Health and Safety Product Stewardship Workbook For High Pressure Appplication of Spray Polyurethane Foam (SPF)

June 2016

American Chemistry Council | Center for the Polyurethanes Industry

Disclaimer

This Work presents general information with respect to the use of spray polyurethane foam chemicals and other associated chemicals used in spray polyurethane foam applications. It cannot and does not present chemical-specific information with respect to a particular job. For specific information related to the chemicals used on a particular job, and the specific health hazards that may be presented by such chemicals, consult the manufacturer's Safety Data Sheets (SDS) for information.

The information presented in this Work is necessarily general in nature and individual companies may vary their approach with respect to particular practices based on specific factual circumstances and the practicality and effectiveness of particular actions. Any mention of any specific product, service, supplier, or vendor is for illustrative purposes only and is not intended to constitute an endorsement.

ACC will not be held liable for any improper or incorrect use of the Information presented in the Work and it assumes no responsibility for any user's use of them. In no event shall ACC be liable for any direct, indirect, incidental, special, exemplary, or consequential damages however caused or on any theory of liability arising in any way out of the use of the Work. This disclaimer of liability applies to any damages or injury, including but not limited to those caused by any alleged breach of contract, warranty, tortious behavior, negligence, or under any other cause of action. Information included in the Work may include technical inaccuracies or typographical errors. The Information is subject to updates and changes may be periodically incorporated. Check for the most recent update to this Work on www.spraypolyurethane.com or consulting with ACC's Center for the Polyurethanes Industry staff.

ACC makes no warranty or representation, either express or implied, with respect to the accuracy or completeness of the Information contained in this manual; nor does ACC assume any liability or responsibility for any use or misuse, or the results of such use or misuse, of any information, procedure, conclusion, opinion, product, or process disclosed in the Work. ***NO WARRANTIES ARE GIVEN; ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE ARE EXPRESSLY EXCLUDED.***

Law and Jurisdiction The terms and conditions of use of the Work will be governed by and construed in accordance with the laws of Virginia without regard to its conflicts of law provisions. Any cause of action must be brought in Virginia.

Table of Contents

Disclaimer 1
Table of Contents 2
1Scope of Workbook 4
2 Overview of Spray Polyurethane Foam (SPF) 4
3 Potential for Exposure During SPF Application 4
3.1 A-Side 4
3.2 B-Side 7
3.2.1 Polyols 7
3.2.2 Catalysts 7
3.2.3 Blowing Agents 8
3.2.4 Flame Retardants 8
3.2.5 Surfactants 8
3.3 Coatings, Primers, and Organic Solvents 9
4 Hazard Communication 9
4.1 Labels and Other Forms of Warning 9
4.2 Safety Data Sheets (SDS) 12
4.3 Employee Training and Information 12
4.4 “Green” Marketing Claims and Hazard Communications 13
5 Good Practices 13
5.1 Engineering Controls 13
5.1.1 Workspace Containment 14
5.1.2 Ventilation Design 15
5.2 Work Practices 16
5.2.1 Site Preparation 16
5.2.2 Occupant Outreach 17
5.2.3 Chemical Storage and Handling 18
5.2.4 SPF Application 19
5.2.5 Trimming and Cutting 20
5.2.6 Coating and Priming 21
5.2.7 Cleanup and Equipment Maintenance 21
5.2.8 Spill Response 22
5.2.9 Disposal of SPF Chemicals and Drums 23
5.2.10 Reoccupancy 23
5.3 Personal Protective Equipment (PPE) 24
5.3.1 PPE Evaluation 25
5.3.2 Protective Clothing 25
5.3.3 Gloves 26
5.3.4 Eye and Face Protection 27
5.3.5 Respiratory Protection 28
5.3.6 PPE Care and Maintenance 32
5.3.7 First Aid 33
6 Other Considerations for SPF Application 33
6.1 Electrical Hazards 33
6.2 Confined spaces 34
6.3 Pressurized Equipment 34

6.4 Walking and Working Surfaces..... 34
6.5 Occupational Noise..... 35
6.6 Temperature Stress..... 35
6.7 Environmental Reporting..... 35
Appendix A: SPF Systems – High Pressure and Low Pressure..... I
Appendix B: General OSHA Standards Related to SPF Application..... II
Appendix C: Occupational Exposure Limits..... III
Appendix D: Discussing Spray Foam Application with Building Owners and Occupants..... V
Appendix F: Additional Resources..... VI

1. Scope of Workbook

This Workbook provides guidance to applicators and helpers who apply professional grade high pressure spray polyurethane foam (SPF) in both interior and exterior construction applications. While other SPF products (including but not limited to one-component foams (OCF) and two-component low pressure kits) may also be used at construction sites, they are not the primary focus of this Workbook. Further guidance is provided in Appendix A to this Workbook with respect to low-pressure SPF products and available at www.spraypolyurethane.org.

When this Workbook refers to "SPF chemicals," we are referring specifically to those chemical components that are used to make professional grade, high pressure SPF. Other chemicals, coatings, and solvents may be used at a spray foam application site, and this Workbook also will address some – but not all– of the more commonly used materials.

This Workbook addresses the spray foam application job including initial site assessment, occupant outreach, site preparation, SPF chemical storage and handling, SPF application, trimming and cutting, coating and priming of the foam surface, site cleanup, spill response, disposal of SPF chemicals, and reoccupancy.

2. Overview of Spray Polyurethane Foam (SPF)

SPF is formed via an exothermic (heat-releasing) chemical reaction between approximately equal amounts of polymeric methylene diphenyl diisocyanate (pMDI) and a polyol system, referred to as the A-side and the B-side, respectively. The A-side or pMDI, is typically a mixture of monomeric MDI (primarily 4,4'-MDI, a two ring structure) and 50% higher molecular weight oligomers of MDI. The B-side, or resin, is a mixture of polyols and other chemicals that have specific roles in the reaction process or impart important characteristics to the finished foam insulation. These chemicals may include catalysts, blowing agents, fire retardants, or surfactants. Among these constituents, the A-side is generally considered to present the greatest potential hazard due to its potential to produce respiratory and dermal sensitization.

Within a few minutes of application, the foam achieves a tack-free state when the foam surface is no longer sticky. Respirators and other protective equipment are needed to minimize exposure to vapors and aerosols of pMDI, and other chemicals during the spray application and subsequent operations. Depending on the characteristics of the foam, including the composition of the B-side chemicals, the heat dissipated during the exothermic reaction, and ambient conditions including temperature and humidity, some manufacturer's times range from 8 to 24 hours before the foam is fully cured. Curing is not related to chemical emissions, but when the optimum physical properties of the foam are achieved), depending on product and site conditions. Follow the manufacturer's instructions regarding the amount of time between applying layers or passes.

3. Potential for Exposure During SPF Application

The potential risk from exposure to a chemical is dependent on several factors, including the route of entry, the dose, the frequency and duration of exposure, and the individual's susceptibilities such as whether the individual has already become sensitized to the chemical.

The **route of entry** is how a substance enters the body. For SPF chemicals, the exposure would typically occur through breathing (inhalation), direct skin contact, or eye contact. Skin or eye contact may occur through direct contact with the chemical or through contact with contaminated supplies, contaminated equipment, or contaminated personal protective equipment (PPE). Further, if an individual eats, drinks, or smokes after working with chemicals and does not wash hands prior, the chemical may be inadvertently ingested. The chemical must enter the body through one of the routes of exposure for an effect to occur. The **dose** is the amount of a chemical that enters the body. The **frequency and duration** of exposure are other important considerations. How long did the exposure last? How often did the exposure occur? **Individual susceptibilities** affect the likelihood of an individual to experience a response such as whether the individual has become sensitized to the chemical.

It is critical to avoid inhalation, skin, and eye contact with SPF chemicals.

For inhalation exposure, occupational exposure limits (OEL) to various chemicals have been set by regulatory agencies and other organizations, including the Occupational Safety and Health Administration (OSHA), the National Institute for Occupational Safety and Health (NIOSH), and the American Conference of Governmental Industrial Hygienists (ACGIH). These limits are the air concentrations that these organizations believe represent exposures that are acceptable from a health perspective for healthy workers and – depending on the organization – may include time-weighted averages (TWA) for the duration of an entire work shift, short-term exposure limits (STEL), and ceiling limits (C). Additional information regarding OELs and a table including OELs for some chemical components in SPF chemicals, coatings, and solvents are included in Appendix C of this workbook.

If there is the potential for exposure to an employee in excess of the above mentioned OEL, employers must consider engineering controls, administrative controls and PPE to reduce exposure to workers. Engineering controls may include establishing a containment zone that is mechanically ventilated using adequately-sized exhaust and supply air systems. (See Section 5.1 of this document.)

The following sections detail chemical substances that may be encountered during the application of SPF.

Note: This Workbook does not discuss chronic health hazards that may be presented by SPF chemicals or other chemicals, coatings, or solvents at a worksite. Generally, the terms "acute" and "chronic" are used to delineate between effects on the basis of severity or duration. "Acute" effects usually occur rapidly as a result of short-term exposures, and are of short duration. "Chronic" effects generally occur as a result of long-term exposure, and are of long duration. Consult the manufacturer's SDS for more information with respect to potential chronic and acute health hazards.

3.1 A-Side

The A-side is typically a mixture of approximately 50% monomeric MDI and 50% higher molecular weight oligomers of MDI. A-side chemicals are very reactive. Reactions can result from improper mixing with water; acids; inorganic bases (such as sodium hydroxide),

ammonia, and amines; magnesium, aluminum and their alloys; other metal salts, especially halides (such as tin, iron, aluminum and zinc chlorides); oxidizing agents (such as bleach or chlorine); or polyols.

Personnel may be exposed to airborne concentrations of A-side SPF chemicals during: 1) handling of SPF chemicals prior to beginning work, 2) application of SPF, 3) trimming, cutting, and shaping immediately after SPF application, 4) cleanup and equipment maintenance, and (5) spill response. During these tasks, restrict work area access to personnel whose job responsibilities require them to be in the work area, and who are trained in the hazards of exposure to A-side chemicals and are using the appropriate PPE properly. Hazardous concentrations of A-side chemicals are not anticipated within minutes after application. However, rentry to the work area may also be influenced by the potential risk of airborne exposure to B-side chemicals.Contact your supplier for information regarding when applicators, helpers, other trade workers, and occupants may re-enter the work area.

Inhalation overexposure can cause 1) irritation of the nose, throat, and lungs, causing runny nose, sore throat, coughing, tightness in the chest, and shortness of breath, and 2) respiratory tract sensitization (i.e., the development of asthma) with symptoms of chest tightness, shortness of breath, coughing, and/or wheezing. Sensitization is the process of developing an allergy to a substance resulting in an allergic response upon re-exposure. Sensitized individuals typically have a response to a chemical exposure at progressively lower concentrations, even below concentrations considered safe for most people. An asthma attack can be life-threatening. NIOSH notes that "early recognition of sensitization and prompt and strict elimination of exposures is essential to reduce the risk of long-term or permanent respiratory problems for workers who have become sensitized." www.cdc.gov/niosh/topics/isocyanates. **Individuals sensitized to SPF chemicals should not be assigned work tasks where there is potential for exposure to SPF chemicals.**[1]

A-side chemicals may have a musty odor, but because of the relatively high odor threshold, most people cannot smell A-side chemicals when present in concentrations equal to applicable OELs. **As a practical matter, this means that if you smell pMDI (musty odor), you may have exceeded the exposure limits.** If a musty odor is recognized over the course of work, exit the work area and re-evaluate engineering controls and PPE to prevent overexposure. The OELs for monomeric MDI are presented in Appendix C.

