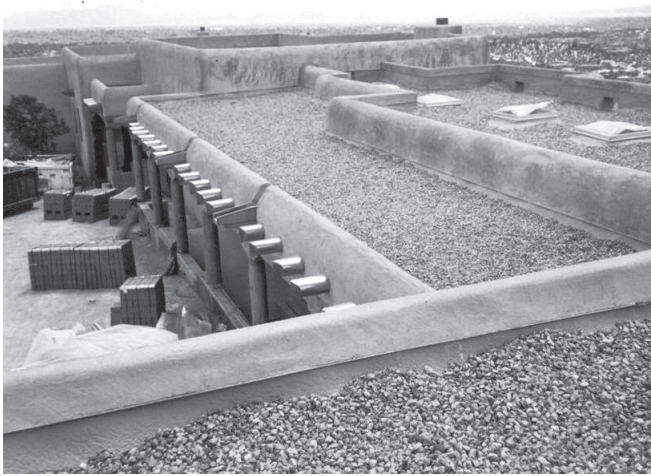


Figure 1. In the Southwest, where traditional architectural styles favor flat roofs, spray polyurethane foam roofing is fairly common. The SPF roofing on this home is covered with aggregate ballast. [Photo credit: North Carolina Foam Industries]

Mitchell Smith, the owner of Solarsmith Custom Homes in Santa Fe, New Mexico, uses SPF roofing on many of the houses he builds. "We shoot for a minimum thickness of 5 inches," says Smith. "Once in a while we taper down to 2 or 3 inches, but the goal is to

have 5 inches minimum over the heated space. We can create the slope of the roof with the foam if we need to. Closed-cell foam is monolithic — there are no joints. We top the foam with gravel ballast. If there are a few places where the gravel won't stick, like at a skylight curb, we coat the exposed vertical surfaces with a latex coating that lasts for about ten years. I have not had a single problem with any of my foam roofs."

No Flashing Necessary

The stickiness of SPF roofing allows it to be installed with almost no flashings; some roofers call the material "self-flashing." According to Rick Radoboenco, president of SprayFoam Southwest in Tempe, Arizona, basic drainage principles still make some types of flashing necessary. "When we terminate into a stucco wall, we like to cut into the stucco and get behind the underlayment, and insert Z-metal flashing," he notes.

To investigate the performance of roofs that use SPF as a flashing material, the National Roofing Foundation, a branch of the National Roofing Contractors Association, surveyed 140 existing roofs averaging 11.3 years of age. The study concluded that such roofs perform well.

In an April 1, 2004 article in *RSI* magazine titled "Field Performance of SPF Flashings," Rene Dupuis summarized the study's findings: "The 1998 study found that regardless of age, location or building use, SPF materials retained their physical properties regarding density and compressive strength. ... SPF flashings were seen to do remarkably well when attached to well-secured existing perimeter metal, panels, and brick. SPF flashings were found applied to virtually every type of membrane roofing system available, including asphalt, coal tar, modified bitumen, and single-ply, in addition to metal panels. We found SPF curb flashings could

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solve a number of problems, including withstanding structural vibrations when applied to light-gauge metal roof curbs. No need for metal counterflashing was seen, although its inclusion may offer a better finished appearance for some roofs."

Spraying Sloped Roofs

From an engineering standpoint, SPF roofing is almost ideal. With one layer it forms a perfect air barrier, vapor barrier, insulation layer, and roofing. The main drawbacks to SPF roofing have nothing to do with performance. Among the disadvantages: it costs more than most alternatives, and some homeowners object to its appearance, especially when used on sloped roofs visible from the street.

Many Florida homeowners are looking for more hurricane-resistant building materials, and a few brave souls, unconcerned about the opinions of their neighbors, have re-roofed their houses by installing SPF roofing directly over concrete-tile roofs. Although less attractive than tiles, SPF roofing contributes to cooler attics and is better able to resist high winds.

"It looks a little like snow," says Mason Knowles, the executive director of the Spray Polyurethane Foam Alliance (SPFA). "Some homeowners' associations didn't like the look of it." Indeed, even SPF advocates don't pretend that sloped foam roofs are attractive. "Aesthetically, a foam roof doesn't add much to the looks of the building," admits Rick Radoboenko. But Jim Andersen, vice president of technical services at Foam Enterprises in Minneapolis, Minnesota, takes a pragmatic approach, advising homeowners in hurricane-prone areas: "It's kind of like, do you want to get wet, or do you want to build for robustness and watertightness?"

Waiting For Good Weather

Since SPF roofing can only be installed on warm, dry, relatively windless days, it is more popular in areas of the country where such weather is common (see Figure 2). "In Minneapolis, weather is always a problem," says Andersen. "We typically look at a spray foam roofing season that begins about March 15 and runs through October 15. We would like to have warm sunny conditions without much wind. Acceptable weather is 45 degrees and warmer, with winds gusting up to 15 miles per hour."

Some roofers are willing to begin spraying at lower temperatures, especially if the thermometer is rising. "You can spray down to about 35 degrees in good dry conditions," says Bruce Schenke. "Getting a good



Figure 2. Spray polyurethane foam roofing can only be installed when the weather is warm, dry, and relatively windless. [Photo credit: Goodrich Roofing Co.]

weather window to put on a good roof has always been somewhat a matter of luck. The roofing season is shorter up North than it is down South — even in the middle of the summer you can get some rainy weeks."

Coatings Versus Aggregate Ballast

SPF roofs can be protected from ultraviolet light with coatings — typically acrylic, polyurethane, or silicone coatings — or with crushed stone aggregate. Aggregate-covered roofs, sometimes called "foam and stone," require stone ranging in size from ¼ inch to ¾ inch (see Figure 3).



Figure 3. Some roofers protect SPF roofing from ultraviolet light with crushed stone ballast. Stone ballast only works on relatively flat roofs. [Photo credit: Thermal Coatings and Insulation]

Needless to say, coating manufacturers are in the business of selling coatings, so they tend to emphasize the advantages of coatings compared to stone. "We make more money and assure better longevity through our coating systems," says BASF's Schenke. Among the limitations of stone: it can only be used on relatively flat roofs, and its weight may exceed structural limits. "Coated foam weighs only $\frac{1}{3}$ pound per square foot, while aggregate-covered foam is closer to 6 pounds per square foot," says Andersen. "Also, coated foam makes it easier to spot and repair a roof leak." On this point, Radoboenko agrees with Andersen. "With gravel, maintenance is more difficult, because you can't see what's under the gravel," says Radoboenko. "Gravel also can stop up drains."

