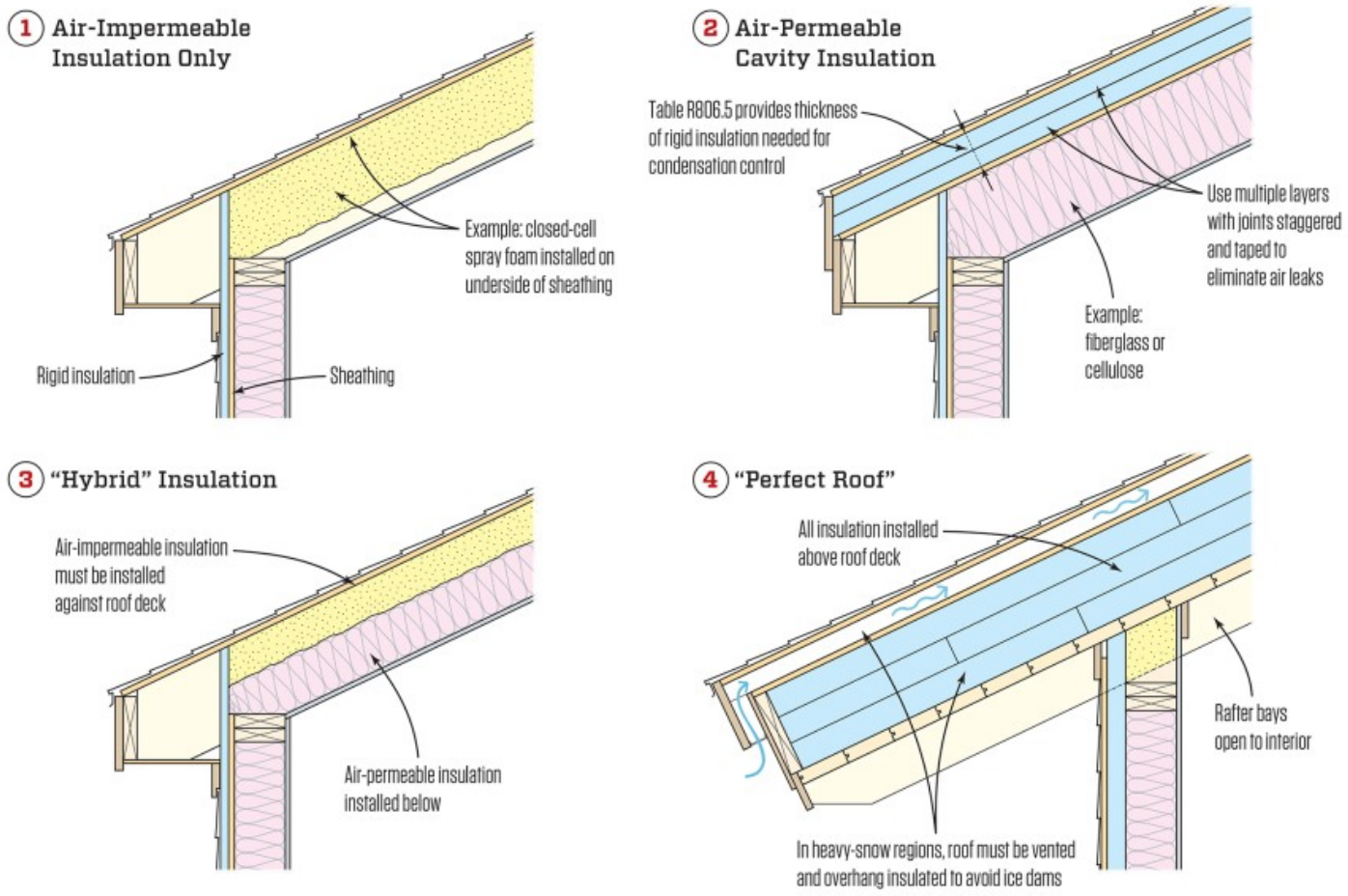
R806.5 Unvented Attics and Roofs (from the Journal of Light Construction July 2018)

Unvented assemblies are relatively new to the building code and a lot more complicated. Section R806.5 of the 2015 IRC, titled "Unvented attic and unvented enclosed rafter assemblies," states that the attic or roof assembly can be unvented if five conditions are met.