Skin or eye contact may occur throughout the application when there is a potential for contact with A-side chemicals or any items contaminated with A-side chemicals, such as supplies, tools, equipment, and PPE. Skin contact can cause 1) irritation, and 2) sensitization (allergy). Symptoms may include reddening, itching, swelling, and rash. Skin contact alone may lead to respiratory sensitization (asthma). Eye contact can cause reddening, tearing, stinging, and/or swelling of the eyes.

[1] Jolly, A., Klees, J., Pacheco, K., Guidotti, T., Kipen, H., Biggs, J., Hyman, M., Bohnker, B., Thiese, M., Hegmann, K., Harber, P. (2015). Work-Related Asthma. *J. Occup. Environ. Hyg.*, Vol. 57 - Issue 10, e121–e129.

3.2 B-Side

The B-side is a polyol resin system which typically contains a blend of several different classes of chemicals. These include the polyols—the principal ingredients—and smaller amounts of amine and/or metal catalysts, blowing agents, surfactants, and flame retardants. There is a large variation in the chemical composition of the B-side. A summary of the typical composition of a polyol resin system is depicted in Table1.

Table1: Typical Composition of Polyol Resin Systems

Component	Low Density, Open Cell SPF	Medium Density, Closed Cell SPF
Polyols	25-40%	45-60%
Blowing Agents	10-20%	10-20%
Catalysts	3-10%	3-10%
Flame Retardants	20-40%	10-20%
Surfactants and Glycerin	0-5%	0-5%

Personnel may be exposed to airborne concentrations of B-side SPF chemicals during: 1) handling of SPF chemicals prior to beginning work, 2) application of SPF, 3) trimming, cutting, and shaping SPF after application, 4) cleanup and equipment maintenance, and 5) and spill response. Restrict access to the work area during these tasks to personnel whose job responsibilities require them to be in the work area, who are trained in the hazards of exposure to SPF chemicals, and who are using the appropriate PPE properly. Contact your supplier for information regarding when other trade workers and occupants may re-enter the work area.

3.2.1 Polyols

Polyols are the primary components in the B-side and react with the A-side chemical to form polyurethane foam. Polyols are polyfunctional alcohols with low vapor pressure and low toxicity for all routes of entry into the body. However, they may be irritating to the eyes, skin, and respiratory tract at high exposure levels, especially during spray applications.

3.2.2 Catalysts

Catalysts promote the reaction between the B-side polyol and the A-side, helping polyurethane foam cells develop sufficient strength to maintain their structure to resist collapsing or becoming deformed. They also help with the completion of the reaction or "cure" in the finished foam. Most catalysts used in SPF are amine based; however, some B-side formulations may use metal catalysts.

The polyol resin blend typically contains 3-10% amine catalyst. Overexposure to airborne concentrations of amine catalysts may result in irritation to the respiratory system, skin, and eyes. Airborne exposure to the eyes may cause a reversible effect known as glaucopsia or “blue haze” or “halovision” in the eyes. Glaucopsia is characterized by clouding or fogging of vision due to swelling of the outer layer of the cornea. Once removed from the exposure, vision is gradually restored. If vision is not restored within a few hours, seek medical attention. Amines are derived from ammonia and often have a characteristic ammonia/fishy

odor. Exposure limits are not yet established for the majority of the amine catalysts used in SPF systems.

Metal catalysts usually comprise less than 0.15% of the polyol resin and may include organic tin compounds or other metals. Metal catalysts can be absorbed through the skin resulting in headache and/or nausea. Organic tin compounds can irritate the eyes, skin, and respiratory tract. Prolonged skin contact can cause dermatitis. Metal catalysts used in polyol resins do not have OELs.

3.2.3 Blowing Agents

The B-side polyol resin blend typically contains 10-20% by weight of blowing agents. Formulations may use chemical (reactive) blowing agents, physical blowing agents, or a combination of both types of blowing agents.

A chemical blowing agent reacts with another raw material to generate a gas. Water is often used as a chemical blowing agent in a polyol blend. It reacts with pMDI to generate carbon dioxide.

Physical blowing agents are vaporized by the heat of the polyurethane reaction. Hydrofluorocarbons (HFCs) are common physical blowing agents. Hydrofluoroolefins (HFOs) are being used as low-global warming potential alternatives in some SPF formulations. Skin and eye contact with physical blowing agents can result in contact irritation. Overexposure to airborne concentrations of physical blowing agents can be irritating to the respiratory tract, cause central nervous system depression, and in some cases can cause irregular heartbeat.

If large amounts of blowing agents are released in an enclosed area, oxygen can be displaced, resulting in an oxygen-deficient atmosphere which is a hazardous atmosphere. Because blowing agents comprise a small percentage of SPF and mechanical ventilation is required, an oxygen-deficient atmosphere is not likely to develop.

3.2.4 Flame Retardants

Flame retardants help to increase fire resistant characteristics of the finished foam. Flame retardants can range from 10% to 40% of the particular polyol resin system.

Chemical overexposure to flame retardants may be irritating to the respiratory tract and direct contact with flame retardants may be irritating to the eyes and skin. There are different classes of flame retardants and different toxicological profiles for these compounds, so the SDS must always be consulted for acute and chronic chemical-specific information.

3.2.5 Surfactants

Surfactants affect size and structure of foam cells. Surfactants are typically 0-5% of the polyol resin system. Surfactants include silicone polymers which typically have low toxicity by all routes of entry into the body. Some surfactants can cause slight irritation to the eyes, skin, and respiratory system. OELs have not been established for surfactants.

3.3 Coatings, Primers, and Organic Solvents

A variety of coatings may be used in conjunction with foam applications to protect the finished polyurethane foam from physical damage and exposure to ultra-violet (UV) light, particularly in roofing or exterior applications. These include acrylic, butyl, silicone, polyurea and polyurethane materials. Many of these roof coatings contain organic solvents such as toluene, petroleum distillates, xylene, methyl ethyl ketone, varnish makers and painters (VM&P) naphtha and n-butyl acetate. In addition, solvents may be used to prepare the surface prior to application or for cleanup after application is completed. A list of some of the solvents included in coatings and used for cleanup and their respective OELs is included in Appendix C.

Skin contact with organic solvents may result in defatting, drying, and cracking of the skin. Many organic solvents are readily absorbed through the skin. Solvents can also be inhaled. Effects due to overexposure to organic solvents may include headache, nausea, and vomiting followed by unconsciousness at higher levels of exposure. There also are reports of permanent nervous system damage resulting from long-term overexposure to many of the common organic solvents. Refer to the manufacturer's SDS for specific information related to the coatings, primers, and solvents you are working with.

4. Hazard Communication

According to OSHA, the Hazard Communication Standard (HCS) (29 CFR 1910.1200) was designed to provide employees with information on the identities and hazards of all chemicals used in the workplace and recommended protective measures. Pursuant to HCS, all employers are required to have a written hazard communications program. Violations related to the HCS are some of the most frequently cited by OSHA compliance officers. Requirements of the Standard include development of a written program to address the followings components: labels and other forms of warning, SDSs, and employee training and information. Additional guidance related to the HCS is available on OSHA's website at https://www.osha.gov/dsg/hazcom/.

4.1 Labels and Other Forms of Warning

According to the OSHA HCS, chemical containers must be labeled and the information included on the label must be legible and prominently displayed. Chemical labels identify the contents of a container used at a worksite. In addition, labels also convey information related to the toxicological, chemical, and physical properties associated with the chemical. When chemicals are transferred into unmarked containers, OSHA requires that these containers be labeled with the required information as well, except when transferred for immediate use by the employee who performed the transfer (29 CFR 1910.1200(f)(8)).

In 2015 OSHA revised the HCS 2012 to conform to the United Nations' Globally Harmonized System (GHS) of Classification and Labeling of Chemicals with implementation of most elements required. The revised standard requires labels on shipped containers have the following elements: pictogram, signal words, hazard statement, product identifier, manufacturer information, and precautionary statement. An example of the new pictograms and hazards is shown in Figure 1. Employers may choose to label workplace containers either

with the same label that would be on shipped containers for the chemical under the revised rule, or with label alternatives that meet the requirements for the revised standard (29 CFR 1910.1200(f)(7)). Alternative labeling systems such as the National Fire Protection Association (NFPA) and the Hazardous Material Information System (HMIS) are permitted for workplace containers. However, the information supplied on these labels must be consistent with the revised HCS. Additional guidance entitled *CPI Guidance on OSHA's Revised Hazard Communication Standard: Globally Harmonized System (GHS) of Classification and Labeling of Chemicals* is available at www.polyurethane.org.

Figure 1: OSHA HCS Pictograms and Hazards

Health Hazard  ▪ Carcinogen ▪ Mutagenicity ▪ Reproductive Toxicity ▪ Respiratory Sensitizer ▪ Target Organ Toxicity ▪ Aspiration Toxicity	**Flame**  ▪ Flammables ▪ Pyrophorics ▪ Self-Heating ▪ Emits Flammable Gas ▪ Self-Reactives ▪ Organic Peroxides	**Exclamation Mark**  ▪ Irritant (skin and eye) ▪ Skin Sensitizer ▪ Acute Toxicity ▪ Narcotic Effects ▪ Respiratory Tract Irritant ▪ Hazardous to Ozone Layer (Non-Mandatory)
Gas Cylinder  ▪ Gases Under Pressure	**Corrosion**  ▪ Skin Corrosion/Burns ▪ Eye Damage ▪ Corrosive to Metals	**Exploding Bomb**  ▪ Explosives ▪ Self-Reactives ▪ Organic Peroxides
Flame Over Circle  ▪ Oxidizers	**Environment** (Non-Mandatory)  ▪ Aquatic Toxicity	**Skull and Crossbones**  ▪ Acute Toxicity (fatal or toxic)

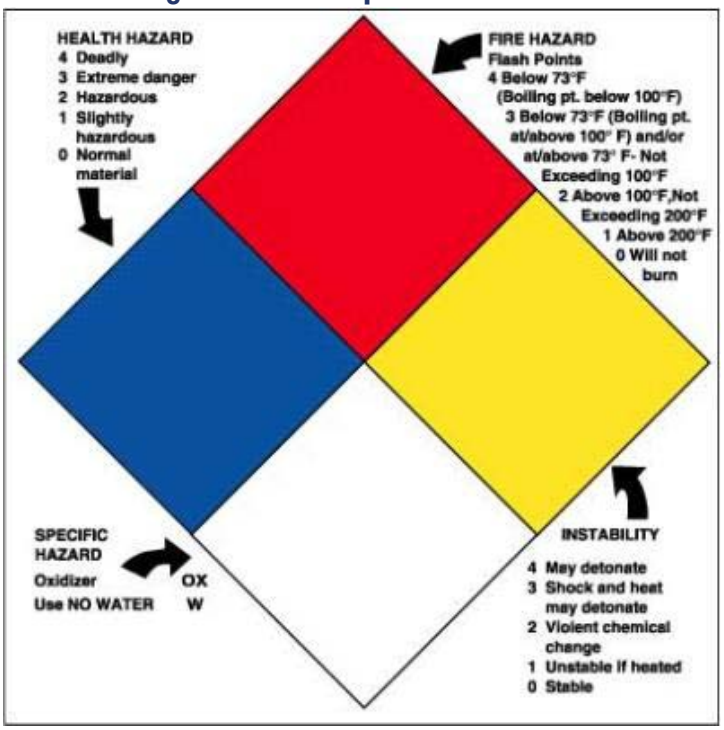
Many systems have been developed for labeling potentially hazardous chemicals. Two examples are the Hazardous Material Identification System (HMIS) and the National Fire Protection Association (NFPA) 704 Hazard Rating System. Note that, the two systems may have different hazard categories for the same material.