Another possible advantage of coatings: they may help slow the evaporation of trapped gas in the polyurethane foam that, as it escapes, contributes to "thermal drift" that lowers the foam's R-value. Finally, since the emissivity and reflectivity values of coatings are known, some coatings (unlike gravel) are eligible to receive an Energy Star label (see Figure 4).

Coatings also have some disadvantages: they usually cost more than stone, and they need to be periodically renewed. Depending on who you talk to, the coating on an SPF roof will last anywhere from 10 to 15 years. "When the coating wears thin, the first thing that happens is we see spots on the roof where the UV has changed the color of the foam," says Andersen.

Roger Morrison prefers using gravel. "There is an economic advantage to gravel," he says. "The upfront cost is less, and the maintenance cost is less. The gravel tends to absorb impact and foot traffic better, and to evaporate water faster. The main disadvantage is one of weight."

Ricardo Sanchez, the owner of Goodrich Roofing in Santa Fe, New Mexico, also uses gravel whenever possible. "If you use coating, then in 10 years, everything will have to be recoated, and that will cost the customers a lot of money," says Sanchez. "All I'll have to recoat are the parapets."

How Long Will The Roofs Last?

Now that the oldest SPF roofs are about 30 years old, questions about SPF longevity are beginning to be laid to rest. According to Schenke, "We know of some roofs that are on their third recoat. We are routinely running into roofs that are lasting that long."

Although some promoters of coated SPF roofs have wondered whether aggregate-covered roofs will



Figure 4. Another option to protect SPF roofing from ultraviolet light is a sprayed-on coating. Most roof coatings last for 10 to 15 years before they need to be renewed. [Photo credit: Thermal Coatings and Insulation]

prove to be as long-lived as coated roofs, there appears to be no reason for concern. "Around twenty years ago, when a few contractors started putting spray foam down on roofs and covering it with aggregate ballast, there was some controversy as to whether this was a viable roofing system," says SPFA's Mason Knowles. "We know that under the short term, spray foam is resistant to water penetration. But over twenty years, the question was, would water soak in eventually? As part of an industry study, we hired around seven inspectors around the country to look at 25 projects. We asked them to look at these roofs to find out the answer to a basic question: Are they working? What we found — and it's been reaffirmed by other folks — is that they do seem to be viable systems. In the north, where there is a lot of snow load, you will get some water absorbed in the top $\frac{1}{2}$ inch of foam, but it does seem to dry out. On the basis of that study and some of the other testimonials, we included the system in our SPFA guidelines. The main thing is, you still want to have positive drainage."

Cost

Most roofers say that a typical residential installation of one-inch-thick SPF roofing costs between \$2.00 and \$2.50 a square foot. In some areas of the country, the price is higher. "I tell people spray foam is \$3.50 a square foot," says Jim Andersen. "Compared to other types of roofing, we are kind of in the middle to the low side. Single-ply fully adhered roofing can cost \$3.50 to \$4.00 a square foot."

Of course, if a builder wants 5 or 6 inches of foam for a full insulation job, the price will be higher. According to Mitchell Smith, who routinely installs 5 inches of foam on his roofs, "For what I'm describing, the cost is \$4.00 to \$4.50 a square foot, including the cost of 2 inches of gravel ballast."

[Note: The editors of *EDU* would like to thank several companies for contributing photos for consideration to illustrate the article, including Dri-Zone of Beltsville, Maryland; Goodrich Roofing of Santa Fe, New Mexico; North Carolina Foam Industries of Mount Airy, North Carolina; and Thermal Coatings and Insulation of Santa Fe, New Mexico.]

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Vapor Retarders and Icynene

The two major types of spray-in-place foam insulation — open-cell and closed-cell — are both excellent air barriers (see Figure 5). But some builders remain confused about vapor retarder requirements when using open-cell spray foam.

Installers of Icynene, the leading brand of open-cell spray foam, have been known to tell builders that their insulation can be installed without a vapor barrier, or even, in some cases, that the foam *is* a vapor barrier. For example, the following information can be found on the Web sites of Icynene installers:

- "Icynene foam insulation provides its own air infiltration protection and moisture control. Unlike common insulation materials, it does not need the protection of a polyethylene vapor retarder, building wraps, air tight electrical fittings, sticky tape or cases of caulking and cans of foam." (Web site of Environmental Foam of Vermont at <http://home.earthlink.net/~envirofoam/>.)
- "By virtue of its low permeability to air, its adhesion to other building materials and its flexibility, the Icynene Insulation System becomes much more than just insulation. It provides superior air leakage control, moisture control and sound control in addition to insulation, thus becoming a one-step insulation, moisture/vapor barrier, wind barrier system." (Web site of Energy Smart Insulation, "Minnesota's Premium Icynene Installer," at www.energysmartinsulation.com/faq.html.)

BASF, 100 Enterprise Drive, Cartersville, GA 30120. Tel: (770) 387-2525; E-mail: schenk@basf.com; Web site: www.basf.com/urethanechemicals/spray/applications/html/application-roofing-system.htm.

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North Carolina Foam Industries, P.O. Box 1528, Mount Airy, NC 27030. Tel: (800) 346-8229 or (336) 789-9161; Fax: (336) 789-9586; Web site: www.ncfi.com.

Resin Technology, 2270 S Castle Harbour Place, Ontario, CA 91761. Tel: (800) 729-0795 or (909) 947-7224; Fax: (909) 923-9617; Web site: www.permax.com.

UCSC, 3010 West Lincoln Street, Phoenix, AZ 85009. Tel: (800) 289-8272 or (602) 269-9711; Fax: (602) 269-9115; E-mail: info@buyucsc.com; Web site: www.buyucsc.com.



Figure 5. When Icynene is installed in a cold climate, the manufacturer recommends the installation of an interior vapor retarder. [Photo credit: Energy Smart Insulation]

Although many sources make the blanket claim that Icynene does not require a vapor barrier, the truth is more complex. "Icynene is not a vapor barrier — it's incredibly vapor open," notes Joe Lstiburek, a principle of Building Science Corporation in Westford, Massachusetts. (Unlike Icynene, closed-cell spray polyurethane foams — for example, Corbond — *are* vapor retarders.)

According to Icynene's product specifications, three inches of Icynene has a permeance of 16 perms.

