SPRAY POLYURETHANE FOAM ALLIANCE

SPFA-147

Spray Polyurethane Foam Insulation for Hybrid Insulation Systems – Part 2: Cold Climates

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ABOUT SPRAY POLYURETHANE FOAM ALLIANCE (SPFA)

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

This document was developed to aid building construction and design professionals in choosing spray-applied polyurethane foam systems. The information provided herein, based on current customs and practices of the trade, is offered in good faith and believed to be true to the best of SPFA's knowledge and belief.

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DOCUMENT HISTORY

Date	Sections Modified	Description of Changes
August 2015	All	Administrative changes
January 2021	Cover and Header	New SPFA Logo

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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*SPFA would like to acknowledge the voluntary contributions of these individuals in the revision of this document.

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BACKGROUND

For the purpose of this document, hybrid insulation systems consist of SPF (spray polyurethane foam) used together with fibrous insulations to create a code-compliant thermal envelope, primarily for buildings with frame construction. These hybrid systems include a layer of SPF to provide air sealing and moisture management, and fill the balance of the cavity with fibrous insulation to meet the R-Value requirements of the building code at a lower cost than using SPF insulation alone.

To be considered an air-barrier material by the U.S. model building codes, construction materials are measured for air permeance using ASTM E2178, "Standard Test Method for Air Permeance of Building Materials"; or ASTM E283, "Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen." These tests apply a known pressure difference of 75 Pa (1.57 psi) across the material tested and measure air flow through the material. The air flow results are measured in cfm/ft^2 (L/s-m^2). To qualify as an air barrier material, this measurement must be less than 0.004 cfm/ft^2 (0.02 L/s-m^2).

Both low-density open-cell SPF and medium-density closed-cell SPF are recognized as air impermeable, "air-barrier" materials when applied at a sufficient thickness. The inherently open-cell structure of low-density SPF will make it more air permeable than closed-cell foam at the same thickness. Low-density foams can typically achieve an air permeance below 0.004 cfm/ft^2 (0.02 L/s-m^2) when installed at a minimum thickness of 3-1/2 inches to 5-1/2 inches, and most medium-density insulations will have measured air permeance below 0.004 cfm/ft^2 (0.02 L/s-m^2) at a minimum thickness of about one inch. Always check the product data sheet or evaluation reports for air permeance data for specific SPF products.

DEFINITIONS

Hybrid Insulation: A combination of insulation types typically arranged so the SPF insulation acts as an air barrier and/or a vapor retarder, and the other insulation type contributes by adding R-Value.

Low-density SPF (open-cell SPF, ocSPF): A type of SPF expanded with reactive blowing agents to yield a semi-rigid cellular structure and a density between 8 and 22 kg/m^3 (0.4 and 1.4 lb/ft^3).

Medium-density SPF (closed-cell SPF, ccSPF): A type of spray polyurethane foam expanded with non-reactive blowing agents to yield a rigid cellular structure. It is characterized by a predominance of closed-cells and a density between 1.5 and 2.5 lb per cubic foot.

Air Impermeable: An insulation having an air permanence at a specific thickness that is equal to or less than 0.02 L/s•m^2 at 75 Pa pressure differential (0.004 ft^3/ft^2•min at 1.57 lb/ft^2) tested in accordance with ASTM E 2178 or E 283.

It should be noted that air-permeable insulations such as fiberglass batts and fiberglass or cellulose loose-fill insulations, cannot achieve the low air permeance required for air barrier materials at practical thicknesses. This is one of the main reasons why hybrid insulation systems are used. Also, while SPF can meet the air permeance requirements of an air barrier material at practical thicknesses, other air-sealing measures may be needed for an assembly or building to meet air leakage performance requirements. These measures include the use of caulks, tapes and foam sealants at cracks, gaps, and penetrations in the building envelope.

Proper installation of both SPF and fibrous insulations can be used to meet specified R-Value, air leakage, and moisture control in building envelopes. The purpose of this document is to provide guidance on the proper design and installation of hybrid insulation systems.

In Climate Zones 4–7, site-specific designs employing WUFI analyses or other hygrothermal modeling tools is encouraged. The ICC climate zone map is shown in Figure 1.

DEFINITIONS

Vapor Retarder: A vapor retarder is a component of the building enclosure used to control moisture diffusion through the component or assembly. It is generally placed at the warm side of the enclosure assembly to control condensation within the assembly. In terms of the International Model Building Codes, there are three classes of vapor retarders used in building enclosures, categorized as follows, based on the measured water vapor transmission per ASTM E 96 dry-cup or desiccant method A:

- Class I: less than 0.1 perms
- Class II: greater than 0.1 perms but less than or equal to 1.0 perms
- Class III: greater than 1.0 perms but less than or equal to 10 perms.