An example of a typical HMIS hazard-warning label is shown in Figure 2. It ranks the hazard the material poses from 0 to 4 in these categories: Health (blue), Flammability (red), and Physical Hazard (yellow). A rank of 0 indicates that the material presents a minimal hazard for that category. A rank of 4 indicates a severe hazard for that category. The HMIS label also may depict the type of PPE required, but review the narrative descriptions which may be found on the drum label and in the SDS.

Figure 2: Example of HMIS Label

An example of a typical NFPA hazard-warning label is shown in Figure 3. It is in the shape of four small diamonds that make up a larger diamond. Each small diamond contains a numerical ranking, again on a 0 to 4 scale, for the severity of the hazard in a particular category. In the NFPA label, the left diamond is for the health ranking (blue), the top for the fire or flammability ranking (red), and the right for the instability ranking (yellow). The bottom diamond (white) denotes any other significant hazards associated with the material such as a chemical that is reactive with water.

Figure 3: Example NFPA Label



4.2 Safety Data Sheets (SDS)

As part of the revised HCS, OSHA requires chemical manufacturers and importers to obtain or develop an SDS (formally known as Material Safety Data Sheets or MSDSs) for each hazardous chemical they produce or import. Employers are required to have an SDS in the workplace for each hazardous chemical they use. If you do not have an SDS for a chemical used at your worksite, contact the manufacturer.

Before using any SPF products, read and understand the entire SDS for the product. The SDS contains very important information about the product, including the chemical constituents and the approximate concentrations; the appropriate PPE for the job; information on how to handle accidental releases; and information on storage, handling, transportation, and disposal.

Because these documents are important, make them readily accessible at a job site. Keeping one clean copy of each SDS in a clearly marked binder is a good practice that helps keep the information readily accessible. Many contractors like to keep several spare copies of SDSs on hand; in the event of an emergency or incident, this allows multiple copies to be available for emergency responders. Another good practice is to review the location of the SDS binder with all workers on the SPF jobsite before the job begins. Note that OSHA requires that all SDS be readily available to all workers at the jobsite, which may include other trade workers.

In addition, it may be possible to obtain the SDS in multiple languages if needed. Contact the manufacturer for more information.

Additional CPI guidance entitled *Have You Read Your SDS?* is available at www.spraypolyurethane.org.

4.3 Employee Training and Information

As a component of the OSHA HCS, employees are expected to be provided Hazard Communication training upon initial assignment. Ensure all training requirements are met in accordance with OSHA 29 CFR 1910.1200(h). The training may include information on the hazardous chemicals the employees are working with, the control measures to reduce the potential for exposure, and how to read the SDS and product labels. The training also includes worksite-specific information including work practices, PPE to be used, and emergency procedures. OSHA requires that the employee have the opportunity to ask questions and be able to demonstrate comprehension.

Employees must be able to understand the training. When employees receive work instructions in languages other than English, employers are required to provide training in that language as well.

Additional training is needed when a new chemical hazard is introduced into the work area. At multi-employer worksites, multiple trainings may be needed so that all employees know where the SDSs are located, details related to the labeling systems, and the hazards associated with other chemicals at the worksite they may be exposed to.

4.4 "Green" Marketing Claims are not Hazard Communications

"Green" claims are typically found in advertisements, promotional materials, sales claims, and labels today. Green claims are the marketing response to consumers' increasing interest in protecting the environment. They can help consumers better understand the environmental attributes of a product or service, such as its contribution to energy efficiency, and help inform purchasing decisions.

An SPF marketing claim often points out a particular product feature or benefit; for example, an SPF marketing claim may point out that a product is made using a renewable, plant-based resource. A properly qualified "green" marketing claim about a particular attribute, such as renewable content in a product, should never be confused with the toxicity profile of a product. Consult application and use instructions, including SDS, manufacturer's instructions, and label instructions. An SPF marketing claim should not be confused with instructions on how to safely use and apply the SPF product. The Federal Trade Commission enforces such claims. Thus, companies should follow the FTC's Guides for the Use of Environmental Marketing Claims available on the FTC's website - https://www.ftc.gov/enforcement/rules/rulemaking-regulatory-reform-proceedings/guides-use-environmental-marketing-claims.

Additional CPI guidance entitled *"Green" Marketing Claims and Spray Polyurethane Foam* is available at www.spraypolyurethane.org.

5. Good Job Site Practices

It is critical to avoid inhalation of, and skin and eye contact with, SPF chemicals, for any person on the job site, including applicators, helpers, occupants, and adjacent workers. The following good practices include engineering controls, work practices, and PPE intended to reduce the potential for exposure to SPF chemicals via inhalation or skin or eye contact. Consider a combination of engineering controls, work practices, and PPE for SPF applications. Engineering controls are the first line of defense against chemical exposure, followed by the use of work practices and PPE.

5.1 Engineering Controls

Proper containment and ventilation techniques for indoor SPF applications can help protect workers and building occupants from potential chemical exposure. Containment creates a contained workspace while the ventilation system helps remove SPF chemicals from the work area by drawing the air out of the workspace through the use of a fan. Additional guidance entitled *Ventilation Considerations for Spray Polyurethane Foam* can be found at www.spraypolyurethane.org. In addition to the engineering controls, the use of proper PPE can further reduce the potential for inhalation exposure.

Before determining engineering controls, identify and define the workspace where SPF is being applied. Signs, barriers and construction tape can help separate work areas from other spaces where other trades or building occupants are allowed. Assign personnel to areas to prevent entry into work areas without authorization. Place signs where other trades and building occupants can see them before entering the work area. ***Example: Caution: Spray***

Foam application in process, no entry allowed without authorization and appropriate PPE. See Figure 4 for another example of a warning sign that may be used.

Figure 4: Example of Warning Sign

5.1.1 Workspace Containment

Workspace containment is used in conjunction with ventilation to help isolate and remove chemicals from the work area. A workspace does not need to be perfectly airtight, but containment is most effective when a workspace is as close to airtight as can practically be achieved. If a workspace is contained, clearly mark the area externally, and take appropriate steps to restrict entry into the workspace only to personnel wearing appropriate PPE.

One example of a way to create an effective containment space is to bound the workspace by solid walls (e.g., the outside walls where foam is applied), and solid floors and ceilings. Shut windows and doors, and seal them well; typically, plastic sheeting such as 4-6 mil polyethylene is used, secured well with a suitable tape. Temporary containment walls or curtains can be created by attaching the plastic sheeting to existing interior framing, or by using temporary framing. In either case, seal the seams and boundaries of the sheets with tape. An illustration is provided in Figure 5. When selecting a sealing technique, remember to maintain the function of windows and doors as emergency egress points. It also is important to note that this approach features a ventilation trade off: windows and doors are closed and sealed to create the containment space, whereas in many applications, open windows and doors to support improved ventilation are desirable. Additional guidance entitled *Ventilation Considerations for Spray Polyurethane Foam* can be found at www.spraypolyurethane.org.

Figure 5: Example of Temporary Containment Using Plastic Sheeting and Tape

After the contained workspace has been created, check it for air leakage. Activate the fans and get a visual check to be sure a negative pressure is being created. This can be as simple as observing an inward billowing of the plastic sheets. Air leaks can also be readily detected with a smoke pencil, shown in Figure 6, which are available at building supply stores.

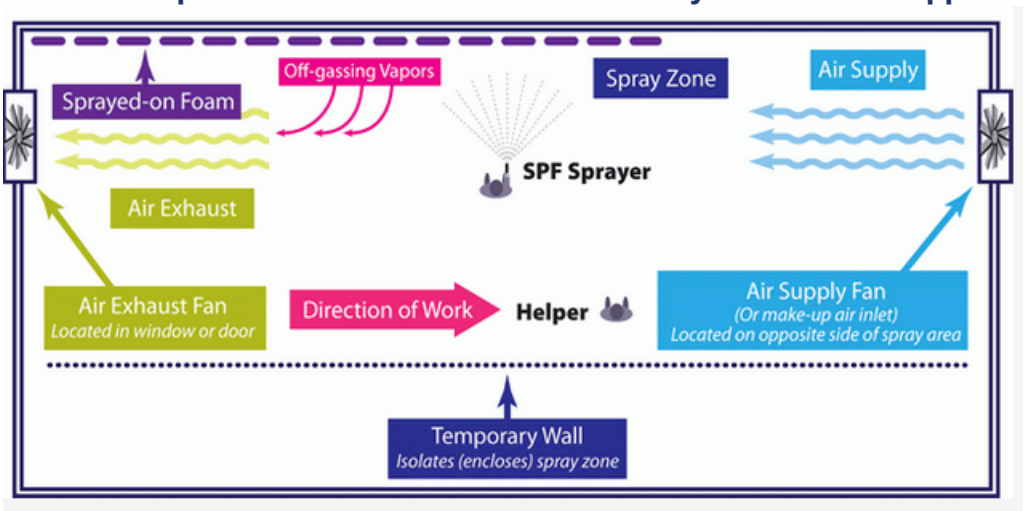
Figure 6: Smoke Pencil Used to Check for Air Leaks

5.1.2 Ventilation Design

Ventilation used with workspace containment helps remove chemicals from the isolated area via negative pressure. Having negative pressure in a contained work zone will draw in air from small cracks and gaps around the workspace boundary and exhaust the work zone air. Active ventilation is achieved by using one or more fans, with particulate filters, to draw air to or from the workspace and create negative pressure inside the workspace.

Give careful consideration to the location of the exhaust. Release exhaust air to a location outside the building away from occupied areas to protect occupants and workers in adjacent areas from potential exposure. Figure 7 provides an example of a ventilation system that may be used during SPF application.

Figure 7: Example Containment and Ventilation System for SPF Application



The Environmental Protection Agency (EPA) diagram establishing air flow across the spaying area and draw overspray away from the workers.

Additional guidance entitled *Ventilation Considerations for Spray Polyurethane Foam* can be found at www.spraypolyurethane.org and *Ventilation Guidance for Spray Polyurethane Foam Application* at www.epa.gov.

