Equipment and Organization for Application of Polyurea Elastomer Systems

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Abstract:

So you want to be in the polyurea spray elastomer / coating application business? Maybe you already are or have other coating technology application experience. That's great! Are you obtaining and using the proper equipment to insure a successful application? Hopefully so, but there are some issues that most people take for granted that usually end up costing time or money before the project is complete. This paper will focus on the basic equipment requirements for proper application and processing of this fast cure coatings technology. The auxiliary equipment required; as well as and most importantly, the proper organization and safety will also be addressed to insure you are doing a professional, cost effective job.

INTRODUCTION:

For decades, coating and lining systems have been used for a variety of applications. These initial systems, though complex in preparation at the time, were fairly simple to install. The common installation technique mainly involved brush / hand application. Newer system developments and the evolution of spray application soon realized enhanced coating and lining performance. This spray technique was mainly single component applied. Excellent atomization could be easily achieved in these systems by introduction of various solvents, which also extended the system "pot life".

With new regulations and the move to higher solids content coating and lining systems, new means of application technique and equipment were required. This gave rise to the plural component application equipment. Due to the extremely fast reactivity and cure of the 100% solids polyurea elastomer technology, plural component equipment is required. The system must also be heated during processing, not for reactivity control, but for the ability to atomize and spray correctly. High-pressure proportioners are used to properly deliver product to the impingement mix spray gun.[1]

Selection of the proper application equipment, surface preparation techniques, auxiliary equipment and proper training will be crucial to application success. Proper organization and pre-application preparation will assist in a professional installation. Remember you are the one actually making the coating system.

Proportioning Pump Basics:

In order to process these coating / lining systems, considerations must be given to the processing equipment. The key to processing is within the proportioning pump and the spray gun. This is the "life support" system for proper installation and application.[2] There are 2 types of proportioning pumps, vertical and opposed horizontal. These can either be air operated or hydraulically driven.

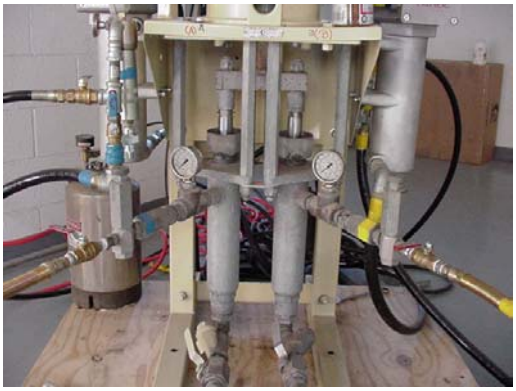

Figure 1: Proportioning Pump Types

Ideally, one would like to see comparable viscosities between each component. This aids in the mechanical delivery of equal volumes of material to the spray gun. Most systems are processed at a 1:1 volume ratio. For proper proportioning and application of polyurea spray elastomer systems, you must have the following:

- Pressure,
- Temperature,
- and Volume material flow.

Regardless of the type of proportioning pump used, these pumps must have the capability of heating the 2 components of the polyurea spray elastomer system. Heat is not required so as to promote the reaction of the system. That is built into the formulation. Heat is required to lower the mix viscosity of the 2 components as the reaction is initiated inside the mixing chamber of the spray gun. This initiation reaction causes a rapid viscosity build in the mixed system. The heat allows for proper atomization and sprayability of the polyurea system. This is much like heating high solids, conventional coating systems such that they properly atomize and spray. Heating output should be such that the delta T is a minimum of 70°F at full operation. Preheaters can be installed to aid in this for cooler climate conditions.

It has been shown that the optimum spray pressure for proper application of polyurea spray systems is at or above 2000 psi, coupled with high flow rate and heat. Higher pressure allows for complete impingement mixing.

Whether one uses vertical or horizontal opposed proportioning pumps, material flow rate is essential. Many utilize a proportioning unit that will develop high pressure but lacks material output capacity to properly feed the spray gun. This is the same scenario when one uses a low-cost household pressure washer. Sure, you have "high" pressure but without volume water flow, you are not going to get the job done.

This high pressure, low volume flow will result in poor mix, atomization and installation of the material due to the fluid pressure drop at the spray gun. The gun output / proportioner capacity ratio must be less than 0.75 for proper operation and application.

