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INDUSTRY NEWS

Changing the Code on Vapor Retarders

Joseph Lstiburek, a principal of the Building Science Corporation in Westford, Massachusetts, has long argued against the use of polyethylene vapor barriers in air-conditioned homes. In a typical warning to builders, Lstiburek told the *Southface Journal of Sustainable Building* (Spring 2002), "Don't put plastic on the inside of your building. No vinyl wallpaper, no polyethylene vapor barriers, except if you're in Minnesota. I've seen more buildings trashed because of vapor barriers on the interior because of misguided information on energy conservation requirements than any single failure."

IN THIS ISSUE

Inappropriate polyethylene vapor retarders are often installed due to job-site ignorance. Most frustrating to Lstiburek, however, are the cases when poly is inappropriately required by a code official. In hopes of improving the code, Lstiburek is now rallying a group of engineers and scientists to submit a proposal to change vapor-retarder requirements in the International Energy Conservation Code (IECC) and the International Residential Code (IRC).

Currently the IRC (section R322.1) and the IECC (section 502.1.1) require a vapor retarder with a permeance of 1.0 or less on the warm-in-winter side of insulation except in counties designated as hot and humid. Since the code does not require the use of polyethylene—kraft facing meets the code definition of a vapor retarder—the requirement, at first glance, does not appear problematic. However, the current code language often steers builders to choose, or inspectors to insist on, polyethylene in walls. According to Betsy Pettit, an architect and principal at Building Science Corporation, "Even where the existing code requires a vapor retarder with a permeance of 1 perm or less, there are many jurisdictions where that often gets interpreted as meaning 'Nothing but poly will do.'"

Moreover, the vapor-retarder requirement makes many builders unwilling to switch from kraft-faced batts to insulation products like cellulose or blown-in-place fiberglass that do not incorporate a vapor retarder.
As Lstiburek notes, "The current code is dangerous—not because it is completely wrong, but because it is not clear enough to allow us to do the right thing without interference from the authorities who have jurisdiction."

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Southern States Don't Need Vapor Retarders

The first step towards eliminating unnecessary vapor retarder requirements in the International codes occurred last September, when code change proposal EC48 passed a preliminary hurdle and was approved with modifications in Nashville, Tennessee (see ***EDU***, December 2003). The Department of Energy (DOE) proposal, a radical simplification of the existing energy code, included a provision (section 402.5) removing all vapor retarder requirements in Climate Zones 1 through 4. With this change, the area exempted from vapor retarder requirements expanded to embrace not only the regions designated as hot and humid in the current code, but also regions that are somewhat drier and further north, including most of California, Missouri, Kentucky, Virginia, Maryland, and Delaware.

This past winter, proposal EC48 was released for public comment. On May 17, 2004, at the Spring Meeting of the International Code Council (ICC) in Overland Park, Kansas, code officials weighed the comments and voted to approve Proposal EC48 with only slight modifications. (The May 17 modifications to EC48—mostly changes intended to bring the requirements of the IECC and the IRC into better alignment—were proposed by the DOE.) EC48 is, in effect, an entirely new residential energy code. Having passed its last hurdle, it will be published in July 2004 as the *Supplement to the 2003 I-Codes*.

A New Proposal

With the adoption of Proposal EC48, vapor-retarder requirements have been eliminated in Zones 1 through 4. Code reform advocates are now turning their attention to changing the requirements for the northern half of the US (Zones 5 through 7). Lstiburek and his colleagues at the Building Science Corporation are working to build a consensus on a code-change proposal for submittal to the ICC by August 20, 2004. Although the details of Lstiburek's proposal have not yet been finalized, a version of the proposal is circulating among stakeholders in an attempt to build a consensus. If the proposal is adopted, it will eventually be incorporated into the 2006 editions of the I-Codes.

The proposal would establish three different classes of vapor retarder based on permeance (see Table 1). It sets requirements for vapor retarders based on climate zone

Table 1—Proposed Classification System for Vapor Retarders

Type of vapor retarder	Permeance	Description	Example
Class I	0.1 perm or less	Vapor impermeable (vapor barrier)	Polyethylene
Class II	1.0 perm or less	Vapor semi-impermeable	Kraft facing
Class III	10 perms or less	Vapor semi-permeable	Gypsum wallboard with one coat of latex paint
Unclassified	Greater than 10 perms	Vapor permeable	Tyvek Homewrap

Table 1. Joseph Lstiburek proposes that vapor retarders be divided into three classes, with the classes separated by an order of magnitude difference in permeance.

