SPRAY POLYURETHANE FOAM ALLIANCE

SPFA-137

High-Pressure Spray Foam Equipment Guidelines

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ABOUT SPRAY POLYURETHANE FOAM ALLIANCE (SPFA)

Founded in 1987, the Spray Polyurethane Foam Alliance (SPFA) is the voice, and educational and technical resource, for the spray polyurethane foam industry. A 501(c)6 trade association, the alliance is composed of contractors, manufacturers, and distributors of polyurethane foam, related equipment, and protective coatings; and who provide inspections, surface preparations, and other services. The organization supports the best practices and the growth of the industry through a number of core initiatives, which include educational programs and events, the SPFA Professional Installer Certification Program, technical literature and guidelines, legislative advocacy, research, and networking opportunities. For more information, please use the contact information and links provided in this document.

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DOCUMENT HISTORY

Date	Sections Modified	Description of Changes
April 2005		
August 2015	All	Administrative changes
June 2018	All	Full update of the complete guide
January 2019	About SPFA and Mission Statement	Minor edits to the About SPFA and Mission Statement sections
January 2021	Front Cover and Header	New SPFA Logo
October 2022	All	New title, spelling errors
December 2022	New Appendix	Added checklist

EQUIPMENT COMMITTEE

MISSION STATEMENT

1. Provide a wide range of technical information to the Spray Polyurethane Foam industry to help members select equipment that best suits customers' needs using input data for customers' Spray Foam applications.
2. Maintain current SPFA TechDocs SPFA-137 Spray Polyurethane Equipment Guidelines and SPFA-144 Coating Equipment Guidelines.
3. Develop new TechDocs and TechTips as needed.
4. Develop a new category with non-biased performance facts for low-pressure (under 1K) Spray Foam systems as they enter the market.
5. Identify, explore, develop, and communicate an understanding of technical issues related to Spray Foam processing equipment.
6. Provide a forum for SPF equipment and accessory suppliers and members who perform equipment maintenance services, troubleshooting, rebuilding and complete overhauls.
7. Develop guidelines for best-practices, safe and efficient design and maintenance of SPF equipment, rigs, and accessories.
8. Identify all types of spray guns, categorizing as appropriate into plastic/throw-away, air purge, mechanical purge, manually operated no air, and re-useable low-pressure guns.
9. Identify all types of available Proportioners.
10. Provide better data analysis of ancillary equipment used with and for the backup of Spray Foam equipment.
11. Analyze and evaluate air-respiratory types of Spray Foam equipment into low-pressure, high-pressure, and OGV mask types.

EQUIPMENT COMMITTEE MEMBERS

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TABLE OF CONTENTS

PREFACE

The purpose of this guide is to assist those entering the SPF (spray polyurethane foam) business in the selection of application equipment. This guide discusses the equipment components necessary to spray-apply polyurethane foam as well as capacities and alternatives. This document applies to high-pressure SPF as defined in SPFA-119:

> ***SPF, HIGH PRESSURE****: Spray polyurethane foam where the A- and B-components are delivered at a pressure between 1000 and 1300 psi, at a rate up to 30 lb/min wherein the components are atomized and impingement mixed in a spray gun.*

INTRODUCTION

SPF is the reacted product of two components that are mixed and sprayed to a substrate. The two components are:

A-component Ingredient: Polymeric isocyanate (MDI)
Synonyms: ISO

Comments: The A-component will react with moisture in ambient or compressed air to form hard polymerized crystals or flakes. Therefore, equipment handling the A-component must be designed to exclude moisture.

B-component Ingredients: Polyols, blowing agents, catalysts, flame retardants, surfactants
Synonyms: Resin or R-component, polyol, or B-component

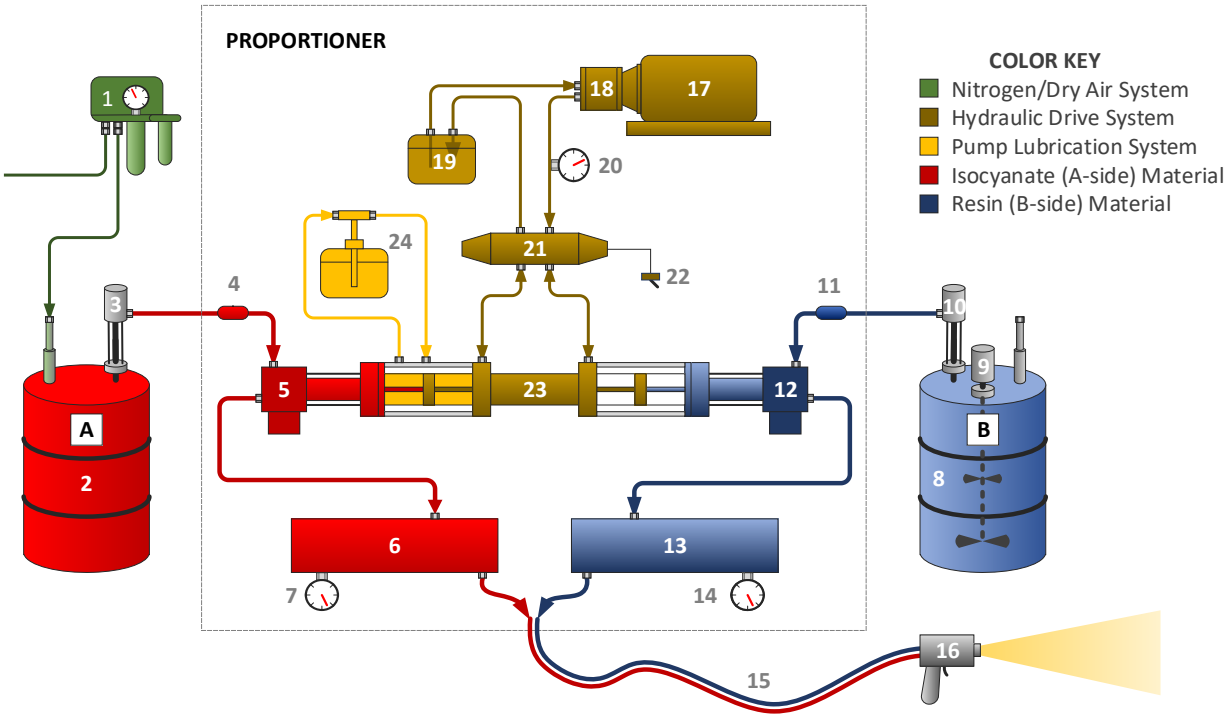
Comments: The blowing agent in the B-component may vaporize (boil) if the material becomes too hot before application.

To properly spray polyurethane foam, the application equipment must be capable of storing, pumping, heating, mixing, and spraying these two components at the material supplier's recommended temperature, viscosity, and material ratio.