Class II vapor retarders are generally required in colder climates—check with the local building code. Examples of Class II vapor retarders include asphalt-kraft facings, ~2 inches of medium-density SPF. An example of a Class I vapor retarder is a 6 mil polyethylene sheet.

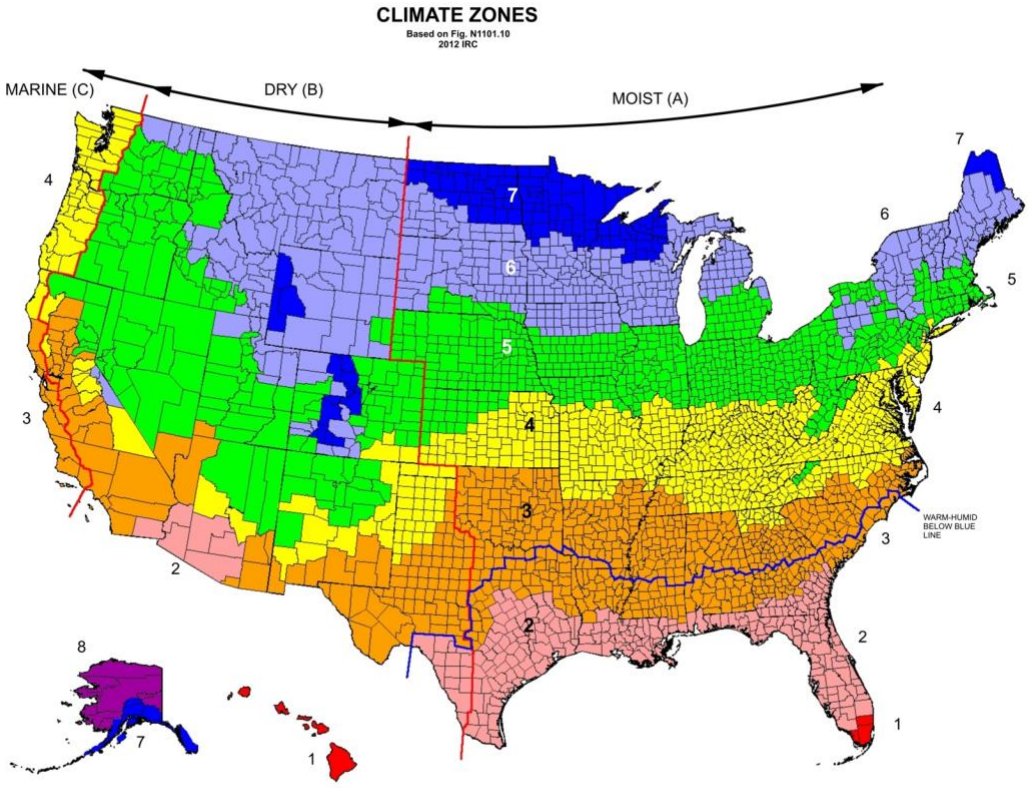


FIGURE 1: ICC (INTERNATIONAL CODE COUNCIL) CLIMATE ZONE MAP

Courtesy Deer Ridge Consulting

(1) DESIGN

Hybrid insulation systems can be used to insulate walls, ceilings, roofs, and floors. Careful design consideration must be given to each application area, to assure that proper R-Value, air-sealing, and condensation control is properly addressed. This document discusses best practices for this application. All applicable building codes must be followed.

a. General Design Considerations

The following are general design considerations to be addressed when specifying and using hybrid insulation systems:

- **Insulation Placement:** Exterior thermal envelope insulation in framed walls should be installed in substantial contact and continuous alignment with the building envelope air barrier.
- **Vapor Retarder Placement:** When any portion of the fibrous insulation is below the interior dew point temperature for winter design conditions in Climate Zones 4–7, vapor retarders must be placed on the warm-in-winter

(interior side) of building assemblies (building code requirement).

- **Double Vapor Retarder Applications**: When OSB is sandwiched between vapor retarders, its ability to dry out after a wetting incident is limited. When OSB exterior sheathing is faced on the outside with a vapor retardant material, such as XPS or PIR foam boards, medium-density SPF on the interior side should be limited in thickness to approximately 1-1/2 inches or less.
- **Foam Thickness:** In order to prevent condensation accumulation when interior vapor retarders are not used, the medium-density SPF is required to be installed thick enough avoid dew point conditions within the fibrous insulation.
- **Interior Humidity and Temperature**: The guidance provided herein assumes typical interior operating conditions of temperature and relative humidity for normal occupancy residential buildings. Uses and occupancies that maintain high humidity, large temperature differentials, and atypical vapor drives will require site-specific designs to control condensation potential. Special designs[1] will be needed for high-humidity rooms (e.g., spas, pool areas, greenhouse additions) and cold rooms (e.g., wine cellars, cold storage).
- **Fire Protection**: All foam plastics, including SPF, must be separated from the interior of the building for fire protection purposes[2], using thermal or ignition barriers, dependent on the use of the space. See SPFA-126 Thermal Barriers and Ignition Barriers for the SPF Industry. Refer to your local building code for further requirements. Check with your SPF/insulation manufacturer for fire resistance performance and testing requirements. All non-SPF insulation materials must meet all building code requirements as installed. Fibrous insulation materials with asphalt-kraft facings may need to be installed in substantial contact with the unexposed surface of the ceiling, floor, or wall finish for fire safety.
- **Manufacturer Recommendations:** Be sure to consult with the manufacturer of the SPF product for guidance on ambient and substrate temperature limitations, thickness limitations, including required minimum thickness for proper mix and adhesion.
- **Materials:**
    - SPF: Medium-density or low-density SPF insulation.
    - Fibrous Insulations (examples):
        - Fiberglass batt insulations
        - Fiberglass blown-in insulations
        - Cellulose—Wet-spray or dense pack
        - Other fibrous insulation products (e.g., stone wool, polyester, cotton, etc.)