Careful consideration must also be given to the spray hoses. These must be heated hoses also. Depending on the overall length, the setup should include a "step-down" so as to minimize pressure drop at the spray gun. The hoses may have an "accumulator" affect so have a larger ID hose at the proportioning pump with a smaller ID section near the spray gun.[3]

Spraying Pressure at the meter set at 2,500 psi					
	1/2" Hose	3/8" Hose	1/4" Whip	Total	Machine Pressure minus
ENTER FLOW RATE IN GPM	1.4	1.4	1.4		Hose pressure Drop
ENTER VISCOSITY IN CENTIPOISE	115	115	115		
ENTER LENGTH OF HOSE IN FEET	**150**	**150**	**10**	**310**	**PSI Actual**
ENTER HOSE I.D. IN INCHES	0.5	0.375	0.25	**PSI Loss**	Gun Spray Pressure
CALCULATED PRESSURE DROP IN PSI	105.4872	333.39164	112.51968	**551.3985**	**1948.60**
	1/2" Hose	3/8" Hose	1/4" Whip	Total	Machine Pressure minus
ENTER FLOW RATE IN GPM	1.4	1.4	1.4		Hose pressure Drop
ENTER VISCOSITY IN CENTIPOISE	115	115	115		
ENTER LENGTH OF HOSE IN FEET	**0**	**300**	**10**	**310**	**PSI Actual**
ENTER HOSE I.D. IN INCHES	0.5	0.375	0.25	**PSI Loss**	Gun Spray Pressure
CALCULATED PRESSURE DROP IN PSI	0	666.78329	112.51968	**779.303**	**1720.70**

Figure 2: Hose Pressure Drop Chart

Keep in mind that if you are in the bedliner business, the proprotioning pump and spray gun used may not be sufficient for high productivity field coating / lining applications.

Joint Sealant / Caulk Application:

While the main processing application of polyurea system is spray applied, certain polyurea systems can also be dispensed using low pressure, low output units via a static tube mix procedure. This application is finding a large market use in joint sealant and caulk application areas. These units are typically smaller than the spray units, although a conventional spray proportioning unit can be adapted for that use.

Figure 3: Joint Sealant / Caulk Units

The units can either be a modified proportioning unit or a continuous delivery gear type pump. Since the polyurea systems are slower to react and have excellent flowability, the high pressure, high output is not required. Keep in mind that you are only using this equipment to fill a very small joint or saw cut in a horizontal surface.

Spray Gun Requirements:

Now that we have the pump basics described, forget the conventional mix block, static mix application for polyurea spray elastomer systems. For the spray guns, only the impingement mix types are appropriate for the fast cure, 100% solids aliphatic polyurea spray systems. There are 2 types of impingement mix spray guns, those with a fixed mixing chamber with moving valving rod and those with a moving mix chamber/valving rod combination.

Figure 4: Impingement Mix Spray Guns

The basic concept for the mix gun is that the material must enter, mix and then leave the mixing chamber of the spray gun as quickly as possible. Flow should not be restricted into the chamber with respect to overall volume of the mixing chamber of the spray gun. A spray tip is often a must, even on the fixed mixing chamber, single valving rod spray guns so as to hold back pressure and finish off the mixing. No free flow of material. Keep in mind also that correct gun setup is crucial to successful installation, as with conventional spray guns.

Something often overlooked with the spray guns are the filter screens used. Those used should be of the size that lets optimum material flow into the spray gun yet still filters any particles that would plug the chamber orifices.

Particle Size Conversions

US Mesh	Inches	mils	Microns	mm
30	0.0232	23.2	595	0.60
40	0.0165	16.5	420	0.42
60	0.0098	9.8	250	0.25
80	0.0070	7.0	177	0.177

Regardless of the spray gun being used, if you have a mixing chamber with 0.020-inch orifices, any gun filter screen used greater that a 40-mesh will only result in restricted flow of material into the mixing chamber and possible off-ratio application.