Since the International Residential Code defines a vapor retarder as a material having a permeance of 1.0 or less, Icynene does not qualify. Icynene specifications also note that the foam can be installed without a vapor retarder "except in climates as cold [as] or colder than Madison, Wisconsin (7,500 Heating degree days)." For builders using the climate zones shown in the 2004 International Energy Conservation Code, Icynene technical representatives advise using a vapor barrier when installing Icynene in Zones 6 and higher.

Spray It With Paint

According to Dan Steinbok, a building science engineer at Icynene, cold-climate installers of Icynene should spray the inside surface of the Icynene with two coats of latex paint after the foam has cured. "The vapor barrier should be directly against the Icynene, not at the drywall layer," says Steinbok. "There shouldn't be an air gap between the vapor barrier and the insulation. Installing the vapor barrier directly against the Icynene allows the installer to underfill the cavity instead of overfilling the cavity and cutting it back. All they have to do is spray the paint against the insulation."

Unfortunately, some Icynene installers do not comply with the manufacturer's recommendations. For example, Glenn Greenwood, an installer for WBC Insulation in Whitefish, Montana, told *EDU* in a telephone interview, "A vapor barrier isn't required with Icynene. We don't do it because it isn't necessary."

Scott Walters is a home remodeler in Burnsville, Minnesota, who sometimes uses Icynene. "The Icynene installer said, before the contract was signed, that we didn't need a vapor barrier with it," Walters told *EDU*. "Around here, Icynene installers want to come in, spray the foam, and get out. They don't want to make a second trip. When I told the Icynene guy that the inspector is making me put on a vapor barrier, he acted dumbfounded."

Wet Roof Sheathing

In cold climates, installing Icynene without a vapor

retarder occasionally leads to problems. One building-science consultant who requests anonymity told *EDU* that he has seen a few houses with saturated roof sheathing behind Icynene. In all cases, he said, the homeowners were using humidifiers.

Clyde Potts, a builder in Big Fork, Montana, had Icynene installed in the cathedral ceilings of his own home. Believing that Icynene did not require a vapor retarder, Potts used tongue-and-groove boards as his finished ceiling. Within a few months, moisture accumulation in the roof assembly was causing problems. The ceiling boards absorbed so much moisture that they swelled, popped their nails, and bowed out towards the living space. "The 1x6s started buckling," Potts told *EDU*. "Water was getting through the foam. The water hit the roof sheathing and had nowhere to go. In one section, it popped the tongue-and-groove boards completely off the rafters, and I had to put up a temporary 2x4 post to prop it all up. So we pulled the boards off the ceiling. Then I cut out some sections of the Icynene, and I could see the roof sheathing was wet. That was what got me concerned."

In Potts's house, as in all other cold-climate houses that have reported problems with Icynene installed without a vapor retarder, high indoor humidity was a contributing factor. Potts's house was tightly built but lacked mechanical ventilation. Once Potts installed an exhaust fan, the indoor humidity levels in his home dropped enough to allow his ceiling to dry.

Because of Icynene's many virtues, including its exceptional performance as an air barrier, it remains an excellent choice for residential insulation. However, builders in cold climates who specify Icynene should be alert to published recommendations on the use of vapor retarders.

For more information, contact: Icynene, 376 Watline Avenue, Mississauga, Ontario L4Z 1X2, Canada; Tel: (800) 758-7325 or (905) 363-4040; E-mail: inquiry@icynene.com; Web site: www.icynene.com.

NEWS BRIEFS

2004 IECC R-Value Requirements Are Upheld

CINCINNATI, OH — On March 1, the International Energy Conservation Code (IECC) Development Committee rejected a proposal to lower the bar for wall-system R-value requirements. Among the supporters of

the rejected proposal were members of the National Association of Home Builders (NAHB), who argued that the IECC's existing wall-insulation requirements add too much to the cost of a typical house. NAHB had proposed lowering wall-insulation requirements from R-15 to R-13 in Zones 3 and 4 and from R-21 to R-19 in

Zones 4 Marine, 5, and 6. According to a recent study by the American Council for an Energy-Efficient Economy, the controversial wall-insulation requirements incorporated into the 2004 IECC will save homeowners \$7 billion in energy costs over the next 30 years.

Improving the Energy Efficiency of Affordable Housing

NEW YORK, NY — New York City Mayor Michael Bloomberg has announced the launch of a new program, the High-Performance Housing Initiative, to improve the energy-efficiency of 5,000 affordable New York City apartments. With funding of \$7 million from public benefit charges collected by the New York State Energy Research and Development Authority, the initiative will make grants of \$1,750 per apartment to developers of affordable housing for the installation of efficient windows, HVAC equipment, lighting fixtures, refrigerators, and insulation. The improvements are expected to save tenants up to \$200 per apartment per year on their utility bills.

Solar Decathlon Home Uses PV to Make Hydrogen

OLD WESTBURY, NY — A team of students competing in the 2005 Solar Decathlon is designing a home that will include a photovoltaic-powered electrolyzer to produce hydrogen from water. The house will also include a hydrogen fuel cell to produce electricity and heat. Students from the New York Institute of Technology are designing and assembling the \$500,000 house, one of 19 entries in the second Solar Decathlon competition scheduled for September in Washington, DC. "We brought together a panel of professors to review students' proposals and very quickly realized they had come up with a truly innovative and somewhat risky option," said professor Michele Bertomen. "Instead of proposing the traditional use of batteries to convert and store solar power, our students suggested using hydrogen fuel cells." The competition, designed to honor the best-performing off-grid home, is sponsored by the US Department of Energy's Office of Energy Efficiency and Renewable Energy. The first Solar Decathlon was held in 2002 (see *EDU*, May 2002).

Hot Water Piping Contributes to System Inefficiency

SACRAMENTO, CA — Researchers have calculated that the overall efficiency of the domestic hot water system of a house in Sacramento equipped with a gas storage water heater is only 35%. Although the water heater has an Energy Factor (EF) of 0.60, the system efficiency was dragged down by distribution losses.

