U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Building America Solution Center

Application of Spray Foam Insulation Under Plywood and OSB Roof Sheathing

Scope

Install spray foam insulation along the underside of the roof deck to create an insulated, unvented attic, which can provide a conditioned space for HVAC equipment that is located in the attic.

DOE Zero Energy Ready Home Notes

The U.S. Department of Energy Zero Energy Ready Home National Program Requirements specify as a mandatory requirement (Exhibit 1, #2.2) that, for all labeled homes, whether prescriptive or performance path, ceiling, wall, floor, and slab insulation shall meet or exceed 2012 IECC levels. See the guide 2012 IECC Code Level Insulation – DOE Zero Energy Ready Home Requirements for more details.

The DOE Zero Energy Ready Home National Program Requirements also specify as a mandatory requirement (Exhibit 1, #3) that ducts are located within the home's thermal and air barrier boundary. See the Compliance tab for exceptions and alternative compliance options.

ENERGY STAR Certified Homes Notes

ENERGY STAR Certified Homes requires that ceiling, wall, floor, and slab insulation levels meet or exceed those specified in the 2009 International Energy Conservation Code (IECC) with some alternatives and exceptions. See the guide 2009 IECC Code Level Insulation - ENERGY STAR Requirements for more details.

Description

Unvented roofs with spray foam applied to the underside of the roof deck have been used since the mid-1990s. Open-cell spray polyurethane foam or closed-cell spray polyurethane foam (ccSPF) insulation is sprayed along the underside of the roof sheathing to provide a conditioned and insulated attic space that can be durable and efficient in all climate zones. Moving the air control layer and thermal control layer to the underside of the roof deck has significant advantages in cases where the HVAC system is located in the attic; by locating HVAC equipment and ducts within the thermal envelope of the home, conductive thermal losses are minimized and any losses due to air leaks still contribute to space conditioning (see Figure 1). Insulating and air sealing at the roof line may also be a more effective means of providing a continuous thermal barrier in house designs that have complex coffered ceilings and numerous holes through the ceiling plane for lights, wiring, etc., which would otherwise make it difficult to achieve the airtightness needed below the insulation layer. In addition it might not be desirable (in hurricane or wildfire areas) or practical (in retrofits) to add roof vents at soffit locations.

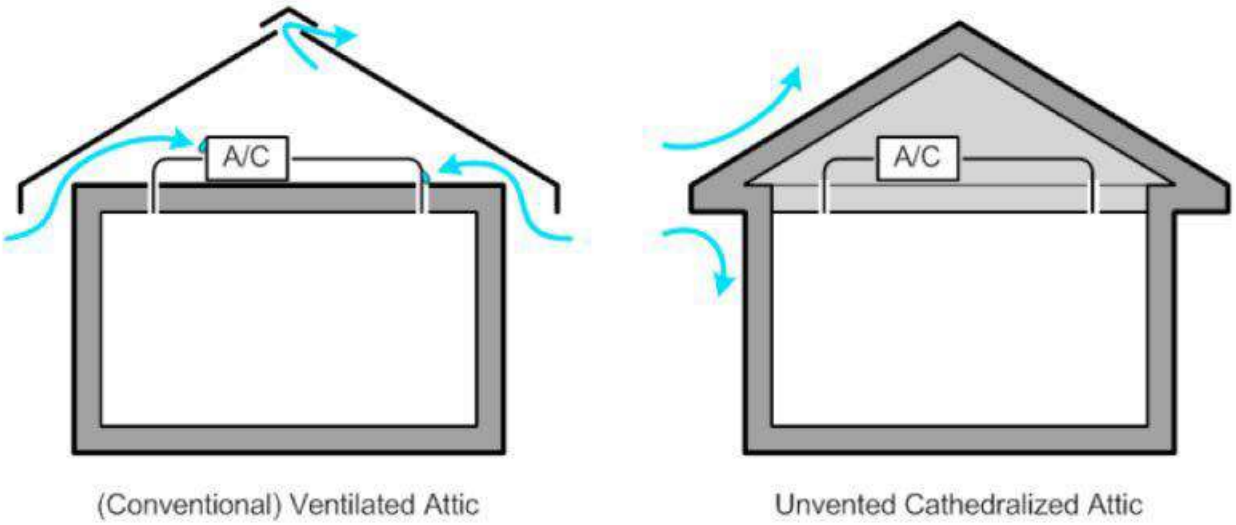

Figure 1. Constructing an attic that is unvented and is insulated along the roof line provides a conditioned space for HVAC equipment that is located within the home's thermal envelope.