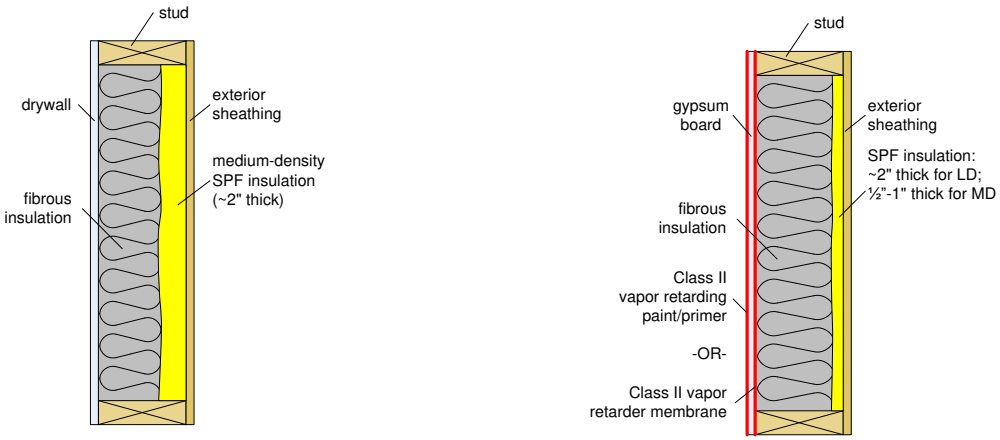
[1] A special hygrothermal analysis may be needed using a computer program such as WUFI.

[2] Check with your local building official and SPF manufacturer to determine if the hybrid system requires additional fire protection.

b. Walls

Hybrid insulation systems are commonly used to insulate and air seal the exterior above-grade walls, as well as in knee walls. *Hybrid insulation systems are not used in below-grade applications, such as basement walls or stem walls of unvented crawlspaces.*

For exterior walls, the SPF is applied directly to the inside of the exterior sheathing, to a specified thickness to control air leakage. The balance of the cavity is then filled with fibrous insulation to meet the specified R-Value requirements. Figure 2 shows two approaches to using hybrid systems in exterior walls.



(2a) Design Approach A
(No interior-side vapor retarder)

(2b) Design Approach B
(Using an interior-side vapor retarder)

FIGURE 2: HYBRID INSULATION WALL DESIGNS—VERTICAL SECTION VIEW

(1) Design Approach A

Figure 2a shows a thick layer of medium-density SPF applied to the exterior sheathing to provide an air seal. The balance of the cavity is filled with fibrous insulation, and no interior vapor retarder is used on the interior, "warm-in-winter" side of the wall. In Design Approach A, a sufficiently thick layer of medium-density foam is applied to the inside of the sheathing to control condensation by maintaining temperatures on the condensing surface (inside surface of the medium-density SPF layer) above the interior dew point temperature (typically 45–50 °F) during winter design conditions. This approach eliminates the need for a Class I or Class II vapor retarder on the interior side of the insulation assembly in Climate Zones 4–7. It should be noted that Design Approach A does not use an interior vapor retarder, provided the R-Value of the medium-density SPF meets the minimum ratio defined in Table 1.

In knee wall applications, a solid backer material, such as insulated sheathing or building fabric, should be applied to the outer surface to provide a substrate for the SPF.

TABLE 1: MEDIUM-DENSITY SPF MINIMUM INSULATION RATIO CLIMATE ZONE. USING CLASS III INTERIOR VAPOR RETARDER*

IECC Climate Zone	Minimum SPF R-Value to Total Insulation R-Value (Ratio in %)
4A	40
4B	35
4C	35
5A	40
5B	35
6A	50
6B	50
7	60

*The SPF thickness is based on hygrothermal analyses, assuming normal winter interior moisture levels. The SPF thickness based upon the R-Value ratio may or may not meet the minimum thickness required to perform as an air barrier material.