The first four conditions are relatively straightforward:

1. The attic or roof assembly is completely within the building thermal envelope.
2. There is no Class I vapor retarder at the ceiling plane.
3. If present, wood shakes and shingles must be separated from the roof sheathing by a minimum 1/4-inch (6.4mm) vented air space.
4. In Climate Zones 5 to 8, air-impermeable insulation must be (or have) a Class II vapor retarder on the underside of the insulation or assembly.



Insulation options for unvented roofs. When you're using only air-impermeable insulation (option 1, top left), it must be installed directly below the roof deck. When you're using only air-permeable insulation in the framing cavity (option 2, top right), you must install the right amount of rigid insulation above the roof deck. Wood roofing will still need a minimum vent space beneath it. When you're using a mix of air-permeable and air-impermeable insulations in the framing cavity (option 3, above left), the air-impermeable material must be installed directly below the roof deck. All the insulation can be installed over the roof deck with the framing cavities left open (option 4, above right). In snow regions, the roofing will still need to be vented. (Illustration: Tim Healey)

Here is what these first four conditions mean:

1. You must have a continuous air-control layer as part of any unvented attic or roof assembly.
2. Because many unvented roof assemblies have topside elements (such as roof underlayment and cladding) that are Class I vapor retarders, you don't want an interior Class I vapor retarder that virtually eliminates drying to the interior.
3. Roof claddings made out of wood require special attention to drying.
4. Cold climates mean unvented roof assemblies need a bit greater control of warm, moist air moving into the unvented assembly during the winter.

The fifth condition is all about the insulation in the space and assembly. It's complicated because it deals with the type of insulation (air-impermeable or air-permeable), the location of the insulation (exterior or interior to the roof sheathing), and balance (by R-value) of the types of insulation for assemblies with both air-impermeable and air-permeable insulation.

Here is what the fifth condition (R806.5.5) means:

1. If you are using only an air-impermeable insulation (for example, closed-cell spray foam), it must be installed on the underside of the roof sheathing and in direct contact with the sheathing (no chance for air-control-layer discontinuity).
2. If you use air-permeable cavity insulation (batts, blow-in or sprayed cellulose or fiberglass), you must install enough rigid insulation on top of the roof sheathing to provide condensation control (Table R806.5 sets up the R-value ratios by climate that define how thick this rigid insulation needs to be).
3. If you choose a "hybrid" insulation system, the air-impermeable insulation must be against the roof sheathing, and the R-value ratio of air-impermeable to air-permeable insulations must follow Table R806.5 for condensation control.
4. You can do a "Perfect Roof" with rigid foam only above the sheathing and with open framing cavities. (The term "Perfect Roof" was coined by Joe Lstiburek, who has also worked out important details for this assembly in snow regions. See the Building Science Corp. (BSC) article "Joseph Haydn Does the Perfect Wall" for more information.) If you put all your R-value topside of the roof sheathing, that topside insulation can give you enough condensation control (per 2015 IRC Table 806.5) to leave the roof assembly empty and completely open to drying to the interior.

From the IRC 2015

R806.5 Unvented attic and unvented enclosed rafter assemblies.

Unvented *attics* and unvented enclosed roof framing assemblies created by ceilings that are applied directly to the underside of the roof framing members and structural roof sheathing applied directly to the top of the roof framing members/rafters, shall be permitted where all the following conditions are met:

1. The unvented *attic* space is completely within the *building thermal envelope*.
2. No interior Class I vapor retarders are installed on the ceiling side (*attic* floor) of the unvented *attic* assembly or on the ceiling side of the unvented enclosed roof framing assembly.
3. Where wood shingles or shakes are used, a minimum $^1/_4$-inch (6.4 mm) vented airspace separates the shingles or shakes and the roofing underlayment above the structural sheathing.

4. In Climate Zones 5, 6, 7 and 8, any *air-impermeable insulation* shall be a Class II vapor retarder, or shall have a Class II vapor retarder coating or covering in direct contact with the underside of the insulation.

5. Insulation shall be located in accordance with the following:

    5.1. Item 5.1.1, 5.1.2, 5.1.3 or 5.1.4 shall be met, depending on the air permeability of the insulation directly under the structural roof sheathing.

