

Musings of an Energy Nerd

Contemplating residential energy use



Using Rigid Foam As a Water-Resistive Barrier

Some builders of foam-sheathed homes have decided to omit the housewrap

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Do foam-sheathed walls also need housewrap? There's no simple answer to the question.

It is possible to use foam sheathing as a water-resistive barrier (WRB). However, those who choose this route should know:

- Some brands of foam have been approved for use as a WRB, while others have not.
- Even if you choose a code-approved foam, you can run afoul of your local building inspector if you don't follow strict fastening and seam-sealing details.
- According to some building experts, even excellent installations (using an approved foam and approved seam-sealing details) may not be durable.

The code calls for asphalt felt

By now, most builders know that wall sheathing needs to be protected with a WRB — for example, asphalt felt or housewrap.

According to the International Residential Code, builders must install a layer of number 15 asphalt felt or paperbacked stucco lath over the wall sheathing or studs of every new home. The code requirement (section R703.2) includes a qualification: if you don't want to use number 15 asphalt felt, you can use some "other approved water-resistive barrier" (WRB).

The code requirement calling for walls to be covered with number 15 asphalt felt is very odd, because every manufacturer of asphalt felt declares unequivocally that the product is intended for roofs, not walls. In spite of this curious anomaly, asphalt felt performs well when used over wall sheathing as a WRB.

Other approved water-resistive barriers

So, what does the code mean by "other approved water-resistive barriers"? Almost anything, as it turns out — as long as the product (or system) has been accepted by the International Code Council Evaluation Service (ICC-ES). If a manufacturer can present adequate evidence to the ICC-ES that a material or system meets "acceptance criteria" established by the ICC-ES for approval, then the ICC-ES will issue an evaluation report approving the product.

Among the products that have been approved as substitutes for number 15 asphalt felt:

- Plastic housewraps like Tyvek or Typar;
- Grade D building paper; and
- [Liquid-applied WRBs](#) like StoGuard or Tyvek Fluid Applied WB.

If a building inspector challenges your use of Tyvek — "Where's the asphalt felt?" — all you have to do is show your inspector the relevant [evaluation report](#) from the ICC-ES.

Evaluating rigid foam as a WRB

The use of rigid foam as a WRB is a relatively new phenomenon. When rigid foam is used as a WRB, it has to meet more stringent "acceptance criteria" than those set out for housewrap. The relevant acceptance criteria document is AC71, "[Acceptance Criteria](#)

[for Foam Plastic Sheathing Panels Used As Water-Resistive Barriers.”](#)

AC71 requires foam sheathing panels to pass several tests, including artificial weathering tests involving exposure to sun lamps for 10 hours per day for 21 days, as well as repeated cycles of baking in a 120°F oven followed by soaking in a bucket. The test procedure also requires a wall-assembly test in which a 4 ft. by 8 ft. wall panel sheathed with foam is subjected to a water-spray test at a pressure differential of 6.24 psf for 2 hours.

Not all foams have been approved

Dow has announced that many of its polyisocyanurate (Thermax, Tuff-R) and [extruded polystyrene](#) products (including both tongue-and-groove Styrofoam and square-edged Styrofoam) may be used as wall sheathing without housewrap.

Similarly, Pactiv has announced that its [GreenGuard extruded polystyrene](#) (XPS) board and its GreenGuard fanfold XPS (used as a re-siding underlayment) have passed the AC71 tests for use as WRBs.

In addition to XPS and polyisocyanurate, a third type of rigid foam can be used as a wall sheathing: expanded polystyrene (EPS). Insulfoam, a manufacturer of EPS based in Tacoma, Washington, has announced that its [R-Tech EPS sheathing](#) has passed AC71 tests for use as a WRB, but only when used under stucco.

Although Owens Corning foam products are now being tested for use as WRBs, none of them have passed the AC71 tests.

