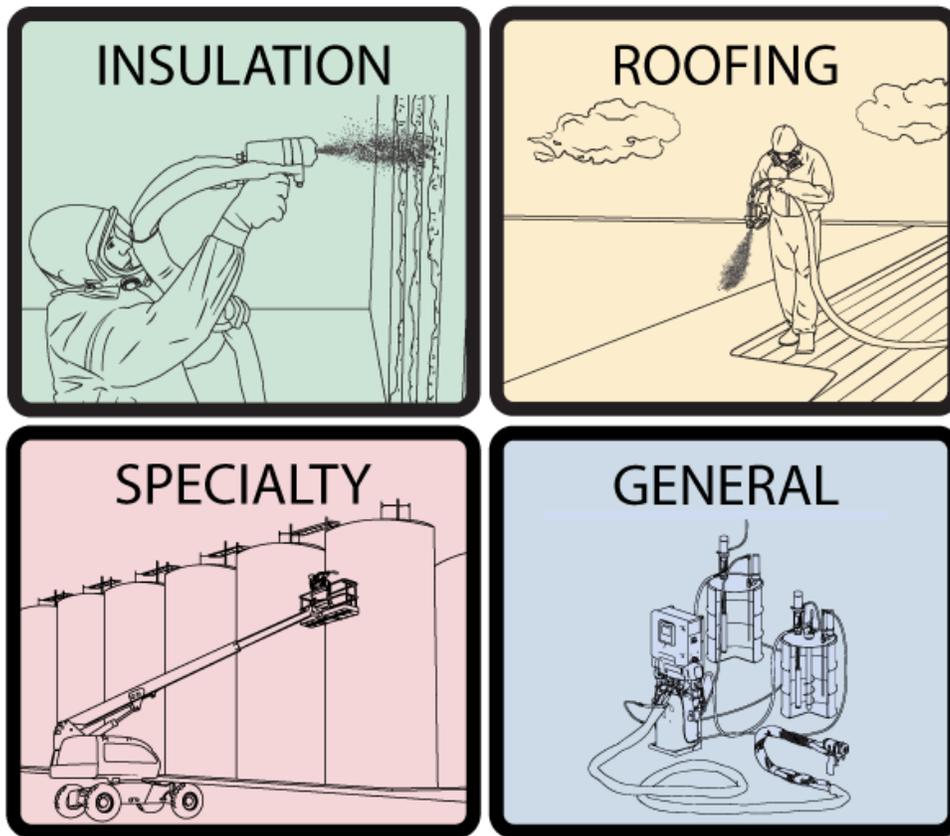




Spray Polyurethane Foam for Exterior Subgrade Thermal and Moisture Protection

SPFA-140



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ABOUT THE 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 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

NOTE: 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, 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 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
August 2015	Updated format	None
December 2018	All	Updated content

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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DESIGN CONSIDERATIONS

GENERAL CONSIDERATIONS

Energy codes require that below-grade walls must be insulated in most climate zones. In certain climate zones, insulation around and below footings, as well as frost-protected shallow foundations¹, may also be required. An effective means to insulate below-grade surfaces, especially during new construction, is the application of closed-cell foam to the exterior side of below grade walls. This application provides a continuous, air-impermeable water-resistant layer of insulation around the entire perimeter of the building.

The performance of an SPF (spray-applied polyurethane foam) thermal and moisture protection system can be affected by all the component parts of a foundation structure.

Building codes may not approve the installation of foam plastics on building exteriors below grade in areas where termite infestation is considered “very heavy.” Check with local building code authorities for the applicability of applying SPF below grade in your area. Additionally, building codes may have physical property requirements for below-grade insulations, including maximum water absorption limits and minimum compressive strength values.

Structural design, specification review, and contractor and material selection, coupled with the compatibility and positioning of the various structural components, are necessary to produce a successful SPF thermal and moisture protection system.