        5.1.1. Where only *air-impermeable insulation* is provided, it shall be applied in direct contact with the underside of the structural roof sheathing.

        5.1.2. Where *air-permeable insulation* is provided inside the building thermal envelope, it shall be installed in accordance with Section 5.1. In addition to the *air-permeable insulation* installed directly below the structural sheathing, rigid board or sheet insulation shall be installed directly above the structural roof sheathing in accordance with the *R*-values in Table R806.5 for condensation control.

        5.1.3. Where both *air-impermeable* and *air-permeable insulation* are provided, the *air-impermeable insulation* shall be applied in direct contact with the underside of the structural roof sheathing in accordance with Item 5.1.1 and shall be in accordance with the *R*-values in Table R806.5 for condensation control. The *air-permeable insulation* shall be installed directly under the *air-impermeable insulation*.

        5.1.4. Alternatively, sufficient rigid board or sheet insulation shall be installed directly above the structural roof sheathing to maintain the monthly average temperature of the underside of the structural roof sheathing above 45°F (7°C). For calculation purposes, an interior air temperature of 68°F (20°C) is assumed and the exterior air temperature is assumed to be the monthly average outside air temperature of the three coldest months.

    5.2. Where preformed insulation board is used as the air-impermeable insulation layer, it shall be sealed at the perimeter of each individual sheet interior surface to form a continuous layer.

❖ Unvented attics are attics where the insulation and air barrier boundary are directly above the attic space, instead of on top of the ceiling. Unvented attics eliminate the extreme temperatures of the attic, thereby placing the HVAC, ducts, pipes, and anything in the attic space into a more favorable environment. Unvented attics increase energy efficiency and decrease wear and tear on equipment in the attic. This section describes such attics, where conditions are similar to the conditions of the residential space below. The primary benefit of having the insulation and air barrier above the attic is that ducts and/or HVAC equipment in the attic are not delivering cooled air through a hot summer attic and heated air through a cold winter attic. Another benefit is to eliminate the attic vents that sometimes allow moisture to condense inside the attic, admit rain during extreme weather and possibly admit sparks in fires.

Because this space is inside the building's thermal envelope, the traditional attic ventilation required by Sections R806.1 and R806.2 is not required. Unvented attics require water/moisture control. Water moves in (or out) of buildings three main ways. The greatest amount of moisture is moved as bulk water (rain or any kind of water flow). Less moisture is moved by moving moist air, such as with infiltration. The least amount of moisture is moved by moisture migration through materials. As with any attic, the roof itself is the main barrier for keeping water from entering the attic.

Unvented cathedral ceilings (enclosed roof framing assemblies) are permitted under this section. Unvented attics and unvented cathedral ceilings are similar. The governing physics are identical so these requirements work for both.

The provisions of this section can be applied to any attic area that is in compliance with this section. The attic is a traditional attic space, with the exception that it need not be ventilated and it will not get as hot or as cold as an attic that is open to the exterior.

It is very important that all of the five listed conditions be reviewed and considered for each building that uses the provisions of this section.

Item 1 requires that the attic space be completely contained within the building thermal envelope.

Item 2, which applies to all climate zones, prohibits the installation of a Class I vapor retarder where it is typically installed at the ceiling level (attic floor) of a traditional ventilated attic. This ensures that no barrier is installed that would separate the conditioned attic area from the remaining portion of the home. This requirement gives the attic space a limited potential to dry into the space beneath the attic so that small amounts of excess moisture can be removed from the attic.

Item 3 applies to all climate zones and contains special requirements that apply to wood shingles and shakes roof coverings. Wood shakes and shingles require a vented space under them to allow the wood to dry after it gets wet from rain.

Item 4 applies only to Climate Zones 5 or higher. The air-impermeable insulation must qualify as a Class II vapor retarder or have a Class II vapor retarder coating or covering in direct contact with the insulation on the underside (interior) face of the insulation.

