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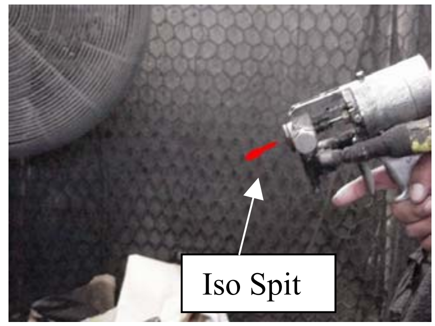
Blister, Pinholing & Bughole Troubleshooting



In coating applications, blistering of the coating system can always present a difficult situation for the integrity of the installation. One can spray a coating system for an extended period of time and never experience a blister. Then, blisters may appear in the very next job or even the next spray period of an existing blister free application area.

It is important that one understands the type, source and how to trouble shoot the blister problems that are found. There are several types of blisters that can occur and each of these may be due to one or more of the following conditions:

a) System formulation / reactivity,
b) Application techniques,
c) Substrate condition / preparation,
d) Application over uncured, improperly installed primer,
e) Application equipment performance and setup.

Thermal Blistering / Delamination:

Thermal blistering is usually a blister that forms between two layers of the coating system. These are due primarily to the higher exotherm generated by the second or subsequent coat of material over the initial coat that has not properly cured. This slower cure of the first coat is due to the heat sink effect of the cooler substrate. This initial coat acts as in insulator to the substrate and the second coat starts to cure faster resulting in stress shrinkage being applied on the first coat, which is softer from the slower curing. An example of this would be spraying on to a piece of thick, very cold, steel. The first coat is still soft while additional coats are applied and dry faster. This can cause blisters. **Not true with Polyurea Spray**.

Thermal blistering can also be caused by the high degree of exotherm build within the layers of application. This high heat tends to soften the layers and a searing effect occurs with the next layer of application. This does not allow the next layer to "wet out" the previous surface and no bonding reaction can occur. A delamination will then result. **Not true with Polyurea Spray**.

A big advantage of the polyurea spray elastomer technology is the high thermal stability qualities as compared to conventional polyurethane systems. Polyurea systems are not prone to thermal blistering.

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Moisture Blistering:

This is probably one of the most common causes of blistering experienced in the field today. This occurs as a result of excess moisture reacting with the isocyanate component of the polyurethane and/or polyurea coating system. This reaction forms carbon dioxide gas and will result in a pressurized blister formation. This type of blistering may not be noticeable immediately and may show up from 4 to 24 hours after spray application.

While it is true that the polyurea elastomer systems are not sensitive to moisture during application like polyurethane elastomer systems, there can be times when the moisture really does have an effect. This type of blistering in polyurea systems will be due to one or more of the following:

a) Off ratio application of material: isocyanate rich,
b) Isocyanate spitting in the spray gun,
c) Leaking isocyanate manual valves,
d) Incorrect Module / PCD configuration,
e) Proportioning unit failure,
f) Spraying over primers too soon, i.e. solvent based, uncured.

There is also another type of moisture blistering that is not a reactive one. This is moisture that may be trapped in the substrate being coated. The high exotherm of the elastomer systems causes the moisture / air in the substrate to expand and force a ballooning or outgassing force on the fast cure membrane. In many cases, one may also notice a significant amount of pinholing in the elastomer system during application. In most cases, this type of blistering can be eliminated by the use of a primer system, sufficient substrate drying or application of the coating system when the concrete substrate in “inhaling” or cooling down. This is typically in the afternoon or evenings. See Figure 1. A surface should **never** be left like this, it will leak!

