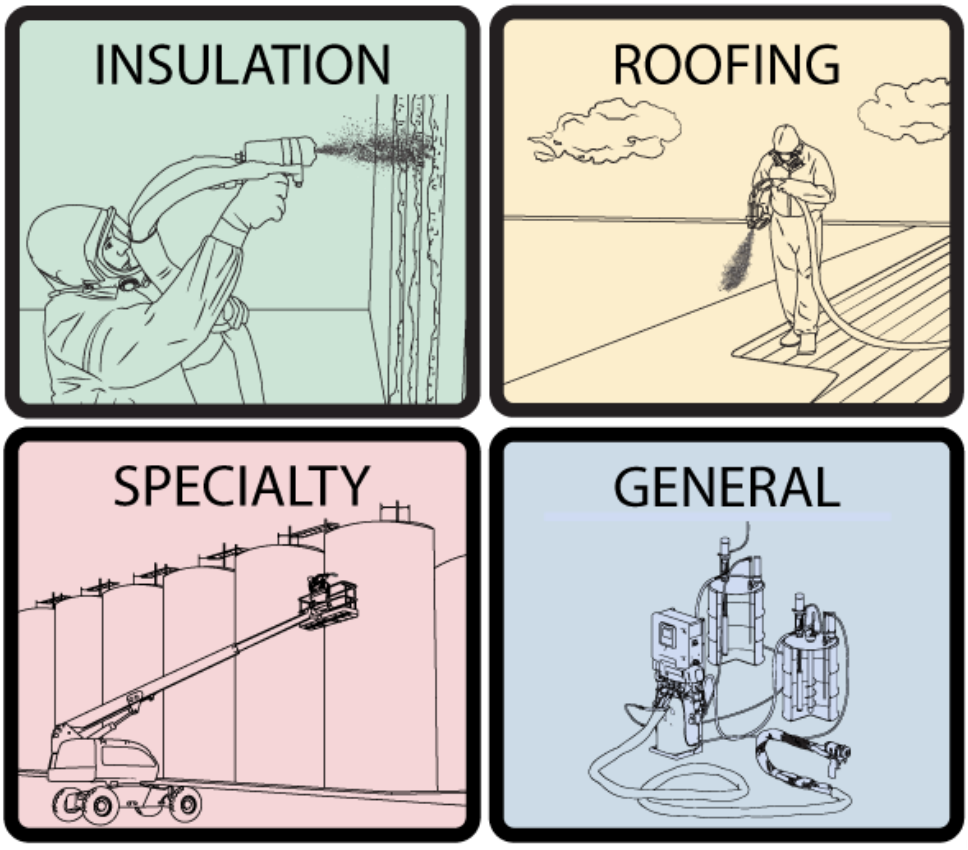
INSULATION

UNVENTED (CONDITIONED) ATTICS

Spray Polyurethane Foam in Cathedral Ceilings and Unvented (Conditioned) Attics

SPFA-141



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Founded in 1987, the Spray Polyurethane Foam Alliance (SPFA) is the voice, 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 consultants who provide inspections and other services. The organization supports the best practices and the growth of the industry through several 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	Updated format	None
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BUILDING ENVELOPE COMMITTEE

MISSION STATEMENT

The mission of the Building Envelope Committee is to:

1. To identify, explore, develop, and communicate an understanding of technical issues, including building codes and other standards, for the SPF industry.
2. Provide a wide range of technical information for members and building design professionals to properly specify and install spray foam insulation.
3. Maintain current and develop new SPFA TechDocs and TechTips applicable to application of spray foam insulation.

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TABLE OF CONTENTS

DESIGN CONSIDERATIONS

DEFINITION

Unvented attics (UVAs) (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 exterior 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. Cathedral ceilings are essentially identical in performance to UVAs with two minor exceptions: (1) there is no attic floor assembly separating the attic space from the living space and (2) the underside of the rafters/truss chords are not typically covered with foam to facilitate installation of interior cladding.