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(using the proposed DOE climate zones approved for use in the Supplement to the 2003 IECC) and exterior sheathing permeance (see Table 2, page 4). In most cases, a builder would not be able to use foam sheathing without first showing that the sheathing was thick enough to keep the interior face of the sheathing above the dewpoint.

Although exterior foam sheathing creates a "wrong-side" vapor retarder in cold climates, by warming the wall cavity it makes for a robust and forgiving wall assembly, as long as it is thick enough. As Anton TenWolde, a supervisory research physicist at the US Forest Products Laboratory in Madison, Wisconsin, explains, "When you put enough foam in the wall you get away from the cliff rapidly, and there's no reason to worry about vapor barriers any more."

To determine the appropriate thickness of foam sheathing, designers would have to perform a "dewpoint test" following a procedure specified in the proposal. Bill Rose, a building science researcher at the University of Illinois in Urbana-Champaign, says, "If we have insulated sheathing, then I would argue that we need a climate-based amount of insulated sheathing—maybe 1 ½ inches or 2 inches in New England or Minnesota, but less south of that. If you can meet the dewpoint test, then I think vapor barriers with insulated sheathing should be discouraged. Insulated sheathing brings the southern recommendation up north. So, in the South, no vapor barrier, and in the North, with insulated sheathing that meets the dewpoint test, also no vapor barrier."

According to the proposal, the permeance of vapor retarders would be determined by ASTM E96 Test Method A (the dry cup test), while the permeance of exterior sheathing would be determined by ASTM E96 Test Method B (the wet cup test), to reflect the fact that some types of sheathing have increased permeance when exposed to high humidity.

The proposal is designed to provide builders with the maximum flexibility rather than to steer builders towards the best vapor retarder for their climate. Although it would set a maximum permeance for vapor retarders, it would not set a minimum. In other words, the proposal would still allow builders to make inappropriate choices, including the installation of a polyethylene vapor barrier anywhere in the country. Following the proposed code would provide no guarantee that a builder would stay out of trouble. As Pat Huelman, coordinator of the Cold Climate Research Center at the University of Minnesota, observed, "The wide range of options might lead to problems if the practitioner doesn't clearly understand all the elements."

Seeking Consensus

Lstiburek and Pettit began laying the groundwork for their code-change proposal at a Vapor Barrier Summit in June 2002 (see *EDU*, August 2002), and networking has continued since then. "Joe took this proposal to the January ASHRAE meeting and showed it to the people who he considered were able to help make policy, and he lobbied them to consider it," says Betsy Pettit. "He floated these ideas with dozens of engineers that have a stake in this."

This year's Vapor Barrier Summit, hosted as usual by the Building Science Corporation in Westford, Massachusetts, was held on June 14, 2004. At the day-long session, 67 experts and stakeholders discussed the details of the code-change proposal (see Figure 1).

Most of the assembled experts agree with Lstiburek's broad goals. "I don't think anyone disagrees with the elimination of vapor barrier requirements in hot humid climates, nor with the idea that we don't really need poly virtually anyplace in the US," said TenWolde. "Those are the things that are not controversial."

It's Complicated

Yet several summit participants expressed reservations about the proposal's complexity. "We could give a very simple answer, but a simple answer is too restrictive, and I want to be as inclusive as possible," said Lstiburek at the summit. "I'm not going to accept the

Figure 1. Bill Rose, Stan Gatland, and John Straube sharing a joke at the Vapor Barrier Summit in Westford, Massachusetts, on June 14, 2004. Bill Rose is a building researcher at the University of Illinois in Urbana-Champaign; Stan Gatland is the manager of building science technology at CertainTeed; and John Straube is an assistant professor of civil engineering at the University of Waterloo in Waterloo, Ontario.

