

Guidance on Best Practices for the Installation of Spray Polyurethane Foam



Guidance for Residential Homes and Commercial Buildings

Spray Foam Coalition
of the ACC Center for the Polyurethanes Industry



**Spray Foam
Coalition**



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The Center for the Polyurethanes Industry (CPI) of the American Chemistry Council serves as the voice of the polyurethanes industry in North America and works with polyurethane trade associations across the globe. CPI members are companies that produce and sell the raw materials and additives that are used to make polyurethane products, equipment used in the manufacture of polyurethanes, and companies engaged in end-use applications and the manufacture of polyurethane products.

The Spray Foam Coalition (SFC) champions the use of spray polyurethane foam in U.S. building and construction applications and promotes its economic, environmental and societal benefits while supporting the safe manufacture, transport, and application of spray polyurethane foam. SFC consists of manufacturers of spray polyurethane foam systems as well as suppliers of raw materials and machinery used to apply the foam.

Introduction

In recent years, spray polyurethane foam (SPF) insulation has seen significant growth in both general interest and acceptance as a high-performance solution to seal and insulate the entire building envelope. SPF insulation is energy efficient, durable, and helps create a comfortable building environment by helping keep homes warm in the winter and cool in the summer. Because it is sprayed directly into the gaps, cracks, and other surfaces that contribute to heat loss, SPF both insulates and air seals, offering an easy and effective way of weatherizing existing buildings and new construction.

The Spray Polyurethane Foam Installation Guidance is intended to provide an overview of best practices to help professional installers use SPF effectively and efficiently to insulate homes and commercial buildings. It discusses considerations for the use and handling of materials as well as steps that help make the jobsite safe and secure. It also addresses health and safety hazards and offers steps to avoid potential issues. Steps and tips for installing, measuring, and inspecting SPF are included to supplement those offered by the manufacturer. Product-specific steps provided by the manufacturer and code requirements override the steps offered here, so always verify with your specific manufacturer what steps to take on a specific project. Finally, the document offers resources and references to help the installation proceed more smoothly. This document does not substitute for the extensive training provided by manufacturers and industry organizations associated with the manufacture and installation of SPF, nor does it provide detailed information on many of the areas covered in that training. It is designed to outline best practices and to provide helpful information to professional practitioners in the field and homeowners wanting to know what to expect from their spray foam contractor.





SPF insulation is created onsite using liquid components and equipment that could pose a potential hazard, especially to those having no experience or training in polyurethane chemistry and applications. Therefore, it is essential that SPF installers and SPF component suppliers work towards ensuring every SPF installation is done properly and with the utmost consideration for health and safety, both on the jobsite and the surrounding area.

This SPF Installation Guidance focuses on SPF application in residential and commercial buildings within the building envelope. While there are many similarities in requirements and procedures between high and low pressure SPF applications, there are some distinct differences. Where these occur, this guidance attempts to highlight the differences between the two products and their application, but always refer to the SPF manufacturer's instructions and Material Safety Data Sheets (MSDS) for more precise information.

The following pages will provide the reader with useful guidance and best practices related to:

- 1. Training**
- 2. Health and Safety**
- 3. Jobsite Practices**
- 4. SPF Application on the Jobsite**
- 5. Post-Application Inspections**

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What is Spray Foam?

Spray polyurethane foam (SPF) is a spray-applied plastic that can form a continuous insulation and air sealing barrier on walls, roofs, around corners, and on all contoured surfaces. It is made by mixing and reacting unique liquid components at the job site to create foam. The liquids react very quickly when mixed, expanding on contact to create foam that insulates, seals gaps, and can form moisture and vapor barriers. SPF insulation is known to resist heat transfer extremely well, and it offers a highly effective solution in reducing unwanted air infiltration through cracks, seams, and joints.

Types of Spray Polyurethane Foam

There are three primary types of SPF that can be used for insulation and other specific purposes:

High Density: often used for exterior and roofing applications

Medium Density: often used for continuous insulation, interior cavity fill, and unvented attic applications

Low Density: often used for interior cavity fill and unvented attic applications

Medium and High Density SPF are frequently called “closed-cell foam” because they use an internal closed cell structure that improves thermal resistance and other properties. Low Density SPF is frequently called “open-cell foam” because the cell structure includes tiny holes in the cells to provide improved drying capability and flexibility.

Each product offers unique benefits that a professional SPF contractor can explain and help people determine which types of foam will be most appropriate for a specific building, climate, and project. Beyond the structure of the foam itself, the other significant difference relates to how it is created and installed. The main delivery systems include:

- **High-pressure, two-component foam**
- **Low-pressure, two-component foam SPF kits**

High-pressure, two-component foam is often used to insulate large areas on new construction or major renovations of walls and roofing systems. For a typical high-pressure SPF application, a spray rig (truck or trailer) that houses the spray foam ingredients, air supply and other items is parked near the building to be sprayed. Hoses up to about 300 feet in length deliver the liquid ingredients to the application area.

Low-pressure, two-component SPF kits or refillable cylinders are smaller, portable systems that can insulate and air-seal small to mid-sized areas. This type of foam is usually applied around duct work, electrical or piping penetrations, rim joists and roof repairs. Both high-pressure and low-pressure foams are applied by professional spray foam applicators.



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1) Training and Advanced Preparation Best Practices

Prior to working with spray polyurethane foam (SPF) component materials, process equipment, or performing actual SPF installations, employees of an SPF installation company should receive training. Proper initial training and regular “refresher” training of all those involved with SPF operations can help prevent poor installations, accidents, and overexposure to SPF chemicals to workers and bystanders.

Below is a list of some of the training programs that an SPF installation company can use to train employees involved with SPF operations.

Occupational Health & Safety Administration (OSHA)

Outreach Class for Construction: 10-hour version or 30-hour version – this course provides general training for workers and employers on the recognition, avoidance, abatement, and prevention of safety and health hazards in workplaces and is not specific for spray foam installation.

<http://www.osha.gov/dte/outreach/index.html>

SPF Manufacturers' Training

Several SPF component material suppliers offer training for handling and use of SPF component chemicals and the installation of SPF products.

Contact your SPF component material supplier directly for information regarding available training programs.

Center for the Polyurethanes Industry (CPI)

CPI Spray Polyurethane Foam Health and Safety Training

<http://www.spraypolyurethane.org/SPF-Chemical-Health-and-Safety-Training>

CPI Health and Safety Product Stewardship Presentation for High-Pressure Application of SPF

<http://www.spraypolyurethane.org/Presentation>

CPI Health and Safety Product Stewardship Workbook for High-Pressure Application of SPF

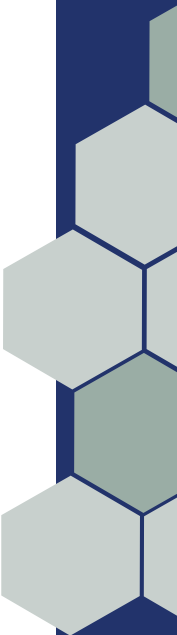
<http://www.spraypolyurethane.org/Workbook>

Spray Polyurethane Foam Alliance (SPFA)

SPF Accreditation Program

http://www.sprayfoam.org/index.php?page_id=372

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2) Health and Safety Best Practices

Introduction to Health and Safety Considerations when Working with SPF

During installation, health and safety are important considerations. However, once properly installed and allowed time to cure, SPF is considered to be relatively inert by the Environmental Protection Agency (EPA). This section will discuss the potential hazards during SPF application; proper handling of component chemicals; jobsite first aid and safety practices; and use of appropriate personal protective equipment while handling SPF chemicals.

The information presented here is in summary form. More in-depth information about the health and safety aspects of SPF is available at www.spraypolyurethane.org. There you will find information, guidance documents, health and safety training materials and more.

2.1) Chemicals

Overview of Spray Polyurethane Foam

Spray polyurethane foam is a thermoset cellular plastic insulating material formed by combining methylene diphenyl diisocyanate (MDI) and a polyol blend. The reaction between these two materials releases heat and within a few minutes foam is formed and is typically no longer tacky or sticky. In the United States, MDI is known as the A-Side and the polyol blend is known as the B-Side.



Figure 1: Drums strapped inside truck

Component Materials Health Risks MDI (A-Side or Isocyanate Side):

MDI has a potential risk of irritation and sensitization through inhalation and skin contact. Exposure can affect skin, eyes, and lungs. Once sensitized, continuing exposure can cause persistent or progressive symptoms and even life-threatening asthmatic reactions, so remove sensitized people from potential exposure activities. Wear the proper personal protective equipment (PPE) when working with MDI (See section 2.3). See the manufacturer's Material Safety Data Sheet (MSDS) for more detailed information on potential health effects¹.

¹OSHA is modifying their Hazard Communication Standard to adopt the Globally Harmonized System and the transition is scheduled to be complete by the end of 2015. MSDSs will be called Safety Data Sheets (SDS) under the new requirements, so while this document will use the term MSDS, SDS is equally applicable for companies that have transitioned to utilizing the new standard.

Polyol Blend (Resin or B-side):

The B-side formulations for SPF use five basic chemical classes: polyols, blowing agents, catalysts, flame retardants and surfactants. The polyol blend has a potential health risk of irritation to the respiratory system, skin, and eyes. Wear the proper PPE when working with polyol blends. See the manufacturer's MSDS for more detailed information on potential health effects.