In general, six equipment elements are necessary to apply SPF, as shown in the diagram of Figure 1:

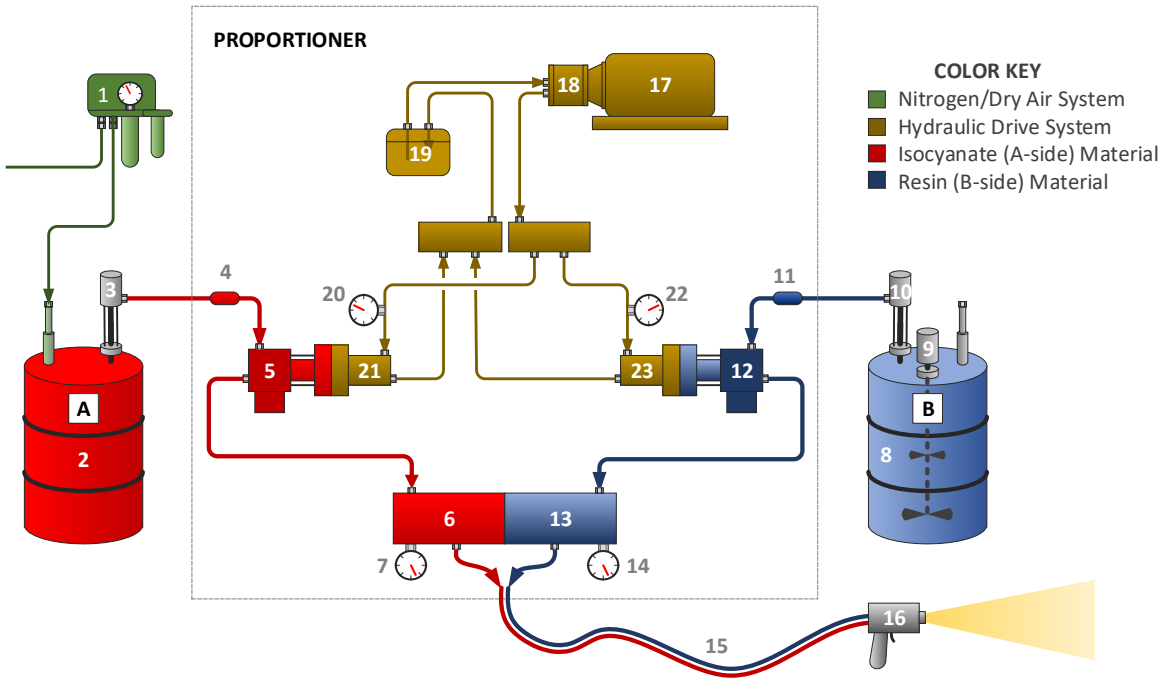
(1) Material storage and handling system
(2) Material delivery system (siphon, pressurized or pump)
(3) Drum mixing system - if agitation is required by manufacturer
(4) Proportioner pumping/heating system
(5) Material delivery in a heated hose system
(6) Plural component spray gun

These elements will be discussed in detail in later sections.



1. Nitrogen/Dry Air System
2. Isocyanate Drum/Tote
3. Isocyanate Transfer Pump
4. Isocyanate Filter
5. Isocyanate Proportioning Pump
6. Isocyanate Primary Heater
7. Isocyanate Output Pressure Gauge
8. Resin Drum/Tote
9. Resin Drum Mixer
10. Resin Transfer Pump
11. Resin Filter
12. Resin Proportioning Pump
13. Resin Primary Heater
14. Resin Output Pressure Gauge
15. Dual Heated Hose
16. Spray Gun
17. Electric Motor
18. Hydraulic Pump
19. Hydraulic Fluid Reservoir
20. Hydraulic Pressure Gauge
21. Hydraulic Directional Valve
22. hydraulic Directional Switch
23. Hydraulic Cylinder
24. Pump Lube System

Common Drive



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7. Isocyanate Output Pressure Gauge
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9. Resin Drum Mixer
10. Resin Transfer Pump
12. Resin Filter
12. Resin Proportioning Pump
13. Resin Primary Heater
14. Resin Output Pressure Gauge
15. Dual Heated Hose
16. Spray Gun
17. Electric Motor
18. Hydraulic Pump
19. Hydraulic Fluid Reservoir
20. Hydraulic Pressure Gauge - Isocyanate Pump
21. Hydraulic Motor – Isocyanate Pump
22. Hydraulic Pressure Gauge - Resin Pump
23. Hydraulic Motor – Resin Pump

Independent Drive

Figure 1: Typical SPF equipment setup

Most SPF applicators install their equipment in self-contained trucks or trailers. Auxiliary equipment (such as air compressors, coating spray equipment, and electrical generators) may be mounted in the same truck or trailer. Such a truck or trailer is commonly called a “foam rig.” Foam rigs are normally insulated and heated to keep the A- and B-components at their appropriate storage or feed temperatures.

OEMs (Original Equipment Manufacturers) install their equipment at a fixed location or shop. Whether mobile in a foam rig or fixed in a shop, equipment needs are similar.

It is critical to keep the A- and B-components separate until they reach the spray gun. It is also critical that equipment elements designed for one component never be used for the other. To do otherwise will result in plugged and blocked equipment, which will cause downtime and costly equipment repairs or replacement. Always plan and design your foam rig to minimize the opportunity to inadvertently misuse the equipment. Color coding your equipment components to match your polyurethane foam supplier's color-coding system will help prevent mix-ups.

⚠ **CAUTION:** Spray polyurethane foam and coating application equipment operate at high pressures. Always relieve the pressure before disconnecting or servicing equipment components. Never exceed the pressure rating of equipment components.

EQUIPMENT OUTPUT

Size your equipment based on the type of projects you expect to undertake. Generally, output is expressed in weight per unit time, such as lb/min or kg/min.

Market	Typical Projects	Output Range
Residential, light commercial, light industrial	Residential insulation, small tank insulation, small roof spray adhesive, crawlspaces, etc.	Up to 15 lb/min (7 kg/min)
Large residential, commercial, industrial	Roofing, residential insulation, medium tank insulation, large roof spray adhesive, concrete lifting (slab jacking), etc.	Up to 30 lb/min (14 kg/min)
Heavy commercial, heavy industrial	Large roofing, large tank insulation, etc.	Up to 45 lb/min (21 kg/min)
OEM	Boat floatation, spa insulation, specialty molding, manufactured housing, insulated consumer products, etc.	Up to 60 lb/min (27 kg/min)

Once an output range is selected, choose your equipment to meet this requirement. It may be advantageous to select certain equipment elements oversized to allow for future expansion into other markets.

MATERIAL STORAGE SYSTEMS

The material storage system stores and conditions the A- and B-components. The storage system you use will depend on your material supply source and type of foam products used.

Most material is delivered in 55-gallon drums, but 5-gallon pails and 275-gallon totes are also available. Consult with your materials supplier to determine the best container type for your application.

The material storage system must be capable of storing the A- and B-components within the temperature ranges specified by the material supplier.

UNPRESSURIZED CONTAINERS

The A- and B- components can be supplied directly from unpressurized containers such as drums and totes. Consider positioning and color marking the containers, lines and transfer pumps to minimize the possibility of accidental pump switching. Locate containers close to the axles for best weight and balance distribution.

Figure 2: 55-gallon drum (left) and 275-gallon tote (right)

PRESSURIZED TANKS

Alternatively, one may use pressurized storage tanks or day tanks. Follow DOT regulations when selecting pressurized tanks for over-the-road foam rigs.

