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To Vent or Not to Vent: That is the Question.

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The spray polyurethane foam (SPF) insulation community has been installing unvented-conditioned attics in homes for decades. But with the changes in the International Residential Code, first implemented in the 2004 Supplement, the Code now recognizes the practice and broad general acceptance of unvented-conditioned attics is a fact. The SPF community has embraced this development because SPF's combination of high R-value and low air permeability make it an ideal insulation for this application.

But, do unvented attics **always** make sense? The answer is an unequivocal "No."

Advocates of unvented attics claim that they save energy over vented attics. This can occur but only under certain circumstances. There are good reasons to install unvented attics but there are also good reasons to insulate the attic floor and vent.

When considering whether or not to vent an attic, my default position is to vent. That is, install SPF insulation on the attic floor and provide the classic soffit, ridge, and/or gable ventilation that the building codes require. The main reason for this lies in the geometry and thermodynamics of attics.

The relationship between heat loss and insulation is generally expressed by the conductive heat transfer equation:

$$Heat\ transfer\ (loss\ or\ gain) = \frac{Area \times Temperature\ Difference}{R\ value}\quad or$$

$$Q = \frac{A \times \Delta T}{R}$$

Note in the above equation that heat transfer (Q) is proportional to **both** area (A) and temperature difference (ΔT). Increasing either area or ΔT increases heat transfer proportionally.

Now, let's consider, for example, a simple rectangular, one-story house, 35 feet wide by 70 feet long, with a shingle roof having its axis parallel to the length of the house, gable ends and a 6:12 pitch.

Should we insulate the attic floor or the roof line?

First, take a look at the comparative areas that must be insulated. The footprint of the attic floor is 1750 ft^2. But the footprint of the roof line and gable ends adds 513 ft^2, increasing the total insulated area to 2263 ft^2. The roof line and gable ends add 29% more area that needs to be insulated. And since heat transfer is proportional to area, insulating the roof line and gable ends contributes 29% greater heat loss and/or gain.

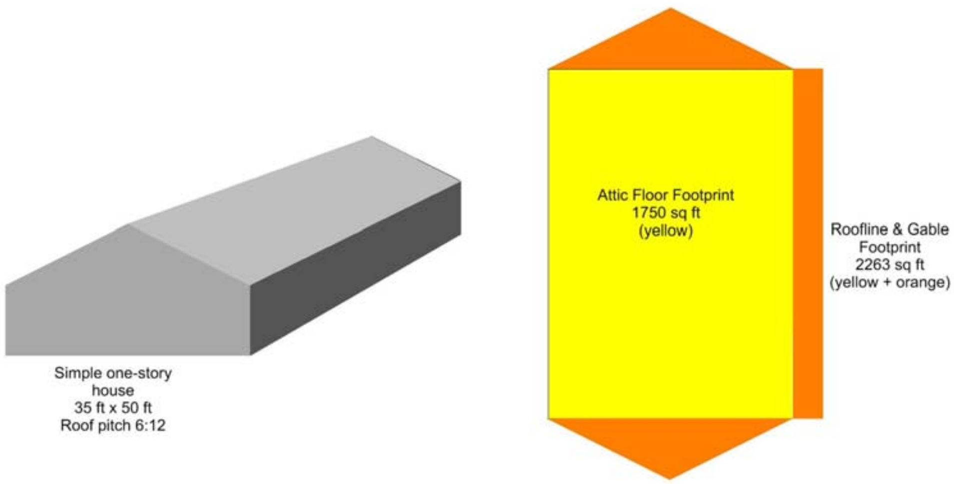

Figure 2: Comparative insulated areas for vented and unvented attic

Next, take a look at the comparative temperature differences. Temperatures of shingles and attics depend on many factors, far too complex for the scope of this article. But the net effect is that the ΔT across the insulation of an unvented-conditioned will be much greater than the ΔT across insulation on the attic floor with venting.

Why is this?

The temperature difference (ΔT) across insulation in a vented attic (insulation is placed on the attic floor) is governed by the attic temperature and the interior temperature. And when the attic is vented, its temperature is mitigated by the air circulation into and out of the attic. Thus on a typical sunny, summer day when shingle temperature are 165° F, attic temperature may be in the neighborhood of 120°. With an interior temperature of 75° F, the net ΔT would be 120 - 75 = 45°F.

