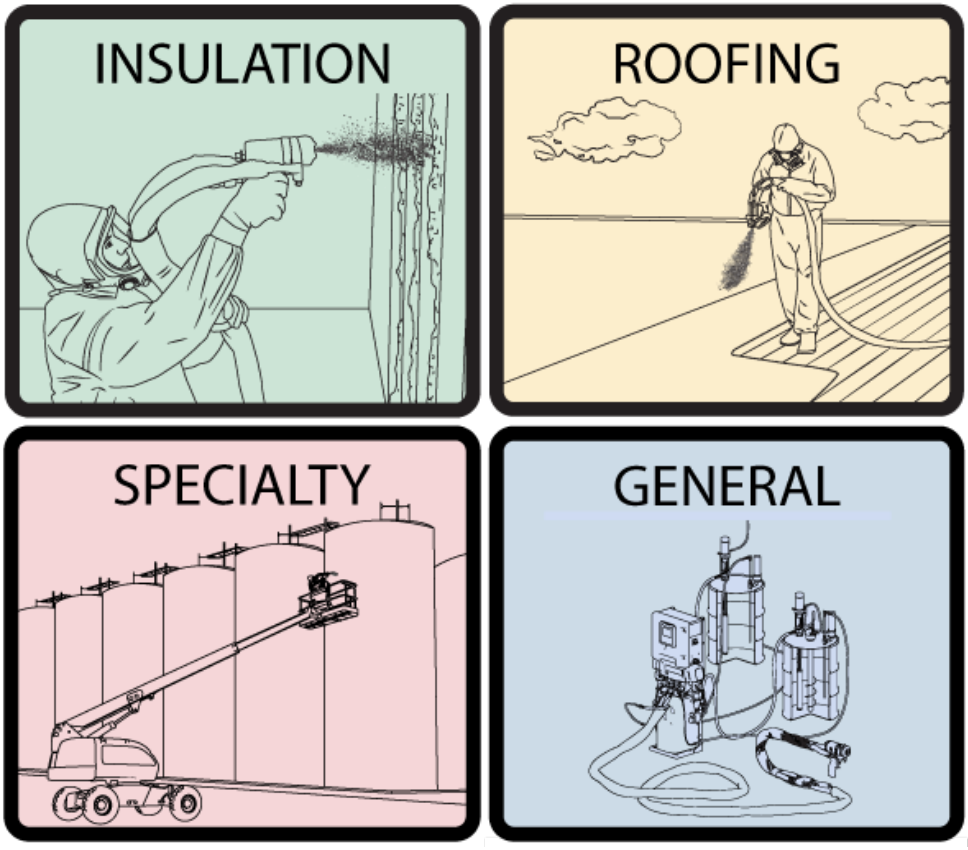
INSULATION

CATHEDRALIZED ROOFS

Spray Polyurethane Foam in Unvented Cathedral Ceilings and Cathedralized Attics

SPFA-141



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Founded in 1987, the Spray Polyurethane Foam Alliance (SPFA) is the voice, and educational and technical resource, for the spray polyurethane foam industry. A 501(c)6 trade association, the alliance is composed of contractors, manufacturers, and distributors of polyurethane foam, related equipment, and protective coatings; and who provide inspections, surface preparations, and other services. The organization supports the best practices and the growth of the industry through a number of core initiatives, which include educational programs and events, the SPFA Professional Installer Certification Program, technical literature and guidelines, legislative advocacy, research, and networking opportunities. For more information, please use the contact information and links provided in this document.

DISCLAIMER

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DOCUMENT HISTORY

Date	Sections Modified	Description of Changes
August 2015	All	Administrative changes

TECHNICAL OVERSIGHT COMMITTEE

Mission Statement

To provide a technical basis for expanding the use of polyurethane-foam-in-place within the building envelope.

To achieve this mission, the BEC will review and support the development of methods for performance evaluation of SPF, participate in activities leading to development, documentation and dissemination of information on applications of SPF in different building envelopes and systems.

To participate in the planning, organizing, documenting and supporting of construction and monitoring of selected demonstration projects with SPF in the building envelope.

To assist the Management and IPC committees in developing and carrying out market oriented programs.

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DESIGN CONSIDERATIONS

DEFINITION

Unvented attics, also known as conditioned or cathedralized attics, are created by applying insulation directly to the underside of the roof deck and omitting or sealing all ventilation paths against air leakage (soffits, ridge, and gable vents). This application extends the thermal envelope to include the attic space, increasing the energy efficiency of the building and decreasing the potential for moisture problems.