Cured Foam:

The polyurethane foam that forms from the reaction of the A- and B-side chemicals is considered essentially inert and non-hazardous when properly installed and cured. Avoid exposing the polyurethane foam to extreme heat ($\rightarrow 200^{\circ}\text{F}$) or open flame due to the possibility that such extreme heat can ignite the foam.

Material Safety Data Sheet (MSDS)

Before using any SPF product, read and understand the entire MSDS for the material. The MSDS contains very important information about the product, including the chemical constituents and the approximate concentrations; potential health effects; appropriate PPE for the job; first aid measures; information on how to handle accidental releases; and information on storage, handling, transportation, and disposal. It is an OSHA requirement to make MSDSs readily accessible at a jobsite. Keeping one clean copy of each current MSDS in a clearly marked binder is a good practice that helps keep the information readily accessible for employees and first responders. As noted above, OSHA is revising their Hazard Communication Standards and the term "Safety Data sheets" will replace MSDSs. (<http://www.spraypolyurethane.org/WorkerProtection#MSDS>)



Figure 2: MSDS

Handling and Storage Considerations for the Chemicals

It is important that SPF component chemicals are stored properly before and during use on the jobsite. Improper storage conditions can reduce shelf life and make the components unusable. It is also important to store incompatible materials separately. Storing drums in a secured, cool area away from direct sunlight, excessive heat, and general storage areas helps protect them. Consult the manufacturer's instructions for the recommended temperature at which to store drums. Ventilate the storage space as described by the manufacturer and locate the storage space away from possible sources of ignition.

Store MDI (A-side) drums in locations that limit the risk of contact with water, acids, caustics (such as lye), alcohols, and strong oxidizing and reducing agents. Oxidizing agents include oxygen and chlorine. Oxidizers can be recognized by a yellow diamond-shaped label marked "oxidizer." Most strong reducing agents also are corrosive. These can be identified by a half-black, half-white diamond-shaped label marked "corrosive." MDI contact with any of these materials could trigger a violent reaction that could cause significant damage or injury. In addition to storing containers away from incompatible materials, it is important to maintain a tight seal on MDI containers to protect against moisture or direct contact with water. Water reacts with MDI to release carbon dioxide gas. If high levels of carbon dioxide gas accumulate inside a sealed container, the drum can rupture or explode.



Figure 3:
Be sure to dispose
of drums properly

When opening the “B-side” drums, slowly open the bung or stopper to help release any built-up pressures, allowing the drum to be opened safely. This is especially important when the B-side contains a physical blowing agent such as in closed cell SPF.

Disposal

Follow proper disposal procedures for all drums, cans, and cylinders in accordance with legal, federal, state, and local requirements. Consult the MSDS for information on proper disposal procedures. Note that in drum systems, small amounts of unused A-side chemicals can be reacted with small amounts of unused B-side chemicals to produce foam. Cured foam does not meet the criteria of a hazardous waste according to Resource Conservation and Recovery Act (RCRA) and can typically be disposed of as non-hazardous waste. Wear appropriate PPE at all times when handling SPF chemicals and the drums containing these materials. Consult the manufacturer’s MSDS for specific information about PPE and for disposal guidance on unused chemicals and empty containers. The Reusable Industrial Packaging Association (RIPA) can assist in locating a qualified container reconditioner in your area.

<http://www.reusablepackaging.org/find-a-member>

2.2) Personnel

Hazard Communication

The OSHA Hazard Communication (HazCom) Standard was designed to provide employees with information on the identities and hazards of all hazardous chemicals used in the workplace and recommended protective measures. According to the OSHA Hazard Communication Standard (29 CFR 1910.1200), all employers are required to have a written hazard communication program. The OSHA standard includes requirements for container labels, MSDSs, and employee training.

Systems have been developed for labeling potentially hazardous chemicals. The two common examples are the Hazardous Material Identification System (HMIS) and the National Fire Protection Association (NFPA) system. The HMIS refers to hazards during anticipated use while the NFPA system describes hazards under fire conditions. Please note these two systems may have different hazard categories for the same material.

OSHA has revised its Hazard Communication Standard, aligning it with the United Nations’ Globally Harmonized System (GHS) of classifying and labeling chemicals, and it will be fully implemented in the United States by 2016. During the transition period, chemical manufacturers, importers, distributors and employers may comply with the new standard, the current standard, or both. For more information, go to: <http://www.osha.gov/dsg/hazcom>.

Employee Training and Certification

Proper training before handling SPF chemicals is important. Contractors, applicators, and helpers can receive training from various sources, including manufacturers’ programs, the Spray Polyurethane Foam Alliance (SPFA) Accreditation courses, and CPI SPF Chemical Health and Safety Online Training, among others. Please see Section 1 on Training and Advanced Preparation for more specifics.

Confined Spaces

Some attics and crawlspaces could fall within the OSHA definition of “confined spaces” in the code of federal regulations. Work in confined spaces should comply with the requirements specified in the OSHA Safety and Health Regulations for Construction, specifically 29 CFR 1926.21. OSHA requires that workers be instructed in the nature of the hazards involved, precautionary measures to be taken, personal protective equipment needed, and emergency procedures.

Fall Protection

OSHA requires that employees receive training in the following areas prior to assignment to work projects (OSHA Standard 29 CFR 1926.503):

- Nature of fall hazards in the work environment
- Correct procedures for erecting, maintaining, disassembling, and inspecting fall protection systems
- Role of each employee in a safety monitoring system when the system is in use
- Correct procedures for handling and hoisting materials and equipment
- Correct procedures for working with ladders, scaffolding, and aerial lifts

Use guardrails, warning lines, safety monitoring, and personal fall arrest systems as described in applicable regulations. A fall protection plan is required by OSHA for each project if the worker is to be six feet off the ground or higher.

First Aid

Read the MSDS: It is critical to be familiar with the MSDS in advance to know the proper first aid procedures for the SPF component chemicals on the jobsite.

Inhalation Exposure: Avoid breathing vapors or mists of A-side or B-side chemicals at all times to avoid potential exposure. The appropriate product safety information, such as the MSDS and the chemical manufacturer’s documentation, will provide installers with more information. If someone is affected by inhalation of A-side or the B-side chemicals, move them to an area with fresh air immediately and seek medical attention. High concentrations of the blowing agent, typically included on the B-side, can reduce oxygen concentrations available for breathing. Inform individuals involved in incidents that the onset of symptoms may occur or become worse several hours after the exposure.

Skin Contact Exposure: If someone is exposed to SPF component chemicals through skin contact, shower or splash the affected area with large amounts of water to cleanse the skin and then wash with soap and water. Corn oil or propylene glycol can be more efficient than water at removing MDI from the skin. Review the MSDS for more information on skin contact exposures. Remove contaminated clothing and discard. Consider seeking medical attention if skin contact is extensive or if irritation develops or persists. If a cut or abrasion is received while handling pressurized fluid, seek emergency care immediately because the chemical may have entered the wound. Do not treat as a simple cut despite appearances and provide medical personnel with a copy of all relevant MSDS documents.



Figure 4: Safety data sheets or MSDS

Eye Contact: For eye contact with SPF chemicals, flush the eye(s) immediately for at least 15 minutes with large amounts of lukewarm water. Seek professional medical attention as soon as possible. Review the MSDS for additional information.

Ingestion: If SPF chemicals are ingested, do not induce vomiting. Obtain professional medical attention as soon as possible and refer to the MSDS.

Respiratory Protection Considerations (High Pressure Products)

Properly designed ventilation can reduce airborne levels of aerosols, mists, and vapors generated during spray application and can help protect SPF applicators, helpers, and others who may be working in adjacent areas. During and after spray application, vapors and mists as well as particulates and dust from trimming or sanding the foam can linger until the area is ventilated and fully cleaned. Carefully schedule construction activities so that no other trades or occupants are in the area during SPF Installation.



Figure 5: Full-face Supplied Air Respirator (SAR) with portable breathing air compressor

During application, airborne levels may exceed the exposure guidelines; therefore, use proper PPE. OSHA's Respiratory Protection Standard (29 CFR 1910.134) sets forth the requirements for respiratory protection. Supplied air respirators (SAR) are typically used in interior applications. Air purifying respirators may be adequate in exterior (outdoor) applications. Refer to the NIOSH Respirator Decision Logic for more information regarding respirator selection at www.cdc.gov/niosh/docs/2005-100/pdfs/05-100.pdf. The OSHA Respiratory Protection Standard (29 CR 1910.134) requires employers to have a written respiratory protection program when employees are required to use respiratory protection. The Standard outlines requirements for respirator selection, respirator maintenance, annual fit testing, medical surveillance, and annual training.

Low Pressure Products: As for high-pressure products, during use of low-pressure products, airborne levels may exceed the exposure guidelines; therefore, use proper PPE. OSHA's Respiratory Protection Standard (29 CFR 1910.134) sets forth the requirements for respiratory protection. Use a NIOSH approved air purifying respirator equipped with an organic vapor cartridge and a particulate pre-filter. If airborne levels exceed 10 times the threshold limit value (TLV) or the permissible exposure limit (PEL) for which an air-purifying respirator is effective, use a powered air purifying respirator (PAPR). Additional information on low pressure products can be found here: <http://spraypolyurethane.org/Main-Menu-Category/Weatherization-Contractors/Installing-SPF>.

