



SPFA-152

Spray Polyurethane Foam Insulation for the Interior of Basement and Crawlspace Walls

Spray Polyurethane Foam Alliance

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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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Individual manufacturers and contractors should be consulted for specific information. Nominal values which may be provided herein are believed to be representative but are not to be used as specifications nor assumed to be identical to finished products. SPFA does not endorse the proprietary products or processes of any individual manufacturer, or the services of any individual contractor.

DOCUMENT HISTORY

Date	Sections Modified	Description of Changes
December 2019	All	New document



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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POLICY STATEMENT

It is the policy and recommendation of the SPFA (Spray Polyurethane Foam Alliance) that spray polyurethane foams installed within buildings be covered with a thermal or ignition barrier as soon as possible after the initial application, except as an assembly specifically approved by a building code authority based on fire tests specific to the application.

DOCUMENT SCOPE

For this document, the terms basement and crawl space are used interchangeably, referring to the portions of buildings that are primarily below grade. Some codes specify the interior heights and percent below grade in their definitions of basements and crawl spaces. This document addresses any portion of a structure that is below or on grade underneath or at the lowest level of an occupied structure.

It is not the purpose of this guidance document to provide building science decisions or recommendations for specific project needs, but to provide guidance on the means and methods for the installation of the SPF on the interior of the foundation walls.

General Considerations:

- In all installations, SPF and related membranes and coatings should always be processed in strict accordance with the manufacturers' recommendations.
- In all cases, air quality management provisions, such as minimum ventilation requirements for occupancy and combustion appliance makeup air, should be in place before beginning SPF installations.

BUILDING SCIENCE AND APPLICABLE RESEARCH

The building science community has researched and written a large body of information on heat, air, and moisture control in below-grade applications. Information relevant to the use of SPF in these applications includes literature on the following topics:

1. Inclusion of the basement/crawl space within conditioned space (vented vs. unvented)
2. Bulk water management
3. Vapor control
4. Air leakage control
5. Insulation performance and minimum requirements (including ROI [return on investment] for insulation on crawl space floors)
6. Frost action in wet soils
7. Embedded wood members in insulated masonry walls in cold climates
8. Radon control
9. Vermin control

The IBC (*International Building Code*®) and the IRC (*International Residential Code*®) also contain general and specific requirements for insulation in basements and crawlspaces.

While evaluation or code compliance research reports contain information about code-compliant installation of spray foam insulation in basements and crawl spaces, it is not part of the code and any approval of the applications may require approval of the local Authority Having Jurisdiction.



All model building codes require that SPF, with some exceptions, be separated from interior [occupied] spaces by an “approved thermal barrier.” Therefore, unless an exception applies, all interior SPF applications are required to be covered with a prescriptive thermal barrier, an approved thermal barrier covering/coating or be part of a tested alternative thermal barrier assembly. The specific code requirements for each application should be reviewed on a case-by-case basis with the ultimate decision being left to the discretion of the local code authority. See SPFA-126 “Thermal Barriers and Ignition Barriers for the Spray Polyurethane Foam Industry” for more information on thermal barriers.

CAUTION: Just because a material is advertised as a “thermal barrier,” or an assembly is advertised as not requiring a thermal barrier, that does not mean it has been approved by a code agency or a local code official. Ask for test data and code body approvals, listings, or other written indications of acceptability under the code to be sure that the product selected offers the fire protection that the code requires. Consult ICC-1100 or IAPMO ES-1000 (both to be published in 2020) that provides test methods for demonstrating material and assembly code compliance in crawl spaces. Also consult sections of the codes addressing ventilation requirements for basements and crawl spaces.

USING SPF VS OTHER INSULATION SYSTEMS

Closed-cell rigid foam board and closed-cell SPF products are generally recommended for all below-grade installations where bulk water may contact the insulation. Closed-cell SPF can generally be used in any location indicated as appropriate for rigid foam board in the cited literature, even if SPF is not prescribed as an option.

Insulation materials, such as fiberglass or open-cell SPF, that are moisture permeable and can absorb and retain water are typically not used for basements and crawlspaces.

