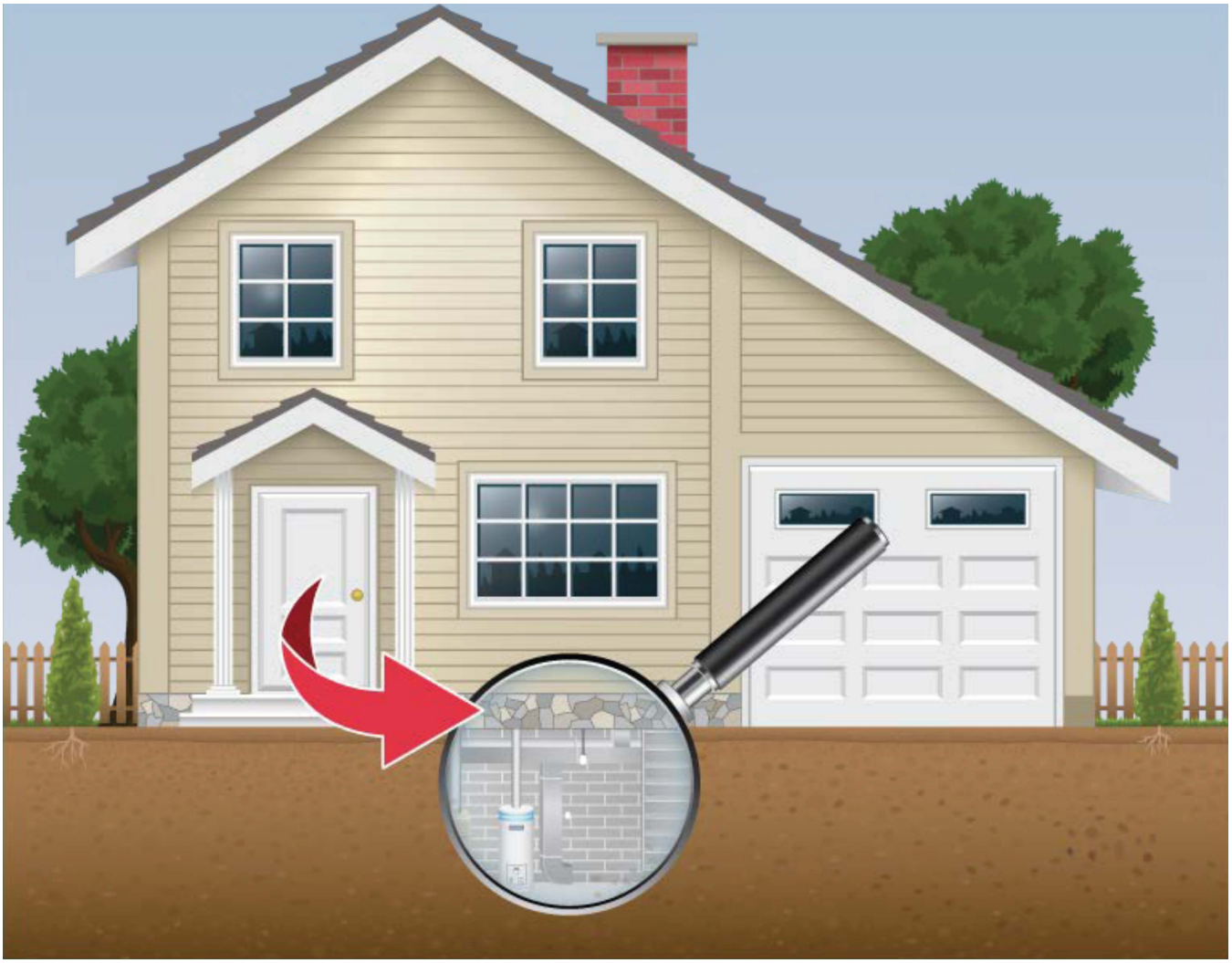
UNIVERSAL POLYMERS CORPORATION

A Division of General Manufacturing Coatings Corp.

# APPLICATION GUIDE

## Residential Foundations and Crawlspaces



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## Overview

The purpose of UPC's Application Guide for Residential Foundations & Crawlspaces is to provide the installer and specifier with the knowledge necessary to install UPC spray foam products safely and effectively in residential foundations and crawlspaces. While we make every effort to include the technical information most needed for typical residential foundations and crawlspaces, we cannot account for every type of foundation and crawlspace assembly and situation. We also cannot detail every type of application scenario and condition. We encourage applicators and specifiers to contact our technical and building science support at: 203.760.0025. While this guide can provide in depth design and application instruction, it cannot replace the practical need for hand-on installation experience. UPC has technicians available for application training and support.

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## Disclaimer

Published Technical data and instructions are subject to change without notice. Contact your local UPC representative or visit our website at www.upcfoam.com for current technical data and instructions. All guidelines, recommendations, statements, and technical data contained herein are based on information and tests we believe to be reliable and correct, but accuracy and completeness of said tests are not guaranteed and are not to be construed as a warranty, either expressed or implied. It is the user's responsibility to satisfy himself, by his own information and tests, to determine suitability of the product for his own intended use, application, and job situation. User assumes all risk and liability resulting from his own use of the product. Neither seller nor manufacturer shall be liable to the buyer or any third party for any injury, loss or damage directly or indirectly resulting from use of, or inability to use, the product.

## Description

Spray Applied Polyurethane Foam (SPF) is commonly used in foundations as an insulation and sealant both inside and outside foundation walls. In addition to the foundation walls, closed cell SPF (ccSPF) under the slab floor provides excellent insulation and a highly effective radon gas barrier. Crawlspaces are often difficult to insulate and SPF provides excellent insulation, air infiltration control and moisture control in a single product.

## Definitions

| | |
|---|---|
| Attic | A space immediately below the roof of the building.<br><br>*Vented Attic* Assembly: The attic space is connected to the outdoor environment. The thermal envelope (insulation layer) ends at the attic floor.<br><br>*Unvented Attic* Assembly: The attic space is connected to the conditioned space. The thermal envelope (insulation layer) extends to the roof of the structure. |
| AHJ - Authority Having Jurisdiction | An organization, office, or individual responsible for enforcing the requirements of a code or standard. |
| Building Code | A collection of regulations adopted by a city to govern the construction of buildings. |
| Crawlspace | *Vented:* A crawlspace with open walls, vents or other openings to the environment.<br><br>*Unvented:* A crawlspace which is sealed and insulated to the surrounding environment. Access is internal to the structure or a sealed access door. Concrete Masonry Unit such as poured concrete or block |
| CMU | Concrete masonry unit such as poured concrete or block |
| Combustible | All SPF products are considered combustible by the various Building Codes and must be protected with an approved 15 minute thermal barrier – except under special circumstances identified in the IBC/IECC/IRC. |
| Dew Point | The atmospheric temperature (varying according to pressure and humidity) below which water droplets begin to condense and dew can form. |
| Exotherm | Heat generated by a compound when undergoing change or formation. |



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## DEFINITIONS (CONT)

| | |
|---|---|
| Exothermic Reaction | A reaction creation or destruction which gives off heat. |
| Exfiltration | Air moving from inside the conditioned space to outside. |
| Thermal Barrier | An element of low thermal conductivity placed in an assembly to reduce or prevent the flow of thermal energy between conductive materials. |
| Thermal Envelope | The exterior or shell of a building that repels the elements. |
| Thermal Resistance | The ability of a material to resist the flow of heat energy across a stated thickness and temperature. |
| Ignition Barrier | A material which is applied directly to a combustible material to eliminate the potential for ignition from minor heat sources and incidental spark, flame, or heat source – meeting the specific criteria as tested. |
| Infiltration | Air moving from outside the conditioned space to inside. |
| Primer | A substance used as a preparatory coat on previously unpainted substrate, especially to prevent the absorption of subsequent layers of paint or the development of rust. |
| Radon Gas | An inert, radio-active gas which occurs naturally in various bed-rock structures. Radon is the second leading cause of lung cancer in North America. |
| Rim Joist | The lateral framing member or assembly placed on top of CMU structural foundation walls. |
| R-Value | The capacity of an insulating material to resist heat flow. |
| Sill Plate | The wood framing member placed on top of CMU foundation walls to transition to wood framing. |
| Termite Inspection Strip | A 6-inch-wide gap in the insulation providing direct visual access to the top of the crawlspace wall and wood framing interface. |
| Vapor Drive | The movement of moisture vapor from an area of high pressure to an area of low pressure. Drive can be a result of temperature difference, wind, air pressure, relative humidity. |



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## DEFINITIONS (CONT)

| | |
|---|---|
| Vapor Permeable | A material with a perm rating over 10 which allows moisture to pass relatively easily. |
| Class I Vapor Barrier/Retarder | A material with a perm rating less than 0.1. |
| Class II Vapor Retarder | A material with a perm rating between 0.1 and 1.0. |
| Class III Vapor Retarder | A material with a perm rating between 1.0 and 10.0. |
| Vapor Barrier | A material with a perm rating less than 0.1. |
| Vented Roof Assembly | The roof sheathing and roof covering (shingles) is vented above or below the roof sheathing. |
| Unvented Roof Assembly | The roof sheathing and roof covering (shingles) is in direct contact with the interior insulation as part of an unvented attic assembly. The assembly does not include a space for air. |

## BASIC BUILDING SCIENCE – FOUNDATIONS AND CRAWLSPACES

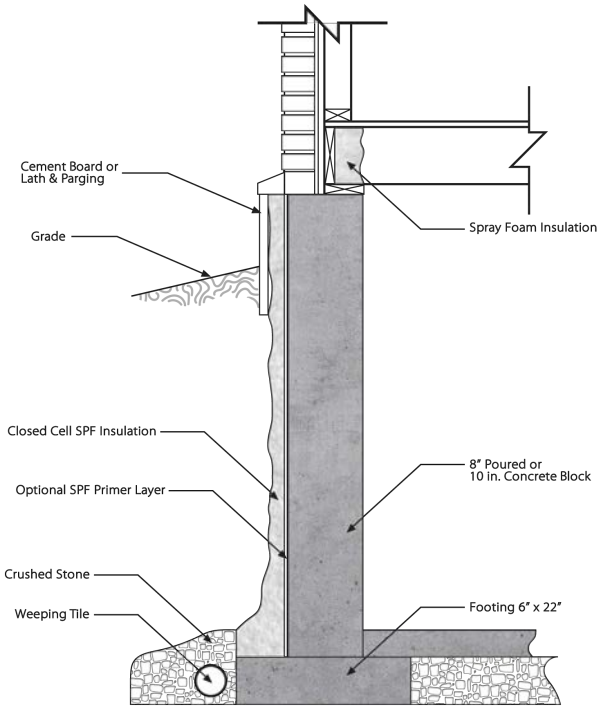
### *Foundation Walls*

Open cell or closed cell SPF can be directly applied to foundation walls. Closed cell is used on the interior in combination with fire protection (gypsum board) or exterior, while open cell is only used on the interior with additional attention to fire protection and moisture control.

When UPC closed cell foams are used on the exterior of foundation walls, no additional water or vapor control layer is required to protect the installed foam from bulk water or soils, provided the entire foundation is above the local water table and there is a layer of drainage material (gravel) included between the face of the foam and the surrounding earth. In many designs, drainage is provided by a drainage fabric or open weave material which can be terminated below grade at the board/spray foam contact location.

Above grade, foam must be protected from mechanical damage and weathering. Typical installations combine ccSPF below grade and board insulation above grade. UPC provides several design details for your consideration.

