Guest Column

Vapor Barriers: Putting the Rumors to Rest

"Tar paper fastened under rafters supporting a sheet metal roof might have the advantage of avoiding dripping, from the fact that it would interpose a barrier between the moist air and the cold surface of the underside of the roof....To accomplish this it will be necessary to put the paper on very carefully, making tight joints along the rafters.

—from **Carpentry & Building,** March 1887
(courtesy G.E. Hahns, USDA forest Products Lab)

by Bill Rose

Three separate studies, along with reports in the press about them, have raised serious questions about vapor barriers, sparking controversy and confusion among people in the building trades.

A look at the facts, however, quickly puts the matter to rest. Vapor barriers are just as important as ever.

Oregon Research

Research by George Tsongas at Oregon's Portland State University involved opening the siding and sheathing in 103 homes in Spokane, Wash., to determine whether condensation or moisture damage was occurring at the locations checked.

Seventy-nine of the homes had been retrofitted with insulation; the other 24 were a control group. None of them had a vapor barrier before or after retrofitting. Of the 103 homes, only five had plywood sheathing, and five had Celotex sheathing; the others had lapboard sheathing—a particularly leaky sample.

Tsongas found no evidence of condensation or moisture damage. "Much of the discussion of condensation in walls is really a myth," he was quoted as saying in the February issue of *Family Handyman.* Tsongas claims that his results and conclusions "should also apply to other areas with winter weather similar to that of Spokane (6,835 degree-days), *which includes much of the central portion of the middle west and northeastern United States."*

But no one should be astonished that Tsongas didn't find condensation. First, while Spokane is cold, it also is semiarid. Second, the houses were opened only low in the wall, where dry *infiltration* would be likely to occur but where wet *exfiltration* would be quite unlikely.

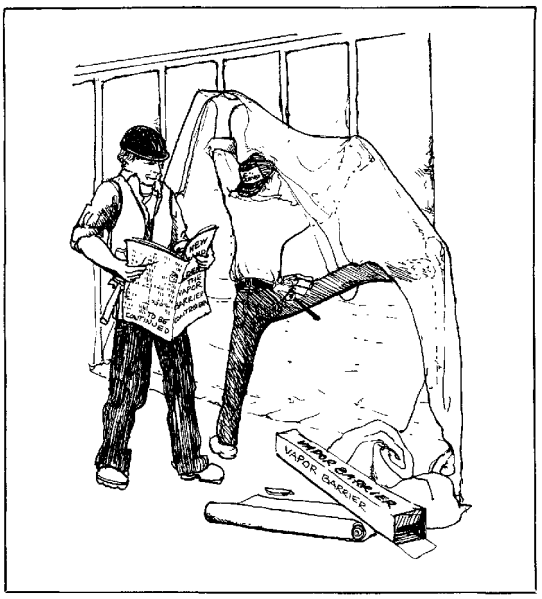
Tsongas maintains that condensation and moisture damage seldom are observed in actual field situations. But he has been looking in the wrong places—in houses with lapboard sheathing, in the desert, and in other areas where dry outdoor air is most likely to *infiltrate* the house.

To find condensation, you simply have to look where it occurs. You look in geographic regions where condensation occurs on windows. You look at houses sheathed with low-perm panel products, and you look at the parts of the house where the humid indoor air is exfiltrating. Paint may peel on walls, and siding may buckle or swell, but walls are not the most common site of major moisture damage. Eaves and roof sheathing are.

Larson & Benner Study

Another bit of research, known as the Larson and Benner study, took place at Drexel University in Philadelphia, Pa. It establishes that hygroscopic insulating materials such as cellulose, and adsorbing materials such as fiberglass, respond to indoor humidity levels. Their weight and conductivity increase as the relative humidity increases.

There's nothing startling here. What is startling, however, is Larson and Benner's conclusion, as quoted in the February '86 issue of *Energy Design Update (EDU),* that "at normal indoor humidity levels, i.e., 40 percent relative humidity, *the absence of a vapor barrier causes no problems" (EDU's* emphasis).



Builders would be wrong to presume that indoor air in a tight building somehow always will stay below 40 percent relative humidity—or that they are not responsible for damage if it goes above that. Besides, air at 40 percent relative humidity and 70 F condenses at 52 F. Even if the Drexel test panels showed no problems from condensation under these conditions, air with a 52 F dew point should not have the run of any and all building cavities.

