APPLICATION OF POLYSILOXANE TOPCOATS DURING NAVY SHIPBUILDING

A National Shipbuilding Research Program
Surface Preparation Panel Project
March, 2015

GENERAL DYNAMICS
Bath Iron Works

Elzly Technology Corporation

International Marine Coatings

Sherwin-Williams Protective & Marine Coatings

PPG Protective & Marine Coatings

JOTUN

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EXECUTIVE SUMMARY

The National Shipbuilding Research Program Surface Preparation and Coatings Panel (SPC) has completed this project to expand the use of polysiloxane topside coatings within the US Navy. These coatings are increasingly being used during maintenance and repair cycles but have not yet been implemented during new construction. The focus of this project was to generate cost-benefit data based on activities and identify build sequences that cost-effectively incorporate polysiloxane coatings into new ship construction. The project included a shipyard demonstration and two, 4-hour information exchange workshops.

During the shipyard demonstration all three of the Navy approved products were applied to over 1000 square feet of a drydock wingwall. Sequences of primer, intermediate, and finish coat were applied in schemes intended to replicate situations which may occur during new construction and throughout a ships life-cycle. The demonstration evaluated product behavior in a shipyard environment, ability to tie-in with aged coatings at different stages of construction, compatibility among the approved products, feasibility of an experimental Navy coating, color matching issues, and cleanability of the polysiloxane.

The information exchange workshops allowed various stakeholders to share their experiences and perspectives on overcoming the challenges and maximizing the benefits of using the new technology associated with the new technology. Participants in these workshops included the coating manufacturers, NSRP shipyards, coating subcontractors, and Navy representatives.

This project in conjunction with past efforts by the Navy have demonstrated that polysiloxane coatings can be incorporated into all phases of a Navy ships life to generate significant life-cycle benefits for the Navy. These benefits include a lower life-cycle cost, reduced operational maintenance needs, and improved overall durability.

The project identified issues unique to new ship construction which impact the ability to cost-effectively incorporate polysiloxane coatings. The shipbuilder will likely need to adjust their build strategy to take advantage of the cost-saving opportunities and minimize activities which may increase cost or risk associated with using polysiloxane coatings. Depending on the ship class, build strategy, and shipyard flexibility it may be possible to have negligible net cost impact associated with the change to a polysiloxane finish coat.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

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CONCLUSIONS

1. Polysiloxane coatings are a relatively new chemistry that offers an alternative to polyurethane and silicone alkyd finish coatings for ships, offshore structures and other industrial maintenance applications. Polysiloxane topcoats offer the Navy a more durable finish coat for ship exteriors than current silicone alkyd coatings.

2. Trade-offs among application requirements, coating cost, durability, and health/safety concerns should be considered when selecting among the three materials.

3. Polysiloxane topcoats should offer the Navy life-cycle cost savings. However, there are challenges that need to be overcome to fully recognize the benefits of this more durable coating throughout the ship life cycle. These challenges include implementation of cleaning procedures, improving color-matching and developing materials that are more practical for application by ships' forces.

4. Sufficient financial advantages of applying polysiloxane topcoats in new construction need to be identified to offset the increase in material cost before it will be implemented in new construction.
   - Need to weather longer – the differences are just starting to become apparent
   - Recommend adding rust runners and doing a cleaning in 12 months
   - All products work well; various minor preferences depending on the applicator
   - Need to evaluate adhesion of other stuff to the polysiloxane (radar adsorbing material tiles, adhesive backed nonskid, label plates, etc.)

5. While the benefits associated with using polysiloxane in maintenance and repair do not translate directly to new construction, there are opportunities to reduce cost on some portion of the ship topside area. These result from eliminating aesthetic repainting and eliminating the epoxy midcoat in some areas.

6. The shipbuilder will likely need to adjust their build strategy to take advantage of the cost-saving opportunities and minimize activities which may increase cost or risk associated with using polysiloxane coatings. Depending on the ship class, build strategy, and shipyard flexibility it may be possible to have negligible net cost impact associated with the change to a polysiloxane finish coat.

RECOMMENDATIONS

1. The Navy should continue to integrate polysiloxane coatings into all phases of ship life-cycle. While each new situation presents unique challenges, and the coatings technical community has been able to overcome them.

2. Develop cleaning methods for use on an industrial scale (i.e., for shipyard rather than sailor use). The sailor cleaning kits developed by NRL may be well suited to smaller cleaning needs but shipyards may be able to take advantage of other technologies for large areas.

3. Develop a set of field color and gloss data to identify a reasonable acceptable range for the materials when they are applied to a ship. This project demonstrated variability in color and gloss of the field applied coatings. Currently there is no basis to say that these field measurements are indicative of an acceptable (or unacceptable) coating.

4. Develop methods to blend in small touch up areas which are aesthetically acceptable. This will reduce the amount of painting applied to take repairs to structural discontinuities which hide subtle color differences.

5. Evaluate and approve adhesives for use on polysiloxane coatings. Various items are adhered to the current topside coatings (radar adsorbing material tiles, adhesive backed nonskid, label plates, etc.). Without the evaluations or without approved adhesives to be applied over polysiloxane coatings, new construction yards will incur additional cost associated with masking in way of these applications or need to remove the polsiloxane coatings down to the epoxy layer to allow adequate application of these adhered products.

6. Develop low temperature cure options for polysiloxane coatings.

BACKGROUND

Polysiloxane coatings became commercially available to the marine industry in the mid-1990's. This relatively new class of weather-resistant coatings was purported to provide improved weathering properties and be easier to use than the historically specified alternatives. While the coating materials do offer some significant advantages, experience has demonstrated that polysiloxane coatings have their own set of challenges. This paper will discuss the polysiloxane coating materials and practical issues associated with their use for both commercial and military applications.

Polysiloxane Coating Chemistry and Systems

For over 70 years, coating technologists have sought to improve the properties of organic coatings by incorporating silicon into coating chemistry. In the 1940's, heat-cured alkali silicate inorganic zincs became the first commercial use of silicone-based coating binders (Kline 1996). Over the next 20 years, the inorganic zinc silicate coating technology evolved as post-cure and self-cure ethyl-silicate inorganic zincs were introduced. During this same timeframe, heat-cured silicone coatings were developed for high temperature applications such as exhaust stacks, boilers, heat exchangers, mufflers, engines, and aircraft components (Finzel 1995).

In the 1950's, silicone alkyd coatings became the first organic-inorganic hybrid industrial maintenance coatings. Incorporation of the silicone resin dramatically improved the weatherability of alkyd coatings. Silicone alkyd coatings are still used on steel structures, including as a topcoat over epoxies on US Navy ships.

A 1981 patent describes binders based on interpenetrating polymer networks (IPN) comprised of a polysiloxane network and an epoxy-amine network which overcame the need for heat curing (Foscante 1981). Unfortunately, these early coatings were expensive, unstable and prone to intercoat adhesion problems. In the mid 1990's, a patented epoxy siloxane hybrid was commercialized as the first of the current generation of polysiloxane coatings (Mowrer 1997). Since that time, interest in polysiloxane coatings has increased as evidenced by the number of patents issued for epoxy-polysiloxane coatings (Figure 1). Most recently, silicone amine resins are being developed to make polysiloxane coatings more stable and user friendly. (Witucki, 2012) One reported goal of the new technologies is to "reduce potential embrittlement of polysiloxane hybrids."

Polysiloxanes have a strong silicon-oxygen-silicon backbone which provides more resistance to thermal oxidation (heat), photo-oxidation (sunlight) and chemical attack than conventional organic coatings (e.g., epoxies). Modification with an organic resin such as epoxy or acrylic provides flexibility, toughness, gloss, adhesion, and reduced cost. Polysiloxanes do not contain isocyanates, which have been banned by some owners/ jurisdictions for h ealth reasons.

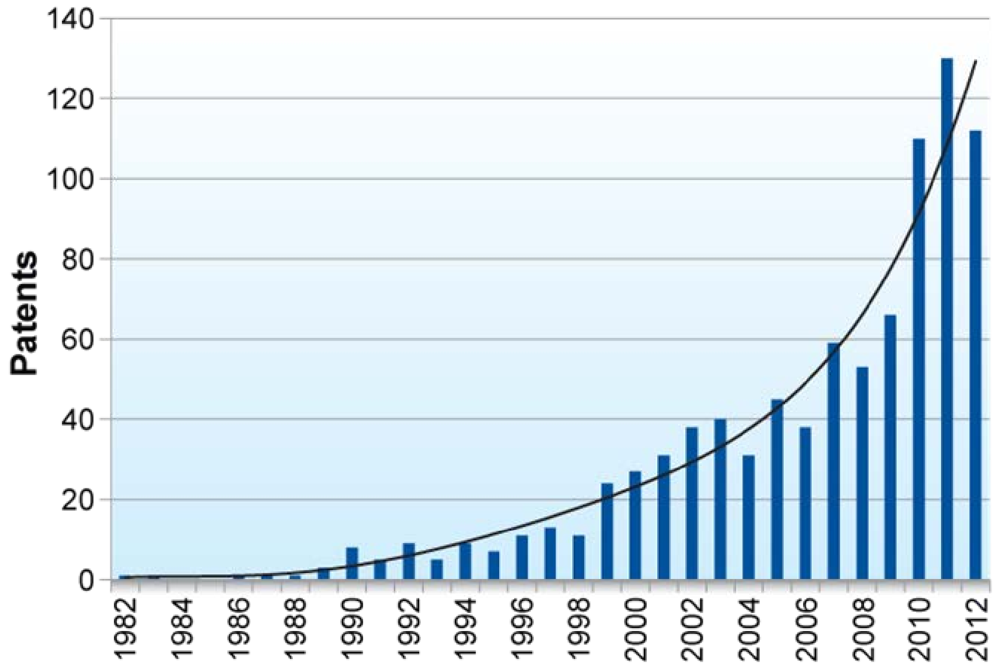

Figure 1. U.S. Patents Issued for Polysiloxane-Epoxy Hybrid Coatings Per Year. (Witucki 2012)

Commercially available coatings marketed as "polysiloxane" vary considerably in chemistry. Manufacturers vary the organic modification and the polysiloxane resin content as well as other aspects of the formulation in order to balance cost and performance parameters. According to a recent survey of the available products, organic modifications may include epoxies, acrylics, or urethanes. Depending on the formulation, the polysiloxane resin content can vary from 37 to 77% by weight. (Andrews 2005) Naturally, the difference in chemistry impacts a wide array of properties. Color retention, gloss retention, recoat window,[1] and flexibility have been reported to vary considerably among what are marketed as generically similar products. (Andrews 2005, Graversen 2007) Figure 2 illustrates the range of color and gloss retention of various products after an accelerated test. Manufacturer's product data sheets show recoat intervals between weeks and months depending on the products involved and curing conditions.

For industrial maintenance, polysiloxane coatings are generally applied as part of a multi-coat system. While polysiloxanes can be applied direct to metal, epoxy or zinc-rich primers are commonly used to enhance corrosion protection for steel. Since primers do not need to have weathering characteristics, epoxy primers are typically used in a two-coat system since they are more economical than polysiloxanes. Zinc-rich primers are used in applications that demand improved corrosion protection.[2] Polysiloxane coatings can be applied directly to zinc-rich primers whereas polyurethane coatings require an epoxy tie-coat. As a result, two-coat systems can be used in place of more traditional three-coat

[1] Recoat window refers to that period of time required for a coating to cure before the polysiloxane can be applied over the coating and achieve proper adhesion.
[2] The US Navy stopped using Zn-rich primers in any significant way in the late 1980's.

systems for industrial applications (Figure 3). The resulting labor and schedule savings associated with one less coat can be significant.