The research, reported by Marc Hoeschele in an article in the March/April issue of *Home Energy* magazine, was conducted by the Davis Energy Group of Davis, California, and funded by the DOE's Building America program. At a 2,070-square-foot house occupied by a working couple without children, Davis Energy researchers monitored water temperature at each fixture and water temperature and flow at the water heater for 11 months. They categorized 7.5% of hot water usage as "draws with no end use" — that is, occurrences when a hot water tap was turned on, and then turned off before any hot water reached the tap. "On average, 59% of the energy leaving the water heater arrived at a hot water fixture," Hoeschele wrote. "Combining the 59% distribution efficiency with a 0.60 Energy Factor for a typical gas storage water heater results in an overall system efficiency of approximately 35% for this particular application." Among Hoeschele's suggestions for improving overall system efficiency: locating the water heater closer to the fixtures, and downsizing the hot water distribution pipes to reduce the volume of water wasted while waiting for hot water to arrive at a fixture.

If It's Not Broken, Don't Fix It

NASHUA, NH — A contest sponsored by a heating contractor has identified the oldest working boiler in New Hampshire, a 134-year-old steam boiler manufactured by the Richardson Boiler Company. To tempt homeowners to enter the contest, Wilkins Mechanical Service of Bedford offered a prize: a free 85% AFUE Smith cast-iron boiler. The prize was claimed by homeowner Marc Palmadon of Nashua, whose old Richardson boiler, originally designed for coal, had been converted to burn oil in the 1950s. Still putting out heat, the boiler was the original heating plant installed when the house was built in 1871.

A Swedish Zero-Energy Home

SOLNA, SWEDEN — A Swedish construction company has produced plans for an off-grid building designed to be totally self-sufficient in energy. A team from NCC Technology designed the Concept House, a 10,000-square-foot conference facility adapted to the Swedish climate. The Concept House requires two wind turbines and the same area of photovoltaic modules (10,000 square feet) as the heated floor area of the building. The design for energy storage includes a bank of lithium-ion batteries and an electrolyzer to produce hydrogen from water. Since the estimated cost to construct the Concept House is \$11 million, the plans are likely to remain unbuilt. "The house is expensive, and building it today would not be commercially feasible," explained Kristina Gabriell, the

project manager on the Concept House design team. For more information on the Concept House, visit www.ncc.info.

Wisconsin Governor Proposes Raiding Energy Efficiency Funds

MADISON, WI — Wisconsin Governor Jim Doyle has proposed a budget that diverts \$53 million of public benefit funds from energy-efficiency programs to the state's general fund. The \$53 million raid amounts to a 40% cut in the state's energy-efficiency budget. "These proposed cuts signal that securing funding for energy efficiency and renewable energy programs is not a high priority at this time," lamented Janet Brandt, the executive director of the Wisconsin Energy Conservation Corporation. The latest news comes on the heels of fund raids of \$17.6 million in 2003 and \$29.5 million in 2004 (see *EDU*, January 2005).

Minnesota Renewable Energy Funds Diverted to Coal Project

MINNEAPOLIS, MN — The Minnesota Public Utilities Commission (PUC) has approved the use of \$10 million from a fund earmarked for renewable energy projects to finance the construction of two coal gasification plants. According to the Associated Press, Diane Jensen, the executive director of the Minnesota Project, an economic development and environmental group, said, "This makes no sense at all. Coal is not a renewable resource under any definition or version of reality." Senator Ellen Anderson, who chairs the Minnesota Senate committee responsible for energy legislation, called the PUC decision "outrageous." The company promoting the construction of two power plants fueled by gasified coal is Excelsior Energy. Excelsior co-president Tom Micheletti explained, "Environmental groups can be as upset and angry as they want, but the problem they've got is that elected officials and policymakers in Minnesota have spoken."

Northwest Energy Efficiency Programs Have Stable Funding

PORTLAND, OR — The Northwest Energy Efficiency Alliance has received financial commitments from the Bonneville Power Administration, electric utilities, and public benefit funds to fund the Alliance's energy-efficiency programs at the level of \$20 million per year for the next five years. The Alliance serves four states in the Northwest: Idaho, Montana, Oregon, and Washington. Among the Alliance's initiatives are programs to encourage the construction of high-performance buildings and programs to promote the sale of more efficient appliances.

Surprise: Paper-Faced Gypsum Sheathing Is Prone to Rot

VANCOUVER, BRITISH COLUMBIA — The details of the meeting at which a manufacturer of paper-based gypsum first proposed using the product as exterior sheathing have been lost to history, but one can imagine the conversation: "Come on, Fred, be reasonable — will anyone really spec this stuff for sheathing?" Now, several years later, comes a technical paper by Vancouver engineer Mark Lawton to provide evidence, if any is needed, that paper-faced gypsum sheathing is vulnerable to degradation, especially when specified for use over steel studs on high-rise buildings. Lawton's paper, "Lessons to be Learned from Performance Failures of Framed Walls in High-Rise Buildings," details examples of corrosion of metal elements, mold growth, and physical degradation of exterior gypsum sheathing under a variety of claddings on British Columbia high-rise buildings. Lawton writes, "It would appear that in coastal climates, much more emphasis should be placed on the durability of the materials and systems we use on the outer portion of wall systems. We suggest that paper-faced gypsum sheathing is too vulnerable to moisture-induced degradation to be used as exterior sheathing in temperate maritime climates because physics tends to concentrate moisture collection in the exterior sheathing." Presenting his paper at a December 2004 Florida conference on building envelopes, Lawton noted, "Gypsum sheathing softens when wet and is an excellent substrate for mold growth, so it's not surprising that we're seeing a lot of problems." For more information, contact Mark Lawton at Morrison Hershfield Limited in Burnaby, British Columbia; E-mail: mLawton@morrisonhershfield.com.

Energy-Efficient Houses for Habitat for Humanity

JUNO BEACH, FL — A Florida electric utility has donated \$500,000 for the construction of six energy-efficient Habitat for Humanity homes this year. Florida Power & Light (FPL) is funding the construction of six houses complying with the utility's BuildSmart standards. The standards require home specifications to be subject to a performance-based analysis using EnergyGauge software. According to FPL, residents of BuildSmart homes can expect their electric bills to be between 10% and 30% lower than residents of typical new homes. For more on the BuildSmart program, visit www.fpl.com.

Proposed Solar Incentives In Maine

AUGUSTA, ME — Maine Governor John Baldacci has proposed using public benefit funds to pay for rebates

and tax credits to encourage sales of photovoltaic (PV) and solar thermal equipment. According to Beth Nagusky, the director of Maine's Office of Energy Independence and Security, the governor's plan calls for PV incentives of \$3 a watt and solar thermal incentives amounting to about 25% of installed costs.

