Spray Foam Applicators that are trained well in processing material, application techniques, and equipment maintenance will be more productive, yield great profits, and build a stellar reputation among the building community. Paratus Supply can guide you and your crew every step of the way, so that you have all the proper tools and knowledge to succeed. We take this business and its reputation seriously, and will do everything in our control to help you to become an ambassador of the spray foam industry.

Our objective is to provide the proper training and support to spray foam contractors and applicators who choose to invest their time and dedication to produce a quality end user insulation product. We do this by teaching the trade secrets of the pros. Practicing proper equipment usage and maintenance, application techniques, and health & safety procedures are the keys to your business’s future.

By
Craig E Cutcher
Copy Right 2016
What is Spray Foam Polyurethane Foam?

Spray Foam is a cellular thermoset plastic material.

The two types of spray foam on the market today include:

**Open Cell** - Which is a low-density foam that measures about ½ lbs. per cubic foot. Open Cell Foam can easily be crushed by hand. *Open Cell Foam the gas inside the cell is air.*

**Closed Cell** - which is about 4 times stronger and has a much higher density than Open Cell will start at a 2 lbs. per cubic foot and is used for residential and commercial construction insulation. Other densities such as 3 lbs. used in commercial roofing, and higher densities used in concrete lifting. Closed Cell Foam the Gas inside the cell is mostly made up of HFC-245fa, HFC-365mfc, HFC-141b or the latest Solstice LBA.

**Solstice Liquid Blowing Agent** is the latest advance in foam blowing agent technology developed by Honeywell. Solstice based formulations have a slightly different reactivity profile which makes the optimization of pressure and temperature more important. Solstice products appear to require slightly higher temperatures for processing. A 3°F to 5°F increase in temperature using the same spray pressure of 1200 to 1400 psi appear to result in a 10 to 15 percent increase in yield as well as an improved R-Value.
WHAT IS GWP?

(GWP) A measure of how much heat a substance can trap in the atmosphere.

With a global warming potential (GWP) equal to 1, its widespread adoption could save about 60 MILLION metric tons per year of CO2 equivalent, comparable to eliminating carbon dioxide emissions from more than 11.8 million cars every year.

<table>
<thead>
<tr>
<th>Substance</th>
<th>GWP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solstice LBA</td>
<td>1</td>
</tr>
<tr>
<td>HCFC-141b</td>
<td>725</td>
</tr>
<tr>
<td>HFC-365mfc</td>
<td>794</td>
</tr>
<tr>
<td>HFC-245fa</td>
<td>1030</td>
</tr>
</tbody>
</table>

Solstice LBA has a global warming potential (GWP) of 1, which is more than two orders of magnitude (99.9%) lower than current HFCs used in this industry. It is a near drop-in replacement for other liquid foam blowing agents and is nonflammable, making it a cost-effective choice.
Chemical Makeup of Spray Foam

Spray Foam is made up of two Materials:

1. The A-side is made up of just one component, Polymeric Methylene Diphenyl Diisocyanate (PMDI). Often referred to as Isocyanate, or short ISO.

2. The B-Side or Resin is a mixture of many components.
   - Polyols
   - Water and Blowing Agents
   - Catalysts
   - Fire Retardants
   - Surfactants and miscellaneous additives
Processing Spray Foam on the Jobsite

Spray Foam is created by mixing the a-side and B-side in the spray Gun.

- Mixing is by impingement- A & B streams collide at a high Velocity to mix properly.

- The spray gun creates a fine mist exiting the gun in a symmetrical pattern, most often is a round pattern, other types of mix chambers can be used to achieve patterns such as flat or spattered as needed.
- The most common spray gun used in the market today is the Graco AP Fusion with mix chamber sizes 1, 1 ½, and 2 for most residential and commercial insulation jobs and a 3 for commercial roofing.

- Within seconds the mixture foams and reacts to form a tack-free urethane foam.
- Proper pressures and temperatures at the spray gun are important to insure a quality mix of both A&B. This is where the proper Spray Foam Reactor and supporting equipment comes into play.
- The desired temperatures and pressures will be located on the material Technical Data Sheets.

- Desired temperatures may need to be adjusted depending on the ambient air temperature, humidity and other uncontrollable conditions. Graco Reactor 2 can assist in storing these recipes to fine tune your spraying, Saving much wasted time tinkering with pressures and temperatures.

- It is also important that the Material in your drums are kept between 70 to 80 degrees.

- Pressures and temperatures will vary from one foam manufacture to another. So, if you are spraying XYZ company one week and ABC’s the next pay attention to the Data sheets provided by that material supplier.
Material Arrival

- When materials arrive at either a warehouse or jobsite the first concern is the temperature of the materials throughout the entire drum.

- Materials not immediately needed should be stored in an area with temperatures maintained between 50°F and 90°F. This material will require conditioning to a minimum of 65°F prior to use.

- Materials for immediate use must be a minimum of 65°F. If the materials temperatures are lower than 65°F the material should be heated by either

  - Storage in an area above 65°F to slowly raise the temperature of the material.
  
  - Using drum blankets, floor heat or potentially band heaters to bring the material up to temperature more rapidly.

- Storing Material in a warm area to raise the material temperature may take up to 4 days depending on the temperature of the material and the ambient temperature in the storage area.

- The exterior temperature of the drum is not an accurate indication of the core temperature of the material in the drum. This temperature should be measured using a long temperature probe and not an infrared gun.

- Drum blankets are available in multiple preset temperature ranges.

- Our in-house testing has shown that drums may be warmed in an environment kept at 30°F, directly in the floor, at a rate of 2°F per hour without additional agitation or mixing using a blanket with a preset temperature of 80°F.

- The use of agitation or blankets with higher set points can shorten this process.