**EXTERIOR FOUNDATION SPF DETAIL**
**ZONES 1-4A**

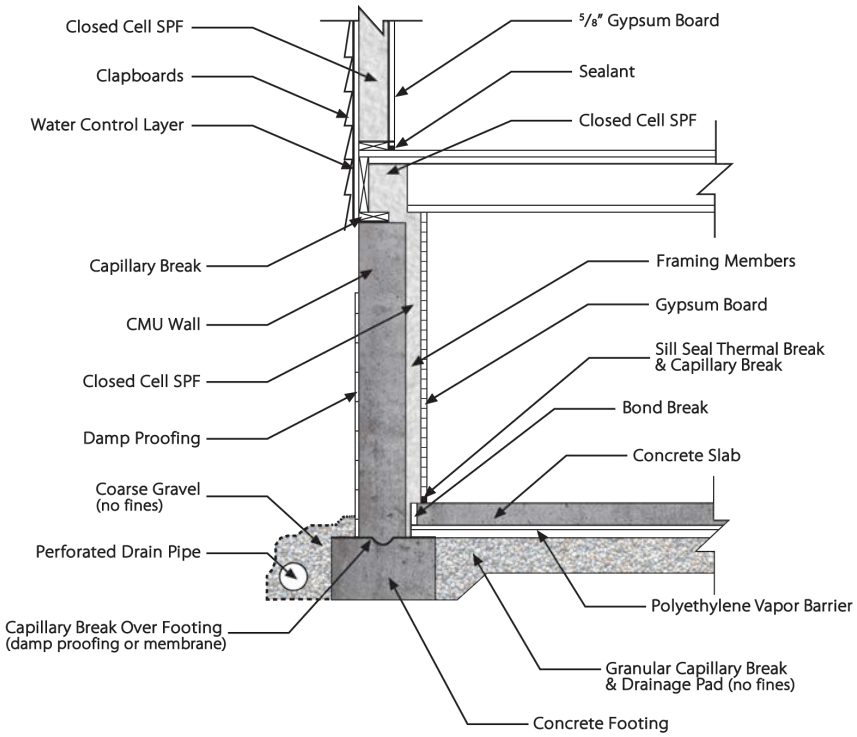


Foundations are generally cementitious and may require additional preparation. UPC recommends the use of primers or adhesion promoters. Refer to industry best-practice documents available from the UPC website and the Spray Polyurethane Foam Alliance (SPFA) regarding substrate preparation.

In all cases, the substrate must be free of oil, grease, process films and release agents, waxes, rust scale, frost, mold, loose dirt or dust and the moisture content of substrates must be below 19% before applying any UPC SPF product. Substrate temperature should always be a minimum of $5^0$F above the ambient air dew point. UPC recommends the use of a test area to evaluate the adhesion of SPF to the substrate.

Concrete must be allowed to cure a full 28 days before the application of SPF foam.

**INTERIOR FOUNDATION SPF DETAIL**




The suitability of the substrate for the application of UPC SPF is at the discretion of the applicator.

Open cell SPF (ocSPF) must not be used below grade on the exterior of foundation walls at any time. Open or Closed cell SPF may be used on the interior side of foundation walls to provide a thermal control layer. When ocSPF is used on the interior side of foundation walls, the foundation wall must have adequate foundation waterproofing on the exterior to keep the wall dry and leak free definitely to avoid the potential for moisture build-up in the ocSPF. In general, UPC encourages the use of ccSFP on the interior side of foundation walls. Refer to the local Building Code for the R-value requirement for foundations. In some areas, full-height foundation insulation is not required. In all cases, when SPF is applied to the interior face of foundations, an approved thermal barrier must be installed as the interior is now considered "occupied space".

UPC recommends using ccSPF and flood tolerant wall designs when the structure is located within a designated flood zone. (see *Residential Wall Application Guide*).



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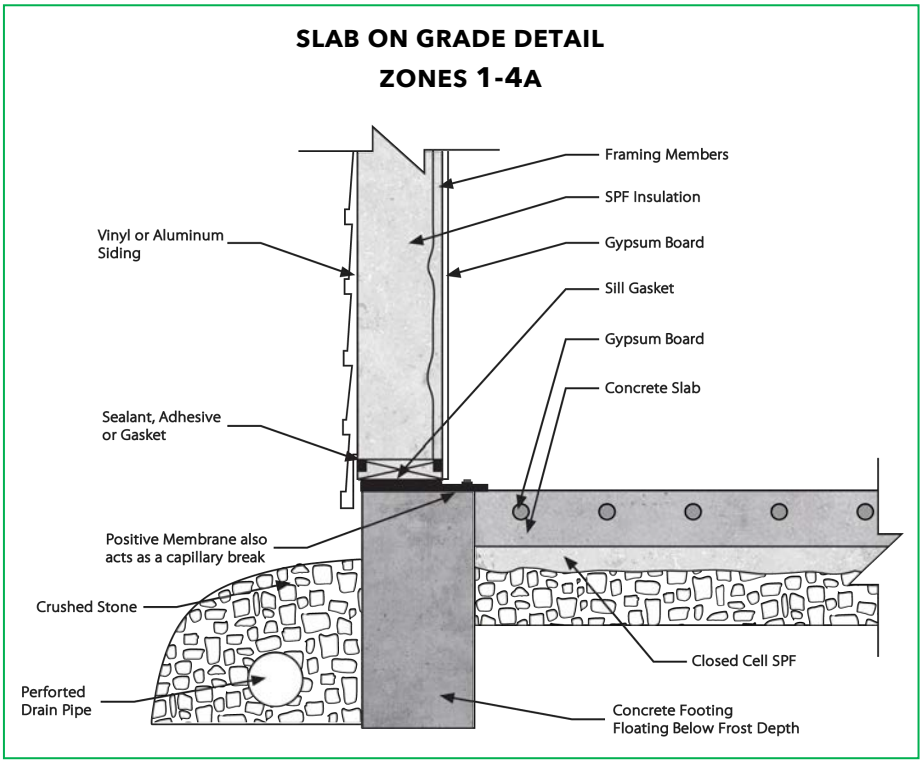
### *Below Slab*

Closed cell spray foam is a superior choice when choosing insulation for use under a poured concrete slab. UPC recommends the use of closed cell spray foam with an in-place density of at least 1.7 lb/ft$^3$. The compressive strength of these materials should be above 25 lb/in$^2$ when tested in accordance with ASTM D 1621 @ 10% deflection to withstand the live and dead loads associated with residential construction and 4 inches of concrete. *(Open cell SPF is not acceptable in this application.)*




Closed cell SPF can be installed directly onto prepared soil (drainable) and a minimum 3" of gravel. When spraying onto gravel, the first pass of foam is limited to a depth which "just covers" or "levels" the gravel surface and provides a suitable surface for the second pass. R-value thickness requirements are then applied to the initial "leveling pass" as required by local Building Code.

When UPC closed cell products are applied at minimum thickness of 1.5 inches, they provide an effective air retarder of 1 perm. Being continuous (no cracks, gaps or seams), an air barrier and a vapor retarder, the material qualifies as a radon barrier. UPC foams are currently undergoing extensive testing to provide 3$^{rd}$ party confirmation of their ability to provide an effective barrier against radon gas.

### *Crawlspaces*

Crawlspaces, like attics, are considered limited access spaces. As such, the various codes and authorities permit SPF to be protected from flame and fire by an ignition barrier. The same fire protection rules and conditions for attics also apply to crawlspaces.

Like attics, crawlspaces generally fall into two categories – vented or unvented which dictate where the SPF is installed, just like attics. In a vented crawlspace, the outside environment is allowed to enter the crawlspace (connected) and the thermal envelope includes only the floor assembly above the crawlspace but not the crawlspace walls or dirt floor.

Building Science principles play a strong role in determining the choice of insulation, the need for additional moisture control and the durability of the design in vented crawlspaces. Here are a few considerations when installing SPF in a vented crawlspace.



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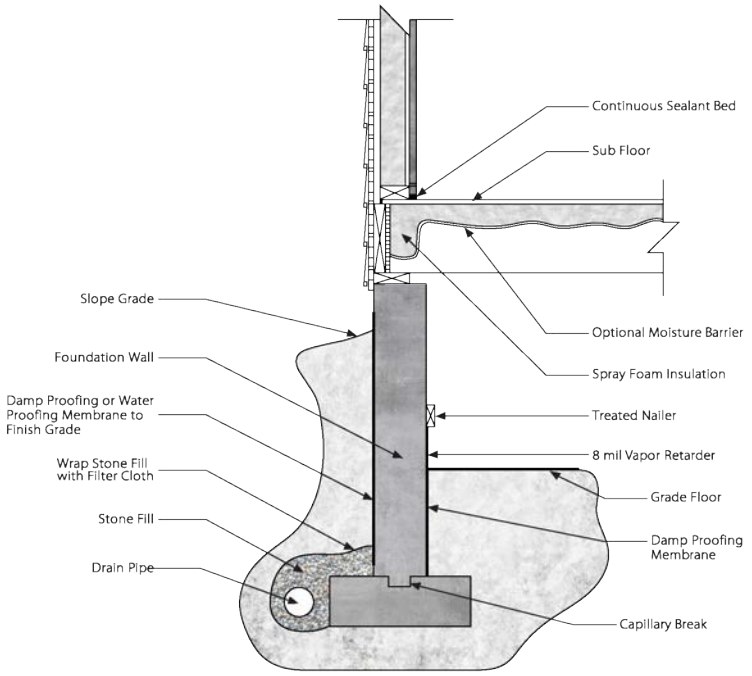
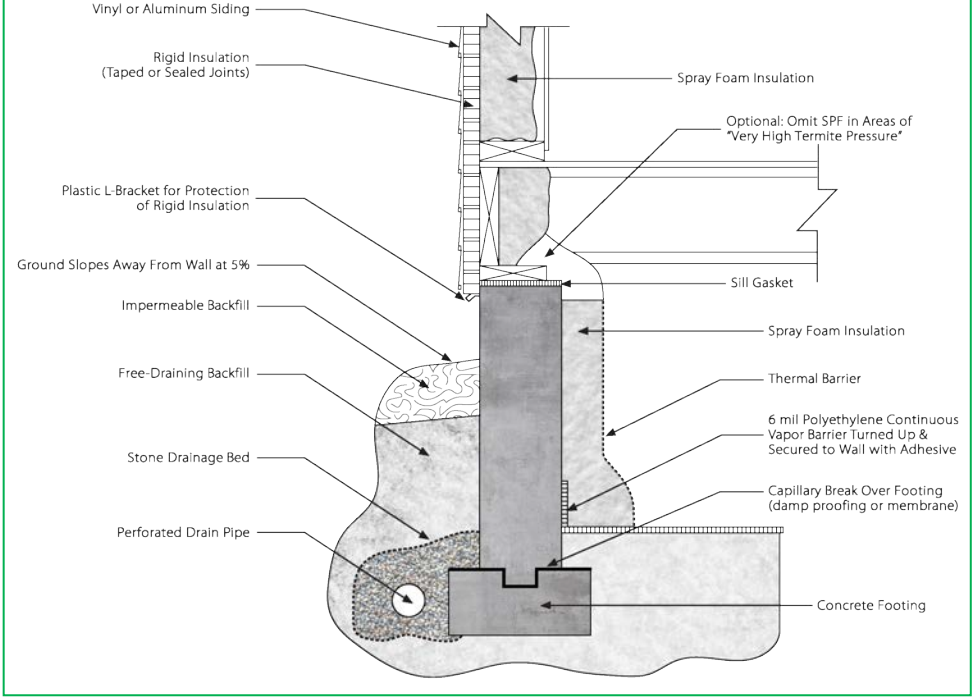
## VENTED CRAWLSPACE DETAIL
## ZONES 1-4A




## UNVENTED CRAWLSPACE DETAIL
## ZONES 1-4A



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## Vapor Drive

Moisture vapor moves from areas of high energy to low, high temperature to low temperature, and high moisture content to low moisture content. When the temperature of the air in the crawlspace is higher than the design temperature inside the home, moisture will attempt to drive through the insulation towards the cooler interior of the structure. Thermal bridging of joists and wood structural members is a concern in a warm/wet environment as framing members (floor joists) may be cooler than the surrounding insulation and subject to moisture condensation leading to mold, rot and premature failure. UPC recommends encapsulating all wood framing members with a minimum of 2 inches of ccSPF in climate zones 1a-4a (moist) and all marine climate zones. Full encapsulation of framing members is not required when the crawlspace is fully open to the environment such as *raised floor designs*.

In climate zones 1-4a and all marine zones, vapor permeable and vapor semi-permeable insulation (open cell SPF) must be protected from moisture vapor with an additional class 1 vapor retarder installed on the warm (exposed) side of the insulation.

Cold water supply lines and HVAC ducting are often encountered between floor joists in crawlspaces, there must be enough insulation between the cold water and cool HVAC ducting and the warm moist exterior environment to eliminate the potential for condensation forming on the surface of the ducting/piping within the SPF insulation. UPC recommends conducting a Heat/Air/Moisture analysis to determine the R-value required to eliminate the potential for condensation on all mechanical fixtures.