CheckMe! Program Results Verified

SAN RAFAEL, CA — A new evaluation of the CheckMe! program shows that homeowners with air conditioning systems that have received CheckMe! performance testing have achieved 108% of predicted electricity savings. The CheckMe! program requires HVAC technicians to report results from on-site testing of air conditioning systems to a central computer. The computer then verifies whether the technician's measurements of duct leakage, system airflow, and refrigerant charge are within acceptable ranges for best system performance (see *EDU*, February 2000 and March 2001). The CheckMe! program was developed by Proctor Engineering Group and is funded by the California Public Utilities Commission. For more information, visit Proctor Engineering's Web site at www.protoreng.com.

China Announces Push for Energy-Efficient Buildings

BEIJING, CHINA — China will launch "a massive campaign soon to implement energy savings and promote environment-friendly building nationwide," according to an announcement by Qui Baoxing, China's vice-minister of construction. At a press conference reported by *China Daily*, Qui cited several examples of waste and inefficiency, including the fact that the typical Chinese toilet uses 30% more water per flush than toilets used in other countries. The article quoted James Jao, the CEO of J.A.O. Design International, who applauded the new commitment from the Chinese government, noting, "The most important work is to improve the awareness of the public and strengthen enforcement of the energy-saving codes and regulations."

Increase In PV Incentives Could Lead To Job Growth

WASHINGTON, DC — An increase in incentives for the installation of photovoltaic (PV) systems could create 35,000 new jobs in the US, according to a new report from the Renewable Energy Policy Project. The report, "Solar PV Development: Location of Economic Activity," attempts to quantify job creation resulting from "a reasonable set of incentives" — that is, incentives generous enough to produce 30% annual growth in PV installations for the next 20 years. The report

notes that increased PV incentives "will lead to jobs and investment in areas of the country that manufacture the parts that make up a PV system, in addition to locations that install the systems." According to the report's projections, the state most likely to see significant job growth is California, which could see 6,858 new jobs in PV manufacturing and 3,578 new jobs in PV system installation. To read the full report, visit www.repp.org.

Canadian Geothermal Target Called Unrealistic

OTTAWA, ONTARIO — A renewable energy group has asked the Canadian government to renounce its ambitious plan to increase the number of installations of ground-source heat pumps. According to *Refocus*, the international renewable energy magazine, the Earth Energy Society of Canada is concerned that the establishment of unrealistic targets will taint the reputation of the ground-source heat pump industry. The government's Sustainable Development Strategy calls for the installation of 25,000 commercial ground-source heat pumps in Canada by 2008. In a letter to Energy Minister John Efford, a representative of the Earth Energy Society of Canada wrote, "Natural Resources Canada has no intention of meeting that target; there is no action plan, no strategy, and no support, as there is for wind and ethanol. ... Without an action plan and with no support, that target is doomed to failure and the earth energy industry would prefer not to be labeled as such."

Building With Hemp Bricks In Australia

LISMORE, N.S.W., AUSTRALIA — An Australian university professor is planning to build Australia's first homes with hemp-brick walls, one in New South Wales and one in Queensland. According to an article from Australian Associated Press, Dr. Keith Bolton from Southern Cross University has overseen the cultivation in a secret location of 2.5 million cannabis plants. "We will harvest the hemp," said Bolton. "Then we'll grind the stems up to the right composition and then we'll incorporate those stems with lime and some other ingredients, and that then sets." Although hemp is rarely used as a construction material in Australia or the US, it has been used for years in Europe as an insulation material and as an ingredient in bricks (see *EDU*, November 2002). Bolton is a hemp booster. "It's lightweight, and it's got far superior insulation properties compared with conventional building materials," he said. If Bolton stays on schedule, the homes will be finished by the end of the year.

2004 Was the Fourth Warmest Year Ever

NEW YORK, NY — Recently released data from the

National Aeronautics and Space Administration (NASA) show that last year was the fourth warmest year since systematic recording of temperatures began in the 19th century. The three warmest years ever recorded were 1998, 2002, and 2003. According to a report in the *New York Times*, Dr. James Hansen, the director of NASA's Goddard Institute for Space Studies, announced that increases in global temperatures are "due primarily to increasing greenhouse gases in the atmosphere."

Traditional Malaysian Housing Beats New Housing For Comfort

KUCHING, MALAYSIA — A study comparing traditional Malaysian housing with modern Malaysian housing has concluded that traditional housing provides occupants with better thermal comfort. John Tinker, an engineering professor from the University of Leeds in the United Kingdom, used data loggers to monitor indoor and outdoor temperatures, airspeeds, and relative humidity at two houses in Malaysia, and reported his findings in a paper titled "An Evaluation of Thermal Comfort in Typical Modern Low-Income Housing in Malaysia." The traditional Malaysian house is an uninsulated wooden house on stilts with gapped floor boards to allow underfloor ventilation. Such traditional houses usually have roofs with large overhangs at the eaves and rakes, and large floor-to-ceiling windows left open all day for ventilation. A

traditional house was monitored, as was a modern low-income house built on a slab. Such modern houses typically have stingy roof overhangs, metal roofing, and small windows. Tinker's data showed that because the modern house design has insufficient provision for ventilation, "thermal comfort was achieved in the traditional Malay house throughout the monitoring period, but the modern low-income house was thermally uncomfortable under certain conditions." For more information, contact John Tinker at the University of Leeds, Leeds, England LS2 9JT, United Kingdom; E-mail: j.a.tinker@leeds.ac.uk.

Quote Without Comment

"Early refrigerator cabinets were insulated with cork-board or even seaweed. (Frigidaire found that dried eel-grass made a good refrigerator insulation.) Insulation choices for later cabinets included cellulose fiber board, metal foil separated with air spaces, corrugated cardboard, mineral wool, or kapok." ["Electric Refrigerators' Vital Contribution to Households," by Bernard Nagengast, in *ASHRAE Journal*, November 2004.]

Correction

In "Air Barrier Durability" (*EDU*, March 2005), Anil Parekh was misidentified as a Winnipeg researcher. Anil Parekh is in fact a senior researcher at the Sustainable Built Environment Group at Natural Resources Canada in Ottawa, Ontario. *EDU* regrets the error.

RESEARCH AND IDEAS

Fiberglass-Insulated Homes Are the Leakiest

Proponents of cellulose insulation have long maintained that houses insulated with cellulose have less air leakage than those insulated with fiberglass batts. Yet not all researchers looking into the issue have found a clear correlation between insulation type and airtightness, and most fiberglass manufacturers have been reluctant to cede any ground on the issue.