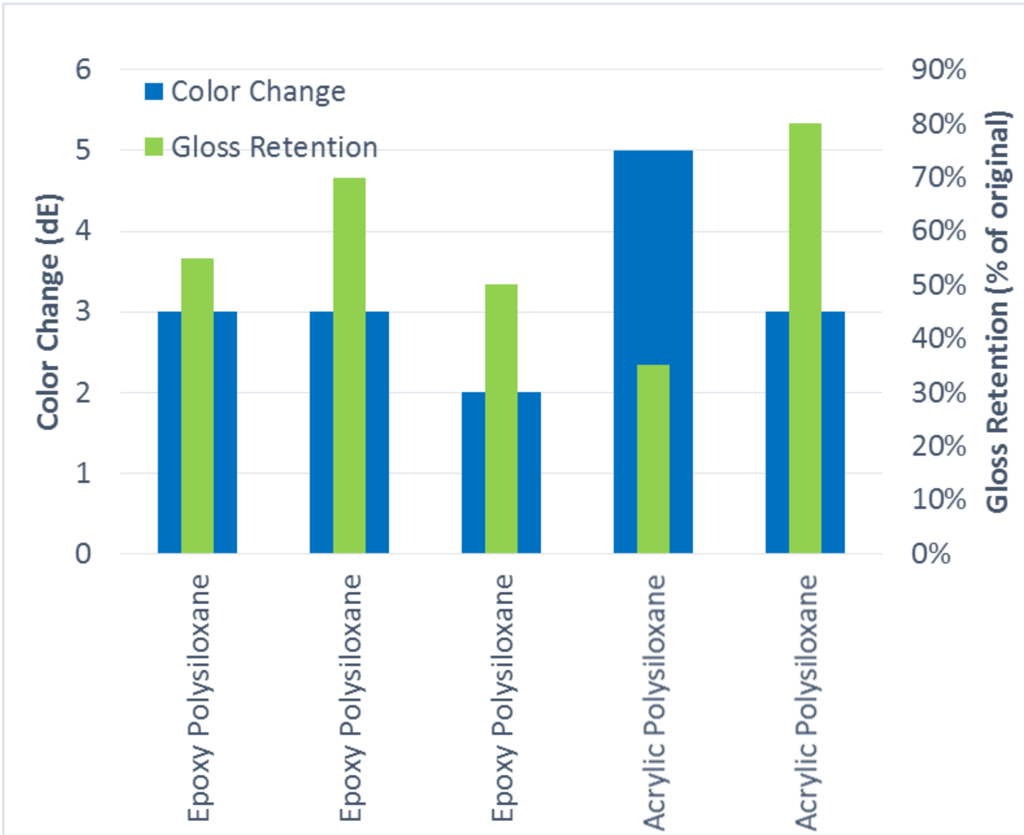

Figure 2. Color and Gloss Retention of Various Polysiloxane Coatings after 6500 hours QUV-A Exposure. (Graversen 2007)

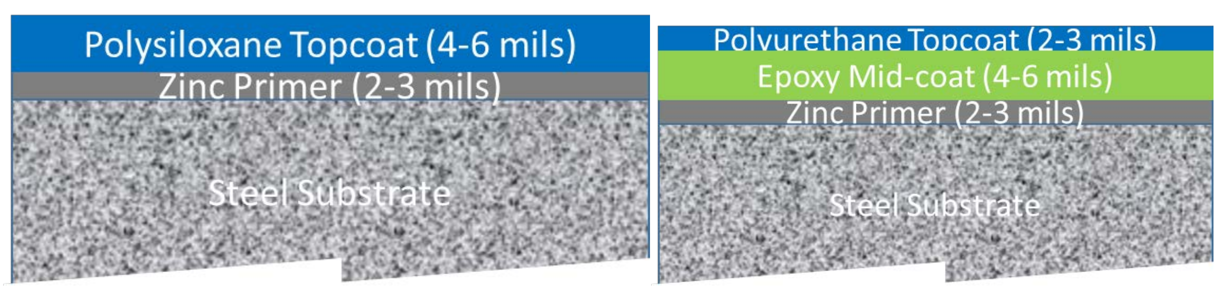

Figure 3. Typical 2-coat Polysiloxane system (left) and 3-coat Polyurethane system (right).

Industry Experience

After being commercially introduced in the mid-1990's, polysiloxane coatings found use as an alternative to polyurethane topcoats in a number of industrial maintenance applications on structures such as storage tanks, offshore platforms, bridges, petrochemical facilities, and water / waste-water facilities. While some significant issues with polysiloxane coatings were reported, the material was successful enough for more than 25 suppliers to introduce competing products within 10 years of its initial commercial use. (Huffman and Hower 2003)

While polysiloxane technology has been condsidered a truly innovative technology with much promise, problems have been experienced in the field and challenges remain to be overcome. (Wilson 2012) Moisture sensitivity and adhesion issues seem to be the primary causes of "catastrophic" failures, but issues with gloss and color retention have also been reported. The significant differences among polysiloxane chemistries contributes to confusion in the industry regarding the performance of these materials. As with all coatings, the generic chemistry does not sufficiently describe the material – a problem whose consequences are magnified by the number of polysiloxane patents and formulations and the rapid evolution of the technology.

Reported on adhesion problems with polysiloxane coatings have been attributed to product formulations as well as application and cure conditions. A series of papers have explored the mechanical properties and internal stresses generated in polysiloxane coatings as they may relate to adhesion issues. (Axelsen 2010a, 2010b, 2010c) The papers report research aimed at explaining cracking and flaking of polysiloxane topcoats applied to Norwegian offshore structures after a relatively short time in service. The papers explore the mechanical properties, internal stresses, and adhesion of polysiloxane coatings under various conditions postulated to impact coating performance. The testing demonstrated:

- Tensile properties of polysiloxane films changed with exposure to wetness and/or UV exposure. Specifically, tensile strength and elastic modulus increased with a corresponding decrease in elongation at break.
- Polysiloxanes subjected to cyclic loading may fail at lower loads than under static loading conditions.
- Internal stresses in polysiloxane coatings increased with increasing temperature and relative humidity.
- Coating adhesion was reduced when exposed to wetness or applied under unfavorable condition.

Despite these observations, the authors concluded that none of the environmental effects were of sufficient magnitude to explain the observed cracking and flaking. The authors note that the coatings which were tested were a newer generation of materials than those which failed. It is possible that either the older generation of materials was more susceptible to the mechanical effects or there was another contributing factor for the failures. Given the industry concern with longer-term stability of polysiloxane films, it is possible that the mechanical properties change over a longer timeframe (months to years) versus the shorter timeframe of the laboratory testing discussed above (days to weeks).

During an NSRP coating benchmarking study,[3] polysiloxanes were observed in commercial shipbuilding. They were especially common for cruise ship builders. One shipyard had an innovative coating sequence to take advantage of the indefinite overcoat window for a polysiloxane product (versus the limited overcoat window for polysiloxane over epoxies). This scenario was replicated in the demonstration phase of the present project.

US Coast Guard and US Navy Experience

In the early 2000's the US Coast Guard (USCG) began evaluating polysiloxane coatings for boat and cutter topside application and application on Aids-to-Navigation. USCG has since approved several two-coat and three-coat systems incorporating polysiloxane coatings. USCG experience with polysiloxane coatings has been positive as evidenced by its widespread use within the fleet. However, issues with application conditions in Alaska have led them to investigate additional topside coating options.

In November 2006, the US Navy added Type V and Type VI, High Durability classifications to *MIL-PRF-24635D, COATING SYSTEMS, WEATHER-RESISTANT, EXTERIOR USE*. Several demonstration projects were completed prior to 2009, when the Navy qualified three polysiloxane coatings to the specification. Figure 4 illustrates the legacy three-coat system (two coats of epoxy followed by a coat of silicone alkyd) and newer two-coat system (epoxy primer and polysiloxane topcoat) specified by the Navy. Polysiloxane use has expanded rapidly – over 30 navy ships now have polysiloxane topside coating. The 2014 version of the NAVSEA Standard Item for painting specifies a polysiloxane coating system for topside application.

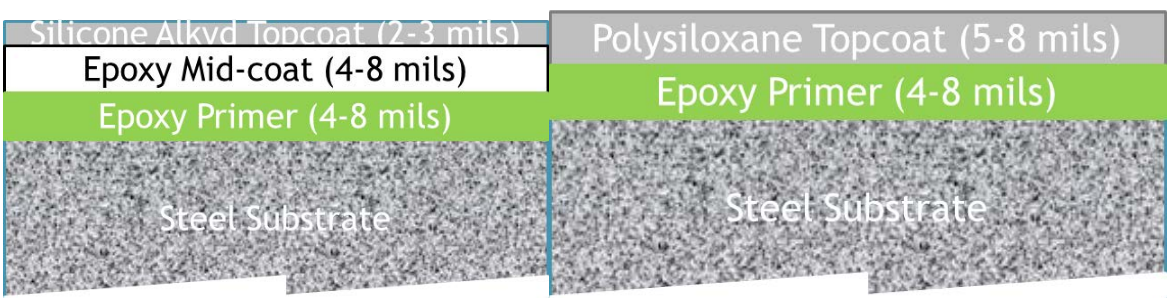

Figure 4. Legacy Navy 3-coat system (left) and new 2-coat Polysiloxane system (right).

The Navy will recognize savings in both the installed cost and life cycle maintenance cost by transitioning to polysiloxane topcoats. While the reported material cost of the polysiloxane coating system is approximately 32% higher, the labor savings associated with the two-coat system more than offsets the increased coating material cost. Overall project savings of 26% have been reported. (Kuljian 2011) In addition, the polysiloxane coatings tend to retain their color longer and resist staining better than the silicone alkyd coatings. Figure 5 shows data comparing color and gloss retention of legacy, silicone alkyd coatings and newer polysiloxane coatings after approximately 3 years at NRL's Key West exposure site.

[3] Foreign Shipyard Coatings Benchmarking Study, NSRP Surface Preparation and Coatings Panel Project Report, May 2013.

Note that the silicone alkyd color change is more than three times the polysiloxane change. Gloss retention is also significantly lower for the silicone alkyd coatings. As a result, less touch-up painting will be required. When discoloration occurs, it is often possible to clean the coating instead of painting. This enhanced durability provides a life-cycle cost savings.

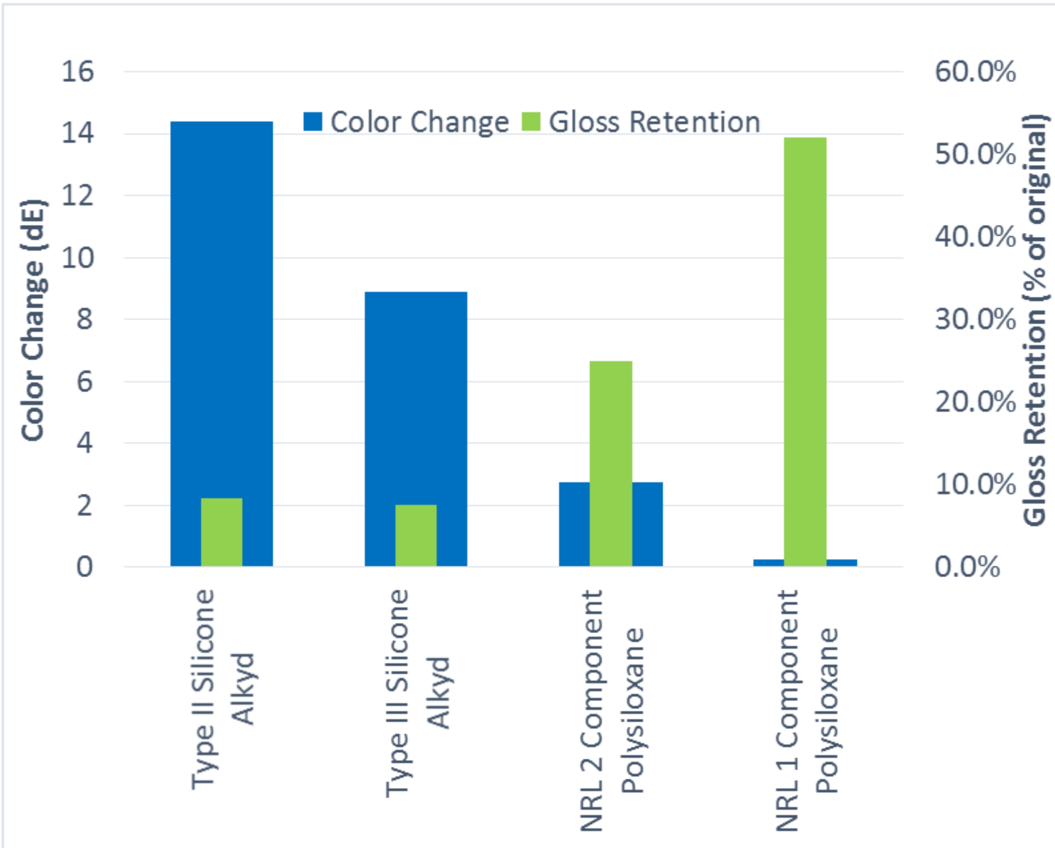

Figure 5. Color change and gloss retention of silicone alkyd and polysiloxane Navy ship coatings. (Iezzi 2014)

Challenges Being Addressed by the Navy

Adoption of polysiloxane topcoats is not without challenges for the Navy. The Navy has had some of the adhesion problems experienced in other industries. In addition, they are addressing challenges associated with polysiloxane use during organizational level maintenance (i.e. Ship's Force) and new construction.

The Navy organizational level maintenance community must undergo a paradigm shift to fully recognize the life-cycle cost savings. Current Navy practices involve a significant amount of painting for cosmetic purposes. It is important that Navy ships maintain their appearance; application of a coat of silicone alkyd paint has historically been the most expedient way to keep a ship looking good. Polysiloxane topcoats retain color and gloss longer than silicone alkyd coatings and tend to resist staining better than the silicone alkyd coatings. However, staining still tends to drive more touchup painting than is desirable. The Navy is working to develop and implement practical cleaning procedures that will continue to reduce the amount of touch-up painting performed by sailors.