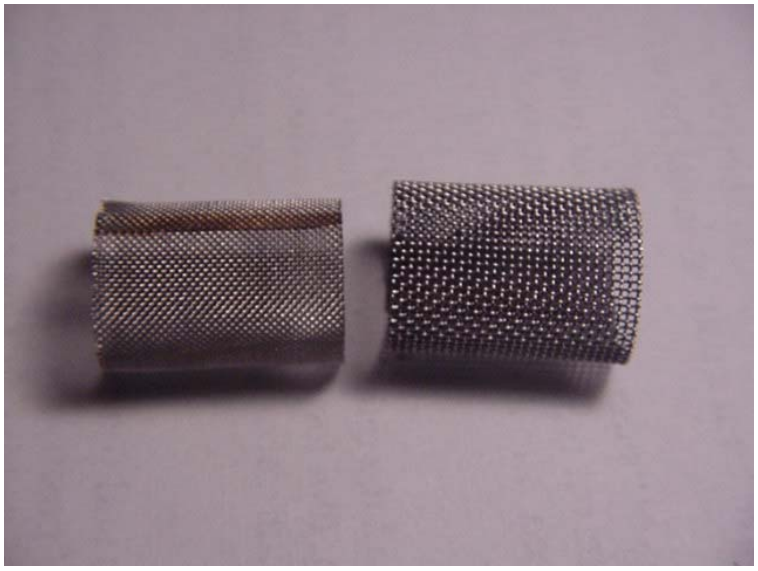

Figure 5: 80-Mesh vs 40-Mesh Screens

It must be noted that not all polyurea spray systems supplied are the same. Different processing conditions / spray gun set-up may be required to optimum mix and performance. You might also require different spray gun configurations for different type application areas. Refer to your system supplier for the proper spray gun configuration for the system being used.

And most importantly, a gun flush / service kit to properly clean and service the spray guns with all the functional accessories.

Material Delivery:

Material flow throughout the equipment setup must be matched. What does that mean? Well, you have a spray gun setup for 1.2 gallons per minute, the proportioner can deliver up to 3 gallons per minute but your material supply pumps (drum pumps) only put out about 0.8 gallons per minute for low viscosity materials. With this setup, you are asking for trouble. This would lead to severe cavitation problems and off-ratio spray areas.

Many of the 1:1 drum pumps are designed to give good flow rates of material, at relatively low material viscosities. For the plural component systems, viscosities are much higher than typical paint systems. The 1:1 drum pumps just may not keep up during high output, large field applications. Therefore, 2:1 drum pumps are recommended. Insure the material output for the product being applied as not all 2:1 pumps are the same.

Diaphragm pumps are also used quite successfully with plural component systems. For these pumps to work properly, a foot valve must be installed on the bottom of the dip tube. Otherwise, the material will drain from the pump and tube and lead to cavitation.

Also, the supply hose diameter should be such that the higher viscosity material uses a larger hose ID. As much of the plural component application equipment technology has derived from plural component rigid polyurethane foam systems, the material supply hoses concept has followed into the coatings area. For polyurethane foam systems, the resin blend component tends to be higher viscosity than the isocyanate component and hence the hose for the resin was a larger ID. This is typically just the opposite for coating systems, especially polyurea systems. The material supply hoses should at least be the same ID, recommended at 0.750 inches ID (19 mm) each. This will insure good feed of material to the proportioning unit.

An insufficient material supply package is a common oversight in equipment setup!

Generator / Air Compressor:

The generator and air compressor used are essential to proper operation of the application equipment. This is an area were many applicators and contractors fall short on. Before you set one up, you need to know the complete electrical requirements of your equipment and the air pressure and flow rate needed to properly operate drum pumps, spray gun and some proportioning units. All of this information is provided in equipment manuals. Sounds simple enough but you would be surprised as to what is used so as to cut corners and costs.

For a hydraulic proportioning unit, the air supply is only required to operate the drum pumps and the spray gun. When using an air purge gun, the airflow requirements may be a slightly higher. For the air operated proportioning units, a significantly higher airflow is needed. It should also be noted that that air operated proportioning units may be prone to freeze-up in cold, humid environments.

For the air compressor needs, the following is a general guide as published in the equipment manuals:

Equipment	Air Flow at 100 psi
Drum pumps	2.0 cfm, each
Spray gun	2.0 – 4.0 cfm
Hydraulic proportioner	0 cfm
Pneumatic proportioner	50 cfm
Pneumatic drum mixer	up to 75 cfm

From this, to properly run a hydraulic proportioning unit, a minimum 10-hp air compressor, fitted with an 80-gallon tank, will be needed. For a pneumatic proportioning unit, a self contained, commercial grade diesel generator capable of delivering 100 – 125 psi at a minimum of 75 cfm continuously will be required.

