

MONITOR

THE INFORMATION SOURCE FOR THE STRUCTURAL INSULATED PANELS INDUSTRY

SPECIAL EDITION

MONITOR EXCLUSIVE

ROTTING SIP ROOFS IN JUNEAU

by Stephen Andrews

Part I: The Base Line Info

"There are two sides to every question."
Protagoras (485 – 410 B.C.)

In 1997, one year after closing on her new home in the Bellview subdivision of Juneau, Alaska, Susan Kaiser reported a very small leak dripping from the interior of her vaulted ceiling. That was the camel's nose under the tent- initial evidence of what has since mushroomed into a multi-million dollar damage claim on roof structures built with structural insulated panels (SIPs).

Reports of 6-year-old SIP roof panels rotting in Juneau, as previously posted on the SIP Talk section of this website (see the thread "Anything wrong with SIPs?"), have been confirmed by numerous parties in Juneau. The number of homes with roofs requiring complete replacement is estimated to be around 60 and growing. Most quotes for combined replacement costs plus per-diem expenses range between \$90,000 and \$120,000, depending on home size and other factors.

Three issues readers should appreciate.

- First, while there appear to be majority opinions on some factors in this growing situation, there isn't full agreement about the root causes of the problems, about any surefire way to prevent the problems in today's real construction world, and even about the best way to fix the existing problems in Juneau's severe climate. Observations and comments from one building official and four groups of other involved parties—builder/developers, consulting engineers, homeowners, and SIP manufacturers—are presented below.

- Second, significant non-SIP roof rotting has occurred in Juneau and some SIP roofs appear to be holding up well.
- Third, this is a fast-evolving story. Inspections of structures with SIP roofs continue as this article goes to print. All the facts are not in.

The Climate

Juneau is one of the wettest cold climates in the US. The key data:

- Roughly 90 inches of rain a year
- About 9000 heating degree-days and zero cooling degree-days
- The sun is out about 36% of the year—notably worse than Erie's (PA) 43% record within the Lower-48.

Says Juneau building official Steve Shows, "We experience 75% relative humidity 12 months of the year. The only time we dry is in the winter when it freezes. Up here we lose more buildings to moisture-induced failures than to any other cause. The difference from Florida is that up here we just don't rot quite as fast as they can down there."

"The soils in our crawl spaces are often saturated," said Shows. "We're losing floors over crawls and rims in crawls. In homes with hydronic heating pipes running through the crawls, the condensation occurs at the rim and rot follows."

The Building Official's Concern

When asked to comment on the failures he's seen, Shows replied, "It isn't good. I think it may be an industry-wide phenomenon up here. Then again, we also have non-SIP roof failures."

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ABOUT THE AUTHOR

Steve Andrews has written all three editions of Foam-Core



Panels & Building Systems, the authoritative book on SIPs. He is a board member of the Energy Efficient Buildings Association, has been a keynote speaker at a number of national conferences, and has consulted to national institutes and government agencies on energy efficiency. He published frequent articles and essays on SIP construction and energy efficiency in trade and popular periodicals.

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Editorial Staff**Editor**

Rick Kang

Production & Design

Mark Galvin

Web Development

Jin Kang

Jung Seo

Contributing Editors

Steve Andrews

Bill Chaleff

Damian Pataluna

Michael Morley

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Editorial and Subscription Office:

BuildCentral, Inc.

675 Massachusetts Avenue, 8th Floor

Cambridge, MA 02139

sipmonitor@buildcentral.com

www.sipmonitor.com

ROTTING SIP ROOFS IN JUNEAU*continued from page 1*

"Depending on how well they go together, the SIP product seems particularly prone to air leakage along joints," said Show. "I don't think the construction industry is geared to make these panel joints airtight. It rains 200 days a year here, and they're not erecting these buildings inside tents."

Shows reports that homeowner lifestyles can have a significant impact. In side-by-side townhomes with SIP walls and roofs, he noted that a unit with a single woman had significantly less damage in the roof panels above than right next door where he said the roof panels in a family of four's home were heavily damaged.

The Builders' Perspectives*Bill Heumann, Builder*

Bill Heumann has been in the construction business for 20 years. Between 1994-96, he built 38 structures with SIP walls and roofs in Juneau. Most were duplexes and triplexes. "Of all my buildings we've looked at, only one has no problem. All the rest have problems in the roof panels. We can save a couple of those roofs; the others are totally shot. When it's really bad, you see mushrooms growing out of the roof and leaks inside the house at the beams." He reports no problems yet in the SIP wall systems, and doesn't expect to encounter any.

In the Bellview subdivision where Heumann sold his homes, most of his SIP units ranged between 1,100 and 1400 sq-ft. The typical price fell between \$130,000 and \$160,000--generally considered between lower-end and move-up prices for Juneau.

"All the homes met the 5-star energy rating level," said Heumann. "Since we used electric heat, we had to make the homes incredibly tight for them to meet the 5-star level." He says his energy rater told him the homes' measured air tightness fell generally between 3 and 3.5 air-changes per hour at 50 pascals of test pressure; for reference's sake, the Building America program expects homes to test at or tighter than 3 air-changes per hour at 50 pascals of pressure.

The roof assemblies Heumann described included drywall facing the living spaces, a layer of polyethylene for a vapor retarder (though not lapped over beams), 10-inch EPS panels at roughly a 4/12 pitch, a layer of 15# roofing felt, and three-tab asphalt shingles.

Heumann said that panels for his first seven housing units came from North American Panel Systems (Keene, NH; now out of business) and Insulspan of Idaho (Kellogg). Subsequent panels were purchased from Premier Building Systems (Fife, WA).

Heumann stated one manufacturer sent a crew to erect the first four units. While two of those four roofs are in generally better condition than the others, Heumann said they included some detailing that has since been determined to be poor workmanship. He says his crews installed the rest, without any technical education, replicating the approach used by the factory crew. "That's how we were taught to do it," he said. He acknowledged that his crews "weren't too thorough on the first go-round."

According to Heumann, during the time of construction, no manufacturers supplied him with an instruction manual. Furthermore, he reported that two other builders dealt with the same shortcoming. He observes that his roof systems with I-beam splines appear to have been "much more vulnerable" to damage than roof systems attached with

Editor's note about this report

A little more than a month ago, a prospective homeowner posed a seemingly simple question on the SIP Talk message board system regarding any disadvantages of SIPs. A week or so later, a builder in Alaska invited readers to email him directly to receive photos depicting "millions of dollars" in damages as a result of using SIPs. A simple follow-up phone call by Stephen Andrews has evolved into this comprehensive report. The purpose of this report is to disseminate factual, unbiased information surrounding the events in Juneau, Alaska. The conclusion is yours to make and you should make them with more information than what is provided in this report alone.

The report is divided into three parts. Part I introduces the background information, Part II covers the building science and possible solutions, and Part III includes general discussions and the author's concluding thoughts on the subject.

other splines (2x dimensional lumber; surface splines, etc.).

Having since seen the construction details provided by manufacturers, Heumann claims that the foam pockets cut to accommodate I-beam splines are oversized at the factory. "The panels don't fit tightly. We have a picture of a one-inch gap between the foam and the I-beam spline. Panels don't meet tolerances specified in the manufacturers' own literature. The foam sealant doesn't stick to wet wood. We ended up with a lousy job of sealed panels."

All of Heumann's homes were equipped with heat-recovery ventilators (HRVs). "The panel guys seem to rely on HRVs. They said the homes should be okay if HRVs are in there. They ask 'How could this happen if you have HRVs in the homes?' Unfortunately, homeowners don't maintain their HRVs, so the manufacturers are relying on technology here. In some projects in Indian villages, they tend to unplug the HRVs."

Heumann reports that his homeowners "are decent folks. They haven't harassed me." Recently he has turned very active at digging for information about similar SIP-roof problems in Juneau and elsewhere. He reports the first rotten SIP roof problem turned up in 1994 in a home built with Premier Building Systems' panels. Premier should have "raised the flag...issued a bulletin, looked at the work under way, especially in Juneau, and caught any problems. To their credit, when I called them and said we have serious problems, they were on a plane within a week."

Heumann acknowledges his insurance companies "don't like me too much. They only tell me what they have to. R-Control doesn't talk too much either. Their people provided no technical education or support [during construction]. Now we have big-time technical failures."

Don Madsen, Builder/Developer

Don Madsen (Madsen Development Corp.) says he built 38 units with SIP walls and roofs between 1994 and 1996. Apart from his own home and a 15-unit apartment building, most of the SIP dwellings were duplexes. Sizes

ranged between 2000 and 2500 sq-ft, with prices between \$250,000 and \$350,000. His own home fits the million-dollar category.