- Floor heating to increase material temperatures is slower than using a blanket, but can help maintain the heat of more than one drum at a time, particularly in harsh environments.

- Heating with Band style heaters results in more concentrated areas of heat on the exterior of the drum. Mixing or agitation is highly recommended when using this type of heating to minimize hot and cold spots throughout the drum.
Machine Capabilities and Flow Rates

- Each type of machine has specific output maximums or flow rates and heating capabilities. Machines with limited heating capacities may require the materials to be warmer than 65°F.

- Heating capability is also affected by mix chamber selection. Oversized mix chambers increase flow rate reducing the heating capability of the machine. In cold weather applications, mix chamber selection is critical to the performance of the system being applied.

Effects of Temperature on Reactivity and Foam Quality.

- High Temperature Effects
- Greater pressure and variation on the gauges.
- Inconsistent spray pattern
- Increases tip cleaning.
- May increase the potential of scorched foam.

Optimizing your equipment with proper mix chamber selection

- “A” and “B” pre-heat settings and hose temperature will reduce time and tip or chamber cleaning during the application. The foam produced from an optimized configuration will be of higher quality resulting Improved yield and fewer processing issues.
Effects of Pressure on Foam Quality

- Low Mix pressure
- Creates a rough surface and increased foam splatter.
- Increases cell size and inconsistency of the foam cell structure
- Slows the reactivity and reduces the yield of the foam system

Effects of Pressure on Foam Quality

- High Mix pressure increases the area of overspray
- Increases blow back and interrupts the cell structure of the foam
- Decreases the ability to apply thicker passes of material.
- Increases the amount of clean up required increasing the costs for the application and wasted material, reducing yield.

Gauge Reading versus Ratio

- Pressure imbalances do not mean the material is being sprayed off ratio.
- Pressure is a function of viscosity most “B” side resins are thicker than Iso, so there is a tendency for the “B” side pressures to be higher than the “A” in most cases. In most cases, minor temperature adjustments can resolve the pressure balance issues and improve the quality of the foam being sprayed by improving the mix of the material.
- NEVER use the recirculation valves to balance pressures during an application.

Effects of Moisture Contaminated ISO

Iso can also react with water vapor in the air and create solid urea. These hard particles can clog the filters and spray foam gun creating flow restrictions of the equipment used to process the spray foam material. Use of desiccant dryers in the vent holes of your barrels can reduce this from occurring, as well as a refrigerated air dryer between the compressor and the transfer pumps and gun. Always seal your barrels and never leave Iso in an unsealed container.
Effects of Substrate Types and Temperature.

**Wood Substrates**
- In cold weather applications moisture, may be an issue due to condensation. Do not heat structures with open flame heaters. These heaters produced large amounts of moisture which will collect on cold surfaces.
- Concrete - Concrete is a very large heat sink that steals heat from the foam reaction. Concrete must be cured a minimum of 28 day prior to application.

**Drywall/ Gypsum**
- First pass on drywall should be limited to 1 inch maximum to minimize potential deformation of the substrate.

**Metal Substrates**
- The gauge of a metal substrates will affect the method required for proper application of spray applied insulations. Metal with a gauge of greater than 26 should be avoided. Metal substrates are also more likely to have condensation in winter months.

**Effects of Substrate Temperatures**
- Cold substrates, particularly metal and concrete may create issues with adhesion and foam reactivity. Reduced pass thickness can resolve these issues.
Spray Foam Density

Density is expressed most often in Pounds per Cubic Foot

- Core Density – is the weight from the center of the sample
- In Place Density – is a sample with points of adhesion, knit lines, and skins
- Technical Date Sheets refers to the Core Density and is substantially higher, also can vary greatly with the application and environment conditions.

*** Note that Higher Altitudes reduce the density of spray foam, due to atmospheric pressure. ***

Comprehensive Strength and Dimensional Stability

- **Comprehensive Strength** - is a measurement of the resistance of the foam to deformation under a load. Closed Cell has a much higher compression strength than open cell spray foam.
- **Dimensional Stability** is the measure of the ability to keep its shape when exposed to extreme environmental conditions.

Technical Data Sheets – Include

- Density
- Tensile Strength
- R-Value
- Air Permeability
- Compressive Strength
- Dimensional Stability
- Cell Structure
- Vapor Permeance

*** If Spray foam is not processed correctly it will not achieve the listed physical properties. ***
LOW-DENSITY SPRAY FOAM INSULATION

0.5 LBS. PER CUBIC FT. (OPEN-CELL FOAM) R-Value 3.7/In.

Also, known as open-cell spray foam insulation, low-density spray foam insulation is applied as a sprayed coating to provide a continuous insulation and air-sealing barrier. The open-cell structure of low-density spray foam insulation give flexibility to the hardened foam. Low-density foam is also called half pound foam, because it weighs almost a half-pound per cubic foot. Low-density foam is applied as a low-pressure or high-pressure, two-component spray foam.

Low-density spray foam insulation can be applied on walls, in unvented attics, ducts and ceilings, and in vented attics and crawl spaces. It is impenetrable to air, but penetrable to moisture.

LOW-DENSITY SPRAY FOAM ADVANTAGES

Due to the large cell structure, low-density spray foam insulation stays soft and flexible after it has finished curing. This increases the probability of its continuing to provide high insulation value even as the building settles and shifts over time. Low-density (open-cell) spray foam insulation provides effective heat insulation and seals air flow through cracks, joints and seams by filling the cavities. In addition, this foam can absorb sound thanks to its soft texture.

Open cell spray foam: $0.35 – $0.55 per board foot
MEDIUM-DENSITY SPRAY FOAM INSULATION

2 LBS. PER CUBIC FT. (CLOSED-CELL FOAM) R-Value 6.7/In.

Medium-density spray foam insulation is applied by professional insulation contractors as either low-pressure or high-pressure, two-component polyurethane spray foam. This is the most common type of spray foam insulation that is used in new construction homes and crawlspaces.