From the generator perspective, there is also a considerable amount of discussion as to whether you should have a single or 3-phase spray unit, for the US market. There is a perceived notion that the single phase, 220-volt unit can simply plug into a normal power supply. Well, most common 220-volt service will not handle the required 75 – 100 amps to properly power the unit. A 3-phase unit only requires a minimum of 50 amps for proper operation. A 3-phase setup also runs more efficiently.

In any event, a minimum of 25 - 45 kW generator will be required to properly power-up the spray unit and any auxiliary equipment in most equipment setups. Note that an air driven proportioning unit does not exclude one from the noted electrical requirements. The primary heaters and hose heat do draw a considerable amount of current.

Trailer Layout:

Now that you have the equipment, how are you going to lay it out? A very important aspect of successful operation and application of the polyurea spray elastomer technology is the layout for your transportation trailer and/or truck. While everyone may have their own ideas as to the individual layout, there are some very important considerations. These are notations that will save you time and money by keeping everything organized and within easy access.

- Must have enough room for machine, material and auxiliary equipment.
- Should have a good workbench with storage space / tool trays / surface deck.
- Workbench / area should include a vice for holding spray gun.
- Spray machine should be secured, **but** not permanently attached.
- Load distribution should be such that no excess / overweight is placed on tongue.
- Easy access doors (with ramp) for loading drum sets of material.
- Hose storage rack.
- Good interior lighting with numerous approved electrical outlets.
- Good air compressor with supply / manifold system with air dryer.
- May also consider and air cooler system, cuts down on moisture build.

Figure 6: Various Trailer / Truck Views

One of the most overlooked aspects of setting up a trailer or truck is the inside height clearance. Why is this important? Well, what happens when you run out of a drum set and try to switch to another full set of material? If the inside height of the trailer is not enough, then you will not be able to insert the drum pump into the new material without trying to tilt the full drum. Good luck, these drums are full and weight about 500 lbs (227 kgs). You will surely spill material and have a mess.

- Material drums are 34 inches (86 cm) tall
- Material drum pumps are 54 inches (138 cm) tall
- Inside height must be a minimum of 7.5 feet (2.3 meters)

Figure 7: "Moon Roof" Installation for Pump Removal

In setting up your trailer / truck, organization is critical for production and performance. A customer's observation of how you might be organized goes a long way to the job you may do. Remember visual appeal and how you are perceived in the industry carries a lot of weight!

Safety Equipment:

It can't be stressed more than enough the importance of proper safety equipment associated with application of plural component polyurea elastomer systems. This not only includes respiratory protection but also skin, eyes and for other people in the area. In the early days, it may have been implied that only a dust mask is required. This is simply not enough!

Figure 8: Safety First!

The SSPC has recently issued Technology Update No. 8, "The Use of Isocyanate-Containing Paints as Industrial Maintenance Coatings", which notes the use of "polyurea" systems.[4] The report contains detailed information concerning the use of isocyanate types and the required respiratory protection. At a minimum, you will require an appropriate organic cartridge respirator fitted with a HEPPA filters for dust particles. A prescribe cartridge change-out procedure will also be required.

The isocyanates are not the only part of the system that requires safety. Since the resin blend component is a labeled corrosive material, appropriate skin protection is a must. Keep in mind that you are also dealing with these materials under pressure, proper safety eye protection is also required.

In addition to information presented in that report, as well as others, you **must** also follow the required rules as presented by OSHA and the local Department's of Transportation. Transporting the materials also requires proper paperwork.

Safety in handling these materials and spray application is a major issue and this paper is not designed to deal with all aspects. You as an applicator have the responsibility of implementing a safety program and having direct communication with your system supplier as to the required safety equipment when working with their systems.

You should have ample supply of related safety equipment:

- Extra masks: includes extra cartridge filters, **STORE PROPERLY**, use log;
- Fresh Air Supply: must be in a clean area, stored properly;
- Safety glasses / goggles: face shield for spray/splash back in hose depressurization;
- Hearing Protection;
- Communication Radios: between applicator and trailer person;
- Hard hats;
- Steel toe boots;
- Portable eye wash station;
- First Aid kit;
- Fire extinguisher;
- Blue nitrile gloves: approved for materials used;
- Tyvek suits;
- Drinking water;
- Industrial paper towels;
- Cat litter: makes good absorbent;
- Empty pails: for waste materials and gun flushing;
- Broom / Shovel;
- Trash bags;
- Iso Decontamination Solution for spill cleanup.