Figure 3: Example of a pressurized storage tank

Pressurized feed tanks may be used in lieu of pumps to supply the proportioner. This system provides the most constant, even pressure to the proportioner. This system also does not use any transfer pumps requiring less maintenance and troubleshooting and air demand from your auxiliary power. However, in using pressurized feed tanks, ensure that the feed tanks are rated for the intended pressure. Also, make sure all lines and hoses are sized properly for the material delivery requirements of the proportioner.

Pressurized tanks need the following:

(1) **Pressure blanket system** for nitrogen or dry air. Tanks requiring pressurization above 12 psig (80 kPa) must be ASME (American Society of Mechanical Engineers) rated. Should modifications be made to the tank after ASME certification, the certification is void and the

tanks must be recertified. Pressurization below 12 psig (80 kPa) does not require an ASME certification.

(2) **Material level indicators** (optional)
(3) **Material temperature monitoring** system (customized)
(4) **Material refill systems** (customized)
(5) **Material outlet system** (customized)

Pressurized tanks avoid potential problems of transfer pumps as these pumps are not required. Some contractors find this beneficial when using the same type of foam on large jobs (e.g., large roofing projects). Pressurized tanks may not be the best choice if a contractor frequently changes foam materials.

On-board storage tanks are pressure fed with nitrogen or dry (desiccated) air used to push the material out of the vessels, through feed lines to the proportioner inlet. Tank pressure and transfer hoses sizing (diameter and length) between the tanks and the proportioner must ensure a minimum of 50 psi.

MATERIAL CONDITIONING

SPF chemicals may need to be conditioned prior to delivery to the proportioner. The A-component will need to have dry air inside its storage vessel (tank, tote or drum) to prevent reaction with airborne moisture. A- and B-components may need to be heated and mixed prior to transfer to the proportioner.

INERT GAS BLANKETING

Whether feeding from 55-gallon drums, supply tanks, or 275-gallon totes, always keep a blanket of dry air[1] in the headspace of the A-component tanks. Moisture in the air will react with the A-component, forming crystals or flakes that will clog equipment strainers. Air dryer canisters are available to insert into the vent bung of the 55-gallon drum or 275-gallon tote. The silica gel in the air dryer canister changes color when they are saturated with moisture. These silica gels can be readily changed, and most can be dried and re-used. See manufacturer's recommendations regarding maintenance of silica gel dryers.

B-component vessels may require inert gas blanketing to keep the blowing agent in solution under high ambient temperature conditions. A nitrogen gas blanket can be utilized by using a nitrogen cylinder, regulator, and safety relief valve. Avoid over-pressuring a drum or tote (3.0 – 5.0 psi [20–35 kPa] maximum).

Figure 4 - Silica Gel Dryer mounted in ¾" hole of A-side Drum

HEATING

The drums and totes can be heated which allows startup with warm material. Refer to your material suppliers for recommendation prior to installing a drum or tote heating system. There are several types, silicone band heaters are not recommended. At present, there are aluminum stand heaters and drum or tote heating and cooling blankets available.

[1] Inert gas such as nitrogen or argon may be used in place of dry air.

Figure 5 –Blanket-style drum heater (left) and under-drum heater (right)

MIXING

Drum mixers may be required for the B-component when high pressure equipment is used to apply low-density spray foam. Drum mixer impellers should a folding type which will fit into a 2-inch bung hole. Typical drum mixers include two 6-inch and one 8-inch impellers.

Drum mixers may be driven by air, electric or hydraulic power sources. When selecting the type of drive for drum mixers, consideration should be given maintenance, reliability, speed control, and capacity of the auxiliary power system(s).

Small mixers and auger-type mixers are not recommended as they do not thoroughly mix the contents in a B-component drum. It is not recommended to use a drum mixer in an A-component drum as it could cause air entrainment and moisture contamination.

Figure 6 – Different drum mixer types; pnuematic, electric and hydraulic-driven (left to right) and foldable blades (far right)

MATERIAL SUPPLY SYSTEM

The material supply system must deliver A- and B-components from the storage drums, totes or tanks to the proportioner at sufficient volume and pressure to prevent cavitation of the proportioner pumps. There are three ways to deliver materials from the supply vessel to the proportioner:

(1) Transfer pumps and supply hoses for each component. (By far, this is the most common method.)
(2) Pressurized supply tanks.
(3) Siphon system with a check valve at the foot of the siphon tube.

The material supply system depends on the type of proportioner system, the type of foam and the viscosity of the A- and B-components that you are using.

To maintain proper flows and pressures, components of the entire system need to be properly sized. The proportioner must have a higher output than the spray gun. The material supply system must have an output higher than the proportioner or cavitation may occur. Without proper sizing, the spray pressures could fall below optimum. Proportioners have different feed

pressure and volume requirements; check with your proportioner manufacturer to determine the minimum and maximum pressure and volume requirements.

⚠ **CAUTION:** If the material feed system cannot feed A- and B-components as required by the proportioner, cavitation will occur, can cause intermittent off-ratio foam or plugged, damaged equipment (a.k.a. crossover).

***CROSSOVER**: An undesirable mixing of ISOCYANATE and RESIN components as a result of unbalanced pressures at the spray gun. May result in an equipment blockage.*

PUMPING FROM 55-GALLON DRUMS

Material in 55-gallon drums can be fed to the proportioner by using drum pumps that are inserted into the bung in the top of the drum.

Figure 7 – Standard drum pumps of different lengths

Drum pumps are usually air operated and are typically supplied with 100-psi air pressure. Air consumption can be up to 3 cfm for every 1 gallon of material pumped depending on the specific drum pump used.

A-component drum pumps are usually of a “divorced design,” whereby the fluid and air sections of the pump are separated (“divorced”). This prevents the A-component from being contaminated by moisture in the exhausting air from the air motor. Divorced design drum pumps

normally have a 2:1 pressure ratio (i.e., 100 psi air pressure fed to the air motor will develop 200 psi material output pressure).

Many SPF applicators use a 2:1 divorced design drum pump for the B-component for commonality of components for maintenance, spare parts, etc. Diaphragm-type drum pumps are not recommended for the B component as they may cause frothing of the blowing agent.

⚠ **CAUTION:** When changing out empty drums, it is easy to make the mistake of inserting the A-component drum pump into a B-component drum (or vice versa). To prevent this: (1) keep A- and B-components in different sections of the foam rig; (2) color code the drum pumps, hoses, and valves with paint and/or tape; and (3) fully train your workforce as to the importance of keeping the A- and B-components separate.

PUMPING FROM SUPPLY TANKS OR 275 GALLON TOTES

Air-powered double diaphragm pumps are commonly used with supply tanks (unpressurized) or totes. These pumps usually have pressure ratios of 1:1. The same size pumps are used for both A- and B-components. Wetted parts of the A-component pump are normally aluminum; the wetted parts of the B-component pump are normally polypropylene. Diaphragms may be Teflon® or polypropylene. Be sure that diaphragm pumps are equipped with anti-stalling air motors.