Despite best efforts to improve cleaning practices, some degree of organizational level touch-up painting is inevitable. Since polysiloxane coatings are two component and silicone alkyd coatings are one component, the latter tends to be used for touch-up. Obviously, any benefits of the more expensive polysiloxane coatings are lost once they are covered with the older technology. The Naval Research Laboratories have developed a single component polysiloxane coating that does not require the mixing of components before application, can be applied direct-to-metal or over an epoxy primer, and outperforms all Qualified Product Database (QPD) silicone alkyds and 2K polysiloxane coatings when tested for color stability in accelerated weathering tests. (Iezzi 2013)

As the maintenance community begins to take advantage of the longer service life and life cycle cost reduction associated with polysiloxane topcoats, color matching of existing coatings is becoming a more significant issue. Field activities have found that despite tight specifications for color, touch-up coating does not always match existing coating. Differences can exist from batch to batch and supplier to supplier. As a result, larger areas than necessary may be painted so that the new coating ends at an edge or other feature that masks the mismatch. The Navy is presently exploring ways to deal with this challenge and further decrease the amount of touch-up painting.

Polysiloxane coating systems have been promoted as a cost savings because only a single coat of epoxy primer is required under the polysiloxane topcoat when applied over steel surfaces and no epoxy primer is required on aluminum structure prior to top coating with polysiloxane. However, during Navy new construction, primed steel is exposed in the shipbuilding environment for a sufficiently long time to dictate the need for a second coat of epoxy before topcoating. Since two coats of epoxy are applied rather than one, the cost savings that is recognized during ship maintenance is not recognized in new construction. In addition, the Navy typically requests an additional dress coat prior to sail away. If a polysiloxane topcoat were applied, it would be preferable to clean the coating to "like new" conditions, eliminating the necessity to recoat prior to sail away. However, it is unclear whether satisfactory levels of cleaning can be achieved.

The benefits of polysiloxane coatings are not limited to topside coatings. A Navy MANTECH project evaluated alternative coatings for improved durability and cleanability as interior finish coatings for submarines.[4] Current interior coatings require frequent over-coating to maintain cosmetic appearance. A polysiloxane material was identified as the most suitable of three alternative chemistries evaluated. While it demonstrated improved durability and cleanability, the polysiloxane coating had slightly higher smoke density than allowed by MIL-PRF-24596B (SH). The coating did meet remaining fire, smoke and toxicity (FS&T) testing requirements.

[4] "Improved Interior Finish Coatings" 30 May 2014, Charles S. Tricou, Applied Research Laboratory State College PA

DEMONSTRATION TESTING

Demonstration testing was performed at General Dynamics – Bath Iron Works (GD-BIW) as part of the project. The purpose of the demonstration testing was to generate data on the use of polysiloxane and provide the GD-BIW shipbuilding community (including NAVSEA and BIW technical and program personnel) an opportunity to work with and observe polysiloxane and it might be integrated into new ship construction.

Approximately 1,200 square feet on the wingwall of BIW's drydock was identified for the demonstration tests. The objective of the tests was to apply each of the approved products in sequences which could be encountered during the new build process. Key to the demonstration was a weathering period of several months. Prior to this weathering period, the test areas were left in varying degrees of completion (from a coating perspective). Subsequent to this weathering period, the weathered and damaged surfaces were repaired and the coating system application completed. Challenges and opportunities associated with the overall process were documented and used to identify low risk opportunities to integrate polysiloxane coatings into new construction activities at GD-BIW.

Initial Application (Build Process Phase)

Figure 6 shows the general layout of each test section on the drydock wall. An individual test section was created for each of the three polysiloxane products on the current Navy Qualified Products List. A fourth test section was created for a commercially available polysiloxane product.

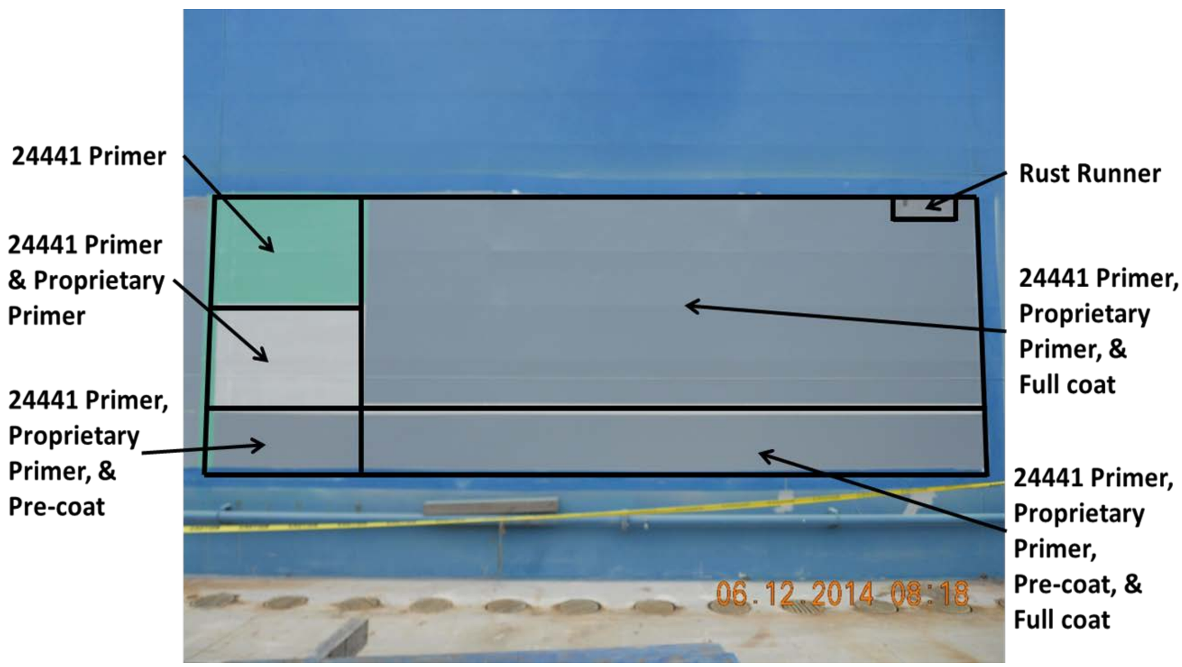

Figure 6. General layout of each test section.

Surface Preparation and Priming. All test surfaces were abrasive blasted with garnet to a SSPC-SP10, Near White Metal Blast Cleaning with an average 4.3 mil surface profile. Blasting took place over two days; surfaces blasted on the first day were sweep blasted on the second day. After blasting was completed, one coat of MIL-DTL-24441, Type IV, Formula 150 (green) was applied to all surfaces at an average of 5.2 mils dft.

Proprietary Primer Application. Six days after the MIL-DTL-24441 primer was applied, each vendors' suggested primer was applied to the majority of the test section. Prior to applying the epoxy, the MIL-DTL-24441 was pole sanded with 80 grit, blown down and then dry wiped. A few square feet in the upper left corner of each test areas was left uncoated, allowing the MIL-DTL-24441 to weather. The combined average DFT of the vendor primers and MIL-DTL-24441 was between 9.6 and 10.2 mils. This suggests that slightly less than 5 mils of each vendors' primer was applied. All of the proprietary primer application was completed on May 29, 2014.

Initial Finish Coat Application. Beginning four days after the proprietary primer application, the proprietary polysiloxane finish coats were applied. The general sequence of operations involved preparing all areas of the proprietary primer by pole sanding with 80 grit paper, blowing down with compressed air, and wiping with a dry cloth. After surface preparation, the finish coat was applied at a thin build (pre-coat)[5] on lower portion of the test area with conventional spray equipment. After the pre-coat has reached sufficient cure, a Polysiloxane finish coat was applied at the full recommended thickness to a majority of the sample area with airless equipment. Approximately 5 hours was allowed between the pre-coat and full coat. A few square feet in the center left side of each test area was left uncoated, allowing the proprietary primer to weather.

During the initial application of the finish coats, each manufacturer was present to observe and answer any questions that arose during the demonstration. All manufacturers' representatives provided excellent support during the project. Local NAVSEA representatives were also invited to observe the coating application. Subsequent to the coating application, a post-job meeting was held to collect feedback from all interested participants.

Vendor A finish coat was applied on June 2 and 3, 2014. The pre-coat was allowed to cure overnight before applying the full coat. Vendor B (the commercial product) withdrew from the project; this area was used for preliminary spray out of all products. Vendor C finish coat was applied on June 9, 2014. Vendor D finish coat was applied on June 11, 2014. For Vendor C and D, the pre-coat and full coat were applied on the same day, allowing approximately 4 to 5 hours between the pre-coat and full coat.

Five days after the final polysiloxane material was applied, a few square feet of LSA Silicone Alkyd Haze Gray Type II was applied each Polysiloxane test area. Areas to receive Silicone Alkyd were scuff sanded with 80 grit sandpaper followed by a dry wipe and final alcohol wipe. Two Silicone Alkyd patches were applied: one area about a foot beneath the rust runner and an area toward the lower right corner of the patch which included polysiloxane and proprietary epoxy primer. Figure 7 shows these locations.

[5] For the purposes of this testing pre-coat (also referred to as a mist coat) was defined as a coating film below the manufactures recommend film thickness but sufficient to form a continuous closed film. The pre-coat is not intended to be a standalone coating and must be coated at a later date with the same coating at the manufactures recommended film thickness. The pre-coat was generally applied at 3-4 mils (approximately half of the manufacturers recommended thickness).

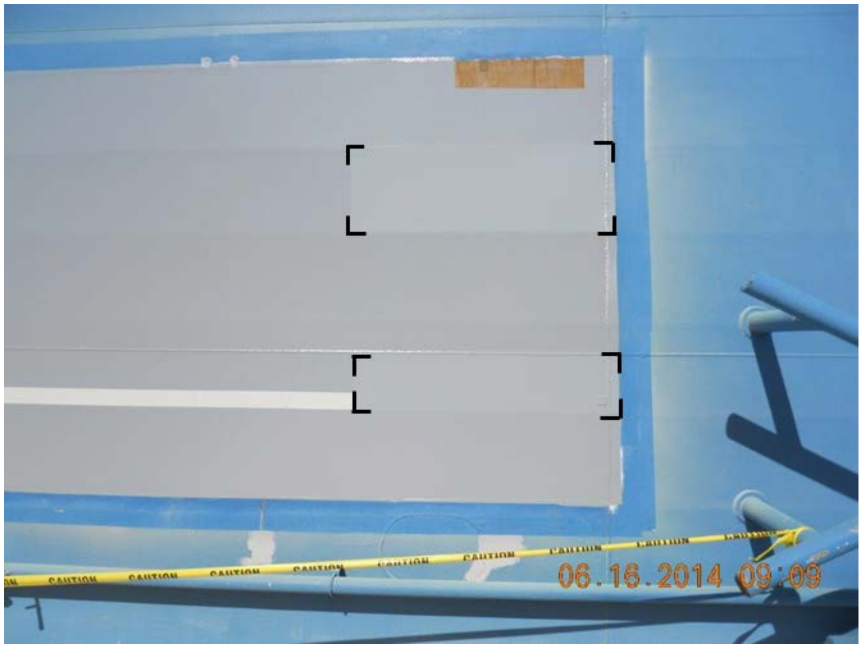

Figure 7. Typical location of LSA Silicone Alkyd application over polysiloxane.

After each product application during the demonstration, all persons involved with the process met to debrief lessons learned. During the debrief, individual observations were recorded and the product was given a grade (1-10, 10 being best) for each of the following characteristics: Conventional Spray, Airless Spray, Sag Resistance, Brush Applied, Roller Applied, Viscosity/Pot Life, Clean-up, Masking/Unmasking, and Odor. All of the products received ratings between 7 and 10 for each characteristic. Furthermore, the average ratings for each product was within 10% of each other. Given the subjectivity of the rating system, it is reasonable to conclude that the products are comparable on average. While most users expressed a preference for one product over others, there was no consensus on a “best” product.

All three finish coats were successfully applied with airless spray, conventional air spray, brush and roller. Airless pressure ranged from 1800 to 3000 psi, depending on the material. GD-BIW was able to effectively clean up using their standard blended solvent after applying each of the three finish coats.

Color and Gloss of Applied Coatings

On July first, after a minimum of two weeks cure, color and gloss measurements were made at eighteen locations on each test patch. Color measurements were made using an X-Rite SP60 series spectrophotometer. The meter has a D65 light source and diffuse (sphere) geometry (d/8°) which was set to included specular effects.[6] Gloss was measured at 30°, 60°, and 85° angles in accordance with ASTM D523 using an Elcometer 470 statistical glossmeter.