A 2005 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 ft^3) and medium density (2 lb per ft^3) 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 or U-factor, air permeance 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. Figure 1 shows a diagram of SPF insulation below a roof deck. Figure 2 shows a UVA installation and Figure 3 shows a cathedralized ceiling. Architectural details of this application are shown in the Appendix; Figure A1 for unvented cathedral ceilings and in Figure A2 for UVAs.

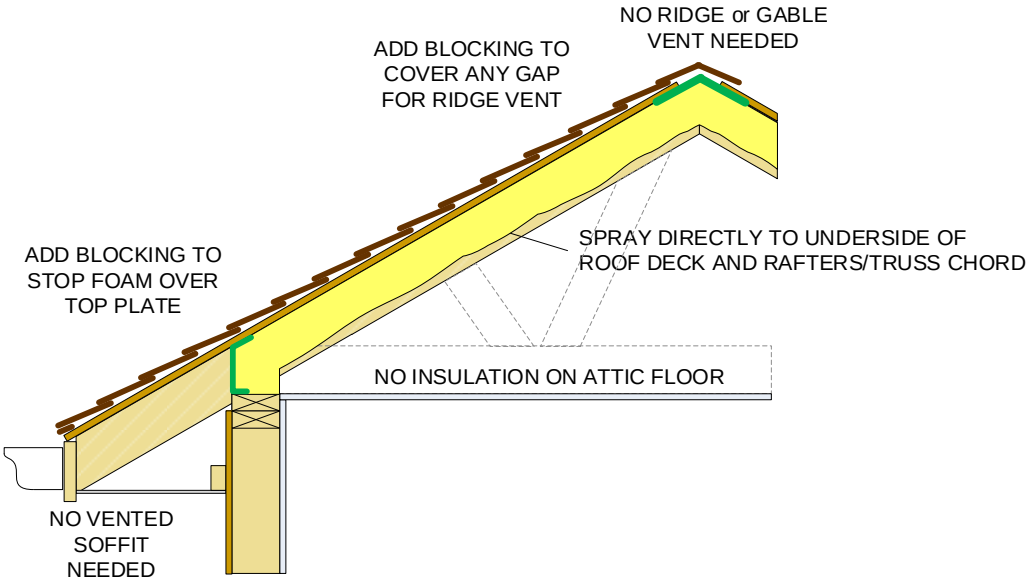

Figure 1 - Typical installation diagram for SPF applied to underside of roof deck to create an unvented attic

Figure 2 - Actual installation of SPF in an unvented attic. Notice that ductwork is now in conditioned space.

Figure 3 - Actual installation of SPF in a cathedralized ceiling.

UNVENTED ATTICS AND THE MODEL BUILDING CODES

UVAs, 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 UVAs to be used in all U.S. climate zones (see R806.4), with additional amendments made in the 2007 Supplement [3]. Subsequent versions of the IRC in 2009, 2012, 2015 and 2018 include these additions. Beginning in 2015, the same requirements are included in the 2015 IBC (International Building Code) in Section 1203.3.

According to the IRC and IBC, UVA 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. Insulating both the roof deck and the attic floor may lead to unwanted moisture accumulation. SPF must be applied so it prevents any air leakage between the attic and the exterior.

If existing attics are retrofitted to create a UVA, attic floor insulation should be removed to eliminate any odors from prior infestation by birds, rodents and other pests. Attic floor insulation should also be removed to be compliant with the building codes.

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

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 or under the roof deck where wood shakes and shingles are installed without a ventilation space.

(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 thicknesses required to achieve a Class II vapor retarder vary.

Low-density (open-cell) spray foams are more vapor-permeable than medium-density (closed-cell) foams, and alone do not serve as a Class I or II vapor retarder. A vapor retarder covering, or coating 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. See section on Fire Safety and SPF in Unvented Attics.

(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

[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.

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.

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 UVAs are approved before using spray foam in this type of application**.