Example Using Table 1:
A building in Climate Zone 5A, under the 2012 IECC, requires R20 cavity insulation. From Table 1, the minimum R-Value ratio of SPF to the total wall R-Value is 40%. The minimum R-Value for the medium-density SPF layer is:

R20 x 40% = R8

For a medium-density SPF having an R6.1 per inch thermal resistivity, the minimum thickness of foam is:

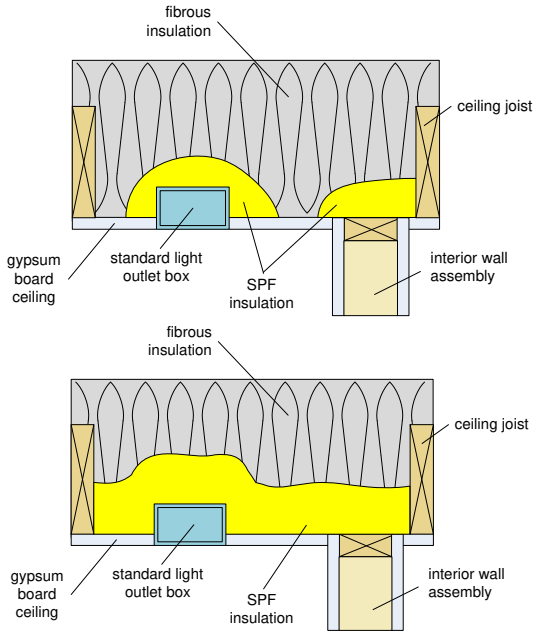
R8 ÷ R6.1 per inch = 1.3 inches

To be conservative, the minimum SPF thickness should be rounded up to the next 1/2 inch to 1-1/2 inches. The balance of the insulation (R12 in this case) is provided with either fibrous insulation or low-density SPF.

(2) Design Approach B

Figure 2b shows a thin layer of SPF applied to the sheathing to provide an air seal and only a modest amount of R-Value. Typically this layer is 1/2 inch to 1 inch thick for medium-density SPF and about 2" for low-density SPF. The balance of the cavity is filled with fibrous or other insulation to meet code-required R-Value for the wall. A Class II interior vapor retarder (as required by the building code in Climate Zones 4–7) should be applied on the interior of the insulation assembly. A vapor retarder is required either when the ratio of the medium-density SPF R-Value is not high enough to control the condensation within the fibrous insulation, or when low-density foam is used as part of the hybrid assembly.

a. Ceilings (Vented Attic Floors)
Hybrid insulation systems can be used to insulate flat or low-slope ceilings that are part of a vented attic floor. In this application, SPF will be installed down onto the gypsum board to limit air leakage at the ceiling plane. Figure 3 shows examples of this application. Figure 3a shows SPF strategically applied to seal air leakage around ceiling fixtures and interior wall penetrations. Figure 3b shows SPF applied to the entire ceiling surface. Required R-Value is achieved by covering the layer of spray foam with fibrous insulations.



(3a) Critical Air Seal at air-leakage locations (3b) Continuous SPF on entire ceiling

FIGURE 3: HYBRID INSULATION CEILING DESIGNS—ELEVATION SECTION VIEW

Use caution with medium-density SPF installed onto gypsum board to avoid distortion of the ceiling—thinner initial passes (1/2 inch to 1-1/2 inch) will reduce heat generation and create a tight bond onto the surface without creating voids or excessive stresses. Check with your local building official and SPF manufacturer to determine if the hybrid system requires additional fire protection.

When using medium-density SPF, follow the manufacturer's recommended minimum and maximum pass thicknesses (typically 1/2 inch minimum and 1-1/2 to 2 inches maximum). The balance of the R-Value requirement may then be fulfilled with fibrous insulation materials.

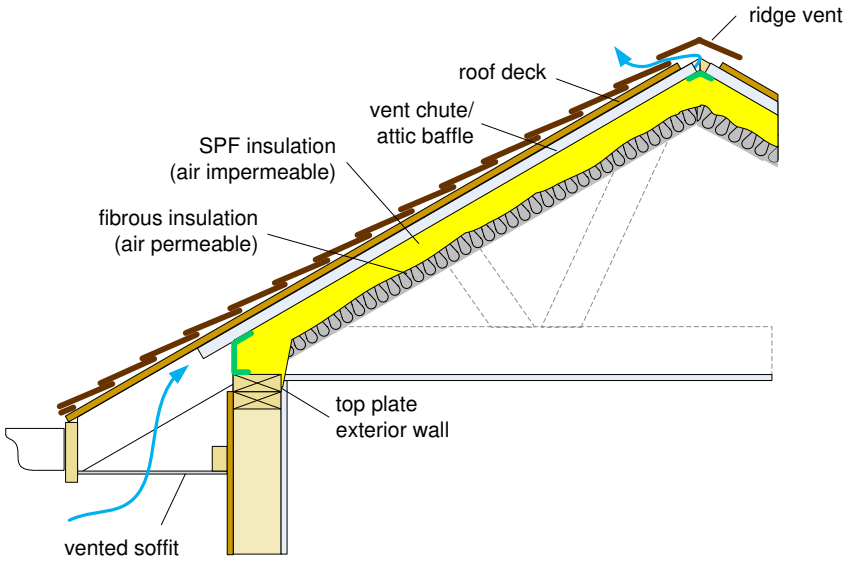
When using low-density SPF, apply it to a thickness that achieves the desired air-sealing at the ceiling plane, and cover it with fibrous insulations to meet the R-Value requirements.