Item 5 requires sufficient insulation to keep moisture from condensing on the "condensing surface" inside the attic in "average conditions." The insulation works to prevent condensation by keeping the condensing surface above the temperature where condensation will occur. Small amounts of condensation may occasionally occur at more extreme conditions; however, this is not a concern. The condensing surface is the interior side of the roof deck for air-permeable insulation and the interior of the insulation for air-impermeable insulation. The condensing surfaces differ because attic air can circulate through air-permeable insulation to contact the roof deck but can get only to the interior of air-impermeable insulation. The requirement for "air-impermeable" insulation will ensure that air and the moisture it can contain will not pass through the insulation to reach a point where it could condense because of the temperature. Item 5 specifies that air impermeable insulation be in direct contact with the interior side of the roof deck. Air-impermeable insulation prevents the movement of moist air that comes in as infiltration through the roof into the interior of the attic. Air-impermeable insulation is defined as having an air permanence of 0.02 L/s-m^2 (at 75 Pa pressure) or less. Expanding spray foams and insulated sheathing (hard-foam sheathing board) are common types of air-impermeable insulation. When using insulated sheathing, attention to the details of completing the air sealing is required as the sheathing is installed in the roof. Fiberglass and cellulose are common types of air-permeable insulation.

Note that the insulation required by Item 5 may be more or less than the insulation required for energy efficiency in Chapter 11. If the amount of insulation required by Item 5 varies from the amount specified in Chapter 11, the provisions of Section R1102 would apply, and the higher insulation value would be required. The insulation provided to comply with Item 5 may be considered as contributing to the insulation required in Chapter 11.

It is important to realize that this section cannot be viewed as modifying or eliminating requirements found elsewhere in the code. Examples of sections that still affect these attic areas include Sections R302.10, R302.13, R316, R807, N1102.1 and others. Because the insulation typically used with this provision is some type of foam plastic, the requirements of Section R316 must be applied. The provisions of Section R806.4 do not in any way modify or eliminate the requirements for a thermal barrier (Section R316.4) or protection from ignition (Section R316.5.3). See the commentary to Sections R302.10 and R316for a complete discussion regarding these requirements and the options available. Ducts in this unvented attic construction would be considered as being inside the building thermal envelope and would not require insulation (see Section N1103.3.1).

The provisions of this section consider the attic assembly as a "conditioned" space; there is no requirement for the space to be provided with conditioned air supply. The attic space is considered indirectly conditioned because of omission of the air barrier, insulation at the ceiling and leakage around the attic access opening. An attic assembly complying with Section R806.5 will generally fall within the temperature ranges specified in the definition of "Conditioned space."

The key concept of this section is to move the thermal envelope (insulation) above the attic, resulting in the attic being in a conditioned (or sometimes semi conditioned) space. Direct air supply to the attic is not required if the attic floor is

not insulated; the attic temperature would be similar to interior conditioned spaces. Ducts and/or HVAC equipment in the attic also help moderate the attic conditions.

TABLE R806.5

INSULATION FOR CONDENSATION CONTROL

CLIMATE ZONE	MINIMUM RIGID BOARD ON AIR-IMPER-MEABLE INSULATION *R*-VALUE[a, b]
2B and 3B tile roof only	0 (none required)
1, 2A, 2B, 3A, 3B, 3C	R-5
4C	R-10
4A, 4B	R-15
5	R-20
6	R-25 (Topsham Climate Zone)
7	R-30
8	R-35

a) Contributes to but does not supersede the requirements in Section N1102.

b) Alternatively, sufficient continuous insulation shall be installed directly above the structural roof sheathing to maintain the monthly average temperature of the underside of the structural roof sheathing above 45°F (7°C). For calculation purposes, an interior air temperature of 68°F (20°C) is assumed and the exterior air temperature is assumed to be the monthly average outside air temperature of the three coldest months.

❖ Section R806.5 provides three options for installing insulation at the roof line for unvented attics and unvented rafter spaces: air-impermeable insulation (typically foam plastic) installed directly below the roof sheathing; a combination of air-impermeable and air permeable insulation installed below the roof sheathing; and air-impermeable insulation (rigid board or sheet insulation) installed above the structural roof sheathing. In the last case, the minimum R-value for the rigid board or sheet insulation is determined from Table R806.5 based on climate zone to prevent condensation on the underside of the structural roof sheathing. Note b provides a calculation procedure to determine necessary rigid board or air-impermeable insulation R-values for roof assemblies that do not meet the requirements of Table R806.5.