"We've had some leaks in our own home over the last few years, but we just found out yesterday that the foam panels on the roof have rotted," said Madsen. As for his other dwellings, he said "the inspection process is underway as we speak." Preliminary results indicate that rot has been detected in over half his SIP roofs.

Most of his roof assemblies included 10-inch panels with building paper and asphalt shingles. Splines used in Madsen's roof assemblies included both 2x10s and I-beam splines. Like Heumann, he reports that some foam recessed to accommodate I-beam splines was cut too large.

For the record, on this writer's own home, this writer observed slightly mismatched tolerances between roof panels—pre-cut by the manufacturer—and the I-beams supplied by the manufacturer. Where the top OSB panel facings were held the specified 1/8" apart, the total of the two gaps to either side of the I-beam spline is 3/8" or more. Most of that gap tends to be present opposite the side where the I-beam was installed on the ground prior to being craned into place. See illustration (right)

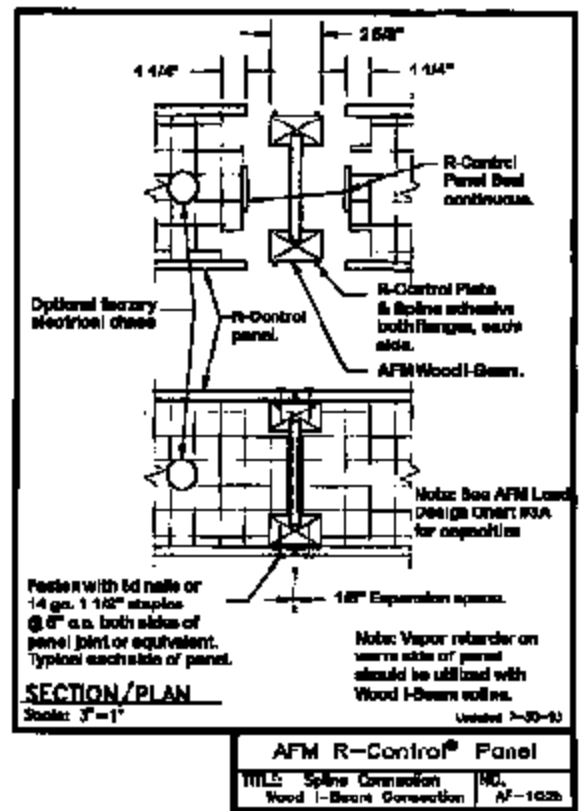
Madsen says some of his panels were supplied by North American Panel Systems, some by Insulspan of Idaho and the rest by Premier Building Systems. "The roof panels in my own home were installed by Dale Hedquist personally. He was a principal with North American Panel Systems. Ten of our units were installed by North American Panel Systems' crew—American Panel Installation Company. Eleven of the units built were supervised by a manufacturer's rep from Insulspan of Idaho."

"I've got side-by-side houses with roof panels and truss roofs," said Madsen. "The roofs with panels are failing, and the truss roofs aren't. Right now I'm scared of the panels. I wouldn't put in another panel if it was a gift."

Madsen was born and raised in Juneau. In his 32 years in building and development, he says he has never had to submit a large claim to his insurance company, until now.

Jan Van Dort, Developer/Lawyer

Jan Van Dort's primary work is his real estate law practice in Juneau. At times, he also participates more directly in the building world. His development efforts have ranged from 4-unit to 92-unit residential building projects. Between 1995-97, he used SIPs to put up four 8-plex buildings.



"So far, ours seems to be the one larger project that doesn't seem to have any problems," said Van Dort, though not all of his buildings have been inspected yet. "Seems like everybody's trying to understand what's going on. I'm still assimilating information and guessing."

Nobody's come up with anything definitive yet as to the causes."

Van Dort acknowledged that he did not completely understand the issues and fully recall his own building assembly details. Based on discussions with his engineer, he believes that the choice of splines (no I-Beams) and their attention to air sealing is what may have prevented damage in the one 8-plex inspected to date. "We used special steel brackets to pull the panels together and used a lot of glue, so our panels were very tight," said Van Dort.

"The system was tried, which wasn't bad, but it failed, and now we're dealing with the consequences," said Van Dort. "This is just another products case. Nobody was doing anything intentionally wrong."

Dan Ulery, Builder

Dan Ulery (Four Eagles Construction) has been building in Juneau since the late 1960s. His company has contracts to replace a number of the rotting SIP roofs. When interviewed, he said, "Right now, we have approximately 47 failures. We will work on well over half of them. We will shortly find out about the excitement of replacing roof panels in Juneau's wind and rain."

"Installation of panels is highly critical," said Ulery. "The original work was apparently done by people unfamiliar with how panels go together. They just weren't installed properly, according to Premier's details."

Ulery reported seeing cases of the custom-cut foam wedges, commonly installed at ridges where two panels meet, either not installed at all or being substituted with scrap foam. In his observation, the original installers didn't use enough adhesive and left out a critical component—sheet polyethylene for a vapor barrier.

"We took training and are now certified by Premier as installer," said Ulery. "We just finished a panel house, and had a factory rep on site. I'm fairly happy with the product."

Jim Sydney, Pollard Construction

A condo complex of six multi-plex units called Spruce Corners was built in 1973. The roof

system was a cathedral design framed with 2x dimensional lumber and insulated with fiberglass. Between two and three years ago, those roofs all failed. Pollard Construction was hired to replace the roofs in five of the six buildings.

"We put on SIP roofs for the replacements," said Sydney, who is Pollard's electrical and mechanical administrator. "They went together fine. On the roof we put down tar paper, then laid 2x4s vertically up and down the panels and 1x4s horizontally, with a layer of Tyvek in-between. On top of the 1x4s we attached metal roofing, so we have a cold roof. So far we haven't heard of any problems."

Sydney is also a silent partner in a 15-unit complex built with SIP roofs and walls back in the early 1990s. So far he is unaware of any problems, though he is a little worried. "We can see the spline joints through the shingles. I don't know about any failure yet, though I have my suspicions."

The Engineers' Take

John Cooper, Engineer

At the time he was interviewed, John Cooper (Cooper Consulting Engineers) had inspected several dozen SIP roofs for signs of rotting. Of those, he had identified 42 SIP roofs with rot problems. One of those is repairable; the rest are "remove and replace" roofs.

Cooper has seen a few houses where intrusion by bulk water caused rot, mostly around plumbing stacks where wind-driven rain entered at the roof jack around the vent. But in most of the cases, he blames a combination of diffusion of water vapor through the building assembly, plus movement of warm moist air within panel joints up to ridge lines.

Said Cooper of SIP roof assembly practices, "You've got to seal the joints very carefully. We've seen 3" to 4" sections of the panels with no sealants at the joints, nothing to stop air and moisture movement. We've also seen splines that don't fit skin-tight. In quite a few of the panels, over-routed spline pockets could have adversely contributed to the situation we find ourselves in. One of the homes I inspected had a combination of half surface splines and half I-joint splines. The half with

surface splines was working well, and the half with I-joint splines has to be replaced."

Cooper reported rot up to 6" either side of the I-joint splines. Usually the rot damage narrows as it extends down from the ridge line. Occasionally it reaches all the way down the roof panels to the top of exterior walls.

Cooper reported that he has seen "a huge difference of effort and attention to air sealing detail. This appears to have helped" the roof on the building built by VanDort's people that he inspected. "He had people from the manufacturer up here, plus one of his own people who was well trained and knew how these panels were supposed to go together." Cooper also credits the type of spline used by VanDort—a combination of surface splines plus dimensional lumber.

Another concern cropped up during Cooper's inspections. "We have a 24x6-inch chunk of OSB that has no foam attached to it and provided no resistance when we lifted it up," said Cooper. "That is delamination to me."

Tom Savoy, Engineer

Tom Savoy is a key member of Premier Building Systems' technical support team. When Premier heard reports about roof panel rot in Juneau last winter and spring, Premier sent three different individuals up to inspect. Savoy made the trip last May 9-10, spending both days looking at the problems.

"The detailing on those roofs is nowhere near what's specified in our manuals," said Savoy. "Even before we got on the roofs, there were visible detailing issues. We noted missing splines and sealant in panels exposed under overhangs."

On the roofs, Savoy said he noted shingle damage, with some debris wedged in the shingles on the windward side. Once shingles were removed, he observed sections of standard surface splines missing and "many places where it was obvious that there was absolutely no sealant. In some cases, the panels had been field-fabricated to accept a different spline than the one that was installed. For example, I saw single 2x splines inserted

where the panel had been fabricated for I-beams. In these cases, there were large voids."