Note that special considerations for ceiling applications include:

- **Recessed Lighting[3]:** Maintain separation of SPF from all recessed lighting and other heat-producing electrical fixtures; provide an air space or separate with another non-combustible material (fiber glass, protective gypsum board box, etc.) to allow for heat dissipation.
- **Hot Air Flues / Chimney Shafts:** Maintain a 3-inch minimum separation of SPF from all hot air flues and chimney shafts with an air space or with another non-combustible material (fiber glass, protective box, etc.).
- **Attic Ventilation:** Proper attic venting requirements per IRC (Section R806) should be followed.

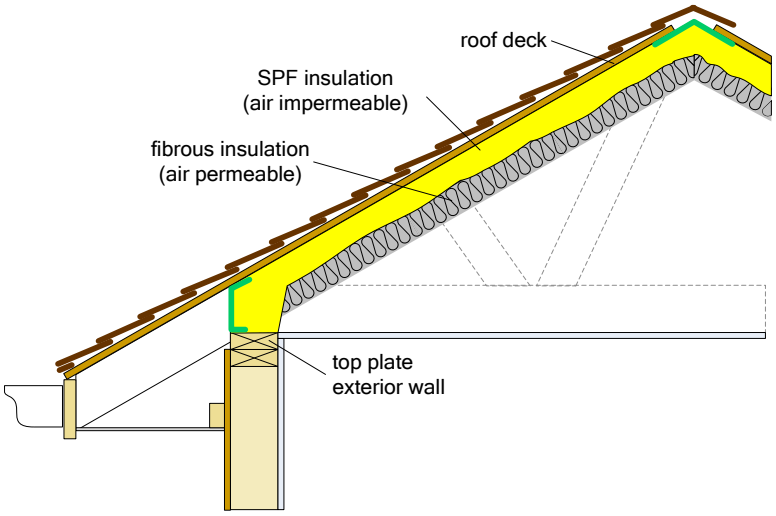
b. Unvented Attics and Cathedralized Ceilings

Hybrid insulation systems may also be applied directly to the underside of the roof deck to create an unvented attic assembly or to insulate a cathedralized ceiling. SPF insulation is applied directly to the underside of the roof deck, and then covered with fibrous insulation in a manner so that it will durably remain in-place for the life of the building. In this application the fibrous insulation can take the form of batts, adhesively-bonded loose fill or loose-fill insulation supported by netting (e.g., Blown-in-Blanket™). Examples of this application are shown in Figure 4.



(4a) With roof deck ventilation

[3] See the attached detail drawing on Recessed Lights in Appendix B.



(4b) Without roof deck ventilation

FIGURE 4: HYBRID INSULATION UNVENTED ATTIC
AND CATHEDRALIZED CEILING DESIGNS—VERTICAL SECTION VIEW

The IRC (International Residential Code) permits the use of hybrid insulation systems in unvented attic and cathedral ceiling assemblies. The code differentiates the use of air-impermeable and air-permeable insulations. SPF may be air-impermeable but this is dependent on thickness. Always check with the SPF manufacturer when using SPF as part of a hybrid system in an unvented attic or cathedral ceiling to determine how thick the SPF must be applied to be considered air-impermeable.

Table 2 shows the minimum levels of air-impermeable insulation required by the IRC for unvented attics and cathedralized ceilings. If the total insulation R-Value exceeds the building code levels indicated in Table 2 for a given climate zone, use the R-Value percentages for SPF as minimums.

TABLE 2: MINIMUM AIR-IMPERMEABLE SPF INSULATION FOR HYBRID INSULATION SYSTEMS USED IN UNVENTED ATTICS AND CATHEDRALIZED CEILINGS

(Based on 2009 IRC Section R806.4 or 2012 IRC Section R806.5)

IECC Climate Zone	Minimum R-Value from SPF	Total Insulation R-Value / SPF R-Value % Ratio (2009 IRC)	Total Insulation R-Value* / SPF R-Value % Ratio (2012 IRC)
4C (Marine)	R-10	R38 / 26%	R49 / 20%
4A, 4B	R-15	R38 / 39%	R49 / 31%
5	R-20	R38 / 53%	R49 / 41%
6	R-25	R49 / 51%	R49 / 51%
7	R-30	R49 / 61%	R49 / 61%

*When more total R-Value than required in the 2009 or 2012 IECC is utilized, a higher R-Value for the SPF is required than that listed in Table 2. Use the minimum percentage as indicated to the right to determine the SPF R-Value.