Figure 8 shows the average measured color for each of the coatings approximately two weeks after application. Each bar represents the average measured value for the coating. The high and low values for each measurement are indicated by the lines on each bar. The data for each coating was quite consistent. The horizontal lines represent the specification color requirement for L, a, and b values adjusted based on our measurement equipment. Each dimension is allowed to be 0.3 units higher or lower than the specification requirement. None of the field applied test patches were within the specification requirement.

Certificates of compliance containing color data were obtained from each manufacturer to confirm that the materials did in fact meet the specification requirement. The data demonstrate that it is probably not reasonable to expect the same repeatability in color on lab and field applied samples. Laboratory tests for appearance are performed by mixing a sample from the production batch of the pigmented component (typically Part A, "base") with a standard hardener. The cured film is formed using precise laboratory techniques.[7] The color measured in the field may be impacted by a number of factors including the effects of packaging, settling, and re-mixing; application by spray, brush or roller; uniformity of the coated surface; influence of the second paint component; and field curing conditions. The specifications do not contain any requirements for field color measurements.

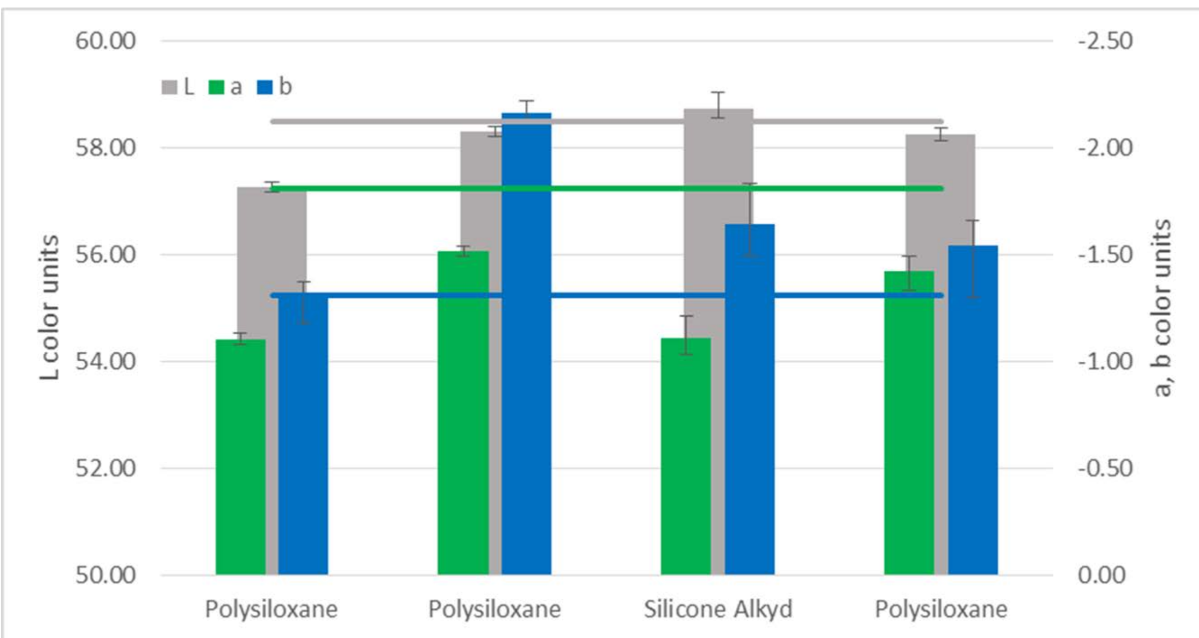

Figure 8. Average measured color of each test coating.

[6] Note that this is slightly different instrumentation than required by MIL-DTL-24635. However, for the purposes of our analysis, we used the following reference values for this type of instrumentation: L = 58.49, a = -1.81, b = -1.31. These values were measured on a FED-STD-595 Haze Gray (26270) color reference using this type of instrumentation.

[7] The specification states "Test specimens shall be prepared in accordance with ASTM D823 Methods C or E using a nominal 0.006-inch blade film applicator onto a clear plate glass of not less than ⅜-inch (nominal) thickness that has been ground to a uniform finish with 1F carborundum. A standard black and white Leneta chart is also acceptable."

Figure 9 shows the average deviation of the field applied test patches from the standard reference data. The specification requires that the production QA sample be within 0.5 units E. The acceptable ranges is indicated by the green shaded box. For the reasons previously mentioned this requirement may not be reasonable for field applications.

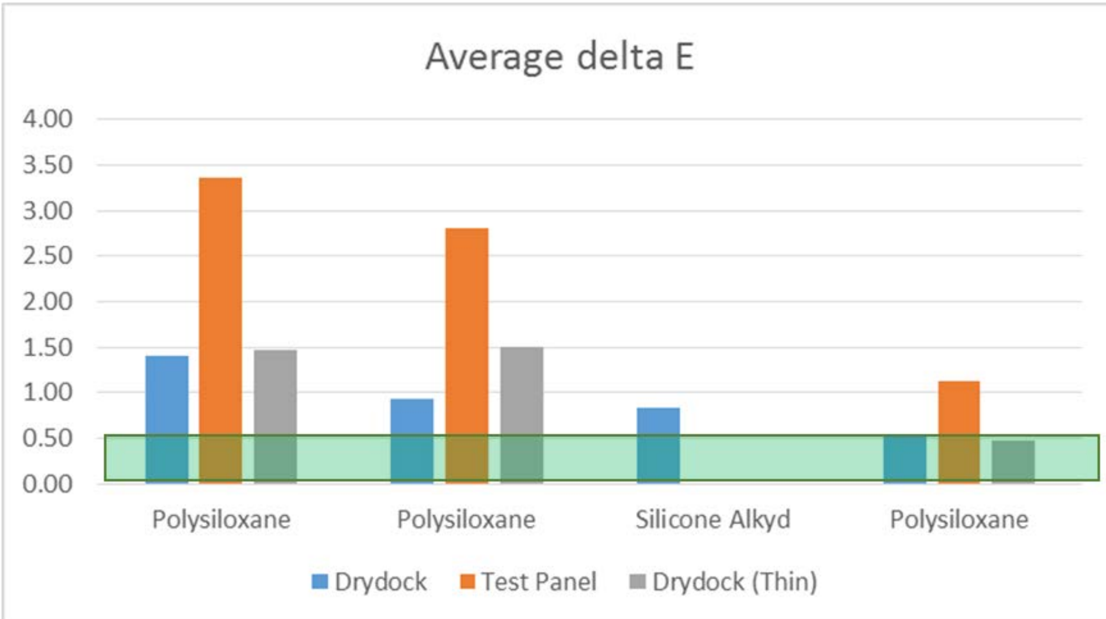

Figure 9. Average deviation of each coating patch from the reference. The green box indicates the specification requirement for batch acceptance.

Figure 10 shows the average measured 60-degree gloss for each test patch after two weeks. The green box indicates the specification requirement for batch acceptance (45-60). Field gloss measurements are impacted by the texture of the finish and the texture of the underlying surface. Only one of the polysiloxane products met the specification as applied on the test patches and test panels.

It is important to recognize the variability in color and gloss of the field applied coatings. Currently there is no basis to say that these field measurements are indicative of an acceptable (or unacceptable) coating. As it is becoming more important to quantify appearance of topside coatings, it may be useful to develop field expectations for these values.

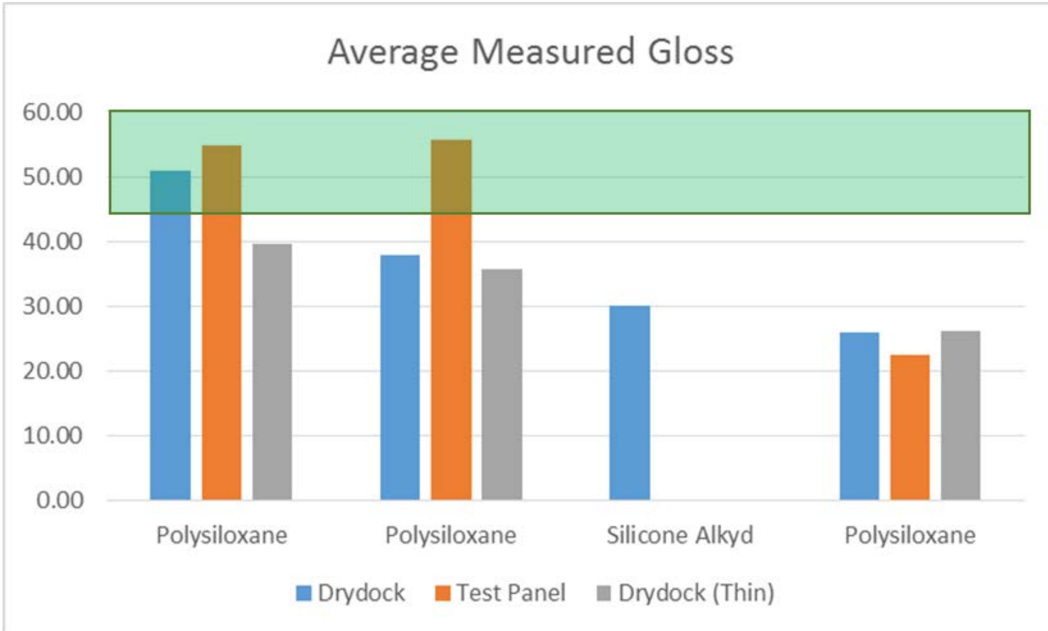

Figure 10. Average measured gloss of each test patch. The green box indicates the specification requirement for batch acceptance.

Final Finish Coat Application (Completion Phase)

The initially applied coatings were allowed to weather for four months. During that timeframe, they were exposed to outdoor weather conditions and eastern sun. After the exposure period, color and gloss readings were measured. Table 1 shows the average changes in gloss and color for each coating after the 4-month exposure period. The polysiloxane coatings lost about half as much gloss as the silicone alkyd. Color shift was not significant for any of the coatings. Overall, the changes observed over four months were significantly less than the differences among the originally applied coatings.

Table 1 - Color and Gloss Change over Four Months

Coating	Change in 60-degree Gloss	Change in Color (Delta E)
Polysiloxane	-4.70	-0.02
Polysiloxane	-4.56	-0.33
Silicone Alkyd	-10.11	0.16
Polysiloxane	-2.09	0.36

Figure 11 shows the various activities which took place during the completion phase of the demonstration. At the far left of the test area, the finish coat was applied over alternative existing coatings which were washed with fresh water and scuff sanded by hand using 80 grit sandpaper. The next section included four alternative surface preparation techniques prior to finish coat application – no preparation, fresh water wash, fresh water wash and scuff sanded by hand using 80 grit sandpaper, and three spots power tool cleaned to bare metal (SP-11). The third section included compatibility tests with other polysiloxane products. These products included the other tested products as well as the experimental one component product being developed by NRL.

Figure 12 shows a close up of the three spots which were power tool cleaned to white metal. The surrounding coating was feathered and tied in using three different techniques. To the left in the photo, MIL-DTL-24441 epoxy was applied to the exposed metal taking care not to apply it over the entire feathered area. The second spot had MIL-DTL-24441 applied to the bare metal and feathered area. The third spot did not have any epoxy applied – the polysiloxane finish coat was applied direct to metal.

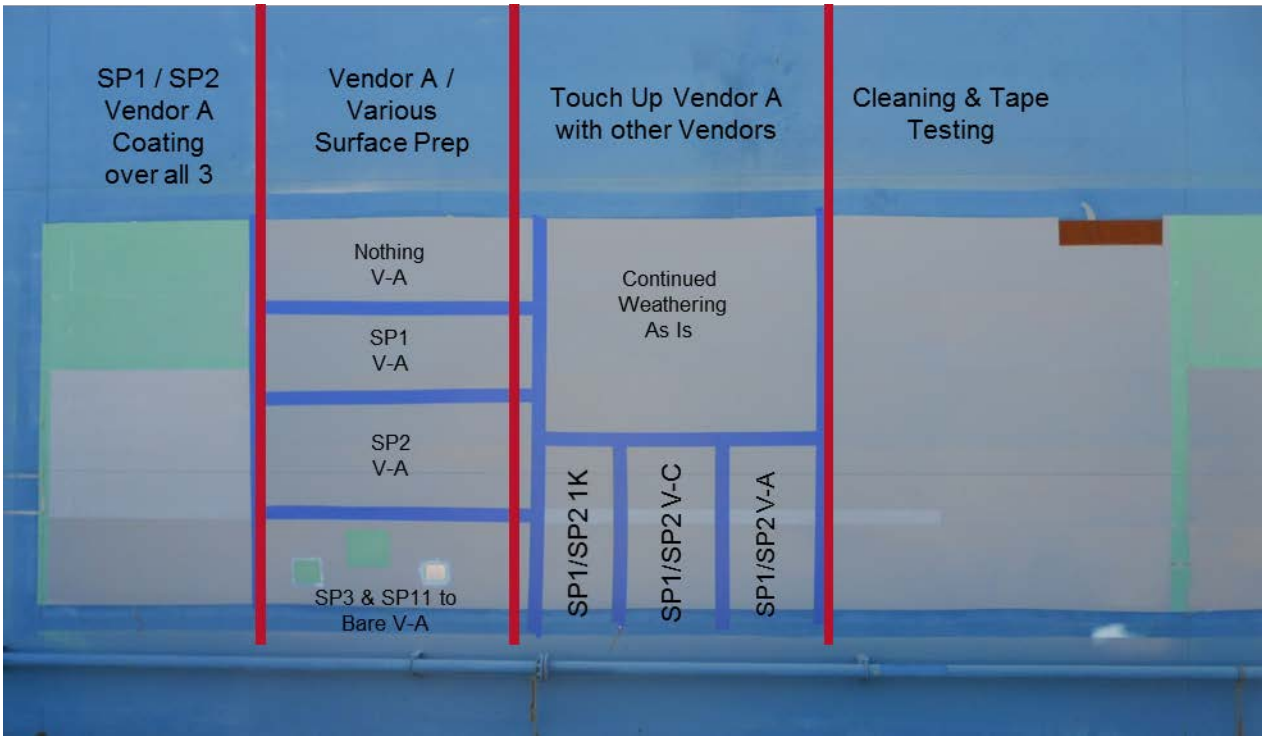

Figure 11. General layout of finish coat application variations.