FIRE SAFETY AND SPF IN UNVENTED ATTICS

Building codes require that SPF be separated from interiors with a thermal barrier. An exception to the thermal barrier requirement are attics where entry is limited to the service of utilities and not used for storage; the SPF in such attics need not be covered by a thermal barrier provided: the attic space is separated from the interior by a thermal barrier and (1) the SPF is protected from ignition by covering it with a prescriptive ignition barrier; or (2) the SPF is part of a full-scale tested alternate ignition barrier assembly (see SPFA-126 “Thermal and Ignition Barriers for the SPF Industry”).

An ignition barrier is defined as a coating or covering over SPF, which slows the involvement of the SPF in a fire. Building codes list several prescriptive ignition barrier coverings. Alternative

ignition barrier assemblies (those not using a prescriptive ignition barrier covering) may be tested under the International Code Council Evaluation Services (ICC-ES) Acceptance Criteria AC-377, Appendix-X, that includes test specifications and qualification thresholds.

Alternative ignition barrier assemblies, tested in accordance with AC-377, Appendix X, may or may not require that the SPF be covered with a fire protective material. Many SPF products qualify without additional coatings or coverings. Consult the manufacturer's listing service evaluation or research reports for ignition barrier qualifications.

Depending on accessibility and use, some attics may be considered occupied (useable for storage) or fully accessible spaces where the ignition barrier exception would not apply and the SPF would need thermal barrier protection. **Encourage the builder to contact the local code official to qualify the attic space. Contractors should consult with spray foam suppliers to determine proper life safety protection methods for attic applications, including fire protection**.

COMBUSTION APPLIANCES (HEATING SYSTEMS) AND SPF IN UNVENTED ATTICS

In many areas of the country, natural gas and propane fired heating systems may be located in the attic space. These gas heating appliances draw in combustion air from and release combustion byproducts to the outdoors.

Highly efficient gas furnaces (Annual Fuel Utilization Efficiency, AFUE > 94%) use a sealed combustion design, where PVC piping or flexible metal ducts provide inlet air from and exhaust air to the outdoors. These high-efficiency systems waste little heat, and SPF may be placed into contact with low-temperature pipes and ducts. Figure 4 shows an example of a high-efficiency, sealed combustion gas furnace in an attic. Note that these units, when installed in a vented attic may have the inlet duct drawing air from the attic. For UVAs, these units will need additional ducting to the outside to draw in outdoor air.