The IRC includes certain design requirements for insulating the underside of roof decks with hybrid insulation systems, as follows:

- Air-impermeable, spray foam insulation or foam sheathing shall be in direct contact with the roof deck.
- The unvented attic space is completely contained within the thermal envelope. No insulation is permitted on the attic floor.
- No interior vapor retarders are installed on the ceiling side (attic floor) of the unvented attic assembly.
- Check with your local building official and SPF manufacturer to determine if the hybrid system requires additional fire protection.
- Considerations in retrofit applications such as combustion appliances and HVAC sizing are outside the scope of this document.

c. Floors

Hybrid insulation systems can be used to insulate and air-seal the underside of flooring assemblies over unconditioned spaces, including floors over vented crawlspaces, bonus rooms over garages, and cantilevered floors. In this application, SPF insulation is applied directly to the underside of the subfloor, and then covered with fibrous insulation in a manner such that it will durably remain in place for the life of the building. In this application, the fibrous insulation can take the form of batts, adhesively bonded loose fill, or loose-fill insulation supported by netting (e.g., Blown-in-Blanket™). An example of this application is shown in Figure 5.

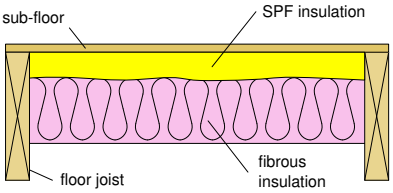


FIGURE 5: HYBRID INSULATION FLOOR DESIGN—ELEVATION SECTION VIEW

In vented crawlspaces where the underside of the floor or crawlspace ceiling is insulated, consider insulation of pipes and ductwork. Follow the specific code provisions in 2009/2012 IRC Section 1601.3 for insulation installed over ductwork present in this space. Avoid hybrid systems over ductwork unless specific design considerations have been made. Also, SPF installed over cooling-supply air ducts is required to have a maximum 3 perm per inch at the installed thickness (see IRC M1601.4.5).

When using medium-density SPF, apply 1/2 inch or greater thickness of foam, installed per manufacturer's instructions directly to the underside of the subfloor. When using low-density SPF, apply it to a thickness that achieves the desired air-sealing at the floor plane, and cover it with fibrous insulations to meet the R-Value requirements. The balance of R-Value requirement can be fulfilled with fibrous insulation materials, as noted earlier.

Appendix A:
Recommended Guide Specification for Hybrid Building Envelope Insulation Systems with SPF in Climate Zones 4–7

PART 1 — GENERAL

This guide discusses the application of seamless SPF as a component of a hybrid building envelope insulation system. Your contractor, selected systems manufacturer, and local code agencies can assist you, as each project must be assessed individually.

(1) SCOPE OF WORK

a. Furnish all labor, materials, tools, and equipment necessary for the application of a hybrid building envelope insulation system with SPF, including accessory items, subject to the general provisions of the contract.
b. Section Includes: High-performance, hybrid insulation system for stud cavity assemblies in walls, ceilings and floors of residential structures, consisting of the following components:
    i. SPF insulation
    ii. Additional insulation for balance of cavity

(2) RELATED WORK SPECIFIED ELSEWHERE

a.	Rough Carpentry	Section 06100
b.	Insulation, Other	Section 07200
c.	Fire Protection	Section 07220
d.	Vapor Retarder	Section 06100
e.	Mechanical	Division 15
f.	Electrical	Division 16

(3) REFERENCE STANDARDS

a. ASTM C518 - Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
b. ASTM C665 - Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
c. ASTM C764 - Mineral Fiber Loose-Fill Thermal Insulation
d. ASTM C1104 - Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation
e. ASTM C1338 - Determining Fungi Resistance of Insulation Materials and Facings
f. ASTM D1621 - Compressive Properties Of Rigid Cellular Plastics
g. ASTM D1622 - Apparent Density of Rigid Cellular Plastics
h. ASTM D1623 - Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics
i. ASTM D2126 - Response of Rigid Cellular Plastics to Thermal and Humid Aging
j. ASTM D6226 - Open Cell Content of Rigid Cellular Plastics

k. ASTM E84 - Surface Burning Characteristics of Building Materials
l. ASTM E96 / E96M - Water Vapor Transmission of Materials
m. ASTM E136 - Behavior of Materials in a Vertical Tube Furnace at 750 Degrees C
n. ASTM E283 - Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
o. ASTM E970 - Critical Radiant Flux of Exposed Attic Floor Insulation Using a Radiant Heat Energy Source
p. ASTM E2178 - Air Permeance of Building Materials
q. ASTM C1363 - Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus
r. ASTM C236 - Steady-State Thermal Performance of Building Assemblies by Means of a Guarded Hot Box