Figure 12. Alternate schemes for repairing feathered areas.

After weathering, one product appeared to have heavier rust staining, though it is unclear if this is the result of more pickup by the coating or more rusting of exposed steel. All of the products had a light white streaking. The weathered coatings were readily cleaned with fresh water wash (low pressure). Some white streaking on the surface of one weathered product did not wash off with the fresh water wash. The streaking was not as noticeable on other vendors' coatings. The heavier rust stain was not completely removed by water washing.

All polysiloxanes were easy to grind and sand; they behaves similarly to epoxies. All of the polysiloxane repair coatings were easy to apply using brush and roller. The experimental single component polysiloxane from NRL outgassed and had minor cratering after cure. This has been corrected in the production product. As the two-component products began to cure, more drag was noticed when applying by brush/roller.

After 24-hour cure, the repair areas were visually discernable from the same vendors originally applied coating (even though they were the same batch). Interestingly, in some cases one vendors repair matched another vendor's aged coating. While the color differences were discernable to the team, they would probably be less of a concern to the casual observer.

At GD-BIW, coatings which can be used at low temperatures are often used to maintain project schedule. One of the approved Navy vendor offers a low temperature cure additive for their commercial polysiloxane. GD-BIW evaluated this additive in the Navy approved coating on a cool day in late March, 2015. The product was mixed and applied by brush and roller in the morning when the ambient temperature was 43°F and the steel temperature was 32°F. The product applied was applied without any concerns. While the temperatures were below 40°F in the morning, they rose to near 50°F by mid-day. The coating was touch dry within 4 hours and cured hard by the next morning (approximately 24 hours). Approval of a low temperature product for Navy applications is an important need for work performed in northern shipyards.

WORKSHOPS

During the course of this project, two information-sharing workshops were held to allow shipbuilding industry representatives to share their experiences with polysiloxane. Two, half-day workshops were held in conjunction with NSRP Surface Preparation and Coating Panel meetings. Workshop participants included representatives from seven NSRP shipyards (BAE Systems Southeast, GD-NASSCO, GD-EB, HII-NNS, HII-Ingalls, BIW, Vigor), NAVSEA representatives, and other industry representatives (preservation sub-contractors, paint manufacturers, vendors, standards organizations and academia). Table 2 shows each workshop agenda.

Table 2 - Polysiloxane Workshop Agendas

April, 2014 Agenda

- Introductory Comments
- Naval Research Laboratory (NRL) polysiloxane Coating Efforts – Eric Iezzi and Jimmy Tagert
- Manufacturer Perspectives
    - Sherwin Williams – Mark Shultz
    - International Paint – John Mangano
    - PPG – Tom Morrissey
- Discussions
    - Experiences and Issues during Ship Repair
    - Ships Force Maintenance
    - Implementation in New Construction

September, 2014 Agenda

- Introductory Comments
- NRL Update, Polysiloxane Cleaning Kits – Jimmy Tagert and Colton Spicer
- Cartridge Systems – Rich Parks, Sulzer Mixpac
- Shipyard/User Perspectives
    - Main Industries– John Chambers
    - NSWC – Anita Adams (CCAT experience)
    - BAE Southeast Shipyards – Steve Cogswell
    - HII Ingalls – Jay Pertuit (USCG Experiences)
- Open Discussion

During the workshops, the following issues and concerns were discussed:

- One advantage of polysiloxane coatings is the ability to apply them directly to zinc primers. The use of a zinc primer provides improved corrosion protection and extends the recoat window (potentially reducing the risk of adhesion problems). Zinc primers are commonly used for polysiloxane coatings by the US Coast Guard and on offshore structures. The Navy is presently evaluating zinc primers for shipboard use.
- The community recognizes the potential value of being able to clean staining from polysiloxane coatings. However, the actual best practices for cleaning must be determined. The Naval Research Laboratory has done extensive testing of cleaning methods for use by ships force and developed a cleaning kit for distribution within the Navy. However, it is unclear if these solutions are optimum or even suitable for use in an industrial setting. It also remains to be seen whether current shipyard cleaning methods are suitable for cleaning polysiloxane coatings.
- Adhesion between polysiloxane topcoats and epoxy primers is an ongoing concern. A few instances of catastrophic delamination of the polysiloxane topcoat from the epoxy primer have been reported in industrial as well as Navy projects. The importance of observing overcoat/recoat windows and using compatible topcoats and primers was stressed by the manufacturers.

- The group generally agrees that color matching will continue to be a concern and should not be over-sold. Polysiloxanes provide substantially better color matching than legacy products. However, a perfect color match cannot be achieved and should not be expected. Even if batch QA data meets rigorous Navy specifications, by the time the material is packaged, mixed by the applicator and applied there may be noticeable differences with aged product. The limits or repair areas may be extended to natural boundaries such as welds or edges to minimize the effect of any color differences.
- The coatings community needs to prepare a strategy (and supporting data/experiences) to help convince shipyard and Navy program offices that polysiloxane materials pose limited risk during new construction and offer the Navy significant life-cycle savings.
- New build shipyards did not seem to be aware that the Navy allowed direct to aluminum application of polysiloxanes. This is documented in NAVSEA Standard Item 009-32 (FY15) but is not in the current version of NSTM Chapter 631.

ECONOMIC CONSIDERATIONS FOR USING POLYSILOXANE IN LIEU OF SILICON ALKYD DURING NEW SHIPBUILDING

As discussed above, polysiloxane coating systems offer as a cost savings during maintenance and repair because the epoxy intermediate coat can be eliminated. The increased cost of the coating material is more than offset by eliminating the labor associated with the intermediate coat. However, during Navy new construction, primed steel is exposed in the shipbuilding environment well beyond the overcoat window. Furthermore, primer damage, erection welds, and outfitting damage all make it necessary to apply a second coat of epoxy before topcoating. Since two coats of epoxy are applied, the cost savings recognized during ship maintenance is not recognized in new construction.

During this project, various costs and benefits of transitioning from silicone alkyd to polysiloxane topside coatings were identified through the demonstration and workshops. Table 3 outlines the issues which were identified.

Table 3 - Costs and Benefits Associated with Polysiloxane versus Silicone Alkyd Topside Coating in New Build

Costs/Risks	Benefits/Opportunities

• Increased material cost
• Potential cost increase associated with two component coating
• Will still require some degree of touch-up for aesthetics
• Compatibility with various materials needs to be addressed
  o Adhesive materials
  o Color-marking paints
  o Masking tapes
  o Peel and stick non-skid
• Color match isn't perfect; can still see "lines" at border of touch-up; still need to extend re-work to a physical boundary
	• Life-cycle benefit to the Navy/owner
	  o Eliminate complete finish coat prior to final delivery
	• In some instances, intermediate epoxy coat can be eliminated
	• Reduced color shift (less pinking) eliminates need for additional coats during long build cycles
	• Stain resistance reduces contamination and makes cleaning an option in lieu of re-painting Can eliminate primer coat for some substrates (i.e., aluminum)
	• Reduced color shift will eliminate some need for dress coats resulting from exposure during long build cycles (i.e., no pinking)
	• Closer color match makes it easier to camouflage touch-up edges at structural features such as weld seams, physical edges, etc.
	• Less retention of dirt and industrial debris makes cleaning a possibility in lieu of re-painting for some situations.

A number of the costs/risks are "one-time" issues associated with adopting polysiloxane. Once the shipyard and Navy resolve these issues their impact will be reduced or eliminated. These issues include:

- Compatibility of items installed using adhesive over the polysiloxane (e.g., radar adsorbing material tiles, adhesive backed non-skid, and label plates).

- Color-coding and marking coatings are still silicone alkyd or industrial enamel coatings which must be applied over polysiloxane.[8] Their compatibility over polysiloxane has not been demonstrated and polysiloxane coatings have not been considered for these applications.
- Some adjustment of current shipbuilder practices may be required. For example, at the beginning of the demonstration, if was discovered that the masking and taping products used at GD-BIW did not adhere well to the polysiloxane products. GD-BIW worked with a major tape supplier to evaluate four tapes, all of which had satisfactory adhesion to the polysiloxane but some of which were extremely difficult to remove.

Obvious recurring costs include the higher cost of the coating and the increased cost of working with two-component products. These costs are compounded when substantial areas of topside coating will require an additional coat due to late stage outfitting or incidental damage. Current polysiloxane color matching technology is not perfect and will still require the coating repairs extend to geometry changes (weld beads, edges, etc.) which hide the minor color differences.

While coating damage will still require touch-up, any topside repainting currently performed solely due to "pinking" of the silicone alkyd material will be eliminated. NRL data show that the currently approved products will retain color for many years longer than the current silicone alkyd products. Currently, the entire ship gets re-painted (at a cost to the Navy) after PSA due in large part to color shift. Therefore, the Navy will recognize a life-cycle cost benefit of switching to polysiloxane very early in service life of ship.

There is some opportunity to take advantage of cost savings scenarios in new construction. However, this may require the shipbuilder to adjust their build strategy. For example, items which are substantially completed may be primed and finish coated early in the shipbuilding cycle. This would allow elimination of the intermediate epoxy coat as in ship repair. The two-coat system is feasible for components which are not subject to erection and outfitting damage. DDG-51 class masts are an example of this type of location.

The stain resistance of polysiloxane helps reduce the need for cleaning and touchup painting associated with shipyard industrial contamination. In the demonstration, contaminated polysiloxane surfaces were found to be considerably easier to clean than silicone alkyd surfaces. It is reasonable to expect that in some cases the improved cleanability may eliminate the need for touch-up painting.

While the cost savings associated with the use of polysiloxane in maintenance and repair will not be recognized on an entire ship in new construction, various cost saving opportunities will exist on portions of the ship. Locations where coating damage or late cycle configuration changes drive the need for touch up painting may still require an additional finish coating to achieve consistent appearance. However, the use of polysiloxane coatings will reduce the need for cosmetic repainting during the build cycle in locations where the only driver for cosmetic painting is color shift or surface contamination.

A cost analysis was performed as part of a demonstration of polysiloxane coatings on USS Bon Homme Richard (LHD-6) (Kuljian 2011). The data from that presentation is presented in Table 4. The data showed a material cost increase of 32% due to the higher cost of coating materials. This cost increase was offset by a labor savings of 43% due to the elimination of a coat of epoxy. The overall project savings was projected to be 26.3%.

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[8] It is not practical to mask all of these areas off when the polysiloxane is applied; for example, the VLA (Vertical Landing Aid) location is not precisely known until late in build cycle.

Table 4 - Publically Available Polysiloxane Cost Data for Comparison

Polysiloxane Cost data based on USS Bon Homme Richard (LHD-6) presentation (MegaRust 2011)							
	Total Estimated Cost			Estimated Cost per Sq Ft			Percent Savings (Cost)
	Traditional	Polysiloxane	Savings (Cost)	Traditional	Polysiloxane	Savings (Cost)	
Material	$ 160,580	$ 212,350	$(51,770)	$ 0.52	$ 0.69	$ (0.17)	(32.2%)
Labor	$ 569,625	$ 325,500	$ 244,125	$ 1.84	$ 1.05	$ 0.79	42.9%
Total	$ 730,205	$ 537,850	$ 192,355	$ 2.36	$ 1.74	$ 0.62	26.3%

As noted above, this analysis does not directly translate to new shipbuilding. However, if we assume that the cost data is representative, the data suggests that the increased material costs could be offset if the epoxy mid coat could be eliminated on roughly 20-25% of the structure surface area. Specifically, a material cost increase of $0.17 for every square foot is offset by a cost savings of $0.79 per square foot on 21% of structure area where intermediate epoxy & stripe is avoided. Obviously, the extent to which this offsetting cost is realized is ship dependent, and the costs from the LHD-6 analysis will not translate directly to any given new build shipyard. The important conclusion is that "some" savings will be recognized due to elimination of midcoat and the breakeven point will be at substantially less than the topside surface area on the entire ship.