## Air Barrier Continuity

40-60% of the HVAC cost associated with our homes is due to air infiltration or exfiltration. As the cost of energy continues to rise, the value of an effective air barrier will also rise. In the vented crawlspace design, we must seal the floor area (ceiling of the crawlspace) of the occupied space to disconnect the crawlspace from the conditioned space. As SPF provides an excellent seal around penetrations, this is easy to accomplish, however, the transition from floor to wall must also be continuous. UPC provides several details for your consideration.

In an unvented crawlspace, the thermal envelope includes the crawlspace walls and, depending on climate, may include the floor. The unvented crawlspace is "connected" to the conditioned space above – no need to install insulation onto the underside of the floor assembly or to seal penetrations. As in the case of attics, the "use and occupancy" of the crawlspace will dictate the level of fire protection required over the combustible SPF foam insulation.

UPC recommends, and in most jurisdictions the code requires, the installation of a continuous type 1 vapor barrier (VB) onto the dirt floor of the crawlspace in unvented assemblies. The VB is continued up the stem wall a minimum of 12 inches as is adhered to the concrete or block wall. SPF is applied to the wall and over the top edge of the VB terminating at the bottom of the wall.

In areas of high termite pressure (see termite pressure map) the Building Code requires an inspection strip. The 6" wide open area (no foam) will allow the inspector to visually inspect the area for signs of infestation. The area is located at the top of the stem wall exposing the top of the wall and lower wooden joist area.



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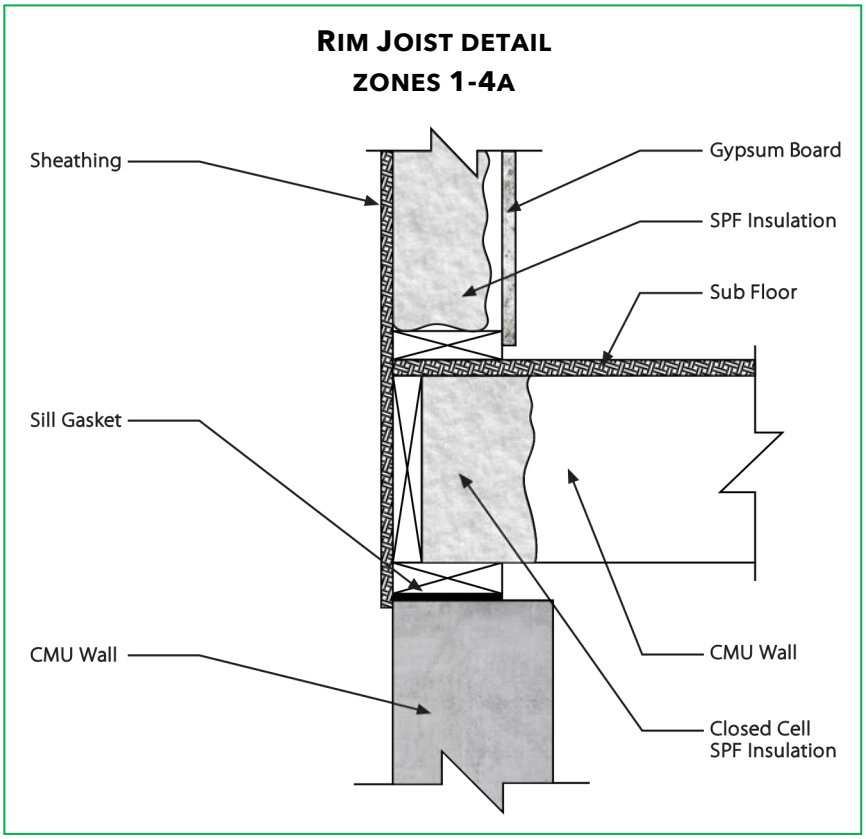
## Rim Joist

Rim Joist, Box Sill or Band Joist are the open areas protected from the outside by the sheathing between floor joists. They are notorious for being cold and leaking air. In fact, they are one of the top three air leakage points in residential construction. In some U.S. states, it is now a code requirement to air seal and insulate these critical areas. The most effective material is spray applied polyurethane foam (SPF). If the rim joist is a component in an unvented crawlspace, the SPF application must permit inspection of the base plate (lower flange of joist component) and top of wall connection. The foam may be left exposed (not protected by a thermal/ ignition barrier) provided the foam material has a less than 25 FSC when tested in accordance with ASTM E 84 and is less than 3 ¼ inches thick. Only foams with finished density of 1.5 to 2.0 lb/ft$^3$ are permitted. UPC recommends you confirm the requirements for exposed foam with the local AHJ and Building Code.

In retrofit applications, these areas are often damp, and the substrate may have a moisture content greater than 19%. UPC recommends confirming the moisture content of the wood substrate is less than 19% and suitable for the application of SPF.



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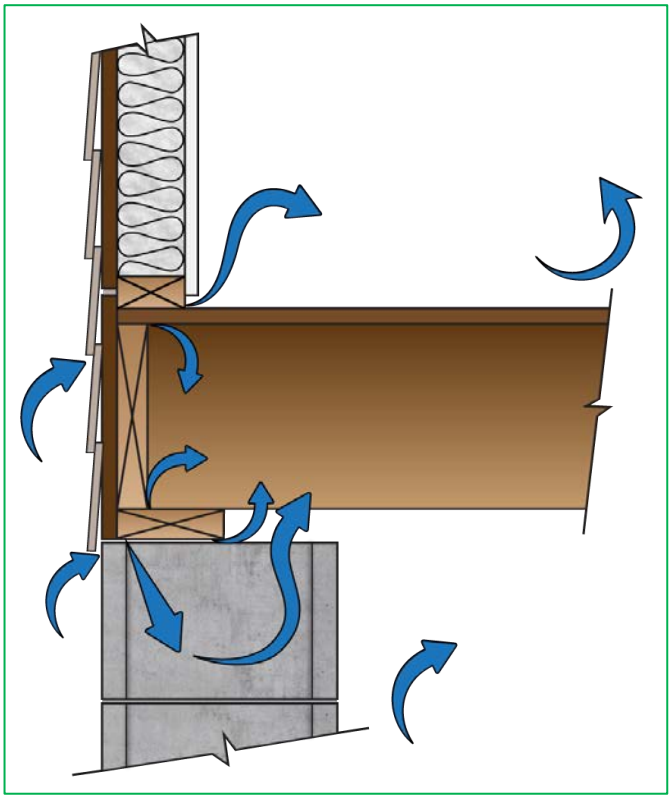
**2603.4.1.13 TYPE V CONSTRUCTION**
Foam plastic spray applied to a sill plate, joist header and rim joist in Type V construction is subject to the following:

1. The maximum thickness of the foam plastic shall be 3¼ inches (82.6 mm).
2. The density of the foam plastic shall be in the range of 1.5 to 2.0 pcf (24 to 32 kg/m$^3$).
3. The foam plastic shall have a flame spread index of 25 or less and an accompanying smoke-developed index of 450 or less when tested in accordance with ASTM E84 or UL 723.



## Raised Floor Assemblies

A raised floor design is also referred to as an open crawlspace (different than vented crawlspace) and is predominant in pre-1950 single family home construction and flood zone construction. These homes are built on piles and piers, usually in flood prone areas, and provide open space between the ground and the structure. In this design, insulation and air barrier are installed in contact with the underside of the first floor, just like vented crawlspace assemblies. As the foam is "exterior" to the building envelope and a high-risk potential for exposure to UV light and bulk water (flood zones), UPC recommends the use of a protective coating such as exterior latex paint.



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## Benefits of Using SPF in Foundations

SPF is an excellent sealant and is the most effective common insulation available.

Foundations and crawlspaces are often wet with higher than expected relative humidity. UPC Closed cell foams have the ability to resist bulk water pick-up and moisture vapor transfer, while eliminating the potential for condensation when designed and installed correctly – according to local building code.

Wood structural components and framing members need to stay dry. Joe Lstiburek of Building Science Corporation often says "dry wood is happy wood" and installing ccSPF will help keep it happy.

Air movement and infiltration is addressed by ccSPF's air barrier features. The penetrations which connect our living space with the outdoors through the crawlspace is easily sealed in a single application.

Radon gas, the second leading cause of lung cancer in North America, is effectively stopped from entering our homes through foundation cracks when a 2" thick layer of ccSPF is installed directly onto our prepared gravel surface under the concrete slab. Concrete can then be poured directly onto the foam ensuring all penetrations are sealed. The poured floor is now more resistant to cracks as its insulated and won't see harsh changes in temperature. Spray foam is seamless and eliminates cold spots in concrete floors caused by shifting boards or gaps in the insulation.

When used on the outside of high-mass foundation walls (concrete, block, rubble) we leverage the principle of thermal mass. Similar to the central, big stone fireplaces in European homes and castles, when we insulate high-mass walls on the outside, we can heat them once and they stay warm, radiating heat into the living space. Since they are no longer exposed to extremes in temperature, they (the high-mass walls) don't crack and we get more useable space on the inside.



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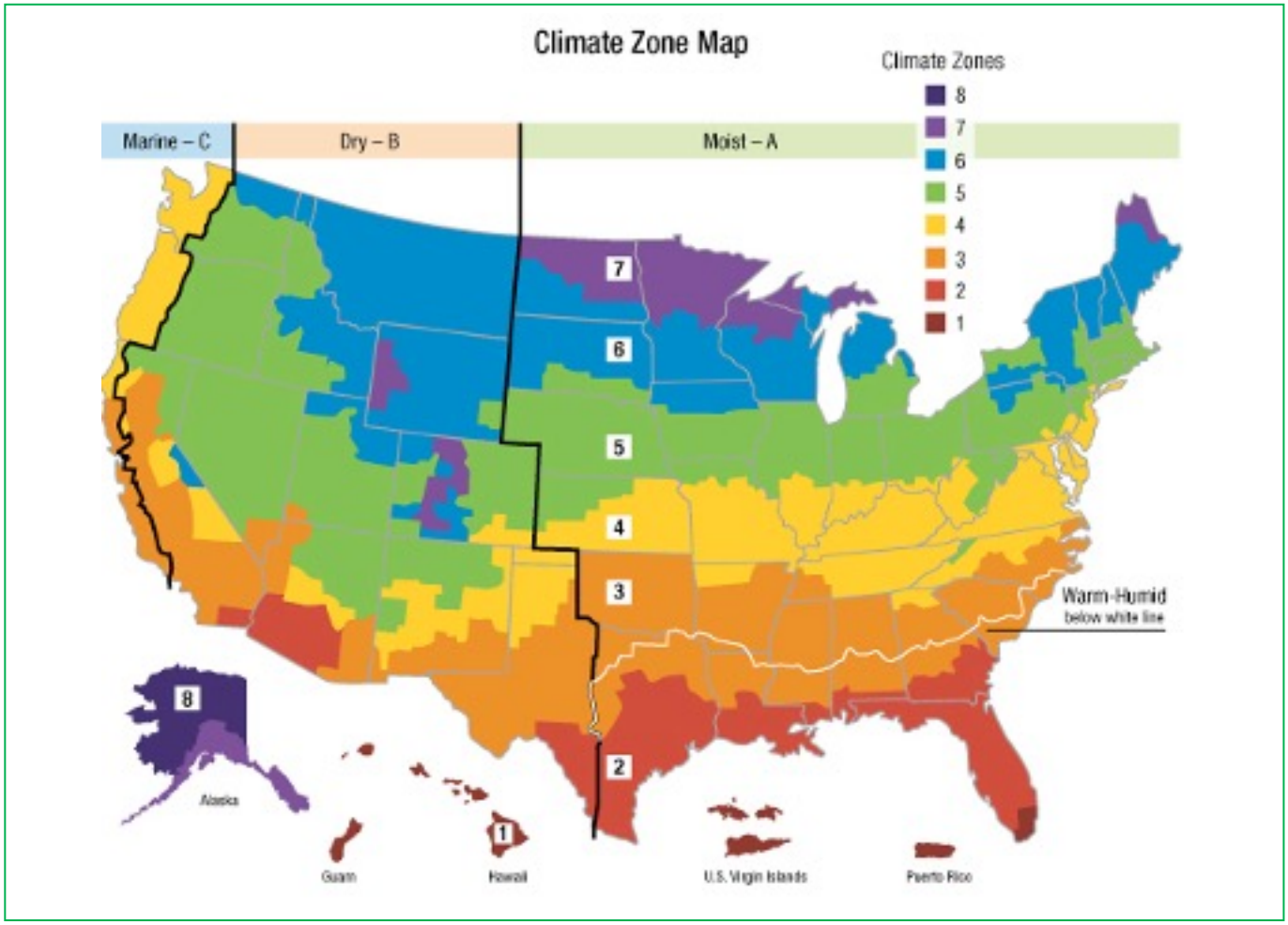
## Code References & Requirements by Zone, Fire protection Requirements, Vapor Retarder Requirements

Local Building (IBC) and Energy Codes (IECC) will provide the minimum requirements for insulation thickness, expressed as R or U value, the level of fire protection (thermal protection) required for the application, and the need for additional vapor retarders based on the geographic location of the building and the type of SPF used. Closed Cell SPF (ccSPF) is considered a type II vapor retarder – semi permeable, while Open Cell SPF (ocSPF) is *always* vapor permeable.