In an unvented-conditioned roof, with insulation applied to the underside of the roof deck, the exterior side of the insulation will be close to the temperature of the shingles (and shingles over an insulated deck will be slightly higher than those over a vented deck). The underside (interior) temperature of the insulation will be close to the interior temperature. Thus on a hot, sunny day, the shingle temperature may be 170° F while the interior temperature is around 75° F. Allowing for the insulating effects of air films, roof decking, ceiling, etc., the net ΔT across the insulation would be approximately 165 - 80 = 85° F.

The ΔT across the insulation in the unvented attic is 40° (89%) higher than the vented attic. As heat transfer is proportional to ΔT, the greater temperature difference contributes 89% greater heat transfer (in this case, gain, as summer conditions were used in the example).

The combined effects of increased area and increased ΔT are multiplicative. Thus, in the example shown, if we assume, in both cases, the insulation has an R-value of 30, heat gains for each case are:

$$Q = \frac{A \times \Delta T}{R}$$

$$Q_{vented} = \frac{1750 \times 45}{30} = 2630\ Btu/hr$$

$$Q_{unvented} = \frac{2263 \times 85}{30} = 6410\ Btu/hr$$

As can be seen, the combined effects of greater area and greater ΔT in the unvented-conditioned attic result in a heat gain of 3780 Btu/hr greater than the vented attic–this is equivalent to almost 1/3 ton of air conditioning capacity (a ton of air conditioning capacity is equal to 12,000 Btu/hr). (Obviously, this example represents extreme conditions, not those a house would really experience with daily and annual temperature fluctuations. Also, the ΔT across the insulation in the gable ends would be less the insulation under the roof line.)

Furthermore, the installation costs of an unvented-conditioned attic will generally be higher due to the larger area that requires insulation.

Based on this analysis, the obvious answer to “Should we insulate the attic floor or the roof line?” would be “Insulate the attic floor.”

But not so fast. There are crucial mitigating factors I haven’t mentioned.

In spite of the greater heat transfer (and energy consumption) that unvented-conditioned attics will experience, there are some excellent reasons to install them:

- Ductwork: Probably the most widely mentioned reason for unvented-conditioned attics, is the energy savings that result from HVAC duct losses. When ducts are run through an attic, the energy losses from physical and thermal leaks can be considerable. In fact, by moving the duct work within the thermal envelope (as in an unvented-conditioned attic), the net energy savings can be dramatic.
- Recessed Lights: With an unvented-conditioned attic, recessed or can lights can be installed without the expensive need to separately air seal and insulate them.
- Additional Floor Space: Often unvented attic space can be converted to occupied space with little additional cost. Space can be added to a home this way either during initial construction or as a later remodeling project. Either way, this“harvesting of space” can add considerable value to the house.

- Wind and Water Mitigation: Hurricane prone areas and other regions subjected to high winds and wind-driven rain benefit from having SPF applied to the roof line. Wind uplift resistance is enhanced and the likelihood of rain penetrating vents is reduced.
- Wildland-Urban Interface Zones: Wind can drive embers and burning brands into attic vents, starting fires resulting in catastrophic damage. Unvented-conditioned attics eliminate the vents, reducing this fire hazard.
- Ice Damming: One of the most common causes of ice dams is having a non-uniform temperature profile of the roof surface between the roof ridge and the eave. Have a well insulated roof line can eliminate these temperature differences and the subsequent ice buildup and damming.
- Architectural Options: The attics of some house designs are impractical (or impossible) to vent. By designing unvented-conditioned attics, architects can be much more creative with roof lines and configurations.
- Construction Scheduling: The insulation package can be installed in a single visit; vented attics require that the insulation contractor return after the dry wall has been installed.
- Installation Access: Installing SPF insulation to the underside of roof decks before the drywall ceiling is installed simplifies access, speeds up the insulation installation and avoids difficult to insulate tight spots.

Conclusion

So, Should we insulate the attic floor or the roof line?

Simple answer: Insulate the roof line when one or more of the mitigating factors discussed above are applicable; otherwise insulate the attic floor. SPF can be applied in either configuration and provide excellent long-term insulation and an air seal in one product.