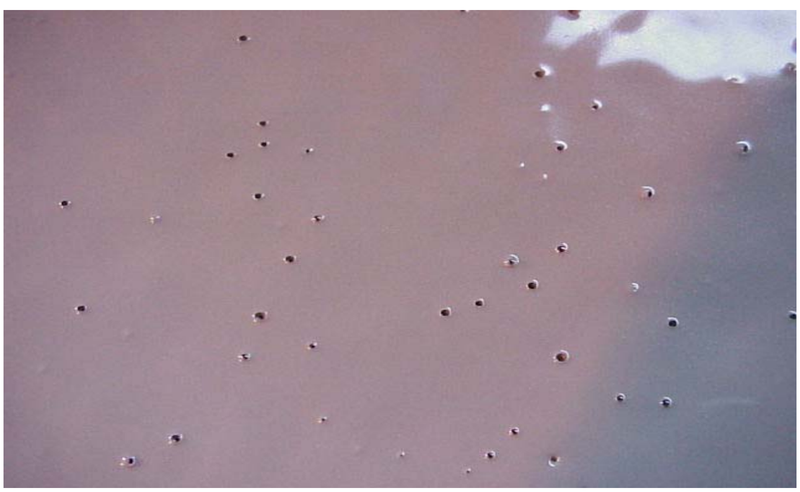

Figure 1: Surface Pinholing

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It may sometimes be noted that when a pinholed spray surface is recoated, even larger pinholes may result. The more you apply, the larger they get. The following diagram is an illustration of pinhole formation in coating systems:

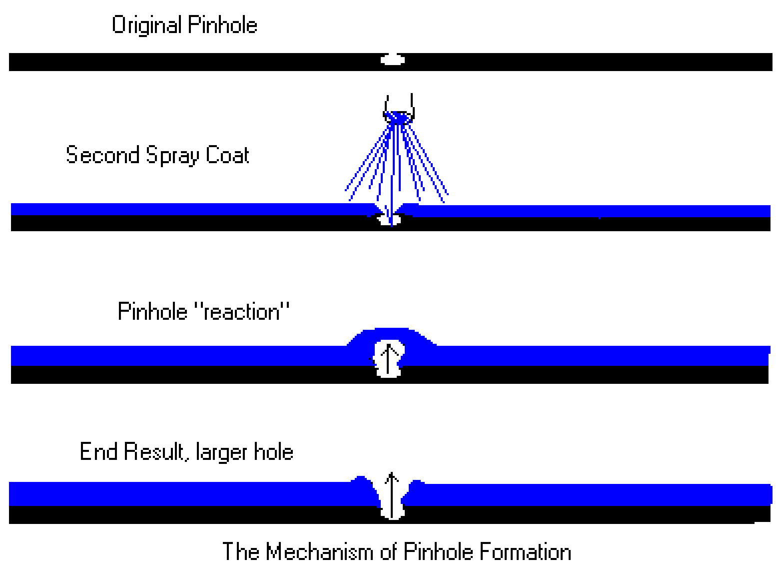

Figure 2: Surface Pinholing Mechanism

Keep in mind that you are applying a plural component system that is heated to about 150°F (66°C). When applied over a void area or existing pinhole, the hot system, couple with the reaction exotherm, warms the air / moisture in the void causing it to expand. This gas expansion pushes through the freshly applied liquid coating system. Pinholing in a polyurea coating system can be a very serious problem, especially in an immersion application. All pinholes must be repaired prior to turning the coating application over for use.

One method or repair or solution would be to lower the application temperature (140°F, 60°C) and spray using a flash coat or misting application with multiple passes. Random pinholes can be repaired using a caulk material.

Another phenomenon, sometimes confused with pinholing, is voids in the coating system due to a shadowing affect. This occurs when a fast set coating system is applied to a substrate that may be dirty or contain overspray. As you are spraying in one direction, the fast set coating builds on the contamination and does not completely flow around it. This dirt or overspray particles actually create a shadow for additional spray over the surface, creating a small bare spot in and around the shaded side of the substrate contaminant. While this may be a common occurrence, it should not be overlooked, as this is a point for coating failure, especially in immersion applications. An illustration of this can be seen as follows (Figure 3):

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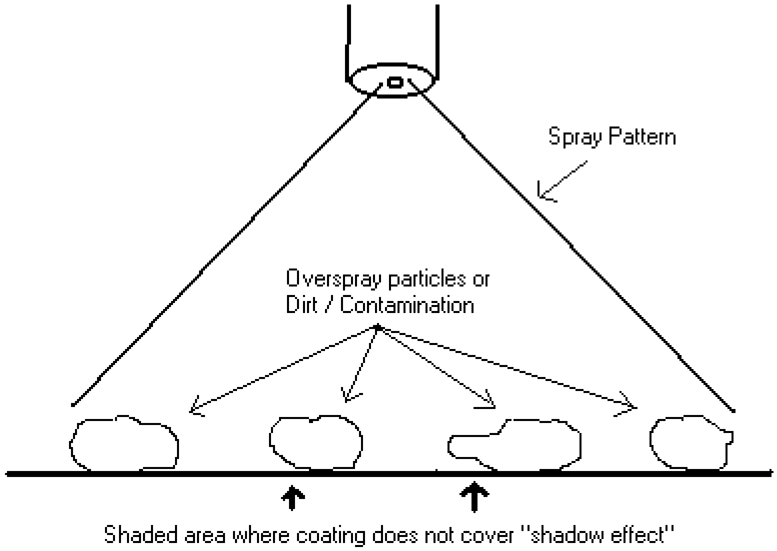