Eye Protection Considerations (High Pressure Products)

Appropriate eye protection helps protect eyes from splashes of liquid SPF component chemicals; accidental sprays of reacting foam, aerosols, and particulates that are likely to be present during spraying; and airborne particulates associated with sanding and grinding operations. The type of eye protection needed depends on the nature of the activity. Persons handling liquid SPF chemicals in open containers can protect their eyes by wearing safety goggles or safety goggles in combination with face shields. During the application of SPF, eye protection may be provided by wearing a hooded or full-face respirator. In addition to proper eye protection, a portable eyewash station available in the rig/truck or directly in the work area and properly covered can be helpful.

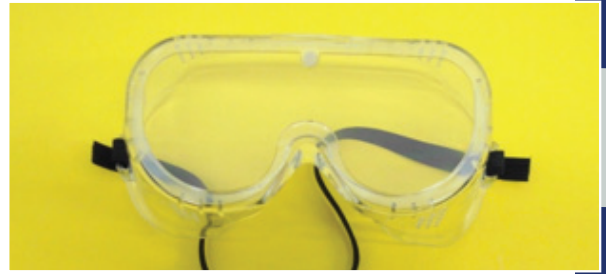


Figure 6: Chemical resistant safety goggles




























	One-component Cans 	Low Pressure Two-Component Kits 	Refillable Systems 	High Pressure High Pressure Spray Systems 
Routes of Exposure	PPE	PPE	PPE	PPE
Eyes	Safety Glasses  Safety Glasses	Safety Glasses  or  Safety Glasses or Goggles	Safety Glasses  or  Safety Glasses or Goggles	 or  FF Mask/ Hood
Skin	Long Sleeves 	Long Sleeves 	Long Sleeves 	Full Body Suits  Full Suit
Hands	Gloves 	Gloves 	Gloves 	Gloves 
Lungs	Avoid Breathing Vapors  Provide Good Ventilation	Respirator  &/or  Air Purifying OV / Pre-filter Provide Good Ventilation	Respirator  &/or  Air Purifying OV / Pre-filter Provide Good Ventilation	Air Supply  or  &  FF Mask/ Hood or FF Air Purifying Airline OV/Pre-filter Provide Good Ventilation

Figure 7: PPE guidance for applicators and helpers

Low Pressure Products: Appropriate eye protection for low pressure application can include safety glasses with side shields or goggles. These can protect against accidental sprays of reacting foam, vapors that are present during spraying, and airborne particulates associated with trimming the cured foam.

Clothing

Wear appropriate protective clothing whenever there is a possibility of direct contact with SPF component chemicals. Appropriate protective clothing varies depending upon the potential and type of exposure, such as for liquid chemicals versus particulates. Applicators and helpers typically wear disposable coveralls to keep spray and mist from contacting skin and clothing. Launder non-disposable clothing that is exposed prior to wearing again. For proper skin protection, wear PPE in such a manner that no skin is exposed.

Gloves

Gloves made of nitrile, neoprene, butyl, or PVC generally can provide adequate protection against A-side materials. The same protection is generally considered adequate to provide B-side protection as well. Consult the manufacturer's MSDS for specific information about B-side protection. A range of glove sizes are available. Gloves which are too large or too small for the user may not provide proper protection. Fabric gloves, fully coated with nitrile, neoprene, butyl, or PVC typically can also provide good protection for SPF applicators.

2.3) Equipment

Potential Skin Injection Hazard

High-pressure fluid from leaks can potentially inject fluid into the body. High-pressure fluid from dispensing devices, hose leaks, or ruptured components could pierce skin. This may look like just a cut, but it can be a serious injury in need of immediate medical attention. The following safety tips can help avoid injury, including possible amputation.

- In case of skin injection, get immediate medical treatment.
- Inspect hose before each use for cuts, bulges, kinks, or any other damage. Replace damaged hose immediately.
- Check hoses and couplings daily. Replace worn or damaged parts immediately.
- Engage trigger lock when not dispensing.
- Do not point dispensing device at anyone or at any part of the body.
- Do not put your hand over the fluid outlet.
- Do not stop or deflect leaks with your hand, body, glove, or rag.
- Follow the Pressure Relief Procedure when you stop dispensing and before cleaning, checking, or servicing equipment.
- Tighten all fluid connections before operating the equipment.
- Keep clear of leaks.
- Follow hose maximum pressure or temperature ratings.
- Use chemicals that are compatible with the hose materials you are using.

Equipment (Low Pressure Products): When working with low pressure products, avoid kinking or folding the hoses and secure all fittings before use. Keep the outlet ports of the dispensing unit free from any dust, dirt, or chemical that can affect the proper sealing of the nozzles. Also, keep outlet ports pointed away from persons while opening outlet port valves and leave chemical in the hose for storage.

Electrical

Electric power lines near a worksite can be a source of ignition and other extreme hazards, including shock and electrocution. If you notice downed power lines in the area, secure all ignitable materials and evacuate personnel until the lines are repaired. Never let equipment touch or come close to overhead electric lines or other sources of electricity.

For work near energized equipment, follow the OSHA standards (29 CFR § 1926.417 or 1910.147) to properly lock out or tag out machines and equipment during repair or servicing activities.

Ground any electrical equipment used as part of the SPF application to prevent electrical shock or electrocution. This is especially important when working near water or on damp or wet floors and roofs. Ground or bond all process equipment and containers of flammable materials (e.g. cleaning solvents). Remember that plastic containers used to transport solvents cannot be grounded. Use non-sparking tools (such as those made of brass or aluminum) where flammability may be a concern. Employers on construction sites are required by OSHA to use either ground fault circuit interrupters (GFCI) or an Assured Equipment Grounding Conductor Program (AEGCP) to protect employees from the risk of electrocution or shock. There are several different means of employing a GFCI: (a) as an attachment to an appliance cord, (b) installed at the breaker panel, or (c) provided at the receptacle.

Extension cords are considered to be temporary wiring; therefore, consider using ground fault protection with all extension cords on construction sites. All 120-volt, single-phase 15-ampere and 20-ampere receptacle outlets on construction sites that are not a part of the permanent wiring of the building or structure and which are in use by employees need to have approved GFCIs for personnel protection. Your local electrical code will have detailed grounding and bonding instructions for your area and type of equipment. Consult the equipment manufacturer's instructions for specific instructions.

2.4) Fire

Install SPF in accordance with the chemical component manufacturer's recommendations. Do not use open flames, cutting and welding torches, and lighted pipes, cigars, and cigarettes in and adjacent to chemical storage and installation areas. Post clearly visible warning signs in all sprayed areas and do not expose SPF to flames or to the sources of intense heat ($\rightarrow 200^{\circ}\text{F}$). Provide fire extinguishing equipment at both storage and installation sites. As described in more detail in Section 4, applying too much SPF per pass, without allowing appropriate time for the foam to cool, can also create a fire hazard resulting from too much heat from the reaction and spontaneous combustion. Following the manufacturer's guidance is important. Consider disposing of waste insulation daily in a designated location with due regard for its combustible characteristics. Since large buns of waste insulation can create internal temperatures high enough to cause smoldering or fire, cut open the buns, douse with water, and allow adequate time to cool prior to disposal to minimize the risk of a fire.

CPI has created a fire safety guidance document for working with polyurethane foam products: <http://polyurethane.americanchemistry.com/Resources-and-Documents-Library/11365.pdf>.



Figure 8: Provide fire extinguishing equipment

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3) Jobsite Safety & Preparation Best Practices

Introduction to Jobsite Safety when working with SPF


Jobsite safety is always an important consideration when working with SPF. This section goes into greater detail about what to consider when preparing and maintaining a safe jobsite, including documentation, inspections, and guidance for helping keep workers and others from harm.

3.1) Jobsite Safety

Jobsite safety begins long before a crew arrives onsite. A safe jobsite begins with education and training that occurs on a continual basis, not just one time. Know and understand the health and safety best practices outlined in Section 2 of this Installation Guidance and effectively communicate these to all applicable personnel. When employees receive work instructions in languages other than English, employers are required by OSHA regulations to provide training in that language as well.

Written Jobsite Safety Plan

A Jobsite Safety Plan can include the following items (a printable version of this sample checklist is available at the end of the document in the Resource section). The checklist below is meant as an example only. Each jobsite may have unique needs to consider and include in the Jobsite Safety Plan.



	Verification that all personnel read and understand the MSDS for each material involved with the spray polyurethane foam application process.
	A copy of the most current MSDS should be available at all times (i.e. cab of the truck or in the trailer that is transporting the spray equipment).
	Communication procedures between the crew and customer.
	Overspray mitigation plan.
	Proper start-up and shut-down procedures for both SPF process equipment and the customer's equipment (i.e. HVAC system) when applicable.
	Review of Manufacturers Technical Data sheets that detail proper application procedures.
	Onsite review of the jobsite; note any potential safety hazards and special needs.
	Controlling access to the spray area.
	Proper set up for all equipment with particular emphasis on ladders or scaffolding which could present fall hazards.
	Proper set up for establishing the work area and restricting access by posting warning signs.
	Emergency procedures with notification procedures.
	Chemical spillage with current remediation procedures and notification procedures.
	Jobsite location and directions to the jobsite from the nearest major intersection.