- water	90 – 95 parts
- aqueous ammonia solution	3 – 8 parts
- liquid detergent	2 – 5 parts

Job Organization:

One of the keys to a successful installation is being prepared and ready for that installation. The same holds true for your spray application equipment. As difficult as it may seem for some, YOU NEED TO BE ORGANIZED!

This organization starts with having the correct "tools" to do the job, which includes having your "tools" in a readily accessible fashion. The following suggestions will help keep you organized and ready to spray in a timely manner.

While your spray equipment purchase includes a small tool box, this is not enough. It is suggested that this tool box be used for the commonly used wrenches, pliers, drivers, etc.

It is also recommended that you also get a tool box that has sectional drawers and compartments to store all the backup spray gun parts. This includes the modules, Pattern Control Disks, gaskets, seals and trigger rebuild kits. In this fashion, you can quickly assess your stock and order replacement parts before you deplete your supply. If you have several type guns, you should have a separate box for each. That way, you will not mix up the parts.

A full copy of the equipment manuals should be kept in a cabinet inside your trailer / truck. That way, you can easily refer to the parts required or for equipment trouble shooting. It is also recommended that you make copies of the pages out of the equipment manual that show the exploded views of the pump and gun configuration, laminate and post above the work bench of the trailer for easy reference during disassembly and re-assembly work. Also have electrical schematics for proper trouble shooting in the field.

In addition to the normal tools you may carry, these are some additional items that will really come in handy out in the field:

- Gun flush kit: a must have item for properly cleaning the gun;
- Spare parts:
- Bench vice: this is an important item and aids in disassembly of the gun and pump parts;
- Bung wrench: this is to open the bungs on the drums;
- 2” bar stock: have a piece about 1 foot in length, 3/8” thick. Use this with a large pipe wrench to open those stuck or frozen bungs;
- Heat Gun: electrical heat gun so as to heat and help loosen stuck bungs;
- Vaseline: apply to threads on drum bungs to keep from sticking;
- Drum cart: makes moving drum a whole lot easier; pneumatic tires;
- Funnels: for transfer of material so as to avoid spills;
- Grease: white lithium grease or super-lube for lubrication of drum pumps, air motors and trigger assemblies in spray gun, drum bung threads;
- Duct tape: the wonder material, has several roles;
- Volt Meter: for checking incoming volts, hose heat wattage (very important);
- Paper towels: might also have a box of cloth rags for cleanup work
- Misc: wood blocks (4”X4”) for under drums edge, rope, staple gun, tie wire, electrical tape, hand cleaner.

Material Storage / Use:

A very important aspect of successful coating application is proper material storage. The manufacturers and suppliers of the system do give recommendations for proper storage. These **must** be followed in order to insure good life of the system.

These basic procedures require that the materials be stored away from cold temperatures, extreme heat and moisture. This means that the materials must be stored inside a building for protection.

The most sensitive part of the system is of course the isocyanate component. This material must be protected from freezing temperatures, moisture, and prolonged extreme heat. Isocyanate producers and suppliers note that the isocyanate will freeze when exposed to temperatures below 40°F (5°C) for extended periods. Technically, the material will begin to "polymerize" at temperatures below 70°F (21°C). When this happens, small crystals will form and if left unattended, this will ruin the isocyanate component.

A general characteristic of the use of an isocyanate component that has been exposed to low temperatures for extended periods is that the resulting elastomer system may exhibit cracking when applied to "unsupported" substrates. This would include spraying over a geotextile membrane or bond-breaker type joint.

The isocyanate will also react with moisture, and especially water. This will cause the product to solidify and this is not reversible. Should moisture or water get into the drum and then sealed, extreme pressures will be generated and the drums may explode!

It is always a good practice to treat the resin blend component the same as that for the isocyanate component even-though it is not sensitive like the isocyanate component. For the resin blend component, moisture will not "react in", but it can contaminate the component, which will lead to foaming in the elastomer system during processing.

Some polyurea systems have been found to be less sensitive to these type conditions than polyurethane systems, but it is a good idea to follow good practices. This will save you time and money.