At least one U.S. manufacturer of extruded polystyrene, DiversiFoam, has so far chosen not to pursue AC71 testing. “To stop liquid water, you have to do something to treat the seams,” says Dick Schmith, DiversiFoam’s director of marketing. “I have my own personal opinions about tapes. In a lab, you have a perfect environment — everything is nice and clean — so it’s not hard to imagine that you can pass a test. Sure, it works. But on a construction site, where you have dust and dirt blowing around, I’m not sure whether the tape is as good as it is in the lab.”

Sealing horizontal seams

To be considered an acceptable equivalent to asphalt felt, foam sheathing must be installed with [details identical to those used by the lab that performed the AC71 tests](#). “Our testing was done with the window installed in a certain way, so builders need to use the same window installation method the test used,” says Doug Bibee, Dow’s residential technical manager. “A flangeless window has not been tested. My interpretation now is that only flanged windows would be included.”

When Dow Styrofoam is used as a WRB, all seams must be sealed with WeatherMate tape. The specifications call for fasteners to be installed 12 inches on center around the panel perimeter, and 16 inches on center in the field. The bottom flanges of windows must be set in caulk — a detail that many builders abhor — because rough sills cannot be detailed to drain to the exterior.

How do you lap the WRB over the window fins?

If you’re using asphalt felt or housewrap, the WRB is easily lapped over the top flange of a window. However, when foam sheathing is used as the WRB, such laps are not as easily achieved.

When foam sheathing is used as a WRB, there are three possible ways to flash the top flange of a window:

- Tape the flange to the foam;
- Extend Z-flashing down from a horizontal foam seam above the window head; or
- Flash the flange with metal flashing inserted into a reglet (horizontal groove) in the foam.

Taping the flange to the foam

When installing a flanged window in a wall using foam sheathing as the WRB, the only code-approved method for flashing the top flange is to tape the flange to the foam.

All of the manufacturers now promoting foam sheathing as a WRB recommend that window flanges should be treated like vertical and horizontal foam seams: they should be taped. However, some building experts, including Joe Lstiburek of the Building Science Corporation, are reluctant to depend on tape to seal horizontal seams.

“At every possible practical opportunity, I want to displace tape with a layered assembly, because gravity doesn’t require maintenance,” says Lstiburek. “There is no reason not to use a strip of polyethylene as a Z-flashing at a horizontal joint — it’s

simple and trivial to install. But now, with these new Acceptance Criteria, the building officials probably won't let you do it. The building officials will make you tape the seams."

Extending Z-flashing down from a horizontal foam seam above the window head

The "Z-flashing in a horizontal foam seam" detail is illustrated in the *EEBA Water Management Guide* (see accompanying illustration).

Although the use of Z-flashing results in a dependable water-shedding detail, foam manufacturers require builders to use a face-sealed window installation method (one depending on the chemistry of adhesives in tape) rather than a water-managed installation (one depending on laps and gravity).

Inserting metal flashing into a reglet

The "flashing in a reglet" detail can be found in "[Installing Windows with Foam Sheathing on a Wood-Frame Wall](#)," a 17-page brochure published by the National Renewable Energy Laboratory as part of the Building America program. The brochure was prepared by engineers from the Building Science Corporation in Westford, Massachusetts.

The document includes the following recommendations:

- There should be no vertical seams in the foam sheathing above the head of any window or door.
- No caulk should be installed under the bottom window flange.
- The top window flange (or drip cap, if one has been installed) should be covered with head flashing — either metal flashing or self-adhering membrane.
- If metal flashing is used, a builder can create a horizontal reglet (a groove) in the foam sheathing above the window head and then insert a leg of the metal flashing into the reglet.
- The top of the head flashing should always be sealed with a layer of housewrap tape or sheathing tape.

Since these details (like the details shown in the *EEBA Water Management Guide*) differ from the details shown in foam manufacturer's AC71 documents, they do not comply with code.

All three methods will work

According to Joseph Lstiburek, a principal at Building Science Corporation, all three methods — the Z-flashing method, the reglet method, and the two-tape method — can perform well.