"When using foam scoops during field fabrication, they had over-cut the foam and not sealed in the gap at the spline with sealant," said Savoy. "You could feel warm moist air rising up the gaps."

"Most of the observed damaged was concentrated at the ridges and along the spline joints," said Savoy. "It was likely that the condensation occurred on the bottom side of the building paper. In areas where there was a vapor retarder beneath the ridge beam, the ridge looked good. Where they tried to put foam sealant in place, there was little or no damage. But sealant was often missing."

"The homes did have HRVs. However, one might question how effective they were. Often they were venting underneath an eave, with the fresh-air intake six feet or less above the exhaust vent. That's not recommended practice."

Savoy's summary statement: "There were numerous deviations from good installation practices. In my opinion, we have detailing installation errors that allowed warm moist air to enter through gaps and cause panel deterioration."

Joe Lstiburek, Engineer

Earlier this year, Joe Lstiburek (Building Science Corp., Westfield, MA) was asked by the Structural Insulated Panel Association (SIPA) to review SIP building details, explore best design and installation practices, and summarize those observations in a modified version of his Builders' Guide series of publication (available through www.eeba.org). Last week Lstiburek, a forensic engineer, was asked by SIPA to visit the Juneau homes next month, inspect the rot in SIP roof panels and offer his professional opinion.

By happenstance, Lstiburek presented a seminar in Juneau to the US Coast Guard during April of this year. After his presentation, he was asked to visit a home with evidence of roof rot. It turned out to be one of the homes with rot in a SIP roof.

"I think air leakage up into the roof assembly is the problem," said Lstiburek. "This is an old problem. I dealt with this problem in Ontario in some homes I built with SIPs back in the late 80s. There was a recent case out on Martha's Vineyard where the whole roof of an architect's own home rotted out. This problem can happen in all cold climates that have high levels of moisture."

"The industry is in denial," said Lstiburek. "This in no way detracts from the utility of a good product. No product is perfect. There are no bad products. There are only bad uses."

"The SIP industry needs to realize that this is a legitimate issue," said Lstiburek. "But this is not an indictment of the SIP industry. I'm a fan of SIPs. An inherently advantageous product like a SIP needs to be properly installed."

The Homeowners' Perspectives

Gary Patton

"Our roof has been declared in danger of imminent collapse," reports homeowner Gary Patton. "Up here that's a real concern. We can get a foot of heavy wet snow in a day, and then it can rain the next day and get immensely heavy. In the scope of the problem in our neighborhood, ours is the worst roof. But we did not see any water entering until the spring thaw of the year 2000. Our neighbor had problems way back in 1997."

When Patton was in high school, he worked summers in construction for his father, doing light carpentry—framing, roofing, basic electrical and plumbing. Today, he still does minor remodeling. What he learned in his early work gave him a feel of what to look for in quality construction.

"There's a lot of shoddy construction up here and not a lot of craftsmanship," said Patton. "By Juneau standards, these homes were half-way decent. It looks good on the surface, but it's pretty low-grade construction."

"This was not a case of an intentional mistake," states Patton. "With roof panels, you can make an honest mistake and have problems. In this case, they did not know what they were doing. Nothing was done right in the roof pan-

els. They didn't even fill the gap at the peak of the roof with a wedge of foam. It was just covered over with building paper and shingles. These buildings get inspected by the City. You would think that somebody might have noticed something, but obviously not."

Patton reports that the vapor barrier was not installed continuously from the ridge to beam, so water drips down through light fixtures and at his beam. Up on the roof, Patton saw what he described as 3/4-inch gaps between panel facings of adjacent panels. In some cases, splines were missing. He reports that "you can pull up the OSB with your hands, up to six or eight inches either side of the spline joints."

"I was up on the roof with the guys from Premier and my own engineer [John Cooper]," said Patton. "They said they had never seen a failure of that magnitude and over that little time. There was no disagreement as to the cause—shoddy construction. The insurance company was on the roof on the time and they seemed to indicate they wanted to settle quickly."

When he bought the home new in 1996, Patton said he "didn't have a problem with the panels. It was a selling feature: high R-values that made the home 5-star energy rated. Even today, our engineer doesn't have a problem with panels as long as you follow the installation instructions," said Patton, whose home will have new panels installed soon. Patton reports regular use of his HRV, including boosting the ventilation rate during showers and baths.

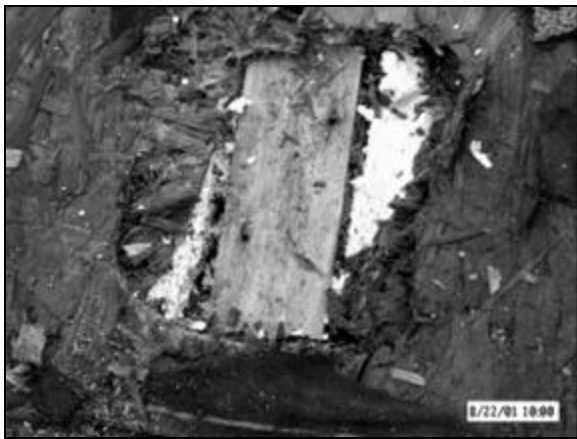
"I feel for Bill [Heumann]," said Patton. "He had honest intentions. He's not running and hiding. This wasn't an intentional act. During construction, they didn't contact Premier for help and Premier didn't contact them. But in my opinion, the people building and supervising didn't have the knowledge to build this structure correctly."

Roger Snippen

Lawyer Roger Snippen closed on his 1100 sq-ft, \$132,000 home in December 1996. To date, the only interior damage he's observed is a little leakage down the ceiling at the com-

mon wall with the neighboring unit in his triplex. Yet based on an inspection two months ago, he recently settled with his insurance company. His SIP roof is due for replacement soon—a process projected to take 12 to 14 days. He'll be living in a hotel during that stretch; the per-diem cost of that stay is included in his \$85,000 settlement.

Snippen's experience with Heumann wasn't smooth. A string of flooding problems with his garden-level basement meant that his carpet had to be replaced four times within the first twelve months of occupancy. A drywall screw pierced a copper pipe, causing additional



damage and repairs. "I sued my builder for things he wasn't getting done. There were three- and four-month delays between the time problems were brought to his attention and when they were fixed. I decided it was time to get his attention."

Snippen reports that Heumann's townhomes offered terrific views. He reports that similarly sized homes with no view sold for about \$30,000 less. "Some owners here express concern about losing value on their homes. An appraiser friend of mine doubts that will happen. The homes have already appreciated in value, based on some resales."

Susan Kaiser

When Susan Kaiser brought the initial leak in her roof to builder Bill Heumann's attention in 1997, his people thought it was a simple shingle problem. But about 100 days later, when her one-year warranty had expired and the

leak was back, it was apparent that minor repairs had not solved the problem.

"The roof leak was not related to snow melt or outdoor weather," said Kaiser. "The small leak was a nasty brown gooey fluid, staining the beam and ceiling. Homeowner's insurance denied any subsequent claim, stating that the problem was not the result of a sudden occurrence."

For the next several years, Kaiser dueled with her insurance company and her builder, sending him registered letters of complaint about leaks in her ceiling and posting claims that were denied. She got little response from either one. By 1999, she had what she called "significant leaks" in front of her sliding glass doors, along interior beams, at the ridge, and from light fixtures. When she finally found a contractor who agreed to try to fix her roof, the crew pulled up three rows of shingles and stopped dead in their tracks. After seeing the extensive evidence of roof rot, their statement to her was "you've got a lot more problems up there than we can handle."

Since replacement shingles couldn't be fastened to the rotting OSB, the crew attached a tarp over the exposed panels, which Kaiser stated has been in place for about a year. On the day she was interviewed, she reported having placed nine three-quart containers around the house to catch leaks; she said they fill up in about 48 hours. "I would have better protection in a tent on my front lawn."

Once a second home in the subdivision began experiencing the same problem, Kaiser reports that her builder became more responsive. Eventually, he called Premier Building Systems and visited the site when their inspectors came for their inspections. Admits Kaiser, "That earned him a star."

Kaiser reported not being pleased with the entire building process. "I don't believe he took reasonable care in supervising the work up here. We had our driveway replaced twice

within the first year and the basement flooded the day before we moved in. Our carpet delaminated when his crew missed installing a clean-out in the drain and it overflowed. Others on my street have reported cabinets falling off." Kaiser and her neighbors have communicated about these errors on a web-based discussion group titled roughly "the Heumann Error."