Personnel

Daily Work Log: Establish a company daily work log that is for internal use. A daily work log can provide the framework for a company to support safe and consistent operation. The historical data accumulated in a work log can prove invaluable when documenting a work place incident. It is also a good way for a business to monitor equipment, material usage, and quality control. The following is an example of a daily work log (Appendix 8.3):

CONTRACTOR		DAY/DATE		DAILY LOG PROJECT REFERENCE NO./NAME:
JOB NAME		JOB NO.		
WEATHER		TEMP		
FIELD NOTES				
CONTRACT EXTRAS	??	AMOUNT	CRAFTSMEN NO.	
			<input type="checkbox"/> Superintendent	
			<input type="checkbox"/> Clerk	
			<input type="checkbox"/> Bricklayers	
			<input type="checkbox"/> Carpenters	
			<input type="checkbox"/> Cement Masons	
			<input type="checkbox"/> Iron Workers	
			<input type="checkbox"/> Laborers	
			<input type="checkbox"/> Operators	
			<input type="checkbox"/> Plumbers	
			<input type="checkbox"/> Pipe Fitters	
			<input type="checkbox"/> Sheet Metal	
EQUIPMENT RENTED TODAY			TOTAL:	
	??	AMOUNT	EQUIPMENT HRS	
APPROVED BY _____				
PROJECT REFERENCE NO./NAME _____				

Personal Protection Equipment (PPE): Section 2 on Health and Safety of this Installation Guidance briefly summarizes the OSHA PPE requirements and best practices involved with a spray polyurethane foam application. The OSHA Respiratory Protection Standard (29 CR 1910.134) requires employers to have a written respiratory protection program when employees are required to use respiratory protection.

Additional details regarding several aspects of PPE can be found at the CPI Health and Safety website: www.spraypolyurethane.org.

Equipment

Equipment Inspection (Safety) Checklist: Proper equipment care and maintenance is important and a regular focus on the jobsite. A simple equipment inspection checklist that contains a schedule of routine preventative maintenance helps with a long-term, safe, and efficient operation.

Consider a systematic approach that includes routine inspections and daily start-up and shut-down procedures that identify potential safety issues before they occur and reduce the possibility of failing to comply with OSHA requirements.



Figure 9: Routine inspections can prevent safety issues

Items included as part of the inspection routine could include, but are not limited to:

✓ Air and chemical leaks

Inspect air and chemical lines for signs of wear or fatigue.
Ensure the compressed air system has the proper OSHA-compliant disconnects.

✓ Proper ventilation of engine exhausts

Verify adequate ventilation. The buildup of carbon monoxide from engine exhausts can be deadly.

✓ Ladders, scaffolding, and aerial lifts

Improper use of ladders, scaffolding, and aerial lifts can be a source of jobsite injuries or deaths. Proper use of ladders, scaffolding and aerial lifts is a major point of emphasis in the overall jobsite safety plan.
Consult the OSHA website along with the manufacturers care and use specifications for this equipment.

✓ Hoses, electrical cords and lights

Use properly rated electrical cords and lights.
Remove from service cords that are damaged, frayed or spliced.
Properly ground/bond plugs and receptacles, including ground wire.

✓ Ventilation fans and ducts

Clean fans and check if fully operational.
Clean ducts and seal to eliminate leakage.

✓ Chemical storage and handling

Proper environmental controls to ensure proper storage conditions.
Proper restraining devices to secure chemicals during transportation.
Spill control equipment.
Decontamination solution.

✓ Emergency equipment

A fully stocked and OSHA-compliant first aid kit.
Eye wash station.

✓ Fire Prevention

Fire extinguisher(s) fully charged and accessible.
--

✓ Other

Tools, spare parts, and equipment manuals.
Jobsite Safety Plan.

Material (components of SPF and the final product)

Material Safety Data Sheet (MSDS): Employers are required by OSHA to provide training on MSDSs and employees need to have a full understanding of the contents of an MSDS. Employers are also required by OSHA to have MSDSs readily available on jobsites. Here is an overview of the key sections of most MSDSs for SPF-related chemicals:

Name of Product or Chemical:

- Component A (isocyanate)
- Component B
(typically includes: polyol, amine catalyst, blowing agent, fire retardant, surfactant)
- Solvents
- Cleaning solutions
- Coatings

Potential hazards:

- Acute and chronic toxicity
- Irritation
- Sensitization

Personal protection equipment (PPE):

- Respiratory protection
- Eye protection
- Gloves
- Disposable coveralls or clothing that protects against exposure
- Boot covers (resistant to wear)

Storage and handling of the chemicals:

- Proper storage conditions for the materials
- Procedure and equipment/supplies to properly contain and clean a spill

Procedures in case of an accidental exposure or overexposure:

- First-aid procedures
- First aid materials to keep on the jobsite

Other information that is provided in an MSDS:

- Fire-fighting measures
- Physical and chemical properties
- Stability and reactivity
- Toxicology
- Disposal
- Transportation
- Regulatory information

Product Technical Data Sheet(s): It is important to have a thorough understanding of the Technical Data provided by the manufacturer of the product. Provide this information to personnel working with the material.

Regulatory Postings Related to the Material Used: Proper regulatory postings are critical from both a safety and legal standpoint. OSHA requires employers to post certain information as outlined in their compliance notifications. Locations can include:

- Company office/warehouse
- Chemical storage area
- Work truck or trailer and the jobsite itself

Consult the OSHA website at <http://www.osha.gov/Publications/poster.html> for a current list of required compliance notifications.

Applicable Safety Standards

When establishing jobsite safety standards, a company needs to refer to the applicable safety standards. These can include, but are not limited to, the following OSHA standards:

- Hazard Communication: 29 CFR 1910.1200 and 1926.59
- Respiratory Protection: 29 CFR 1910 Part 134
- Personal Protective Equipment: 29 CFR 1910 Part 132-138 and 1926.95
- Ventilation: 29 CFR 1910.94 and 1926.57

3.2) Jobsite Preparation

There are many factors to consider when planning any SPF installation, such as the place of work, area of building occupancy, size of work area, and many others. Assess any special requirements or risks before the job starts and develop a plan to address them.

Understanding ventilation requirements is essential. For example, shut down HVAC systems during a SPF application. System shut-down stops dust, aerosol and vapors from being drawn into the HVAC system. For interior applications, this can help prevent airborne materials from being distributed from one part of a building to another. Once the HVAC system is shut down, seal the air intakes with plastic sheeting and tape to prevent dust and spray from entering the system. Some SPF manufacturers recommend that the HVAC system stay sealed and inoperable for up to 24 hours after the SPF application. Individual SPF manufacturer's recommendations concerning re-occupancy supersede any general recommendation.

Once you determine when an appropriate time has elapsed, based on the manufacturer's recommendation, remove the plastic sheeting and tape.



Figure 10: Sealing the windows

General Preparation Steps

There are several steps to consider prior to the actual application of the foam insulation. Examples of steps to consider include:

1. Provide a briefing for the general contractor and/or owner of the building so they can better understand the scope of the work and the safety procedures to utilize during the application process.
2. Confirm necessary inspections associated with the other trades have been completed and approved prior to the installation of the insulation.
3. Confirm all permits are in place prior to the spraying operation.
4. Complete other trade work to avoid later disturbance of insulation.
5. Install warning signs and caution tapes.
6. Clear building occupants and non-SPF personnel from building. Consider utilizing the best practices for the use of containment and ventilation techniques detailed in the U.S. Environmental Protection Agency's "Ventilation Guidance for Spray Polyurethane Foam Application":
<http://www.epa.gov/dfe/pubs/projects/spf/ventilation-guidance.html>
7. Designate an area for putting on and removing PPE.

Jobsite Crews and Safety Briefings

Many commercial jobsites may require contractors to conduct safety briefings with the jobsite crews. They may require that documentation of meetings be submitted to the general contractor for the project. As a good safety practice, companies may consider implementing this policy regardless of whether the job is residential or commercial in nature.

The Daily Work Log outlined in the previous section (3.1) can provide a helpful structure for developing your own work log. Daily Work Logs are also a method for improving record keeping.

Notice to Other Trades and Occupants

Vacate building occupants and non-SPF personnel from the building during the application of SPF and for a period of time following the completion of spraying. Where this is not possible or practical for large commercial buildings, the use of containment and ventilation techniques can be utilized. For residential applications, the homeowner needs to vacate the home and return only after the specified re-occupancy time. Communicate with other trades working in proximity to the spray application area. Giving notice to other trades is an important aspect on larger commercial projects due to the number and kinds of workers in and around the jobsite.



Figure 11: Provide notice to trades and occupants

The focal points for this communication are the general contractor, building owner, home owner, or other responsible personnel for the project. Educate the onsite supervisor or project manager at the start of the project long before the actual spray application starts so that they have a complete understanding of the jobsite safety requirements before the beginning of the spray application process. Critical jobsite safety concerns include proximity of open flame sources and personnel to the spray application area.

General Safety Considerations

After the spray application area is secured, check the overall area and extinguish all sources of flame (e.g. pilot lights). Also, check for flue piping, lighting fixtures, and other heat producing devices.

Set up and prepare the necessary ladders, scaffolding, aerial lifts, and rigging. Once set up, perform a safety check of all the equipment to check that it is properly assembled, nothing is broken or missing, and that all safety devices are operational and in place. Check walking and work surfaces and the routing and location of process equipment hoses and electrical cords as they can present a trip hazard. If gas powered equipment is in use, vent the exhaust fumes to an open environment in order to limit the risk of a buildup of carbon monoxide in the work area.