General procedures for storage:

- Store material at 60°F to 110°F (16°C to 45°C). Do not store outside exposed to weather.
- Store on pallets and not on bare concrete;
- Keep lids sealed and drums away from moisture;
- Keep away from extreme heat;
- Only open containers when ready to use; and,
- Use air desiccant or nitrogen blanket before sealing opened containers;
- Always agitate the resin blend before use as pigments do settle.

For drum mixers, use collapsible mixing blades such that the diameter of the mixing blades fully extended are one-third the diameter of the container or drum. This gives the optimum mechanical mix to the system.[5]

Figure 9: Collapsible Mixer Blades

Field Quality Control:

"***Quality control in the field? I thought that the system supplier handled quality control of the preparation of the system, I just apply it***." Well that may be true but the systems manufactures may have little to no control of how the applicators apply the system on every job. The coating system manufacturer / supplier uses the utmost quality control to prepare the blends for the coating system. You as the applicator are actually making the coating / lining product in the field.

In order to have a top-notch, quality organization, there are a few quality and record keeping issues that should be used when applying coating systems. To protect your interests as the applicator, the application and the integrity of the coating system, records of the application and material used must be noted.

To do this, there are several steps that must be followed:

1. Keep daily reports from the field / application;
   - Weather conditions / dew point
   - Substrate condition / preparation
   - Coating systems used, including lot numbers
   - Gel / tack free time
   - Spray equipment set-up
   - Problem areas

2. Spray a free film sample of the material used;
   - This can used in case there is a problem or issue at a later date
   - Sample can be sent to test lab for confirm of system's physical properties
   - This sample is also a lasting record of the application

3. Check film thickness of the system at various locations:
   - Can use both non-destructive and destructive techniques

4. Check adhesion of coating system to substrate:
   - Use Elcometer adhesion test

By having and implementing a Quality Control Program, you can insure application to application consistency and performance. This quality program can be used to help secure that potential project / application when dealing with the end use customer or engineering firm. In order for the program to work, you **must** use it.

You must also have an equipment maintenance procedure in place as well.[6] This will insure trouble free operation of the application equipment from job to job. Many equipment / system suppliers have documented schedules available.

New Concepts:

Now that we have had a look at most of the required individual components, what if we could roll it up into one complete package? This would mean having one unit that could power the application proportioner and be easily towed behind an average work vehicle. The ability to turn one switch and have generator, air compressor and hydraulic application equipment all on and ready to go is not a dream.

Figure 10: Self Contained / Skid Unit

A self-contained skid unit that utilizes one diesel motor to power the generator, air compressor pump and drive the hydraulic pump all in an inline configuration is a reality. All mounted "outside" the unit to allow for quietness and room to work. Using the hot water from the unit radiator will allow one to preheat the material and balance viscosities before entering the proportioning meter

Rather that trying to fight pressure loss and string out in excess of 300 feet of hose at the site, the skid unit can be easily moved or lifted by a crane to within a few feet of the project. The small size of the unit allows for easy manipulation into very tight spaces. It also allows one to "down-size" the truck so that you don't have to stop at every way scale. The ability to go where no other complete rig can go!

Figure 11: Skid Unit on the Move

CONCLUSION:

Over the past 10 years, the use of spray polyurea elastomer coatings has increased in importance as a method of lining and waterproofing applications in building and construction. Whether this type of coating will continue to grow in effectiveness and popularity or decline, rests to a great degree on the kind of job that applicators and/or contractors are doing now all over the country.

As you have seen, the spray polyurea elastomer technology requires the contractor to pay closer attention to detail than most other materials. Since the spraying of polyurea involves the fabrication of a lining system on the job site, the process is subject to various environmental factors. The inability of the contractor or applicator to control environmental conditions, such as temperature, wind and moisture conditions, be it rain or humidity, requires constantly being alert to immediate and upcoming weather conditions. Due to the rapid gel times and cure of the technology, the processing equipment is very important.

It means storing materials at the job site in accordance with manufacturer's recommendations. It means checking to see that the materials are not too old and/or deteriorated. But, most important, it means knowing your spray equipment, how it works and how to maintain it in good operating condition, especially when processing the polyurea technology.

For proper application of polyurea spray elastomer coating and lining systems, it's not just having the spray equipment that makes an applicator. It's that plus all the accessory materials, training, organization and record keeping that go along.

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[3] Hose Pressure Calculation Chart Courtesy of GUSMER Corporation.