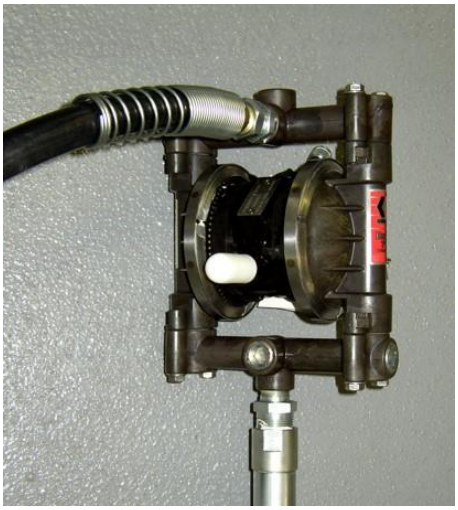

Figure 8 - Typical diaphragm pump

⚠ **CAUTION:** Double diaphragm pumps may cause frothing of the B-components, especially when the B-component is warm.

MATERIAL SUPPLY HOSES

The hoses used to link the transfer pumps, or pressurized tanks to the proportioner are normally 3/4 inch (100 mm), 500 psi (3,500 KPa) rated, nylon-lined. Vapor impermeable type hoses are needed for the A-component hose. The hose length should always be as short as possible, yet sufficient to allow ease of transfer pump movement. These are typically available in 10 foot (3 meter) sections, and can be fitted together for additional length if required. High-capacity applications will require hoses of larger diameter. The draft or siphon systems use 1" truck type suction hoses from the drums to the proportioner.

PROPORTIONER

The proportioner, or metering pump, commonly consists of two positive-displacement, double-acting piston pumps with a common drive system. There are also non-common drive full variable ratio systems. These designs assure that the A- and B-components will be delivered to the spray gun at a constant ratio at high pressure. The piston pumps may be mounted vertically or horizontally.

Proportioners are available in output capacities of 8 lb/min (3.6 kg/min) to 60 lb/min (27 kg/min) and output pressures of 1,000 psi (6,900 kPa) to 3500 psi (24,000 kPa). The type and size of projects should determine the output capacity of the equipment you select.

Proportioner drive systems may be air, electric, or hydraulic powered. The selection of drive system is largely determined by the output capacity—smaller units tend to be powered by air or electricity while larger units tend to be powered hydraulically. Availability of job site services (air or electrical power) may influence your selection. However, most SPF applicators have selected the proportioner drive system based on output and acquired the auxiliary equipment (air compressor and/or electrical generator/shore power) necessary to power their unit; this approach allows for flexibility.

Pump packing material should be Teflon or other inert material compatible with the A- and B-components. A wetting cup or lube cylinder is a must for the A-component proportioning pump due to isocyanate reaction with moisture to form hardened crystals. These wetting cups or lube cylinders should be filled with a plasticizer agent (such as TCP or DOP, or mineral oil). Lubrication or diesel oil is not recommended due to its moisture content and subsequent reaction with the A-component material. A wiper ring is recommended for the B-component proportioning pump

due to potential dirt contamination of the B-component film on the proportioning pump shaft and its subsequent damage to the pump packings.

The positive displacement pumps of proportioners can develop high pressures and must be equipped with a safety system to ensure that the maximum working pressure of the equipment is not exceeded. Both A- and B-component proportioner pumps must be outfitted with over-pressure safety switches which deactivate the drive system, or all the components must be rated to safely handle any pressure imbalance that the proportioner could generate.

All proportioner pumps should be equipped with pressure gauges to display output pressure of both the A- and B-components. Gauges should be at least 2-1/2 inches (60 mm) in diameter and of the oil-filled type for easy visibility. The gauge range should be about twice the operating pressure of the proportioner. Proportioners may also be equipped with pressure transducers and gauges.

Proportioners are normally supplied with inlet material strainers to remove foreign particles and crystallized isocyanate before it can reach the displacement pumps. These Y strainers are typically 20 to 40 mesh for SPF chemicals. As they get dirty and fill up they restrict the ability of the fluids to adequately supply the proportioner pump, which can then lead to cavitation and an off-ratio situation or equipment shutdown. These strainers should be checked periodically per supplier's recommendations to prevent clogging.

It is a good practice to install pressure and temperature gauges at the A- and B-component inlet of the proportioner. The information from these gauges is helpful in diagnosing both temperature and fluid supply problems. With the gauge on the outlet side of the screen, abnormal pressure drops indicates issues with material delivery, which can be critical for the proper operation of the proportioner.

PROPORTIONER PUMP AND HEATING SYSTEM

The proportioner/heating system is the heart of the SPF equipment setup. It determines the maximum output capacity of the SPF application system and is designed to accomplish four tasks:

(1) Proportion or meter the A- and B-component materials in the appropriate feed ratio (usually 1:1).
(2) Pressurize the A- and B-component materials so that they will mix properly in the spray gun.
(3) Move the A- and B-component materials at the desired pressure and temperature in lb/min (L/min or gal/min) to the spray gun.
(4) Heat the A- and B-component or condition, so that the viscosities allow for proper mixing in the spray gun.

Note: Some polyurethane spray adhesive materials are formulated with lower viscosities so that a heating system is not required.

A heating system is necessary to raise the temperature of the A- and B-components to reduce their viscosities and to help with proper mixing. Without lower viscosities, the materials would not impingement mix properly or maintain the proper spray pattern. This could result in poor foam quality.

Heat is normally supplied to the A- and B-components in two stages: a primary heater (or pre-heater) and a heated hose (discussed in the next section). Generally, the primary heaters are responsible for heating the A- and B-components to their application temperatures, while the heated hose is designed to maintain that temperature during application. Most proportioners have a primary heating system built into them. Those that do not require a separate primary heating system. In either case, the heating system operates independently of the proportioner pumps.

Primary heaters are typically electric resistance, but some are heated using coolant from the generator engine. Some primary heaters use electric rods in contact with the A-side and B-side chemicals (direct contact); others use electric rods to heat plates, which, in turn, heat the chemicals (high mass). Some primary heaters heat both the A- and B-components in a single heater; some have dual heating units, one for each component. Most primary heaters are automatically controlled. All primary heaters should be equipped with high-temperature safety switches to prevent over heating of the material.

One crucial factor in selecting a primary heater is the total power requirements (wattage). Increased material output and increased material temperature rise require greater wattage. Check with the proportioner manufacturer to determine the wattage you will need for your primary heater based on the output capacity and temperature rise. Primary heaters must also handle the high fluid pressures.

Hybrid design primary heaters take the *direct contact* design and place the material tube and heater element inside a *high mass* aluminum block, significantly increasing the efficiency of the heater.

Thermal mass heaters have no heating elements in direct contact with the fluid and can heat both the A & B components.