Another identified cost savings is eliminating the need to repaint significant areas of the ship that would otherwise only be repainted as a result of the color shift or surface contamination. It is assume that some repainting will be dictated by coating damage through the final stages of outfitting and that repainting due to damage will translate to significant repainting simply because the color-matching is not perfect. However, those areas which are repainted solely due to "pinking" or surface contamination will not require re-painting. If we assume that application of an additional, cosmetic finish coat costs $1.00 per square foot, the material cost increase of $0.17 per square foot from Table 4 is offset by avoiding purely aesthetic overcoating on 17% of the structure area. Of course, the extent to which this offsetting cost is realized is ship dependent, and the material costs and topcoat costs will vary by shipyard. The important conclusion is that "some" savings will be recognized due to elimination of aesthetic repainting and the breakeven point will be substantially less than the entire ship.

REFERENCES

Andrews, Adrian F. "Polysiloxane Topcoats – A Step too Far?" Paper No. 05007 presented at Corrosion 2005. NACE International, Houston, TX.

Axelsen, S.B., Johnsen, R., and Knudsen, O.Ø. "Internal Stress in Polysiloxane Topcoats." *Corrosion* 66:6 (2010a). p. 065005.

Axelsen, S.B., Johnsen, R., and Knudsen, O.Ø. "Mechanical Properties of Polysiloxane Topcoats." Corrosion 66:6 (2010b). p. 065006.

Axelsen, S.B., Johnsen, R., and Knudsen, O.Ø. "Adhesion Properties of Polysiloxane Topcoats." *Corrosion* 66:12 (2010c). p. 125003.

Finzel, William A. "Silicone Coatings." *Journal of Protective Coatings and Linings*, August 1995: 93-106.

Foscante, et al., "Interpenetrating Polymer Network Comprising and Epoxy Polymer and Polysiloxane," US Patent 4,250,074 (1981).

Graversen, Erik, "Comparison between Epoxy Polysiloxane and Acrylic Polysiloxane Finishes." Paper No. 07008 presented at Corrosion 2007. NACE International, Houston, TX.

Huffman and Hower, "The Emergence of Polysiloxanes and Protective Coatings." Journal of Protective Coatings and Linings, August 2003: 5-9.

Iezzi, E.; Martin, J.; Tagert, J.; Slebodnick, P.; Wegand, J.; and Lemieux, E. "Single-Component Polysiloxane Coating for Navy Topsides." *NRL Review* (2013).

Iezzi, E.; Tagert, J. "Polysiloxane Topside Coatings for Navy Surface Ships." Presented at MegaRust 2014 (June 2014). ASNE, Alexandria, VA.

Kline, H.H. "Inorganic Zinc Rich." *Journal of Protective Coatings and Linings*, November 1996: 73-105.

Kuljian, G; Slebodnick, P; Schultz, M. "Time & Cost Savings Associated with the Application of MIL-PRF-24635 Type V Polysiloxane to the Freeboard of the USS BonHomme Richard (LHD-6)." Presented at MegaRust 2011 (June 2011). ASNE, Alexandria, VA.

Mowrer, et al., "Epoxy Polysiloxane Coating and Flooring Compositions," US Patent 5,618,860, (1997).

Wilson, Lee. "Field Performance of Polysiloxanes." *Journal of Protective Coatings and Linings*, March 2012.

Witucki, Gerald. "Next Generation Polysiloxane Hybrid Coatings." *Polymers Paint Colour Journal*, November 2012: 22-24.

APPENDIX A – POLYSILOXANE COATING PRODUCT DATA SHEETS

Interfine 979SG

Polysiloxane Finish

PRODUCT DESCRIPTION

A patented high performance, high volume solids content acrylic polysiloxane cosmetic finish with low solar absorption (LSA) pigmentation providing excellent long term durability. Interfine 979SG will provide superior gloss and color retention on exterior exposure compared to typical marine polyurethane finishes.

INTENDED USES

As a cosmetic finish on above water areas.
For use at Newbuilding and Major Refurbishment.

PRODUCT INFORMATION

Color	SYA200-Haze Grey
Finish/Sheen	Semi-gloss
Part B (Curing Agent)	SYA056
Volume Solids	76% ±2% (ISO 3233:1998)
Mix Ratio	4.00 volume(s) Part A to 1 volume(s) Part B
Typical Film Thickness	5 mils dry (6.6 mils wet)
Theoretical Coverage	244 ft²/US gal at 5 mils dft, allow appropriate loss factors
Method of Application	Air Spray, Airless Spray
Flash Point	Part A 98°F; Part B 131°F; Mixed 100°F

Drying Information	41°F	50°F	77°F	95°F
Touch Dry [ISO 9117/3:2010]	6 hrs	5 hrs	3 hrs	2 hrs
Hard Dry [ISO 9117-1:2009]	8 hrs	6.5 hrs	4 hrs	3 hrs
Pot Life	3.5 hrs	3 hrs	2 hrs	1.5 hrs

Overcoating Data - see limitations — **Substrate Temperature**

	41°F		50°F		77°F		95°F	
Overcoated By	Min	Max	Min	Max	Min	Max	Min	Max
Interfine 979SG	8 hrs	ext	6.5 hrs	ext	4 hrs	ext	3 hrs	ext

REGULATORY DATA

VOC 218 g/lt (1.82 lb/US gal) as supplied (EPA Method 24)
175 g/kg of liquid paint as supplied. EU Solvent Emissions Directive (Council Directive 1999/13/EC)

Note: VOC values are typical and are provided for guidance purposes only. These may be subject to variation depending on factors such as differences in color and normal manufacturing tolerances.

MIL SPEC MIL-PRF-24635 Type V Class 2 Grade B

SYSTEMS AND COMPATIBILITY

For use on Marine projects, Interfine 979SG may only be applied over Intergard 264, Intershield 300 and Intershield 300V.
Alternative primers may be used, depending upon region. Consult International Paint.
Consult your International Paint representative for the system best suited for the surfaces to be protected.

SURFACE PREPARATIONS

Use in accordance with the standard Worldwide Marine Specifications.
All surfaces to be coated should be clean, dry and free from contamination.
High pressure fresh water wash or fresh water wash, as appropriate, and remove all oil or grease, soluble contaminants and other foreign matter in accordance with SSPC-SP1 solvent cleaning.

NEWBUILDING/MAJOR REFURBISHMENT

Interfine 979SG should always be applied over a recommended primer coating scheme. The primer surface should be dry and free from all contamination, and Interfine 979SG must be applied within the overcoating intervals specified (consult the relevant product data sheet).
Areas of breakdown, damage etc. should be prepared to the specified standard (eg. Sa2½ (ISO 8501-1:2007)) and primed prior to the application of Interfine 979SG.

Consult your International Paint representative for specific recommendations.

NOTE

For use in Marine situations in North America, the following surface preparation standards can be used: SSPC-SP10 in place of Sa2½ (ISO 8501-1:2007)

APPLICATION

Mixing	Material is supplied in two containers as a unit. Always mix a complete unit in the portions supplied. Once the unit has been mixed it must be used within the working pot life specified. (1) Agitate Base (Part A) with power agitator. (2) Combine entire contents of Curing Agent (Part B) with Base (Part A) and mix thoroughly with power agitator. After mixing Part A and Part B a slight exotherm may be noted, which is typical of this product, and is a result of chemical reaction.
Thinner	International GTA007. Do not thin more than allowed by local environmental legislation.
Airless Spray	Recommended Tip Range 11-21 thou (0.28-0.53 mm) Total output fluid pressure at spray tip not less than 2200 psi (155 kg/cm²)
Conventional Spray	Recommended. Gun DeVilbiss MCB or JGA Air Cap 704 or 765 Fluid Tip E
Brush	Application by brush is recommended for small areas only. Multiple coats may be required to achieve specified film thickness. When brush applied, an induction time of 5 minutes is required to promote best color formation properties.
Roller	Application by roller is recommended for small areas only. Multiple coats may be required to achieve specified film thickness. When roller applied, an induction time of 5 minutes is required to promote best color formation properties.
Cleaner	International GTA007
Work Stoppages and Cleanup	Do not allow material to remain in hoses, gun or spray equipment. Thoroughly flush all equipment with International GTA007. Once units of paint have been mixed they should not be resealed and it is advised that after prolonged stoppages work recommences with freshly mixed units. Clean all equipment immediately after use with International GTA007. It is good working practice to periodically flush out spray equipment during the course of the working day. Frequency of cleaning will depend upon amount sprayed, temperature and elapsed time, including any delays. Do not exceed pot life limitations. All surplus materials and empty containers should be disposed of in accordance with appropriate regional regulations/legislation.
Welding	In the event welding or flame cutting is performed on metal coated with this product, dust and fumes will be emitted which will require the use of appropriate personal protective equipment and adequate local exhaust ventilation. In North America do so in accordance with instruction in ANSI/ASC Z49.1 "Safety in Welding and Cutting."

SAFETY

All work involving the application and use of this product should be performed in compliance with all relevant national Health, Safety & Environmental standards and regulations.

Prior to use, obtain, consult and follow the Material Safety Data Sheet for this product concerning health and safety information. Read and follow all precautionary notices on the Material Safety Data Sheet and container labels. If you do not fully understand these warnings and instructions or if you can not strictly comply with them, do not use this product. Proper ventilation and protective measures must be provided during application and drying to keep solvent vapor concentrations within safe limits and to protect against toxic or oxygen deficient hazards. Take precautions to avoid skin and eye contact (ie. gloves, goggles, face masks, barrier creams etc.) Actual safety measures are dependant on application methods and work environment.
EMERGENCY CONTACT NUMBERS:
USA/Canada - Medical Advisory Number 1-800-854-6813
Europe - Contact (44) 191 4696111. For advice to Doctors & Hospitals only contact (44) 207 6359191
R.O.W. - Contact Regional Office

LIMITATIONS

Overcoating information is given for guidance only and is subject to regional variation depending upon local climate and environmental conditions. Consult your local International Paint representative for specific recommendations. The optimum curing conditions for Interfine 979SG are between 40% and 85%, curing times may vary outside these parameters.
Apply in good weather. Temperature of the surface to be coated must be at least 5°F above the dew point. For optimum application properties bring the material to 70°F-81°F, unless specifically instructed otherwise, prior to mixing and application. Unmixed material (in closed containers) should be maintained in protected storage in accordance with information given in the STORAGE Section of this data sheet. Technical and application data herein is for the purpose of establishing a general guideline of the coating application procedures. Test performance results were obtained in a controlled laboratory environment and International Paint makes no claim that the exhibited published test results, or any other tests, accurately represent results found in all field environments. As application, environmental and design factors can vary significantly, due care should be exercised in the selection, verification of performance and use of the coating.
In the overcoating data section 'ext' = extended overcoating period. Please refer to our Marine Painting Guide - Definitions and Abbreviations available on our website.

UNIT SIZE

Unit Size	Part A		Part B	
	Vol	Pack	Vol	Pack
20 lt	16 lt	20 lt	4 lt	5 lt
5 US gal	4 US gal	5 US gal	1 US gal	1 US gal

For availability of other unit sizes consult International Paint

UNIT SHIPPING WEIGHT

Unit Size	Unit Weight
20 lt	28.7 Kg
5 US gal	58.5 lb

STORAGE

Shelf Life

Part A - 12 months minimum at 77°F.
Part B - 6 months maximum at 77°F.
Subject to reinspection thereafter. Store in dry, shaded conditions away from sources of heat and ignition.

WORLDWIDE AVAILABILITY Consult International Paint.

IMPORTANT NOTE

The information in this data sheet is not intended to be exhaustive; any person using the product for any purpose other than that specifically recommended in this data sheet without first obtaining written confirmation from us as to the suitability of the product for the intended purpose does so at their own risk. All advice given or statements made about the product (whether in this data sheet or otherwise) is correct to the best of our knowledge but we have no control over the quality or the condition of the substrate or the many factors affecting the use and application of the product. Therefore, unless we specifically agree in writing to do so, we do not accept any liability at all for the performance of the product or for (subject to the maximum extent permitted by law) any loss or damage arising out of the use of the product. We hereby disclaim any warranties or representations, express or implied, by operation of law or otherwise, including, without limitation, any implied warranty of merchantability or fitness for a particular purpose. All products supplied and technical advice given are subject to our Conditions of Sale. You should request a copy of this document and review it carefully. The information contained in this data sheet is liable to modification from time to time in the light of experience and our policy of continuous development. It is the user's responsibility to check with their local International Paint representative that this data sheet is current prior to using the product.