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BIOGRAPHY:

Dudley J. Primeaux II

Dudley received an M.S. Degree in Organic Chemistry from Lamar University in Beaumont, Texas in 1984. He then joined Texaco Chemical Company - Austin Research Labs where he was involved in the development of rigid and flexible polyurethane foam systems and applications. It was under this area where he developed and first demonstrated the 100 % solids polyurea spray elastomer technology. In 1987 he joined the Performance Polymers Group where he has been

involved in polyurea RIM and spray elastomer development and applications development of amine catalyst in polyurethane foam systems.

In 1994, Dudley became part of Huntsman Corporation following the sale of Texaco Chemical Company. Here, he was a Research Chemist in the Thermoset Applications Group devoting his efforts to marketing and applications development of the polyurea spray elastomer technology. In October 1998, Dudley became Managing Partner / Chief Chemist with EnviroChem Technologies. Dudley was responsible for all formulation development for the *EnviroLastic*® polyurea product line and marketing of those systems and applications. He also interacted with the Certified Contractor Network on products and application techniques. Application equipment setup, training and servicing also fell under his responsibilities.

In November 2000, Dudley left the association with EnviroChem Technologies to pursue a personal consulting business, Primeaux Associates LLC. This work relates to the polyurea industry, equipment, application and training throughout the world.

Dudley is active in the National Association of Corrosion Engineers (NACE), SSPC: The Society for Protective Coatings and President-elect of the Polyurea Development Association (PDA). He is named inventor of 22 US Patents and 6 European Patents on polyurethane and polyurea foam applications as well as polyurea spray elastomer systems/applications. He also has 24 technical publications on the polyurea elastomer technology.

John P. Courier

Born in Mitchell, South Dakota, John completed his Masters degree in Industrial Arts and Vocational Education in Greeley, Colorado in 1970. He then moved to Fairbanks, Alaska to teach Vocational Welding and Machine Shop. He also taught evening classes for the University of Alaska. These developed into Ironworker and Pipefitter, Structural Steel, and Pipe Welding Certification classes.

In 1975, John left teaching to join a Heavy Equipment Construction partnership in Dragline and Long Haul trucking. He joined Local 375 Plumbers and Steamfitters. He spent most of the next 20 years as a Pipefitter, Foreman, and General Foreman working on the Alaska Pipeline in Prudhoe Bay, Alaska.

During his time off from teaching and pipefitting, John was welding, making, and setting up polyurethane foam storage tanks and heated plural-component spray-polyurethane foam rigs. These were sent into the bush for insulating in Alaska. He received his first

GUSMER Certificate in 1975. He built two spray foam and coating lathes up to 40 feet long. He was also involved in plant management, pipe drawings, bid estimates for Insulation Specialties and Manufacturing Company (ISMC).

In 1990, John moved to Tacoma, Washington to set up a warehouse and business for UCSC but named the new business Speciality Products, Inc. He was the General Manager and formulator of cementitious fireproofing materials, polyurethane specialty foams, single-component moisture-cure urethanes, fast-set urethanes, and polyureas. Under his management, SPI became one of the largest GUSMER distributors in the United States. He wrote most of the papers and procedures for applications of Polyurea still used at SPI today.

In I998, John left SPI and worked for Visuron Technologies, and then went into business as a consultant. He has designed and built many accessories for the heated-plural component industry. These include air drum mixers, silica gel dryers, inline preheaters, flush air harness, and many others. He set up a Web page and has consulted for GUSMER and EnviroChem Technologies. He has several patent disclosures.

In 1999, John started working as a fulltime consultant for the Willamette Valley Co. in Eugene, Oregon. His work with the Research and Development staff includes advising the development of new Polyurea products which include caulks, primers, aromatic, aliphatic, and expanded fire-rated polyureas. He was instrumental in getting the GUSMER distributorship for Willamette Valley Co., and is currently selling, training customers, and troubleshooting their equipment.

John is also a Certified GUSMER Instructor, teaching many GUSMER training classes throughout the United States, England, Japan, Puerto Rico, Australia, and New Zealand. John has created and presented several presentations at various company's including NAPCA and Spray Foam.

John is still active in designing new items, setting new standards, and providing training for the spray polyurea industry. He has many certificates of achievement and is a member of the Technical Committee for the SPFA as well as head of the Educational Training committee for the Polyurea Development Association (PDA).