Figure 3: Shadowing Effect

Shadows can also be present when the improper spray technique is used. This would be were the spray gun is not being held perpendicular to the substrate during the spray work. The "shadows" will appear as a form of pinhole or "crack" in the applied polyurea. This is especially true at floor / wall intersections. The following figure shows improper spray technique and the result on the substrate.

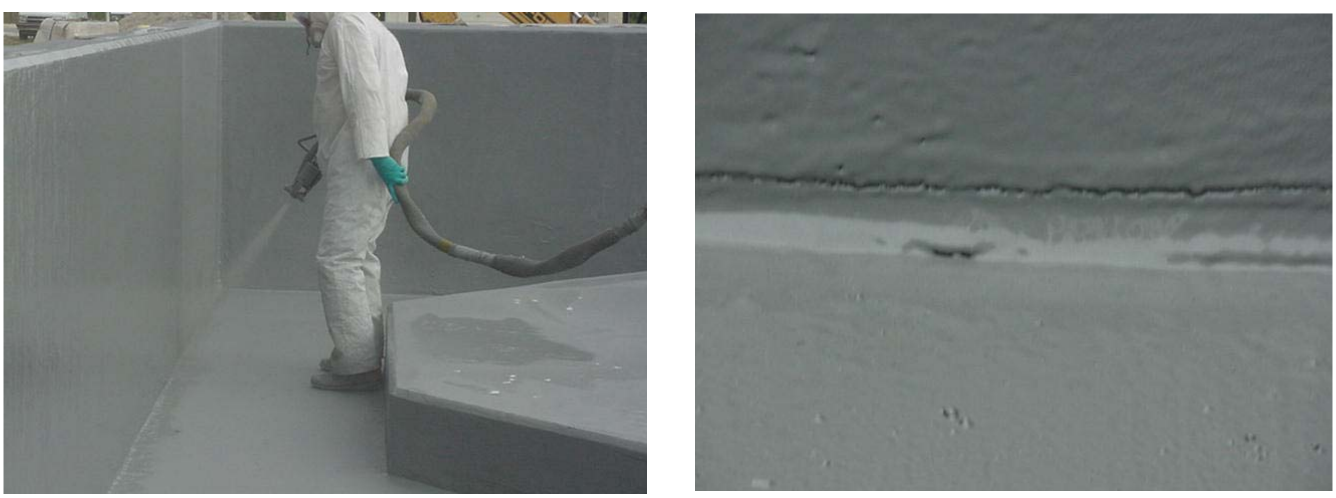

Figure 4: Improper spray technique and resulting "shadows" / "cracks"

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Bugholes in Concrete

Another major issue in coating application is spray application over bugholes in concrete. If the bugholes are "just sprayed over", the coating will not properly cover the substrate and give void areas in the coating. This is similar to the shadowing affect as noted above. The bugholes must be filled prior to installation of the polyurea coating system, as is the case with any other type coating systems. An illustration of this can be seen in Figure 5.