(4) QUALITY ASSURANCE

a. Qualifications / Certification:
    i. SPF Contractor: Provide information concerning projects similar in nature to the one proposed, including location and person to be contacted. Some manufacturers of SPF systems have approval programs and/or licensing methods that could be required.
    ii. SPF Installer: The SPF installer must be certified or approved by the SPF manufacturer or approved designee.
    iii. Other insulation contractor/installer
b. Field Sample: Complete the field sample area for evaluation of surface preparation techniques and application workmanship:
    i. Install the system in a 4-foot wide by full height section of the exterior wall at a location designated by the architect.
    ii. The exterior sheathing and stud framing of the sample area shall be complete before the installation of the field sample.
    iii. Include all components of the system assembly. Do not install interior gypsum board.
    iv. Do not proceed with remaining work until the field sample is approved by the architect.
    v. Accepted Sample Areas: These areas may remain part of the completed project.

(5) SUBMITTALS

a. Procedures: Submit all procedures for review, acceptance and return in accordance with Section 01 33 00. [01330.]
b. Product Data: Include the manufacturer's technical data sheets for all system components to be installed, including:
    i. SPF insulation
        1. Include the current Code Compliance Research Report or Evaluation Service Report, if available.
    ii. Other insulations for balance of cavity (one of the following materials):

1. Fiberglass batt insulations
2. Fiberglass blown-in insulation
3. Other fibrous insulation products (e.g., rock wool, polyester, cotton, etc.)
4. Cellulose—wet-spray or dense pack
5. Low-density foam insulations

iii. Vapor retarder, if applicable per design requirements.

c. Contractor Certification: Include the contractor/applicator certification from the SPF supplier, SPFA and other insulation manufacturers and experience.
d. OSHA-compliant written safety program
e. Include an air-quality management plan, including ventilation during and just after installation, spray zone containment and negative pressurization, and safety warning signs.
f. Manufacturer's Instructions: Submit and maintain additional copies of the following on site until installation of insulation system is complete:
   i. Preparation instructions and recommendations
   ii. Storage and handling requirements and recommendations
   iii. Installation methods
   iv. SDS (Safety Data Sheets)
g. Include the safety and handling instructions for storage, handling, and use of the materials to including, but not limited to, the SDS.
h. Include the Field Quality Control Procedures to be utilized by the contractor/applicator to ensure proper preparation and installation of SPF, other insulations, vapor retarders (if applicable), detail work, and follow-up inspection.

(6) DELIVERY, STORAGE, AND HANDLING

a. Materials shall be delivered in the manufacturer’s original, tightly sealed containers or unopened package, all clearly labeled with the manufacturer’s name, product identification, safety information and hatch or lot numbers, where appropriate. Where materials are covered by a referenced specification, the labels shall bear the specification number, type, and class, as applicable.
b. Storage: All materials shall be stored in compliance with local fire and safety requirements, as follows:
   i. Protect material and installation equipment while it is stored at the site to prevent damage.
   ii. Store products in the manufacture’s unopened packaging until they are ready for installation.
   iii. Comply with the protection requirements of each product manufacturer. Store materials under cover in a secure, dry area protected from weather, and where the temperature is within the limits specified by product manufacturer.
c. Handling: Strictly adhere to detailed safety requirements and all health, environmental, handling and processing precautions published by the insulation manufacturer, including, but not limited to, SDS.

(7) SEQUENCE AND SCHEDULING

a. In new construction projects, the hybrid insulation system including SPF is installed when the preparation of the perimeter wall/roof is in place, and in coordination with other building trades and after the inspection requirements have been met.

(8) SAFETY REQUIREMENTS

a. Refer to www.spraypolyurethane.org for all other relevant and up-to-date chemical safety documents available from the American Chemistry Council's Center for the Polyurethanes Industry for SPF insulations.
b. Refer to appropriate SDS for additional safety information.
c. Proper disposal of waste materials and containers must be done in compliance with the manufacturer's guidelines and/or federal, state, and local regulatory agencies.
d. For protection against exposure to airborne MDI, workers must wear either a self-contained breathing apparatus, with full face piece, operated in a pressure-demand or other positive-pressure mode; or a combination respirator, including a Type C air-supplied respirator, with full face piece, operated in a pressure-demand or other positive-pressure mode; or an auxiliary self-contained breathing apparatus, operated in a pressure-demand or other positive-pressure mode.
e. Personal protective clothing should be worn. This includes wearing the appropriate protective clothing, including eye protection (e.g., face shield or chemical worker's goggles), gloves, and coveralls. This is essential to preventing skin exposure for individuals who work with MDI.
f. Protect the site and the occupants from exposure to SPF vapors during the work and until re-occupancy.
g. Communicate re-occupancy schedule to building owners and occupants.