Foundations and crawlspaces are generally wet and/or high humidity environments. UPC recommends careful consideration of the moisture exposure potential when deciding which type of SPF to install.

The chart below shows the American Society of Heating, Refrigerating and Air- Conditioning Engineers (ASHRAE) Climate Zones in the U.S. These zones are used to determine the level of insulation required to eliminate the potential to form condensation within the assembly under "normal" conditions. The Building Code (IECC and IBC) use this chart to establish the minimum insulation requirements for various assemblies including attics and ceilings. Local Building and Fire Officials (AHJ – Authority Having Jurisdiction) should always be consulted to confirm the requirements before installing any insulation.



Chapter 4 of the International Energy Conservation Code (IECC) entitled "Residential Energy Efficiency" specifically identifies the level (R-value) and type (cavity or continuous) of insulation required to meet the minimum requirements of the Building Code. The chart below is taken from the 2018 IECC. Always understand and confirm the specific requirements of the Building Code and Energy Code in effect in the project area. The version (year) of various codes varies dramatically from state to state. Local Building and Fire Officials (AHJ – Authority Having Jurisdiction) should always be consulted to confirm the requirements before installing any insulation.

## TABLE R402.1.2 INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT

| CLIMATE ZONE | FENESTRATION U-FACTOR[b] | SKYLIGHT[b] U-FACTOR | GLAZED FENESTRATION SHGC[b,e] | CEILING R-VALUE | WOOD FRAME WALL R-FACTOR | MASS WALL R-VALUE[i] | FLOOR R-VALUE | BASEMENT[c] WALL R-VALUE | SLAB[d] R-VALUE & DEPTH | CRAWL SPACE[c] WALL R-VALUE |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | NR | 0.75 | 0.25 | 30 | 13 | 3/4 | 13 | 0 | 0 | 0 |
| 2 | 0.40 | 0.65 | 0.25 | 38 | 13 | 4/6 | 13 | 0 | 0 | 0 |
| 3 | 0.32 | 0.55 | 0.25 | 38 | 20 or 13+5[h] | 8/13 | 19 | 5/13[f] | 0 | 5/13 |
| 4 Except Marine | 0.32 | 0.55 | 0.40 | 49 | 20 or 13+5[h] | 8/13 | 19 | 10/13 | 10, 2 ft | 10/13 |
| 5 and Marine 4 | 0.30 | 0.55 | NR | 49 | 20 or 13+5[h] | 13/17 | 30[g] | 15/19 | 10, 2 ft | 15/19 |
| 6 | 0.30 | 0.55 | NR | 49 | 20+5[h] or 13+10[h] | 15/20 | 30[g] | 15/19 | 10, 4 ft | 15/19 |
| 7 and 8 | 0.30 | 0.55 | NR | 49 | 20+5[h] or 13+10[h] | 19/21 | 30[g] | 15/19 | 10, 4 ft | 15/19 |

NR= Not Required • For SI:1 ft=304.8 mm

a. R-Values are minimums. U-Factors and SHGC are maximums. Where insulation in a cavity that is less than the label or design thickness of the insulation, the installed R-Value of the insulation shall not be less than the R-Value specified in the table.
b. The fenestration U-Factor column excludes highlights. The SHGC column applies to all glazed fenestration.
Exception: In climate zones 1 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements proved the SHGC for such skylights does not exceed 0.30.
c. "10/13" means R-10 continuous insulation on the interior or exterior of the home or R-13 cavity insulation of the basement wall. "15/19" means R-15 continuous insulation on the interior or exterior of the home or R-19 cavity insulation at the interior of the basement wall. Alternatively, compliance with "15/19" shall be R-13 cavity insulation on the interior of the basement wall plus continuous insulation on the interior or exterior of the home.
d. R-5 insulation shall be provided under the full slab area of the heated slab in addition to the required slab edge insulation R-Value for slabs, as indicated in the table. The slab edge insulation for heated slabs shall not be required to extend below the slab
e. There are no SHGC requirements in the Marine Zone
f. Basement wall insulation is not required in warm-humid locations
g. Alternatively, insulation sufficient to fill the framing cavity and providing not less than and R-Value of R-19.
h. The first value is cavity insulation, the second value is continuous insulation. Therefor, as an example, "13+5" means R-13 cavity insulation plus R-5 continuous insulation.
i. Mass walls shall be in accordance with section R402.2.5. The second R-Value applies where more than half the insulation is on the interior of the mass wall.

**2603.4.1.13 TYPE V CONSTRUCTION**

Foam plastic spray applied to a sill plate, joist header and rim joist in Type V construction is subject to the following:

1. The maximum thickness of the foam plastic shall be 3¼ inches (82.6 mm).
2. The density of the foam plastic shall be in the range of 1.5 to 2.0 pcf (24 to 32 kg/m$^3$).
3. The foam plastic shall have a flame spread index of 25 or less and an accompanying smoke-developed index of 450 or less when tested in accordance with ASTM E84 or UL 723.



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LET'S LOOK AT THE REQUIREMENTS FOR FOUNDATIONS & CRAWLSPACES, SPECIFICALLY.

## UPC PRODUCT THICKNESS REQUIRED (INCHES)
### Crawlspace Walls

| CLIMATE ZONE | R-VALUE | 2.0 R & HL | 1.7 R | 2.0 HL HFO | 500 R | 500 MAX/PRO | 500 OCX |
|---|---|---|---|---|---|---|---|
| 1 | 0 | | | | | | |
| 2 | 0 | | | | | | |
| 3 | 5/13 | 1/2 | 1/2 | 1/2 | 1.5/3 | 1.5/3 | 1.5/3 |
| 4 Except Marine | 10/13 | 1.5/2 | 1.5/2 | 1.5/2 | 2.5/3 | 2.5/3 | 2.5/3 |
| 5 & Marine 4 | 15/19 | 2.5/3 | 2.5/3 | 2.5/3 | 4/5 | 4/5 | 4/5 |
| 6 | 15/19 | 2.5/3 | 2.5/3 | 2.5/3 | 4/5 | 4/5 | 4/5 |
| 7 & 8 | 15/19 | 2.5/3 | 2.5/3 | 2.5/3 | 4/5 | 4/5 | 4/5 |

## UPC PRODUCT THICKNESS REQUIRED (INCHES)
### Under Slab

| CLIMATE ZONE | R-VALUE | 2.0 R & HL | 1.7 R | 2.0 HL HFO | 500 R | 500 MAX/PRO | 500 OCX |
|---|---|---|---|---|---|---|---|
| 1 | 0 | | | | | | |
| 2 | 0 | | | | | | |
| 3 | 0 | | | | | | |
| 4 Except Marine | 10/2 ft. | 1.5 | 1.5 | 1.5 | NA | NA | NA |
| 5 & Marine 4 | 10/2 ft. | 1.5 | 1.5 | 1.5 | NA | NA | NA |
| 6 | 10/2 ft. | 1.5 | 1.5 | 1.5 | NA | NA | NA |
| 7 & 8 | 10/2 ft. | 1.5 | 1.5 | 1.5 | NA | NA | NA |



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## UPC PRODUCT THICKNESS REQUIRED (INCHES)
### Basement Walls

| CLIMATE ZONE | R-VALUE | 2.0 R & HL | 1.7 R | 2.0 HL HFO | 500 R | 500 MAX/PRO | 500 OCX |
|---|---|---|---|---|---|---|---|
| 1 | 0 | | | | | | |
| 2 | 0 | | | | | | |
| 3 | 5/13 | 1/2 | 1/2 | 1/2 | 1.5/3 | 1.5/3 | 1.5/3 |
| 4 Except Marine | 10/13 | 1.5/2 | 1.5/2 | 1.5/2 | 2.5/3 | 2.5/3 | 2.5/3 |
| 5 & Marine 4 | 15/19 | 2.5/3 | 2.5/3 | 2.5/3 | 4/5 | 4/5 | 4/5 |
| 6 | 15/19 | 2.5/3 | 2.5/3 | 2.5/3 | 4/5 | 4/5 | 4/5 |
| 7 & 8 | 15/19 | 2.5/3 | 2.5/3 | 2.5/3 | 4/5 | 4/5 | 4/5 |

## UPC PRODUCT THICKNESS REQUIRED (INCHES)
### Floor (under 1st floor, ceiling of crawlspace)

| CLIMATE ZONE | R-VALUE | 2.0 R & HL | 1.7 R | 2.0 HL HFO | 500 R | 500 MAX/PRO | 500 OCX |
|---|---|---|---|---|---|---|---|
| 1 | 13 | 2 | 2 | 2 | 3 | 3 | 3 |
| 2 | 13 | 2 | 2 | 2 | 3 | 3 | 3 |
| 3 | 19 | 3 | 3 | 3 | 5 | 5 | 5 |
| 4 Except Marine | 19 | 3 | 3 | 3 | 5 | 5 | 5 |
| 5 & Marine 4 | 30 | 4.5 | 4.5 | 4.5 | 7.5 | 7.5 | 7.5 |
| 6 | 30 | 4.5 | 4.5 | 4.5 | 7.5 | 7.5 | 7.5 |
| 7 & 8 | 38 | 6 | 6 | 6 | 10 | 10 | 10 |



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## Approvals & Certifications

All UPC products have been independently tested by a Nationally Accredited laboratory to exceed the requirements of the Clean Air Gold standard. Properly mixed and installed by approved contractors and installers in accordance with all prevailing building codes, our installation and processing guidelines as well as industry best practices, the foam produced is inert and will continue to meet the requirements of the Clean Air Gold standard and our product technical data sheet.

All UPC products have been independently tested by a Nationally Accredited third-party laboratory to exceed the requirements of the International Building Code (IBC), International Residential Code (IRC) and the International Energy Conservation Code (IECC) as stated on the product Code Compliance Research Report (CCRR) specific to the product under consideration. Refer to our website for the latest version of the CCRR.

All physical properties of UPC products have been determined by an independent, Nationally Accredited third-party laboratory as provided on our Product Technical Data Sheet.

UPC stands behind its products with a Limited Lifetime Residential Insulation Warranty available to the original homeowner under the terms and conditions stated on the warranty document.

## Thermal Barrier (fire) Protection Requirements

In all cases, the foam must be protected by an approved 15-minute thermal barrier or ignition barrier depending on attic accessibility, end-use and code interpretation. Local Building and Fire Officials (AHJ – Authority Having Jurisdiction) should always be consulted to confirm the requirements before installing any insulation.

The intended use of the attic will determine the level of thermal protection required. UPC provides Code Compliance Research Reports (CCRR) for all SPF products. The CCRR identifies the conditions of use and appropriate thermal protection, describes the maximum allowable thickness for the insulation and thickness of the thermal protection as well as the specific Building Code (IBC, IRC, IECC) reference for attics.

CCRR Section 5.3 Thermal Barrier. This section, and subsections, describe the fire protection requirements for SPF when installed in living spaces in two ways – with or without a prescriptive thermal barrier.

**Section 5.3** - Thermal Barrier. This section, and subsections, describe the fire protection requirements for SPF when installed in living spaces in two ways – with or without a prescriptive thermal barrier.