The specifier should consult product literature to confirm that the thermal and moisture protection system meets the design intent.

There must be sufficient space in the trench to allow a minimum of 2-1/2 feet (760 mm) distance from the spray gun to the substrate wall. (Note: 4 feet [1,200 mm] minimum space from the substrate wall to the trench wall should be sufficient). Sufficient excavation protection techniques should be provided by the general contractor or building owner, as described in OSHA 2226 Guide on Trenching and Excavation Safety, and documented in 29 CFR Part 1926, Subpart P.

DETERMINING SPF INSULATION THICKNESS

Determine the minimums for each of the situations described below, and choose the method that prescribes the greatest insulation thickness:

- (1) Model Building and Energy Codes^{2,3}: Most code agencies require certain buildings to meet

¹ ASCE 32-01 – Design and Construction of Shallow Frost-Protected Foundations, American Society of Civil Engineers, 2001.

² International Energy Conservation Code, International Code Council.

³ International Residential Code, International Code Council.

- energy conservation standards. Check with local code authorities for requirements.
- (2) Condensation Control: Condensation can occur inside a building or a building cavity when a surface temperature is lower than the dew point of the air. SPF insulation thickness to control this condensation must be based on the design dew point and the design exterior ambient temperature. See SPFA publication SPFA-118, “Moisture Vapor Transmission.”
 - (3) Economic Thickness: Greater insulation thickness decreases heat and cooling costs and the size of HVAC equipment. An economic thickness calculation determines the added incremental insulation thickness, which meets a specified return on investment from energy cost savings. See *ASHRAE Handbook of Fundamentals*. The insulation contractor or supplier may also be able to assist in determining economic thickness.
 - (4) Minimum Practical Thickness: SPF applications must be sprayed to a minimum thickness to uniformly cover the substrate and to achieve suitable physical properties. For relatively smooth substrates, the minimum practical thickness is 1 inch (25 mm) or as recommended by the manufacturer, but corrugated or unusual substrate configurations may require greater thickness to achieve a suitable finished foam surface.
 - (5) Wall joint areas that set on top of the footings are generally sprayed in a manner to create a cove or fillet that will aid in drainage away from the wall to drainage systems, as shown in Figure 1.

SURFACE PREPARATION

Typical below grade construction materials such as metal, poured concrete, concrete block, treated wood and EPS forms containing concrete in the cavities, when properly prepared, will allow successful application of SPF. However, the following general practices must be observed.

(1) GENERAL SURFACE PREPARATION PROCEDURES

- a. The building assembly must be secure against delamination and 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. Wet or damp mortar in dry concrete block walls can receive spray foam without adhesion or off-ratio foam problems. Walls with wet or damp joints and block will likely result in these problems, as the excess moisture present can react with the A-side isocyanates.

(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.
- c. Pre-cast concrete walls likely have release agents or sealants that could reduce SPF adhesion. Test SPF adhesion and use surface preparations such as mechanical abrasion, de-greasing agent, power washing or primers, if necessary.

SELECTION OF PRIMER

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

SELECTION OF A VAPOR RETARDER

If a vapor retarder is required, its selection should consider the following criteria:

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

SELECTION OF THE SPRAY POLYURETHANE FOAM SYSTEM

For exterior below-grade thermal and moisture protection, only closed-cell SPF may be used. There are many closed-cell SPF systems available, each exhibiting different temperature limitations and physical properties. Important SPF properties for this application include closed-cell content, water resistance, moisture transmission, dimensional stability, compressive strength, density, as well as thermal performance. Closed-cell SPF compliant with ASTM C1029 typically meets the required properties for this application.

Polyurethane foam insulation is combustible and should be treated as such. Flame spread ratings provided for polyurethane products using small scale tests are not intended to reflect the hazards presented by this or any other materials under actual fire conditions. Care must be taken to ensure that the foam is not exposed to temperatures in excess of 200°F (93°C). Additionally, during the time between foam installation and application of a coating or backfilling of the trench around the foundation, warning signs regarding SPF contact with heat, sparks and open flames should be posted. Accumulation of combustible materials in the trench area should be avoided.