Lockout/Tagout

Some projects may present instances where you want to consider locking out/tagging out of equipment. Lockout/tagout includes practices and procedures to safeguard employees from the unexpected energizing or startup of machinery and equipment, or the release of hazardous energy during service or maintenance activities. For work near energized equipment, contractors should follow the OSHA standards (29 CFR § 1926.417 or 1910.147). The SPF contractor coordinates with the appropriate facility personnel for locking/tagging out equipment.

Ventilation Considerations

Another jobsite consideration is ventilation. Turn off HVAC duct system fans and seal them so overspray does not enter the duct system. If gas powered equipment is used, direct the exhaust fumes to an open environment to prevent a buildup of carbon monoxide in the work area.

If evacuating an entire commercial building is not practical or possible, consider the potential for SPF chemicals to migrate to other floors. Containment and ventilation methods help prevent migration of chemicals and particulates. Discussing the project and application with property management and other contractors in areas or floors that will remain occupied during the period of SPF application is an important consideration.



Figure 12: Provide adequate ventilation

Set up and check portable ventilation equipment to provide fresh air into the immediate spray application area and exhaust humidity, vapors, and odors. Exercise care so that portable exhaust ducts do not introduce the exhausted air into occupied, unprotected areas. Consider utilizing the best practices for the use of containment and ventilation techniques detailed in the U.S. Environmental Protection Agency's "Ventilation Guidance for Spray Polyurethane Foam Application": <http://www.epa.gov/dfe/pubs/projects/spf/ventilation-guidance.html>.

One possible consequence of inadequate ventilation during the spray application is the absorption of vapors and odors by adjacent materials or surfaces (e.g. furniture). Vapor/odor absorption can be amplified by the presence of wet or dusty materials such as fiberglass duct insulation and ceiling tiles. Cover materials that cannot be removed during the spray and ventilation operation.

Overspray

Overspray is when the SPF application goes beyond the intended area. Train employees in overspray prevention and determine in advance the overspray risk posed by the job. Having a plan in place to address overspray incidents in the event that an issue arises is a good practice. Identify and protect surfaces that could be affected (e.g., windows, doors, equipment, or building exterior and automobiles) in advance of the spray application. When in doubt about covering a surface, it is a best practice to cover it.

For work outdoors, take wind direction into account for all spraying operations. Note that for a job that takes place over several days, the wind direction may change and the work area may need to be adjusted accordingly. In slightly windy conditions, use windscreens. Tenting is also an option to address wind and overspray issues. Adjust your plans for PPE if considering the use of any type of containment area outdoors.

Avoid spraying foam or coatings in excessively windy conditions for exterior applications. Avoid spraying during sustained wind speeds or gusts exceeding 15 miles per hour.

Substrate Considerations

Prepare the surface that the SPF will be applied to prior to the application to help minimize future problems. Before application, check the following substrate characteristics:

- Substrate temperature is within the parameters established in the manufacturer's specifications.
- Substrate moisture level is within the parameters established in the manufacturer's specifications using a moisture meter.
- Surfaces are clean, free of contaminants, and dry.
- Flashings and attachments are clean and/or primed.
- Substrate and any associated flashing materials are secured, specifically around windows and doors, so the SPF does not pull the flashing away from the substrate.

3.3) Jobsite Retrofit Applications

Retrofit applications also have a number of additional considerations. In addition to considerations discussed in Sections 3.1 and 3.2, retrofit applications may impact building occupants differently than in new construction applications. For example, SPF manufacturers generally recommend that building or home occupants and non-SPF personnel vacate the structure during the spray application process and for a period of time after completion. Specific SPF manufacturer's recommendations concerning re-occupancy supersede any general recommendation. Where large commercial buildings cannot be vacated, use containment and ventilation techniques. For residential applications, vacate the home.

Use PPE as set forth by OSHA. SPF installers typically work with an assistant wearing the same PPE as the installer.

Buildings are complex systems with all major components contributing to overall performance. A change to one component can impact the other components of a system that can influence the performance, indoor air quality, moisture level, and energy consumption of the structure. Moving the thermal envelope from one area of the structure (the ceiling or attic floor) to another area (under the roof deck or roofline) could significantly impact other systems and cause needed alterations so that the structure continues to perform in a safe, healthy, and efficient manner. Understanding the building science involved with changes to the building (e.g. the unvented attic assembly) is important so all aspects of the job can be explained to the home or building owner. This helps the home or building owner understand what is required on their part as well as the reasons for the various steps involved in the preparation and spray operation. SPF applications typically improve air sealing of the structure and it is important for building owners to understand how this impacts the overall building and the potential need for new or additional ventilation.

Being familiar with the building structure and systems prior to submitting a bid for the work is part of a retrofit application. This is the time to ask about the history of the structure, its use, and the purpose it will serve after the retrofit. These and other questions can help to prevent any potential complications associated with the retrofit process, both during spray application and after the job is completed.

Odors and Smells for Retrofit Applications

Any existing problems prior to the installation of SPF, such as moldy or mildewed carpets, wet ducts, or existing insulation, may be accentuated by the tighter building envelope that results from installing SPF. Identify, document, and rectify any of these existing conditions before the spray application and discuss them with the homeowner. Make the building owner aware of this possibility as odors may emanate from pre-existing sources and may only become noticeable once the SPF is installed. Additionally, new materials installed by other trades (such as carpeting, flooring, cabinets) as part of an overall retrofit project may release odors that could dissipate more slowly due to the tighter and more energy efficient building envelope. Give homeowners guidance regarding ventilation practices during a retrofit to avoid SPF being inaccurately identified as the source of odors.



Retrofitting Attics

General Safety Considerations (Attics)

Attics can be especially challenging places to work.

Walk only on the joists when moving in an attic. The space between the joists may not hold the weight of a worker. The use of walk boards may be utilized to more easily maneuver around the attic. Look for electrical wires and junction boxes and avoid stepping on these as well to avoid injury or damage to the home. Additionally, be especially careful of nails protruding down from the roof to avoid puncture wounds. Wearing some sort of head covering such as a hard hat, in addition to proper PPE, can help maintain worker safety.

When installing SPF in an existing attic within a home or building, as with other indoor applications, vacate the building during and after application and for a period of time afterward. Check the manufacturer's production information for specific recommendations. See section below on "Ventilation During and After Application of SPF."

Applicators and helpers must wear PPE appropriate for the job as set forth by OSHA (See Section 2.3). If the attic space is tight, refer to the information presented earlier on "Confined Spaces."



Figure 13: Attic retrofit

HVAC Systems (Attics)

The contractor and the homeowner should be aware that retrofitting an existing attic by employing an unvented attic assembly technique can result in the existing HVAC system becoming "oversized" in relation to the new demand. This situation is of special concern in the southern and coastal climate zones where the HVAC also serves to reduce or otherwise manage moisture levels of buildings in order to improve comfort and prevent moisture related problems, such as mold and mildew. If an existing HVAC becomes "oversized" due to the increased thermal efficiency of the unvented attic assembly, the HVAC system may begin to short cycle, or to quickly turn on and off, as it works to manage temperature. This short cycling of the HVAC system may have negative impacts on the comfort and efficiency of the building and possibly on the lifespan of the system. Involve an HVAC consultant to adapt the system to the new, more efficient building envelope associated with the spray foam retrofit.

Open Combustion Appliances (Attics)

Open combustion heating systems and hot water tanks are routinely installed in conventional attics. Moving the thermal envelope to the roofline places the open flame inside the envelope and could create the possibility of carbon monoxide and other combustion by-products from the appliances entering into the occupied area. In the event that open-combustion, gas-fired appliances are present in the existing attic, constructing a sealed equipment room with combustion air supplied from the exterior is one option. An additional option is installing high-efficiency, closed-combustion appliances with the combustion air ducted directly to the units from the exterior of the building. Involve a professional HVAC consultant or plumber.

Duct Systems (Attics)

Check that duct systems are in good condition and securely connected to the register boots and plenums. Be careful when dragging hoses, electrical cords, and lines over the ducts to avoid damaging them.

Soffit and Ridge Vents (Attics)

Ventilation for conventional attic designs is typically achieved through soffit vents, ridge vents, and passive or powered vents. When converting an existing, conventional attic to an unvented attic assembly, the existing attic ventilation is closed off. Appropriate methods to close off existing attic ventilation will vary depending on the layout of the existing structure.

Sewer and Exhaust Fan Vents (Attics)

In some homes, builders and plumbers terminate sewer system vents within vented attics. If sewer vents are found, extend them outside the building envelope. Check for damage, cracks, or improper connection of the sewer vents and repair as needed. Failure to conduct these inspection and repairs could lead to the buildup of odors that owners will mistakenly attribute to SPF and result in callbacks for odor concerns. It is also not uncommon to find ventilation fans from kitchens and bathrooms vented directly into the attic as well. Route the ducts outside the thermal envelope to help avoid an increase in moisture levels and possible condensation problems.

Dividing Walls (Attics)

Dividing walls can be made of various materials such as gypsum board, oriented strand board, or other materials. Dividing walls may need to be built in an unvented attic in order to separate the unvented space from conventionally vented areas. Once the dividing wall is constructed, apply the spray foam directly to it. By applying spray foam directly on these dividing walls, an air boundary will be established between the new unvented attic and existing vented portion of the attic.