Over the past decades, *EDU* has published several articles looking into correlations between air leakage and insulation type. Regardless of the findings reported, such articles generate an above-average number of letters to the editor, as representatives of competing insulation manufacturers probe every study for flaws.

One possible weakness of some earlier studies is the small number of houses involved. For example, a study reported in the November 1989 issue of *EDU*

involved only 4 houses; one reported in the February 1997 issue involved only 7 houses; one reported in the November 1997 issue involved only 2 houses; and one reported in the May 1998 issue involved only 26 houses. (A study involving an unspecified number of houses was reported in our June 1994 issue.)

Data From Hundreds of Homes

Recently Bruce Harley, the technical director for residential energy services for the Conservation Services Group in Westborough, Massachusetts, was able to study correlations between airtightness and insulation type in a much larger number of buildings. Harley assembled airtightness data on Energy Star homes (including single-family and multifamily homes) completed in 2004 in Massachusetts and Rhode Island (see Figure 6). All of the homes were blower-door tested after completion.



Figure 6. A comparison of the airtightness of 182 cellulose-insulated houses and 684 fiberglass-insulated houses revealed that the cellulose-insulated houses are significantly more airtight.

The number of houses in the data set differs depending on whether the houses are divided by wall insulation type or ceiling insulation type. (There are several reasons for this, including the fact that a small number of houses, including homes with SIP walls or roofs, use a variety of insulation types or unusual insulation types. There was no easy way to segregate the houses with more than one type of insulation from those with a single insulation type.) Harley was able to look at airtightness data for 906 homes divided by wall insulation type, and 702 homes divided by ceiling insulation type.

Houses With Spray Foam Are the Tightest

Harley found that houses with walls insulated with spray polyurethane foam were significantly tighter

than those houses with walls insulated with cellulose, and that houses with walls insulated with cellulose were significantly tighter than those insulated with fiberglass (see Table 1). Sorting the houses by ceiling insulation type yielded similar results to those obtained by sorting the houses by wall insulation type.

Although the data clearly show a consistent correlation between insulation type and airtightness, the reasons for the correlation are unknown. It is possible that builders who choose cellulose or spray foam insulation — both of which have a reputation for resisting air flow — may be more meticulous in performing air sealing tasks than builders who choose fiberglass batts. Perhaps builders' attention to detail in certain areas unrelated to insulation performance — for example, careful sealing between wall bottom plates and subfloors — partially explains the measured differences in airtightness. If this theory is true, the extra dedication to air sealing may be motivated by the builders' desire to justify the added cost of spray foam or cellulose over fiberglass batts.

However, the principle of Occam's Razor favors a simpler explanation: that the measured differences in airtightness are due to differences in the material characteristics of the different insulations. For more information, contact Bruce Harley at 577 Boulger Road, Stamford, VT 05352; E-mail: bruce.harley@csggrp.com.

Table 1 — Airtightness of Energy Star Houses

Houses Separated By Wall Insulation Type	Average Airtightness
Houses with fiberglass-insulated walls (684 houses)	0.38 ACH _{nat}
Houses with cellulose-insulated walls (182 houses)	0.31 ACH _{nat}
Houses with walls insulated with spray polyurethane foam (23 houses)	0.26 ACH _{nat}
Houses Separated By Ceiling / Roof Insulation Type	
Houses with fiberglass-insulated ceilings / roofs (466 houses)	0.40 ACH _{nat}
Houses with cellulose-insulated ceilings / roofs (192 houses)	0.30 ACH _{nat}
Houses with ceilings / roofs insulated with spray polyurethane foam (18 houses)	0.24 ACH _{nat}
Table 1. Energy expert Bruce Harley recently compared the blower-door results of a large database of new Energy Star homes built in Massachusetts and Rhode Island. On average, the houses insulated with fiberglass batts were the leakiest.	

NEW PRODUCTS

Easy-To-Clean Spray Foam

Hardware-store cans of one-component spray urethane foam are an indispensable item on many job sites. Although many contractors who are serious about air sealing have graduated to Pageris foam guns and Pur-Fill cartridges, or even two-component

polyurethane foam kits (see *EDU*, June 2002), the hardware store cans have certain advantages: they are available everywhere, they are relatively cheap, and they don't require the maintenance of expensive, easy-to-clog equipment.

Many builders have a love/hate relationship with spray urethane foam, which, though effective at sealing leaks, leaves uncleanable black spots on fingertips and unremovable globs on clothing. Dap, a manufacturer of joint compound and caulk, has recently introduced an alternative to one-component urethane called DapTex Plus Window & Door Foam Sealant (see Figure 7). The main advantage of the product: since it is latex-based, it cleans up with soap and water.



Figure 7. Unlike one-component urethane spray foam, DapTex foam cleans up with soap and water.

For some, easy cleanup may be reason enough to switch from canned polyurethane foam to canned DapTex. However, the performance of DapTex fails to match that of one-component polyurethane.

Not As Sticky

DapTex looks very much like shaving cream when it comes out of the can. Unlike one-component urethane, it barely expands, so cracks need to be completely filled. Although DapTex's lack of stickiness is a virtue when it comes to cleaning fingers, it is less useful when it comes to gap-filling. Because of its minimal rate of expansion, it can sag a little when used to fill wide horizontal cracks, leaving an unsealed gap at the top.

A can of DapTex dispenses only one-third to one-half the volume of cured foam as does a can of one-

component urethane — 0.17 cubic feet versus 0.33 to 0.50 cubic feet for canned urethane. Moreover, to be sure a can of DapTex dispenses all of its contents, a user will need to be diligent about shaking the can to mix the propellant before dispensing. The DapTex instructions advise users to shake the can “vigorously” for a full minute before each use. Even 60 seconds of shaking, however, may be inadequate. According to Shree Nabar, Dap's vice president of technology, “If the can is cold or not shaken for a long enough time — typically 2 to 3 minutes — prior to each time it is applied, the propellant does not mix in and the pressure may not be adequate to pull all the foam out of the can.” So, get ready, DapTex users: there's going to be a whole lot of shakin' going on.

Unlike one-component urethane, DapTex is never very firm, even when fully cured. Although it eventually skins over, it yields readily when prodded with a finger. Because of its sponginess, it is far less versatile than one-component urethane. Cured urethane is firm, and can therefore be used to solve a wide variety of construction problems — for example, securing the copper tubing holding an unsecured shower arm, or filling a hole in gypsum wallboard with a material firm enough to support drywall compound.