In some building designs, the thermal boundary is located at the floor level, above the basement or crawlspace. In these cases, the basement/crawl space is outside the thermal envelope, vented to the exterior and considered unconditioned space. The use of open-cell foam or fibrous insulations may be appropriate when the dynamics of moisture and vapor drive permit.

FUNCTIONS OF SPF IN BELOW-GRADE INTERIOR APPLICATIONS

Closed-cell SPF serve multiple tasks in basement and crawlspace applications, including:

- Insulation
- Air Sealing
- Water Vapor Control

1. **Insulation:** The rate of heat loss to the exterior in cold climates decreases with the depth below grade. Conversely, the rate of heat gain to the interior in hot climates decreases with the depth below grade. The most important area to insulate is the rim or sill area, and the walls above grade. The R-value should be the minimum required by code for the location. To provide optimal payback, use of U-factor tables may permit insulating the above-grade area of basement walls at higher R-values, with reduced R-values becoming adequate for basement wall sections below-grade.
2. **Air Sealing:** For residential construction, one of the most significant sources of air leakage exists at the interface of the framing and foundation. Insufficient sealing of the mudsill to the top of the masonry/concrete foundation, along with plumbing and electrical penetrations through the band joists and other discontinuities, provide air leakage paths. A substantial amount of air infiltration at these locations can occur. These areas should be insulated and sealed, provided they do not obstruct inspection and treatment of wood destroying organisms. Consult with local pest management professionals prior to installing any permanent insulation at the framing-foundation interface.
3. **Water Vapor Control:** In most parts of the US, below-grade foundation walls are subject to water or high levels of moisture, depending on the season. Proper control of this inward vapor drive, as well as preventing interior condensation is key. Use of water vapor semi-impermeable products such as closed-cell SPF insulation can help moderate these moisture effects.

OTHER DESIGN CONSIDERATIONS

FOUNDATION DRAINAGE SYSTEMS

Construction of new buildings should include proper foundation drainage systems. Gravel backfill, and water-resistant coatings should be used on the exterior side of below-grade walls. Additionally, proper grading and water runoff is necessary to prevent the possibility of interior flooding of basement and crawlspaces during heavy rains. If properly installed, these systems can reduce or eliminate groundwater intrusion into these areas and prevent wetting of below-grade foundation walls. Dry foundation walls will permit direct, fully-adhered application of SPF to the interior, provided that the moisture content of the walls meet the requirements of the SPF manufacturers installation instructions.

However, dry foundation walls are not always achievable, especially in existing buildings. In these cases, a perimeter drainage system may be needed. For economic reasons, an exterior foundation drainage system may not be feasible, especially in retrofit work. Instead, a perimeter drainage system along the interior side of the foundation walls may to be installed. An example of an interior perimeter foundation drainage system with a sump pump is shown in Figure 1.



Figure 1 – Interior Foundation Drainage System with Sump Pump

The installation of a drainage plane should be considered where subgrade walls are regularly wet or moist on the interior or where an interior foundation drainage system is present (see SPF Over Drainage Plane on Page 15). For buildings with wet foundation walls, questionable drainage, or susceptible to flooding, it is recommended that SPF contractors consult with companies providing foundation drainage services prior to the installation of SPF.

RADON AND SOIL GAS CONTROL SYSTEMS

Buildings located in some parts of the US may be subject to infiltration of radon, methane or other unwanted soil gases. These gases enter the building through exposed soil in crawlspaces or through cracks, gaps and penetrations in the masonry walls and/or concrete slab in the basement or crawlspace. SPF, alone or in combination with air-impermeable vapor barriers covering the crawlspace floors, can dramatically reduce infiltration of these gases. In some cases, a passive or active radon mitigation system may need to be installed behind or below the air impermeable barrier created by SPF. In regions susceptible to radon or other soil gases, it is recommended that SPF contractors consult with companies that provide radon testing and mitigation services prior to installation of SPF.