This Technical Data Sheet is available on our website at www.international-marine.com or www.international-pc.com, and should be the same as this document. Should there be any discrepancies between this document and the version of the Technical Data Sheet that appears on the website, then the version on the website will take precedence.

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www.international-marine.com

PSX® 700SG

December 2014
Revision of October 2012

DESCRIPTION	Semi-gloss Engineered Siloxane

PRINCIPAL CHARACTERISTICS

- Unique, semi-gloss epoxy siloxane
- Virtually HAPs free, ultra-low VOC
- High durability in challenging environments
- Abrasion resistant
- Resists dirt pickup, easily cleaned
- Can be applied directly to zinc primers as a 2-coat system

COLOR AND GLOSS

Semi-gloss
White, Black, Haze Gray, other Federal Standard colors

Yellow, red, and orange colors will fade faster than other colors due to the replacement of lead-based pigments with lead free pigments in these colors.

BASIC DATA

Volume solids	90% ± 3%
VOC*	0.7 lbs/gal (84 g/L)

* *The mixed and applied coating cure reaction will produce VOC of mixed alcohols. For 100 g/l VOC requirements, a VOC - exempt thinner such as 97-939 may be used as needed.*

Recommended Dry film thickness* (per coat)	4 - 7 mils (100 - 175 microns)

* *When applying more than one coat, it is recommended that the total dry film thickness not exceed 10 mils.*

Theoretical Spread Rate	@ 1 mils dft 1444 ft²/gal @ 5 mils dft 289 ft²/gal
Components	2
Shelf Life	1 years from date of manufacture when stored indoors in the original unopened container. Store product in dry conditions at temperatures of 40-100°F

SURFACE PREPARATION

Coating performance is proportional to the degree of surface preparation.

Steel
- Abrasive blast to SSPC SP-6 or higher with an angular 1.0-3.0 mil as soon as possible to prevent the blasted surface from rusting. Keep moisture, oil, grease, or other organic matter off surface before coating.

  Apply *PSX* 700 as soon as possible to prevent the blasted surface from rusting. Keep moisture, oil, grease, or other organic matter off surface before coating.

  For touch up and repair, power tool cleaning in accordance with SSPC SP-11 is acceptable.

Concrete
- See specific primer

Aged Coatings
- Contact your PPG representative. A test patch of *PSX* 700SG over in-tact clean coating and observation for film defects and adhesion over a period of time may be required, dependent upon the type of coating.
- *PSX* 700SG is compatible over *Amercoat* 450-series

ENVIRONMENTAL CONDITIONS

Ambient temperatures*	32°F to 120°F (0°C to 49°C)

Surface temperature must be at least 5°F above the dew point temperature.

Material temperatures	32°F to 100°F (0°C to 32°C)
Relative humidity	40% minimum

Work area can be artificially humidified by atomized water spray and/or ponding water under the coated structures. After the film is dry-to-touch, a fine mist may be applied over the coating to expedite curing in low humidity environments.

Surface temperature

32°F to 120°F (0°C to 49°C)
Surface temperature must be at least 5°F above dew point temperature.

General air quality

Area should be sheltered from airborne particulates and pollutants. Ensure good ventilation during application and curing. Provide shelter to prevent wind from affecting spray patterns.

INSTRUCTIONS FOR USE

Mixing ratio by volume

4 parts base to 1 part hardener
Only mix full kits. Pre-mix base component with a pneumatic air mixing at moderate speeds to homogenize the container. Pour in the hardener component and power agitate until thoroughly mixed.

Pot life

Temperature	50°F	70°F	90°F
PSX 700SG	6.5 hours	4 hours	1.5 hours

Airless spray

Standard airless spray equipment, 30:1 pump or larger, x.015 – x.017 fluid tip recommended

Air spray

Thin up to 10%, standard conventional equipment, 0.070" fluid orifice. A moisture and oil trap in the main line is recommended. Separate regulators for air and fluid pressure are recommended. Use an agitated pressure pot.

Brush & roll

Use a well loaded, high quality natural bristle brush. Maintain a wet edge.
Use a high quality, well loaded, solvent resistant, low nap (1/4"-3/8") roller. *Amercoat* 851 flow control additive may be used to enhance flow and leveling of brush strokes and roller stipple.
Be aware that multiple coats may be required to achieve uniform and sufficient film thickness to provide proper hiding when applying by brush or roller.

Thinner

Amercoat 911, *Amercoat* 101 (recommended for > 90°F)

Cleaning solvent

Amercoat 12 Cleaner or *Amercoat* 911 thinner

Primers

Dimetcote 9-series, *Dimetcote* 21-5, *Dimetcote* 302H, *Amercoat* 68HS, *Amerlock* 2/400, *Amercoat* 370, *Amercoat* 385, *Amercoat* 240, *Amercoat* 235
A mist coat / full coat application technique is required when applying over inorganic zincs to prevent application bubbling. Thin the mist coat up to 15% with *Amercoat* 911 or *Amercoat* 101. Ensure dry spray is removed from the surface.

Safety precautions

For paint and recommended thinners see safety sheet 1430, 1431 and relevant material safety data sheets
This is a solvent borne paint and care should be taken to avoid inhalation of spray mist or vapor as well as contact between the wet paint and exposed skin or eyes.

DRY/CURE TIMES*

PSX 700SG @ 4 mils dft and 40% relative humidity

	32°F	50°F	70°F	90°F
Dry to touch	12 hours	6 hours	3 hours	1.5 hours
Dry through	38 hours	11 hours	6 hours	4 hours
Dry to overcoat*	32 hours	9 hours	4.5 hours	3 hours
Maximum overcoat	unlimited*			

* *Surface must be power washed as needed to remove all surface contaminants. Surface must be clean and dry. When re-coating within 72 hours, solvent wipe the surface with Amercoat 911 thinner prior to application of the second coat.than three times the dry through time.*

PSX 700SG with FD Cure @ 4 mils dft and 40% relative humidity

	32°F	40°F	50°F	70°F	90°F
Dry to touch	9 hours	9 hours	4.5 hours	2 hours	1 hour
Dry through	32 hours	24 hours	8.5 hours	4.5 hours	3 hours
Dry to overcoat*	24 hours	18 hours	7 hours	3 hours	2 hours
Maximum overcoat	unlimited*				

* *Surface must be power washed as needed to remove all surface contaminants. Surface must be clean and dry. When re-coating within 72 hours, solvent wipe the surface with Amercoat 911 thinner prior to application of the second coat.*

PRODUCT QUALIFICATIONS

- SSPC Paint 36 Level 3 Performance
- NFPA Class A Flame Spread
- USDA Incidental Food Contact
- AWWA D102-08

AVAILABILITY

Packaging

Available in 1 gallon and 5 gallon kits

Product codes

PX700SG2	F/S 26270 Haze Gray LSA
PX700SG26	F/S 26173 Ocean Gray
PX700SG210	F/S 26008 Deck Gray
PX700SG3	White
PX700SG9	Black
PX700-B	Hardener component
PX700FD-B	Fast Dry hardener component

Worldwide statement

While it is always the aim of PPG Protective & Marine Coatings to supply the same product on a worldwide basis, slight modification of the product is sometimes necessary to comply with local or national rules/circumstances. Under these circumstances an alternative product data sheet is used.

WARRANTY STATEMENT

PPG warrants (i) its title to the product, (ii) that the quality of the product conforms to PPG's specifications for such product in effect at the time of manufacture and (iii) that the product shall be delivered free of the rightful claim of any third person for infringement of any U.S. patent covering the product.

THESE ARE THE ONLY WARRANTIES THAT PPG MAKES AND ALL OTHER EXPRESS OR IMPLIED WARRANTIES, UNDER STATUTE OR ARISING OTHERWISE IN LAW, FROM A COURSE OF DEALING OR USAGE OF TRADE, INCLUDING WITHOUT LIMITATION, ANY OTHER WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE OR USE, ARE DISCLAIMED BY PPG.

Any claim under this warranty must be made by Buyer to PPG in writing within five (5) days of Buyer's discovery of the claimed defect, but in no event later than the expiration of the applicable shelf life of the product, or one year from the date of the delivery of the product to the Buyer, whichever is earlier. Buyer's failure to notify PPG of such non-conformance as required herein shall bar Buyer from recovery under this warranty.

LIMITATION OF LIABILITY

IN NO EVENT WILL PPG BE LIABLE UNDER ANY THEORY OF RECOVERY (WHETHER BASED ON NEGLIGENCE OF ANY KIND, STRICT LIABILITY OR TORT) FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES IN ANY WAY RELATED TO, ARISING FROM, OR RESULTING FROM ANY USE MADE OF THE PRODUCT.

PSX 700SG

The information in this sheet is intended for guidance only and is based upon laboratory tests that PPG believes to be reliable. PPG may modify the information contained herein at any time as a result of practical experience and continuous product development. All recommendations or suggestions relating to the use of the PPG product, whether in technical documentation, or in response to a specific inquiry, or otherwise, are based on data, which to the best of PPG's knowledge, is reliable. The product and related information is designed for users having the requisite knowledge and industrial skills in the industry and it is the end-user's responsibility to determine the suitability of the product for its own particular use and it shall be deemed that Buyer has done so, as its sole discretion and risk.

PPG has no control over either the quality or condition of the substrate, or the many factors affecting the use and application of the product. Therefore, PPG does not accept any liability arising from any loss, injury or damage resulting from such use or the contents of this information (unless there are written agreements stating otherwise). Variations in the application environment, changes in procedures of use, or extrapolation of data may cause unsatisfactory results.

This sheet supersedes all previous versions and it is the Buyer's responsibility to ensure that this information is current prior to using the product.

Current sheets for all PPG Protective & Marine Coatings Products are maintained at www.ppgpmc.com. The English text of this sheet shall prevail over any translation thereof.

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Protective & Marine Coatings

POLYSILOXANE XLE-80 HAPS FREE
EPOXY SILOXANE

Part A	B80AW650	Haze Gray 26270 LSA
Part B	B80V600	Hardener

Revised: March 8, 2013

Product Information

Product Description

POLYSILOXANE XLE-80 HAPS FREE is a high performance, two-component, high solids epoxy siloxane that combines the properties of both a high performance epoxy and a polyurethane in one coat. Plus, it is free from isocyanates.

- Replaces a two coat epoxy/polyurethane system
- High-gloss, self-priming coating
- High solids, VOC compliant
- Long term color and gloss performance
- Corrosion and chemical resistant

Product Characteristics

Finish:	Semi-Gloss
Color:	Haze Gray 26270 LSA
Volume Solids:	80% ± 2%, mixed
Weight Solids:	86% ± 2%, mixed
VOC (EPA Method 24):	<150 g/L; 1.3 lb/gal, mixed
Mix Ratio:	4:1 by volume

Recommended Spreading Rate per coat:

	Minimum	Maximum
Wet mils	**4.0**	**9.0**
Dry mils	**3.0**	**7.0**
~Coverage sq ft/gal	**180**	**420**
Theoretical coverage **sq ft/gal** @ 1 mil dft	**1280**	

NOTE: Brush or roll application may require multiple coats to achieve maximum film thickness and uniformity of appearance.

Drying Schedule @ 5.0 mils wet @ 50% RH:

	@ 40°F	@ 50°F	@ 77°F	@ 100°F
To touch:	5 hours	2 hours	1 hour	20 minutes
To handle:	20 hours	16 hours	4 hours	2 hours
To recoat:				
minimum:	20 hours	16 hours	4 hours	2 hours
maximum:	14 days	14 days	14 days	7 days
To cure:	10 days	7 days	7 days	7 days

If maximum recoat time is exceeded, abrade surface before recoating.
Drying time is temperature, humidity, and film thickness dependent.