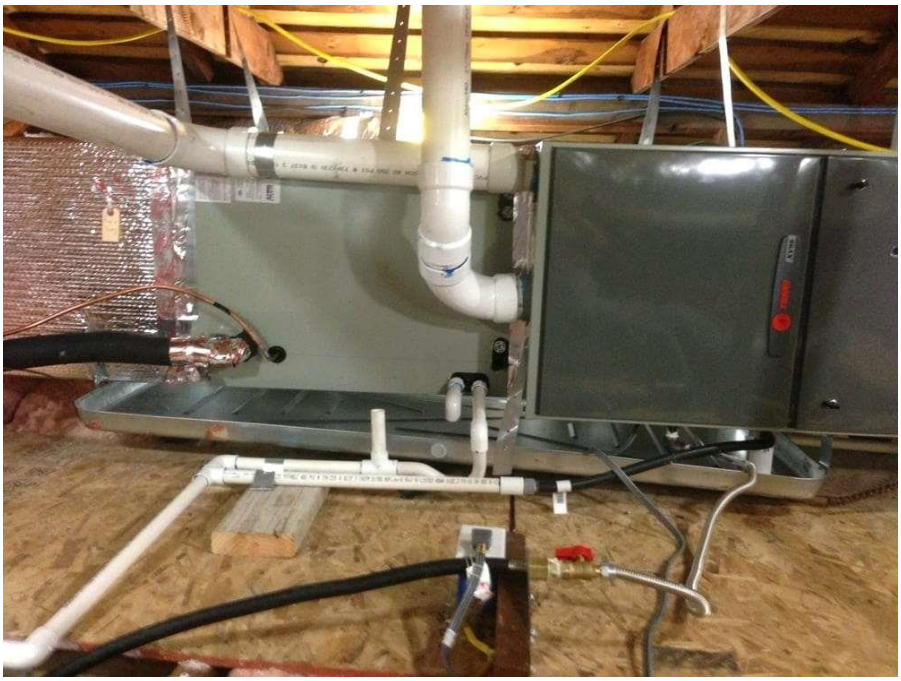

Figure 4 - High-efficiency gas furnace in an attic space. Note large-diameter PVC pipes used for combustion air and exhaust gases.

Converting an exisitng vented attic with older gas heating appliances into a UVA requires additional design considerations and review by a qualified HVAC contractor and local code officials, including:

- A dedicated source of outdoor combustion air must be provided to the furnace;
- Metal exhaust flues (or stack) that may operate at high temperatures will, by code, require a 3" separation between combustibles like SPF and metal exhaust flues to prevent ignition (See IRC Section M1306);
- Local code jurisdiction may require a thermal barrier protection between the gas burning appliance and the SPF.

SHINGLE LIFE AND SHINGLE WARRANTIES

All insulations, including SPF, fiberglass, cellulose, insulated sheathings, and radiant barrier materials, when applied in direct contact to the roof deck to create an unvented attic, will increase shingle temperatures slightly. Increased 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 life. This review developed some important conclusions from numerous research reports regarding roof life from UVAs:

- The impact of shingle color on temperature is far greater than the effect of attic ventilation.

- 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 geographic location on shingle temperatures is also much greater than that associated with ventilation.
- One estimate referenced by this review paper showed that having 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, insulated roof decks. Some manufacturers allow the use of their shingles over an unvented attic without roof deck ventilation; others may modify or 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.**

If roof deck ventilation is needed, consider installation of continuous attic vent chutes from the vented soffit to the ridge vent in every rafter/truss cavity. SPF may then be applied over these vent chutes. An example of an attic vent chute installed near the soffit area is shown in Figure 5. Figure 6 shows how these continuous vent chutes provide a ventilated roof deck in an unvented attic.

Figure 5 - Attic vent chute installed in each cavity between adjacent rafters/trusses. These are installed continuously from the vented soffit to the ridge/gable vent to allow cooling of the roof deck.

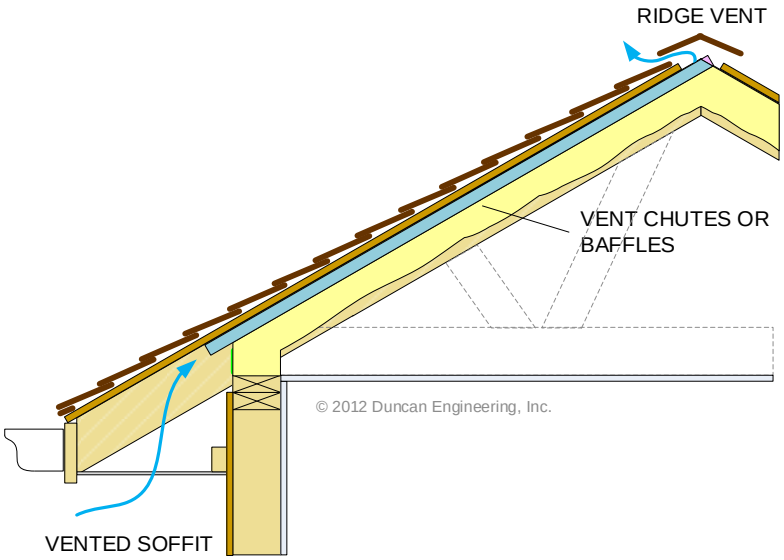

Figure 6 - Diagram showing use of vent chutes to create a vented roof deck in an unvented attic

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, whether it has spray foam in the assembly or not..