PEST MANAGEMENT INSPECTION AND TREATMENT

For application of SPF in basement and crawlspaces, optimum insulation and air sealing of the framing to foundation interface can be achieved when a continuous layer of SPF is applied from the underside of the subfloor, over the band joist and sill plate and continuing over the interior of the foundation wall. In some areas of the US, most notably in hot, humid climates of the southeastern US, there are concerns with infestation and detection of subterranean termites.

Subterranean termites typically have large colonies below the ground and enter the building to feed on the wood framing. Termites travel from underground colonies to the food source by constructing tell-tale mud tubes along the foundation walls. Pest management professionals typically perform annual inspections looking for these mud tubes as well as the initiation of visible termite damage at the sill plate and band joists. In areas of high termite infestation probability, it may be necessary to leave an inspection gap in the foam at the top of the foundation to facilitate termite inspection. An example of an inspection gap is shown in Figure 2.



Figure 2 - Example of a Termite Inspection Gap in a Crawlspace Wall

Additionally, it may be necessary to leave portions of the sill plate or band joists partially exposed. In some states, termite inspection gaps are prescribed in the local or state building code. Prior to installing SPF at the foundation-framing interface, consult with your local code officials and pest management companies for guidance.

SPF APPLICATION EXAMPLES

SURFACE PREPARATION

SPF can successfully be applied to most surfaces. However, the following general practices should be considered:

(1) GENERAL SURFACE PREPARATION PROCEDURES

- a. The building assembly must be secure against movement that could affect the performance of the SPF thermal and moisture protection system.
- b. There must be full adhesion between the SPF and the substrate. Prior to the



application of SPF, the foundation wall must be dry and free of loose dirt or any contaminants that may interfere with adhesion.

(2) MASONRY AND CONCRETE FOUNDATION WALLS

- a. Concrete surfaces must be dry and free of laitance, release agents, and other contaminants that could affect the adhesion of SPF.
- b. Primers are typically not required on raw masonry or concrete; however, primers may be required under special circumstances.

SELECTION OF PRIMER

If circumstances require a primer, it should be considered in accordance with the type substrate to be sprayed, the intended end use of the wall assembly, and the recommendations of the SPF and primer manufacturers. See SPFA-143 “Primers: Why, When and How to Use Them” for more information on primers.

SELECTION OF A VAPOR RETARDER

If a vapor retarder is required, its selection should be based on the following criteria:

- (1) Permeance (based on moisture vapor drive and perm ratings of other components)
- (2) Compatibility with adjoining materials

SELECTION OF THE SPRAY POLYURETHANE FOAM INSULATION

Many different SPF systems are available in various densities, each exhibiting different temperature limitations and physical properties. Ensure that the product selected is approved by its manufacturer for use on below-grade interior walls.

TYPES OF BASEMENT/CRAWLSPACE APPLICATION

This guide discusses the application of continuous SPF for use as a subgrade thermal and moisture protection system. Your contractor, systems manufacturer, and local code agencies can assist you, as each project must be assessed individually.

SPF is typically applied in basements and crawlspaces in one of the following manners:

- Fully adhered SPF
- SPF over a drainage plane
- Extending the air and vapor barrier with limited SPF usage
- Unvented Crawlspaces
- Integrated Framing
- Filling CMU Block Cavities

These approaches address the various foundation materials and degree of finish installed over the SPF.

FULLY ADHERED SPF

Fully adhered SPF includes installations where the foam is applied directly onto a dry masonry substrate. The SPF normally extends from the underside of the floor decking down to the base of the foundation wall, sometimes in varying thicknesses to address payback considerations and R-value requirements of the building/energy code. This approach requires that the substrate to be dry and free of loose dirt, dust and other debris to assure adequate adhesion to support the foam.

Note that SPF should not be used as a water barrier when installed on the inside of foundations. If water ingress is present, use the SPF over a drainage plane method as described in the next section. A diagrams and photo of this fully adhered application are shown in Figures 3, 4 and 5.