SELECTION OF WATERPROOFING

Most closed-cell foam plastic insulations, including SPF, is resistant to water and moisture intrusion; however, under some circumstances, such as certain soil conditions (sand vs clay), inadequate foundation drainage and high-water tables that result in prolonged contact with standing water, moisture could accumulate in the foam. If these circumstances are anticipated, a waterproof coating over the exposed SPF surfaces is recommended. Waterproofing, if used, must form a water-resistant protective membrane over the SPF. Consult with SPF manufacturer for compatibility, and/or applicable waterproofing membrane performance standards⁴ when selecting a waterproofing coating.

⁴ ASTM D7832 “Standard Guide for Performance Attributes of Waterproofing Membranes Applied to Below-Grade Walls/Vertical Surfaces (Enclosing Interior Spaces)”

SELECTION OF ABOVE GRADE PROTECTION

SPF installed on wall sections just above grade are subject to mechanical damage from abrasion, landscaping tools and grass trimmers, as well as UV damage from exposure to sunlight. To protect SPF from damage, consider polyurea and acrylic coatings over foam installed above grade.

This guide discusses the application of seamless 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 APPLICATION

Figure 1 shows a typical application of SPF on a subgrade masonry wall. Closed-cell SPF is applied directly to the outside surface of the masonry wall. The minimum thickness of the foam is determined by thermal energy requirements of the applicable building codes, or per the installation contract.

A continuous layer of foam extends from the footer and perimeter drain to (1) the anticipated grade or (2) the top of the masonry wall. If option 2 is considered, consult local code requirements regarding application of foam plastics near ground level. Some codes prevent using foam between the grade line and the framing to facilitate regular pest inspections. In addition, any foam above grade near the ground level should be protected from mechanical damage with a durable coating or covering.

If foam will extend to the top of the masonry wall, builder may optionally install the mudsill approximately ½" outside the exterior face of the wall, and a 90 degree metal flashing between the mudsill and top of masonry wall may be installed to receive the tapered edge of the SPF. This is shown in Figure 2.

An optional waterproof coating may be used, especially if the foam may be in prolonged contact with water. During backfill of the trench, builder or general contractor should avoid the use of fill that could damage the foam and coating. Optional protective boards and/or drainage boards may be placed over the foam prior to backfill (not shown in Figure 1).