5.2 Work Practices

Employee work practices are an important factor in the overall safety performance at any worksite. Work practices are used in combination with engineering controls and PPE to reduce the risk of exposure to SPF chemicals via inhalation or skin or eye contact. The following work practices can be reviewed with employees involved in the spray foam application process, including applicators and helpers, as well as other trade workers who may work adjacent to the application area.

The use of hygiene practices can help minimize the possibility of ingesting SPF chemicals. Consideration is given to practices that may introduce SPF chemicals to the mouth and result in ingestion or inhalation, so worksites typically prohibit the storage, preparation, or consumption of food in areas where SPF chemicals are used, as well as smoking, tobacco, or gum chewing. To avoid ingestion, remove gloves and wash your hands after working with chemicals.

5.2.1 Site Preparation

There are many factors to consider when planning an SPF installation. Will the work take place in an occupied building or a building under construction? Will the building be vacated? Will other trades workers be present at the time of application? Will the application take place indoors or outdoors? What is the size of the work area – a large open area or an attic or crawlspace with limited ventilation? HVAC systems are typically shut down during some parts of roof preparation, as well as during application of primers, SPF, and coatings. System shut down modifies the drawing of dusts, aerosols and/or vapors into interior spaces. Once the HVAC system is shut down, seal the air intakes with plastic sheeting and tape, which will

prevent dust and spray from entering the intakes. Keep the plastic sheeting in place at least several hours after the spray application is completed; some manufacturers recommend 24 hours or more. A longer period may be appropriate for coatings, depending on when the coatings have hardened or set and are no longer emitting vapors. Do not restart the HVAC system until appropriate time has elapsed and the plastic sheeting and tape is removed. Contact the manufacturer for additional information.

Consider the following practices when preparing a site for SPF application:

- If the entire building is not vacated, consider the potential for SPF chemicals to migrate to other floors. Containment and ventilation methods may help prevent migration. Discuss with property management or other contractors which floors will be occupied.
- If local exhaust ventilation and containment methods are not used, establish a work zone around the work area to protect adjacent workers. The distance between the work area and adjacent workers should be at least 50 feet,[2] but depends on several factors including, but not limited to, the volume of SPF applied, the nature of the application area (location, size or volume of space), height of the structure, and air movement. Signs may be used to communicate access restrictions.
- Before beginning work, designate an area for putting on and removing PPE.
- Determine in advance the potential for overspray. Have a plan in place to address potential overspray damages to adjacent property. Train all employees in overspray prevention.
- Identify and protect surfaces that could be damaged (e.g., windows, doors, equipment, or building exterior) in advance of application.
- 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 be adjusted as needed. In slightly windy conditions, use windscreens.
- Do not spray foam or coatings in excessively windy conditions. Sustained wind speeds or gusts of about 15 mph (24 kph) make controlled application more difficult.

Additional guidance on *effective workplace practices* related to the application of SPF chemicals and interior and exterior applications is available at www.spraypolyurethane.org.

5.2.2 Occupant Outreach

SPF applicators and their helpers receive professional training regarding the hazards associated with SPF application. However, building occupants are not necessarily aware of the potential health hazards associated with SPF application or safety precautions to minimize the risk. SPF application involves the potential for exposure to a variety of chemicals, including SPF chemicals, coatings, and solvents. Consider potential exposures to all of the chemicals used on a job when developing an occupant outreach strategy.

[2] Ecoff, S., Lambach, J. (2012), *A Proposed Methodology for Establishing a Safe Work Zone Around an SPF Application to Exterior Walls of a Commercial Structure,* Paper presented at the CPI Polyurethane Technical Conference, Atlanta, 24-26 September.

Provide information to building occupants about the health hazards associated with the application of SPF and the ways they can protect themselves from these hazards. Communicate, with building occupants, the period of time before adults, children, and pets may reenter following installation. A sample checklist of information you may wish to consider discussing with owners, designees, or occupants is included as Appendix D. Although there is typically a lower degree of risk of inhalation exposure to SPF chemicals in exterior applications than interior applications due to natural ventilation, contractors may wish to consider use of the checklist as a tool to guide discussions with occupants. In commercial and public buildings, contractors may choose to provide additional outreach to building owners or their designee as well as to individual tenants.

On occasion, owners or their designee may wish to enter the work area before the building is cleared for occupancy in order to review the work. PPE may be needed for entry into the work area even for persons who are not involved in the application of SPF chemicals. You may wish to discuss alternatives for viewing the application or the work status with the owner or designee that avoid exposure issues, such as using photographs or real-time video to allow the owner or designee the opportunity to view the work.

5.2.3 Chemical Storage and Handling

It is important that SPF chemicals be stored properly before, during, and after use on the job site. Improper storage conditions can make the components unusable for certain coatings and solvents, and also can create a potential for fire and/or explosion. It is also important to store materials which are incompatible with each other in separate storage areas.

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 temperature at which to store drums; typically, temperatures between 45 and 75ºF are suggested. Materials which are allowed to freeze and then thaw, or overheat, can present hazards and product quality issues, so follow the manufacturer's instructions with respect to storage. Ventilate the storage space well, and locate the storage space away from possible sources of ignition.

Store pMDI (A-side) drums an appropriate distance from contact with water, acids, caustics (such as lye), alcohols, and strong oxidizing and reducing agents. Oxidizing agents include bleach and chlorine. Oxidizers can be recognized by a yellow diamond shaped label on the container marked "oxidizer" or a GHS pictogram with a flame over a circle (See Figure 1 in Section 4.1 of this document). Most strong reducing agents also are corrosive. These can be identified by a half-black, half-white diamond-shaped label marked "corrosive" or a GHS corrosion pictogram (See Figure 1 in Section 4.1 of this document). Contact of pMDI with any of these kinds of materials can 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 pMDI (A-side) containers to help protect against moisture or direct contact with water. Contamination with water could result in the drum rupturing or exploding because water slowly reacts with pMDI to produce carbon dioxide gas.

Likewise, store polyol system resin (polyol blend) drums an appropriate distance from acids, caustics, and strong oxidizing and reducing agents in order to avoid contact. When opening the "B" drums, the slow opening of the bung on top of the drum helps release built-up pressure so the drum can be opened safely. If heating drums with a blanket heater (or other methods), loosening the "B" side bung on the top of the drum will allow for off-gassing. A thermometer can be inserted into the material to monitor the material temperature to help prevent overheating; longer thermometers (24" in length) are available to access the liquid drum contents. Gentle agitation of materials helps evenly heat the contents.

Finally, coating or primer material drums or containers that contain solvents may have a U.S. Department of Transportation (USDOT) "Flammable" or "Combustible" label. Flammable labels are red and bear the word "flammable" and will also typically have a GHS flame pictogram. Store drums away from heat and ignition sources in a designated area or cabinet.

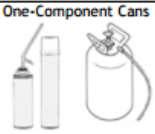
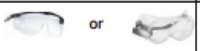
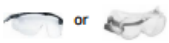
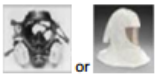
Appropriate PPE should be worn, in accordance with the SDS, by personnel handling containers with A-side or B-side chemicals to minimize the potential risk of exposure to SPF chemicals via inhalation or skin or eye contact. Depending on the task, this may include chemical-resistant gloves, chemical-resistant clothing, and eye protection. Respiratory protection may be needed if there is the potential for inhalation exposure.

5.2.4 SPF Application

When applying SPF, applicators and helpers can be instrumental in helping to reduce the potential risk of exposure to SPF chemicals for occupants and other trade workers at the worksite. Restrict the work area to personnel who are required to be in the work area due to their job responsibilities, have completed the required training, and who are properly using the required PPE.

Generally, appropriate PPE for high pressure applications includes at a minimum chemical-resistant gloves, protective clothing, eye and face protection, and respiratory protection. The specific types of PPE may vary depending on the conditions at the jobsite, such as whether the application takes place indoors or outdoors, the amount of ventilation, the specific components of the B-side chemicals, and the quantity of SPF chemicals applied. Figure 8 lists general PPE guidance for different SPF applications by product type. Refer to the manufacturer's SDS for specific information related to PPE for the products you are working with.

Figure 8: General PPE Guidance for Applicators and Helpers - All Systems

	Low Pressure SPF			High Pressure SPF
	One-Component Cans 	Two-Component Kits 	Refillable Systems 	High Pressure Spray Systems 
Potential Routes of Exposure	PPE recommendations may include:	PPE recommendations may include:	PPE recommendations may include:	PPE recommendations may include:
Eyes	 Safety Glasses with Side Shields	 Safety Glasses or Safety Goggles	 Safety Glasses or Safety Goggles	 Full Face (FF) Mask or Supplied-Air (SA) Hood
Skin	 Long Sleeves	 Long Sleeves	 Long Sleeves* *Additional PPE may be required (i.e., full body suit) depending on the job and/or the product. Consult manufacturer's instructions.	 Full Body Suit or Coverall with Hood/Long Sleeves
Hands	 Chemical Resistant Gloves	 Chemical Resistant Gloves	 Chemical Resistant Gloves	 Chemical Resistant Gloves
Lungs	Avoid Breathing Vapors Provide Good Ventilation 	Respirator  Air Purifying Organic Vapor (OV)/Pre-filter Provide Good Ventilation 	Respirator*  Air Purifying Organic Vapor (OV)/Pre-filter Provide Good Ventilation  *Additional respiratory protection may be required (i.e., FF mask) depending on the job and/or the product. Consult manufacturer's instructions.	Respiratory Protection*  FF Mask/ or SA Hood Pre-filter FF Air OV/ Purifying or Supplied Air Provide Good Ventilation  *PPE may vary depending on the job and/or the product. Consult manufacturer's instructions.

Attic and crawl spaces can present unique hazards due to the potential to generate hazardous atmospheres in confined spaces. Refer to the OSHA Permit Required Confined Space in Construction Standard (29 CFR 1926.1200) and the American National Standards Institute (ANSI) Standard Z117.1 *Safety Requirements for Confined Spaces* for information on additional requirements.

Ambient conditions (including temperature, humidity, and wind conditions) may affect the cure time and the time between material application passes. Ventilate interior application areas for a period of time following installation to allow aerosols and vapors to dissipate. If working outdoors, work upwind of the spray as much as possible.

Additional guidance materials *related to interior and exterior application of SPF* is available at www.spraypolyurethane.org.

5.2.5 Trimming and Cutting

Trimming and cutting of high pressure SPF may be necessary after application. SPF typically reaches 90% of its cure and will have obtained at least 90% of its optimal physical properties

within one hour of application. As the exothermic reaction of the foam subsides, the rate of cure slows down considerably, and it can take additional time to complete cure depending on the ambient temperature and humidity. In addition, study data currently available indicate that the surface reaction for SPF is complete within 15 minutes.[3] A study specifically conducted to evaluate particulates generated during trimming and cutting of SPF insulation, one hour after application, concluded isocyanates were not detected in the particulates generated, indicating no exposure to this SPF component when trimming is conducted.[4]

Trimming and cutting activities that will move beyond the surface into the interior of the applied SPF, where cure may still be occurring, may present the potential for exposures to SPF chemicals, and the need to wear appropriate PPE for this activity. PPE that may be needed during trimming and cutting includes chemical-resistant gloves, coveralls for skin and clothing protection, eye protection, and respiratory protection for inhalation exposure to dust and SPF chemicals. These PPE recommendations are supported by a study completed on SPF monitoring and reoccupancy of high pressure open-cell applications to new residential constructions.[5]

5.2.6 Coating and Priming

Chemicals used for coating and priming during SPF projects also may present a risk of potential chemical exposure. Generally, coatings and primers may contain organic solvents, although other chemicals also may be present. Some coatings and primers may be harmful if inhaled or upon skin contact. When using coatings and primers, consider the following PPE: chemical resistant gloves, protective clothing, eye and face protection and respiratory protection. In addition, if the SPF has not completely cured, then respiratory protection may be needed. Consult your manufacturer's SDS for specific information related to the contents and precautions during coating and priming.