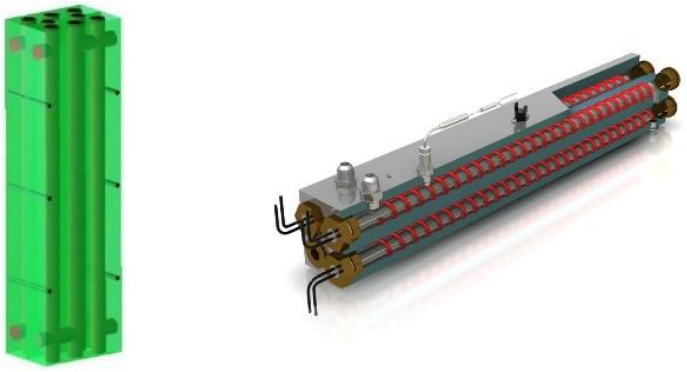

Figure 9 – Primary heater designs
(dual thermal mass on left, single hybrid thermal mass on right)

HEATED HOSE SYSTEM

The obvious function of the heated hose system is to transfer the A- and B materials from the proportioner to the spray gun. But it does more than this, including:

- Heats the A- and B-components within the hoses at start up
- Maintains A- and B-component temperatures during the SPF application
- Has temperature sensor lines compatible with the temperature controller at the proportioner or meter
- Delivers operating and/or purge air to the spray gun, if needed
- Delivers solvent to solvent-flushed spray guns, if used

In addition, the hose system (or hose "bundle") must be thermally insulated to minimize heat loss, covered with an abrasion-resistant covering to protect the hoses and its electrical components, and constructed of materials that can resist the absorption of moisture (particularly on the A-side).

The hose system, therefore, is a complicated piece of equipment and is specially designed for spraying plural component materials. When selecting a heated hose system, you need the following information:

- What type of spray gun will you be using? Will it require air for operation and/or purging? Will it require solvent for flushing?
- What type of proportioner will you be using?

Many proportioners provide electrical feed to the hose system and the hose system will have to be compatible in wattages and sensor type with the proportioner.

- What length of hose will you need?

  Hose bundles vary in length from 22 feet (6.5 meters) to 50 feet (15 meters), depending on the manufacturer. They are connected together to extend the hose reach, but the total length is limited by the total hose heating amperage. Four-hundred feet (122 meters) is the maximum length of most heated hose systems. Auxiliary hose heat systems are available for longer lengths. Length of hose, as well as elevation difference between the gun and proportioner, will result in pressure losses in the hose. This pressure loss can affect foam quality. Consult with your manufacturer regarding acceptable maximum hose length.

- What diameter of hose will you need?

  Material delivery hoses are available in 1/4-inch (6 mm) to 1/2-inch (12 mm) diameters; keep in mind larger diameter hoses have less pressure loss and reduce pressure variations (accumulator effect). An excessive loss or variation of pressure in the heated hose system may contribute to inadequate pressure at the spray gun or poor spray pattern.

- At what pressures will you be operating your proportioner and gun?

  Note: static pressure is measured while not spraying; dynamic pressure is measured during spraying. Most SPF applications will be below a dynamic pressure 2,000 psi (14,000 KPa), but special materials may require higher operating pressures.

Figure 10 - Insulated hose bundle without protective jacket (left), hose bundle with flex braid scuff jacket (center) and hose bundle with Velcro™ jacket (right).

Figure 11 - Hose joint with Velcro™ cover

Figure 12 - Typical thermal sensing units (RTD or thermocouples) (left) and thermal sensing unit connectors (right)

Figure 13 - Heated 'whip' hose with braided scuff jacket

PROPER HOSE STORAGE

A hose rack is useful to neatly store hoses in the rig. However, racks must be designed and used properly. Racks should be designed to have a gradually curved support surface to uniformly support the weight and eliminate sharp bends in the hose. Ideally, when hanging a hose on a rack, the lower loop should rest on the floor to minimize the weight supported on the rack itself. Hanging the hose on a single or double rack in a 'figure 8' design can make the hose easier to load and unload.

A single layer of hose on a rack may be preheated without removing the hose from the rack. Hoses on racks that are overlapped in more than one layer must be removed from the rack prior to preheating to avoid hot spots and subsequent damage to the hose components (see Figures 15 and 16).

Figure 14 - Standard rack design which stacks more than one layer of hose. This hose must be removed from the rack down to a single layer before preheating.

Figure 15 - Three-tiered rack hangs the hose in single layers, preventing electromagnetic effect and overheating of the hoses, enabling preheating of the entire hose while on the rack.

Figure 16 - 180-degree swing-out rack releases the hose directly out the rear door of the rig.

WHIP HOSES

Whip hoses connect the main heated hose bundle to the gun. It is lighter and more flexible than the main hose due to its smaller diameter, facilitating handling and spraying. Whip hoses are typically heated, especially in colder weather or when intermittently spraying. Additionally, should a crossover occur, most likely only the whip hose would be contaminated minimizing replacement expense. Whip hoses come in various lengths up to 20 feet (6.0 meters).

Some installers use unheated whips in certain applications. If unheated whips are used, the length should be as short as possible to prevent unwanted cooling and purging of SPF chemicals.

Figure 17 - Whip (unheated) attached to a gun

Figure 18 - Typical whip (heated)

SPRAY GUNS

The function of the spray gun is to mix the A- and B-components and discharge the mixture in a uniform spray pattern or pour method. Spray guns are designed to mix and spray out the A- and B-components without the mixed material reacting in or on the gun. Different guns employ different strategies to accomplish this. Elements common to most guns include:

- Hose connection blocks, coupling blocks
- Material shutoff valves
- Material filter screens, inside the gun or upstream of the gun
- Material check valves
- Mixing chamber or module
- Spray tip or nozzle
- Trigger air cylinder and piston (except on mechanically operated guns)

Plural component spray guns operate by mixing the A- and B-components at high velocity and discharging the mix out of the spray tip or nozzle. This “direct impingement” mixing relies on the kinetic energy of the two materials rather than on moving parts. Some guns also employ a static mixer. Mixing requires consistent material viscosities, temperatures and pressures to control the proper mix and spray pattern.

The material delivery hose is connected to one or two hose connection blocks. The coupling block or manifold assembly allows for disconnecting the gun assembly from the hose for easier maintenance and safe gun storage. Coupling blocks or manifold assemblies may have material shutoff valves. Most guns have check valves (to hinder back flow and crossover), and material filter screens (to remove small particles which might clog the gun orifices). Some add external

gun pressure monitoring Y strainers so that you don't have to take a gun apart to clean the screens.

Most spray guns have A and B material inlet ports or orifices opening into a mixing chamber. The ports or orifices are designed so that the A- and B-components are directly or slightly off center impinge on one another to mix the streams. The mixed material is then forced out a spray tip or nozzle forming a spray pattern. When the spray gun is "off," some mechanism of positive material shut-off is employed.

To keep reacted material from accumulating in and on the spray gun, the gun must be equipped with a purge mechanism. Spray guns employ one of the following purge methods:

- Mechanical self-cleaning: A rod or plunger completely fills the mixing areas of the gun physically forcing material out of the spray gun.
- Air purge: Air is blown through the spray gun's mixing areas at high velocity to blow out residual material. The purge air must be dry.
- Solvent flush: A solvent is flushed through the spray gun at high pressure and velocity to remove residual material. Solvents used for flushing should be non-flammable and should leave no residue.