Kaiser carefully followed and documented the building process. She reports that roof panels were left directly on the ground, in the rain and unprotected from the weather, for between three and four weeks. She reports that once they were placed during November—"our monsoon season"—they remained uncovered by roofing felt for an additional 30 days.

During the recent inspection process, she reports that the specified vapor barrier was not present in five different locations in her ceiling where core samples were taken. She said her engineer told her that the foam wedge in her roof ridge was indeed installed, but without the specified layer of OSB over it prior to installing building paper and shingles.

"I sent three e-mails to SIPA, begging for performance information" said Kaiser. "I didn't need the marketing information they have there about how wonderful SIPs are. I needed information about failures. I got no response."

"My engineer agreed that the quality of installation was poor," said Kaiser. "He also said that properly installed, the SIP is a superior product. But if a home I liked had a SIP roof, I don't know if I would buy it today."

SIP Manufacturers Respond

Mike Bryan, Premier Building Systems

"What I know is there were a number of Premier panels, back when we were an R-Control plant, that were installed in Juneau, and now we have problems with the top layer of OSB turning to mush," said Mike Bryan.

"Last February through May, we sent three different people up on four different occasions. During our investigations, we determined that there were numerous problems with the

installations. The builder's liability insurance company paid the entire bill. The problems with the installations were so flagrant that they didn't have much choice. The good news is that 80%-90% of the people want replacement panels on their new roofs."

"The deficiencies were obvious to the casual observer," said Bryan. "The list starts with missing OSB spline connectors, missing pieces of lumber, missing foam, missing adhesive."

"In retrospect, I can see that a climate like Juneau is somewhere we would want to be particularly careful about the details."

Jim Ferraro, Insulspan of Idaho

"I know there is a roof rot situation up there, but I don't know all the facts yet," said Jim Ferraro. "I don't know Bill Heumann, but I know Don Madsen quite well. He's got quite a reputation."

"Madsen's company owed me money, claiming they were holding it for back-charges. I made a trip up there to collect. Their issues weren't legitimate. That meant I broke that relationship—I decided to not sell them any more panels."

"I never sent a factory crew to help put up any buildings for Madsen in Juneau," said Ferraro. "North American Panel Systems and I parted ways in 1994. That's when I moved to Idaho. Dale Hedquist had been doing business with Madsen. We finished off supplying panels for a big job from here."

Ferraro is not aware of any other instances of roof rot in his SIP panels. "We do a lot of work in Seattle and Oregon, and haven't experienced problems with rot."

Phil Reynolds, Alchem (Anchorage, Alaska)

"I can say that Alchem has had no structural failures due to moisture intrusion since we started manufacturing back in 1970," said Reynolds. He reported that the company manufactured SIPs for structures built in Barrow, the coldest weather station in the US—20,000 heating degree-days.

"We use urethane panels. Our joints go together differently. Ours is an interlocking system. You have to be sure that those joints are carefully sealed." Reynolds reported having seen panels manufactured by a competitor being installed within a mile of his manufacturing facility. He stated he saw "slop in the panel joints."

"We have had one floor destroyed by hydrochloric acid from a battery spill in a communications building," said Reynolds. "And we did have some rot in one communications building; but it had been sitting wet in the water for a while before it was put in place."

"Back in 1990, we made roof and wall panels for a house in Juneau that was built by Dudley Field of Field Construction," said Reynolds. "That I'm aware of, the builder hasn't heard of any problems with that house."

Frank Baker, Great Lakes Insulspan, Michigan

"The first we heard about this was 30 days ago," said Frank Baker. "Some of the statements that Mr. Heumann is e-mailing around, claiming non-responsiveness by Insulspan, are not accurate. The day after we saw some pictures of damaged Insulspan panels, Bill Heumann called me down here. We talked. I said 'this sounds like something we would want to investigate, so I'll call Bill Wachtler at SIPA.' He said he had to run, but said 'I'll call back tomorrow.' He hasn't called back since."

"There is nothing inherently wrong with the product," said Baker. To address moisture problems in SIP buildings, he states, "We have steadfastly recommended installation of heat-recovery ventilators and careful air sealing. In the near future, we need an objective third-party's observations about this case. For the long haul, SIPA is developing an authoritative information source that will serve as an industry-wide best practices guide."

Mike Tobin, AFM/R-Control, Minneapolis, MN

After seeing some e-mailed photos of the roof rot panels, Mike Tobin observed "It looks like some people misapplied a lot of panels up there. In more challenging environments like Juneau, more attention to detailing has to be made. Some mistakes can be a train wreck

waiting to happen. We're hiring a consulting forensic engineer to look at the problems. We're not afraid of what he'll find."

Tobin has seen roof rot in SIP panels before. "In almost every case, where I've seen a problem occur, it's been an installation deficiency. Too often we send out 6 cases of caulk, based on computer takeoffs of sealant requirements, and the builder ends up with three cases left over asking 'what do I do with these?'"

Tobin adds that when a discontinuity in panels occurs, due to difficulty of design and/or application, R-Control mandates that a vapor retarder be installed beneath the panels.

Dave Gauthier, Winter Panel Corp. (New Hampshire) & SIPA president

"Our company has more than a dozen, maybe two dozen homes with rot in panels," said Dave Gauthier. "That's a very small percentage of our homes. Almost without exception, it's due to installation problems. Consider a poorly sealed vent stack by a plumber. Warm moist air from the house rises up beside the vent stack, hits the bottom side of the flashing, drips onto the panel surface and causes damage. In any climate where the vapor drive is strong, if you don't foam the joints and penetrations correctly, you are going to have problems."

"While I don't know all the facts, I see this as a manufacturer/builder issue," said Gauthier. "Judging by the few pictures I saw, I didn't see foam in some of the joints. But there are two sides to the story. We need all the facts established. Both sides need to be heard before we rush to conclusions."

"The manufacturers have to work to solve the problem, and they have to assure that builders know how to properly install the products to prevent the problem."

Bill Wachtler, SIPA Executive Director

When interviewed on September 5th, Bill Wachtler said the first he had heard of the roof rot problems in some Juneau SIPs was Wednesday, August 29th. "We had a conference call today, trying to get as many facts as we could. I'm very interested in gathering the

absolutely true, honest facts. We hope to hire Joe Lstiburek to help us gather and analyze those facts. I'm not going to rush to judgment until then."

"There is already a lot of emotion about this," said Wachtler. "The potential for misstatements and miscommunications is great."

"In a recent issue of the Energy Design Update, they pointed out that moisture intrusion in building envelopes is the single biggest risk in residential construction to building durability. To minimize these potential problems, we want to look at the best ways to do things with SIPs. We're working on it now."

Bill Porter, W.H. Porter, Inc. (Michigan)

Bill Porter has been manufacturing SIPs since the mid-1960s, longer than anyone else in the business. Said Porter on September 5th, "I just found out about this 24 hours ago. I'm not surprised it happened. Yet the only time I've ever seen saw ridge rot was when a chimney went through the ridge and there was no sealing by the contractor. I've even lived in a SIP house with a hot tub in it up here in Michigan, and had not problem with roof rot."

"We are in the discussion and planning stages for SIPA's research program with the Forest Product Lab. Hopefully they'll do the research testing of different SIP details for us fairly soon. Having third-party involvement by someone like Joe Lstiburek is important. After the research findings are in, education about the findings and best recommended practices will be really important."

Part II: Building Science and Solutions for Juneau's SIP roofs

"The fool doth think he is wise, but the wise man knows himself to be a fool."
(Shakespeare, in As You Like It)

"Truth varies." (Murphy's Laws)

In Juneau, heavy snows typically start arriving in November. According to Juneau-based engineer John Cooper, there are legitimate questions as to whether some of the failed SIP roof systems might collapse beneath a

heavy snow over the course of the coming winter. So even though September falls during Juneau's rainy season, the first few SIP roof systems for 24 housing units—mostly for duplexes and triplexes—are being replaced as this article goes to press.

Some of the roofs are being replaced with truss roofs and vented attics. Many of the repairs contracted to date will involve removing the rotted SIPs, replacing them with a tightly-sealed new panel roof above a continuous polyethylene vapor retarder, and installation of a vented (cold) roofing layer above the top OSB surface of the panels.

This should work. Yet there are some uncertainties about the efficacy of this solution. There is even some disagreement as to whether this is the best approach. What follows is an examination of the background building science and strategies behind both this solution and other possible options.

The basic building science

There are two primary mechanisms by which water enters roof systems and causes damage: by leakage of bulk water from the outside (e.g., leaks from standing snow or wind-driven rain) or by movement of water vapor from either side. In Juneau, there is general agreement that the principal problem with SIP roofs is caused by water vapor movement up from the indoors into the panels. The resulting problem is then exacerbated by the extremely wet and frequently cold climate that comes with this particular territory.