PART 2 — PRODUCTS

(1) SPRAY POLYURETHANE FOAM

a. The SPF 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:

Product	Tests Required	Value Required
Low-density SPF (0.4–1.4 pcf) (Nominal Core Density)	Thermal Resistance in accordance with one of the following methods: ASTM C 177 ASTM C 236 ASTM C 518 ASTM C 1363	As reported
	Core Density, in accordance with D1622	As reported
	Dimensional Stability, in accordance with D2126	15% maximum total change
	Surface Burning Characteristics in accordance with ASTM E-84 /UL 723*	75 or less flame spread index 450 or less smoke developed index
	Vapor Permeance in accordance with ASTM E96, Method A (Desiccant/Dry Cup)	As reported
	Air Permeance in accordance with ASTM E2178 / E283	As reported
Medium-density SPF (1.5–3.0 pcf) (Nominal Core Density)	Thermal Resistance in accordance with one of the following methods: ASTM C 177 ASTM C 236 ASTM C 518 ASTM C 1363	As reported
	Core Density, in accordance with D1622	As reported
	Dimensional Stability, in accordance with D2126	15% maximum total change
	Surface Burning Characteristics in accordance with ASTM E-84 /UL 723*	75 or less flame spread index 450 or less smoke developed index
	Vapor Permeance in accordance with ASTM E96, Method A (Desiccant/Dry Cup)	As reported
	Air Permeance in accordance with ASTM E2178 / E283	As reported

* 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) OTHER INSULATION FOR BALANCE OF CAVITY/R-VALUE

a. Fiberglass and rock wool blown insulations
    i. ASTM C764 Type 1 Mineral-Fiber Loose Fill Insulation
b. Fiberglass and rock wool insulations
    i. ASTM C665 Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
c. Other fibrous insulation products (e.g., polyester, cotton)
    i. Cellulose—wet-spray or dense pack
d. ASTM C739 Standard Specification for Cellulosic Fiber [Wood-Base] Loose-Fill Thermal insulation

e. Low-density foam insulations

(3) VAPOR RETARDERS

a. Design Approach B in the foregoing guidelines requires the use of a code-mandated vapor retarder. Use one of the following types of vapor retarders per the code requirements.

b. Vapor Retarders (example materials and perm rating given)

i. Class I—Sheet Polyethylene, unperforated aluminum foil (0.1 perm or less)

ii. Class II—Kraft-faced fiberglass batts (greater than 0.1 perm and less than 1 perm)

iii. Class III—Latex or enamel paint (greater than 1 perm and less than 10 perms)

PART 3 — EXECUTION

(1) APPLICATION OF PRODUCTS

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

(2) SUBSTRATE CONSIDERATION AND PREPARATION

a. The surface preparation for those substrates that are to be insulated, and statements regarding the selection of materials related to the successful performance of the SPF insulation, are outlined in this section. The general condition of surfaces to receive SPF application shall be clean, dry, and secure.

b. WOOD SUBSTRATES

i. Wood substrates shall contain 19% or less water.

ii. Most untreated and unpainted wood surfaces need not be primed. The SPF can be applied directly to the dry wood. Priming may be required in certain instances. See the SPF manufacturer for specific details.

iii. Most sheathing boards need not be primed prior to the application of sprayed-in-place polyurethane foam.

c. CONCRETE AND MASONRY

i. The concrete and masonry must be dry and free of surface moisture, with loose dirt and any other contaminants removed, to ensure proper adhesion.

(3) SPRAY POLYURETHANE FOAM APPLICATION

a. The SPF A- and B-components shall be processed in accordance with the manufacturer's instructions and relevant quality assurance procedures

b. The polyurethane foam shall be sprayed in minimum 1/2-inch-thick passes (lifts) with the overall thickness to be a minimum of ___ inches. The full thickness of SPF to be applied within any given area should be completed in one day.

c. The SPF shall be applied to the substrate to seal cracks and gaps before the application of fibrous insulations, unless otherwise specified.

(4) FIBROUS INSULATION PRODUCT FOR BALANCE OF CAVITY

a. The fibrous insulation materials shall be installed in accordance with the manufacturer's instructions and local building code provisions.

(5) VAPOR RETARDER APPLICATION

a. Install the vapor retarder material in a manner so that it performs to control vapor diffusion through the assembly.
b. If applicable, the vapor retarder material shall be fully cured before additional insulation is installed.

(6) THERMAL AND/OR IGNITION BARRIER

a. The interior surface of the SPF must be covered with a thermal barrier or ignition barrier, depending on the use of the space and the requirements for the specific foam products that are used. The thermal or ignition barrier must be applied in accordance with the manufacturer's guidelines. Follow the guidance of the local building code provisions.

Appendix B:
Detail Drawings

DETAIL DRAWING 1: IC-RATED RECESSED LIGHTING