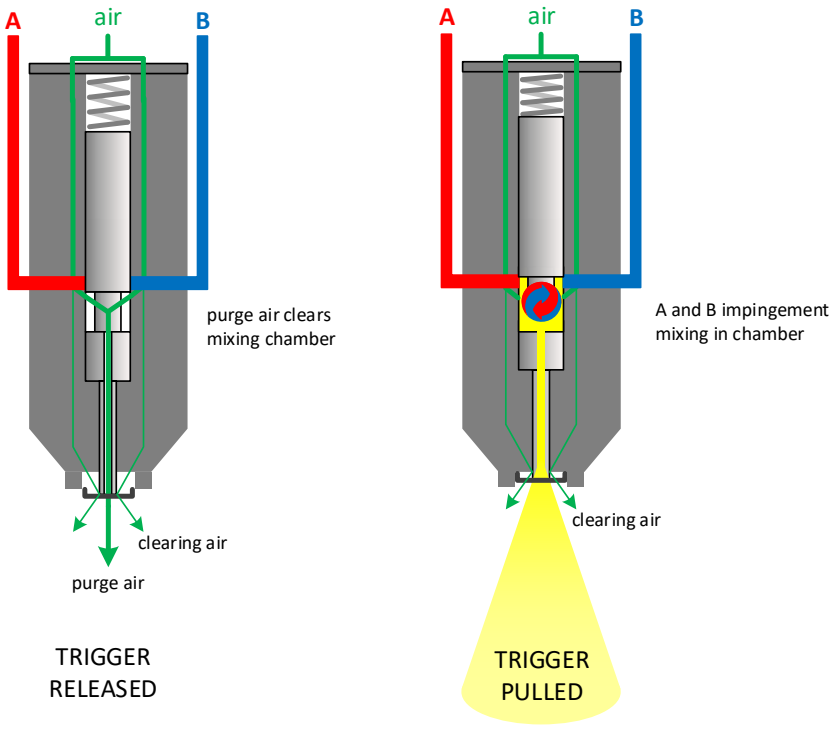

Figure 19 - Air-purge gun schematic

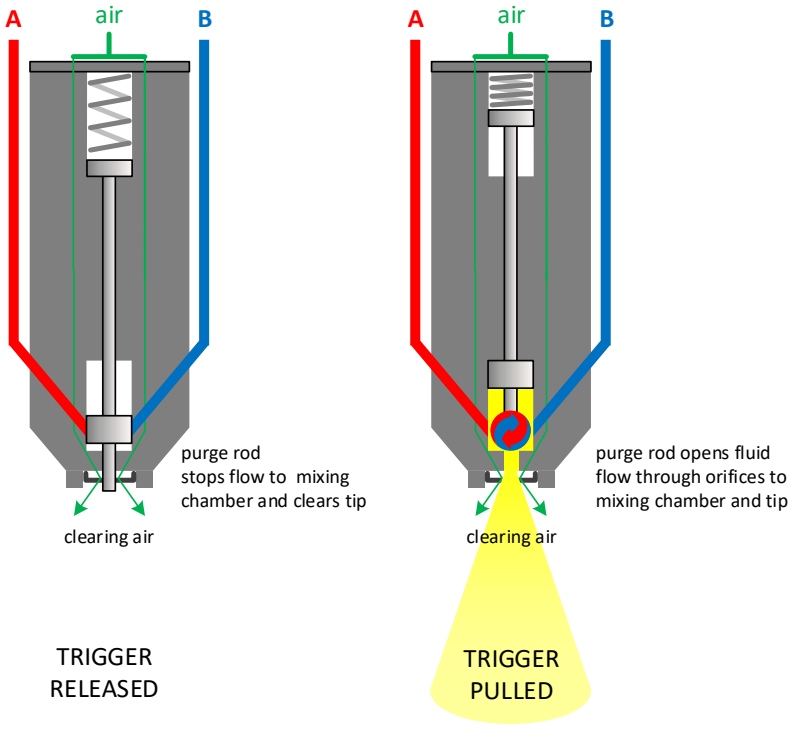

Figure 20 - Mechanical-purge gun schematic

Some spray guns are equipped with an air purge at the spray tip or nozzle to prevent the buildup of reacted polyurethane on the tip.

Most spray guns operate with a trigger activated air piston to initiate mixing and spraying. Release of the trigger or loss of air pressure may shut the mixing off. Some spray guns are mechanically operated and do not require air for this purpose.

Many spray guns can be modified with internal parts to operate over a broad range of application rates. Additionally, they can be modified to spray a round or flat spray pattern. Consider your anticipated maximum output when selecting a spray gun. Many foam applicators use a low-output spray gun for detail work and a high-output spray gun for production. Some just change the size of the mix chambers or tips. Gun tip selection as well as mixing chamber orifice diameters and mixing chamber size must be properly matched to the proportioner output to avoid undesirable pressure losses. Consult with your equipment manufacturer regarding acceptable combinations based on your application.

SPRAY GUN FLUSH POTS

Typically, a solvent is used to flush out the spray gun. Consult with your gun manufacturer for a list of approved solvents.

Flush pots are a valuable tool for:

- Flushing the gun before working on it.
- Checking how the gun sprays both components.
- Cleaning A-component out for extended storage.
- Checking function, action of the gun and settings.
- Saving time and money

Figure 21 - Example of a flush pot.

SCARIFIERS AND SPF SAWS

Scarifiers and saws are handy for shaping and sculpting finished SPF surfaces; they are also useful for preparing some surfaces prior to applying SPF. On roofs, they may be used to remove old coatings before re-foaming and coating. On walls, they may be used to plane the extra SPF flush with the front of the studs. In marine holding tanks, scarifiers and saws may be used to shape and sand the SPF in freezers and water tanks before coating.

There are different types of scarifiers that use carbide blades to cut coatings, to fine wire wheels for trimming foam. It should be noted that electric units can become plugged with the fine dust particles. Care should be used to keep these tools clean to prevent motor overheating.

Figure 22 - Scarifier with wire-wheel brush (air driven)

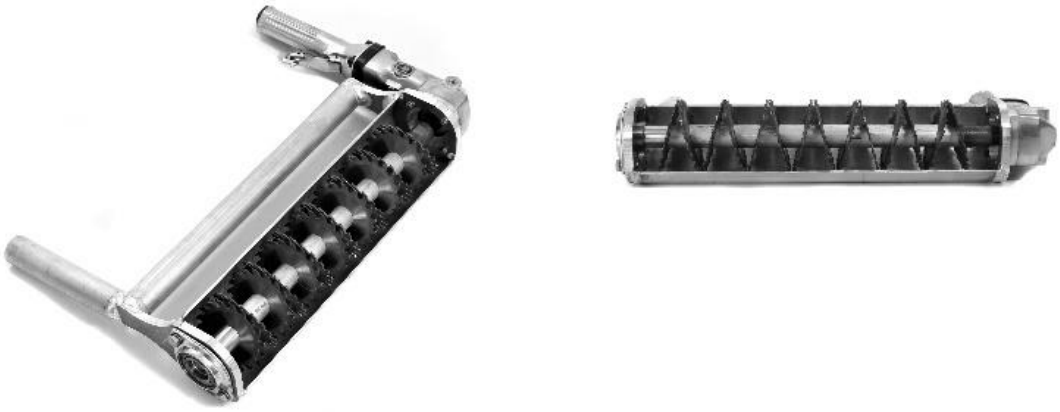

Figure 23 - Scarifier with carbide cutting wheels (air driven)

Figure 24 - Scarifier for roof coating removal

Figure 25 - Reciprocating saw for cutting open-cell SPF in stud cavities

ROBOTIC APPLICATION EQUIPMENT

Robotic spray applicators can boost production on flat roofing applications. They can apply accurate SPF thickness while reducing labor and fatigue. Robotic applicators may also be used to apply roof coatings.