"The Z-flashing method — usually they use 6-mil poly for the flashing — is common in Texas, while the reglet method is very common in Michigan," said Lstiburek. "In Chicago, we used membrane — Ice and Water Shield — for the head flashing, and then Tyvek tape over the top of the membrane. The Tyvek tape is important, because the Ice and Water Shield always peels away from the foam at the top edge. We learned that after we opened up some walls, and saw some problems because of membrane peeling away from the foam. So we went to the two-stage tape."

Do rigid foam panels shrink?

Builders considering the use of foam sheathing as a WRB need more than code approval; they also need reassurance that rigid foam is stable enough not to shrink away from a taped seam. According to Timothy Lenahan, the residential programs manager for the Ohio Energy Office, extruded polystyrene (XPS) foam is prone to so much shrinkage that it shouldn't be used as a WRB.

When Lenahan's home was built in 1977, the unknown builder sheathed the walls with ¾-inch-thick Dow Styrofoam, attached with long roofing nails directly to the studs. Aluminum siding was then nailed to the studs through the foam sheathing.

The tongues have pulled away from the grooves

In 2006, Lenahan removed his siding as part of a renovation project. "The first thing I noticed were some gaps at the end of the foam," said Lenahan. "The foam has physically pulled away from the nails, and the gaps were fairly consistent. That's a good indicator that this is not a workmanship issue. At some of these gaps, the tongue is completely out of the groove, and you can see the fiberglass insulation through the gap." The visible fiberglass fibers had turned black — a clear indication that air has been moving through the gap for years.

After carefully examining the gaps between the Styrofoam sheets and the way that the foam deformed in the vicinity of each nail, Lenahan concluded that the Styrofoam had shrunk. "At first I thought I was going to tape all the seams with Tyvek tape, but

when I pulled more siding off, and looked at the size of the gaps, I realized that tape wouldn't do any good — the gaps were too wide. If someone intended to use foam as a water-resistive barrier, I would be really concerned."

Styrofoam has been reformulated

Curious to learn more about the dimensional stability of extruded polystyrene, I contacted Doug Bibee, an application technology leader at Dow. After visiting Lenahan's house, Bibee concluded that the Styrofoam has, indeed, shrunk. "Photos, descriptions and observation of the 30-year-old foam from Mr. Lenahan's home appear to show 1/2 to 5/8 in. shrinkage of the foam in the length direction," Bibee wrote in 2006. "This is not typical of performance then or today. Formulation of the foam has changed over the last 30 years to comply with changing regulations and to improve performance."

Manufacturers of extruded polystyrene and polyisocyanurate have tried for years to address foam shrinkage problems. In recent years, foam manufacturers have adjusted their formulations in hopes of limiting dimensional changes over time. In the case of polyisocyanurate, changes in blowing agents necessitated by concerns about the depletion of atmospheric ozone may have contributed to problems with dimensional stability (see "[Shrinking Insulation Boards Plague Roofers.](#)").

Dow's explanation that Styrofoam has been reformulated will be reassuring to some. Other builders may respond with unease; after all, if the product is regularly reformulated, it's hard to know how a foam panel purchased today will behave over the long run. In a recent phone conversation, Bibee told me that within the past year, Styrofoam has once again been reformulated.

"It's not a stable product," says Lenahan

For Lenahan, the amount of shrinkage in his Styrofoam sheathing is worrisome. "DOE needs to rethink their position on using foam as a WRB," Lenahan wrote in an e-mail. "Foam is not a stable product. The idea of taping vertical joints is flawed in that the tape will fail by the shear forces that will develop as the foam shrinks."

Lenahan is not alone in his skepticism about the long-term watertightness of taped XPS seams. According to Alan Hubbell, a residential marketing manager for Tyvek, Tyvek housewrap tape should not be used to seal XPS seams. "Foam will expand at different rates from the tape, and over time it will crinkle and wrinkle and pull off."

For anyone worried about foam shrinkage or the longevity of tape adhesive, there's a simple solution: just use housewrap as your WRB.