Table 2—Proposed Vapor Retarder Requirements

Climate Zone	Exterior wall sheathing greater than 1.0 perm (OSB, plywood, fiberboard)	Exterior wall sheathing / cladding between 0.1 perm and 1.0 perm (stucco, unfaced extruded polystyrene 1 inch thick or less)	Exterior wall sheathing less than 0.1 perm (foil-faced polyisocyanurate)
1 (e.g., Key West)	No vapor retarder required	No vapor retarder required	No vapor retarder required
2 (e.g., New Orleans)	No vapor retarder required	No vapor retarder required	No vapor retarder required
3 (e.g., Little Rock)	No vapor retarder required	No vapor retarder required	No vapor retarder required
4 not marine (e.g., Kansas City)	Class III (paint)	Class III (paint)	Class III (paint)
4 marine (e.g., Seattle)	Class III (paint)	Class II (kraft facing) or Class III (paint) if dewpoint test shows that the interior face of the sheathing stays above the dewpoint at 40% interior RH	Class III (paint) if dewpoint test shows that the interior face of the sheathing stays above the dewpoint at 40% interior RH
5 (e.g., Chicago)	Class III (paint)	Class II (kraft facing) or Class III (paint) if dewpoint test shows that the interior face of the sheathing stays above the dewpoint at 30% interior RH	Class II (kraft facing) if dewpoint test shows that the interior face of the sheathing stays above the dewpoint at 30% interior RH or Class III (paint) if dewpoint test shows that the interior face of the sheathing stays above the dewpoint at 35% interior RH
6 (e.g., Minneapolis)	Class II (kraft facing)	Class II (kraft facing) or Class III (paint) if dewpoint test shows that the interior face of the sheathing stays above the dewpoint at 25% interior RH	Class II (kraft facing) if dewpoint test shows that the interior face of the sheathing stays above the dewpoint at 25% interior RH or Class III (paint) if dewpoint test shows that the interior face of the sheathing stays above the dewpoint at 30% interior RH
7 (e.g., Duluth)	Class II (kraft facing)	Class II (kraft facing) or Class III (paint) if dewpoint test shows that the interior face of the sheathing stays above the dewpoint at 20% interior RH	Class II (kraft facing) if dewpoint test shows that the interior face of the sheathing stays above the dewpoint at 20% interior RH or Class III (paint) if dewpoint test shows that the interior face of the sheathing stays above the dewpoint at 25% interior RH

Table 2. According to a code-change proposal being put forward by the Building Science Corporation, vapor retarder requirements would depend on the climate zone and the choice of exterior sheathing. The use of exterior foam sheathing would usually trigger the need for a dewpoint test.

idea that this is too complicated for the average builder to figure out. These requirements are straightforward and simple. The code already requires us to consult span tables. We already use sophisticated tools like Manual J for HVAC design."

The proposal's complexity is not arbitrary, but arises from the fact that many variables affect the need for a vapor retarder. The current proposal accounts for three of these variables—climate, the permeance of the exterior sheathing, and the temperature of the interior face of the exterior sheathing. "You always need to know the climate," notes Achilles Karagiozis, a senior research engineer at Oak Ridge National Laboratory. "In North Carolina, it makes a big difference whether you are on a mountain or on the beach."

According to Lstiburek, the parameters of the code proposal are determined by physics. "The physics is really simple," he says. "It's based on what people decide to put on the outside of the building. If people had only one kind of sheathing and cladding, it would be much simpler."

Pettit admits that some builders would prefer a more prescriptive code. "Some people don't want to know the basis for the rules," she noted. "They say, 'Just tell me what to do.' But there is no substitute for knowledge. You have to understand the function of the materials you are using. If this code change forces people to understand what they are doing, I think that is a good thing."

Even if the calculations behind the proposal are irrefutable, the proposal's complexity is likely to affect its enforceability. Among those expressing doubts that local code officials will understand the requirements well enough to enforce them properly is Wagdy Anis, a principal at Shepley Bulfinch Richardson and Abbott in Boston, Massachusetts. At the June 14 summit, Anis noted the poor attendance at educational sessions on air barriers that he taught in collaboration with Massachusetts state energy officials. Although some of the sessions were targeted directly to local code officials, only a very small fraction of the state's officials ever showed up.

Twin Legs

Lstiburek emphasizes that the code-change proposal is built upon twin legs: investigations of building failures and computer modeling. "We're promoting it based on our experience on the forensic side, and because of DOE-funded Building America research," he said.

For Lstiburek, one cluster of building failures—the rotting walls in Cincinnati built by Zaring Homes (see *EDU*, August 2002)—has become a signature cautionary tale. As Lstiburek tells it, Zaring Homes was forced into bankruptcy when dozens of air-conditioned homes were damaged by the condensation of exterior moisture on wall poly. Like most building scientists, TenWolde is familiar with the oft-told story of Zaring Homes. "This all was initiated by our concerns about poly on walls with storage cladding subject to solar vapor drive," says TenWolde.