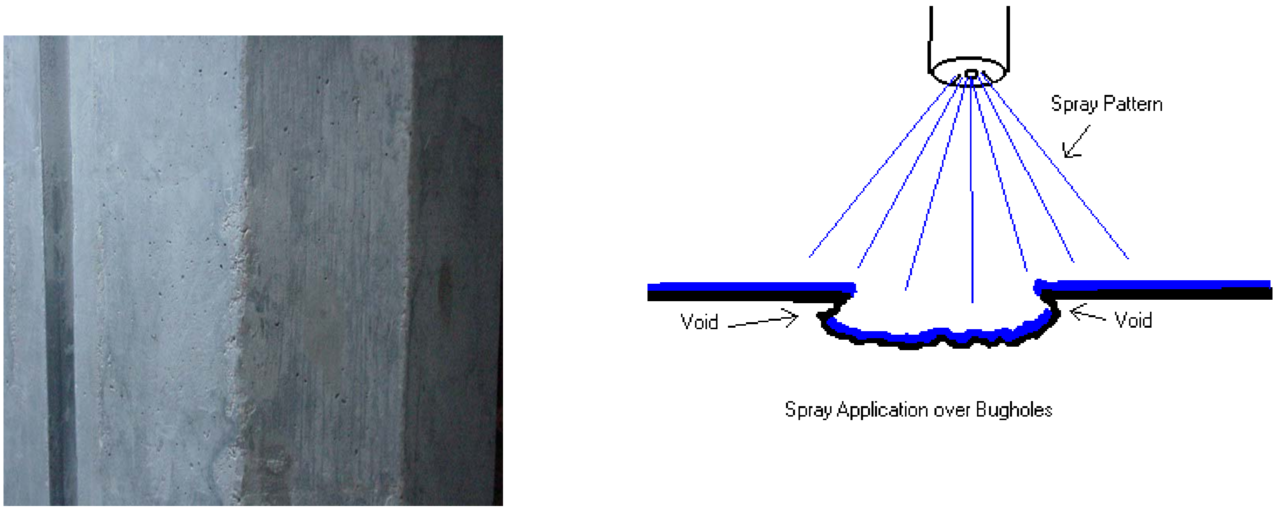
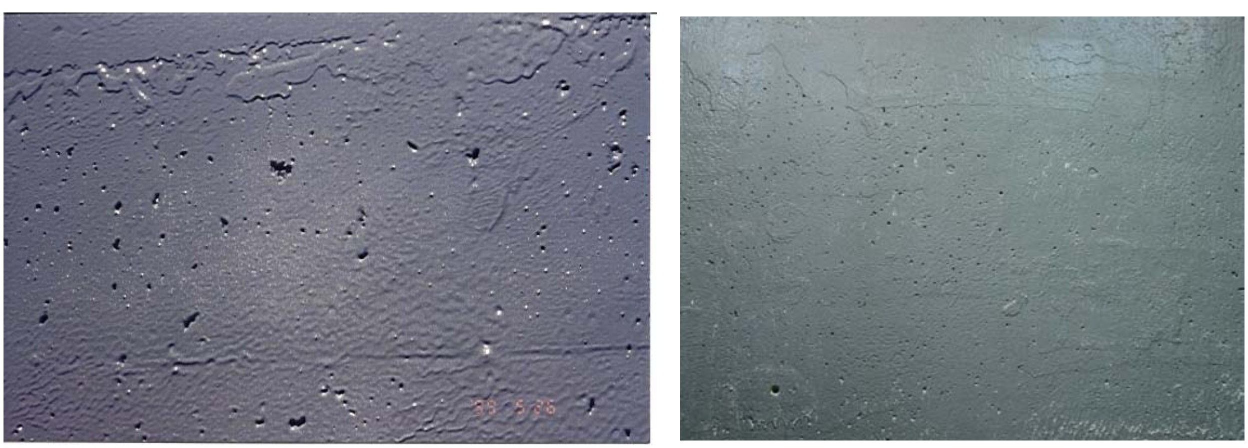


Figure 5: Bughole Application



Figures 6: Application over bugholes – BAD!

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If you apply a polyurea system in a lining / immersion application and bugholes are not filled and pinholing is present, a failure is likely to occur. In the case of aqueous environments where corrosive chemicals are present, chemical attack of the cementicious substrate can and will occur. This will result in blistering and disbonding of the lining system. This is especially true in wastewater lining application for lift stations, C-2 clarifiers and aeration / treatment tanks.

For filling / repair of bugholes, one of the following methods should be used:

- polymer modified cementicious
- epoxy / epoxy gel and aggregate
- latex-based surfacer, thin application only!

Before any of the methods are used, the concrete surface ***must*** be abrasively cleaned to removed laitence and "open" the bughole areas.