MOISTURE AND ODORS

Most UVAs depend on passive conditioning and air exchange from the adjacent occupied spaces below, or from natural air leakage from HVAC equipment and ductwork in the attic. Code provisions requiring low duct leakage rates may result in insufficient air exchanges between the occupied space and the attic space to properly condition air in UVAs. For this reason, recent editions of the IRC require active ventilation strategies between conditioned space and attic space when air-permeable insulations are used (See 2018 IRC Section 806.5.2.10; 50 cfm per 1000 SF of attic floor area).

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

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

- Decrease the fire hazard potential by keeping burning embers out of attics during wildfire events.
- Block wind-driven rain 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.
- 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.

APPENDIX A – CSI SPECIFICATION

PART 1—GENERAL

1.01 SCOPE OF WORK

Furnish all labor, materials, tools, and equipment necessary for the application of an SPF subgrade thermal and moisture protection system, including accessory items, subject to the general provisions of the contract.

1.02 RELATED WORK SPECIFIED ELSEWHERE

(1) Rough carpentry	Section 06 10 00
(2) Thermal Insulation	Section 07 21 00

1.03 QUALITY ASSURANCE

Contractor Qualifications: The SPF contractor should provide information concerning SPF projects similar in nature to the one proposed, including location and person to be contacted. SPFA has a Professional Certification Program for installer certification and contractor accreditation. Many manufacturers of SPF systems have contractor approval programs and/or certification programs.

1.04 SUBMITTALS

(1) Manufacturers to provide application/installation instructions as well as published data sheets or letters of certification that their products comply with the materials specified, including primers (if required), SPF, and waterproofing
(2) Shop drawings on specific foundation and footer terminations
(3) Contractor accreditation and installer installer certification from SPFA Professional Certification Program or SPF manufacturer or other evidence of contractor qualification and experience. (See Section 1.03)
(4) Safety and handling instructions for storage, handling, and use of the materials.
(5) Field Quality Control Procedures to be utilized by the contractor and installer to ensure proper preparation and installation of SPF and protective coating, detail work and follow-up inspection
(6) Receipt or insulation installation certificate (e.g., SPFA-148) showing the installed R value for the product used and installed for the job.

1.05 MATERIALS, DELIVERY, AND STORAGE

(7) Materials shall be delivered in the manufacturer's original, tightly sealed containers or unopened packages, all clearly labeled with the manufacturer's name, product identification, safety information, and batch or lot numbers where appropriate.
(8) Containers shall be stored out of the weather and direct sun, where the temperatures are within the limits specified by the manufacturer.

(9) All materials shall be stored in compliance with local fire and safety requirements.

1.06 ENVIRONMENTAL CONDITIONS

Do not apply the SPF below the temperature or above the humidity specified by the manufacturer.

1.07 SEQUENCE AND SCHEDULING

The SPF is installed when the foundation walls and penetrations have been completed. Subsequent penetrations must be resealed. There should not be any other trades in the immediate area when the SPF and waterproofing are being installed.

1.08 SAFETY REQUIREMENTS

(1) CPI - Guidance on Best Practices for the Installation of Spray Polyurethane Foam.
(2) Refer to appropriate SDS for liquid chemicals and cured foam for additional safety information.
(3) See OSHA 29 CFR 1926 “Safety and Health Regulations for Construction.”