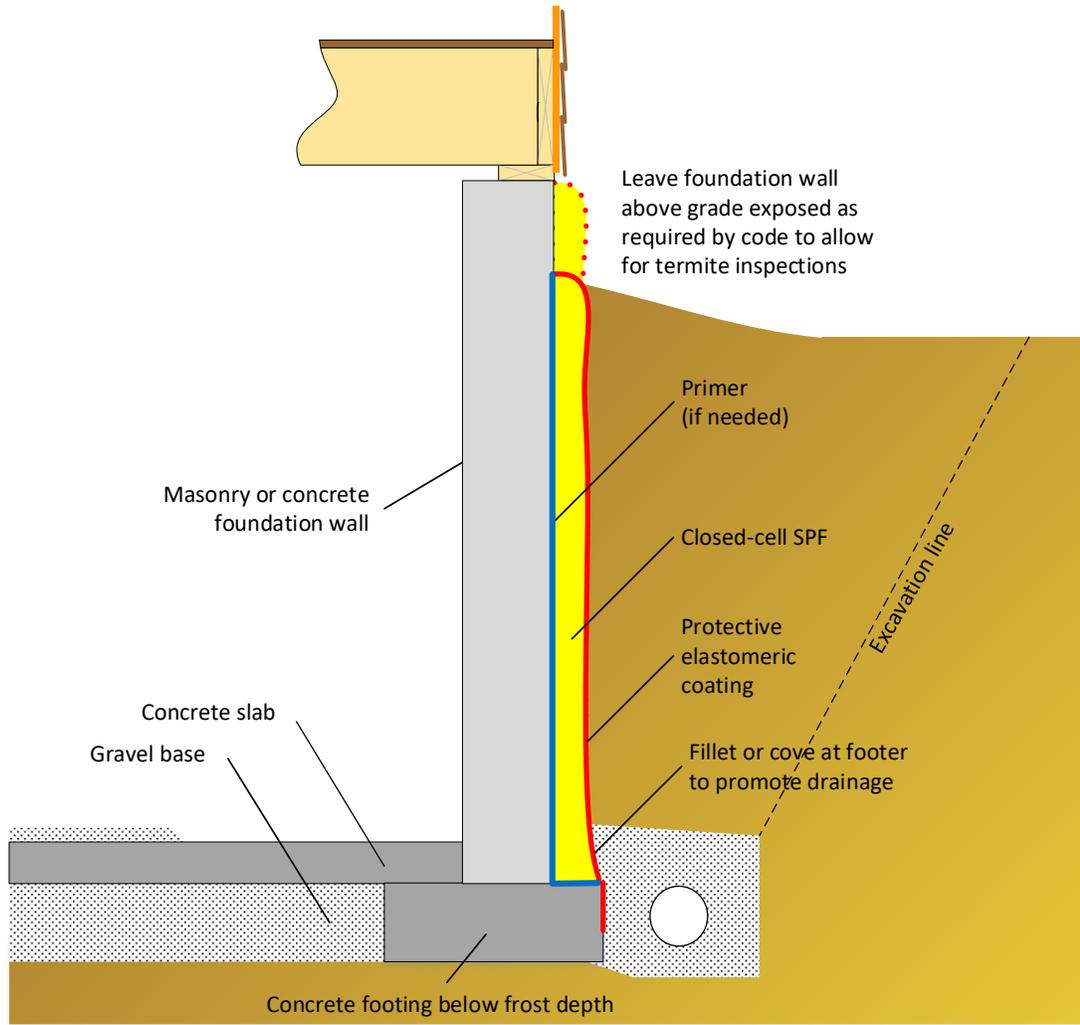


Figure 1 - Exterior below-grade wall installation: optional protective/drainage boards not shown