Medium-density being sprayed into a wall cavity

MEDIUM-DENSITY SPRAY FOAM ADVANTAGES

Medium-density spray foam insulation offers specific benefits, depending on the climate and the type of building in which it is used. Like low-density foam, medium-density spray foam insulation is often used for continuous insulation, interior cavity fill, and unvented attic applications. As a closed-cell spray foam, however, medium-density spray foam insulation is the best used where there is need for the greatest R-Value insulation per inch possible, such as in tight spaces like crawlspaces.

Medium-density spray foam insulation can also provide a high bond and tensile strength. It also can provide low vapor penetration and is typically not affected by moisture, such as rain, in typical applications.

Closed cell spray foam: $0.90 – $1.50 per board foot
HIGH-DENSITY SPRAY FOAM INSULATION

3 LBS. PER CUBIC FT. (CLOSED-CELL FOAM) R-Value 6.7/In.

When extra high insulation r-values and strength are needed, insulation contractors such as Reichel Insulation turn to high-density spray foam insulation.

As its name implies, this foam has a denser structure than medium-density or low-density spray foam insulation. Therefore, it requires more material to cover and insulate any given space and does not expand as much as lower density foams.

A typical application is performed by professional insulation contractors. The main components of a spray foam insulation system include a large spray truck, where the ingredients are heated and mixed. An air compressor, and a specially designed spray gun with hoses attached that run out to the spray truck.

HIGH-DENSITY SPRAY FOAM ADVANTAGES

This spray foam insulation is an excellent choice for roofing or other exterior insulation because it's applied in a continuous manner, in addition to its thermal resistance properties. In roofing applications, its thermal and vapor-delay qualities provide great benefit, while its strength provides load support to the structure. High-density foam insulation can help reduce energy costs over the lifetime of the roof, while also offering high protection against heat and water infiltration. It also strengthens the structure that it is applied to. The bond that high-density spray foam insulation forms to the roof can increase a building’s resistance to wind uplift, which can help reduce damage experienced from high winds.

High Density 3 lbs. Closed Cell Spray Foam $1.70 - $2.32 per square foot
Quality Control of the Material Manufacturer

All quality spray foam should come with Technical Data provided by the Manufacturer of the material. This Data should include:

**Batch** - The B-side or Resin will be made in a batch by the material manufacturer. Each batch is tested in the lab, prior to making the barrels available for distribution. This process will confirm reactivity and density are acceptable.

**Lot Number** - Both the A-side and B-side Barrels will have a Lot number located on the label that is adhered to the drum of the material. This number helps track product issues, if they should occur.

**Shelf Life** - Both the A-side and the B-side will have a shelf life typically of 6 months. This should also be located on the Technical data sheet.

*A sample Technical Data Sheet can be found on the next page.*
FOAM-LOK™ FLX 500 is an Open-Cell spray applied foam, which when installed following application guidelines adheres tenaciously to framing members and substrates. FOAM-LOK™ FLX 500 provides superior energy economy and durability while significantly reducing unmanaged moisture and air infiltration.

**Product Use**
FOAM-LOK™ FLX 500 forms a completely sealed air barrier in wall cavities and can be used to fill 2" x 6" stud wall construction in a single application. Its performance is superior to commonly used fiber-glass batt or blown-in insulation, it adheres well to most building materials and will provide a continuous barrier against air infiltration for the life of the building. As a component of a "systems approach" to proper building envelope construction in both residential and commercial construction, FOAM-LOK™ FLX 500 provides exceptional performance in reducing heat transfer.

**Recommended Product Applications**
- Attics
- Crawls Spaces

**Recommended Processing Parameters**

<table>
<thead>
<tr>
<th>Processing Designation</th>
<th>Regular</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient Temperature</td>
<td>45-120°F</td>
</tr>
</tbody>
</table>

FOAM-LOK™ FLX 500 insulation must be thoroughly mixed 20 - 30 minutes prior to application. Lapolla recommends the use of a Graco Air-Driven Expanding Blade Bung-Mounted Agitator (Part# 24C729). To properly drive the mixer, 22 scfm of air is required. Using less air volume may require extended mixing times. A thorough high-speed mix is an essential step in high-quality foam production. FOAM-LOK™ FLX 500 must be continually agitated throughout the entire spraying process in order to avoid any separation of the "B" side material. See the application guide for further detail.

### Physical Properties

<table>
<thead>
<tr>
<th>Properties</th>
<th>Test Method/Requirements</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aged &quot;R&quot; Value</td>
<td>ASTM C518</td>
<td>3.7 per inch</td>
</tr>
<tr>
<td>Core Density</td>
<td>ASTM D1622</td>
<td>.4-.6 lbs./ft³</td>
</tr>
<tr>
<td>Open-Cell Content</td>
<td>ASTM D1940</td>
<td>&gt; 95%</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>ASTM D1623</td>
<td>5.1 psi</td>
</tr>
<tr>
<td>Air Permeance</td>
<td>ASTM E283</td>
<td>0.0012 ft.²/min-ft.² @ 3.5 inches</td>
</tr>
<tr>
<td>Dimensional Stability</td>
<td>ASTM D2126</td>
<td>15% max by volume change</td>
</tr>
<tr>
<td>Sound Transmission</td>
<td>ASTM C423</td>
<td>50 (STC)</td>
</tr>
</tbody>
</table>

**Credentials/Certifications**

- UES ER 0401

FOAM-LOK™ FLX 500 is a Class I formulation, as Tested per ASTM E84, and possesses the flammability characteristics shown: (UL 723, NFPA 255, UBC 8-1)

<table>
<thead>
<tr>
<th>ASTM Method E-84</th>
<th>Class I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flame Spread</td>
<td>≤25</td>
</tr>
<tr>
<td>Smoke Development</td>
<td>≤450</td>
</tr>
</tbody>
</table>

### Start-up Procedure

- Place Air-Driven Expanding Blade Bung-Mounted Agitator (minimum required (Graco Part# 24C729) in FOAM-LOK™ FLX 500 B-Side and start agitation.
- Recirculate through proportioner and hose to preheat material in drum to 85-95°F and ensure that product is well blended.
- The B-Side Air-Driven Expanding Blade Bung-Mounted Agitator should remain on throughout the recirculation process and application process to maintain a uniform blend.

