Q I need to insulate the cathedral ceiling of a large building, which is located in western Virginia (climate zone 4) with hot summers and cold and snowy winters. The insulation contractor recommends insulating the rafters with a 1-inch layer of closed-cell foam, followed by fiberglass batts. Is this "flash and batt" system a good choice in my climate? Do I need to worry about condensation?

A Peter Yost, vice president of building performance for BuildingGreen in Brattleboro, Vt., responds: Flash-and-batt systems are hybrids that use more than one type of insulation—an air-impermeable outer layer and then an inner layer. But before discussing the flash-and-batt system, we first need to understand that in any building that is being heated or cooled, warmer, more-moisture-laden air can result in condensation if that air hits a surface with a temperature that is at or below dew point. When this happens inside a building assembly, we call that surface the first condensing surface.

If you are cooling a house in the summer, the warmer, more-moisture-laden air is outside and the colder, dryer air is inside. If that outside air leaks into the house, the first condensing surface that the air hits is typically the reverse side of the gypsum wallboard. If you are heating a house in the winter, the warmer, more moist air is inside, and the colder, dryer air is outside. So if inside air leaks out of the house, the first condensing surface that the air hits is usually the interior-facing side of your structural sheathing. The longer you need to cool or heat your home, and the hotter or colder the climate is outside, and the more moist or dry the air is either inside or outside a home, the greater the chance is for condensation to occur.

There are many ways to prevent condensation from occurring inside building assemblies (called "interstitial condensation"). The first way is air-sealing. Much more moisture as vapor moves through walls by air leakage than by diffusion. If you don't air-seal to control interstitial condensation, don't even bother trying to manage condensation with the other ways listed below.

The next way is warming the first condensing surface so it is less likely to be at or below dew point temperature. You can also try to manage inside moisture

MINIMUM AIR-IMPERMEABLE SPF INSULATION FOR HYBRID INSULATION SYSTEMS USED IN UNVENTED ATTICS AND CATHEDRALIZED CEILINGS

(Based on 2009 IRC Section R806.4 or 2012 IRC Section R806.5)

IECC Climate Zone	Minimum R-Value from SPF	Total Insulation R-Value / SPF R-Value % Ratio (2009 IRC)	Total Insulation R-Value* / SPF R-Value % Ratio (2012 IRC)
4C (Marine)	R-10	R38 / 26%	R49 / 20%
4A, 4B	R-15	R38 / 39%	R49 / 31%
5	R-20	R38 / 53%	R49 / 41%
6	R-25	R49 / 51%	R49 / 51%
7	R-30	R49 / 61%	R49 / 61%

*When more total R-Value than required in the 2009 or 2012 IECC is utilized, a higher R-Value for the SPF is required than that listed in Table 2. Use the minimum percentage as indicated to the right to determine the SPF R-Value.

To control condensation in hybrid roof assemblies, the code sets minimum R-values for the air-impermeable layer (column 2) and its percentage of the total R-value of the system (columns 3 and 4). R-value requirements have not increased since the 2012 code. While this table addresses the R-value of SPF, the R-value percentages also work for rigid-foam insulation installed above the roof sheathing.

when you are heating (you can't really do the reverse when you are cooling). Finally, you can retard the moisture moving by vapor diffusion into the assembly.

So what does any of this have to do with flash-and-batt insulating systems? We know that vapor moves readily through air-permeable insulations such as fiberglass batts. To keep that vapor from condensing in your wall or roof assembly, a flash-and-batt system is one way to warm the first condensing surface with air-impermeable insulation. There are other ways to accomplish this: Continuous rigid insulation on the exterior of the structural sheathing warms the sheathing and, if the insulation is thick enough, can prevent condensation on the first condensing surface. A flash-and-batt system uses air-impermeable insulation, such as closed-cell spray foam in the building cavities (joist or stud bays) installed against the inside of the structural sheathing. This strategy does not make the structural sheathing warmer, but it does move the first condensing surface to the inside face of the spray foam, and if this layer of insulation is thick enough, it will prevent condensation on that new surface.

The bottom line is that the R-value of the outer air-impermeable layer of insulation needs to be great enough to keep that first condensing surface above dew point. The colder the climate, the greater the R-value needs to be in that air-impermeable layer. For determining the thickness of the air-impermeable layer in a flash-and-batt system (also called flash-and-fill), there is guidance from both the most recent energy codes as well as the Spray Polyurethane Foam Alliance (SPFA). The table on the previous page shows how much R-value the foam layer should provide to a flash-and-batt insulation system, both as a minimum R-value and as a percentage of the total.

Using that SPFA table, let's look at our example in western Virginia (climate zone 4A). Virginia has adopted IRC 2015, but with some amendments. One of those amendments keeps the climate zone 4 ceiling-insulation minimum total value at R-38, the 2009 IRC level. For the building in the question to comply with both the building code and SPFA guidance, the spray-foam "flash" layer would need to equal an R-value of 15 (column 2), which represents 39% of the 2009-required total minimum ceiling R-value of 38 (column 3). If the R-value of closed-cell spray foam is 6.5 per inch, then 2 1/3 inches of spray foam would be the minimum requirement to meet the Virginia code.

If you decided to go beyond code for total ceiling R-value, let's say to R-60, then use the ratios shown in the fourth column. (While these ratios reflect the amount of spray foam needed to control condensation in a flash-and-batt system that meets the higher 2012 insulation requirements, they are safe to use for higher-R assemblies as well). That is, the flash layer needs to be 31% of the total insulation R-value, which means R-18.6. To achieve that R-value with spray foam, the layer would need to be 2.9 inches thick.

The SPFA provides two reference documents for guidance with hybrid insulation systems, one for warm climates (zones 1–3) and one for cold climates (zones 4–7). Both of these documents can be downloaded from the SPFA website, sprayfoam.org.