5.2.7 Cleanup and Equipment Maintenance

After the application is completed, decontaminate the equipment, as necessary, and clean up the work area. Wear appropriate PPE while cleaning equipment contaminated with A-side or B-side chemicals and while handling any A-side or B-side containers (e.g., drums, buckets, spray guns). Use of a vacuum equipped with a high-efficiency particulate arrestance (HEPA) filter can help reduce the amount of dust generated during cleanup.

Upon exiting the work area, remove PPE in a designated clean zone away from the areas where there is a potential risk of exposure to SPF chemicals. Remove and dispose of PPE according to applicable local or state regulations. Inspect, maintain, clean, and store

[3] Lesage, J., Stanley, J., Karoly, W.J., & Lichtenberg, F.W. (2007). Airborne MDI Concentrations Associated with Application of Polyurethane Spray Foam in Residential Construction. *J. Occup. Environ. Hyg., 4,* 145-155.
[4] Spence, M., Graham, C. (2010). Evaluation of Particulates Generated During Trimming and Cutting of Spray Polyurethane Foam Insulation. Paper presented at the CPI Polyurethanes Technical Conference, Houston, 11-13 October.
[5] Robert, W., Anderson, J., Wood, R., Bogdan, M. (2014). Spray Foam Monitoring and Re-occupancy of High Pressure Open Cell Applications to New Residential Construction. Paper presented at the CPI Polyurethanes Technical Conference, Dallas, 22-24 September.

reusable PPE for continued effectiveness. Remove damaged PPE from service until repaired, or dispose of the damaged PPE and replace it.

It is a good work practice to keep work clothing at work. Note that leather items including shoes, belts, watch bands, or clothing, that have been exposed to liquid SPF chemicals cannot be decontaminated and are, therefore, to be disposed of appropriately.

5.2.8 Spill Response

A spill or release is the unplanned discharge of a material to the ground, water, or air. It is advisable to have an emergency spill containment kit available that contains absorbent materials such as clay, pads, or socks to contain or minimize the area affected.

A clean work site helps reduce trips, slips, and falls. Because B-side chemicals can be extremely slippery, mark and clean up spills, particularly from smooth walkways or floors, as soon as possible. Keep all containers of chemicals tightly sealed except when they are actually in use.

Although infrequent, spills and releases of A- and B-side chemicals can occur. If this happens, it is important to take immediate action to minimize environmental contamination.
You may be required to report spills and releases of spray foam and coating ingredients to local, state, and/or federal authorities.

In the event of a large A-side chemical spill or release (i.e., more than a few pounds or gallons), consider calling for the assistance of an outside emergency spill response contractor. In addition, consider the following:

- Direct all personnel away from the immediate area to avoid unnecessary exposure.
- Provide appropriate PPE for individuals involved in the cleanup. PPE for cleanup crews may include appropriate respiratory protection, impervious clothing, footwear, eye protection, and gloves.
- Absorb the A-side chemicals with sand, wet earth or absorbent clays (e.g., vermiculite or cat litter). Place the absorbed material in drums and neutralize. Do not seal these drums for an appropriate period (typically, at least 48 hours).
- Check to see if you have exceeded the reportable quantity (RQ) (the RQ for pMDI is 5,000 lbs), which is the equivalent of approximately 15, 55 gallon, drums of a typical A-side material. Call the EPA's Superfund Call Center 1-800-424-9346 or consult 40 CFR 302.4. If it is determined that you have exceeded this amount, you must report the spill to various government agencies. You may be required to report sizable pMDI or solvent spills or releases to a Local Emergency Planning Committee (LEPC), State Emergency Response Commission (SERC), and the National Response Center (NRC) 1-800-424-8802. The penalties associated with not reporting are quite substantial.
- Characterize waste (i.e., hazardous or nonhazardous waste) and dispose of waste in accordance with all applicable regulations.

Job site wastes consisting solely of construction debris, such as old roofing materials, do not normally require any special handling or packaging for disposal, unless they contain asbestos or other hazardous materials. If you are unsure, it is suggested that they be treated as hazardous. However, cured polyurethane foam does not meet the criteria of a hazardous waste according to Resource Conservation and Recovery Act (RCRA), and may be acceptable for landfill disposal. Some landfill facilities may ask for a SDS on cured polyurethane foam before allowing disposal. Consult with the state and/or local waste disposal regulatory authority prior to disposal of any type of waste.

5.2.9 Disposal of SPF Chemicals and Drums

This section provides general guidance related to disposal of SPF chemicals. Not covered here are the many other materials and chemicals that may be present at a job site, including but not limited to solvents, oils and fuels, coatings, primers, and other chemicals, all of which may have separate and very specific waste disposal requirements under applicable law. All persons involved in waste disposal have an independent obligation to ascertain that their actions are in compliance with current federal, state, and local laws and regulations. Consult the manufacturer for additional assistance on waste disposal.

The proper disposal of any remaining SPF chemicals is a crucial part of an SPF application. Likewise, drums containing SPF need to be properly prepared, decontaminated, and disposed of in accordance with regulatory requirements. It is never acceptable to abandon or discard a drum without following proper disposal procedures in accordance with legal requirements. Consult the SDS for more information.

Note that small amounts of unused A-side chemicals can be reacted with small amounts of unused B-side chemicals to produce foam. Cured foam is typically non-hazardous, and can be disposed of as non-hazardous waste (see section 5.2.8).

To ensure proper disposal of drums, contact a professional drum re-conditioner, professional scrap metal recycler, or an approved landfill. The Reusable Industrial Packaging Association (RIPA) can help you find a drum recycler (www.reusablepackaging.org). If a drum recycler is not available contact the product manufacturer for additional guidance. Some metal recyclers or re-conditioners may require drums to be decontaminated prior to accepting the drum. Before attempting to use a neutralization solution to decontaminate an empty drum, contact the product manufacturer for drum decontamination procedures.

Always wear appropriate PPE when handling SPF chemicals and the drums containing these materials. Consult the manufacturer's SDS for specific information about PPE.

Additional guidance entitled *Disposal of Empty Drums Containing Polyurethane Chemicals* is available at www.spraypolyurethane.org.

5.2.10 Reoccupancy

Reoccupancy may be defined as the time elapsed after installation of SPF in a building when it is deemed safe for building occupants or residents to resume normal building operations and activities. Reoccupancy time can be dependent on a number of factors, including SPF

formulation, the amount of foam applied per volume of space, and the degree of ventilation. In addition to the release of airborne SPF chemicals during spray application, certain components can be liberated from some newly-installed SPF products for a short period of time following installation. Contact your supplier for guidance on ventilation time and reoccupancy.

Some SPF manufacturers may have had their SPF products tested using the Canadian Standard Laboratory Guide for the Determination of Volatile Organic Compounds from Polyurethane Foam (CAN/ULC S774-06) or other method. If so, request from the manufacturer the recommended reoccupancy time for that SPF product. In addition, such information is publicly available in some cases. The Canadian Construction Materials Centre has a searchable Registry of Product Evaluations available at www.nrc-cnrc.gc.ca/eng/services/irc/ccmc/registry-product-evaluations.html that contains product evaluations for many types of building products, including SPF insulation. The evaluation reports for specific SPF insulation products often include the recommended reoccupancy time. Some manufacturers recommend a 24 before reoccupancy, but such recommendations do vary.

5.3 Personal Protective Equipment (PPE)

Even with effective engineering controls, personnel who work with SPF chemicals still need to wear appropriate PPE. This section provides general information about PPE. Although not exhaustive, this information may complement the information contained within your company's safety program as well as the SDS. An SDS is an important source of safety and handling information for a product.

Generally, PPE is required for applicators, helpers, and other adjacent workers who may enter a spray foam application work area before the manufacturer's recommended reentry time. Reentry may be defined as the time elapsed after installation of SPF in a building when it is deemed safe for applicators, helpers and other trade workers to enter the building and resume operations without the need for personal protective equipment. Remember, formulations of SPF vary, particularly with respect to B-side chemicals. Contact your supplier for more detailed information regarding reoccupancy time. Implement appropriate work area restrictions to limit entry into the spray enclosure or spray area to personnel wearing proper PPE until the manufacturer's recommended reentry time.

It is critical to avoid inhalation of, and skin and eye contact with, SPF chemicals. A PPE evaluation prior to beginning work is a useful tool to determine the appropriate PPE for the job. PPE to consider includes: protective clothing, gloves, eye and face protection, and respiratory protection.

The effectiveness of PPE depends on both proper selection and proper use. It is important for workers to understand what PPE is needed, how to put on, operate, and take off the equipment, and how to maintain and/or dispose of the equipment.

5.3.1 PPE Evaluation

PPE evaluations are conducted to determine the appropriate type of PPE needed for a job task, depending on the conditions at the worksite. Some considerations when selecting PPE for a job task:

- Location of the job tasks, such as outdoors vs. indoors; whether the work will take place in an enclosed space; the type of ventilation available; and the ambient temperature, relative humidity, and wind speed and direction if applicable.
- Potential for inhalation exposure or eye or skin contact with SPF chemicals based on the job tasks.
- The quantity of SPF chemicals applied and work practices.
- The type of work being conducted and the potential for wear and tear on the PPE must be considered.
- Characteristics of the PPE that may affect the wearer's ability to complete a task such as gloves that permit dexterity and respiratory protection that allows adequate peripheral vision.
- PPE that does not fit the user may not provide sufficient protection. In addition, if an individual does not like the PPE he or she may be less likely to use it when needed (wearer acceptance).

Air monitoring is one way to evaluate the potential for inhalation exposure to SPF chemicals. Air samples may be collected at specific time intervals during application and after spray application has ceased. These data are helpful in determining appropriate respirators and when it is safe to enter the enclosure or spray area. An environmental health and safety professional can help develop a sampling strategy for contractors.

When working with SPF chemicals, respiratory protection is usually needed due to the relatively low OEL for A-side chemicals as well as the potential for exposure to B-side chemicals, coatings, and solvents.

There are additional considerations when there is the potential to be exposed to multiple chemicals simultaneously, such as for SPF. It is possible that exposures to one chemical may be below OELs, while exposures to another may exceed OELs. In addition, when selecting gloves and protective clothing it is important to make sure that the gloves or clothing are protective for all of the chemicals used. Refer to the SDS when selecting PPE.