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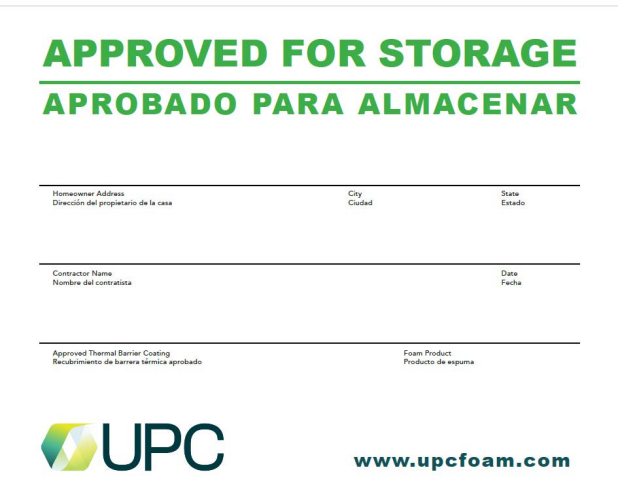
**Section 5.3.1**
Application with a Prescriptive Thermal Barrier describes the allowable thermal barrier materials ($^{1}/_{2}$ - inch-thick gypsum board and $^{25}/_{32}$ - inch-thick wood structural panel) and the maximum thickness of product behind it. This section also identifies the specific IRC/IBC references, Section R316.4 and 2603.4 respectively.

**Section 5.3.2**
Application without a Prescriptive Thermal Barrier describes alternative Thermal Barrier materials which can be applied over the specific UPC SPF insulation while meeting the requirements of the code. These are usually fluid applied (spray) options. UPC has tested and exceeded the requirements of the IRC/IBC regarding alternative Thermal Barriers with the following materials: DC315 and No Burn Plus ThB. The individual insulation product's CCRR identifies the required thickness (WFT – wet film thickness) of each spray applied Thermal Barrier.

**CCRR Section 5.4**
Attics and Crawlspaces. This section, and subsections, describe the fire protection requirements of the IRC/IBC when the insulation is installed in non-living spaces, Attics and Crawlspaces. The term Thermal Barrier is replaced with the term Ignition Barrier, as the intended purpose of the protective coating is to protect the SPF insulation from incidental contact with sparks and minor hot material, not to provide 15-minute thermal protection under fire load.

**Section 5.4.1**
Application with a Prescriptive Ignition Barrier describes the permissible use of the ignition barrier coating provided attic entry is limited to service of utilities.

UPC provides specific signs and placards to be placed by the SPF Installer in obvious locations within the attic to remind the home occupants of attic space limitations. These signs and placards are available on the UPC website.

## 2018 IECC Code References for Joist & Rim Joists

**2603.4.1.13 TYPE V CONSTRUCTION**

Foam plastic spray applied to a sill plate, joist header and rim joist in Type V construction is subject to the following:

1. The maximum thickness of the foam plastic shall be 3 ¼ inches (82.6 mm).
2. The density of the foam plastic shall be in the range of 1.5 to 2.0 pcf (24 to 32 kg/m$^3$).
3. The foam plastic shall have a flame spread index of 25 or less and an accompanying smoke-developed index of 450 or less when tested in accordance with ASTM E84 or UL 723.

## 2018 IECC Code References for Joist & Rim Joists

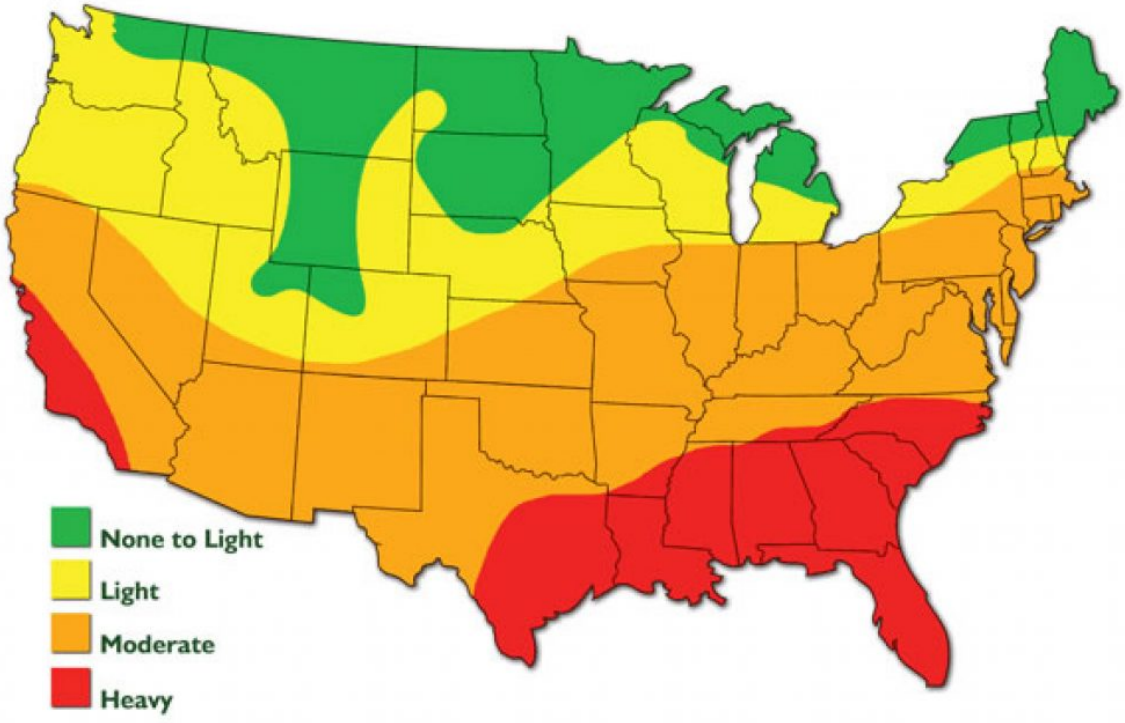
**2603.8 PROTECTION AGAINST TERMITES**

In areas where the probability of termite infestation is very heavy in accordance with figure 2603.8, extruded and expanded polystyrene, polyisocyanurate and other foam plastics shall not be installed on the exterior face or under interior or exterior foundation walls or slab foundations located below grade. The clearance between foam plastics installed above grade and exposed earth shall be not less than 6 inches (152 mm).

**Exceptions:**

1. where the structural members of walls, floors, ceilings and roofs are entirely of noncombustible materials or preservatice-treated wood
2. An approved method of protecting the foam plastic and structure from subterranean termite damage is provided.
3. On the interior of basement walls.

**TERMITE ZONE MAP**



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## JOB SET-UP BEST PRACTICES

Upon arrival at the jobsite, the application team must ensure the jobsite is suitable, secure, and safe to conduct spray operations. Considerations listed below are not exhaustive and members of the installation team must maintain a safe work environment during and after spray operations.

- Park vehicles on level, non-permeable ground (concrete, asphalt) and provide spill containment absorbent "Pigs" around the perimeter of the vehicle.
- If located on level, permeable ground (gravel, earth, sand), place a non-permeable ground sheet on the ground first and locate the vehicle on the ground sheet. Provide spill containment pigs around the perimeter of the ground sheet.
- Provide sufficient spill containment material to contain a spill 2X the liquid volume transported to the jobsite.
- Locate the vehicle on stable, firm ground or hard surface. Do not position the vehicle on wet, soft earth.
- Locate the vehicle in a manner which will not block other traffic or access to or from the workplace.
- Position the vehicle within a reasonable distance from the access point to the jobsite to minimize the length of dispense hose exposed to the elements.
- Protect property from damage caused by the dispense hose – flower beds, decorations, carpeting, furniture etc.
- Position wheel chocks on all wheels to prevent vehicle movement.
- Designate a single, highly visible, accessible location as a "Communication Post" to provide easy access to all product technical information, SDS sheets, permits and general information concerning materials being used by the SPF installation team. Include the location (address) and contact information of the nearest hospital, and emergency response teams.
- Erect hazard, warning signs and physical barricades at all worksite entry points to eliminate or manage access to the SPF application work area.
- Position ABC fire extinguishers inside the work truck, outside the work truck and in the designated spray foam work area.
- Position emergency eyewash stations inside the work truck and in the designated spray foam work area.
- Locate and store all PPE equipment and material in a single location in accordance with the manufacturer's instructions.
- Confirm all surfaces within the isolated work area NOT intended to receive SPF insulation are fully protected from direct contact with SPF chemical or overspray.
- Determine the need for and provide any necessary fall protection equipment in accordance with OSHA Title 29 (CFR) Subpart M – Fall Protection and all appropriate subsections.
- Ensure potable water is available to the jobsite.
- Ensure suitable latrine facilities are available to the jobsite.
- If equipment is left on the jobsite overnight, provide suitable locked storage facilities.
- Confirm and/or establish appropriate jobsite security to prevent unrelated entry during or after normal working hours.
- Collect and remove all waste from jobsite at the end of each day.
- Provide "job card", typically adhered to convenient framing member in attic or attached to attic hatch identifying material manufacturer, Installer/Contractor, contact information, Total R-value of installation and date of installation.



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## Chemical Storage Requirements


- Confirm all SPF chemical arriving at jobsite is provided in suitable containers provided by UPC, all labels are legible and not hidden and there are no leaking containers.
- Confirm chemical temperature is Confirm all SPF chemical arriving at jobsite is provided in suitable containers provided by UPC, all labels are legible and not hidden and there are no leaking containers.
- Confirm chemical temperature is within UPC recommended storage temperature and the chemical temperature is consistent within the drum. Drums must be stored between 50ºF and 75ºF.
- Material should be stored off the floor to eliminate cold chemical on the bottom of drums – specifically in cold climates. Storing material on pallets or skids also allows air to circulate under the drum to help warm or cool the drum.
- Materials not immediately needed must be securely stored in accordance with UPC storage and handling recommendations.
- Do not store material in direct sunlight.

## Isolation and Ventilation Best Practices

For retrofit applications, ensure the attic is isolated from the living space to prevent overspray and airborne SPF particles from entering the occupied space. Confirm the HVAC system is turned "OFF". All home occupants and animals must be out of the home while spraying is conducted. Occupants must remain out of the home for a full 24 hrs. following the completion of SPF installation. The isolated work area is to remain under full ventilation for 24 hrs. following SPF installation.

- Erect continuous, non-permeable material to establish, Isolate and identify SPF work area.
- Locate isolated work area air intake fan in accordance with Industry best practice as provided by the Spray Polyurethane Foam Alliance and American Chemistry Council – Center for the Polyurethane Industry.
- Locate isolated work area exhaust fan in a manner to draw air across the face of the work area in accordance with Industry best practice as provided by the Spray Polyurethane Foam Alliance and American Chemistry Council (Center for the Polyurethane Industry.)
- Provide ventilation intake air at a minimum rate of 10 ACH within the isolated SPF work area.
- Provide ventilation exhaust air at a minimum rate of 11 ACH (10% greater than intake rate) to create a slight negative pressure within the isolated SPF work area.
- Continue ventilating the isolated work area for a period of 24 hrs. following the installation of any/all UPC polyurethane foam products when products are installed in a residential structure.

## PPE Requirements

Before working with any UPC product, you must read and understand the available information (e.g., Safety Data Sheets, Technical Data Sheets, and Industry best practices) on its risks, proper use and safe handling. All applicators and their support teams must use appropriate respiratory, skin and eye Personal Protective Equipment (PPE) in addition to construction task related protective safety gear when handling and processing spray foam systems. Refer to the Center for the Polyurethane Industries (CPI): "Health and Safety Product Stewardship Workbook for High



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Pressure Application of Spray Polyurethane Foam (SPF)", "Guidance for Working with MDI: Things You Should Know", NIOSH Poster: Got Everything Covered?", "High Pressure SPF Insulation in New Home Construction and Retrofit Application: Worker and Homeowner Health and Safety Information", which can be found on the ACC/CPI website at www.americanchemistry.com
The Spray Foam Industry trade association Spray Polyurethane Foam Alliance (SPFA) also provides Health and Safety related resources as well as SPF Professional Certification Training Programs. UPC is a contributing member to the SPFA and active participant in the development of industry standards and guides. The SPFA website is located at www.sprayfoam.org

## Safety Considerations for Foundations and Crawlspaces

The foundation or crawlspace is a unique application area for SPF. A safety inspection of the entire foundation or crawlspace must be conducted before spray foam applications begin to determine and address any safety issues present in the work area. UPC provides several technical tips related to the application of SPF on its website.

