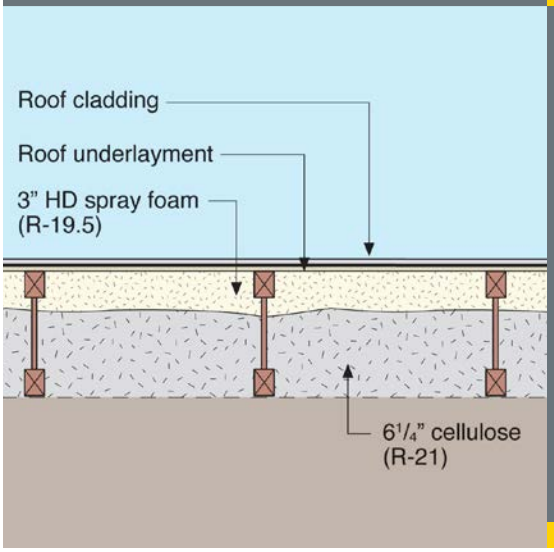

Building America Case Study

Technology Solutions for New and Existing Homes

Application of Spray Foam Insulation Under Plywood and OSB Roof Sheathing

PROJECT APPLICATION

Construction: Existing homes with unvented cathedralized roofs.

Type: Residential

Climate Zones: All

TEAM MEMBERS

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Dow Chemical Company
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CODE COMPLIANCE

2012 International Code Council, International Residential Code

Spray polyurethane foams (SPFs) have advantages over alternative insulation methods because they provide air sealing in complex assemblies, particularly roofs. Spray foam can provide the thermal, air, and vapor control layers in both new and retrofit construction. Unvented roof strategies with open cell and closed cell SPF insulation sprayed to the underside of roof sheathing have been used since the mid-1990s to provide durable and efficient building enclosures. However, there have been isolated incidents of failures (either sheathing rot or SPF delamination) that raise some general concerns about the hygrothermal performance and durability of these systems.

The primary risks for roof systems are rainwater leaks, condensation from diffusion and air leakage, and built-in construction moisture. This project directly investigated rain and indirectly investigated built-in construction moisture and vapor drives. Research involved both hygrothermal modeling of a range of rain water leakage scenarios and field evaluations of in-service residential roofs. Other variables considered were climate zone, orientation, interior relative humidity, and the vapor permeance of the coating applied to the interior face of open cell SPF.

Researchers from Building Science Corporation, a U.S. Department of Energy Building America team, performed hygrothermal modeling using WUFI 5 (Wärme und Feuchte instationär [transient heat and moisture]) was used to determine the effect of 0.01% to 1.00% of rainfall (as predicted by the Typical Meteorological Year 2 and U.S. Climate Normals or WUFI rainfall data) leaking into the unvented roof system and coming in contact with the wood-based roof sheathing. This style of leak was modeled in Minneapolis, Seattle, and Miami for three years. Explorations of 11 in-service roof systems were also completed to measure the sheathing moisture content and verify that it was within a safe range. These explorations involved a visual inspection, quantitative moisture meter readings, and product sampling where necessary.

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Technical Recommendations

LIQUID WATER CONTROL

An adhered membrane underlayment is recommended for the full roof area before the roof cladding is installed.

Flashings and penetrations must be properly detailed and constructed in a gravity-lapped manner.

VAPOR CONTROL

When installing spray foam against the roof sheathing in cold climates, either the foam must be a Class II vapor retarder or the coating applied to the interior surface of the foam must be an effective Class II vapor retarder for use on foam.

AIR LEAKAGE CONTROL

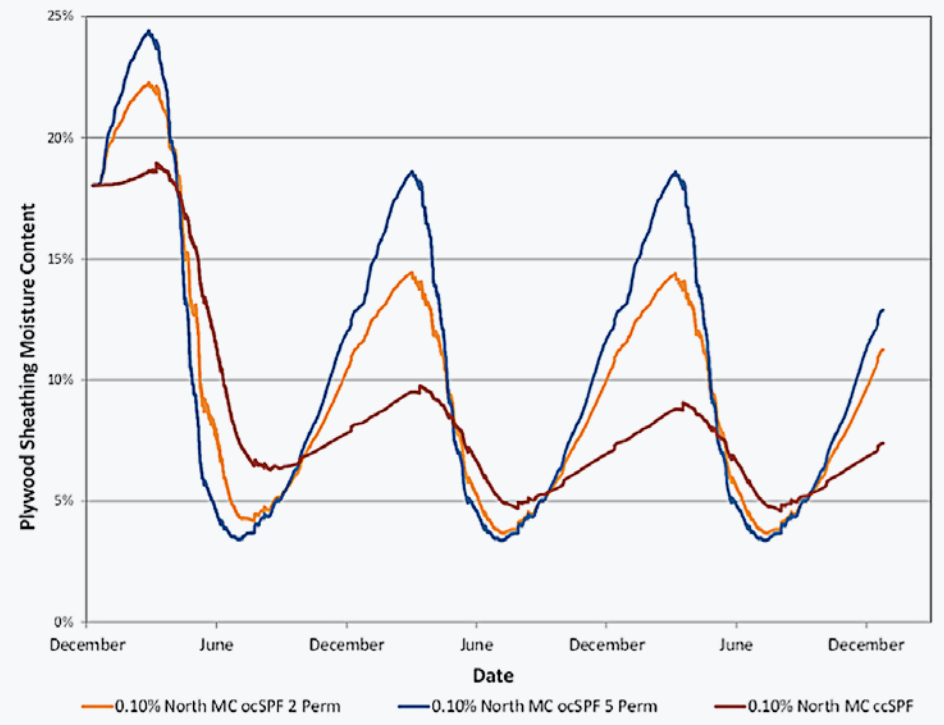
Spray foam is one component of the air sealing system when installed between framing members. To ensure air leakage is controlled, areas such as built-up framing members and penetrations must also be sealed.

THERMAL CONTROL

The 2012 International Residential Code contains recommendations for insulation R-values that should be met or exceeded. It is important to ensure that the ratios of vapor-permeable to vapor-impermeable insulations in the International Residential Code are followed.

For more information, see the Building America report, *Application of Spray Foam Insulation Under Plywood and OSB Roof Sheathing,* at *www.buildingamerica.gov*

Image credit: All images were created by the BSC team.



The graph above shows the sheathing moisture content of three modeled scenarios over 3 years, each with a 0.10% rainwater leak in a Minneapolis climate. The red line is a roof system using closed cell SPF and shows the system dries quickly after installation. The orange line is an open cell system with a 2-perm interior coating and the blue line is an open cell system with a 5-perm interior coating. The 5-perm coating represents the actual effective achieved perm value based on BSC experience with spray-applied Class II vapor retarder coatings. Each system's sheathing dries to safe levels, but the closed cell system is the most stable.

Conclusions

Based on this modeling, there are no known risks with using SPF insulation under plywood and OSB roof decks if the following requirements are met:

- The installation complies with the 2012 International Residential Code.
- A fully adhered leak-free roof membrane is installed.
- The roof sheathing and framing are dry below 18% before SPF installation.
- When using open cell SPF, a low-perm Class II vapor retarder is installed where required.

Field investigations validated the modeling data used to achieve these results. However, damage could occur where the volume of the leak, frequency of the leaks, or quantity of interior moisture driven into the system are more than modeled in this study. Bulk water control using a fully adhered membrane with proper gravity-lapped flashing details should be employed to help ensure leaks do not occur.

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Energy Efficiency & Renewable Energy

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DOE/GO-102013-4255 • November 2013