5.3.2 Protective Clothing

The use of appropriate protective clothing is necessary whenever there is possibility of direct contact with SPF chemicals. The appropriate protective clothing varies depending upon the potential for exposure. Applicators and helpers typically wear disposable coveralls (Figure 9) to keep spray and mist from contacting skin and clothing. To protect skin, wear PPE in such a manner as to protect all skin (in other words, no exposed skin showing). When not wearing a hood respirator, select a coverall with an attached hood or spray head cover. For tasks where there is a potential for splashing liquid chemicals, consider a suit coated with an impermeable coating, such as PVC.

Figure 9: Example of Disposable Coverall

Disposable overboots with skid-resistant soles (Figure 10) may be used for protection from overspray if it does not compromise the grip of the work boots or create a tripping or slipping hazard.

Figure 10: Example of Boot Covers with Skid-Resistant Soles

5.3.3 Gloves

Gloves made of nitrile, neoprene, butyl or PVC generally provide adequate protection against A-side materials. (See *Guidance for the Selection of Protective Clothing for MDI Users*, available at www.polyurethane.org). A-side protection is generally considered adequate to provide B-side protection as well; however, consult the manufacturer's SDS for specific information about B-side protection. A range of sizes may be available. A glove which is too large or small for the user may not provide proper protection. A fabric glove fully coated with nitrile, neoprene, butyl, or PVC provides good protection for SPF applicators, as the fabric may impart additional durability and the coating can help reduce penetration of reacting foam in the event of an accidental spray to the hand.

Figure 11: Example of Fabric Gloves Coated with Nitrile

5.3.4 Eye and Face Protection

Appropriate eye protection helps prevent eye contact with splashes of liquid SPF chemicals, accidental sprays of reacting foam, aerosols and vapors that are likely to be present during spraying, and airborne particulates associated with sanding, grinding, and trimming 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 glasses with side shields in combination with face shields. The use of contact lenses is discouraged.

Figure 12: Example of Chemical Resistant Safety Goggles

During application of SPF, eye protection may be provided by virtue of wearing a full-face or hood respirator.

OSHA, 29 CFR 1910.151(c), [6] requires that an eyewash or safety shower be provided in the work area where the eyes or body may be exposed to "injurious corrosive materials."

Consult the SDS for all materials to be used on the job in advance to help inform whether such materials will be present, and if so, comply with applicable OSHA requirements.

5.3.5 Respiratory Protection

Engineering controls, such as general dilution ventilation and local exhaust ventilation, can be used to help reduce SPF chemical exposures. Administrative controls, such as work schedules and work practices, are used concurrently to minimize exposure. Respirators are needed when air concentrations continue to exceed OELs even after engineering and administrative controls are implemented. These limits have been set for a number of SPF chemicals and some common chemicals encountered during SPF application and are listed in Appendix C of this workbook.

Air-purifying respirators (APR) and powered air-purifying respirators (PAPR) are generally appropriate for exterior applications and may be used when spraying polyurethane foam in exterior applications. Supplied air respirators (SAR) are typically used in interior applications.

Respiratory Protection Program Requirements

The OSHA Respiratory Protection Standard (29 CR 1910.134) requires employers to have a written respiratory protection program for employees who are required to use respiratory protection. The Standard outlines requirements for respirator selection, respirator maintenance, annual fit testing, medical surveillance, and annual training. Refer to your company's policy for specific information regarding your respiratory protection program. To assist site managers in developing their own Respiratory Protection Programs, CPI has created a Guidance for Developing a Written Respiratory Protection Program for reference and guidance, available online at www.polyurethane.org.

OSHA Respiratory Protection Standard requires employers to provide medical evaluations administered by a physician or licensed healthcare professional for all employees required to wear respirators. Employees must receive approval to wear a respirator prior to fit testing and subsequent issuance of the respirator. Sometimes the medical approval has a limitation such as the use being restricted to a PAPR or for emergency only. Adhere to the limitations described by the examining medical provider.

OSHA also requires that employees complete a successful fit test using a respirator of the same make, model and size issued. Fit testing is repeated annually thereafter. Fit testing

[6] OSHA often references the American National Standards Institute (ANSI) "Emergency Eyewash and Shower Equipment" Standard Z358.1-1990, which states; *"[a] personal wash unit may be kept in the immediate vicinity of employees working in a potentially hazardous area. The main purpose of these units is to supply immediate flushing. With this accomplished, the injured individual should then proceed to a plumbed or self-contained eyewash and flush the eyes* **for the required 15-minute period**." Items, like bottled eyewash, Personal Wash Units such as single head hoses, or similar supplemental equipment, may not meet the OSHA requirement and the ANSI standard's 15 minute irrigation period.

must be completed for any employee issued a tight-fitting APR, PAPR, SAR, or self-contained breathing apparatus (SCBA). Fit testing is not required for personnel wearing a loose-fitting hood with a PAPR or SAR (29 CFR 1910.134(f)).

Fit testing cannot be conducted and respirators cannot be used if there is any clothing, jewelry, or hair growth between the skin and the facepiece sealing surface, such as stubble beard growth, beard, mustache or sideburns which cross the respirator sealing surface. Annual training is required under the OSHA Respiratory Protection Standard for all personnel required to wear respiratory protection.

E**ach time the user dons a tight-fitting respirator, the user must complete a negative-pressure and positive-pressure user seal check** in accordance with 29 CFR 1910.134 to confirm that the mask has been donned correctly prior to entering the work area.

Air-Purifying Respirators (APR)

APRs may be appropriate for exterior applications of SPF. Air-purifying respirators are not appropriate in confined spaces or in atmospheres with less than 19.5% oxygen (29 CFR 910.134 (d) (1) (i-iii)). Due to the potential for eye exposure during SPF application, full-face APRs are often selected when applying SPF. Note that this assumes the respirator has been quantitatively fit tested. If only a qualitative fit test was done, the respirator may only be used up to 10 times the OEL (29 CFR 1910.134 (f) (6)).

Figure 13: Full-face APR with Organic Vapor (OV) Cartridge and Particulate (P100) Filter

APRs remove contaminants from the air by mechanical filtration and/or chemical adsorption. Protection provided by APRs is dependent on the cartridge selected, the condition of the cartridge, and the respirator fit. For protection from SPF chemicals, an APR is equipped with cartridges certified by NIOSH for protection against particulates and organic vapors. According to the ANSI standard Z88.7 *Color Coding of Air-Purifying Respirator Canisters, Cartridges, and Filters*, the appropriate cartridges have been color coded as magenta for protection against particulates (P100) and black for protection against organic vapors (OV).

Respirator cartridges must be of the same make as the respirator. If you have any doubt about which cartridge to use, contact the supplier of the respirator for advice.

When respirator filters become clogged, it becomes difficult for the user to breathe through the cartridge. Chemical breakthrough may occur when chemical vapors can pass through a cartridge because the adsorbent material in the cartridge has been used up. Respirator cartridges must be changed out according to a change-out schedule to prevent clogging of the filter or chemical breakthrough. According to the OSHA Respiratory Protection Standard, employers must prevent clogging and chemical breakthrough by replacing cartridges according to a change-out schedule based on the respirator manufacturer's end-of-service life indicator (ESLI) or based on objective information or data to ensure the cartridges are changed out before the end of their service life.

A clogged respirator, or detection of a chemical substance while wearing a respirator through smell or other signs, are indicative that the respirator may not be functioning properly. Exit the work area immediately to attend to the respirator, and replace it or the cartridges if necessary. Exposure to a chemical agent while wearing a respirator may be due to either an incomplete face-to-facepiece seal or chemical breakthrough. If the filter has become clogged or breakthrough has occurred, replace the filter.

Powered Air-Purifying Respirators

Powered Air-Purifying Respirators (PAPRs) are APRs equipped with a battery-operated blower unit designed to filter breathing air to the user's facepiece. The facepiece used with a PAPR may be a tight-fitting facepiece or a loose-fitting hood. When the blower unit is operating, the tight-fitting respirator facepiece is under positive pressure. When the blower unit is turned off, the mask is under negative pressure. For persons wearing a tight-fitting PAPR, annual fit testing and user seal checks prior to each use must be completed when the mask is under negative pressure (i.e., when the blower unit is turned off). For the loose-fitting hood, the respirator is under positive pressure. For both the tight-fitting respirator and hood, the respirator cartridges also must be changed out according to the change-out schedule. Fit testing is only required for users of tight-fitting PAPRs (29 CFR 1910.134(f)).

PAPRs are often used in exterior applications and may be selected for several reasons. When outdoor temperatures are hot, the PAPR can provide an air-conditioning-like effect, making the wearer cooler and more comfortable. Also, fit testing is not required for the loose-fitting hood PAPR. Additionally, for medical or other reasons, some individuals may be unable to use negative-pressure APR, but can use PAPR. Finally, due to the reduced physiologic burden, in some instances, during medical surveillance the examining healthcare professional may determine that the employee is permitted to wear a PAPR but not a negative-pressure APR.

Supplied-Air Respirator (SAR)

Supplied Air Respirators (SARs) are typically used in interior applications. SARs provide a supply of breathing air from an outside source such as a compressor, a bottle of compressed air, or a low pressure pump attached to an air-line hose. SARs also are called "Type C" systems or "air-line" respirators. SARs, when used properly, can provide the greatest protection for the wearer. An SAR consists of a tight-fitting full-facepiece, or a loose fitting hood or helmet

to which air is supplied through a small-diameter hose connected to an air source. There are three types of SARs:

1. Continuous flow, which supplies a constant airflow to the face piece or hood/helmet no matter what the worker's breathing rate is.
2. Pressure-demand, which supplies a constant flow of air to create a slight positive pressure in the facemask and also responds to the worker's breathing rate.
3. Demand airflow provides breathing air to the facemask at a rate that depends on the worker's breathing rate. Demand airflow SARs have limited utility for SPF application; therefore, many contractors opt not to use demand-type SARs.

Figure 14: Full-face Supplied Air Respirator (SAR) with portable breathing air low pressure ambient air pump

Specific requirements for breathing air quality and use are available at 29 CFR 1910.134(i). Under this regulation, compressors used to supply breathing air must be set up to prevent re-entrainment of contaminated air into the breathing air. OSHA requires compressed breathing air shall to meet at least the requirements for Grade D breathing air described in ANSI/Compressed Gas Association Commodity Specification for Air, G-7.1-1989 (29 CFR 1910.134(i)(1)(ii)). The ANSI standard requirements include:

- Oxygen content between 19.5% and 23.5%;
- No more than 5 milligrams per cubic meter of condensed hydrocarbon contamination;
- No more than 10 parts per million of carbon monoxide;
- Lack of noticeable odor;
- A maximum of 1000 ppm of carbon dioxide.

WARNING: Never use pure oxygen in supplied-air systems because it is a fire hazard and can be toxic to the user.

Another consideration is that overheating internally lubricated, piston-type compressors may produce carbon monoxide (CO). Therefore, OSHA requires monitoring to prevent carbon monoxide in the breathing air from exceeding 10 ppm through the use of (29 CFR 1910.134(i)(7)):

1. A high temperature alarm with periodic monitoring of CO concentrations;
2. A carbon monoxide alarm; OR
3. Use of both to monitor carbon monoxide levels.