In new construction, the foundation exterior walls are often an open excavation. Before entering the open area between the foundation wall and the excavated ground, confirm with the site superintendent or project manager a protective "trench box" is not required. Never work in an excavated area alone. Maintain constant visual contact with a designated safety monitor while working in a trench below grade. Crawlspaces are often tight, and not well ventilated. Access is often limited to a single small door. UPC recommends wearing a bump cap (head protection) and using supplied air while in the crawlspace. Always maintain constant visual contact with a designated safety monitor while working in a crawlspace.


In retrofit or new construction, the intended use of the space will dictate the level of fire protection required for the installed product. In addition, many crawlspaces and basements contain combustion appliances such as HVAC units and water heaters.
In basement applications (not crawlspaces), all SPF must be protected with an approved 15-minute thermal barrier. The basement is considered occupied space by code. Do not leave installed SPF unprotected from fire.

## Special Considerations for Foundations and Crawlspaces

UPC provides the following list of items to consider when insulating foundations. The list is not exhaustive but is provided as a reminder.

- Crawlspaces are generally not conditioned spaces and can be hot environments to work in. Be aware of the temperature and environmental conditions – stay hydrated.
- Excavations and open areas below ground level may require a protective trench box be used at all times. Never work in an excavated area alone.
- Crawlspaces often include overhead work which strains the neck, shoulders and arms. Be aware of light-headedness and rest often.
- Crawlspaces often present angles, corners and areas which are difficult to insulate. Do not "over-pack" or "fill" hard to reach areas as this may exceed the maximum recommended pass thickness for the specific system and result in hazardous thermal decomposition of the insulation.



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- Ductwork not intended to be insulated and mechanicals must be properly protected from overspray.
- PVC/cPVC and electrical wires are often encountered in crawlspaces. Follow the UPC recommendations when installing SPF around or onto these plastic substrates.
- Protect all surfaces not intended to be insulated from overspray.
- Protect all surfaces from contact with dispense hose when crawlspace access is restricted to an internal crawlspace hatch or stairway (retrofit application).
- Wear a hard hat or bump cap to protect your hear from accidental contact with truss and low hanging framing members.

## Substrate Preparation

Framing members, flooring and sheathing materials are common substrates for crawlspace insulation applications. Generally, wood, or wood-based products are the most common framing and sheathing materials and plywood the most common flooring material.

In all cases, the substrate must be free of oil, grease, process films and release agents, waxes, rust scale, frost, mold, loose dirt or dust and the moisture content of substrates must be below 19% before applying any UPC SPF product. Substrate temperature should always be a minimum of $5^0$F above the ambient air dew point. UPC recommends the use of a test area to evaluate the adhesion of SPF to the substrate.

Poured concrete and concrete block are common foundation wall construction materials. New concrete must be allowed to cure for a minimum of 28 days before considered dry. UPC recommends conducting moisture content checks on all substrates before applying any UPC product. A damp proofing or water proofing material is not required on the foundation wall or as a protective coating over the installed closed cell SPF provided the local water table is below the level of the finished foundation. A primer is helpful in promoting the adhesion of the ccSPF to the foundation wall.

When applying ccSPF directly onto prepared gravel to provide a layer of insulation below the slab, the first pass of foam is used to level the surface to receive the second insulating layer of SPF. The required thickness of SPF must be installed above the surface of the first pass.

The suitability of the substrate for the application of UPC SPF is at the discretion of the applicator.

Metal substrates may require a primer coating be applied before the application of SPF. Galvanized metals are particularly troublesome and must always be primed before the application of SPF.

PVC and cPVC piping may be present in a below slab application. The perforated pipe is used to provide a collection grid for radon gas and should be completely covered with gravel. Report any exposed piping to the site or project manager. UPC provides specific documentation for the application of SPF to plastic piping. Please read and understand the requirements for the application of SPF to PVC and cPVC piping.

Always protect surfaces not intended to be insulated from overspray before beginning the application of SPF or Primers.

In foundations and crawlspace applications, there are many substrates which may be encountered. The use of primers in specific conditions may be warranted. If adhesion of SPF to typical foundation substrates is in question, prepare a test area and conduct an adhesion test using ABAA T0002-2019 Pull Adhesion Test Method. The adhesion of the closed cell SPF to the substrate must be greater than 15 lb./in$^2$.



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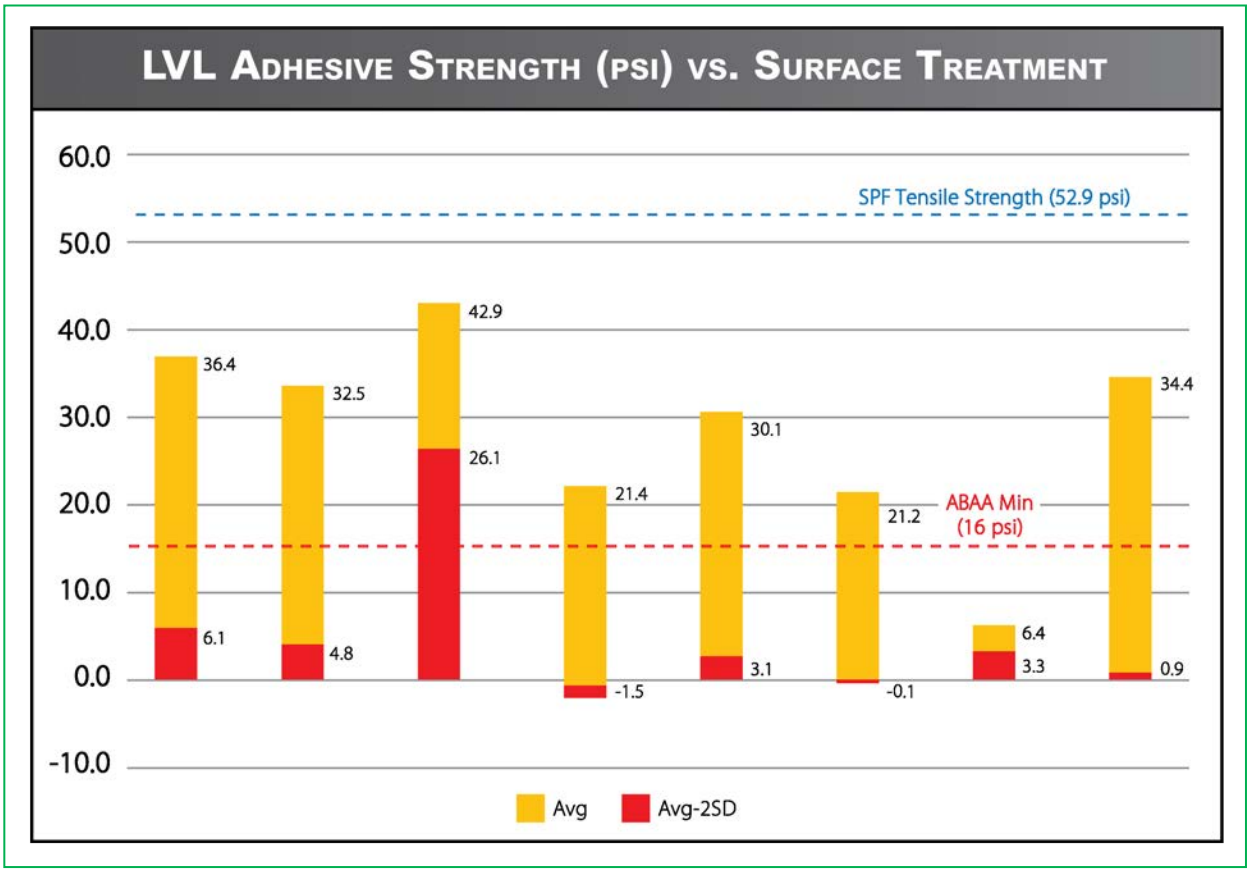
To increase the adhesion of all SPF products to the substrate a suitable primer may be used. Application area ventilation and proper PPE must be used when applying primers to avoid inhalation. UPC recommends the use of water-based primer materials – avoid combustible primer application in basements. Follow manufacturers application guidelines when applying any primer. Avoid excessive application thickness.

UPC supports the development of industry standard documents and industry best practices found on the SPF trade association website at sprayfoam.org.

When applying closed cell foam to engineered wood products, there may be a waxy surface on the substrate. These materials include but are not limited to; Laminated veneer lumber (LVL) beams, oriented strand board (OSB) sheathing and wood I-Joists.

On behalf of the SPF industry, the SPFA conducted extensive testing evaluating several options thought to improve adhesion of SPF to LVL beams. The results are provided below. Your results may vary. The use of primers or other means of apparent adhesion promoters and the final condition and suitability of the substrate is at the discretion of the installer/applicator.



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| ID | NAME | SUBSTRATE CONDITION |
|---|---|---|
| A | Control #1 | Smooth (waxy) LVL Surface |
| B | Control #2 | Rough OSB Surface |
| C | Primer #1 | Modified Acrylic Adhesion Primer (off-the-shelf e.g., Kilz® Adhesion) |
| D | Mech #1 | 80 Grit Sandpaper on Belt Sander |
| E | Mech #2 | Curry Comb Scuff |
| F | Fabric #1 | BIBS Fabric (non-woven PE), T-50 x ½" Staples on 2" Grid |
| G | Fabric #2 | Weather Resistant Barrier (Tyvek), T-50 x ½" Staples on 2" Grid |
| H | Flash Coat | Apply ½" SPF Sacrificial Pass and Remove; Apply Final Pass of SPF |

## Environmental Limitations

Each UPC SPF chemical system has been specifically formulated for application within an ambient temperature range, humidity range and substrate temperature range. Please refer to the product Technical Data Sheet for information regarding Processing Instructions for the specific foam system.

The following chart is provided for your guidance.

| REACTION SPEED | AMBIENT TEMPERATURE | SUBSTRATE TEMPERATURE |
|---|---|---|
| Regular | | |
| Summer | | |
| Winter | | |

In all cases, when substrate temperatures are below 45$^{O}$F, pre-heat the work area to a temperature above 45$^{O}$F.

Do not heat enclosures with propane fueled heaters. This type of fuel adds substantial moisture to the air and may result in condensation forming on the substrate.

Protect installed foam from UV (sunlight) exposure with a suitable, approved, coating.

Not intended for use where direct contact for extended periods of time with liquid water is expected.



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## Limitation of Use Summary

UPC produces polyurethane foam resin formulations in several ISO 9001:2015 certified facilities. With any polyurethane foam material there are limitations of use for both the chemical (resin and Isocyanate) and finished foam insulation. The following list does not include all limitations. Please read and understand all UPC technical and safety information provided on the UPC website and packaging labels. In addition, please read and understand the information provided by Industry Trade Association websites.

- Do not allow foam insulation to enter or be installed in electrical boxes, electrical junction boxes or connection boxes
- Do not exceed the "continuous service temperature" of the specific foam formulation you are installing
- Maintain minimum clearance of 3 inches between recessed lighting and other heat sources (chimney, flue, steam pipe, etc.)
- Maintain correct chemical storage conditions as stated on the chemical container and current Technical Data Sheet for the foam system
- Do not process chemical system outside recommended ambient conditions specific to the chemical system being installed
- Do not install SPF in an area which may experience extended periods of liquid water contact
- Do not exceed "single pass thickness" requirements for the specific chemical system as stated on the current Technical Data Sheet
- Protect the installed foam insulation from sunlight
- SPF must always be protected from fire with an approved, 15-minute minimum thermal barrier unless specifically allowed by local building code and AHJ
- Do not install UPC SPF materials over flexible ductwork
- Do not install UPC SPF materials in passes less than 1 inch thick
- UPC open cell SPF insulation is not a vapor retarder and must be protected with a minimum type II vapor retarder when used in attic applications in climate zone 4a marine and above
- UPC closed cell SPF insulation is not intended for use as a caulk or sealant around window units. Excessive pressure may restrict window operation or result in damage to the window glazing
- Do not use without proper PPE
- Do not use without properly isolated and ventilated workspace

## Start Up and Shut Down Procedure

Equipment manufacturers provide detailed instructions regarding the use and maintenance of the equipment. UPC recommends attending the appropriate training course for the specific equipment intended for use.



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## Yield Calculation

The yield of SPF insulation may be defined as "the area covered by a known quantity of chemical material at a defined thickness". In mathematical terms it is Area divided by Consumption at a defined thickness.