A recent literature review by the Florida Solar Energy Center [1] cites several studies that report energy savings of 9–23% can be achieved by using an unvented attic in hot climates. Most of the energy savings comes from moderating the air temperature surrounding HVAC equipment and ductwork in the attic and eliminating leakage to the outside from ducts installed in the attic space. Building Science Corporation also indicated that using an unvented attic in most cold climates decreases the heating load by approximately 10% [2].

HOW SPRAY POLYURETHANE FOAM INSULATION CREATES AN UNVENTED ATTIC

Many building experts believe that spray foam provides the most durable and effective means to create an unvented attic. Both low density (1/2 lb per ft3) and medium density (2 lb per ft3) SPF (spray polyurethane foam) may be used for this application in any U.S. climate, dependent on design considerations.

SPF should be applied directly to the underside of roof sheathing either between or over the rafters or joists of a roof of any slope. Thickness should be sufficient to satisfy local energy code requirements for R-Value and vapor resistance. SPF must be applied over soffit and ridge areas, and on all gable-end walls to completely contain the attic within the thermal envelope to ensure that it is properly insulated and sealed against air infiltration.

Architectural details of this application are shown in Figure 1 for unvented cathedral ceilings and in Figure 2 for cathedralized or unvented attics.

UNVENTED ATTICS AND THE MODEL BUILDING CODES

Unvented attics, insulated and air sealed with SPF, have been successfully used for decades. Beginning with the 2004 IRC Supplement, the 2006 IRC (International Residential Code) first included unvented attics to be used in all U.S. climate zones (see R806.4, page IRC-70), with additional amendments made in the 2007 Supplement [3]. Subsequent versions of the IRC in 2009, 2012, and 2015 include these additions. Beginning in 2015, the same requirements are included in the 2015 IBC (International Building Code) in Section 1203.3.

> According to new IRC language incorporated into the 2006 IRC and 2007 Supplement, as well as the 2015 IBC, unvented attic assemblies shall be permitted if all of the following conditions are met:

(1) The unvented attic space is completely contained within the building thermal envelope.

The SPF insulation is applied to the underside of the roof deck and to gable-end walls instead of the attic floor. The SPF must be continuous and tied into the top plates of exterior walls. The thermal conditioning of the attic depends on heat transfer through the attic floor; therefore, the attic floor should be left uninsulated. SPF must be applied to prevent any air leakage between the attic and the exterior.

(2) No interior vapor retarders are installed on the ceiling side (attic floor) of the unvented attic assembly.

Moisture buildup in the attic is avoided by allowing water vapor transfer between the attic and occupied space. Therefore, no vapor retarders should be installed on the attic floor.

(3) When wood shingles (shakes) are used, a minimum 1/4 inch (6 mm) vented air space must separate the shingles and the roofing underlayment above the structural sheathing.

SPF may be applied to roof sheathing under a wood shake or shingle roof as long as the ventilation prescribed by the building code is provided. Venting under wood shakes and shingles is necessary for their long-term performance; therefore, do not apply SPF directly to the underside of wood shakes and shingles.

(4) In climate zones 5, 6, 7, and 8, any air-impermeable[1] insulation shall be a vapor retarder[2], or shall have a vapor retarder coating or covering in direct contact with the underside of the insulation.

Medium-density (closed-cell) SPF, applied to an adequate thickness, will provide an integral vapor retarder of 1 perm or less (Class II vapor retarder). See the manufacturer's technical data sheet, as these thicknesses vary 1–3 inches.

Low-density (open-cell) spray foams are more vapor-permeable than closed-cell foams, and alone do not serve as a Class I or II vapor retarder. A vapor retarder coating or film may be required for open-cell foams in cold climates.

Note: The application of a vapor retardant coating on SPF installed in attics changes the fire characteristics of the assembly. SPFs coated in this manner must be covered with a thermal barrier or a prescriptive ignition barrier, or should have full-scale attic fire test data to support its use without a prescriptive ignition barrier or a thermal barrier.

[1] The definition of an air-impermeable insulation is a product having an air permeance equal to or less than 0.004 $ft^3/min \cdot ft^2$ at 1.57 lb/ft^2 (0.02 L/s-m2 at 75 Pa) differential tested in accordance with ASTM E 2178 or ASTM E 283. Consult your spray foam supplier to determine if its foam is air-impermeable.

[2] A Class II vapor retarder has permeance of 1 perm or less. A Class I vapor retarder has a permeance of 0.1perms or less. Class I vapor retarders may be required in extremely cold climates. Check with local codes.