Figure 26 – Robotic Spray System for Roofing Applications

AUXILIARY EQUIPMENT

Unless sufficient onsite electrical power and compressed air are available, an electrical generator or air compressor will be necessary. Indeed, most SPF contractors use generators and compressors because of the added independence, flexibility, and mobility they provide. Select generators and compressors of sufficient size to provide service to all the equipment employed on the jobsite. Electrical power and compressed air requirements are available in equipment technical manuals.

Considerations for selecting auxiliary equipment:

- Determine total electrical power requirements to properly size the generator.
- Determine total airflow requirements of all equipment to properly size the air compressor.
- Ensure wiring and piping is sized properly for the generator and compressor.
- Consider special combo generators/compressors designed specifically for SPF application.
    - Combo systems are typically sized at 30KVA/30CFM or larger.
    - Some generators can also provide hydraulics and air in one unit.
- Determine if your proportioner requires single phase or 3-phase power.
- Check the physical size, vibration and loudness of the generator and compressor

    - Vibration dampening and sound deadening walls may minimize noise level.
- Wire your rig so that you can easily back up your generator or compressor if they fail.
    - Many rigs are wired with double throw switches or able to use their own power or shore power.
    - Keep every component serviceable and for replacement if needed.

GENERATOR TYPES

Using diesel-powered generators rather than gasoline powered generators is generally preferred because diesel fuel is less flammable than gasoline and diesel generators provide more consistent electrical power for newer computer-controlled equipment. Some integrated generators (or gen-sets) can also provide hydraulic and air in one unit. This can be more economical and easier to maintain than separate systems.

There are many things to consider when planning for a generator or shore power supply. The following is not intended to replace the expertise of a certified electrician, who should be consulted before any generator purchase or installation. Generator under-sizing is all too common due to budget concerns, lack of understanding, and misinformation. This mistake can not only damage the generator but damage all electrical equipment that is being powered by it.

GENERATOR SIZING

Before inquiring about a generator purchase, you need to calculate your power requirements. Make a list of all the items that you intend to incorporate into your foam rig before you start your shop comparison. The total system requirements for proportioners are listed in the operation manuals under the model's description and/or in the technical data sections. In addition to the proportioner, consider the other electrical equipment requirements typical in a foam rig operation. This can include: air compressor, air dryer, fresh air panel, lights, various outlets for electrical agitators, power tools, rig heating and air conditioning, etc.

Size generators to provide service to all the electrically-driven equipment employed on the job site. Provide excess capacity for accessory tools and miscellaneous needs. Electrical requirements are available in equipment technical manuals.

o List system components using starting requirements, in watts
o Add-up watts required
o Multiply total watts by 1.25 = KVA (Kilovolt-ampere), use this number to size the generator

If on-site power is to be used, be sure that the power source is sufficient enough to provide the required amount of electricity to power the equipment being used.

Figure 27 - Generator Only (left), Generator/Air Compressor/Air Dryer Combination (right)

Figure 28 - Enclosed Generator Sets Examples provide vibration and sound dampening

AIR COMPRESSOR SYSTEMS

Compressed air is needed to run equipment such as drum agitators, drum pumps, proportioners, spray gun, respirator supplied air, as well as air powered tools such as foam planers and saws. For a self-sufficient rig, a properly-sized air system is needed.

A typical air system includes an air compressor, air dryer and filtration system. Air compressors are typically powered by an electric motor, but some compressors are driven directly by the generator engine. Air compressors are piston or rotary screw driven, with the latter being most efficient to generate the 120 psi needed for most applications. Compressor size, in terms of CFM, is determined by the specific equipment used on the rig, but can typically range from 20 to 80 CFM.

AIR COMPRESSOR SIZING

Some proportioners use air driven motors, while others use electric or hydraulic drives. Air-driven proportioners require a much larger amount of compressed air. Always consult your equipment manual for the amount of air needed to run your equipment efficiently. Once you have determined the amount of air (CFM or cubic feet per minute) needed for each item of pneumatic-driven equipment, add the CFM requirements together to assure you have a compressor large enough to run everything. It is always suggested that you pick a compressor that has about 25% more CFM than needed.

Additionally, it is important to understand the duty cycle rating of compressors. While rotary screw compressor runs 100% of the time, piston driven compressors run intermittently. A piston compressor with a short duty cycle may not be adequate to supply some pneumatic equipment. Continuous-duty piston compressors are preferred. It is very important if running an electric compressor off the same generator power source as the proportioner, a continuous run system be used. The power spike needed to repeatedly start a non-continuous run compressor motor may adversely affect the proportioners electrical components.

Figure 29 - Examples of Air Compressors; rotary screw (left), piston (right)

AIR DRYERS

Air dryers are a requirement for most pneumatic equipment. In addition to removing moisture, dryers will filter particulates and oils from the compressed air; these contaminants will shorten the life of your equipment by destroying O-rings and causing excessive wear.

Air dryers come in two types, desiccant and electric. Each have their advantages; follow manufacturer's maintenance instructions.

Figure 30 - Example of an Electric Air Dryer

Figure 31 - Example of a Dessicant Air Dryer

TRUCK OR TRAILER RIG TIPS

Careful planning will pay dividends. Consider the size of the truck or trailer needed. Too large a rig prohibits maneuvering, restricts flexibility on job sites, and costs more to operate. Too small of a rig limits the amount of material and auxiliary equipment that can be taken to the jobsite. With a truck, a liftgate is a great option.

Figure 32 – Box Truck Rig

Figure 33 – Trailer Rig

SUPPLIED AIR SYSTEMS AND BREATHING APPARATUS

Respiratory protection equipment is addressed in your company's respiratory protection program. More information on this equipment can be found here:
https://www.spraypolyurethane.org/personal-protective-equipment-ppe/

APPENDIX

SPF HP EQUIPMENT GUIDE CHECKLIST

This checklist is an abbreviated version of SPFA-137. Please consult this TechDoc for more detail. As you go through the purchase process, use this as a check sheet: cross out, circle, underline, add, pick and choose.

You have read SPFA-137, now it is time to figure out what you need and to set your budget. Start by collecting the following information:

- Legal Documentation, Licenses and Permits including: CDL/licenses, contractor licenses, bonding, financing, insurance, MSDS, all made readily available on rig.
- Cost information, including:
  - Costs of Materials
  - Employee Costs & Labor
  - Costs to operate the equipment per day
  - Cost of the equipment and rig, whether you specified or built to your specifications
- Type of SPF work you plan to do and/or expand

Job Type – Determine the type of work you plan to do.