**Yield = Area / Consumption**

**Consumption:** The amount of chemical used must be accurately determined. The preferred method is by "cycles" as the pump volume is fixed, known and consistent. Each proportioner is equipped with fixed volume pumps and the volume is prescribed in the owner's manual. The table below with common equipment types is provided for your convenience.

| | E-20 | E-30 | H-30 | H-40 |
|---|---|---|---|---|
| **Output Per Cycle** | 0.0104 gal. | 0.0272 gal. | 0.074 gal. | 0.063 gal. |

A "set" of chemical (A and B drums) is often used as the "unit" of consumption. This will lead to inaccurate yield calculations as a "set" volume varies from formulation to formulation and manufacturer to manufacturer. Each drum fill weight also varies from formulation to formulation and manufacturer to manufacturer. Measuring the height of the chemical in the drum is also not accurate as the height of the chemical will vary with temperature and the diameter of the drum is not consistent. Measuring the change in liquid height with a measuring tape and then converting the linear measurement to lbs. is complicated and doesn't consider the materials specific gravity (ratio of the density of the liquid compared to the density of water).

Each cycle of the pump is registered on the cycle counter. When determining yield, set the cycle counter to zero and begin spraying. Once the known area is insulated, record the number of cycles indicated on the cycle counter.

**Area:** The length and height of the test area must be accurately measured. Do not include framing members, windows, doors or penetrations in the calculation. Measure ONLY the area to be insulated. To eliminate variables, use an area without studs, or framing and few/no penetrations as your test area.

**Thickness:** The average thickness of the insulation in the test area must be accurately determined. Take several measurements to determine average thickness over the entire installed area of insulation. Measure and record the thickness to the nearest 1/8$^{th}$ inch. Here is an example:

Convert the number of cycles to lbs. of chemical system.

We know the number of strokes and the volume of the cylinder. Multiply these two numbers together to get the volume of chemical consumed for our known area.

- (# of strokes) x (Volume of Cylinder) = Total Volume of Chemical Consumed



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For Example, if our equipment is a Graco Reactor E-30 with standard pumps:

Here is the information we noted from our test.

- Graco Reactor 2 E-30
- 854 Cycles
- UPC 2.0 HL HFO chemical system
  - Average Specific Gravity = 1.23
    *1.23 is the average specific gravity between the A-side and B-side specific gravity provided on the system Technical Data Sheet
- Area = (60 ft. long X 12 ft. high) X 1.5 inches thick = 1,080 board ft.

1) Calculate the lbs. of chemical consumed:
   - 854 cycles X 0.0272 gal/cycle = 23.23 gallons of system (A & B combined)
     *0.0272 gal/cycle is provided by the Graco Reactor 2 E-30 manual
2) Convert the gallons of system to lbs. of system
   (Use the specific gravity number to do this)
   - 23.23 X ((8.34 lbs. ÷ gal) X 1.23) = 238.3 lb.'s of chemical system
     *8.34 is the number of lb.'s / gal of water
3) Divide the Total Area (board feet) by Total Chemical Consumption (lbs.)
   - 1,080 Brd ft. ÷ 238.3 lb.'s = 4.53 Brd. ft/lb.
     Use the "net weight" of the material in the A + B drum to give you "set weight" (see drum label)
4) Multiply the set weight by the yield/lb. value

   Total Net Weight of set X 4.53 = Yield per set

   In this example, the set of 2.0 HFO is yielding: 1,000lbs x 4.53 = 4,530 Brd Ft.

**IMPORTANT NOTICE:** Before beginning any operation, which may expose you to any chemical, wear appropriate PPE, including but not limited to face shield, splash googles, gloves, skin protection, Tyvek suite, cartridge respirator. Conduct operation near eye wash and emergency body shower location. Read and understand all material SDS. Material may be under pressure, use caution.



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## Factors Effecting Yield

There are many factors which impact yield. Here is a short list or the major factors and their influence, positive or negative, on the yield of SPF chemicals.

**Density:** In general, the lower the density, the higher the yield. Remember the skins (top surface of a pass and the foam contact surface) are higher density material and will negatively impact yield.

**Environmental Temperature:** The lower the temperature, the lower the yield. This is due to heat energy needed for the reaction of SPF being drawn away from the foam chemical and into the surrounding environment.

**Substrate Temperature:** Most applications in foundations or crawlspaces are onto heat sinks such as concrete, concrete block or gravel. These substrates draw heat energy out of the reacting foam and may result in a layer of unacceptable foam. Confirm the reaction is complete and adhesion is acceptable before installing the majority of product. Exterior sheathing is exposed to the environmental elements and may be at a different temperature than the interior space of the Crawlspace. If the substrate temperature is below the recommended lower limit specified by UPC for the specific chemical system, the chemical reaction will be slowed, and the yield of the system negatively impacted. It may be necessary to heat the crawlspace area before installing any SPF product.

**Processing Temperatures:** UPC provides recommended processing temperatures for each SPF system. Processing UPC material outside those recommendations may negatively impact system yield.

**Number of Passes:** Minimize the number of passes. Maximum allowable pass thickness is identified on the system Technical Data Sheet.

**Application Technique:** It's recommended to spray into the rising foam front, to overlap the previous pass by approx. 70% while the foam is still rising. In open stud bays or floor truss assemblies, if long passes are used, at least 50% the liquid foam is applied to foam which has past the tack free stage. This results in a pass-line and thin pass thickness which adds overall density and negatively affects yield.

**APPLICATION TECHNIQUE (Industry Best Practice, High Lift vs. Regular):**

Whenever possible, the application of SPF chemical should be "into the rising foam" in order to eliminate the potential for pass-lines within the foam and maximize yield. In crawlspace applications, much of the foam insulation is installed overhead. Attention to general overhead safety is highly recommended.

When spraying UPC foam insulation into open floor truss assemblies, it is recommended to install the maximum recommended pass thickness stated on the material Technical Data Sheet onto the entire reachable surface area before adding the next pass. This technique provides time to allow the first pass to cool before applying subsequent passes and minimizes the number of times the applicator needs to move.

When spraying UPC high lift formulations, it is recommended to adjust the application technique from 70% overlap to 50% overlap in order to move the liquid in front of the rising foam rather than applying high volumes of liquid onto the rising foam in order to avoid disrupting cell formation. As always, install the required thickness or maximum allowable thickness as stated on the material Technical Data Sheet in a single pass.



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- Refrain from flash-coating the top surface to even out the surface profile.
- Refrain from filling in the top surface edges of stud and truss bays.
- Always confirm applied foam thickness with a depth gage.
- Flash the small hole left by the depth gage.

## Thickness of Pass Limitations

The chemical reactions to produce the final foam insulation produces heat. As SPF is such a good insulation, this heat dissipates slowly. The internal foam temperature of each recommended pass thickness has been measured and the maximum allowable recommended pass thickness determined. UPC provides the maximum allowable pass thickness for each foam system on the appropriate Technical Data Sheet.

The table below summarizes the current SPF systems recommended maximum pass thickness.

| | 2.0 HL HFO | 2.0 Regular | 2.0 HL HFC | 1.7 Regular | 500 Classic | 500 Max | 500 Max Pro | 500 OCX |
|---|---|---|---|---|---|---|---|---|
| **Maximun Pass Thickness** | 5.0 in. | 2.0 in. | 4.5 in. | 2.0 in. | 6-8 in. | 6.0 in. | 10 in. | 6.0 in. |

Once the installed foam has become hard to the touch (surface cure) a second pass may be applied.

Care must be taken with the application of "High-Lift" formulations to control the foam thickness and assure the finished thickness is at or below the maximum recommended pass thickness. UPC recommends the use of multiple 3-inch passes be installed onto each other until the final foam thickness is achieved. This technique will improve cell structure, reduce the potential for shrinkage and substrate delamination, improve thickness control, and improve system yield while providing the productivity advantages associated with High-Lift formulations.

## Quality Assurance Testing Procedures

UPC delivers a fully tested and approved chemical blend from its ISO 9000 series production facilities. We provide installer training and fully support the development of industry best practices. To assure a high-quality installation, UPC provides a "Quality Assurance" form for use by our contractor/installers to gather critical information concerning the installed product. UPC recommends the completion of the Quality Assurance form for each site, each day, and each time a new lot number of chemical material is installed.



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Installed product testing includes the following:

- Installed Foam Thickness
  - Confirm installed thickness with physical probe inserted through SPF to substrate
  - Conduct thickness checks frequently
  - Report installed thickness, maximum pass thickness, and number of passes on daily work report
  - Report Installed R-Value on Installation Report Card to be conveniently located at jobsite

- Density Determination
  - Before beginning to install UPC closed cell SPF each day, each change of material lot number and at new sites, perform a foam density test in accordance with ASTM D 1622 – water displacement method
  - Record density on Daily Work Report

- Adhesion Determination
  - Confirm the adhesion of UPC closed cell SPF to any substrate, each day, change of material lot number and at new sites or when the adhesion of foam to the substrate is questionable

- Void Detection
  - Used predominantly for open cell foam installations, use a coring tool to remove a core sample through the foam to the substrate
  - Inspect the sample for interlaminar voids (pass-to-pass) and loss of adhesion to the substrate
  - Repair sample void with like material

- Cell Structure (Visual)
  - Confirm consistent and regular cell structure throughout the application thickness with visual inspection
  - Use a coring tool to remove a core sample through the foam to the substrate

- Sample Collection
  - UPC recommends installers collect, tag and store core samples in a sealed plastic bag, in a dark, cool location for a minimum of 1 year
  - Samples must be labeled with the installation date, jobsite location, area the sample was taken, manufacturer and material lot number
  - Repair all sample voids with like material

The Quality Assurance form can be found on the UPC website in the Technical Resources Section under Forms. Look for the "UPC Quality Assurance Program".



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## TROUBLESHOOTING

Foundation applications are subject to additional considerations regarding safety, ventilation, and application thickness control. Beyond those, the application of UPC SPF may encounter the following:

- Delamination from the substrate which may be a result of excess contamination on the substrate. In foundation applications contaminants may include, dust, frost, substrate moisture content greater than 19% and loose substrate material. The acceptability of any substrate as suitable for the application of UPC SPF is at the discretion of the applicator.

- Delamination between foam passes is not common and typically a result of applying the foam at too great an angle to the substrate causing the foam to "creep" along the surface of the substrate. Best practice calls for the dispense head to be held at 90 degrees to the substrate while applying foam. The foam then rises perpendicular to the target and not at an angle.

- Interlaminar (between passes) blisters are not common in attic applications and may be a result of slow reacting foam on the edge of a pass where the foam thickness is less than ½ inch thick – specifically in cool/cold ambient conditions. The foam chemical does not have enough mass (amount of chemical) to "drive" the reaction in cold conditions and the reaction is slowed. When more chemical is sprayed over the top, the reaction is suddenly energized, and gas is released. This excess gas results in a blister. Changing the reactivity grade of the chemical system to a faster speed will eliminate the issue. (Regular Grade to Winter Grade)

- Elongated cells in the center of the closed cell foam pass may result in shrinkage (delamination) or cracking in the middle of the pass between framing members. This is an indication of excessive single pass thickness. Reduce the pass thickness.

- Poor cell structure throughout the foam is an indication of resin contamination as a result of improper change-over practice. Chasing one resin with another is not recommended. Attempting to process resin material which is past the stated shelf-life of the material will also result in poor quality foam insulation. Always install UPC SPF material within the recommended shelf-life as stated on the drum label and system Technical Data Sheet.

- Friable surface foam (powder, chalk, crispy) is an indication of an incomplete reaction typically caused by applying the foam system outside the recommended environmental window for the specific system (usually in too cold conditions). Friable surface foam will have reduced adhesion to the substrate resulting in separation from the framing members. Change the resin to a colder temperature grade.

- Excessive dispense head clogging is a result of high temperature processing. Reduce the chemical heaters and hose heater until processing improves. UPC SPF systems are designed to be installed with a minimum of down-time.