(5) Either Items a, b, or c shall be met, depending on the air permeability of the insulation directly under the structural roof sheathing, as follows:

- ***a. Air-impermeable insulation only—Insulation shall be applied in direct contact to 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, air impermeable insulation such as SPF, rigid board, or sheet insulation, shall be installed directly above the structural roof sheathing as specified in Table R806.4 for condensation control.***
- ***c. Air-impermeable and air-permeable insulation—The air-impermeable insulation shall be applied in direct contact to the underside of the structural roof sheathing as specified in Table R806.4 for condensation control. The air-permeable insulation shall be installed directly under the air-impermeable insulation.***

In items b and c, the following chart identifies the thickness of the air-impermeable insulation (SPF) when being used in combination with other (air-permeable) insulation products. To protect against interior condensation in cold climates, foam must be applied to a thickness adequate to ensure that the interior surface of the SPF is not at the dew point temperature at the winter design temperature of the building.

IECC Climate Zone	Minimum Thickness for Air-Impermeable Insulation (SPF)
2B, 3B - Tile Roof Only	0
1, 2A, 2B, 3A, 3B, 3C	R5
4C	R10
4A, 4B	R15
5	R20
6	R25
7	R30
8	R35

The International Codes are *model* building codes that may be modified before they are accepted by state and local jurisdictions. A few jurisdictions specifically require vented attics, despite changes to the model building code. **Check with the applicable building code in your jurisdiction to be sure unvented attics are approved before using spray foam in this type of application**.

FIRE SAFETY AND SPF IN UNVENTED ATTICS

SPF applied in attic spaces must be properly protected against fire, and all SPF requires a thermal barrier, a prescriptive ignition barrier, or a code compliance research or evaluation report from a certified agency that explains the alternate conditions for application. In every case, a 15-minute thermal barrier such as 1/2 inch gypsum board shall separate an attic from interior spaces. For unoccupied attics (accessed only for service of utilities—no storage), prescriptive

ignition barriers must be used (1/4 inch plywood, 1-1/2 inch mineral wool, etc.), unless a spray foam manufacturer has specific fire test data to qualify an alternative assembly. Depending on accessibility and use, some attics may be considered occupied or fully accessible spaces. **Encourage the builder to contact the local code official to qualify the attic space. Contractors should consult with spray foam suppliers to determine proper fire protection methods for attic applications**.

SHINGLE LIFE AND SHINGLE WARRANTIES

All insulations, including SPF, fiberglass, cellulose, insulated sheathings, and reflective insulations, when applied in direct contact to the roof deck to create an unvented attic, will increase shingle temperatures slightly. Increased shingle temperatures may reduce the service life of asphalt and wood shingles, but have little effect on metal or tile roofs.

The Florida Solar Energy Center literature review suggests that many factors will affect shingle temperature and asphalt shingle service. This review developed some important conclusions from numerous research reports regarding roof life from unvented attics:

- Attic ventilation has less effect on roofing with light colored building materials.
- Peak daily shingle and sheathing temperatures are higher for sealed attic construction versus vented attic construction, but are still well below the acceptable service temperature for the shingles and sheathing materials.
- The impact of shingle color on temperature is far greater than the effect of attic ventilation.
- The impact of geographic location on shingle temperatures is also much greater than that associated with ventilation.
- One estimate referenced by this review paper showed that no attic ventilation would reduce shingle life by less than a year in Miami. A second paper in this review indicated an approximately 2-year reduction for a 20-year shingle for the same conditions.

Asphalt shingle manufacturers have taken a variety of positions regarding their warranties when their shingles are applied over unvented attics. Some manufacturers allow the use of their shingles over an unvented attic; others may void their warranties. **Before installing SPF to create an unvented attic, confirm that the builder or homeowner has reviewed the shingle manufacturer's warranty and understands the potential implications of this application.**

ROOF LEAK DETECTION

Insulation applied under a roof deck may hinder roof leak detection. Current inspection technologies, including IR cameras, enable more accurate detection of hidden moisture in roofs and walls. Homeowners should have their homes regularly inspected by a professional as part their routine preventive maintenance program.

ADDITIONAL BENEFITS OF SPRAY POLYURETHANE FOAM FOR UNVENTED ATTICS AND CATHEDRALIZED ROOFS

Using SPF to create an unvented attic or cathedralized roof may have benefits beyond simple energy savings. Depending on the type of SPF used, SPF under a roof deck may:

- Block rainwater and snow from blowing in through the soffit, ridge, and gable vents.
- Prevent soffit failures and roof deck uplift under high wind conditions.
- Help reduce roof water leakage when primary roofing system (shingles and underlayment) fail under high-wind conditions.
- Reduce ice-damming in cold climates through air sealing and an improved thermal profile.
- Decrease the fire hazard potential by keeping burning embers out of attics during wildfire events.
- Reduce rodent and pest infestations.