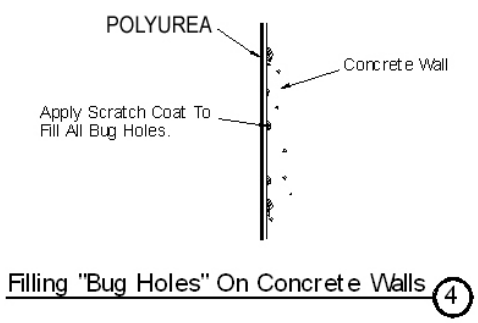

Figure 7: Bughole filling diagram

Special Notes on Bughole Filling:

Polymer modified cementicious:
- SSD surface area with water
- apply cementicuous via trowel up to ½ inch thick
- use a light brust blast to remove "dusting"
- apply recommended primer system
- examples:
    - EMACO® R350 CI, R300 CI, SikaTop® 123

Epoxy / epoxy gel aggregate:
- apply coat of neat epoxy system to walls
- mix same epoxy with "sand" for a paste and trowel or "sponge float"
- "blow" sand into curing epoxy on wall to create sandpaper finish (low pressure)
- CAUTIONS
    - amine blushing

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Latex-based surfacer:
- SSD surface area with latex "milk" liquid
- apply mixed surfacer using rubber trowel, pull tight
- may require two applications for complete fill
- DO NOT install greater than 3/32 of an inch
- example: Resistite (Dex-O-Tex)

Results of not pre-filing bugholes and / or pinholes in lining system in waste-water application.

Figure 8: delamination of lining

Figure 9: substrate "volcanoeing" at pinhole

Blister Characterization

If blistering is experienced in an application, you must first determine what type of blistering you have such that the problem can be addressed. The following is meant as a general guideline to troubleshooting the blister problems. For evaluation of the blistered area, you must first cut a blister out and examine the section carefully.

Blisters between coating system and substrate:

Back Side of Blister	Probable Cause	Solution
Smooth	Substrate contamination	Clean substrate
	Moisture / trapped gas	Prime substrate

Rough / Hairy	Moisture reaction	Dry substrate / prime
		Confirm dry compressor air
	Off ratio / iso rich	Check operating temperature
		Check operating pressures / equal
		Confirm proper Module/PCD
		Clean module / screens
Gummy	Poor primer cure	Confirm primer use
	Off ratio / resin rich	Check operating temperature
		Check operating pressures / equal
		Confirm proper Module/PCD
		Clean module / screens

Blisters between coating layers:

Back Side of Blister	Probable Cause	Solution
Smooth	Surface contamination	Clean surface / abrade
		Wipe surface with Tack Coat
Rough / Hairy	Moisture reaction	Dry substrate / check for
		Moisture drips or dew point
		Confirm dry compressor air
	Off ratio / iso rich	Check operating temperature
		Check operating pressures / equal
		Confirm proper Module/PCD
		Clean module / screens

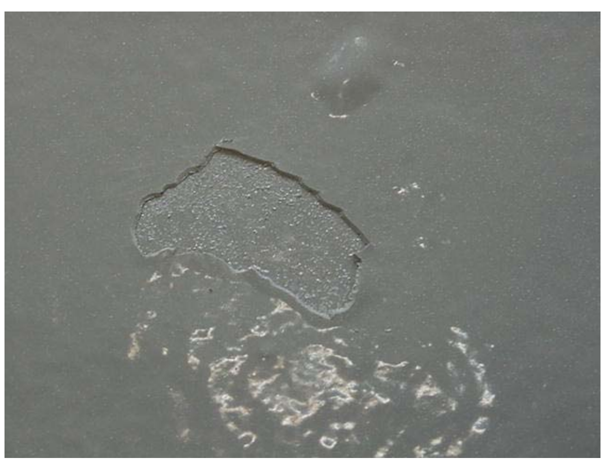

Figure 10: ISO Blister

Gummy	Off ratio / resin rich	Check operating temperature Check operating pressure / equal Confirm proper Module/PCD Clean module / screens

Other Pictures of Blisters:

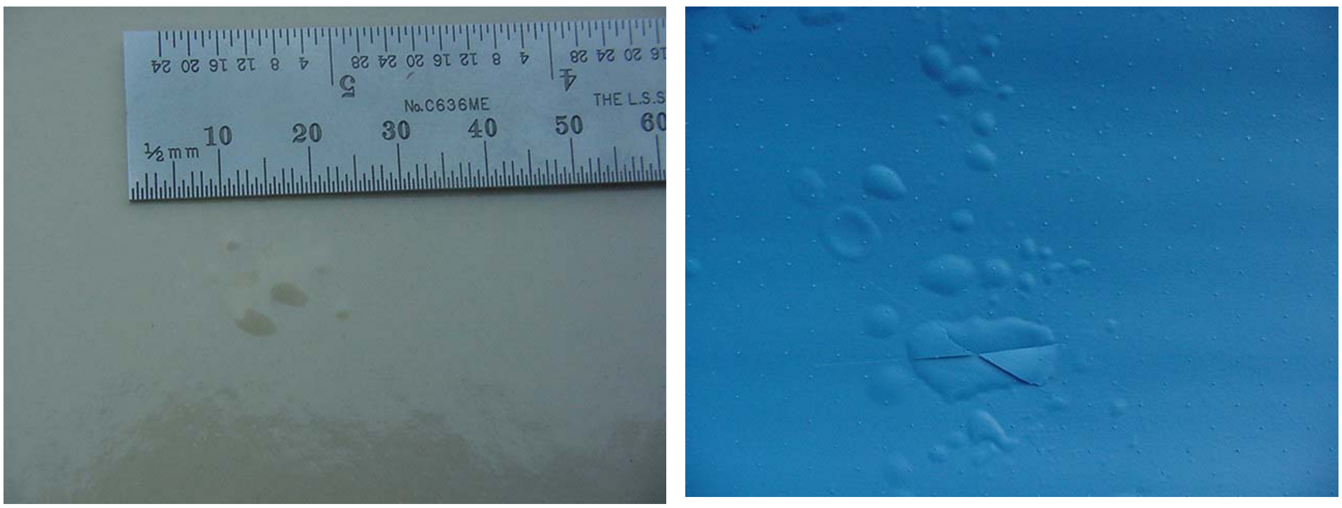

Figure 11: Application over a contaminant; i.e. water

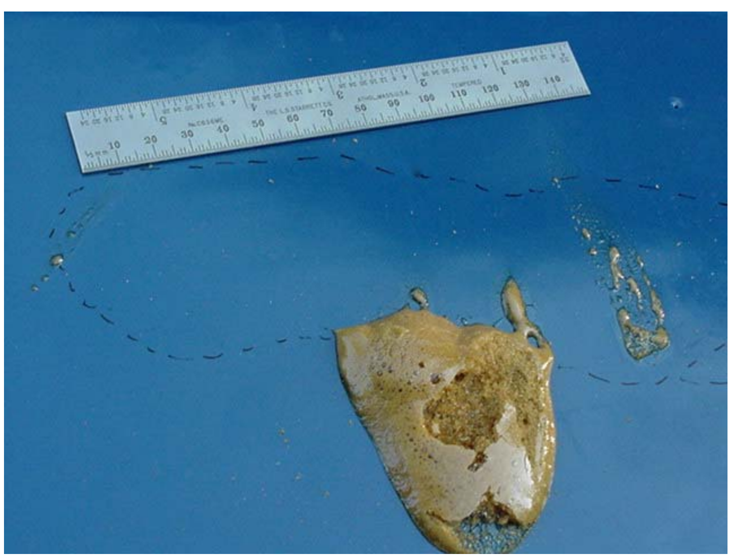

Figure 12: Application over un-cured polyurethane primer
Coupled with primer oozing through a pinhole

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As this is plural component technology, operating pressures between the Iso and Resin side **must** be within a 10% differential. Otherwise, you will be shooting off ratio!

Example: spraying at 2000 psi (x 10%) = 200 psi maximum difference

One important note about blister characterization, if you see a pattern of blisters that form after the application and they appear to be at what would have been the edge of the spray pattern, the blistering is due to mechanical problems in the spray gun. There is a proper Module / PCD configuration for the GUSMER GX-7 spray gun for polyurea spray systems that insures good, thorough mixing of the fast reacting system. This type of blister is due to the incorrect Module / PCD combination such that minimal flow of material is allowed into the small mixing chamber. The concept for good mix is such that the material should flow into the mixing chamber, completely flooding that chamber, and then allowing the PCD to control the outflow and spray pattern of the system.

In additional to the correct module/PCD combination, the filter screens in the spray gun should also be optimized. For the high output spray guns, **40-mesh** screens are used and for the low output spray guns, use the **60-mesh** screens. This will allow for optimum, unrestricted flow of material into the spray gun chambers.

The **best** Module/PCD combination for all polyurea spray elastomer systems can be found in the Primeaux Associates LLC documents relating to the specific spray gun configurations. This would include the air-purge and mechanical-purge spray guns.

Reference:

Munger, Charles G., Corrosion Prevention by Protective Coatings, Second Edition. National Association of Corrosion Engineers, 1999.