PART 2—PRODUCTS

2.01 SPF

The polyurethane foam to be applied shall be a two-component system made by combining an isocyanate (A-component) with a polyol (B-component) and shall possess the following physical characteristics:

Closed-Cell SPF per ASTM C1029

PROPERTIES (Sprayed in Place)	ASTM TEST	SI UNITS	US UNITS
Density (nominal)	D-1622	48 kg/m^3	1.5—3.0 lbs/ft^3
Comprehensive Strength	D-1621	100 kPa (minimum)	15 lb/in^2 (minimum)
Closed Cell Content	D-2856	90% (minimum)	90% (minimum)
R-Value	C-177, C-236, or C-518	1.1 K•m^2/W (minimum)	6.0°F•hr•ft^2/Btu
Smoke Developed Index*	E-84	<450	<450
Flame Spread Index*	E-84	<75	<75
Water Absorption	D-2842	<5%	<5%

Open-Cell SPF

PROPERTIES (Sprayed in Place)	ASTM TEST	SI UNITS	US UNITS
Density (nominal)	D-1622	48 kg/m^3	0.4-1.5 lbs/ft^3
Closed Cell Content	D-2856	50% (maximum)	90% (maximum)
R-Value	C-177, C-236, or C-518	0.66 K•m^2/W (minimum)	3.6°F•hr•ft^2/Btu
Smoke Developed Index*	E-84	<450	<450
Flame Spread Index*	E-84	<75	<75

*This standard is used solely to measure and describe properties of products in response to heat and flame under controlled laboratory conditions. This numerical flame spread rating is not intended to reflect hazards presented by this or any other material under actual fire conditions.

2.02 RELATED PRODUCTS

(1) Substrate primer, if required, shall be used as recommended by the manufacturer of
(2) 15-minute thermal barrier or ignition barrier coatings or coverings as tested and specified by the SPF manufacturer.

PART 3—EXECUTION

3.01 APPLICATION OF PRODUCTS

The products intended for use in the building envelope insulation system must be applied within the manufacturer's guidelines for temperature, humidity, and other atmospheric conditions. They must be sequenced so as to take into consideration substrate preparation, proper cure times, and inter-coat adhesion.

3.02 SUBSTRATE CONSIDERATION AND PREPARATION

(1) Wood

a. Wood products including dimensional framing, plywood and OSB shall contain no more than 18% water, as measured in accordance with ASTM D4449.
b. Priming may be required to achieve maximum adhesion of the SPF. If required, apply priming in in accordance with Section 3.03.
c. The surface shall be free of contaminants prior to the application of the primer or SPF.

3.03 PRIMER APPLICATION

When required, the primer shall be applied to the properly prepared substrate in accordance with the manufacturer's guidelines.

3.04 SPF APPLICATION

(1) Inspection

a. Prior to the application of the SPF, the substrate surface shall be inspected to ensure that conditions required by Sections 3.02 and 3.03 have been satisfied.
b. Verify that temperature, humidity, and other atmospheric conditions are within the SPF manufacturer's guidelines for the application of SPF.

(2) Application

a. The spray polyurethane foam (SPF) A- and B-components shall be processed in accordance with the manufacturer's instructions.
b. The SPF shall be sprayed in minimum 1/2 inch (13 mm) thick passes with the overall thickness to be a minimum of ___ inches (__ mm). The full thickness of SPF to be applied within any given area should be completed in one day.
c. The SPF total thickness will be a minimum of 1 inch (25 mm) or as thick as required to achieve the needed R-value. Excess thickness is permitted.

(3) Surface Finish

a. If coatings are applied over the foam, the final SPF surface shall be “smooth,” “orange peel,” “coarse orange peel,” or “verge of popcorn.” SPF surfaces designated as “popcorn” or “treebark” are not acceptable. Examples of these surface finishes can be found in SPFA-104.
b. Spray Polyurethane Foam Systems for New and Remedial Roofing. These areas shall be repaired to an acceptable surface texture.
c. Damage or defects to the SPF surface shall be repaired prior to the application of the waterproofing.

3.04 FIRE-PROTECTIVE (INTUMESCENT) COATING APPLICATION

1. The SPF surface shall be free of contaminants that would impair the adhesion of the waterproofing.
2. The fire protective coating shall be applied to all exposed SPF surfaces
3. The fire protective coating shall be applied to achieve a minimum dry film thickness of ___ mils (__ mm).