In colder climates, water vapor moves from heated spaces into building assemblies – walls, ceilings, etc. – by one of two mechanisms. First, water vapor molecules get carried by air movement through holes, cracks and gaps in the exposed lower surfaces. Second, those molecules can diffuse through solid components: through painted drywall, wood elements, etc. In both cases, the water vapor moves from warmer air and high pressure (more water molecules in a given amount of air) to areas of lower pressure and colder locations, such as from inside the warmer home towards the colder surfaces on the building's exterior.

When the water vapor arrives at a colder location, it can reach the saturation point (100% relative humidity) and then condense, like morning dew on a car or droplets covering a cold beer bottle. This condensation wets the building assembly. If a building assembly made with wood is sufficiently wetted and doesn't have any way to dry out, it can eventually rot.

A chapter in Builder's Guide: Cold Climates, written by Joe Lstiburek (Building Science Corp; Westfield MA) and published by the Energy Efficient Building Association (www.eeba.org), provides a thorough explanation of the basic water vapor issues at work in residential structures. Refer to Appendix III (30 pages). For purposes of general illustration, Lstiburek writes that, "In most cold climates over an entire heating season, 1/3 of a quart of water can be collected by diffusion through a 4x8-foot gypsum board with a vapor diffusion retarder; 30 quarts of water can be collected through air leakage." (Conditions assume 70 degrees F and 40% relative humidity.) In other words, he's stating that in normal residential applications preventing air leakage around drywall is much more important than preventing diffusion of water vapor through drywall.

The caveat to the diffusion vs. air leakage argument and example figures cited above: climate matters. The severity of cold and degree of outdoor humidity must be considered carefully. Climate doesn't change physics, but it can change the frequency, speed and severity of problems associated with moisture in buildings. A magazine editor in the residential building sector once said, "We could publish a magazine called 'Moisture Mysteries' and never run out of material to cover. The debates could be endless."

Two takes

Joe Lstiburek inspected one of the moisture-damaged Juneau roofs last April, will inspect more in October for SIPA, and in the past inspected many of the SIP homes he built during the 1980s. In an e-mail exchange, he wrote to John Cooper, "I think the air leakage paths at the joints in the panels in Juneau is still the key. I believe that air gets in through

the bottom spline at intersecting walls and at the bottom of the panels at the exterior walls. I think the air migrates up the slope of the panels within the 'airspace/channel' (at the joints) and finds its way through gaps in the lower spline, then through gaps in the misapplied or missing sealant in the middle of the panel joints, through gaps in the upper spline into the butt joint gap of the OSB at the upper panel intersections where it causes trouble."

Cooper disagrees. "In my mind, there is not a clear air-leakage path. There is a clear vapor diffusion path and heat transfer path. The heat transfer path is from the interior, through the wall board and spine to the air gap in the joint. The air sets up convection currents inside the joint and precipitates the moisture on the top skin of the panel and spline. The damage observed roughly approximates an upside down U and tapers out on the joints parallel to the roof as one moves down the slope of the roof."

We'll revisit this disagreement in the third part of this article. Before you take sides, consider the broader issues involved in both solving now and preventing in the future similar problems. And one of the overarching variables here is severity of climate.

Conceptual strategies

There are several generic strategies for combating potential moisture problems in closed ceiling assemblies in heating climates, whether it's a SIP or conventionally framed unvented roof system.

- A. Change the pressure in the living space below the ceiling assemblies, so air can't flow up through holes and gaps in those ceiling assemblies.
- B. Change the indoor relative humidity so that there is less vapor pressure drive across the assembly.
- C. Change the temperature at the condensing surface so condensation is less likely to occur within the assembly.
- D. Eliminate holes so there is no air leakage into the ceiling assemblies.
- E. Install a continuous vapor diffusion retarder on the warm side of the building assembly.

- F. Redesign the assemblies so that, if/once wetted, they can dry to one side or the other (outside or inside).

Solutions designed to employ one or more of these strategies have to consider climate variables, cost factors, installation constraints, and quality of workmanship available.

Applying the concepts in real buildings

Consider the translation of these generic strategies into solution applications.

1 Changing the air pressure. Instead of allowing warm air to rise up into the ceiling through penetrations, cracks and gaps, you put the house under slight negative pressure, such that air is coming in those holes instead of exiting through them. This strategy requires 24/7 operation of an exhaust fan(s).

The size of the fan depends on a particular home's volume, tightness, height and location. The larger and taller the home, the larger the fan needed to overcome the tendency of warm air to rise into ceiling assemblies. The leakier the home, the larger the fan required. The colder the climate, the larger fan required. Thus, as a practical matter, this strategy can only be achieved in a very tight building shell.

If the exhaust fan is ever turned off or fails, this change-the-pressure approach will no longer be effective.

2. Change the relative humidity. In a colder climate, the idea is to maintain a lower level in indoor relative humidity during the heating season. (In Juneau, every month generates at least minor heating requirements.)

Reducing indoor relative humidity (RH) can be achieved by a combination of strategies. First, one can dehumidify the air, such as with an energy-recovery ventilator. Second, at the source, one can ventilate high concentrations of indoor water vapor from bathing, cooking, and clothes-drying activities with exhaust fans or vents. Third, you can design and build crawl spaces-often high sources of water vapor-such that they are drier and don't release water vapor to the indoors. (Note: this takes creativity. Most floor assemblies between

crawl spaces and the living spaces above tend to be much leakier than most exterior wall assemblies, so water vapor normally moves quite easily by air movement.)

All three of these RH reduction strategies rely on proper installation of appropriate building materials and equipment, plus homeowner understanding of why and how that equipment is used. Juneau building inspector Steve Show made it clear how important homeowner understanding can be when he talked about moisture-induced failures that are so common in Juneau. "The worst offenders are actually clothes dryers vented to the indoors. That will destroy a house within a year."

The roof failures in the Juneau SIP homes present evidence that reliance on reducing indoor relative humidity alone is not a panacea in all climates. Many of the Juneau structures with failed roofs were equipped with heat-recovery ventilators (HRV). Some of the homeowners had previous experience with HRVs; some always used their HRV, while others reportedly used them less due to related noise. If a ceiling assembly has gaps, reducing the vapor pressure differential across the roof assembly may slow down but not prevent moisture-related damage.

3. Change temperatures of the condensing surface. In cold climates, if you maintain at higher temperatures those surfaces where water vapor can move, they are less likely to cause condensation. A typical example: replacing OSB exterior sheathing with foam sheathing over 2-by framed walls in Juneau will warm up the inner surface of the exterior sheathing. The warmer that surface is, the less likely it is that the water vapor in adjacent air or water-permeable materials will condense.

Many of Juneau's SIP ceiling assemblies apparently consist of the following: painted drywall; a layer of sheet polyethylene for a vapor retarder (though not always, and not continuous); 10-inch SIPs with foam cores of expanded polystyrene and 7/16-inch OSB top and bottom; a layer of roofing felt; and asphalt shingles. In this assembly, where is the condensing surface for water vapor?

In theory, there would appear to be several possible condensing surfaces in the Juneau SIP ceilings: the under-side of the roof felt, the underside upper layer of OSB, on the structural splines (I-beams and 2x dimensional lumber), and within the foam core near the upper OSB layer. No one investigating the SIP roofs found evidence of condensation within the foam cores; since condensation was present in the other three locations, and they can all be linked, it is a little difficult to pin down exactly where all the condensation occurred.

"Most of the damage was concentrated at the ridges and long the spline joints," said Tom Savoy, the investigating engineer with Premier Building Systems. "It was highly likely that the condensation occurred on the bottom side of the building paper." Then the condensation dripped down and wetted the SIP's top OSB surface.

In these cases, warming up the condensing surfaces here could be achieved by application of several inches of rigid foam insulation over the top of a continuous air/vapor barrier that is attached to the top of the SIP panel.

4. Eliminate holes for air leakage. Ceiling assemblies are usually the leakiest elements in residential construction. On paper, eliminating holes in a standard truss roof is more difficult than eliminating holes in SIPs; the problem is that with truss roofs there are often more variables to the ceiling features and design-recessed lights, dropped ceiling heights, connections between interior walls and attics, attic hatches, etc. But air leaks into any closed cathedral ceiling-SIPs or conventionally framed-can cause serious moisture problems in heating climates.

After Tom Savoy examined several SIP roof systems, he said, "In some locations you could feel warm air at the ridge, so it is obvious there was air movement past the vapor barrier and incomplete expanding foam sealant. Where they tried to put foam sealant in place, there was usually little or no damage."