- a. **Surface Preparation:** Substrate surfaces to which SPF will be applied must be clean, dry and mechanically stable (free of dust, dirt, debris and loose coatings). Wood, concrete and masonry surfaces should not have efflorescence, mold, mildew or other contaminants on the surface. Moisture content should be regularly sampled at various points along the surface and must be below the threshold listed in the manufacturer's installation instructions.
- b. **Adhesion Testing:** A best practice is to regularly test the adhesion of SPF to its substrate. Poor adhesion may result in delamination of the SPF.
- c. **Spray the foam in a continuous manner from the underside of the subfloor to the slab of the basement floor.** Note: if this installation is in areas of high-termite infestation probability, consult with local code officials and pest management companies to determine if inspection gaps are necessary. The thickness of the foam should be applied to meet R-value requirements for above-grade and below-grade portions of the basement wall.

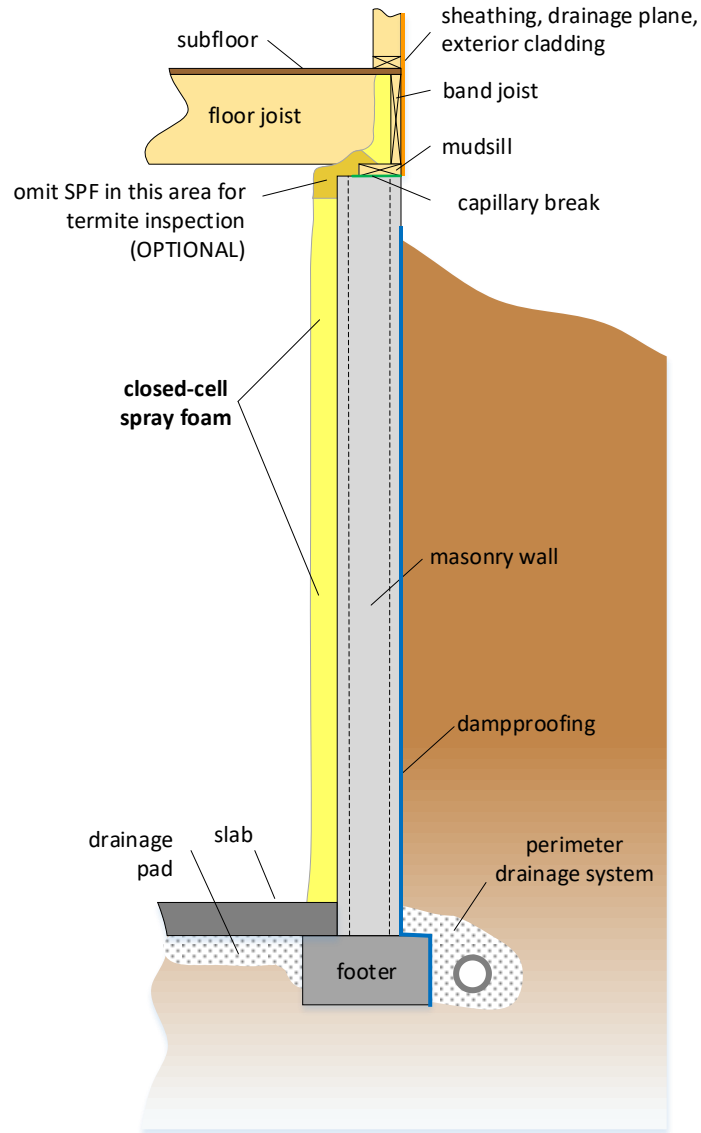


Figure 3 - Fully-Adhered SPF to Dry Masonry/Concrete Basement Wall (diagram)



Figure 4 - Fully-Adhered SPF to Dry Masonry/Concrete Basement Wall (photo)