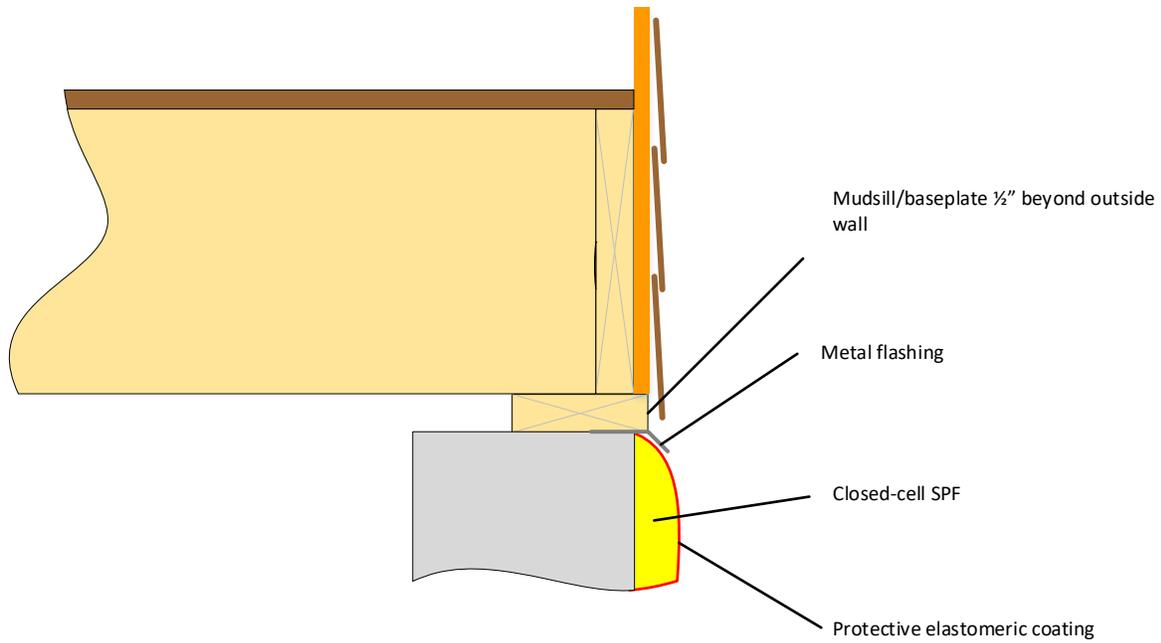


Figure 2 – Detail of mudsill and flashing when SPF is installed just above grade



Figure 3 – Exterior below-grade wall installation (photo)



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.

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	Section 04 20 00
(3) Rough Carpentry	Section 06 10 00
(4) Dampproofing and Waterproofing	Section 07 10 00
(5) Thermal Insulation	Section 07 21 00
(6) Foundation Drainage	Section 33 41 13

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) 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)	D1622	48 kg/m ³	1.5—3.0 lbs/ft ³
Comprehensive Strength	D1621	100 kPa (minimum)	15 lb/in ² (minimum)
Closed Cell Content	D2856	90% (minimum)	90% (minimum)
R-Value	C177, C236, or C518	1.1 K•m ² /W (minimum)	6.0°F•hr•ft ² /Btu (minimum)
Smoke Developed Index*	E84	<450	<450
Flame Spread Index*	E84	<75	<75
Water Absorption	D2842	<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 so as 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 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 "treebark" 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.

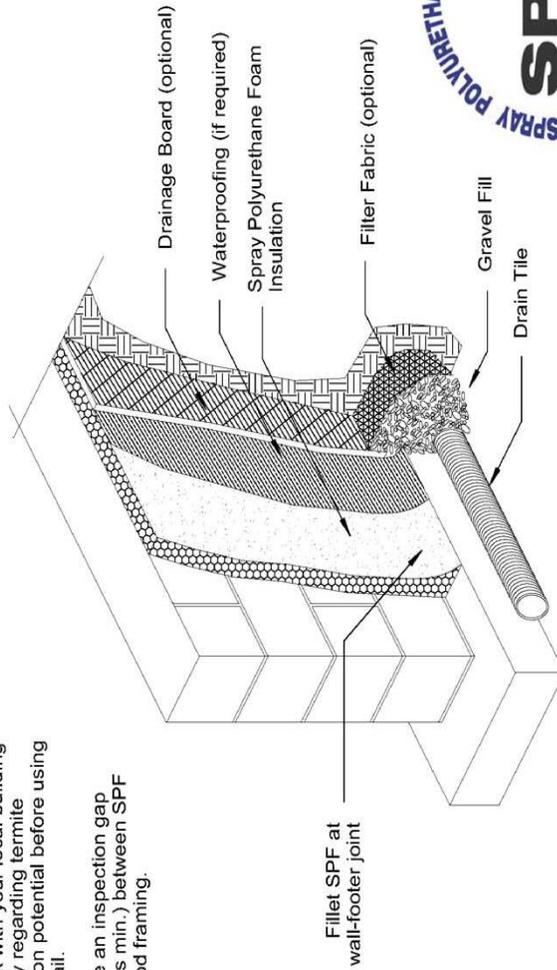
3.05 WATERPROOFING APPLICATION

- (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 inches above the 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.

EXTERIOR SUBGRADE SPF THERMAL & MOISTURE PROTECTION

Notes:

1. Check with your local building authority regarding termite infestation potential before using this detail.
2. Leave an inspection gap (6 inches min.) between SPF and wood framing.



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