Eliminating air leaks into a SIP roof requires concerted attention to detail. The elements are often fairly long and typically weigh 200 -

600 pounds. As they are being placed with a crane, any slight misalignment of a 4x20-foot roof panel, for example, can result in 1/2-inch or larger gaps at either the ridge or at one end or the other of the spline joint.

Training, proper tools and experience all help. Cold and wet weather doesn't. Yet some sealants designed for and regularly used by the industry can be installed in both cold and wet weather and still achieve a tight bond. But at the end of the day, the critical question here is: how practical is it to expect that a SIP roof can be constructed without any air leaks from the home up into the assembly?

SIP manufacturers seem to think this is doable. John Cooper is a little skeptical and Joe Lstiburek is highly doubtful. Says Steve Shows, "I don't think the construction industry is geared to making these panel joints air-tight. It rains 200 days a year up here and they're not erecting these buildings inside of tents. Construction is not an exact science. And sheet rock hides a lot of sins."

Note that as a building shifts over time – due to shrinkage, settling, differential reaction to moisture content, etc. – new gaps tend to develop in exterior building elements. Even a relatively air-tight building at time of construction grows somewhat leakier with age. (This writer is aware of documentation on this point, though not relating to any long-term study of SIP homes.)

5. Install a continuous vapor diffusion retarder. A key word here is "retarder." The term often used during the 1980s was vapor "barrier." That term was replaced with the word "retarder," since most building materials are permeable, in varying degrees, to passage of water vapor.

A material's ability to allow diffusion of water vapor through it is called permeability. In common usage, a vapor retarder is a material with a permeability less than 1.0. Relevant examples are drywall (50), expanded polyethylene foam (2 to 5), exterior grade plywood (0.6, depending on thickness), special vapor-retarding paints (0.5, depending on material and thickness), and sheet polyethyl-

ene (6-mil is 0.06; 4-mil is 0.08). In Juneau, the building department now requires use of a vapor barrier in exterior building assemblies.

In SIP roofs, the two straightforward options consist of installing either sheet polyethylene behind all drywall and above supporting beams or applying a vapor retarding paint over all drywall and other exposed materials in the ceiling assembly.

Note that vapor diffusion retarders are effective in proportion to their perm rating and coverage. Small gaps in diffusion retarder coverage beneath ceilings should not be as large a vapor-transport problem as small gaps in air barriers beneath ceilings.

6. Redesign to improve drying potential. To a surprising degree, exterior shell elements in residential buildings get wet. The most under-appreciated sources of wetting in homes are windows and doors. Minor wetting of elements in the shell is usually followed by drying, either to the outdoor or indoor air. Problems occur where the source is frequent and where the assembly can't dry to either the interior or the exterior; this can be due to either the building assembly (interior and exterior vapor retarders are present) or to indoor and outdoor climate factors.

During the 1980s and early 1990s, many homes built with exterior insulated finish systems (EIFS) suffered major structural rot from moisture damage. In many cases, the homes were located in climates with higher rainfall and relative humidity, and were built with double vapor retarders that prevented drying. The EIFS wall systems were substantially redesigned to prevent moisture damage.

A SIP roof or an unvented cathedral ceiling is called a "hot roof." Since hot roofs can be susceptible to ice dams and to internal roof damage if water vapor enters the assembly, one traditional approach has been to add a "cold roof" element above the hot roof. This typically consists of a ventilation space created by attaching non-structural wood members (1x3s or 2-bys to the roof deck, then sheathing over those wood members with another layer of roof decking [e.g., OSB or

plywood]). The upper layer is then covered with roofing felt and finished roofing material.

In most climates and/or under certain conditions, if elements in the main roof assembly get wet (from whatever source), the vented space above the main roof allows it to dry. The colder and higher the relative humidity of the outdoor air, the more limited its potential to dry out any wetting of the main roof assembly. That may mean that drying on cold (north or shaded) sides of roofs will be slower than on slopes exposed to more sun...when the sun does indeed shine in Juneau.

Solution selected

When in doubt, the concept of belt-and-suspenders design – intentional redundancies – has well-recognized value among engineers. It is being used during the Juneau retrofitting process today.

The primary defense against future moisture-related problems in the Juneau replacement SIP roofs is the application of two items described above: a continuous layer of polyethylene beneath the drywall (lapped over beams) plus very careful sealing of the ridge and all panel joints. The secondary line of defense is installation of a vented (cold) roof element above the SIP roof surface.

"They'll be busting their butts on the vapor barrier, and then they'll be sealing everywhere they can seal from underneath those panels," said Cooper. "Every void will have sealant, so there is no place for air to move around in the panels. On top of that, they'll put on a cold roof so any moisture has someplace to go."

About this overall approach, Cooper said, "I'm practicing what some would say is a high level of paranoia. But this is a tough place to build, one that warrants the paranoia. I've lived with these problems for five or six months. I've seen lots of rot problems that I don't ever want to see again after the job is over."

Part III: Discussion and opinions regarding Juneau SIP roof issue

Complex problems have simple easy-to-understand wrong answers.
(Murphy's Laws)

Our problem is that so much of what we know...just ain't true.
(Will Rogers)

We made too many of the wrong mistakes.
(Yogi Berra)

The key fact in Juneau—that rotting SIP roof panels were discovered on at least 68 housing units this year—is indisputable. A second fact—that insurance is covering the replacement of many of those roofs in five to seven year old homes as this article goes to press—is also not in dispute.

The story behind those and other facts was described in Part I of this series. Part II highlighted the range of options and the particular solution selected for fixing the impacted homes. This article features some of the disputes among experts relating to the Juneau SIP situation.

Those disputes are wide-ranging. They are sorted and addressed briefly below in three categories: the source of the problem, the best way to fix the problem, and the best way to prevent the problem.

I. Source of the problem

Critical comments came from all sides. Note the range in the comments below from three engineers who have at least visited the Juneau homes, if not observed them in detail.

John Cooper, Juneau consulting engineer
"There are lots of things where the original contractors failed to do things right," said Juneau consulting engineer John Cooper. "But I don't know if they could have done it right, under the circumstances up here. If they had followed the letter of the instructions, I think the product still wouldn't have worked."

"Roof panels with surface splines seemed to work a little better. Three different builders

had serious problems at the I-joint splines in their roof systems. I know one owner-builder up here who is an engineer and who paid attention to trying to do things the way he was shown, and it didn't work for him either."

Cooper believes part of the problem starts back at the SIP factory. He indicated that the notching of the foam by manufacturers for I-beams along the edges of roof SIPs is substantially too large for the I-beams that those manufacturers then supplied. He also notes that selection and application of sealants is more critical in Juneau's wet climate.

In a September 13 memo sent to the Juneau building department, Cooper stated that SIP manufacturers "have not thoroughly tested the products in all environments and the ICBO Evaluation Services requirements do not adequately address the moisture problems in the Juneau environment."

Joe Lstiburek, consulting engineer
Lstiburek wrote to Cooper that hot (unvented) roof designs "do work in extremely cold climates if done correctly. In fact that goes for any assembly anywhere: 'if done correctly.'"

While Cooper states the primary means by which water vapor enters the panels is by diffusion, Lstiburek believes the principle moisture transport mechanism is air leakage. "The pattern of damage is pretty obvious. If it were diffusion, the problems would not be concentrated up at the [roof] peaks. Diffusion doesn't work that way. If you do a classic diffusion calculation on the SIP assembly and the spline joint detail this is the only mechanism that can explain the problem....This problem is a classic 3-D network air leakage problem. You could demonstrate this with an infra-red camera scan under cycling air pressure differentials." When two of Lstiburek's Fairbanks-based colleagues visit the Juneau houses during mid-October, they are likely to conduct just such tests.

Tom Savoy, Premier Building Systems
Savoy agrees with Lstiburek that the roof rot is caused by water vapor carried into the roof assemblies by air movement, not vapor diffusion.

II. Fixing the problem

John Cooper

As to the solution for those SIP roofs being replaced today with new SIP roofs, Cooper recommended in his September 13th memo the adoption of the following policies for all SIP roofs in Juneau:

1. A properly installed vapor retarder (0.10 perms or less) on the warm side of the SIP.
2. Roof sealing procedures are described to achieve tight construction. Proper sealants are to be installed on dry surfaces. Voids in the panels are to be filled with sealants. Manufacturers directions are to be carefully followed. Etc.
3. SIP roof systems should be covered with a cold roof, including not less than a 1.5-inch air space above the top skin of the panel.

"I think Joe and I disagree about a few things," said Cooper. "I would be less inclined to disagree with him elsewhere than up here. At 9,000 feet in Aspen, on their wet days, it's drier than it is on our dry days up here. They have summers and things have a chance to dry out. You can't get away with as much up here."