To help reassure code officials of the wisdom of the code-change proposal, Lstiburek has bolstered his observations with data from computer modeling of wall assemblies built with vapor retarders complying with the proposal. To help nail down the details of the proposal, engineers John Straube and Chris Schumacher of Balanced Solutions in Waterloo, Ontario, have conducted a series of WUFI simulations, while Achilles Karagiozis has run simulations using Moisture Expert.

Computer modeling, though useful, is unlikely to be persuasive without confirmation from field observations. "I am always wary of the Nintendo effect," says Rose. "I don't like to have models tell me I'm supposed to see something; I want to see it."

Computer modeling requires establishing a set of assumptions. Straube and Schumacher assumed that the houses they were modeling included mechanical ventilation but not humidifiers, assumptions that make TenWolde wary. "The analysis as described by John Straube and others assumed that ASHRAE 62.2 was in place in every home, and in my view that was not a conservative assumption," TenWolde notes. "The indoor relative humidity loads were not conservative. It can make a big difference, in cold climates, what indoor relative humidity you assume."

Lstiburek defends the indoor humidity assumptions adopted by the modelers. "The builder has influence over what the occupants do," he told the experts at the June 14 summit. "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. Let's establish the limitations of use. Builders should say, 'These are the expected limitations of use for this product.'"

Educating Officials

The fate of the code proposal depends more on politics than the solidity of the underlying physics. On one political issue—the function of the building code—there are widely divergent views. According to one school of thought, one of the benefits of fundamental code change, as opposed to minor code tweaking, is the educational effect wrought by profound changes. Arnie Katz, a senior building science consultant at Advanced Energy in Raleigh, North Carolina, explains, "There are still numerous code officials in North Carolina who view the requirement for a vapor retarder religiously, and just aren't going to be shaken by anything less than a code change."

Lstiburek's views on the question of whether the code should play an educational role are inconsistent. At times, Lstiburek echoes Katz. "The main reason for this [proposal], the most important reason, is to educate the code officials and the building industry," says Lstiburek. "Nothing teaches as well as code change or litigation."

But if code change can play an educational role, why not ban the use, in some climates, of vapor retarders with very low permeance? Defending his reluctance to propose such a ban, Lstiburek minimizes the educational function of building codes. "It is not the function of the code to teach builders and architects how to do their jobs," says Lstiburek. "I want to take the bad requirements out. I don't want to impose regulations now where none exist."

Lstiburek prefers a lenient to a stringent code—one that allows builders to make mistakes. "I am trying to prevent officials from making you do stupid things," he says. "I don't want to get overly restrictive; I would like the minimum control necessary. I don't want to ban vinyl wallpaper. I just don't want to be forced into using these products. I don't want the building code to be the final arbiter on design."

Growing Support

Several participants in the Westford summit likened the consensus-building process to herding cats. In spite of the inherent difficulties in achieving consensus among building scientists, the proposal appears to be gaining sponsors. "I support the proposal," said Rose. "Joe's line of thought is entirely consistent with my own concerning what can or should be done in the building code with regard to vapor barriers. I am a strong supporter of an end-product in which the door is wide open throughout the US to the use of alternatives to polyethylene. In most cases that will mean nothing for the southern half, and something other than poly for the northern half."

Wagdy Anis also favors the code change. "I'm strongly in support of this proposal," he says. "It's a lot more precise than the confused world we were in." On balance, TenWolde expresses a measure of support as well. "I don't see that this [proposal] can do a lot of harm," he says. "Even if it isn't effective at fixing a lot of problems, it probably will not cause a lot of problems either, and it will move a few buildings from the edge of failure. So on balance I'm fairly positive about it."

At present, however, TenWolde's support for the proposal is tepid. "I'm very uncomfortable to give the impression yet again that it is all about vapor barriers and permeance," says TenWolde. "In fact we are looking where the light is, because we can do the calculations. And based on those calculations we come up with these fairly elaborate rules."

According to TenWolde, any code requirements for vapor retarders should take airtightness into account. "How do we deal with air leakage?" he asks. "We give the impression that if you take care of your permeabilities in your construction, you are done. We must remember that prescriptive rules have a habit of becoming dogma."

On this point, Karagiozis agrees with TenWolde. "All of these vapor retarder proposals must be tied to the airtightness of the structure," says Karagiozis. "It's all related—the vapor control strategy, airtightness, and whether or not there is a ventilation cavity behind the exterior cladding. If you have a ventilation cavity behind the cladding, it doesn't matter what kind of vapor retarder strategy you use."