Existing Insulation in Unvented Attic (Attics)

Remove the existing insulation in an unvented attic, such as blown-in fiberglass, from the attic floor prior to the installation of SPF. Failure to remove existing insulation could leave an unconditioned “dead” zone within the structure where temperature and humidity are not actively controlled by either the conditioned space below the floor or the exterior environment. This could result in decreased energy efficiency and potentially damaging humidity conditions. Insulation for sound abatement may be used on the attic floor (not over top plates of exterior walls) assuming it is not sufficiently thick enough to serve as a thermal insulation or an air barrier.

Ventilation During and After Application of SPF (Attics)

Vacate building occupants and non-SPF personnel from the structure during the spray application process and for a period of time after completion. Refer to the SPF manufacturer’s recommendations concerning re-occupancy time. Where it is not practical or possible for the building to be vacated, such as in large commercial buildings, the use of containment and ventilation techniques can be utilized. For residential applications, the homeowner needs to vacate the home and return only after a specified re-occupancy time. Allow time for the foam to cure and ventilation fans to evacuate residual vapors from the attic. Place the attic under negative pressure and a cross ventilation set up utilized. Consider using a ducted fan supplying air into the closed

space (or an appropriately located opening that can serve as a passive supply) and use a separate fan to exhaust air out of the space. Place the exhaust duct in a location so the exhausted air does not return into the structure. Air filters can be used in conjunction with exhaust fans or ducts to prevent overspray material from potentially damaging areas near the exhaust. See the U.S. Environmental Protection Agency “Ventilation Guidance for Spray Polyurethane Foam Application” for additional information: <http://www.epa.gov/dfe/pubs/projects/spf/ventilation-guidance.html>

Odors and Smells (Attics)

As stated above for general retrofit applications, existing problems prior to the installation of SPF, such as moldy or mildewed carpets, wet ducts, or existing insulation, may be accentuated by the tighter building envelope that results from an unvented attic assembly. Identify, document, and rectify any of these existing conditions before the spray application and discuss them with the homeowner.

The contractor and the homeowner need to be aware that odors will exist in a conventional attic and normally escape to the exterior through the natural ventilation out of soffit, gable end, or ridge vents. Sealing the attic as part of the unvented attic technique stops this natural ventilation. Consequently, pre-existing odors may potentially accumulate or become more pronounced. Make the owner aware of this possibility as odors that emanate from pre-existing sources and may only become noticeable once the SPF is installed. Additionally, new materials installed by other trades (such as carpeting, flooring, cabinets) as part of an overall retrofit project may release odors that could dissipate more slowly due to the tighter and more energy efficient building envelope. Give homeowners guidance regarding ventilation practices during application in attics to avoid SPF being inaccurately identified as the source of the odors.

4) SPF Application Best Practices on the Jobsite

Introduction SPF Application Best Practices

Once the jobsite is set up, health and safety concerns addressed, and products secured, the next step is to apply the SPF. This section will discuss, in general, the steps and conditions to consider when applying SPF. Many of these topics are covered in more detail in training courses provided by SPF manufacturers and other organizations. Questions about how to apply a certain product, or what conditions are optimal for a successful implementation, should be directed to the SPF supplier's customer support or technical support contacts.

4.1) Applying and Processing Spray Foam on the Jobsite

Verify the Jobsite: On the day of application, verify and review all the items discussed in Section 3.

Ambient and Substrate conditions: Prior to actual application, review the ambient/atmospheric and substrate conditions for the parameters recommended by the SPF manufacturer. The manufacturer's technical data sheet or guidelines have the parameters associated with the ambient conditions.

Temperature and Recirculation of Material: Comply with the manufacturer's guidelines for the preparation and processing of the SPF component materials. Manufacturers may recommend recirculation of the polyol material and some may recommend recirculation with heating. Follow the manufacturer's instructions closely.



Figure 14:
Check ambient conditions

SPF Quality Testing: Prior to starting the day's spraying operations, spray out a small amount of material to verify the quality of the SPF produced. Use caution when spraying test buns and allow the buns to have an opportunity to properly cool before disposing of them. Use extra caution if spraying SPF test buns into plastic bags because it can reach the point of spontaneous combustion and could cause a fire. Disposal is also important and lack of attention to the disposal of scrap SPF can cause a fire.

Thickness of Application: Follow the SPF manufacturer's recommendations concerning the thickness of individual passes (lifts) and the cooling time between passes. Applying too much SPF per pass, without allowing time for the foam to cool, could cause poor foam quality and create a fire hazard resulting from too much heat from the reaction and spontaneous combustion. Closed cell SPF retains the heat from the reaction more than open cell SPF and can achieve higher temperatures for a longer period of time.

Refer to the manufacturer's guidance for both open and closed cell SPF.

It is important to note that the surface temperature of the SPF will be near ambient temperature while the internal temperature can remain much higher. Installing additional layers of SPF without allowing sufficient time for the previous layer to cool can cause the temperature to continue

rising. Such internal temperatures could cause damage to the cells and lead to poor quality SPF. Consider using a stick-probe type thermometer, typically used by HVAC technicians, for checking the internal temperature of the SPF.

In contrast to SPF applied too thick, if the SPF is applied too thin, especially in the case of open cell SPF, then not enough heat is generated, which can result in poor quality SPF. Knowledge of the characteristics of the SPF products and following the guidance provided in the manufacturer's technical literature will facilitate the application of SPF and obtain maximum yield from the material components.

Total Thickness: Refer to the manufacturer's recommendations, code requirements, and project specifications for total thickness. Monitor the thickness of SPF by periodically measuring it with a thin wire probe or depth gage, which can help manage the spray pattern to obtain an even and consistent thickness as close to the recommended thickness as possible without over spraying the foam and wasting materials.

Trimming the foam: Trimming is a subject of particular importance for open cell SPF installations. There are a variety of methods for trimming the foam in order to obtain a smooth or consistent surface. Follow the SPF manufacturer's recommended methods for trimming the foam. Clean up the trimmings and dust after the job is completed and wear PPE appropriate for this phase of the job. Consider using a vacuum cleaner, which may assist in a thorough cleaning.


Repairs: Often during the trimming process, areas needing repair are discovered. These repairs may be made with the SPF that was initially installed or with sealant foams. Keep protective materials such as plastic sheeting, ventilation equipment, and others in place until all repairs are made and the foam and subsequent coating/covering is inspected for completeness and compliance with the work order and contract.

Application of Coatings/Coverings: To conform to building codes, a protective coating or covering may be required. Follow the SPF manufacturer's technical information for what coating or covering is approved with the specific SPF, the required thickness, surface profile, and parameters for application. Prior to starting, review the manufacturer's recommended method for measuring installed coating thickness as well as documentation required by the authority having jurisdiction (AHJ). As with the rest of the installation process, wear appropriate PPE during the spraying of the coating/covering.

Cleanup: Once the SPF and coating application is complete, clean up the work area and remove and discard the protective materials in compliance with all federal, state, and local regulations.




Figure 15: Contractor trimming foam



Disposal of Waste Material: Dispose of all scrap SPF foam, liquid SPF component chemicals and empty drums in compliance with all federal, state and local waste disposal guidelines. Follow the SPF manufacturer's guidance on how to dispose of waste. Cut open large buns of waste insulation, douse with water, and allow an adequate time to cool prior to disposal to minimize the risk of a fire. CPI has a guidance document with more information regarding responsible disposal of wastes and containers from polyurethane processing:

<http://polyurethane.americanchemistry.com/Resources-and-Documents-Library/10311.pdf>.

Drum Disposal: Empty drums can pose a hazard. As with waste material, dispose of all drums according to procedures in the manufacturer's MSDS and all federal, state, and local requirements. Additional information regarding disposal of drums is available in Section 2 on Health and Safety. The Reusable Industrial Packaging Association (RIPA) can assist in locating a qualified container reconditioner in your area (<http://www.reusablepackaging.org/find-a-member>).





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5) Post-Application Best Practices

Introduction to Post-Application Best Practices

After the preparations are completed and the application is finished, it is time to inspect the SPF. This section describes what to consider when inspecting SPF and various additional items to consider recording on the inspection report. Examples of performance testing, including blower-door air leakage tests, carbon-monoxide testing, and thermographic imaging are described, along with the documentation for the building owner.

This Section on Post-Application is largely based on the Spray Polyurethane Foam Alliance's Building Envelop (BE) Inspector Manual.

5.1) Frequency of Post-Application Inspection

Inspect SPF installations daily, after completion, or both as part of an internal quality control process. Consider hiring an independent, third-party expert to perform some or all of the inspections. If the inspection takes place immediately after installation, wear full PPE.

5.2) Visual Inspection

Scope of Visual Inspection: In general, a visual inspection can help identify the following examples:

- Specific assemblies are insulated to sufficient levels in accordance with the project scope and specifications
- SPF is installed to provide a continuous air barrier, if that is in the scope of work
- SPF is fully adhered to the substrates and is well bonded to cavity framing members
- Surface profile is satisfactory
- Color is uniform and consistent
- SPF is free of cracks, blisters, and delamination
- Thermal barriers, ignition barriers, and coatings/coverings are installed as required by codes

The above list is an example of items to consider when doing a visual inspection. There may be other items that you want to include in a visual inspection.