- Spurts of "A" or "B" side chemical at the dispense head are a result of pump cavitation and will result in poor quality foam product, areas of off-ratio foam and must be corrected immediately. *Resin pump* cavitation may be caused by



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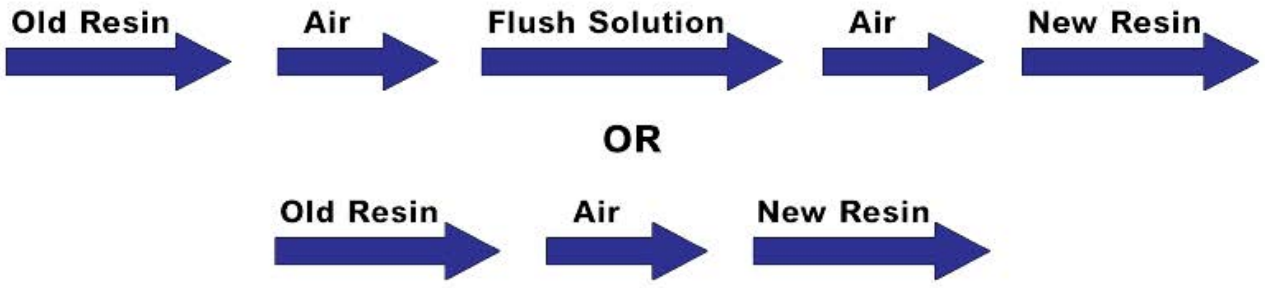
Material, improper chemical temperature which causes the resin to thicken and not flow easily through the transfer pump or supply lines. Confirm the resin drum and chemical temperatures are within the proper temperature range (55ºF-75ºF) stated on the drum label or the specific chemical system Technical Data Sheet. Isocyanate pump cavitation may be caused by dirty chemical filters on the supply side of the isocyanate delivery assembly. Filters must be maintained regularly to assure proper equipment function.

## Material Change Over Procedure

- Isocyanate from one manufacturer may be different than the isocyanate from another manufacturer. The correct isocyanate must be paired with the identified resin from a single manufacturer. Each chemical system has been extensively tested as a matched pair of A-side and B-side. Mixing one supplier's resin with a different supplier's isocyanate is never permitted.
- When handling polyurethane foam chemicals and axillary chemicals (solvents, primers, etc.), always read and understand the material Safety Data Sheet (SDS), wear all required PPE and conduct material change-over operations in a well-ventilated area.
- UPC does not recommend "chasing" one resin after another without using a flushing solution and/or air. Today's equipment is a complex network of small openings and chambers which hold residual chemical. Delivery hoses often have a convoluted core to help the hose bend. These convolutions trap chemical. Open cell resin is simply not compatible with closed cell resin and any amount of closed cell resin will contaminate open cell resin and open cell resin will contaminate closed cell resin. The resulting foam is not suitable for application under any circumstance. Every effort must be made to keep the two resins apart from each other and make sure the dispensing equipment is completely clean before charging the system with the different resin. The following procedure is recommended under the following circumstances.
- Changing from Open Cell to Closed Cell Resin
- Changing from Closed Cell to Open Cell Resin
- Changing from one resin manufacturer to another
- In general terms, this is the concept behind our changeover procedure.




**IMPORTANT NOTICE:** Before beginning any operation, which may expose you to any chemical, wear appropriate PPE, including but not limited to face shield, splash googles, gloves, skin protection, Tyvek suite, cartridge respirator. Conduct operation near eye wash and emergency body shower location. Read and understand all material SDS. Material may be under pressure, use caution.



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## CHANGEOVER WITH AIR ONLY

### *Step 1 Purging B-side Supply Lines*

- Disconnect the air supply to the pump
- Open the Recirculation valve
- Drain transfer pump fluid section by fully depressing the ball valve at the bottom of the pump
- Drain the material wetting cup section of the pump by inverting the pump over a collection bucket
- Once fully drained, close pump air valve and reconnect supply air
- Place pump in clean, open top, empty pail and secure pump
- Open B-side relief valve and slowly open transfer pump air valve
- Slowly cycle transfer pump to draw air into the pump and push resin chemical through return line into old resin drum
- Once air is heard exiting the return line, close B-side relief valve

### *Step 2 Switching Chemical*

The procedure will be different whether you have a recirculating block or not.

**Without Recirculating Block**

- Clean and dry wet section of transfer pump
- Slowly insert transfer pump into new B-side material. Be gentle as agitation may cause closed cell resin to froth
- Secure gun manifold over open large bung of old resin drum and slowly open manifold resin valve
- Drain hose chemical into old B-side drum until air escapes from manifold (15-20 minutes)
- Close manifold B-side valve
- Into properly labeled "waste container" open manifold B-side valve and allow the remaining air in the hose assembly to escape
- When new chemical is draining from hose assembly, continue until liquid is clean and free of entrapped air
- Close B-side manifold valve
- Dispose of "waste" material in accordance with UPC resin material SDS

**With Recirculating Block**

- Clean and dry wet section of transfer pump
- Slowly insert transfer pump into new B-side material. Be gentle as agitation may cause closed cell resin to froth
- Connect gun manifold to recirculating block and open manifold and recirculating block B-side valves
- Drain hose chemical into old B-side drum until air escapes from manifold (15-20 minutes)
- Into properly labeled "waste container" open manifold B-side valve and allow the remaining air in the hose assembly to escape
- When new chemical is draining from hose assembly, continue until liquid is clean and free of entrapped air
- Close B-side manifold valve
- Dispose of "waste" material in accordance with UPC resin material SDS



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## CHANGEOVER WITH AIR + FLUSHING SOLUTION

***Step 1 Purging B-side Supply Lines***

- Disconnect the air supply to the pump
- Open the Recirculation valve
- Drain transfer pump fluid section by fully depressing the ball valve at the bottom of the pump
- Drain the material wetting cup section of the pump by inverting the pump over a collection bucket
- Once fully drained, close pump air valve and reconnect supply air
- Place pump in clean, open top, empty pail and secure pump
- Open B-side relief valve and slowly open transfer pump air valve
- Slowly cycle transfer pump to draw air into the pump and push resin chemical through return line into old resin drum
- Once air is heard exiting the return line, close B-side relief valve

***Step 2 Adding Flushing Solution***

The procedure will be different whether you have a recirculating block or not.

**Without Recirculating Block**

- Clean and dry wet section of transfer pump
- Slowly insert transfer pump into flushing solution
- Secure gun manifold over open large bung of waste resin drum and slowly open manifold resin valve
- Drain hose chemical into waste resin drum until flushing solution escapes from manifold (15-20 minutes)
- Close manifold B-side valve
- Into properly labeled "waste container" open manifold B-side valve and allow the remaining air in the hose assembly to escape
- When flushing solution is draining from hose assembly, continue until liquid is clean and free of entrapped air
- Close B-side manifold valve
- Dispose of "waste" material in accordance with UPC resin material SDS

**With Recirculating Block**

- Clean and dry wet section of transfer pump
- Slowly insert transfer pump into flushing solution.
- Connect gun manifold to recirculating block and open manifold and recirculating block B-side valves
- Drain hose chemical into waste resin drum (15-20 minutes)
- Into properly labeled "waste container" open manifold B-side valve and allow the remaining air in the hose assembly to escape



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- When flushing solution is draining from hose assembly, continue until liquid is clean and free of entrapped air
- Close B-side manifold valve
- Dispose of "waste" material in accordance with UPC resin material SDS

***Step 3 Flush with Air***

- Disconnect the air supply to the pump
- Open the Recirculation valve
- Drain transfer pump fluid section by fully depressing the ball valve at the bottom of the pump
- Drain the material wetting cup section of the pump by inverting the pump over a collection bucket
- Once fully drained, close pump air valve and reconnect supply air
- Place pump in clean, open top, empty pail and secure pump
- Open B-side relief valve and slowly open transfer pump air valve
- Slowly cycle transfer pump to draw air into the pump and push resin chemical through return line into old resin drum
- Once air is heard exiting the return line, close B-side relief valve

***Step 4 Switching Chemical***

The procedure will be different whether you have a recirculating block or not.

**Without Recirculating Block**

- Clean and dry wet section of transfer pump
- Slowly insert transfer pump into new B-side material. Be gentle as agitation may cause closed cell resin to froth
- Secure gun manifold over open large bung of old resin drum and slowly open manifold resin valve
- Drain hose chemical into old B-side drum until air escapes from manifold (15-20 minutes)
- Close manifold B-side valve
- Into properly labeled "waste container" open manifold B-side valve and allow the remaining air in the hose assembly to escape
- When new chemical is draining from hose assembly, continue until liquid is clean and free of entrapped air
- Close B-side manifold valve
- Dispose of "waste" material in accordance with UPC resin material SDS

**With Recirculating Block**

- Clean and dry wet section of transfer pump
- Slowly insert transfer pump into new B-side material. Be gentle as agitation may cause closed cell resin to froth
- Connect gun manifold to recirculating block and open manifold and recirculating block B-side valves
- Drain hose chemical into old B-side drum until air escapes from manifold (15-20 minutes)



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- Into properly labeled "waste container" open manifold B-side valve and allow the remaining air in the hose assembly to escape
- When new chemical is draining from hose assembly, continue until liquid is clean and free of entrapped air
- Close B-side manifold valve
- Dispose of "waste" material in accordance with UPC resin material SDS

## Drum Disposal


- Do not remove empty drums from the worksite for personal use.
- Do not remove tops or bottoms or use a torch (open flame) in contact with either resin or isocyanate drum.
- Remove all material labels.
- Puncture all empty drums to eliminate possible reuse *(never use the drum for a fire barrel).*
- Always wear appropriate PPE when handling SPF chemicals.
- Read and understand material Safety Data Sheet available on UPC website.
- "A"-side drums must be neutralized before disposal. A neutralizer solution consists of 2% liquid detergent, 5-10% sodium carbonate or 3-8% concentrated aqueous ammonia and 80% water. Take care to avoid exposure to high concentrations of ammonia vapor. Neutralizer solution can be stirred rapidly into the waste isocyanate in a well-ventilated area. Keep the drum open – remove all closure bungs. Allow mixture to stand 48 hrs. Separate solid waste from liquid. The collected neutralizer solution may be stored and reused. The solid waste may be considered hazardous waste. Confirm material status with your local landfill authority.
- "B"-side Resin an "A"-side Isocyanate drums can be recycled at a DOT certified recycling center. There are three options for empty drums which contained "A"-side, Isocyanate or MDI:
- Offer the drums to a Department of Transportation (DOT) certified reconditioner for recycling
- Dispose of the drums in a municipal solid waste landfill, unless MDI is considered a hazardous waste in the state
- Dispose of drums through an RCRA-permitted Hazardous Waste Incinerator if MDI is considered a hazardous waste in the state

## Chemical Waste Disposal


- Always wear appropriate PPE when handling SPF chemicals
- Small quantities of resin (B-side) and isocyanate (A-side) can be mixed in an open top container such as a bucket or large plastic bag. The chemicals will react with each other very quickly and produce heat. Keep quantities small to avoid excessive heat build-up. Avoid inhaling any vapors produced. Mix chemicals in a well-ventilated area. Once cool, cut the resulting foam mass in quarters to confirm complete reaction (no liquid material remains) and the material has cooled.
- Once the reaction product has completely cooled, it can be disposed of in a landfill.



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## Spill Containment and Clean-Up

- Wear appropriate PPE during all spill containment and material cleanup operations.
- For small spills, soak up with noncombustible absorbent material (sand, earth, vermiculite) and transfer to a container for disposal according to local/national regulations. Clean contaminated area thoroughly.
- For large spills, contain spill with absorbent pigs or dyke constructed from noncombustible absorbent material.
- Treat spill area with decontaminant solution using 10 parts of decontaminant solution to 1 part spill and allow to react for a minimum of 30 minutes.
- Soak up all material with noncombustible absorbent material. Let stand for 30 minutes.
- Shovel into open-top container and add decontaminant solution, mix, and let stand for 24 hrs.
- Cover and dispose as solid waste at approved waste disposal center.
- Refer to product Safety Data Sheet section 6 for more information.

## Contact and Links

| | |
|---|---|
| **UPC Technical Service**<br>www.upcfoam.com | 203.760.0025 |
| **UPC Customer Service**<br>www.upcfoam.com | 682-503-8069 |
| **Chemtrec Emergency Response**<br>www.chemtrec.com | 800-424-9300 |
| **Spray Polyurethane Foam Alliance (SPFA)**<br>www.sprayfoam.org | 800-523-6154 |
| **Occupational Safety and Health Association (OSHA)**<br>www.osha.gov | 800-321-6742 |
| **Center for the Polyurethane Industry (CPI)**<br>www.americanchemistry.com/industry-groups/center-for-the-polyurethanes-industry-cpi | 800-321-6742 |