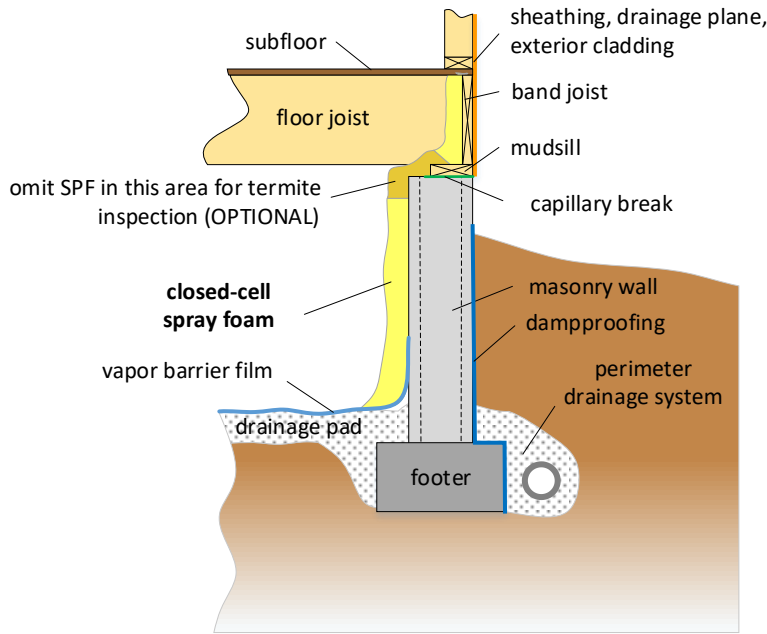


Figure 5 - Fully-Adhered SPF to Dry Masonry/Concrete Crawlspace Wall (diagram)

UNVENTED CRAWLSPACES

Recent changes to several energy codes now require HVAC ductwork to be within the thermal envelope of the building. Plumbing should also be within the thermal envelope in colder climates to prevent freezing damage. A means to easily bring crawlspace-mounted pipes and ducts into the conditioned space is to create an unvented or conditioned crawlspace.

In this application, insulation is removed from the floor plane above the crawlspace, and instead installed on the foundation stem walls on the perimeter of the building.

This application relies on either the fully adhered or over drainage plane application methods, with the same consideration given to adhesion, drainage and termite inspection. Creating unvented crawlspaces is a special case of the extended air barrier and vapor retarder.

In all but the coldest climates, insulation is not needed on the floor of a conditioned crawlspace. However, to reduce infiltration of moisture, liquid water and air (soil gas), an air and moisture impermeable membrane is used to cover the exposed floor of the crawlspace.

INTEGRATED FRAMING

In cases where the basement will be finished with drywall or other interior sheathing, the framing that supports the sheathing should be spaced away from the masonry to allow the SPF to fill between the framing and the masonry. Proper technique is to fill behind the studs, then fill in the bays between the framing members. This allows a continuous layer of SPF to be applied to the interior surface of the wall, while simultaneously adhering the framing to the wall as shown in Figure 6.

The bottom plate of the framing should be pressure treated wood or installed on top of a water-resistant spacer that will hold the untreated wood above any bulk water drainage and prevent capillary transfer from the ground to the framing material.

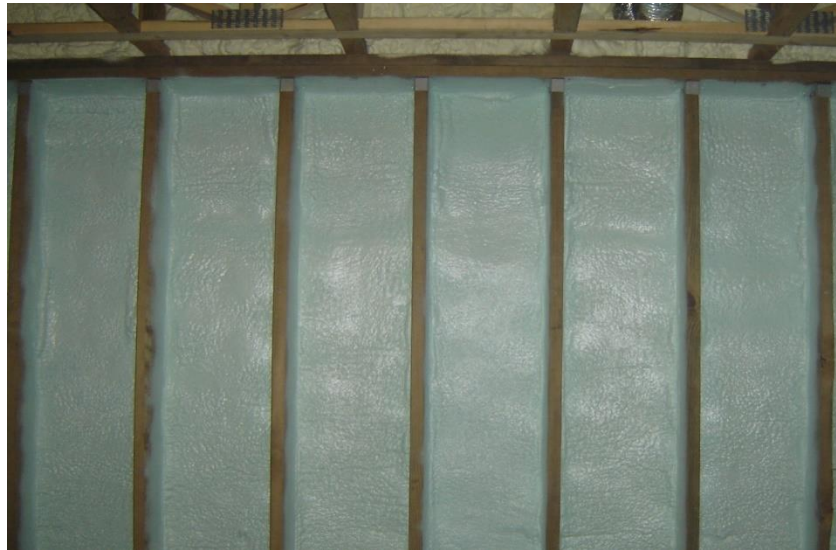


Figure 6 - SPF Behind Basement Wall Framing

POST-INSTALLATION SAFETY PROTOCOLS

Following the installation of SPF, several code requirements and safety protocols may be required, and/or information about the safe use of the occupied spaces after the SPF installation should be provided to the occupants. These include, but may not be limited to the following:

1. Install the required thermal or ignition barrier coating or covering. See SPFA-126 “Thermal Barriers and Ignition Barriers for the Spray Polyurethane Foam Industry” for more information.
2. Verify combustion appliance safety requirements are met after the SPF air sealing has been completed.

3. Recommend that the owner have radon and other IAQ testing performed (insert EPA citation on radon here)

This document was developed to assist in planning and installing spray-applied polyurethane foam on the interior of foundation walls in basements. The information provided herein, based on current model building codes, customs, and practices of the trade, is offered in good faith and believed to be true, but is made WITHOUT WARRANTY, EITHER EXPRESS OR IMPLIED, AS TO FITNESS, MERCHANTABILITY, OR ANY OTHER MATTER. SPFA DISCLAIMS ALL LIABILITY FOR ANY LOSS OR DAMAGE ARISING OUT OF ITS USE. Individual manufacturers, contractors, and building code authorities should be consulted for specific information. SPFA does not endorse the proprietary products or processes of any individual manufacturer or the services of any individual contractor.



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) Cast-in-place concrete	Section 03 30 00
(2) Unit Masonry construction	Section 04 20 00
(3) Rough carpentry	Section 06 10 00
(4) Foundation drainage	Section 33 41 13
(5) Dampproofing and Waterproofing	Section 07 10 00
(6) 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 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 "[SPF Insulation Installation Certificate](#)") showing the installed R value for the product used and installed for the job.

1.05 MATERIALS, DELIVERY, AND STORAGE



- (1) 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.
- (2) Containers shall be stored out of the weather and direct sun, where the temperatures are within the limits specified by the manufacturer.
- (3) 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 according to 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)	6.2°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%

*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 WATERPROOFING

The waterproofing must be suitable for below-grade application.

2.03 RELATED PRODUCTS

- (1) Drainage board, if specified, can be applied to the finished surface.
- (2) Protection board, if specified, can be used to protect the finished installation prior to backfilling.
- (3) Substrate primer, if required, shall be used as recommended by the manufacturer of the SPF specified.

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 to take into consideration substrate preparation, proper cure times, and inter-coat adhesion.

3.02 SUBSTRATE CONSIDERATION AND PREPARATION

- (1) Concrete/Masonry
 - a. Remove loose dirt, dust, debris, or other contaminants prior to the application of the thermal and moisture protection systems.
 - b. If priming is required, the primer shall be applied in accordance with Section 3.03.
- (2) 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 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.
 - d. Foamed-in-place fillets shall be smooth and uniform to allow positive drainage at the intersection of the foundation wall and the footing.
 - e. SPF shall be terminated in a clean, neat line.
- (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 "tree bark" are not acceptable. Examples of these surface finishes can be found in SPFA-104



Spray Polyurethane Foam Systems for New and Remedial Roofing. These areas shall be repaired to an acceptable surface texture.

- b. Damage or defects to the SPF surface shall be repaired prior to the application of the waterproofing.

3.05 WATERPROOFING APPLICATION

- (1) The waterproofing shall be installed in accordance with manufacturer’s instructions.
- (2) The SPF surface shall be free of contaminants that would impair the adhesion of the waterproofing.
- (3) The waterproofing shall be applied to all SPF surfaces and extended 2.0 inches (50 mm) above the spray polyurethane foam termination line or top flashing.
- (4) Waterproofing shall be applied to achieve a minimum dry film thickness of ___ mils (___ mm).
- (5) The waterproofing shall be allowed to fully cure prior to the installation of the protective board and backfill.

3.05 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).