### Shut Down Procedure

For breaks in application less than thirty (30) minutes, it is recommended to grease your gun according to manufacturer guidelines. When returning from break, recirculate for five (5) minutes to ensure material in hose is uniform and ready for application.

**Application Thickness:** 6 inches maximum thickness for open cell foam for each pass.

- CAUTION: Extreme care must be taken when removing and reinstalling drum transfer pumps so as NOT to reverse the "A" and "B" components.
- Do not circulate or mix other suppliers’ "A" or "B" component into FOAM-LOK™ FLX 500 containers.
- The plural component proportioner must be capable of supplying each component within ±2% of the desired 1:1 mixing ratio by volume.

Material shelf life: 6 months when stored within recommended temperature range.
Keep a Job Log

It is important that each Job is recorded in a Daily Log Book filled out by the Lead installer. This will assist if there is a quality issue with the spray foam applied on the job. The information will be recorded will make it easier to assess if there is a warranty claim with the Spray Foam Manufacturer. Below is a sample form. Recording the batch and Lot number from the Barrel Labels will be a part of identifying the material used on the specific job.

### Daily Work Record - Insulation

<table>
<thead>
<tr>
<th>Contractor / Crew &amp; Rig</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Customer Name</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Project Address</th>
<th>Customer Phone #</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Project Type (Circle one)</th>
<th>New</th>
<th>Remodel</th>
<th>Area in sq. feet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Employees (Identify safety officer with a *)

<table>
<thead>
<tr>
<th>Name</th>
<th>Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Safety, Substrate & Setup

<table>
<thead>
<tr>
<th>Type of substrate</th>
<th>Substrate Condition</th>
<th>Clean? Y / N</th>
<th>Dry? Y / N</th>
<th>Properly fastened? Y / N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spray zone signs up, secured from unprotected access &amp; method masked off</th>
<th>Y / N</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Vents Blocked? Y / N</th>
<th>Primer Required? Y / N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spray zone vented to outside? Y / N</th>
<th>Protective coating required? Y / N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ventilation stayed in place until specified time to occupancy? Y / N</th>
<th># of Hours to ventilate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Material Information

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Foam Type</th>
<th>Begin Time</th>
<th>End Time</th>
<th>Lot #</th>
<th>Actual Area sprayed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- A-Side #1
- A-Side #2
- B-Side #1
- B-Side #2

#### Equipment & Processing Information

<table>
<thead>
<tr>
<th>Proportioner Type</th>
<th>Stroke Count</th>
<th>Estimated</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hose Lengths</th>
<th>Gun Type</th>
<th>Mixing Chamber</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8&quot;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time</th>
<th>Ambient Temp &amp; % Rel. Humid.</th>
<th>Hose Temp</th>
<th>A Pressure</th>
<th>A Temp</th>
<th>B Pressure</th>
<th>B Temp</th>
</tr>
</thead>
<tbody>
<tr>
<td>am</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Equip Maintenance or application problems:

Daily log completed by:

[16]
Applicator Influences

The applicator will have influence on the finished spray foam product. This section will outline what the applicator has influence over. These influences will have an impact on the performance of the applicator equipment, quality of the final product, reputation of your company, and profits of the business.

Material Storage and Handling

- Long term storage of both the A-side and the B-side material should be between 65-85 degrees F.
- Before use the material should be stored at between 70 and 80 degrees F. at least 48 hours in advance.

Material Change Over

- Do not mix open and closed cell foam this will impact the processing and properties of the spray foam.
- Flushing of the lines and equipment before switching over from open and closed cell spray foam will prevent cross contamination. Check with your material supplier of how they recommend to switch from one to another. Some manufacturers will vary from one another.

Substrate Preparation

- Metal- should be dry and free of scaling, rust, grease and oil
- Concrete- should be clean and dry, Moisture content should be cured for 28 days and free surface moisture.
- Wood- Free of standing water, moisture content should be less than 18%

****Many substances are candidates for priming you foam rep/technician will be able to make recommendations and may vary from material suppliers. ****

Substrate Temperature

- Check the material data sheets and barrel label for desired substrate temperature recommendations.
- A cold surface temperature will reduce the reactivity and reduce yield. This may also cause the foam to not adhere properly and cause popping of the foam.
- Hot surface temperature can cause the foam to react to quickly.
- Higher mass substrates like concrete or heavy metal can absorb large amounts of heat or cold and are referred to as Heat Sinks.
- If the substrate cannot be heated it is common practice to apply a flash coat of approx. ½ inch to seal off the substrate and add insulation before continuing the remainder application and retain the heat being applied.
- There are different blends of foam. Some dedicated to winter and colder Temps. And other to Summer or warmer climates. Check with your material supplier to make sure they are providing the correct blends, for your applications.
Start with the drum and work your way forward to achieve the desired temperatures and pressure at the spray foam gun.