FIGURE A1: Cathedralized Ceiling Detail

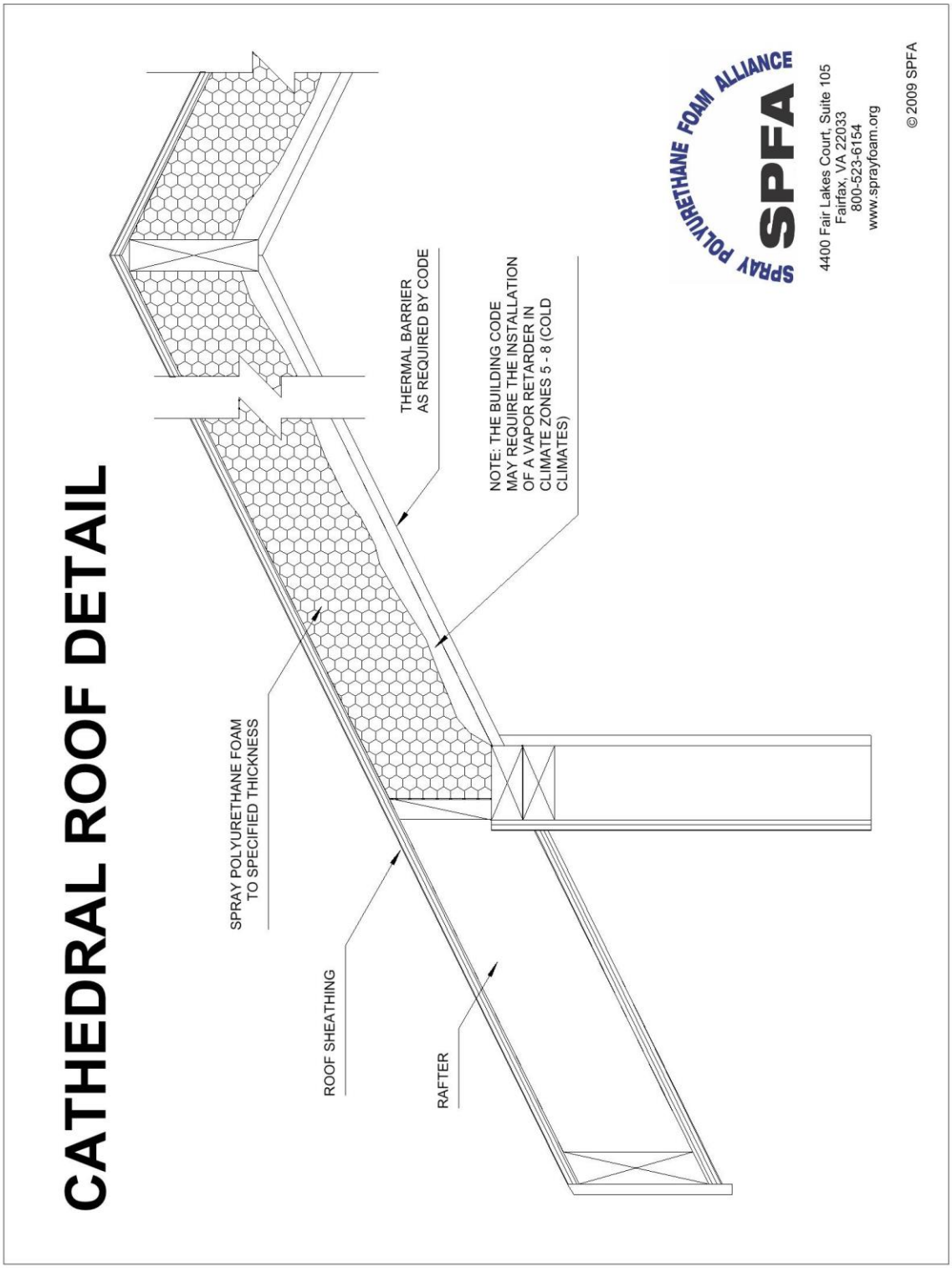

FIGURE A2: UVA Detail