Joe Lstiburek

In an e-mail to John Cooper, Lstiburek wrote that for his preferred approach to work—installing an air barrier over the SIP roof, then more insulation—"sufficient insulation needs to be installed above this air barrier to control moisture accumulation. Additionally, an interior vapor barrier must not be installed so that drying to the interior is possible."

Lstiburek also acknowledged, "...John, you are the man who has been hired to deal with this, not me...I'm sure your approach will work. I think mine will also, but I don't have to make the judgment call. If all the roofs are as bad as the one I saw, I would go with the traditional vented approach with an air barrier and a vapor barrier. I am under the assumption that this is the approach you are taking. I have no problem with it."

Steve Show

This building official said, "I tend to agree with Lstiburek's approach. If you raise the temperature of the OSB to above the condensing

temperature, that solves the leakage problem. That may constitute a good design for panels in the climate. I like it a little better than the permits we issued earlier this week, but it's not bombproof."

Manufacturers are generally against the application of cold roofs. Mike Tobin (AFM/R-Control) believes that specifying a cold-roof as part of a SIP roof design may give the builder a false sense of security—a notion that flaws such as air gaps in the roof installation will be okay as long as there is a means for any moisture entering the panels from below to escape above. With Winter Panel, Dauthier says, "We do recommend a cold roof. Our primary reason is shingle warranty; more manufacturers warrant their shingles above SIPs when they are installed over a cold roof. The cold roof also gives you some venting; any moisture in the panel has an escape route."

III. Preventing the problem

There is a Murphy's Law that says, "Doing it the hard way is always easier." Stated another way, doing it right the first time makes pre-eminent sense.

Cooper is not a fan of SIPS for roof application in Juneau. Where the option existed to use trusses in any of the replacement roofs, he recommended switching to trusses, and most homeowners went with his advice. So his preferred approach from the get-go is to avoid SIPs in roof systems. Short of that, he would require a great deal of attention to particular air-sealing details in order to minimize problems, and still include the cold roof as a "belt-and-suspenders" detail.

Lstiburek's likes the hot roof approach both for new SIP homes and for these retrofits. He acknowledges the extra cost, and doesn't expect it to be widely embraced. Yet when starting from scratch, he still prefers it to the vented roof assembly. "In a new roof assembly using the SIP approach, my design will work better — in my opinion."

That said, Lstiburek will be working short-term with the SIP industry through his US Department of Energy "Building America" program, examining current details and exploring

other options. He expects to modify the Builder's Guide book (available through www.eeba.org) for SIP construction. The goal is to have it available by early 2002. Eventually, that document may be updated to include a generic best-practices set of installation details, something members of the industry acknowledge would be useful.

Mike Tobin (AFM/R-Control) points out that some builders need to use more sealant during installation. "Some builders wonder why R-Control sends out so much sealant with each job. The amount we send is based on computer take-offs. Sometimes builders will end the job with half the sealant left over. That can lead to installation deficiencies." Tobin also points out that wherever a discontinuity in panels is likely to occur, due to complexity of design, R-Control mandates that a vapor retarder be installed. R-Control's Technical Bulletin #2046 (January 2001) takes this a step further; "If it is determined that project conditions could possibly compromise the integrity of the roof ridge detail, R-Control Building Systems recommends the additional installation of a low-profile continuous roof ridge vent."

IV. Final comments

While this writer has not been on site to personally evaluate the evidence at hand, here are few wrap-up thoughts.

- This is a complex problem...in some situations. The apparently simple answer—build an airtight roof—may be considerably easier to describe or draw than to build in the field.
- Juneau presents an extremely unforgiving climate. In a more forgiving climate, some of the installation oversights seen here might not have resulted in catastrophic failures. But the relatively recent SIP roof failure in Martha's Vineyard, previously identified by Lstiburek, indicates that severity of climate is not always the driving factor.
- Absent the level of significant installation error reported in some homes here—such as missing insulation wedges to fit between SIPs along the ridge line—there still might have been failures in Juneau. Having a series of I-beam roof splines (supplied by the factory) that don't fit as tightly in the

recessed foam pockets (pre-cut at the factory), as recommended by manufacturers, is a cause for concern.

- Over the course of the last 30 years, installation of Alchem panels throughout Alaska's extreme climates—including at least one in Juneau—with no reported damage to roof panels, indicates that attention to key details can result in durable SIP roof assemblies.

- SIP manufacturers need to be clear about workable design features and essential installation details.
- The experts don't always agree. In extreme climates—even in more moderate climates—the choice is yours as to whether or not to employ extra belt-and-suspenders type of design features to protect against possible moisture-related damage within roof systems, and which feature might be most practical for you.

The Juneau SIP story presents a compelling rationale for SIP manufacturers and builders to revisit the drawing board. The industry's previously announced efforts to work with the Forest Products Laboratory and Joe Lstiburek would appear to offer a solid starting point in any such effort.

SIPweb will continue following this story and offer updates as new and useful information becomes available. ♦

MONITOR EDITORIAL

LET'S ALL LEARN A LESSON

Damian Pataluna – FischerSIPs



The reports of moisture damage, specifically roof rot, in over 35 homes built by one Alaskan builder has caused a bit of a stir recently in the SIP industry, and rightfully so. This is the kind of situation that can create bad publicity for an entire industry, regardless of who is at fault. I'm not going to go into the details or start pointing fingers at any individual or company. Instead, I'm simply going to suggest that we do not let this opportunity to learn pass us by.

When dealing with a home that has SIP walls and/or roof, we are dealing with an extremely airtight structure. In a normal stick framed home, you will have anywhere from 0.75 to 1.5 ACH (air changes per hour). In an average SIP home, you will easily be below 0.5 ACH, and in some cases, in the 0.2-0.3 ACH. Based on these numbers, a SIP home is four to five times tighter than a stick frame home. This isn't new, but what needs to be understood is how vapor drive and moisture migration behave. When moisture is looking to find its way out, there are less openings for it to escape in an airtight structure. Consequently, the few openings that exist in these structures must handle much more moisture load than openings in a conventional stick frame home. A SIP home must be built in a way to anticipate this, but unfortunately, the average builder is not accustomed to building such a tight structure.

The Juneau situation is regrettable, but we should take the lessons from this to get the

SIP industry moving forward. We, the SIP manufacturers, have known that SIP homes are tight. What we may not know is the best way to prevent these situations from occurring. Sure, all of us have details and ideas, but the variance in vapor drive can be drastic depending on location. For example, the climate here in Louisville, KY is nowhere near the extreme conditions of Juneau, AK and I'm sure there are other issues in Alaska that would require different approaches from those here in Louisville. Our industry is still young and, although much testing has been done, there is still plenty more to do.

In addition, although manufacturers as a whole do a good job of providing information on how to install the product, I wonder if this is enough. In most industries, the answer to that question would be "yes". Yet, in our case, we need to do more than this. I'm not suggesting we attend every job site and inspect every installation. However, somewhere in the sales process, our salesmen need to make the buyer aware of how critical it is to seal a SIP home. Preventative maintenance will help save a lot of future headaches and if we really want to grow our businesses, we need to have answers and information BEFORE the sale.

SIPA is hoping to glean some information from the specialists who are headed to Juneau so that the industry can incorporate any information findings into the "best practices" installation manual. This is a double-

edged sword however. Manufacturers and the association can provide information until we're blue in face, but if the installation is sub par, we will still have problems. With the EIFS situation in the Carolinas, much of the blame was attributed to poor or improper installation practices. The question is, can we avoid it? The answer is likely "no", but I think we can learn from this instance and be prepared to do more research in the future to provide additional information to our customers. Not just hand it to them, but really, really explain it to them.

It's unfortunate what has happened in Alaska, but the manufacturers involved are stepping up to the plate and responding. Thank you. You're not only helping your company and your customer, you are also helping your industry. I feel we should all take a good look at what happened, do the research that's necessary, and take the precautionary steps required. Let's all learn from this experience. SIPs are still a great product. Today, we are in an educational period. Tomorrow, we will be wiser and more informed. ♦

Damian Pataluna is the Division Manager of FischerSIPs, Inc. and Vice President of SIPA

BEING RESPONSIBLE FOR YOUR DESIGN

Bill Chaleff – Chaleff & Rogers, Architects



A client comes to see you. He may be a developer who wants three or four models for his 60-unit subdivision, a manufacturer with a tricky commercial project that needs some engineering, layout and detailing work, a representative from a church building committee, or a young couple with hopes for their dream house. In all cases, if you say, "Yes, I'd be glad to help out and do this design project for you - and how nice to hear you want to build with SIPs, I was just going to suggest we use them in this case," you are accepting responsibility for proper specification of SIPs.