Pot Life:	4 hours @ 77°F
Sweat-in-time:	None required

Shelf Life:	12 months, unopened Store indoors at 40°F to 100°F.
Flash Point:	120°F, PMCC, mixed
Reduction:	Not Recommended
Clean Up:	R6K221 (Exempt solvent) or MEK, R6K10

Recommended Uses

For use on prepared steel surfaces in industrial environments, including:

- Structural steel
- Tank exteriors
- Piping
- Industrial power plants
- Transportation
- Marine
- Conforms to AWWA D102 OCS #5
- Can be applied directly over inorganic zincs
- Qualified to MIL-PRF-24635, Type V, Class 2, Grade B

Performance Characteristics

Substrate*: Steel
Surface Preparation*: SSPC-SP6/NACE 3
System Tested*:
2 cts. Polysiloxane XLE-80 HAPS Free @ 3.0 - 7.0 mils dft/ct
*unless otherwise noted below

Test Name	Test Method	Results
Abrasion Resistance	ASTM D4060, CS17 wheel, 1000 cycles, 1 kg load	80 mg loss
Adhesion	ASTM D4541 / ASTM D3359	1018 psi / 5A
Corrosion Weathering	ASTM D5894, 10 cycles, 3360 hours	Rating 10 per ASTM D714 for Blistering; Rating 10 per ASTM D610 for Rusting
Dry Heat Resistance	ASTM D2485	250°F
Flexibility	ASTM D522, 180° bend, 1/2" mandrel	Passes
Pencil Hardness	ASTM D3363	3H

continued on back

Protective & Marine Coatings

POLYSILOXANE XLE-80 HAPS FREE
EPOXY SILOXANE

PART A	B80AW650	HAZE GRAY 26270 LSA
PART B	B80V600	HARDENER

PRODUCT INFORMATION

RECOMMENDED SYSTEMS

	Dry Film Thickness / ct. Mils
Steel:	
1-2 cts.*Polysiloxane XLE-80 HAPS Free	3.0-7.0
Steel:	
1 ct. Zinc Clad II Plus	2.0-4.0**
1-2 cts. Polysiloxane XLE-80 HAPS Free	3.0-7.0

*One coat acceptable in "light" industrial environments at 5.0-7.0 mils dft

**Other acceptable primers:
- Corothane I GalvaPac Zinc Primer
- Macropoxy 646
- Recoatable Epoxy Primer
- Zinc Clad III HS
- Zinc Clad Primers
- Dura-Plate 235
- Fast Clad Zinc HS
- SeaGuard 5000 HS

Galvanized:	
1 ct. Macropoxy 646	5.0-7.0
1-2 cts. Polysiloxane XLE-80 HAPS Free	3.0-7.0
Aluminum:	
1 ct. Macropoxy 646	5.0-7.0
1-2 cts. Polysiloxane XLE-80 HAPS Free	3.0-7.0
Aluminum:	
1-2 cts. Polysiloxane XLE-80 HAPS Free	3.0-7.0
Masonry:	
1 ct. Kem Cati-Coat	10.0-20.0
1-2 cts. Polysiloxane XLE-80 HAPS Free	3.0-7.0

The systems listed above are representative of the product's use, other systems may be appropriate.

DISCLAIMER

The information and recommendations set forth in this Product Data Sheet are based upon tests conducted by or on behalf of The Sherwin-Williams Company. Such information and recommendations set forth herein are subject to change and pertain to the product offered at the time of publication. Consult your Sherwin-Williams representative to obtain the most recent Product Data Information and Application Bulletin.

SURFACE PREPARATION

Surface must be clean, dry, and in sound condition. Remove all oil, dust, grease, dirt, loose rust, and other foreign material to ensure adequate adhesion.

Refer to product Application Bulletin for detailed surface preparation information.

Minimum recommended surface preparation:

Iron & Steel	
Atmospheric:	SSPC-SP12, WJ-3 (with existing profile) or SSPC-SP 6/NACE 3, 2.0 mil Profile
Galvanized	SSPC-SP1 or blast lightly
Aluminum	SSPC-SP1 or blast lightly
*Masonry	SSPC-SP13/NACE 6, or ICRI No. 310.2, CSP1-3

*Primer required

Surface Preparation Standards

	Condition of Surface	ISO 8501-1 BS7079:A1	Swedish Std. SIS055900	SSPC	NACE
White Metal		Sa 3	Sa 3	SP 5	1
Near White Metal		Sa 2.5	Sa 2.5	SP 10	2
Commercial Blast		Sa 2	Sa 2	SP 6	3
Brush-Off Blast		Sa 1	Sa 1	SP 7	4
Hand Tool Cleaning	Rusted	C St 2	C St 2	SP 2	-
	Pitted & Rusted	D St 2	D St 2	SP 2	-
Power Tool Cleaning	Rusted	C St 3	C St 3	SP 3	-
	Pitted & Rusted	D St 3	D St 3	SP 3	-

TINTING

Tint Part A with Maxitoner Colorant at 100% tint strength. Five minutes minimum mixing on a mechanical shaker is required for complete mixing of color.

APPLICATION CONDITIONS

Temperature (air, surface and material):
40°F minimum, 120°F maximum
At least 5°F above dew point

Relative humidity: 40% minimum, 85% maximum

Refer to product Application Bulletin for detailed application information.

ORDERING INFORMATION

Packaging:	5 gallons mixed
Part A:	1 gallon in a 1 gallon container
	4 gallons in a 5 gallon container
Part B:	1 quart and 1 gallon
Weight per gallon:	10.17 ± 0.2 lb, mixed

SAFETY PRECAUTIONS

Refer to the MSDS sheet before use.

Published technical data and instructions are subject to change without notice. Contact your Sherwin-Williams representative for additional technical data and instructions.

WARRANTY

The Sherwin-Williams Company warrants our products to be free of manufacturing defects in accord with applicable Sherwin-Williams quality control procedures. Liability for products proven defective, if any, is limited to replacement of the defective product or the refund of the purchase price paid for the defective product as determined by Sherwin-Williams. NO OTHER WARRANTY OR GUARANTEE OF ANY KIND IS MADE BY SHERWIN-WILLIAMS, EXPRESSED OR IMPLIED, STATUTORY, BY OPERATION OF LAW OR OTHERWISE, INCLUDING MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

Protective & Marine Coatings

POLYSILOXANE XLE-80 HAPS FREE
EPOXY SILOXANE

PART A	B80AW650	HAZE GRAY 26270 LSA
PART B	B80V600	HARDENER

Revised: March 8, 2013

APPLICATION BULLETIN

SURFACE PREPARATIONS

Surface must be clean, dry, and in sound condition. Remove all oil, dust, grease, dirt, loose rust, and other foreign material to ensure adequate adhesion.

Iron & Steel (atmospheric service)
Remove all oil and grease from surface by Solvent Cleaning per SSPC-SP1. Minimum surface preparation is Ultra High Pressure Water Jetting for Steel per SSPC-SP12/NACE 5, WJ-3 (with existing profile) or SSPC-SP3 Power Tool Clean or SSPC-SP2 Hand Tool Clean. For better performance, use Commercial Blast Cleaning per SSPC-SP6/NACE 3. Blast clean all surfaces using a sharp, angular abrasive for optimum surface profile (2 mils / 50 microns). Coat any bare steel the same day as it is cleaned or before flash rusting occurs.

Aluminum
Remove all oil, grease, dirt, oxide and other foreign material by Solvent Cleaning per SSPC-SP1or blast lightly.

Galvanized Steel
Allow to weather a minimum of six months prior to coating. Solvent Clean per SSPC-SP1 (recommended solvent is VM&P Naphtha) or blast lightly. When weathering is not possible, or the surface has been treated with chromates or silicates, first Solvent Clean per SSPC-SP1 and apply a test patch. Allow paint to dry at least one week before testing adhesion. If adhesion is poor, brush blasting per SSPC-SP7 is necessary to remove these treatments. Rusty galvanizing requires a minimum of Hand Tool Cleaning per SSPC-SP2, prime the area the same day as cleaned.

Concrete and Masonry
For surface preparation, refer to SSPC-SP13/NACE 6, or ICRI No. 310.2, CSP 1-3. Surfaces should be thoroughly clean and dry. Concrete and mortar must be cured at least 28 days @ 75°F (24°C). Remove all loose mortar and foreign material. Surface must be free of laitance, concrete dust, dirt, form release agents, moisture curing membranes, loose cement and hardeners. Fill bug holes, air pockets and other voids with Steel-Seam FT910. Primer required.

Follow the standard methods listed below when applicable:
ASTM D4258 Standard Practice for Cleaning Concrete.
ASTM D4259 Standard Practice for Abrading Concrete.
ASTM D4260 Standard Practice for Etching Concrete.
ASTM F1869 Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete.
SSPC-SP 13/Nace 6 Surface Preparation of Concrete.
ICRI No. 310.2 Concrete Surface Preparation.

Previously Painted Surfaces
If in sound condition, clean the surface of all foreign material. Smooth, hard or glossy coatings and surfaces should be dulled by abrading the surface. Apply a test area, allowing paint to dry one week before testing adhesion. If adhesion is poor, or if this product attacks the previous finish, removal of the previous coating may be necessary. If paint is peeling or badly weathered, clean surface to sound substrate and treat as a new surface as above.

Surface Preparation Standards

	Condition of Surface	ISO 8501-1 BS7079:A1	Swedish Std. SIS055900	SSPC	NACE
White Metal		Sa 3	Sa 3	SP 5	1
Near White Metal		Sa 2.5	Sa 2.5	SP 10	2
Commercial Blast		Sa 2	Sa 2	SP 6	3
Brush-Off Blast		Sa 1	Sa 1	SP 7	4
Hand Tool Cleaning	Rusted	C St 2	C St 2	SP 2	-
	Pitted & Rusted	D St 2	D St 2	SP 2	-
Power Tool Cleaning	Rusted	C St 3	C St 3	SP 3	-
	Pitted & Rusted	D St 3	D St 3	SP 3	-

APPLICATION CONDITIONS

Temperature (air, surface and material):
40°F minimum, 120°F maximum

At least 5°F above dew point

Relative humidity: 40% minimum, 85% maximum

APPLICATION EQUIPMENT

The following is a guide. Changes in pressures and tip sizes may be needed for proper spray characteristics. Always purge spray equipment before use with listed reducer. Any reduction must be compliant with existing VOC regulations and compatible with the existing environmental and application conditions.

Reduction ....Not Recommended

Clean Up ....R6K221 (Exempt solvent) or MEK, R6K10

Airless Spray
Unit................................30:1 pump
Pressure........................2000-2500 psi
Hose..............................3/8" ID
Tip ....015" - .019"
Filter ....60 mesh
Reduction......................Not Recommended

Conventional Spray
Gun ....Binks 95
Tip and needle 66/65
Air cap...........................65 PR
Atomization Pressure.....75-95 psi
Fluid Pressure................12-20 psi
Reduction......................Not Recommended

Brush
Brush.............................Natural bristle
Reduction......................Not Recommended

Roller
Cover ....3/8" woven with solvent resistant core
Reduction......................Not Recommended

If specific application equipment is not listed above, equivalent equipment may be substituted.

continued on back

Protective & Marine Coatings

POLYSILOXANE XLE-80 HAPS FREE
EPOXY SILOXANE

PART A	B80AW650	HAZE GRAY 26270 LSA
PART B	B80V600	HARDENER

APPLICATION BULLETIN

4.69

APPLICATION PROCEDURES

Surface preparation must be completed as indicated.

Mixing Instructions: Mix contents of each component thoroughly with power agitation. Make certain no pigment remains on the bottom of the can. Then combine four parts by volume of Part A with one part by volume of Part B. Thoroughly agitate the mixture with power agitation.

To ensure that no unmixed material remains on the sides or bottom of the cans after mixing, visually observe the container by pouring the material into a separate container.

Apply paint at the recommended film thickness and spreading rate as indicated below:

Recommended Spreading Rate per coat:

	Minimum	Maximum
Wet mils	4.0	9.0
Dry mils	3.0	7.0
~Coverage sq ft/gal	180	420
Theoretical coverage **sq ft/gal** @ 1 mil dft	1280	

NOTE: Brush or roll application may require multiple coats to achieve maximum film thickness and uniformity of appearance.

Drying Schedule @ 5.0 mils wet @ 50% RH:

	@ 40°F	@ 50°F	@ 77°F	@ 100°F
To touch:	5 hours	2 hours	1 hour	20 minutes
To handle:	20 hours	16 hours	4 hours	2 hours
To recoat:				
minimum:	20 hours	16 hours	4 hours	2 hours
maximum:	14 days	14 days	14 days	7 days
To cure:	10 days	7 days	7 days	7 days

If maximum recoat time is exceeded, abrade surface before recoating.

Drying time is temperature, humidity, and film thickness dependent.

Pot Life:	4 hours @ 77°F
Sweat-in-time:	None required

Application of coating above maximum or below minimum recommended spreading rate may adversely affect coating performance.

CLEAN UP INSTRUCTIONS

Clean spills and spatters immediately with R6K221 (Exempt solvent) or MEK, R6K10. Clean tools immediately after use with R6K221 (Exempt solvent) or MEK, R6K10. Follow manufacturer's safety recommendations when using any solvent.

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PERFORMANCE TIPS

Stripe coat all crevices, welds, and sharp angles to prevent early failure in these areas.

When using spray application, use a 50% overlap with each pass of the gun to avoid holidays, bare areas, and pinholes. If necessary, cross spray at a right angle

Spreading rates are calculated on volume solids and do not include an application loss factor due to surface profile, roughness or porosity of the surface, skill and technique of the applicator, method of application, various surface irregularities, material lost during mixing, spillage, overthinning, climatic conditions, and excessive film build.

Do not apply the material beyond recommended pot life.

Do not mix previously catalyzed material with new.

Shelf life is one month after tinting.

In order to avoid blockage of spray equipment, clean equipment before use or before periods of extended downtime with R6K221 (Exempt solvent) or MEK, R6K10.

Refer to Product Information sheet for additional performance characteristics and properties.

SAFETY PRECAUTIONS

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