Reporting of Visual Inspection Results: An SPF Insulation Inspection Report can be used to record visual inspection results and commentary. Including photographic documentation along with the visual observations is a good practice.

5.3) Thickness Measurement

Insulation thickness is typically a fundamental part of an insulation project specification. Thickness can vary depending on several factors, which may include the following:

- **Specification:** The specified thickness is typically related to R-value. Some specifications may require a minimum thickness or R-value while others may require an average thickness or R-value. Often these requirements correspond, at a minimum, to R-values prescribed by the applicable building codes. Refer to the applicable building code for more information.
- **Application Technique within Assembly Cavities:** Many applicators, especially for closed-cell foam, use a “picture framing” technique where the edges of the cavity are sprayed first (referred to as forming a cant), and then the middle is filled in with an up-and-down or side-to-side motion. This can leave the middle section thinner than the edges. Maintain specified minimums or averages in the middle of the cavity.
- **Surface Profile:** Spray foam surface profiles are rarely, if ever, completely flat. Variations occur for a number of reasons and leave a characteristic profile variation. Open-cell SPF exhibits greater profile variations than closed-cell SPF. In spite of profile variations, maintain specified minimums or averages set forth in the applicable building codes.



Figure 16:
Maintain average
thickness throughout

Thickness Measurement Method, Frequency, and Reporting: Thickness measurements can be obtained through nondestructive means by using a reference to measure the foam thickness. The reference can be the framing member or other objects of known measurements. Foam thickness measurements can also be made directly using a calibrated probe gauge or a probe and ruler. Take representative thickness measurements at regular intervals.

Note any areas where thickness measurements fall below minimum or average thickness requirements set by the project and building codes. Clearly mark and repair holes left by thickness measurement probes, as appropriate. If independent inspectors perform the foam thickness measurements, they typically will limit any puncturing of the foam membrane. In addition, it is typically the inspector’s responsibility to repair holes or damage made during the inspection process. A low-pressure SPF product can be used to fix holes created during inspections. Small pin holes may not need to be repaired.

5.4) Physical Sampling and Testing Best Practices

Purpose and Procedure for Physical Sampling (Optional): Physical sampling involves destructive investigation, but can help verify the quality of the installed SPF. Visual inspections and touching the foam (proper PPE is required and can vary depending on amount of time after application) may be sufficient; however, core sampling can be helpful, especially if a concern about quality is suspected. Core sampling involves removing a full thickness sample of SPF from the finished assembly, such as from the wall stud cavity. This may be accomplished using a foam coring tool. Alternatively, a rectangular core may be removed using various cutting tools (e.g., a sharp knife for open-cell SPF or a saw for closed-cell SPF). The core holes can be visually inspected for consistent color, density, and limited cracks and blisters. A low-pressure SPF product along with other options can be used to repair core holes.

5.5) Performance Testing Best Practices

One prominent attribute of SPF is its ability to expand in place and seal cracks, gaps, and penetrations. SPF can function as an integral component of an air barrier system throughout the entire building envelope. SPF, used in conjunction with compatible accessories such as caulks and sealants around framing, windows, and doors can allow for significant reductions in building air leakage and increased energy savings.

Blower Door Testing: Blower door testing is used to verify the air tightness of single-family residential homes and small commercial buildings. The details of this test procedure are described in ASTM E779. Blower-door testing is required by the 2012 International Residential Code (IRC) and all new residential construction receiving ENERGY STAR certification. Blower door testing is also an integral part of many home performance contracting or rating services where the test is performed before and after the energy efficiency improvements are made. Consider measuring air leakage rates via a blower door test after retrofit work and check minimum ventilation requirements to help achieve adequate indoor air quality. Performing a blower-door test after a SPF installation but prior to drywall installation helps the SPF contractor verify a quality installation. During the blower-door test, air leakage locations can be identified and addressed by the SPF contractor.



Figure 17: Blower door testing

Carbon Monoxide Monitoring: Due to the tighter building envelope after SPF applications, undertake carbon monoxide (CO) monitoring and check for safe levels of CO inside the building when combustion appliances, such as ranges, furnaces, and fireplaces, are present. More information about CO in buildings can be found at www.epa.gov/iaq/co.html#MeasurementMethods.

Blower door testing and CO monitoring requires specialized equipment and training. Organizations like Residential Energy Services Network (RESNET) and the Building Performance Institute (BPI) maintain lists of companies and organizations that provide this training. SPF installers that do not have the proper equipment and training to perform the testing can refer to these lists for information on experienced professionals to perform blower door testing and CO monitoring.

Thermographic Imaging (Optional): Thermographic imaging (TGI), or infrared photography, is a non-destructive means to evaluate the quality of an SPF installation. It is often difficult to apply SPF in every cavity and location in a building; however, TGI can detect areas of the building envelope with missing insulation or where excessive air leakage is present. If used after the initial SPF application and prior to drywall installation, TGI enables the SPF contractor to more easily identify and address deficiencies in the initial installation. TGI works best with a relatively large temperature differential, typically 20 to 30 degrees Fahrenheit, between the inside and outside of the building.

As with blower-door testing and CO monitoring, TGI requires training and experience to effectively use this equipment and properly interpret results. Many home performance contractors and home inspection services use TGI.

5.6) Posting of Code Compliance Material Documentation

As part of the post-installation inspection report, the SPF contractor typically provides certain documentation to the building owner. Some of the documentation is required by federal, state, or local ordinances or codes. Consult the local authority having jurisdiction (AHJ) to determine the specific requirements for any given location. Requirements can differ between retrofit and new construction applications in some jurisdictions.

In addition to jurisdictional requirements, it is good practice to include the following documents:

- Manufacturer's Product Data Sheets.
- MSDS documents for finished foam material and coatings.
- Evaluation Reports (as applicable) or test data to support code compliance can be included in lieu of an Evaluation Report.
- Lot/batch numbers of all materials used.
- Location and installed thickness (R-value) of SPF.

5.7) Posting of Use/Occupancy Statements

Current model building codes also require an Installation Certificate. Typically a copy of this certificate is provided to the building owner or general contractor/builder, and a copy is left in a conspicuous location in the building (e.g., near the main electrical panel or in the utility room). The building owner may need to provide this to code officials, energy raters, or home performance contractors for verification of the work done.

6) Emergency Procedures

Introduction to Emergency Procedures

If something does go wrong during the application, knowing what to do and who to contact can help limit the damage and hazards posed to the crew and the environment. This section discusses emergency procedures to consider, including whom to contact, how to handle spills to minimize contamination to the environment, and information on fire safety and first aid. These are some, but not all, of the many items to consider when an emergency occurs.

6.1) Emergency Contact Numbers

Access to emergency services is essential for the safety and welfare of the application crew. On larger projects, the general contractor normally has standard procedures to follow in an emergency situation. Post emergency contact information so it is readily available to all personnel. Inform crew members on where to find emergency information, including phone numbers, address or location of the jobsite and/or directions to the jobsite for emergency personnel, MSDSs, and emergency equipment on the spray rig. Contact information for the following are commonly provided to crews:

- Local fire department
- Local emergency medical services
- Local emergency management organization
- Local environmental management agency
- General contractor/owner emergency contact numbers
- CHEMTREC: 1-800-424-9300 and www.chemtrec.com

6.2) Spill Response Considerations

A spill or release is the unplanned discharge of a material to the ground, water, or air. If this happens, take action to minimize environmental contamination. Comply with federal, state, and local laws and ordinances for spills and responses to spills. Refer to the MSDS for more information. More details on spill response can be found in the CPI Health and Safety Workbook:

<http://www.spraypolyurethane.org/Workbook>.

Isocyanate (A-Side Product) Spill: In the event of a large isocyanate (A-side) spill or release, contact an accredited and trained hazardous material spill response team to address the spill. If the SPF crew has appropriate training and equipment, small spills can be handled by following the company's procedure.



Figure 18: Spill kit

General procedures to follow during an A-side spill can include, but are not limited to, the following:

- Direct all personnel away from the immediate area to avoid unnecessary exposure
- Provide appropriate PPE in accordance with OSHA regulation.
- Absorb the MDI with such substances as sand, wet earth, or absorbent clays (e.g., vermiculite)
- Place the absorbed material in drums and neutralize, as described in the MSDS. It is typically recommended to not seal the drums for at least 48 hours
- If you have exceeded the reportable quantity (RQ) (RQ for MDI is 5,000 lbs), call the EPA's Superfund Call Center 1-800-424-9346 or consult 40 CFR §302.4 to determine if the RQ has been exceeded
- If you determine that you have exceeded this amount, the EPA requires that the spill be reported to various government agencies
- Characterize waste (i.e., hazardous or nonhazardous waste) and dispose of waste in accordance with all applicable regulations. Report sizable isocyanate or solvent spills or releases to a Local Emergency Planning Committee (LEPC), State Emergency Response Commission (SERC), and the National Response Center (NRC). There are legal penalties associated with not reporting

Polyol Spill (B-Side or Resin): If B-side product is released or spilled, evacuate personnel not involved with the clean-up and refer to the MSDS for recommended actions. Wear appropriate PPE as set forth by the MSDS and OSHA. Consider steps like damming up or containing the spill in other ways to prevent spreading and possible environmental contamination. Cover the spilled material with absorbent material (e.g. sawdust, clay absorbent, dry sand, or earth). Consider shoveling the material into suitable containers for waste disposal. Wash the spill area with soap and water to dilute and remove remaining traces of the material. Ventilate the area to remove any remaining vapors. Contact the appropriate authorities.