1. Drum Storage Temp.
2. Drum Temp in Use
3. Proportioner settings: PSI, Temp, & Flow Rate
4. Hose Diameter
5. Hose Length
6. Hose Heat
7. Gun Tip Size
8. Trigger Finger
9. Actual Temp and Pressure at the Gun
10. Substrate Temp, Substrate Moisture, Air Temp, and Humidity

Yield Impacted by the equipment and processing Settings

- Material Temps Too Low will equal poor reactivity and poor mixing
- Material Temps too low will equal spray foam setting up too fast and will result in less yield and lower profit.
- Preheaters undersized will result in Low Delta T and equals poor mixing and low Reactivity.
- Hose Heat needs to be at desired Temp before beginning the day.
- Make sure the hose is well insulated to avoid losing heat during the transfer of the materials.
- Avoid using gravity feed and diaphragm pumps. Stick Pumps are recommended.
- Transfer pumps and feed hoses undersized results in Cavitation
- Improper gun and tip size will decrease yield.

Cavitation- The vaporization of a liquid under the suction force of a pump. Usually due to inadequate flow to a pump; the vaporization can create voids within the pump or the pump supply line. In polyurethane foam spray pumps, cavitation will result in OFF-RATIO FOAM (see also).
Board Foot and yield

Yield is impacted by environmental conditions

- Air Temperature too cold will result in lower yields and less profit.
- Substrate too cold will also result in lower yields.
- Wet Substrate will increase yield but cause poor adhesion to the substrate. Very Costly to profits and reputation.
- Humidity Impacts the substrate moisture content
- Surface contaminants will impact adhesion
- Altitude and wind will decrease yields.

Yield is impacted by applicator skills and experience.

- Overall foam thickness consistency control of lift thickness (primarily applies to closed cell)
- Recognition of issues when they arise will greatly reduce time and wasted materials. Off ratio, shrinkage, voids, and contaminations.
- Spraying Techniques will develop over time and improve yields resulting in more profit.
- Knowing how to assess the conditions of the environment and properly adjust the machine settings will greatly increase yield and profit.
- Properly transitioning from open to closed cell with no hiccups will result in less wasted material.

Foam Oder

If Spray Foam has not complete it reaction, there can be a foul odor left behind. These are the horror stories that you read about online and why it is important to have the proper equipment and trained applicator to prevent this occurrence.

- Exotherm in closed cell spray foam can create very high temperatures if not adequately managed, which can cause foam degradations.
- Do not exceed the recommended Lift thickness commonly 2 inches per pass in most cases. Some new Blowing agents allow a higher thickness per pass, as mentioned previously with the Solstice LBA.
- Successive 2 inch passes must not be applied until the foam core surface cools to less than 100 degrees F.
- Incomplete reactions leave unreacted chemicals in the Spray foam.
- Off ratio can result in A-side rich or B-side rich foam and incomplete reactions between A and B.
- Low pressure or low temperature can lead to inadequate mixing of A and B resulting in incomplete reaction.

**** DO NOT ATTEMPT TO COVER UP BAD FOAM WITH GOOD FOAM! BAD FOAM NEEDS TO BE REMOVED AND REINSTALLED PROPERLY! ****
**Do you need a thermal barrier?**

Yes, absolutely. If you put spray foam insulation in a building, it needs a thermal barrier. That's what separates it from the occupied spaces. If there's a fire in the building, a thermal barrier keeps the combustible spray foam from the flames to increase fire resistance. The International Residential Code (IRC) and International Building Code (IBC) both include requirements for thermal barriers (and ignition barriers, too; see below).

The standard prescriptive material that can be used as a thermal barrier is 1/2" gypsum board (a.k.a. drywall or sheetrock). Anything else must be approved as an 'equivalent thermal barrier' by undergoing tests for temperature transmission and fire integrity. In some cases, however, you need only one test. Per the Spray Polyurethane Foam Alliance (SPFA), "Under specific conditions, the temperature transmission test can be waived if approved by building code authorities based on large-scale fire testing representing actual uses." (See their pdf document, Thermal and Ignition Barriers for The SPF Industry.)

**Do you need an ignition barrier?**

This is where things get a little tricky. If a home has spray foam insulation in an attic or crawl space, the building code requires using materials or assemblies that offer some fire resistance but not as much as is required for a thermal barrier. If you've got spray foam insulation in an attic, for example, it's probably already separated from the living space by a thermal barrier. Most ceilings are made of 1/2" drywall. But the spray foam is still exposed to the attic and needs an ignition barrier.

In this case, you have a choice of several prescriptive materials approved by the code as ignition barriers:

- 1.5" mineral fiber insulation
- 1/4" wood
- 3/8" particleboard
- 1/4" hardboard
- 3/8" drywall
- 0.016" corrosion-resistant steel
- DC-315 Coating

**When do you need an ignition barrier?**

Per the IRC and IBC, an attic or crawl space needs an ignition barrier over the spray foam if the space can be accessed but will not be used for storage or auxiliary living space. You don't need an ignition barrier if the space cannot be accessed without cutting into it, if it is not connected to other spaces, and if it does not communicate with other spaces.

**What if your local doesn't require anything?**

Well, it sure is tempting to keep your costs low and omit ignition barriers in attics and crawl spaces. But what if that house burns, and the insurance company refuses to pay because there was no ignition barrier? It doesn't take a genius to know who the homeowners are going to come after.

The bottom line is that if you're using spray foam insulation, you need to know the code about thermal and ignition barriers and use them where necessary. You need to know your materials, too, and what qualifies in each case.
Health and Safety Considerations for Spray Foam Insulation

The CPI SPF Health and Safety Online Training Certification is a great place to start. This certification is free and is important as it meet OSHA Requirements. Any additional certification will require this certificate be obtained. Download Health and Safety Hand Book

Objectives

- Hazards of Spray Foam Insulation
- Effects of Exposure and First Aid
- PPE
- Disposal
- Communication to Building Owner and Occupants of Existing Home Evaluation and Spray Foam Install Details
- Work Ventilation for Spray Foam Applications
- Basic Ventilation Design Principles
- Enclosures
- Re-occupancy
Spray Foam Chemicals

The reaction between the A-side and the B-side materials that make up spray foam insulation is quick and releases heat, and within a few mins. Foam is formed and is tack free.