Karagiozis is keenly aware of the difficulty of establishing requirements for one element of a wall or ceiling assembly without taking all of the relevant factors into account. "We need follow-up work on the effect of air leakage," says Karagiozis. "If you have a little bit of air leakage, you might have some locations show higher moisture on the inward or outward side of your sheathing. The vapor retarder requirements depend on where the moisture is moving."

Karagiozis, like TenWolde, is reluctant to put too much emphasis on vapor retarders. "Comparing vapor retarder strategies, we are dealing with a small tiny little drop and we are making a big fuss about it," says Karagiozis. "We need to offer some options, but you know what—you have more forgiveness if you have a ventilation cavity behind the cladding than you have by tinkering around with your vapor retarder requirements."

Experts also disagree on the lessons to be extracted from building failures. "I don't know how well we have actually documented and proved that poly is the main culprit in a lot of the failures," notes TenWolde cautiously. "It is clear that it doesn't help, and that taking the poly out is probably making the building more forgiving. But to say it is the culprit in a lot of these failures—I still have not seen the documented evidence. How many of these problems were air-leakage-related and how many were poly-related? When the vinyl wallpaper issue came up in hotels, the wall systems hardly ever failed without negative pressures. Joe is right: when you take off the vinyl wallpaper, most of those problems go away. But how much of the problem was attributable to what?"

Should Scientists Make Construction Recommendations?

In Westford, the herding of cats appeared to be difficult, due in part to disagreements over the proper role of building codes. Moreover, some building scientists are reluctant to make any construction recommendations. "I'd rather keep it in the design arena and put as little in the code as possible," said TenWolde.

Rose is wary of giving builders the impression that a house built to code will necessarily be durable. "To me this is a classic case study in how we derive construction recommendations from building science," says Rose. "There is a perception out there that building science should come out with design recommendations. But I say we should save 'science' for conducting research, developing a hypothesis, and testing."

The details of the code-change proposal are unlikely to be finalized until shortly before the ICC deadline of August 20, 2004. With Lstiburek and Pettit working hard to achieve consensus, it's likely that most of the concerns raised by TenWolde and Karagiozis will have been addressed by then. If consensus can be reached among the building scientists, the only work ahead, in Rose's words, will be "messy marketing and arm-twisting."

NEWS BRIEFS

Energy Star Ad Stirs Controversy

DETROIT, MI—Critics are questioning the wisdom of a new Energy Star ad that encourages home energy efficiency. According to the *New York Times*, the $1 million television ad campaign promotes reductions in home energy use by lampooning attempts to improve fuel efficiency in cars. In one of the public service announcements (PSA), a woman named Suzanne complains about the efforts of her husband Mark to save gasoline. The *Times* explains, "Mark—nerdy, pudgy, harried—is shown rigging up their car, first with a sail, then a microwave contraption using huge satellite dishes, and finally a helium tank with a bulbous hose. 'The EPA says the energy we use in our home can cause twice the greenhouse gases of a car,' Suzanne says, adding that she has started buying energy-saving household products." The *Times* reports that some environmentalists would have preferred that the ad campaign encourage home energy efficiency without ridiculing efforts to improve vehicle gas mileage. EPA spokesperson John Millett defends the ad campaign. "The point of the PSA is to encourage energy efficiency in the home, using the automobile as a benchmark," Millet told ***EDU***. The ads can be viewed by visiting *www.energystar.gov/index.cfm?c=news.nr_psa*.

NREL Director To Retire

GOLDEN, CO—Richard Truly, the director of the National Renewable Energy Laboratory (NREL), has announced that he will retire in November 2004. Truly has served as NREL director for the past seven years. From 1989 to 1997, Truly served as Administrator of the National Aeronautics and Space Administration (NASA). After retiring, he plans to live in Colorado with his wife and family.

Green Power Incentives Said to Favor Small Producers

BOSTON, MA—Three large institutions—the Massachusetts Institute of Technology, Harvard University, and Equity Office Properties Trust, a real estate firm—have accused NStar Electric, a Massachusetts utility, of unjustly favoring small producers of renewable energy over large producers. Complaining that the utility's incentives for distributed generation ignore combined heat and power installations, the three large institutions point out that such installations have the potential to save far more electricity than the small photovoltaic and wind installations now targeted for incentives. According to an article in the *Boston Globe*, "The Harvard-MIT group is accusing NStar of essentially buying off opposition by agreeing to special rates for boutique-sized solar and