- Roofing
  - Small or large buildings
  - Residential or commercial
  - Robotic roof spraying equipment

- Perimeter wall building envelope
  - Homes
  - Commercial buildings, walk-in freezers, potato storage
  - Boats, ships

- Specialty slab jacking, other _____
  - High output type, lifting concrete, structural

- General all kinds of smaller jobs ¬¬¬¬¬¬¬¬¬¬¬¬¬_____

- Do you plan to do plural component coatings? _____

- Chemicals you plan to use and how you will move, store, mount, and open
  - SPF ½# Sound and attics
  - SPF 2# Structural homes
  - SPF 3# Roofing to walk on, flat jacking
  - SPF 4# Boats, freezers, flat jacking
  - Thermal barriers for exposed SPF
  - Gun cleaners (many types, do your homework)
  - Pump lube (maintain the action of the ISO pump, recommend light mineral oil)
  - Acrylics, roofing coatings, single or plural component
  - Polyurea/polyurethanes: Secondary containment, primary containment, many others
  - Silicones, urethanes, polyaspartic esters

- Safety equipment
  - Respirator types, organic vapor, low pressure, high pressure w/ air cooler or heater
  - Protective clothing, coveralls, head gear hoods, masks, gloves, tape
  - Absorption cleanup materials for spills
  - First-aid kits, eye wash portable station
  - All MSDS in cab within reach
  - Different types of fire extinguishers
  - Safety harness when on roofs and scaffolds
  - Case of bottled water, for hydration, exotherm heat when spraying SPF

- Backup equipment
  - Airless spray equipment for coatings, wall mount or portable
  - Scaffolding, ladders
  - Drum bung wrenches, pipe wrench for turning drums, drum carts
  - Roofing backup tools and equipment, roof cleaning and preparation
  - Scarifiers or wall foam planes, or ½# SPF knife/saw

- Mobile, OEM, or specialty equipment portable like in high-rise
  - Specialty equipment needed, drum dollies, etc.

- Size of rig: Weight _____, capacity _____, size _____, ceiling height _____
  - Big truck with lift gate, pros, cons
  - 4-wheel gooseneck or ball-type hitch trailer with size of pickup needed
  - Allows you to expedite when rig has hoses out on site.
  - Back door ramp type of regular swing-open each side, notch for spray hoses.
  - Insulated, lighted, lined, with HVAC or heaters in cold areas.

  - Portable hauler for jobsite mobility of proportioner and containers, equipment
  - Portable compact trailer rig pros, cons. Can't get out of weather, haul extra items

- Size of generator if used (15kW, 20kW, 25kW, 30kW, 40kW, diesel or gas)
  - Mounted and sound-deadened for noise and vibration
  - Outputs in single or 3 phase
  - Composite type also has compressor or hydraulic power pack on flywheel
  - Wired for standalone or bypass to shore power

- Size of compressor if used (15cfm, 20cfm, 30cfm, 40cfm, 50cfm, 125 cfm)
  - Amp load can be very high
  - Noise level can be too loud to think, and prohibited in quiet zones
  - Type: Piston or rotary screw (more expensive, but quiet and high volume)
  - Airless: No hard 90° fittings/pressure loss
  - Different types of air dryers, refrigerator high use to filter element types
  - Fresh air for breathing; bank of filters (particle, coalescent, CO^2), alarm system

SPF Equipment

- Brand and size of proportioner (check market suppliers in your area)
  - Air ____, electric _____, hydraulic _____ most economical to operate
  - Size, type and wattages of the preheater or preheaters (will dictate generator size)
  - Calculation sample: 8,000 watt / 240V = 33.3 amp load
  - Size and length of hose that the hose heater can handle: 150' – 300' (46 – 91 meters)
  - Voltage (240V most common, single or 3 phase needed for proportioner)
  - Stroke length or volume of the pumps: Output in pounds/minute or GPM/minute
  - Pressure capabilities 2000 or 3500 psi for fast set coatings
  - 1:1 or variable ratio
  - Common drive or non-common drive pumps

- Material supply system
  - Pressure tanks: How mounted, insulated, filled, pressurized/nitrogen, dry air
  - Hoses to proportioner: No hard 90°'s--pressure loss
  - Totes: How pumped or drained out. Diaphragm pumps and heat XX not a good combination
  - Drums: Strapped in typical most common, need to recycle many drums
  - Drum warming mounts, Blankets and cooling available
  - Silica-gel dryers for the ISO drum, unless using several sets a day

- Transfer pumps

  - How many, what size if used. Remember 2.5 factors.
  - Recommended to stick with larger IPM/OP series, GHO or T2 type of pumps
  - Bypass and recirculate capabilities, for transfer, TS, Nitrogen or dryer type air

Drum mixer needed? Say ½#; or if you do coatings _____
Air or hydraulic (best, be sure you have the 2-6" od x 5 blade and 1-8" od X 5 blade type)

Spray hoses
How many feet do you plan on needing? _____
Start with ½" hose for volume, accumulator effect, less pressure loss
Type of thermocouple: RTD or TC. Proportioner will dictate this.
Placement of the RTD or TC in the hose, 50' or 10' from the spray end
2000 psi or 3500 psi if you plan to do plural-component coatings
Proper 3-tier non-overlapping hose rack to prevent magnetism and overheating
Choose the best Velcro-type hose covering (easer to fix, many advantages)
Manifold block at the end of the 10' whip hose, mainly two types

- Spray gun types
  - Air purge: All purpose, easier to use, but more expensive to operate
  - Mechanical purge: Fan tips easier, big roofing jobs, high output, all day
  - CS gun: Detail gun for SPF clear-shot liquid keeps gun going, liquid not recommended for polyurea coatings.
  - Rack Gun: Totally manual no air, better yield, most economical to maintain
  - Many contractors have more than one gun and a backup (time is money!)
  - Unheated short mini gun whips for detail work

- Misc. tools and backup parts & equipment
  - Bench with vice to hold the gun when working on
  - Picks, wire brushes, 5/16" nut drivers, squirt cans or bottles for pump lube, cleaners
  - Gun pressure tank for flushing the gun and short unheated whip hoses
  - Replacement screens, Y strainer and for the guns (40 mesh best)
  - Replacement and other sizes of mix chambers, AW3939, 01, 02, 03, typical
  - Many different parts and sizes of O-rings with specific types, Viton most common
  - Ratio check equipment for troubleshooting
  - Part manuals for equipment and guns.
  - Geotextile or scrim for wind breaker on roofs
  - Masking and duct tape for overspray protection
  - Scrapers for cleaning edges of studs after spraying
  - White lithium grease for assembly of parts with O-rings
  - Paper towels, trash bags, and trash can for cleanups
  - Window cleaner (works great for cleaning up spilled resin)

- Carburetor spray can cleaner, when you must work on the spray gun
- MR515 mold release for the face of your mask, clean off SPF easily
- Large channel-locks for drum bung adapters
- Small Prestolite torch for heating to release hardened ISO, SAFETY!
- Red and blue electrical tape for color code marking and electrical repairs.

By now your picture of your rig setup should be taking shape. Go back and triple check as this is going to be a large, long-lasting investment.

We recommend that you work on this and get with more than one distributor or sales representative, go over each item with this person, double check that they are going to get you what you want in the equipment side and mark what items that you need to get yourself.
Have the distributor list everything on their invoice, not just "spray rig". Double check and if you don't understand some item, go ask until you do understand exactly what you are getting.
The distributor needs to be able to give you all the information that you need but, always trust your instinct if you don't feel fully satisfied. You need to do your homework very well, ask until you do.