The installation of spray foam does require protective measures to be taken for health and safety reasons. When properly applied is inert and non-hazardous.

Polyurethane Foam is combustible; care must be taken to avoid exposing the foam to extreme heat or open flames.

The A-Side (ISO or Isocyanate)

- Known as polymeric MDI or pMDI
- ISO part A component does not contain Cyanide
- Brown Liquid
- Virtually Odorless
- Evaporates Slowly
- Does not dissolve in water
- Reacts with water slowly to form polyuria and carbon dioxide gas (CO2)
- ISO is a Health Hazard if not used or handled properly.

The B-Side or (Polyol Blend)

- Consist of several Chemicals
  - Polyol(s)
  - Catalysts
  - Blowing Agents (can be water and or hydrofluorocarbon or both)
  - Flame Retardants
  - Surfactants
  - Amber Liquid
- Slight Amine Odor
- Evaporates Slowly
- Dissolves slightly in water
- Some additives do not present safety and health hazards
Handling and Storage

- Proper Storage is important before and during the use of spray foam materials. Improper storage and conditions can make the components unusable.
- Keep the A-side and the B-side drums dry and at the suggested temperatures.
- Storage temperature should be around 70 degrees F. minimum of 48 Hours before use.
- It is important to maintain a tight seal on MDI A-side containers, to protect against moisture or direct contact with water.
- Open the B-side Drum Slowly to help release any built-up pressure, especially with closed cell products. This is due to the presence of HFC Blowing Agent in CC, which can Expand if the drum is exposed to high temperatures.

Hazard Communication and personal Requirements

Hazard Communications Requirements

- Per OSHA Hazard Communication Standard 29 CFR 1926.59 and 1910.120 ALL EMPLOYERS ARE REQUIRED TO INFORM EMPLOYEES of the safety and health hazards of chemicals they may work with on the job.
Requirements of this law include:
  - Worker Training
  - MSDS Sheets of the Materials
  - Labels
- Per OSHA Hazard Communication Standard 29CFR 1910.1200 all employers are required to have a written hazard communications program that describes how each element of standard is met including: Worker Training, MSDS retention, and Hazard Warning Information System.
Spray Foam Chemical Exposure Information

Routes of Exposure
- Inhalation
- Skin
- Eye Contact
- Ingestion

Signs of Over Exposure
- Sore Throat
- Coughing
- Chest tightness
- Shortness of breath
- Reddening, Itching, and Rash on Skin

Possible ways of Over Exposure
- Improper Use or Fit of Respirator
- Allowing Skin or Eye Contact
- Used in a confined/poorly ventilated space
- Overheating chemical
- Burning foam

Potential Health Effects of Over Exposure
- Short Term Irritation
- Long Term lung effects
- Sensitization- Allergic reaction
First Aid

Inhalation Exposure

- Breathing vapors/mist of the A-side or B-side should be avoided always.
- Remove individual from area if person is affected by inhalation and seek immediate medical attention.
- Skin Contact Exposure
- Wash with soap and water or shower to cleanse the skin. Contaminated clothing should be removed and discarded
- For cuts or abrasions caused by pressurized fluid seek immediate medical attention.

Eye Contact Exposure

- Flush the eye(s) immediately for 15 Min. with large amounts of lukewarm water. After flushing, protect eyes with loosely tied bandage, if victim cannot tolerate light. Seek immediate medical attention.
- Contact lenses are not recommended during spray foam application.

Ingestion

- Do not induce vomiting. Seek immediate medical attention.
Personal Protective Equipment (PPE)

- It is extremely important to wear Respirator Protection for all spray foam installers.
- Air monitoring studies have shown that airborne MDI concentrations often are above the occupational exposure limits for the applicator, and sometimes for helpers working on the same floor or near the spray foam application area.
- Studies have also shown that it is common to find airborne concentrations of amine catalysts and blowing agent in the spray area.
- Indoor Spray foam applications usually result in much higher airborne concentrations of spray foam chemicals than outdoor applications.
- Indoor Spray Foam applications: supplied air respirators are recommended.
- Outdoor Spray Foam Applications: air-purifying respirators may be adequate.

PPE- Respirator Protection

Recommended Respirator Use

Spray Foam Applicator

- Full Face Mask or Hood type supplies air respirator (SAR) operated in a continuous flow or positive pressure mode. Use SAR during post spray activities (Trimming, Clean up, ETC.) if work performed within one hour after application.

Helper

- Air Purifying respirator (APR) with combination organic vapor/particulate (P100) cartridges, generally acceptable unless work in the immediate spray area for extended periods of time, then use SAR.

Liquid Chemical Handling in a Spray Foam Rig

- When handling liquid product that has been heated, use an air purifying respirator (APR with combination organic vapor/particulate (P100) cartridges.