To be fair to Dap, their new canned foam is being promoted not as a full substitute for canned urethane, but only for one application: foaming the perimeters of windows and doors, a purpose for which it appears to be suited. According to the manufacturer, DapTex meets ASTM standards for air-sealing and water-resistance (ASTM E328, ASTM E547, and ASTM E331) referenced by American Architectural Manufacturers Association (AAMA) standard 101.

DapTex Plus Window & Door Foam Sealant (Dap product code 18826) is available at Home Depot for about \$6 a can. For more information, contact DAP, 2400 Boston Street, Suite 200, Baltimore, MD 21224. Tel: (800) 543-3840 or (410) 675-2100; Fax: (410) 558-0953; Web site: www.dap.com.

INFORMATION RESOURCES

A New Edition of the *Water Management Guide*

The Energy and Environmental Building Association (EEBA) has come out with a revised edition of Joe Lstiburek's *Water Management Guide*, first released two and a half years ago (see *EDU*, December 2002).

Although the book is now twice as long as before, with 84 instead of 42 pages, its price remains unchanged, making it a better value. Among the new features:

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- A map of North America showing average annual rainfall;
- More details on back dams for rough window sills;
- Recommendations on choosing draining water-resistant barriers (WRBs) for use under stucco;
- Information on how solar radiation can cause inward vapor drive through walls;
- Details on ventilated cavities behind brick veneer;
- A greatly expanded window installation section, including details for installing windows in concrete-block walls; and
- A list of risk factors to help builders decide when to consider window installation methods that are usually considered risky.

The book's window installation details are among the most useful available from any source (see Figure 8). Much of the credit for the book's success belongs to its illustrator, Stephanie Finegan of Building Science Corporation. The clarity of Finegan's illustrations are exemplary, rivaling those of Tim Healey, the illustrator for the *Journal of Light Construction*.

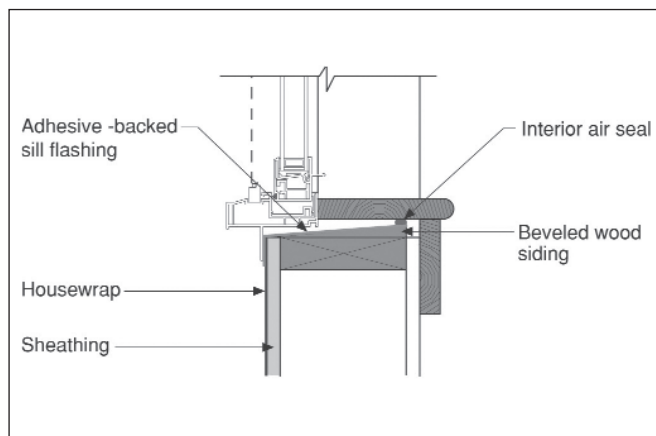


Figure 8. Most of the window installation methods included in the latest version of the EEBA *Water Management Guide* require the installation of drainable flashing on the rough sill. [Illustration by Stephanie Finegan from the EEBA *Water Management Guide*.]

The *Water Management Guide*'s 58 pages of window installation illustrations provide more information, with better clarity, than the 89 pages of dense specifications in the ASTM E2112 window installation standard. Moreover, the recommended details are better: for example, the *Water Management Guide*, unlike ASTM E2112, advises that in most cases, no caulk should be installed under a window's bottom fin.

No More Martini Glass

Some of the *Water Management Guide*'s recommendations have changed since the publication of the first edition: for example, the recommended shape of the housewrap cut at a window rough opening now has two slits at the top corners, to create a housewrap flap to lift over the window's top fin. By contrast, the housewrap cut shown in the first edition was a simple "upside-down martini glass" cut, without any top-flap slits.

The book provides several alternate methods of window installation, depending, for example, on whether the WRB is installed before or after the window, or whether the builder has chosen a "barrier assembly" approach or a "drained opening" approach. Almost all of the recommended window installation methods follow the "drained opening" approach — that is, the book recommends the installation of some type of drained flashing on the rough sill. For this approach to work, the installer must leave the window's bottom fin uncaulked.

Should a Window Ever Be Face-Sealed?

In regards to the fundamental choice between a barrier assembly and drained openings, the *Water Management Guide* unfortunately provides inconsistent advice. At times, as on page 18, the guide is unequivocal: "Window and door openings should be designed and constructed to shed or drain water to the exterior." However, on the very next page, the message is decidedly mixed: "The choice of strategy is determined by many factors. Drained openings are better than barrier openings."

Moreover, beginning on page 52, under the heading "Face-Seal Window to OSB or Plywood," the book provides six pages of illustrations demonstrating a risky window installation method that omits flashing on the rough sill, and instead recommends installing caulk behind all four window fins. A careful reader of the book will realize that the method should only be considered in dry climates, and probably only for windows with little exposure. However, the book fails to flag the installation method with a warning about the risk of face-sealed installations. Such a warning is warranted.

The EEBA *Water Management Guide* is available for \$18 (\$15 for EEBA members) from the Energy and Environmental Building Association, 10740 Lyndale Avenue South #10W, Bloomington, MN 55420. Tel: (952) 881-1098; Web site: www.eeba.org.

READERS' FORUM

Price Correction

Dear Editor,

Thank you for the very thorough and informative article on Dawn Solar. However, I'd like to correct the system price quoted. The quoted price (\$6,500 to \$7,000 installed) includes the cost of the roof-mounted components, solar storage tank, pump, and controller, but not the cost of the metal roofing.

Bill Poleatewich
Dawn Solar Systems
Brentwood, New Hampshire

Commensurate With Other Dictionaries

Dear Editor,

Regarding the review of the *Illustrated Dictionary of Building Design and Construction* in the February issue, I feel compelled to offer this alternate viewpoint as the author of the work.

It is unfortunate that the reviewer concentrated on a negative rebuke of several energy-related definitions, yet failed to mention that the work contains over 1,500 photographs to illustrate the definitions, far more than any other dictionary in its class. Or that the coordination between the roles of the architect, contractor, and subcontractor were identified on design, functional, and legal levels throughout the entire building process, which is really the focus of the work.

The reviewer's comments seemed extraordinarily negative, including criticism for what did not appear in the book and the depth of information offered in the interpretation of terms — a level commensurate with many of the current construction dictionaries printed by major publishers.