When the design choice is made to insulate along the underside of the roof deck, spray foams have advantages over other insulation types because of the ability of spray foams to effectively air seal complex assemblies. The spray foam can also serve as the thermal and vapor control layers in both new and retrofit construction.

Despite the advantages of using spray foam under the roof deck, there are some potential

risks. The primary risks are rainwater leaks, condensation from diffusion and air leakage, and built-in construction moisture. Hygrothermal modeling sponsored by the DOE Building America program and conducted by Building Science Corporation confirmed that even when the roof was modeled with rainfall leaks of up to 1% through the roof sheathing or with initial moisture content of the wood framing and sheathing of up to 18%, roofs insulated with open- or closed-cell spray foam could dry out sufficiently on a seasonal basis. Damage could occur if wood moisture content was above 18%, or if repeated or prolonged leaks above 1% were experienced and if the wood was unable to dry out. However, proper construction techniques, including the following measures, will minimize or eliminate the potential for moisture-related roof damage. (See Grin, Smegal, and Lstiburek 2013 for more details.)

How to Install Spray Foam on the Underside of the Roof Decking

1 Make sure the installation complies with the 2012 International Residential Code (2012 IRC; see the Compliance tab for more details). The requirements of the 2012 IRC Section R806.5 "Unvented attic and unvented enclosed rafter assemblies" are summarized here: Unvented attic assemblies and unvented enclosed rafter assemblies are permitted if all the following conditions are met:

i The unvented attic space is completely within the building's thermal envelope.

ii No interior Class I vapor retarders (e.g., plastic sheeting) are installed on the ceiling side of the unvented attic assembly (i.e., under the ceiling) or on the ceiling side of the unvented enclosed rafter assembly.

iii Where wood shingles or shakes are used, a vented air space of at least one-quarter inch separates the shingles or shakes from the roof underlayment above the structural sheathing.

iv In Climate Zones 5, 6, 7, and 8, any air-impermeable insulation is a Class II vapor retarder or has a Class II vapor retarder coating or covering in direct contact with the underside of the insulation. [Note, the 2012 IRC says "or be coated with a Class III vapor retarder." "Class III" is a typo which has been corrected to Class II in the 2015 I codes.]

v The attic or rafter assembly meets one of the following conditions regarding the air permeability of the insulation directly under the structural roof sheathing.

a Air-impermeable insulation only. Insulation is applied in direct contact with the underside of the structural roof sheathing.

b Air-permeable insulation only. In addition to the air-permeable insulation installed directly below the structural sheathing, rigid board or sheet insulation is installed directly above the structural roof sheathing as specified in Table R806.5 for condensation control.

c Air-impermeable and air-permeable insulation. The air-impermeable insulation shall be applied in direct contact with the underside of the structural roof sheathing as specified in Table R806.5 for condensation control. The air-permeable insulation shall be installed directly under the

air-impermeable insulation.

d Where rigid foam insulation is used as the air impermeable insulation layer, it is sealed at the perimeter of each individual sheet interior surface to form a continuous layer.

2 Install a leak-free roof membrane that is fully adhered to the roof sheathing.

3 Ensure, when using open-cell spray foam, that a low-perm Class II vapor retarder is installed where required.

4 Refer to the current state and local building codes for the minimum R-value of air-impermeable insulation required for the roof assemblies in your climate.

5 Inspect the roof assembly to ensure it has proper drainage protection above the roof deck.

6 Measure the moisture content of the wood prior to applying spray foam insulation to ensure it has dried to below 18% or to the levels recommended by the spray foam manufacturer.