PPE Respiratory Protection

*OSHA has a Respiratory Protection Standard (29 CFR 1910.134 and 1926.3103 which have been identical requirements for both General Industry and Construction Employers.*
Key Requirements of this OSHA Law include:

- **Written Repudiatory Program** established by employer demonstrating compliance.
- **Medical Evaluations** (medical approval that employee is physically capable of wearing.
- **Annual Fit Test** (require all employees provide air purifying respirators or tight-fitting supplied air respirator such as full face (FF) or half mask respirator.)
- **Limitation on Facial Hair** (applied to employees provided FF or half mask respirators)
- **Cartridge Change-out Schedule** (must be clear to employee when to change cartridges: cartridges needed for APRs are organic vapor or charcoal with a (P100) pre-filter.
- **Employee Training** (employee must be trained on how to properly wear the respirator, do daily fit check and inspections, perform routine cleaning and maintenance.)
Eye Protection

Helps Prevent

- Splashes of chemicals
- Overspray
- Aerosols and particulates present in spraying, sanding, and grinding operations

Types of Eye Protection

- Safety Goggles
- Safety Goggles with Face Shield
- Hood or Full Face Respirator

**** Contacts are not Recommended while spraying. ****

**** A portable eyewash station should be available in the work area. ****

Clothing

Appropriate protective clothing is necessary whenever there is a possibility of direct skin contact with the spray foam components.

Disposable coveralls are typically worn to keep spray foam mist from contacting the employees skin and personal clothing.

To assure proper skin protection wear PPE in such way that no skin is exposed.

Gloves

Nitrile, neoprene, butyl, or PVC gloves generally provide adequate protection against the A-side and the B-side materials. Fabric cloves coated in these materials provide the best protection when spraying or handling hoses due to heat associated with the spray foam process.

A good Fit is essential. Too large or too small may not provide the protection you need.
Other Safety Hazards and Precautions
High Pressure Spray Foam Systems

- Pressurized fluid can be very Dangerous
- Never use damaged hose. Check hoses for cuts, leaks, abrasions, bulges, or damage. Replace hose if any of these are present. **Do NOT TRY TO REPAIR!**
- Check for movement of hose couplings. Tighten all fluid connections securely before each use.
- Fluid injection injuries can cause serious damage. Seek immediate medical attention if this occurs.

Electrical

- Electrical Equipment used should be equipped with Ground Fault Circuit Interrupters (GFCI) to prevent Electrocution.
- Ground or Bond all process equipment and containers of Flammable materials. Plastic containers require no grounding
- Do not plug or unplug any power supply cords in the Spray Foam Dispensing Area when there is a chance of igniting vapors still in the air.
- Electrical power lines near a work site can be a source of ignition and other extreme hazards. Never let equipment touch or come close to overhead electrical lines or other sources of electricity.

Fire

- Open Flames, cutting and welding torches, lighted pipes, cigars, and cigarettes are prohibited in and adjacent to chemical storage and installation areas.
- Post warning signs in all areas so that they are clearly visible.
- Do not expose Spray Foam to flames or to sources of intense heat (>200 degrees F)
- Fire extinguishing equipment must be provided at both storage and installation sites.
- Waste insulation should be disposed of daily in a designated location with due regard for it combustible characteristics.
- Large buns of closed cell waste insulation should be cut open, doused with water and allowed adequate time to cool prior to disposal to minimize the risk of fire.
Disposal

Waste including empty drums require proper handling and disposal.

- Do not reuse drums (especially the A-side ISO Drums) Do not expose drums to open flame or cutting torch.
- Arrange for pick up by re-conditioner, a scrap metal dealer, or an approved landfill.
- Drums must meet the definition of empty and check with vendor on how to prepare the drums for pickup.
- Preferred method of disposing drums is to contract a drum re-conditioner. Call RIPA at 301-577-3786 to locate one near you.
- To decontaminate drums if going to landfill or scrap dealer. Mix 90% water, 3-8% ammonium hydroxide or concentrated ammonia, and 2% liquid detergent (Refer to the MSDS Sheets for the product.)
Communication Overview

It is critical that building occupants and owner (if different) have a complete understanding of the project. Prior to commencement or work schedule a meeting with the building occupants and owner should take place, and include

1. Existing Home Evaluation- Discuss issues pertaining to the building before project begins.
   - Pre-existing Conditions
   - Combustion Appliances
   - Venting
   - Existing Duct Work
   - HVAC
   - Insulation Removal
   - Attic Storage

2. Spray Foam install- Discuss all issues related to the installation of spray foam.
   - Review Installation Plan
   - Building Specific Details
   - Vapor Retarder Requirements
   - Unvented Attic Retrofit
   - Safety Precautions
   - Vacating Application
   - Re-occupancy Times
   - Home Ventilation
Worksite Ventilation During and After Spray Foam Install

Ventilation is the method of controlling work exposure to airborne hazardous chemicals or flammable vapors by exhausting contaminated air away from the work area and replacing it with clean air.

There are two basic types:

1. **General Exhaust Ventilation** - Dilutes contaminated air by mixing it with cleaner room air
   - Generally, consist of an exhaust fan mounted in the ceiling or wall
   - Pulls air out of the room and discharges it outdoors.
   - Replacement air is brought in by natural means (window, door, etc.) or separate make up air fan, duct work, and air registers that provide clean air to the room.
   - Would be appropriate after the insulation is applied to ventilate the entire work area and building before other workers or occupants enter the area.

   GENERAL EXHAUST SYSTEMS ARE NOT RECOMMENDED AS THE SOLE SOURCE OF VENTILATION WHEN HAZARDOUS VAPORS OR MIST ARE PRESENT, BECAUSE THEY DO NOT IMMEDIATELY REMOVE CONTAMINANTS FROM THE WORK SPACE.

2. **Local Exhaust Ventilation** - Remove chemicals and other contaminants at their source.

   - LEVS would be appropriate during the application process to capture vapors, mist, dust, and particulates at the source as they are emitted during the spraying and trimming process.
Establish Enclosures to Isolate and Contain Fumes

Enclosures around the work area serves two purposes:

1. Prevents Migration of contaminates to other areas of the building
2. Improves the efficiency and effectiveness of the ventilation system

Remember to place warning signs on the entrance to the enclosure or work area. To alert the other workers of the hazard and prevent them from entering the area.