Note: Portable breathing air compressors do not require a CO or high temperature alarm if using carbon vanes as the air mover. OSHA also requires that employees have a reliable source of air with an oxygen content of at least 19.5% according to 29 CFR 1910.134(d).

Internally lubricated, piston-type (industrial) compressors are typically used to supply air to the gun for spray foam application. They also may be used to supply air for SARs, provided the air is properly filtered and monitored. There are systems designed to be used between the industrial compressor and SARs, as shown in Figure 15. These self-contained systems filter moisture, particulates, oils, organic vapors and odors, and actively monitor CO levels.

Figure 15 – Example filtration and monitoring system for supplied air respirators (SARs) when connected to industrial compressors

5.3.6 PPE Care and Maintenance

Dispose of single-use (disposable) PPE in accordance with local or state environmental regulations, depending on the chemical(s) they may be contaminated with. Decontaminate reusable PPE after exiting the work area. Regular cleaning and disinfection of respirators is typically needed as well to keep the PPE in good condition. Follow the manufacturer's instructions regarding respirator cleaning and disinfection.

Inspecting PPE periodically helps identify equipment or components that need to be replaced, repaired, or refilled. It is important to verify that the PPE available includes the range of sizes needed. Inspect PPE for tears, cracks, or other signs of wear that might compromise its effectiveness. It may be preferable to have trained employees inspect their own PPE before and after each use. Remove defective materials from service and discard or repair them as appropriate.

Respirators are inspected according to 29 CFR 1910.134. Generally, an APR inspection includes inspecting the mask and cartridges for damage and adhering to the ESLI or the respirator filter/cartridge/canister change-out schedule. For PAPR, the inspection includes the elements of the APR inspection as well as the blower unit and the battery. For SAR, the masks, hoses, and air source are inspected. Refer to the manufacturer's instructions for specific information related to your respirators.

Store PPE in areas where the PPE is not exposed to conditions that could compromise the effectiveness of the PPE, such as sunlight, chemical contamination, extreme temperatures, moisture, and animals or insects. You might want to consider designating a cool, dry area away from sunlight for PPE storage.

5.3.7 First Aid

In the event of inhalation overexposure or skin or eye contact with any chemicals over the course of your work; remove yourself from the exposure, refer to the SDS for first aid instructions, and seek medical attention if necessary. Any clothing contaminated with pMDI should be removed and properly disposed of or decontaminated. Leather items cannot be decontaminated and will have to be properly disposed of.

6. Other Considerations for SPF Application

In addition to the possibility of chemical exposure when applying SPF chemicals, other aspects of the job can present hazards. Identify these in advance of the job to address them most effectively. Consider potential electrical hazards, confined spaces, pressurized equipment, walking and working surfaces, occupational noise, and temperature stress.

6.1 Electrical Hazards

Power lines near a work site 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, contractors should 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.

Electrical equipment that is used in SPF applications should be equipped with Ground Fault Circuit Interrupters (GFCI) to prevent electrical shock or electrocution (29 CFR 1926.404(b)(1)(i)). This is especially important when working near water, or on wet floors or roofs. Follow safeguard requirements for personnel protection where there are potential electrical hazards as detailed in 29 CFR 1910.335.

Job equipment and containers of flammable materials should be grounded. 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. Do not plug in or unplug any power supply cords in the spray/dispersing area when there is a chance of igniting vapors still in the air. Check your local electrical code for detailed grounding instructions for your area and type

of equipment, and consult manufacturer's instructions for specific instructions for the equipment.

6.2 Confined Spaces

Attics and crawlspaces may be considered confined spaces. Work in a confined space that may produce a hazardous atmosphere should meet the requirements specified in the OSHA Confined Spaces in Construction Standard (29 CFR 1926.1200). This standard requires employers to evaluate all confined spaces in which their employees work to determine whether hazards exist or whether the work to be done in the space can create hazards.

Additional guidance on OSHA Confined Space in Construction Standard is available at https://www.osha.gov/confinedspaces/.

6.3 Pressurized Equipment

Handle high pressure applications equipment with care because pressurized fluid can be very dangerous. If the spray hose develops a leak, splits or ruptures due to any kind of wear, damage, or misuse, the high pressure spray emitted from it can cause a fluid injection injury or other serious bodily injury or property damage. All fluid hoses typically have spring guards on both ends, which helps protect the hose from kinks or bends at or close to the coupling, which can result in hose rupture. Tighten all fluid connections securely before each use. High pressure fluid can dislodge a loose coupling or allow high pressure spray to be emitted from the coupling. Never use a damaged hose.

Before each use, check the entire hose for cuts, leaks, abrasions, bulges, or damage or movement of the hose couplings. If any of these conditions exist, replace the hose immediately. During repair or servicing activities, contractors should follow the OSHA standards (29 CFR 1926.417 or 1910.147) to properly lock out or tag out machines and equipment. Do not try to re-couple high pressure hose or mend it with tape or any other device. A repaired hose cannot contain the high pressure fluid. Handle and route hoses carefully. Do not pull on hoses to move equipment.

If you receive a cut or abrasion in handling pressurized fluid seek emergency care immediately, because chemical fluid may have entered the wound. Do not treat as a simple cut. Tell the doctor exactly what fluid was injected, and provide a copy of all relevant SDS documents to the doctor.

6.4 Walking and Working Surfaces

Elevated working surfaces are a common hazard in SPF application operations. Poor construction of and improper use of elevated work platforms are two of the leading causes of injury in the construction industry. All ladders and scaffolding must be constructed and used in accordance with current OSHA standards, and all elevated work must comply with OSHA's fall protection standards. For construction projects, these requirements are described in subparts L (Scaffolds), M (Fall Protection) and X (Ladders) of 29 CFR Part 1926. For manufacturing and maintenance projects, these requirements are found in subpart D (Walking Surfaces) of 29 CFR Part 1910.

6.5 Occupational Noise

During SPF application, workers may be exposed to high levels of occupational noise from sources like operation of construction equipment. The OSHA Construction Standard 29 CFR 1926.52, which regulates employee exposure to occupational noise, requires feasible administrative and engineering controls to be used when employees are exposed to occupational noise above the OSHA PEL for noise of 90 dBA (A-weighted decibel) over 8 hours with a 5 dBA doubling rate. If engineering and administrative controls are not feasible to reduce employee exposure below the PEL, hearing protection and implementation of a Hearing Conservation Program is required by OSHA (29 CFR 1926.52 (d) (1)).

As a general guide, if you have to raise your voice to speak with someone at a distance of approximately three feet, the noise exposure likely exceeds 90 dBA.

6.6 Temperature Stress

Application of SPF may take place outdoors or in work areas where the HVAC system is turned off or not available. As a result, workers may be applying SPF in very hot or cold conditions. The following conditions may contribute to cold or heat stress:

- Increased metabolism due to physical nature of the work.
- Increased metabolism due to use of PPE ensembles.
- Increased radiant heat when working outdoors.
- Variations in the temperature and humidity and possibly unconditioned circulation through local supply ventilation may result in an increase in cold or heat stress depending on the ambient temperature.
- Increased sweat rate which can increase cold or heat stress depending on ambient conditions.

Due to these conditions, consider the potential for workers to experience cold or heat stress over the course of their work. It is helpful for all workers, including applicators and helpers, to be familiarized with the signs and symptoms of cold and heat stress and know when to seek medical attention.

Heat stroke can be a life-threatening condition, primary signs and symptoms of heat stroke are confusion; irrational behavior; loss of consciousness; convulsions; hot, dry, skin (no sweating); and high body temperature. If you suspect someone may be experiencing heat stroke, move the individual to a cool shaded area and call 911 for medical attention immediately. Refer to OSHA's Occupational Heat Exposure Prevention webpage for recommended engineering controls, work practices, PPE and training at https://www.osha.gov/SLTC/heatstress/prevention.html.

6.7 Environmental Reporting

If you store 10,000 pounds (approximately 15 individual 55-gallon drums) of A-side chemical at any one time at your warehouse, you are required to submit an initial and annual chemical inventory report for these chemicals under the Emergency Planning and Community Right-to-Know Act (EPCRA) Sections 311 and 312, respectively.

In addition, copies of SDSs or a list of the chemicals must be submitted to the Local Emergency Planning Commission (LEPC), the State Emergency Response Commission (SERC), and the local fire department within 90 days after storing 10,000 pounds or more of SPF chemicals at a facility or on-site.

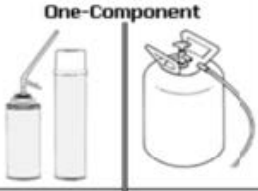
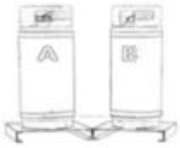
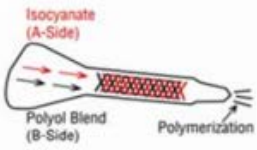
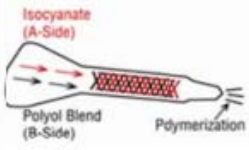
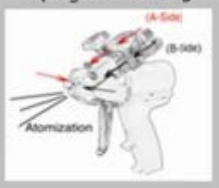
Section 312 of EPCRA requires facilities to submit an annual inventory report, called the Tier II report, to the LEPC, SERC, and local fire department for any chemical reported under Section 311. The Tier II report includes the types of hazard the material may pose, the quantities stored, general storage locations, and type of storage. The reports for each calendar year are due by March 1 of the following year.

Note: Most SPF operations fall under the NAICS code of 238310 (SIC Code 1742) and are exempt from the reporting requirements of EPCRA Section 313.

Appendix A: SPF Systems – High Pressure and Low Pressure

Figure A-1 includes general product information for SPF system; refer to the SDS for specific product information.

Figure A-1: General Product Information for SPF Systems – High Pressure and Low Pressure

	Low Pressure				High Pressure
	One-Component		Two-Component Kits	Refillable Systems	High Pressure Spray Systems
					
Delivery Systems Pressure	<150 psi	<250 psi	<250 psi	<250 psi	1000 psi-1300 psi
Contents	.5lbs - 2lbs	10lbs - 23lbs	2lbs - 110lbs *Combined*	250lbs - 1700lbs *Combined*	900lbs - 1000lbs *Combined*
Output	Full Trigger: up to 2-5 lbs per min		Full Trigger: up to 5-7 lbs per min *Standard fan or cone nozzle*	Full Trigger: up to 5-7 lbs per min *Standard fan or cone nozzle*	Full Trigger: up to 30 lbs per min
Mixing	Prepolymer / Prepolymer  Shake Well		Static Mixing 	Static Mixing 	Impingement Mixing 
Mixer			Static Mixer	Static Mixer	Chamber Mixing
Housing			Nozzle	Nozzle	Spray Gun
Container *Most Popular Size Sold*	Metal Cans	Single Use Cylinder	Single Use Cylinders	Refillable Tanks	55 gallon drums
Hoses		5-9 ft Hose Assembly	9-15 ft Hose/Gun Assembly	30ft to 60 ft Hoses 30ft to 150ft Heated Hoses	transfer pump system up to 400ft Heated Hoses
Product Temperature Recommended Use	70°F-90°F (21°C-32°C)		70°F-90°F (21°C-32°C) *optimal temp for std systems*	70°F-90°F (21°C-32°C) *optimal temp for std systems*	120°F-150°F (49°C-65°C) *machine heater system*
Foam Properties Curing Tack-Free Time	Moisture Cure 3-20 minutes		Chemical Cure < 1 minute	Chemical Cure < 1 minute	Chemical Cure < 15 seconds
How it is used	Bead Application		Bead Application Spray Coating	Bead Application Spray Coating	Large Area Spray Coating

Note: One-component and low pressure two-component SPF products deliver a smaller volume of foam, and typically are used to cover smaller surface areas. In addition, low-pressure foams do not aerosolize the two primary chemicals; instead, the chemicals are combined in a small mixing chamber before release. These application factors combine to result in a significantly lower inhalation exposure potential than is typically associated with the high pressure SPF systems, but it is still important to minimize skin and eye exposures.

