RDH BUILDING SCIENCE LABORATORIES

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TO **Mike Richmond**
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R-24023.000
Genyk – Unvented Spray Foam Roof Assembly Assessment

DATE December 3, 2020

REGARDING **Moisture Risk Assessment of an Unvented Spray Foam Roof Assembly**

Dear Mr. Richmond,

As requested, RDH Building Science Laboratories (RDH) is pleased to provide you with this report for an assessment of an unvented spray foam roof assembly. Concerns have been raised regarding moisture related issues at the interior surface of the foam within the assembly. A dew point analysis was conducted to determine the risk of moisture accumulation at the surface of the foam.

1 Roof Assembly

The roof assembly in question is constructed using a scissor truss, so a void space occurs between the interior gypsum and the underside of the spray foam that is installed directly to the underside of the roof sheathing. The assembly is as follows from the exterior, to the interior.

- Roof cladding – asphalt shingles or metal roof
- Roofing underlay
- Roof sheathing – OSB or plywood
- R-30 minimum Genyk 2pcf closed cell spray polyurethane foam (ccSPF) directly applied to the underside of the roof sheathing around the framing, installed as per manufacturers recommendations and CAN/ULC S705.2
- Variable size void space (~1-20”)
- No vapour barrier
- Interior ceiling drywall with latex paint.

2 Dew Point Analysis

To conduct an analysis of the moisture condensation and risk at the surface of the spray foam, the R-value of every layer in the enclosure were determined, based on material properties found in the 2017 ASHRAE Handbook of Fundamentals, a current industry standard. The R-values used in this analysis are shown in Table 2.1. The R-value ratio to the interior and the exterior of the surface of the spray foam is determined. In this case, There is R-32 to the exterior of the surface of the spray foam, and there is approximately R-2 to the interior of the spray foam including the interior surface film, the drywall, and the air space between the drywall and the spray foam. The R-value ratio determines the temperature at the surface of the spray foam depending on the interior and exterior temperature conditions and hence the condensation risk on that surface once that temperature is compared with the dewpoint of the indoor air.

TABLE 2.1 ASSEMBLY R-VALUES (2017 ASHRAE HOF)	
COMPONENT	R-VALUE [FT² · °F · H/BTU]
Exterior surface film	0.17
Shingles	0.21
Roofing underlay	~0
Roof sheathing	0.62
Closed cell spray foam	31[1]
Air space (approximate)	1
Interior Drywall	0.45
Interior Surface Film	0.68
R-value exterior of spray foam surface	**R32**
R-value interior of spray foam surface	**R2**

Using the calculated R-values to the interior and exterior of the surface of spray foam, the surface temperature of the spray foam can be calculated for a range of exterior temperatures and a constant assumed interior 22°C as shown in Table 2.2.

TABLE 2.2 : TEMPERATURE OF SPRAY FOAM FOR A RANGE OF EXTERIOR TEMPERATURES (INTERIOR TEMPERATURE IS 22°C)	
EXTERIOR TEMPERATURE [°C]	TEMPERATURE OF THE INTERIOR SURFACE OF SPRAY FOAM
0	20.6°C
-10	20.0°C
-20	19.4°C
-30	18.8°C
-40	18.1°C
-50	17.5°C
-60	16.9°C

Winter time design temperatures from the 2015 OBC SB-1Climatic and Seismic Data for some representative cities is shown in Table 2.3. The January 1% design temperature is defined as the lowest temperature at or below which only 1% of the hourly outside air temperatures in January occur.

[1] 2016 OBC SB-12 Energy Efficiency for Housing Requires R-31in ceilings without attic space.

TABLE 2.3 2015 OBC SB-1 CLIMATIC AND SEISMIC DATA	
CITY	JANUARY 1% DESIGN TEMPERATURE
Windsor	-18˚C
Toronto	-20˚C
Ottawa	-27˚C
Barrie	-26˚C
Thunder Bay	-33˚C
Kenora	-35˚C

Table 2.3 shows the exterior design air temperature, but the roof surface temperature could be decreased by 10˚C to 20˚C degrees during the nighttime as a result of night sky radiative cooling[2]. This occurs when surfaces that are exposed to the sky, experience radiative heat transfer with outer space, cooling surfaces below the air temperature.

2.1 Boundary Conditions

One of the key performance criteria for building enclosure systems in cold climates is the winter time interior relative humidity. The recommended maximum interior RH in Ontario during the winter is 35% as per the OBC appendix, and in colder parts of Canada, the recommended maximum is less. For this analysis we used an interior temperature of +22˚C, and an interior RH of 40% to provide some safety factor to the analysis. These interior conditions result in an interior dew point of approximately +8˚C. This means that if the surface of the foam were to approach +8˚C, then the relative humidity would increase and if the surface were to reach +8˚C, it may be possible to see condensation on the surface of the foam.

3 Conclusions

When the calculated surface temperatures of the spray foam for exterior temperatures as cold as -60˚C are compared to the 8˚C dew point of the interior space, it is clear that there is no risk of condensation or moisture accumulation on the surface of the foam or within the interstitial space between the ceiling drywall and spray foam with the assumptions of 22˚C and 35% RH.

[2] Straube, J.F. and Burnett, E.F.P., *Building Science for Building Enclosure Design*. Building Science Press, Westford, Massachusetts, 2005. Section 5.9

4 Assumptions

This analysis and recommendations are based on a few assumptions as listed here.

- There are no defects in construction that are allowing liquid water into the enclosure.
- The winter time interior relative humidity is kept to a recommended level. In Ontario, this is a maximum of 35%.
- The spray foam is installed in a continuous manner without voids, and in compliance with CAN/ULC S705.2
- Any wood to wood connections that pass through the spray foam layer are air sealed to prevent interior air from passing between them.
- No interior vapour barrier is installed on the exterior of the interior drywall.

If you have any questions after reviewing our analysis, please do not hesitate to contact us by phone or email.

Yours truly,

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