- Maintain a negative pressure in the work area or enclosure.
- Avoid openings that will short circuit your ventilation system.
- Remember to seal and shut off the HVAC openings in the work area.

Direct Exhaust to a Safe Location

Always remember to direct exhaust to a safe location outside the building. Always from areas where other workers or people are or could be present.

Particulate exhaust filters should be used to remove spray foam dust and mist from the exhausted air.

Re-occupancy

Continue ventilating the area following application until the material had fully cured, off-gassing has stopped, and vapors are no more.

Worker re-entry should be kept at a minimum and should only include those with proper respirator protection.

Occupants re-entry should only occur after the building is fully ventilated. At least 24 hours after he install.
Spray Foam Retrofit

Why Retrofit with Spray Foam Insulation?

*Spray Foam both insulates and air seals with a single product, and is the easiest and most effective way of weatherizing an existing structure.*

Add insulation to an existing structure

- Most people understand adding insulation will improve the energy efficiency of their home

Air sealing an existing Structure

- Many people do not understand that eliminating air leaks is extremely important to achieve energy efficiency, and helps prevent mold and moisture in the building envelope by eliminating condensation surfaces.

*The most readily available energy resource available to the nation today is energy avoidance though efficiency measures.*

Energy Auditor

Consider combining trades to increase the products to offer a client

Purchasing a Blower door and an inferred camera to perform energy audits and make recommendation of how to increase energy efficiency.

This will add a service you can make money from and assist with selling your products.

Locations for Spray Foam Retro Fit

*Install Spray Foam in areas that are hard to seal and Insulate*

- Attic- Convert to Unvented
- Crawlspace or Basement- seal vertical walls or underside of floor.
- Rim Joist
- Cantilever (overhang structures)
- Floors of rooms over Garage

Benefits of Unvented Attic

*Spray Foam can be used to convert a vented attic into an energy efficient unvented attic.*

- Vented Attics typically have a lot of air leaks. Converting to an unvented seals the attic space and eliminates leaks.
- When the HVAC and Air Handler units are in the attic sealing, the space puts them in a conditioned space and allows them to operate more efficiently.
- By Moving the thermal boundary up to the roof deck, the entire space moves to within a few degrees of the interior of the home.
Pre-Inspection- Overview

Identify pre-existing conditions before undertaking work.

If you do not identify these issues before installation begins they can become safety hazards, and the may be attributed to you after the job is completed.

Possible issues may include:

- Moisture
- Dangerous Wiring
- Pest infestation
- Combustion Safety Issues
- Attic Storage
- Contaminants

Moisture

Evidence of damage due to moisture intrusion or vapor/condensation damage

- Existing or prior water leaks from the Exterior
- Mold—has a fuzzy appearance and can be an orange, green, black, brown pink, or purple color.
- Mildew—could be downy or powdery

  Downy mildew starts as yellow spots that first become brighter in appearance and then changes to brown.

  Powdery mildew is whitish in color and slowly turns yellowish brown and then black.

Checking Moisture Content

All wood substrate materials should be checked to ensure it is below 18%

Pre-Inspection Wiring

Knob-and-tube wiring (sometimes abbreviated K&T) is an early standardized method of electrical wiring in buildings, in common use in North America from about 1880 to the 1930s. **WIRING OF THIS TYPE MUST BE REPLACED BEFORE SPRAY FOAM INSULATING!**

It consisted of single-insulated copper conductors run within wall or ceiling cavities, passing through joist and stud drill-holes via protective porcelain insulating tubes, and supported along their length on nailed-down porcelain knob insulators. Where conductors entered a wiring device such as a lamp or switch, or were pulled into a wall, they were protected by flexible cloth insulating sleeving called loom. The first insulation was asphalt-saturated cotton cloth, then rubber became common. Wire splices in such installations were twisted together for good mechanical strength, then soldered and wrapped with rubber insulating tape and friction tape (asphalt saturated cloth), or made inside metal junction boxes.

Knob and tube wiring was eventually displaced from interior wiring systems because of the high cost of installation compared with use of power cables, which combined both power conductors of a circuit in one run (and which later included grounding conductors).

At present, new knob and tube installations are permitted in the US only in a few very specific situations listed in the National Electrical Code, such as certain industrial and agricultural environments.

**Bare Wires** - Must be replaced before installing spray foam.

[Image of knob-and-tube wiring]
Pre-Inspection - Pest Infestation

Look for evidence of existing or prior pest infestation. Make sure all pests are exterminated.

Miscellaneous

Look for recent changes to the house such as modifications to the structure that could affect the Thermal or Moisture performance.

Look for evidence of attic utilization for storage.

Look for contaminants on the surface that would prevent foam from adhesion. All surfaces must be clean, dry, and free of dust, dirt, oil, debris, and solvents.

Check efficiency and ventilation requirements of all combustion appliances.

COMMON DUCT PROBLEMS AND SOLUTIONS

PROBLEMS:
A. Leaky, torn, and disconnected ducts
B. Poorly sealed registers and grills
C. Leaks at furnace and filter slot
D. Kinks in flexible ductwork restricting airflow
Spray Foam insulation in an Attic

- Access to area where foam must be applied may be extremely tight. No matter how tight the space, required PPE must be worn. Never work alone in these areas.
- Wrap rafters of the joist to achieve a continuous layer of spray foam insulation.
- Use Closed Cell foam in climate zones 5 and Higher to meet the vapor retarder requirements.

Marine (C)     Dry (B)     Moist (A)

All of Alaska is in Zone 7 except for the following boroughs in Zone 8:
Bethel, Northwest Arctic, Dillingham,
Southeast Fairbanks, Fairbanks N. Star,
Wade Hampton, Nome, Yukon-Koyukuk,
North Slope

Zone 1 includes Hawaii,
Guam, Puerto Rico, and the Virgin Islands

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