HUNTSMAN

Enriching lives through innovation

Location:
Eastern Maryland

Building Type:
Wood Frame

A Cottage Revival

Renovation of a Cottage Begins with Closed Cell Spray Polyurethane Foam

Behind the Building:
Location: Eastern Maryland
Home Size: 987 sqft
Home Construction Type: Wood Frame
Climate Zone: 4

Dollars & Common Sense:
- 66% reduction in heating/cooling energy usage
- 81% reduction in air infiltration
- Annual Savings of $660 per year

* Compared to the unrenovated cottage.

A pair of cottages sit along the water in Eastern Maryland. One is leaky, energy inefficient and uncomfortable. The other is airtight, energy efficient and comfortable all year round. Both cottages were built in the 1930-1940s. Both cottages had taken a beating from the cold, moist Maryland weather without sufficient upkeep from the owners. When the cottages were recently purchased, the new owners aimed to give them a new lease on life starting with a "to-the-studs" renovation of one them.

The cottages were originally built with actual wood sheathing. Over time in this type of construction, the building moves, opening up air infiltration points in the building enclosure. CertainTeed's CertaSpray® Closed Cell Spray Polyurethane Foam (SPF) was chosen to reinforce this building's enclosure from a thermal, structural and moisture standpoint. Andy Pittman, the energy rater for the project, commented, "closed cell foam was the only logical choice to tighten up the leakly enclosure. It expands to fill the gaps and cracks to form a robust air barrier and moisture vapor retarder, something other insulations cannot do."

This combination of closed cell SPF's properties makes it a unique building material that can greatly improve energy efficiency, building durability and indoor air quality. Between increased R-value, improved air tightness and the ability to put ducts in conditioned space*, the spray foam will save the homeowner $660 a year in energy bills. This represents a 66% reduction in energy usage for heating and cooling of the home.

Building Enclosure Design

CertaSpray Closed Cell SPF was designed to completely isolate the home from the outdoor environment. Three inches of closed cell SPF (R-19) was used in the wall cavities utilizing old 2X4 studs. The wall facing the river had 2X6 stud cavities and was filled with five inches of foam (R-32).

The vaulted cathedral ceiling assembly was sprayed with five inches of closed cell SPF (R-32) directly to the underside of the roof deck. The crawl space was enclosed with two inches of foam on the floor and three inches of foam on the crawl space walls. The foam was sprayed directly onto a vapor barrier membrane. To comply with the local building code, exposed foam in the closed crawl space was covered with an intumescent coating that had been tested with the applied foam to NFPA 286 Appendix X. The vaulted ceiling was sheetrocked with the gypsum board providing the 15-minute thermal barrier required between the foam and occupied spaces.

To complete the spray foam air barrier system, low-expansion, one-component foam and latex caulk were used to seal rough opening voids, seams and joints. Because of the high R-value of closed cell SPF, the owner was able to achieve higher R-values not possible in the same stud space with other insulations. In addition, the foam's air tightness and vapor permeance allowed the homeowner to confidently build a cathedral ceiling without worrying about interior moisture condensing on the underside of the roof deck. Furthermore, it allowed the loft space to be effectively used and placed the ducts inside a conditioned space, a significant energy saver.

Air Tightness Comparison

	Old Cottage	New Cottage
CFM50	4,873	919
Natural Air Changes Per Hour (n=20)	1.34	0.25
Annual Cost of Infiltration**	$398	$120

**Based on a 9 hpsf heat pump and includes the cost for mechanical ventilation.

Energy Cost

	Old Cottage	New Cottage
Heating***	$898	$263
Cooling***	$104	$77
Water Heating	$225	$225
Lights & Appliances	$381	$381
Service Charges	$108	$108
	$1,716	$1,054

***Based on a 9 hpsf heat pump for baseline and as-renovated cases.

Spraying the cathedral ceiling.

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Air Tightness

One of the primary reasons the cottages were originally so energy inefficient was the leakiness of the building enclosure. Every bit of unconditioned air that infiltrates a home creates a load on the heating, ventilation and air conditioning (HVAC) system. The infiltrating air must be conditioned to the desired temperature and humidity. In typical homes, this load is 30-50% of the heating and cooling energy usage alone. Therefore, air infiltration reduction through the use of SPF as an air barrier is a significant opportunity for energy cost savings.

The table to the left shows the measured leakage of both cottages and the resulting cost for heating and cooling annually. The increased air tightness saves $278 per year. In colder climates, the annual cost of infiltration would be even more dramatic.

Because the house is so tight, a balanced ventilation approach provides fresh air to the home at a minimum rate determined from ASHRAE Standard 62.2. In this approach, air is exhausted from the home at the same rate as fresh air is provided, leaving the house pressure unchanged. The fresh air stream is filtered and pre-conditioned by exhaust air in a heat exchanger called a heat recovery ventilator (HRV), making this an energy efficient approach to ventilation.

Modeled Energy Usage

In Maryland, the heating season dominates both energy usage and cost. Energy cost and consumption were modeled by the energy rater using modeling software.

Total heating and cooling energy usage was 38 MMBTU for the existing cottage. The renovated cottage was modeled at 13 MMBTU, a reduction of 66%.

In the existing cottage, energy use for heating and cooling was dominated by air infiltration (37%) and leaky, under-insulated ducts (23%). By contrast, the renovated cottage's heating and cooling factors were spread evenly with the highest usage resulting from windows and doors.

With the tight, high R-value SPF envelope, there is very little else that can be done economically to lower heat transfer through the opaque walls. Further reductions in energy usage would have to be found in windows, doors, mechanicals, lights, etc.

Conclusion

Because much of our energy usage is controlled by what's behind walls and in attics, "to-the-studs" renovations are an excellent opportunity to improve the comfort and energy efficiency of our homes. With closed cell spray foam, the homes can be tightened up significantly and R-values can be increased within the existing cavity space. The owners are excited to enjoy their comfortable, efficient newly renovated cottage in addition to the money they'll save year after year. Undoubtedly, they will look to spray foam again when the second cottage begins renovation.