While the reviewer did provide a better definition of a term — input that we're glad to have — perhaps there should have been some perspective in pointing out one typo out of 6,000 definitions representing perhaps as many as 100,000 or more words. We would hope that the people who pick up this book will recognize the more valuable aspects of design and construction included and judge the value of this reference for themselves.

Ernest Burden
New York, New York

Editor's Reply

The *EDU* review noted flaws in Mr. Burden's definitions of, or provided better definitions for, not one but 13 terms: air barrier, air plenum, divided light, EPS forms, fascia, heat exchanger, heat pump, insulation batt, LEED, sandwich panel, shoddy, stressed skin panel, and vapor barrier. The terms chosen for discussion in the review make up a list that is indicative but by no means exhaustive of the book's errors. It should be noted that Mr. Burden does not refute any of the technical points raised in *EDU*'s review.

It is altogether appropriate to hold a reference work like a dictionary to a higher standard of accuracy than that expected of, say, a magazine article, especially for architectural terms (including "air barrier" and "vapor barrier") that directly affect a building's performance. Sadly, Mr. Burden is probably correct when he points out that the depth of information offered in his dictionary is commensurate with the depth offered by many current construction dictionaries printed by major publishers.

Why Not Insulate the Rafters?

Dear Editor,

I was surprised that the article on burying ducts in attic insulation in the February 2005 issue did not mention the alternative of insulating the rafters instead of the floor of the attic space. My experience — admittedly, primarily with retrofits and rarely with truss-framed roofs — is that rafter insulation provides far superior overall performance than attic floor insulation, in particular when there is HVAC equipment or ductwork in the attic. What am I missing here?

By the way, I've been reading *EDU* for 17 or 18 years now. It's the one publication that, when it arrives, I stop everything else to read. It's the single most valuable, reliable construction resource out there. Small point: I'm glad you changed the headings for the "News Briefs" items to reflect the content rather than the city of origin — it makes for easier scanning.

Paul Eldrenkamp
Byggmeister, Incorporated
Newton, Massachusetts

Editor's Reply

Thanks for the kind words, and thanks for sharing your experience with sealed, conditioned attics. *EDU* has reported on builders' experiments with so-called "cathedralized" attics for many years (see *EDU*, September 1995, November 1997, December 1997, September 1998, January 1999, May 2001, October 2002, and January 2003).

Although locating HVAC equipment and ductwork within a home's conditioned space has obvious performance advantages, some builders have reported disadvantages with cathedralized attics, including the following:

- Installing insulation between rafters is more difficult and more expensive than installing it on a flat attic floor.
- Venting above rafter insulation is difficult in roofs with hips and valleys.
- Building inspectors may be reluctant to approve the technique, especially if rafter bays are unvented.
- Some builders in hot, humid climates have reported sheathing moisture problems and shingle buckling due to solar vapor drive through asphalt shingles.

However, if the rafter insulation is properly detailed for the local climate, and if the local inspector approves, cathedralized attics perform very well, as your experience bears out.

On the Hygric Properties of Plaster and Stucco

Dear Editor,
In the February "News Briefs" section, I enjoyed reading about Portugal, where new plasters contribute to mold, because I know both people mentioned. But I would like to draw your attention to Minnesota and

other cold areas of North America having the same problem. (In my opinion, there is a large difference between the good stucco practices in the South and Southwest and those not-so-good practices in the Northeast and North, including almost all of Canada).

The problem is partly similar to that mentioned in the next item ("Quote Without Comment") in the February issue, concerning water damage behind cast-stone cladding. I will present two papers on the problem (co-authored by Paul Ellringer from Minnesota and a graduate student at Syracuse University) at the International Lime conference on March 9-11 in Orlando, Florida.

After the conference, I will be looking for interested parties to join a research consortium at Syracuse University to develop a comprehensive methodology that links moisture storage and moisture transmission of the cladding system to the climate and WRB-OSB properties. This consortium should also develop acceptance criteria for hygric properties of stucco placed on thermal insulation.

Mark Bomberg
Syracuse University
Syracuse, New York

Editor's Reply

Thanks for the information. Like the Portuguese researchers cited in the February issue of *EDU*, Dr. Bomberg has found that thin, modern plaster and stucco formulations with finishing layers containing polymeric admixtures do not perform as well as traditional plasters and stuccos. Typically, finishing layers of modern stucco formulations are designed to be more resistant to liquid water — that is, tighter — than older lime/cement stuccos. These tighter stuccos dry much more slowly than traditional stuccos. Stuccos that stay wet longer can contribute to rot in OSB sheathing, especially when subject to inward solar vapor drive.

BACK PAGE

Human Delta-T Champs

In El Centro, California, cooling systems are sized based on a difference between indoor and outdoor design temperatures — that is, a delta-T — of 37 Fahrenheit degrees. Heating system designers usually deal with larger delta-T's; in Fairbanks, Alaska, the design delta-T is typically 120 degrees.

However, the human delta-T champions are undoubtedly the naked scientists and Antarctic support staff who have gained entry to the 300 Club. A long-standing tradition among those who winter over at the South Pole Station calls for an announcement over the PA system whenever the thermometer drops to -100°F — usually in July or August. At that point, the scientific station's sauna is fired up to at least 200°F . To be admitted to the 300 Club, one must dash outdoors from the sauna to the geographic south pole — a distance of about 750 feet — and back, wearing no more than sneakers and a face mask.

The elegance of the 300 Club concept depends, of course, on the use of the Fahrenheit scale. Although another Antarctic station, Vostok, regularly experiences outdoor temperatures of -73°C — the equivalent of

-100°F — and is equipped with a Russian *banya* that can be cranked up beyond 93°C — the equivalent of 200°F — no Russian scientist has yet proposed the creation of a 166 Club.

The South Pole sauna dates back to 1975, when the station's geodesic dome was completed. Because the sauna controls have a conservative safety limit, 300 Club members have learned to insert the thermostat's temperature sensor in a container of cold water to get the sauna temperature above 200°F .

Now that the construction of a new \$153 million South Pole Station (with 11-inch thick SIP walls and a 13-inch-thick SIP roof) is almost complete, the old 1975 station is scheduled for demolition. Although, in acknowledgement of the importance of maintaining the 300 Club tradition, the controls on the new sauna have been altered to increase its maximum temperature, a few scientists have complained that the longer distance between the new sauna and the geographic south pole will make the traditional 300 Club dash virtually impossible. Sadly, the days of the 300 Club may be numbered.

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