Consult the MSDS for specific disposal and response information for both A-side and B-side spills.

Cured polyurethane foam typically does not meet the criteria of a hazardous waste, according to the Resource Conservation and Recovery Act (RCRA) guidelines, and can be acceptable for landfill disposal. However, consider contacting the disposal facility in advance. Some landfill facilities may ask for an MSDS for cured polyurethane foam before allowing disposal.

6.3) Fire Considerations

There are type A, B, and C fire extinguishers (typically dry chemical extinguishers) and professional fire fighting foams that may be used when there is a small fire. Water may also be used in large quantities. SPF is a combustible material similar to many other components in a building. SPF fires can grow very quickly and beyond the point of control of normal extinguishing practices. Evacuate all unnecessary personnel from the affected area during a fire as soon as possible and immediately contact the local fire authorities.

6.4) First Aid Considerations

Applicators are required by OSHA standard 29 CFR 1910.151 to have a person or persons adequately trained to render first aid for worksites that are not in proximity to an infirmary, clinic, or hospital. Design a first aid program to reflect the known and anticipated hazards of spray foam application, which could include general first aid issues and chemical exposure issues. Consult with local emergency medical experts and providers of first-aid training when developing a first-aid program. The program is required to comply with applicable OSHA standards and regulations.



Figure 19: Develop a first aid program



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7) List of Additional Sources and References

Below is a list of some of the training programs that an SPF installation company can utilize for the training of employees, including SPF installers (Section 1 of this Guidance):

- **Center for the Polyurethanes Industry (CPI)**
Spray Polyurethane Foam Health and Safety Training
www.spraypolyurethane.org/SPF-Chemical-Health-and-Safety-Training
- **Occupational Health & Safety Administration (OSHA)**
Outreach Class for Construction: 10-hour version or 30-hour version
www.osha.gov/dte/outreach/index.html
- **Spray Polyurethane Foam Alliance (SPFA)**
SPF Accreditation Program
www.sprayfoam.org/index.php?page_id=372

The following are some of the safety references, discussed in Section 2, for handling fire safety issues when working with SPF:

- **U.S. Model Building Code Fire Performance Requirements**
<http://polyurethane.americanchemistry.com/Resources-and-Documents-Library/11361.pdf>
- **Fire safety guidance when working with polyurethane foam products during new construction, retrofit and repair**
<http://polyurethane.americanchemistry.com/Resources-and-Documents-Library/11365.pdf>

Organizations Having Helpful Information or Training Materials on the Use and Handling of Spray Polyurethane Foam:

- ACC Center for the Polyurethanes Industry (CPI)
www.spraypolyurethane.org www.polyurethane.americanchemistry.com
- Spray Polyurethane Foam Alliance (SPFA) www.sprayfoam.org
- Insulation Contractors Association of America (ICAA) www.insulate.org
- Sustainable Workplace Alliance www.sustainablewp.org
- U.S. Government Agencies
 - Environmental Protection Agency
http://www.epa.gov/dfe/pubs/projects/spf/spray_polyurethane_foam.html
 - National Institute for Occupational Safety and Health www.niosh.gov
 - Occupational Safety & Health Administration (OSHA)
www.osha.gov www.osha.gov/dep/greenjobs

Additional Resources on First Aid and Cardiopulmonary Resuscitation (CPR)

- American Association of Occupational Health Nursing www.aaohn.org
- National Safety Council www.nsc.org
- American Red Cross www.redcross.org
- Center for the Polyurethanes Industry's Health and Safety Product Stewardship Workbook for High-Pressure Application of Spray Polyurethane Foam (SPF) <http://www.spraypolyurethane.org/Workbook>

Table of some OSHA Standards Related to SPF Application. Please go to the code of federal regulations online (www.gpoaccess.gov/cfr/) for the most updated information.

Title	Industry	Reference
<i>General Duty Clause</i>	All	29 CFR 5 (a)(1)
<i>Air Contaminants</i>	General	29 CFR 1910.1000
<i>Limits for Air Contaminants</i>	General	29 CFR 1910.1000 Table Z-1
<i>Hazardous Atmospheres and Substances</i>	Marine Terminals	29 CFR 1917.23
<i>Hazardous Atmospheres and Substances</i>	Longshoring	29 CFR 1918.93
<i>Gases, Vapors, Fumes, Dusts, and Mists</i>	Construction	29 CFR 1926.55
<i>Hazard Communication</i>	General	29 CFR 1910.1200
	Shipyards	29 CFR 1915.1200
	Marine Terminals	29 CFR 1917.28
	Longshoring	29 CF. 1918.90
	Construction	29 CFR 1926.59
<i>Personal Protective Equipment</i>	General	29 CFR 1910, Subpart I
<i>Personal Protective Equipment</i>	Shipyards	29 CFR 1915, Subpart I
<i>Personal Protection</i>	Marine Terminals	29 CFR 1917, Subpart E
<i>Personal Protective Equipment</i>	Longshoring	29 CFR 1918, Subpart J
<i>Personal Protective and Life Saving Equipment</i>	Construction	29 CFR 1926, Subpart E
<i>Respiratory Protection</i>	General	29 CFR 1910.134
	Shipyards	29 CFR 1915.154
	Marine Terminals	29 CFR 1917.92
	Longshoring	29 CFR 1918.102
	Construction	29 CFR 1926.103
<i>Ventilation</i>	General	29 CFR 1910.94
<i>Ventilation and Atmospheric Conditions</i>	Longshoring	29 CFR 1918.94
<i>Ventilation</i>	Construction	29 CFR 1926.57
<i>The Control of Hazardous Equipment (Lockout/Tagout)</i>	General	29 CFR 1910.147
<i>Confined Spaces</i>	General Industry	29 CFR 1910.146
	Construction	29 CFR 1926.21
<i>Work in Confined or Isolated Spaced</i>	Shipyards	29 CFR 1915.94,
<i>Confined and Enclosed Spaces and Other dangerous</i>		29 CFR 1915, Subpart B
<i>Atmospheres in Shipyard Employment</i>		
<i>Walking and Working Surfaces</i>	General Industry	29 CFR 1910 Subpart D
<i>Scaffolds, Ladders, and Other Working Surfaces</i>	Shipyards	29 CFR 1915, Subpart F
<i>Working Surfaces</i>	Longshoring	29 CFR 1918, Subpart D
<i>Occupational Noise Exposure</i>	General Industry	29 CFR 1910.95
	Construction	29 CFR 1926.52

8) Appendices

The following pages contain checklists and printable resources for your use during the installation process.

8.1) Jobsite Safety Plan

You may have different components to your plan due to your jobsite.



	Verification that all personnel read and understand the MSDS for each material involved with the spray polyurethane foam application process.
	A copy of the most current MSDS should be available at all times (i.e. cab of the truck or in the trailer that is transporting the spray equipment).
	Communication procedures between the crew and customer.
	Overspray mitigation plan.
	Proper start-up and shut-down procedures for both SPF process equipment and the customer's equipment (i.e. HVAC system) when applicable.
	Review of Manufacturers Technical Data sheets that detail proper application procedures.
	Onsite review of the jobsite; note any potential safety hazards and special needs.
	Controlling access to the spray area.
	Proper set up for all equipment with particular emphasis on ladders or scaffolding which could present fall hazards.
	Proper set up for establishing the work area and restricting access by posting warning signs.
	Emergency procedures with notification procedures.
	Chemical spillage with current remediation procedures and notification procedures.
	Jobsite location and directions to the jobsite from the nearest major intersection.

8.2) Equipment Inspection (Safety) Checklist

Each jobsite may have unique needs to consider and include in its Jobsite Safety Plan.

✓ Air and chemical leaks

	Inspect air and chemical lines for signs of wear or fatigue.
	Ensure the compressed air system has the proper OSHA-compliant disconnects.

✓ Proper ventilation of engine exhausts

	Verify adequate ventilation. The buildup of carbon monoxide from engine exhausts can be deadly.
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✓ Ladders, scaffolding, and aerial lifts

	Improper use of ladders, scaffolding, and aerial lifts can be a source of jobsite injuries or deaths. Proper use of ladders, scaffolding and aerial lifts is a major point of emphasis in the overall jobsite safety plan.
	Consult the OSHA website along with the manufacturers care and use specifications for this equipment.

✓ Hoses, electrical cords and lights

	Use properly rated electrical cords and lights.
	Remove from service cords that are damaged, frayed or spliced.
	Properly ground/bond plugs and receptacles, including ground wire.

✓ Ventilation fans and ducts

	Clean fans and check if fully operational.
	Clean ducts and seal to eliminate leakage.

✓ Chemical storage and handling

	Proper environmental controls to ensure proper storage conditions.
	Proper restraining devices to secure chemicals during transportation.
	Spill control equipment.
	Decontamination solution.

✓ Emergency equipment

	A fully stocked and OSHA-compliant first aid kit.
	Eye wash station.

✓ Fire Prevention

	Fire extinguisher(s) fully charged and accessible.
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✓ Other

	Tools, spare parts, and equipment manuals.
	Jobsite Safety Plan.



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