What does accepting this responsibility mean? It means that one should have a thorough understanding of the properties of the material so that only appropriate applications are utilized. By "properties" we mean the physical characteristics, the structural/mechanical aspects as well as perm ratings, resistance to ultraviolet light, ozone exposure, construction loading and handling requirements, manufacturing tolerances, and familiarity with accessory components - fasteners, splines, foams, caulks and assembly sequences. This is a lot to integrate, but it's no more than what we deal with for all the other construction materials used all the time. (All the issues around cast-in-place reinforced concrete make me dizzy just thinking about them!) But deal with them we must or we are sure to suffer from either short term problems that might be "just" cosmetic, or long term problems that might cause structural failure. Essentially, we must be aware of the physics of the entire situation. We must be knowledgeable of code requirements, but also mindful of contextual issues that may not be anticipated by the code and arise from user patterns (normal or deviant, but foreseeable), or extreme conditions that arise from micro-climatic abnormalities (carpeting gets moldy and sick occupants - if they don't sue - stop recommending you).

Buildings are different from how they were a generation ago. They are different because they are responding to the market that is requiring them to be different. Houses are now larger, but are also loaded with more

appliances and features that tend to contribute to the increase of humidity levels. We take our cooking seriously; we do more of it and a lot of it on the stovetop. (Pasta rules!) We have hot tubs and whirlpools, steam showers and saunas. Greenhouses abound and so do active wood stoves and fireplaces. We like to think that all the products of combustion (of which water vapor is a large component) go entirely up the chimney, although this may not be the case. We are also more active, so we take more showers. Some luxury homes even have indoor swimming pools. All of this tends to put more moisture into our buildings. On the other side of the equation we are tightening up our buildings. Seems like all the talk about energy conservation is finally beginning to sink in. So we build 'em tight - especially if we're building with SIPs. After all, that's one major reason why we decided to build our project with SIPs in the first place.

The savvy designer can see this coming. If he has done his homework, he knows that the perm rating of the SIP is less than 1 perm - lower than many waterproofing films and coatings. The tight SIP building with a high internal humidity will want to equalize the temperature and humidity of the gas (air) inside with that outside. In the winter, when the delta-T is high and the humidity is low, the pressure to equalize is very high. This is called vapor drive. If there are a few cracks in the building, especially high up where the delta-T is highest, the warm, moist air will find its way out. When it hits the cold outside, the water condenses out and - voila! - rot. The professional designer/architect/engineer knows this. He will design the building to head off this problem in several ways.

On the "supply" side, sources of moisture are controlled and limited. Swimming pools have covers, clothes dryers are vented to the outdoors (yes, especially in the winter!), and bathrooms, steam shower enclosures and saunas are also specified as vented to the outside. For the energy efficiency extremist, all of these vents are passed through a heat exchanger that wrings out every last BTU

before finally exiting the building. In fact, SIP structures are only considered properly assembled when a blower door test shows them to be so tight as to have less than 0.4 Air Changes per Hour (ACH). Many SIP structures test out at less than 0.2 ACH. ASHRAE recommendations, which are referenced by most codes, require supplemental mechanical ventilation for buildings with less than 0.4 ACH, so a Heat Recovery Ventilator (HRV) is almost a default specification for a SIP structure. Strictly speaking, ASHRAE calls for ventilation that will give the building at least 0.4 ACH, the heat-recovery feature is an option.

So the designer/architect/engineer will watch the other components of the building to be sure to control humidity levels within the envelope. From a health standpoint, the ideal is a band between 40 and 50% relative humidity (RH). This helps to prevent the growth of mold and mildew, which require higher levels of humidity to exist. On the "envelope" side of the equation, proper specifications call for the sealing of the SIPs with foams, caulks and gaskets. Ed Stahl of Sunworks in California suggests that intentional vents be designed into the envelope sort of like "pressure-cooker relief valves" so that the moist air can escape without harm. Joe Lstiburek, preeminent building scientist advocates continuously running exhaust or intake fans working together with such vents as being economically competitive with HRVs.

Presently, the SIP industry is catching some flack about structural damage due to vapor drive. The panel manufacturer is not responsible for the improper application of the product. Let the design community take the responsibility for their own work. SIPs can make you look like a hero, but you have to understand their nature fully in order to use them correctly and with imagination. Specifications must deal with proper assembly and sealing. We, the design community, write the specs. ♦

TIME FOR AN INDUSTRY INSTALLATION MANUAL

Michael Morley



The climate in Juneau, Alaska is harsh. Ninety inches of rain per year, 75% relative humidity throughout the year, and the sun comes out only 36% of the time. It is a difficult climate for buildings and tests the performance capabilities of both the building product and the builders' installation practices.

For comparative purposes, I spoke to Steve Meredith, a project architect for Raytheon/Polar Systems, who has been making trips to the Antarctic since the 1980s. Many of the buildings at that time were stick built with heavy framed roof systems and fiberglass insulation. Steve noticed a pattern in that climate. During the long and cold winter, warm moist air generated inside the buildings would migrate into the roof assemblies where the arctic temperatures rapidly turned the ceiling insulation into a sort of cotton candy snow cone. When the short summer season arrived, the entire ceiling joints would continually rain down on the inside as the soggy mixture released its moisture back to the interior.

These days, all the buildings in Antarctica are constructed using SIPs, primarily for speed, high insulation values and more speed. When asked what sort of interior vapor retarder was specified for these buildings, Steve stated that 60 mil continuous vapor barrier was installed on the floor, walls and roof panels for all these buildings. This type of spec is unrealistic, and most likely unnecessary, in normal climates. The point I'm trying to make is that it is better to err on the side of overdoing it than the alternative when it comes to protecting the interior warm side of SIP buildings, especially in extreme climates.

The roof failures in Juneau should make all of us in the construction business stop and take notice. It will be a while before all the facts from Juneau are understood. One thing that is clear now is that there were communication breakdowns between manufacturers and builders and between builders and installers.

In looking through architect binders and installation guides from many manufacturers, I see

that some details include the use of vapor barriers and some do not. Some make notation about barriers and some are included in their line drawing details. The manuals that do include the vapor barrier detail don't emphasize the necessity of these barriers and seem to somehow hope the builder installers will do it right. The liability is there and some of the manufacturers are putting more emphasis on this critical aspect of the assembly.

For example, in November 2000, AFM Corporation issued Bulletin No. 2046 that specifically adds a vapor retarder draped over the ridge beam before roof panel installation. The Juneau events hammer home the point in a very real way that the SIP industry needs to have a comprehensive, thorough, detailed, and universal installation manual. And this is happening.

The first step was taken when SIPA retained the services of building scientist Joe Lstiburek, PhD, PE. Joe's series of climate specific Builder Guides, published by the Energy Efficient Building Association (EEBA), should be in every builder's pickup truck. Right now a team comprising of Joe and other SIP engineers are gathering data and starting this installation guide project from the technical end. I'm sure this team will pull together the necessary data to meet the industry's needs.

What is our responsibility? As system builders, we are charged with designing and building healthy, comfortable, safe, durable, energy efficient and environmentally responsible buildings. This is a somewhat more extensive job description than simply, builder. It means being involved in a building project to make sure necessary installation details are followed even if we are not the general contractor on the project. When we are acting in the capacity of SIP installer, we don't have any control over vapor barrier application in the interior or correct detailing for exterior drainage planes, window and door flashings and other essential details that ensure the integrity of the buildings. We are out there where the rubber meets the road and the liability trails behind

us like a string of tin cans at a wedding.

As the installation guide mentioned previously becomes a reality, we – builders, architects and engineers – need to pool all of our resources and add our practical knowledge to this project. This would be the first step in creating a much-needed SIPA builder training program. There is much to do and I offer to help collect, collate and begin this process. I would like for a group of SIP builders to bring together the common details and procedures that will be the core for this new SIPA sponsored guide. I'll be calling some of you or feel free to drop me an e-mail with comments and ideas for pulling us together to morlinc@sunflower.com.

I can see the day soon when, as we are collecting our final payment and handing warranties to our clients, we will also hand them a copy of the SIPA installation guide and point out the sections on water related problems. We will include a subtle reminder that if the specified details for the moisture related aspects of these buildings are not followed there will be warranty implications to the user. We simply cannot leave this crucial aspect of our buildings to a hope and a prayer. ♦

Michael Morley has been in the building business 25 years and is the author of "Building with Structural Insulated Panels" published by Taunton Press.