Appendix B: General OSHA Standards Related to SPF Application

Table B-1 includes a general list of OSHA standards that may be applicable to those working with SPF. This is not an exhaustive list and does not include all potentially applicable OSHA standards. It is the responsibility of the employer and employee to determine what standards apply to the work being conducted.

Table B-1: General OSHA Standards Related to SPF Application

Title	Industry	Reference
General Duty Clause	All	29 CFR 5 (a)(1)
Air Contaminants *Limits for Air Contaminants* *Hazardous Atmospheres and Substances* *Hazardous Atmospheres and Substances* *Gases, Vapors, Fumes, Dusts, and Mists*	General General Marine Terminals Longshoring Construction	29 CFR 1910.1000 29 CFR 1910.1000 Table Z-1 29 CFR 1917.23 29 CFR 1918.93 29 CFR 1926.55
Hazard Communication	General Shipyard Marine Terminals Longshoring Construction	29 CFR 1910.1200 29 CFR 1915.1200 29 CFR 1917.28 29 CFR 1918.90 29 CFR 1926.59
Personal Protective Equipment *Personal Protective Equipment* *Personal Protection* *Personal Protective Equipment* *Personal Protective and Life Saving Equipment*	General Shipyard Marine terminals Longshoring Construction	29 CFR 1910, Subpart I 29 CFR 1915, Subpart I 29 CFR 1917, Subpart E 29 CFR 1918, Subpart J 29 CFR 1926, Subpart E
Respiratory Protection	General Shipyard Marine Terminals Longshoring Construction	29 CFR 1910.134 29 CFR 1915.154 29 CFR 1917.92 29 CFR 1918.102 29 CFR 1926.103
Ventilation *Ventilation and Atmospheric Conditions* *Ventilation*	General Longshoring Construction	29 CFR 1910.94 29 CFR 1918.94 29 CFR 1926.57
The Control of Hazardous Equipment (Lockout/Tagout)	General	29 CFR 1910.147
Confined Spaces *Work in Confined or Isolated Spaced* *Confined and Enclosed Spaces and Other dangerous Atmospheres in Shipyard Employment* *Confined Space Standard for Construction*	Construction Shipyard Shipyard Construction	29 CFR 1910.146 29 CFR 1915.94 29 CFR 1915, Subpart AA 29 CFR 1926.1200
Fall Protection *Walking and Working Surfaces* *Scaffolds, Ladders, and Other Working Surfaces* *Working Surfaces*	Construction General Industry Shipyard Longshoring	29 CFR 11926, Subpart M 29 CFR 1910, Subpart D 29 CFR 1915, Subpart F 29 CFR 1918, Subpart D
Occupational Noise Exposure *Occupational Noise Exposure*	General Industry Construction	29 CFR 1910.95 29 CFR 1926.52

Appendix C: Occupational Exposure Limits

To reduce the risk of adverse effects due to inhalation of chemical substances, occupational exposure limits (OELs) of various chemicals have been set by regulatory agencies and other organizations, including the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PEL) included in 29 CFR 1910.1000 Subpart Z *Limits for Air Contaminants*, the National Institute of Occupational Safety and Health (NIOSH) Recommended Exposure Limits (REL) listed in the *NIOSH Pocket Guide to Chemical Hazards*, and the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV). These limits are the air concentrations that these organizations believe represent exposures that are acceptable from a health perspective for healthy workers and include time-weighted averages (TWA) for the duration of an entire workshift, short-term exposure limits (STEL), and ceiling limits (C).

For the duration of a workshift, the OSHA PEL and the ACGIH TLV are based on an eight-hour time weighted average (TWA) whereas the NIOSH REL is based on a 10-hour workday. These limits are all based on a 40-hour workweek. For short-term exposures, short-term exposure limits (STEL) and ceiling (C) limits have been developed. STEL is the maximum 15-minute average concentration to which personnel may be exposed. The ceiling limit (C) is the concentration that should never be exceeded for any period of time. A table including OELs for some chemical components in SPF chemicals, coatings, and solvents are included in Table C-1. Table C-1 does not include all products, so read the SDS thoroughly for each product used during applications.

Table C-1: OELs for Some Chemical Components of SPF Chemicals, Coatings, and Solvents

Product Type	Chemical Name (abbreviation)	OSHA PEL	NIOSH REL	ACGIH TLV
A-side	Methylene bisphenyl isocyanate (MDI)	NA 0.02 ppm (C)	0.005 ppm (TWA) 0.020 ppm (C)	0.005 ppm (TWA) NA
Aromatic Polyurethane Coatings	2,4- Toluene diisocyanate (TDI)[2]	0.02 ppm (C)	NA	0.001 ppm (TWA) 0.005 ppm (STEL)
Aromatic Polyurethane Coatings	2,6- Toluene diisocyanate (TDI)	NA	NA	0.001 ppm (TWA) 0.005 ppm (STEL)
Aliphatic Polyurethane Coatings	1,6-Hexamethylene diisocyanate (HDI)	NA NA	0.005 ppm (TWA) 0.020 ppm (C)	0.005 ppm (TWA) NA
Butyl Polyurethane Coatings	o-, m-, and p-Xylene	100 ppm (TWA) NA	100 ppm (TWA) 150 ppm (STEL)	100 ppm (TWA) 150 ppm (STEL)
Polyurethane Coatings	n-Butyl acetate	150 ppm (TWA) NA	150 ppm (TWA) 200 ppm (STEL)	150 ppm (TWA) 200 ppm (STEL)
Polyurethane Coatings	Methyl Isobutyl ketone (MIBK)	100 ppm (TWA) NA	50 ppm (TWA) 75 ppm (STEL)	50 ppm (TWA)[1] 75 ppm (STEL)
Polyurethane Coatings	Toluene	200 ppm (TWA) 300 ppm (C)	100 ppm (TWA) 150 ppm (STEL)	20 ppm (TWA) NA
Polyurethane Coatings and Solvents	Methyl ethyl ketone (MEK)	200 ppm (TWA) NA	200 ppm (TWA) 300 ppm (STEL)	200 ppm (TWA) 300 ppm (STEL)
Polyurethane Coatings and Solvents	v-, m-, and p-Naphtha	100 ppm (TWA) NA	100 ppm (TWA) NA	NA NA
Solvents	2-Ethoxyethanol	200 ppm (TWA) NA	0.5 ppm (TWA) NA	5 ppm (TWA)[2] NA
Solvents	Isopropyl alcohol	400 ppm (TWA) NA	400 ppm (TWA) 500 ppm (STEL)	200 ppm (TWA) 400 ppm (STEL)
Solvents	Triorthocresyl phosphate (TCP)	0.1 mg/m[1] (TWA) NA	0.1 mg/m[3] (TWA) NA	0.1 mg/m[1] (TWA)[2] NA

[1]ACGIH has requested comments regarding a proposed Notice of Intended Change for the TLV-TWA for MIBK. The Notice includes a proposal to lower the TLV-TWA from 50 ppm to 20 ppm.
[2]ACGIH assigned a "SKIN" notation to these chemicals because they can be readily absorbed through the skin. ACGIH has also assigned notations for respiratory sensitizer "RSEN" and dermal sensitizer "DSEN" and A3 – Confirmed Animal Carcinogen with Unknown Relevance to Humans. These notations apply to both the 2,4 and 2,6 TDI isomers.

Appendix D: Discussing Spray Foam Application with Building Owners and Occupants

This general checklist is intended to assist contractors in their discussions with building owners and occupants about some of the health and safety considerations of the spray foam application. While it contains suggested discussion topics for consideration, it is not exhaustive. Consider additional health and safety topics depending on the specific circumstances of the job site.

- ☐ General discussion about the duration, schedule, and size/scope of job, with focus on electric and water access, breaker boxes, emergency ingress and egress by workers on site and owners/occupants

- ☐ Information about chemicals used in the SPF application:
  - ☐ How spray foam is made; reacting A and B-sides
  - ☐ Potential health hazards of A-side and B-side chemicals. Explain that SDSs for all chemicals to be used are readily available on the job site, and review these documents with the owner/occupant if requested
  - ☐ Point out locations of first aid kits, eyewash stations

- ☐ Explanation of controls designed to protect applicators, helpers, adjacent workers, and occupants:
  - ☐ Ventilation and/or containment plans
  - ☐ Review HVAC system location and operation, and discuss shutdown during application and until reoccupancy
  - ☐ PPE to be used and why
  - ☐ Review plans to restrict access to the work area, including plans for postings around the perimeter of the work zone

- ☐ Discussion with owner/occupant about plans to vacate building during and after application:
  - ☐ Identify whether building is occupied by individuals who may have special sensitivities (e.g., persons with respiratory illness or sensitivities) and address the known sensitivities
  - ☐ For large commercial buildings and multi-family residences (e.g., duplexes, condominiums, or apartment buildings), discuss whether partial or full vacation of premises is planned; discuss HVAC and ventilation issues; discuss external venting issues
  - ☐ Provide specific guidance on reoccupancy times following appropriate consultation with the product manufacturer

- ☐ If owner/occupant will not vacate building during application, discuss plans to address exposure issues:
  - ☐ PPE requirements for owner/occupant to enter work area and view application (discuss alternative approaches to inspect or view work that minimize potential exposure, such as photographs or real-time video)
  - ☐ Venting and ventilation issues
  - ☐ Procedures for air monitoring, if used

- ☐ Discuss with the owner what to do to prevent damage to property due to overspray

- ☐ Inform occupants that a fishy or ammonia smell may be indicative of amine catalysts contained in the SPF, and provide guidance and contact information in the event of strong smells or smells that do not dissipate

Appendix E: Helpful Internet Resources List of Helpful Internet Resources

Center for the Polyurethanes Industry (CPI) of the American Chemistry Council	www.polyurethane.org
Spray Polyurethane Foam Health and Safety	www.spraypolyurethane.com
Spray Polyurethane Foam Alliance	www.sprayfoam.org
OSHA homepage	www.osha.gov
NIOSH homepage	www.cdc.gov/niosh
EPA SPF Website	http://www.epa.gov/saferchoice/spray-polyurethane-foam-spf-insulation-and-how-use-it-more-safely

American® Chemistry Council
Center for the Polyurethanes Industry

700 2nd Street, NE
Washington, DC 20002
(202) 249-7000
www.americanchemistry.com