REFERENCES

D. S. Parker, "Literature Review of the Impact and Need for Attic Ventilation in Florida Homes", Florida Solar Energy Center Report FSEC-CR-1496-05, May 6, 2005.

J. Lstiburek, "Unvented Attics in Cold Climates", Home Energy Magazines, Nov/Dec 1999.

"2007 Supplement to the International Codes" July 2007, International Codes Council, Inc.

"Unvented Roof Assemblies for All Climates", July 2007, Building Science Consulting Press.

FIGURE 1: CATHEDRAL ROOF DETAIL

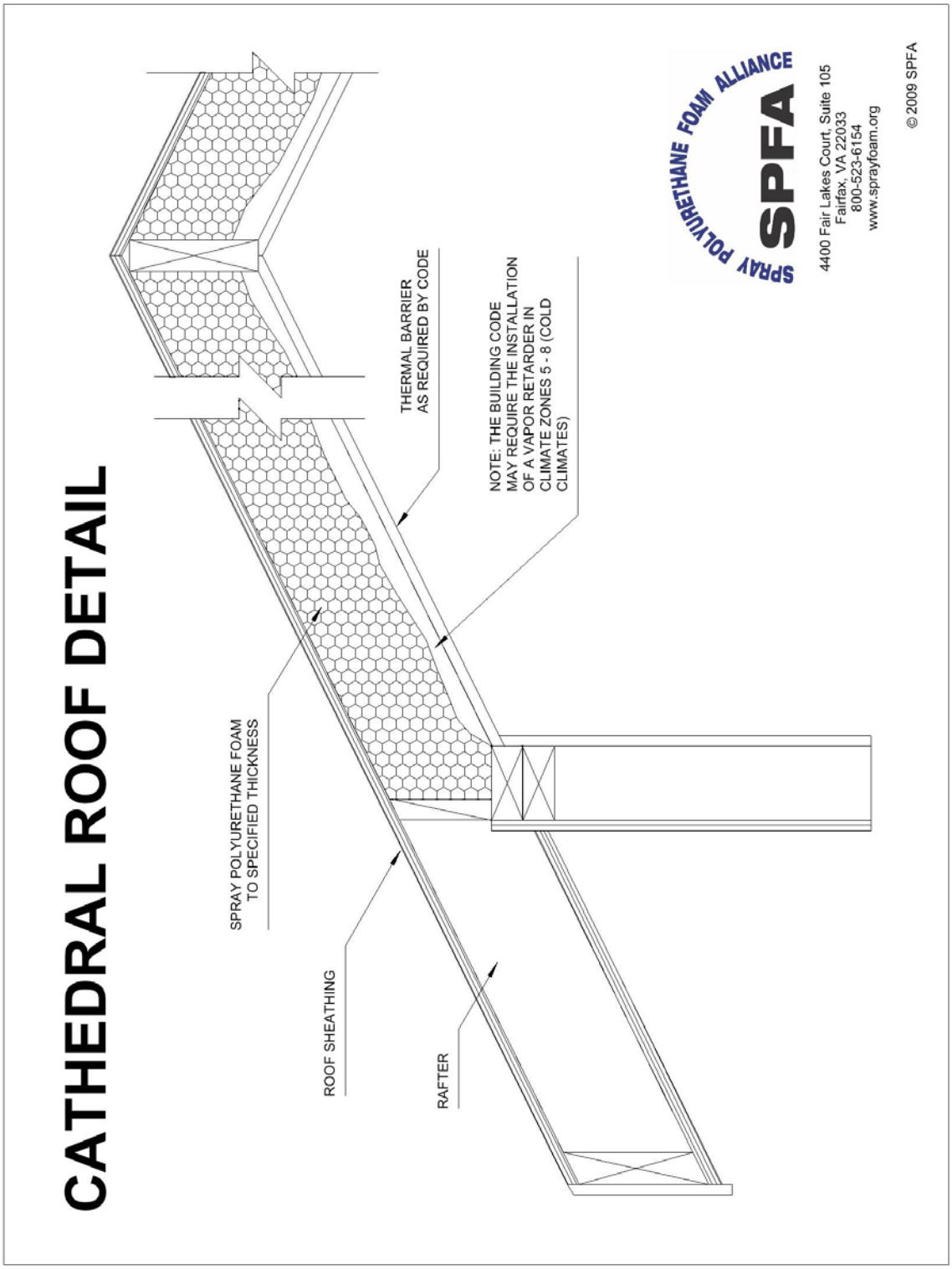

FIGURE 2: **Cathedralized Attic Detail**