7 Ensure the weather conditions and temperatures for installing the insulation are as recommended by the spray foam manufacturer.

8 Clean the surfaces of the roof sheathing and structural members so they are clear of any debris or dust to ensure proper adhesion of the spray foam.

9 Cover any mechanical and electrical equipment and wiring prior to applying the insulation.

10 Provide proper ventilation in the work area during application.

11 Install the spray foam. It is recommended to hire a licensed professional applicator for the spray foam installation.

12 Visually inspect the insulation installation to ensure that foam consistently meets the specified depth with no gaps or voids.

13 Refer to the current state and local building codes for definition and requirements for the ignition and thermal barrier as well as vapor diffusion retarder requirements.

14 Install additional cavity insulation as needed to meet the desired R-value. See Figure 2.

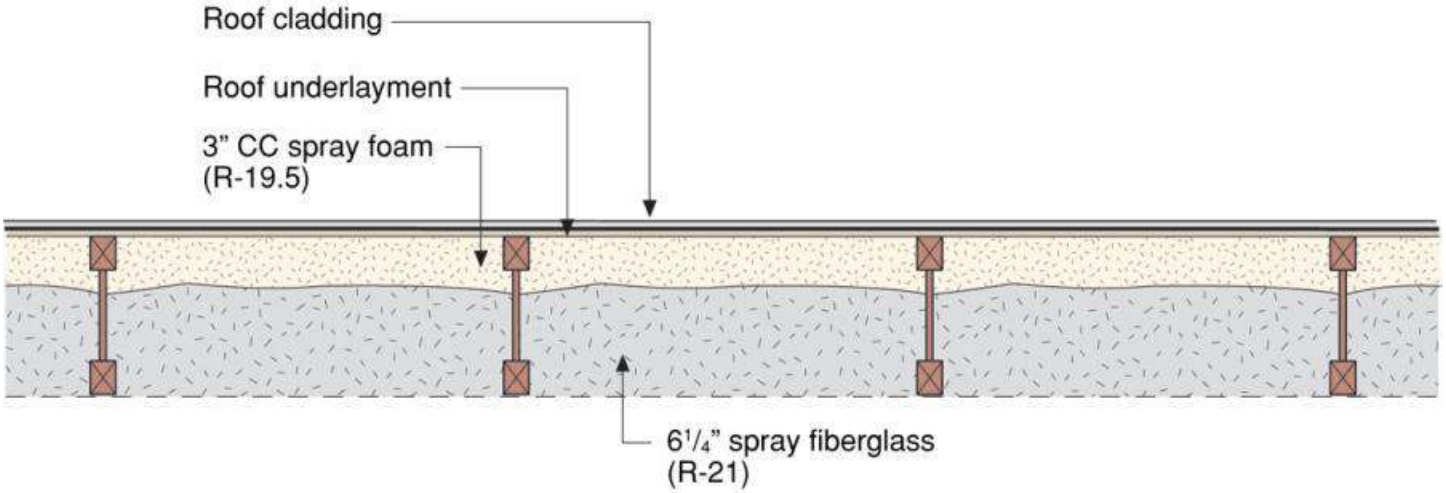

Figure 2. Open- or closed-cell spray foam is applied to the underside of the roof sheathing and additional fiberglass or cellulose insulation is blown in as a cost-saving method for meeting high insulation requirements and filling in the cavity space between the rafters to the ceiling deck.

How to Install Ducts in an Unvented Attic

When installing HVAC equipment in an insulated conditioned attic, good HVAC design principles still apply:

- Design a compact, duct layout with short, straight ducts runs. Seal and test ductwork for air leakage.
- Install a balanced ventilation system such as a heat recovery ventilator or central fan-integrated ventilation with a fresh air intake and timered exhaust. (For more information, see Whole-Building Delivered Ventilation.)

Do not install low-efficiency heating systems that draw their combustion air from the attic. Instead install direct-vent sealed-combustion furnaces or heat pumps. (For more information, see Combustion Furnaces, Traditional Split Heat Pumps.)