The TenWolde Study

Research by Anton TenWolde of the United States Department of Agriculture (USDA) Forest Products Laboratory in Madison, Wise., indicates that in a warm, humid climate (Beaumont, Tex.), condensation occurs on the exterior face of the inside polyethylene vapor barrier when the exterior sheathing is fiberboard, but not when the exterior sheathing is a foil-faced insulative panel or some other less permeable sheathing.

This has caused some people to conclude that an interior vapor barrier *causes* moisture problems. In a *warm,* humid climate this appears to be the case, but in cold climates this finding reinforces classical moisture-transfer theory.

Why the Rumors?

Water vapor is created when people breathe and spaghetti cooks. It comes from showers and uncovered crawl spaces, from unvented kerosene heaters, flue gases and runaway humidifiers.

Water vapor produced in a building has to leave a building (water in equals water out). If the water hits a cold surface on the way out, it condenses at that spot. And if there's enough condensation at the right temperature, the problems start. This isn't myth. This is physics—and pretty basic physics at that.

Why, then, are rumors spreading that vapor barriers are on their way to extinction? Their use became common with the use of panel sheathing products, because extensive research showed that vapor barriers protect building materials against condensation and moisture damage in cold climates.

The issue of just *how* they protected building materials kept research alive for 20 years, pitting diffusion theory against convection effects, and causing the name of this curious membrane to be changed from vapor barrier to vapor retarder, to air barrier, and all combinations of the above.

Not all questions regarding vapor transmission have been answered. (What provides moisture protection in the southern states? Are ceiling vapor barriers a good idea? What constitutes a good vapor barrier, or a bad one?) But building product literature has long stressed the importance of a good vapor barrier, and builders have learned quickly what happened in homes without them. Their use in new construction in northern climates has become universal.

Those who are downplaying the importance of moisture problems certainly have precedents. As Ralph Johnson, president of the National Association of Home Builders (NAHB) Research Foundation, said in a 1980 report, "Now we have millions of house-years of experience that prove without a doubt that moisture problems in homes built during approximately the past 20 years are not extensive and not serious."

In central Illinois where I live, however, it appears that newer, tighter houses are *more*—not *less*—prone to moisture problems. According to Illinois distributors of sheathing products, condensation problems in this state tend to occur where the climate is more humid, even if the climate is warmer.

There are two questions here: 1) Does moisture damage occur often enough to cause concern, and 2) Should—or can—vapor barriers control moisture transfer?

The Need Reaffirmed

The Small Homes Council—Building Research Council now is completing a moisture-condensation survey of 600 of the 25,000 homes in the Champaign-Urbana area. As far as we know, this is the first survey that establishes the statistical (not anecdotal) prevalence of major and minor condensation problems in a region.

The survey defines a major moisture problem as one that is accompanied by both wood decay and loss of strength in structural members; minor moisture problems are considered mildew, water spots, peeling paint, the appearance of condensation or frost and the like. The survey distinguishes between condensation problems (where the condition is caused by the condensation of water vapor) and moisture problems (where the condition is caused by any form of moisture transport—vapor or liquid).

Preliminary reports show that 2 percent of the homes in the county have major condensation problems, and that 10 percent have minor problems. This translates to 500 homes with major problems and a total of 3,000 homes with some significant problem in just one Illinois county. It's worth noting once again that these problems comprise just a part of all of the moisture problems discovered in the area.

So can moisture be controlled by vapor barriers? There are three ways to control moisture: at the source (placing a lid on the spaghetti pot, pulling the plug on the humidifier, removing green firewood from the cellar, eliminating showers, etc.); with the help of ventilation (a rangehood, a bathroom vent, an air-to-air heat exchanger, etc.), or with membranes (vapor barriers, vapor retarders, etc.).

The occupants control (or don't control) the sources; they are also responsible (or not responsible) for the use and/or maintenance of ventilation devices. Hence, the only means of control available to the builder is a membrane. And as an examination of court decisions will affirm, the builder is responsible for providing a dry house. The only certain means available is the vapor barrier.

Research, field observations and common sense all tell the same story: Condensation occurs only where there is no barrier—no membrane that keeps humid air from chilled surfaces. It occurs where water vapor meets its dew point.

Condensation is not a hoax perpetrated by some multinational polyethylene conglomerate. Water vapor is invisible, hard to feel except for extremes of dryness or wetness, and difficult to monitor—all of which contribute to the mystery of its occurrence.

But water vapor hasn't yet overstepped the laws of physics. ■

Bill Rose, an erstwhile New Englander, received an architecture degree from a "prestigious Eastern university." He currently is paying off his student loans by working at the Small Homes Council-Building Research Council at the University of Illinois and writing articles such as this.