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Demonstration and Validation of Two-Coat High-Performance Coating System for Steel Structures in Corrosive Environments

Final Report on Project F12-AR06

Brooke A. Divan, Richard G. Lampo, Susan A. Drozd,
Christopher Olaes, and Larry Clark

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Demonstration and Validation of Two-Coat High-Performance Coating System for Steel Structures in Corrosive Environments

Final Report on Project F12-AR06

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Final report

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Under Project F12-AR06, "Two-Coat High-Performance Coating System for Steel Structures in Corrosive Environments"

Abstract

Department of Defense (DoD) installations have many steel structures in the base infrastructure that encounter problems with atmospheric corrosion. Maintenance and repair costs due to the damage from corrosion are costly to the DoD. Paint systems are the first line of defense for protecting structures from the effects of corrosion. These structures are typically painted with the high-performance coating systems that include epoxies and polyurethanes. This demonstration utilized a two-coat high-performance system to achieve performance standards similar to the conventional high-performance three-coat system using zinc primer, while also comparing cost effectiveness. The two-coat high-performance paint system consisted of an epoxy barrier coating and a fluoropolyurethane topcoat. These coatings were applied to selected diesel fuel storage tanks and static lift cranes at Fort Bragg, NC.

The demonstrated two-coat system performed very well over 12 months, and proved to be effective, faster to apply, and more environmentally friendly than the three-coat control system. The project return on investment was calculated to be 7.03. The demonstrated system is recommended for incorporation into applicable DoD guidance for coating steel structures and equipment in atmospheric exposure.

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Contents

| | |
|---|-------------|
| Abstract | ii |
| Figures and Tables | v |
| Preface | vi |
| Executive Summary | vii |
| Unit Conversion Factors | viii |
| 1 Introduction | 1 |
| 1.1 Problem statement..... | 1 |
| 1.2 Objective..... | 1 |
| 1.3 Approach..... | 2 |
| 1.4 Metrics..... | 2 |
| 2 Technical Investigation | 3 |
| 2.1 Technology overview..... | 3 |
| 2.2 Application..... | 4 |
| 2.3 Performance monitoring..... | 10 |
| 3 Discussion | 14 |
| 3.1 Results..... | 14 |
| 3.1.1 Six-month inspection..... | 14 |
| 3.1.2 Twelve-month inspection..... | 15 |
| 3.2 Lessons learned..... | 16 |
| 4 Economic Summary | 17 |
| 4.1 Costs and assumptions..... | 17 |
| 4.1.1 Costs for smaller jobs (less than 200 gallons of paint)..... | 17 |
| 4.1.2 Costs for larger jobs (more than 200 gallons of paint)..... | 18 |
| 4.2 Projected return on investment (ROI)..... | 20 |
| 5 Conclusions and Recommendations | 22 |
| 5.1 Conclusions..... | 22 |
| 5.2 Recommendations..... | 22 |
| 5.2.1 Applicability..... | 22 |
| 5.2.2 Implementation..... | 23 |
| 5.2.3 Further study..... | 23 |
| References | 24 |
| Appendix A: Six-Month Evaluation of Two-Coat High-Performance Coating System | 25 |

| | |
|--|-----------|
| Appendix B: Twelve-Month Evaluation of Two-Coat High-Performance Coating System | 34 |
| Appendix C: Technical Data Sheets and MSDS for Two-Coat High-Performance Coating System | 41 |
| Report Documentation Page | |

Figures and Tables

Figures

| | |
|---|----|
| Figure 1. Corroded fuel storage tank. | 5 |
| Figure 2. Corroded jib crane. | 6 |
| Figure 3. Pressure washing. | 6 |
| Figure 4. Hand tool corrosion removal. | 7 |
| Figure 5. Abrasive blasting of jib crane. | 7 |
| Figure 6. Applying epoxy barrier coat. | 9 |
| Figure 7. Finished fuel storage tank at Lift Station 7. | 9 |
| Figure 8. SSPC VIS 1 visual guide and reference photographs to determine level of steel surfaces prepared by dry abrasive blast cleaning. | 10 |
| Figure 9. SSPC VIS 1 comparison with coupon. | 11 |
| Figure 10. Primed coupons. | 11 |
| Figure 11. Scribed coupon. | 12 |
| Figure 12. Scribed coupon after 12-months of exposure. | 12 |

Tables

| | |
|---|----|
| Table 1. Ratings of failure at scribe and unscribed areas in accordance with ASTM D1654. | 14 |
| Table 2. Ratings of failure at scribe and unscribed areas in accordance with ASTM D1654. | 15 |
| Table 3. Breakdown of total project costs. | 17 |
| Table 4. Project field demonstration costs. | 17 |
| Table 5. Comparison of material costs for two-coat and three-coat systems for projects using less than 200 gallons.* | 18 |
| Table 6. Comparison of material costs for two-coat and three-coat systems for projects using more than 200 gallons of paint.* | 19 |
| Table 7. ROI analysis. | 21 |

Preface

This demonstration was performed for the Office of the Secretary of Defense (OSD) under Department of Defense (DoD) Corrosion Control and Prevention Project F12-AR06, “Two-Coat High-Performance Coating System for Steel Structures in Corrosive Environments.” The proponent was the U.S. Army Office of the Assistant Chief of Staff for Installation Management (ACSIM), and the stakeholder was the U.S. Army Installation Management Command (IMCOM). The technical monitors were Mr. Daniel J. Dunmire (OUSD (AT&L) Corrosion), Mr. Bernie Rodriguez (IMPW-E), and Ms. Valerie D. Hines (DAIM-ODF).

The work was performed by the Materials and Structures Branch (CEERD-CFM) of the Facilities Division (CEERD-CF), Engineer Research and Development Center—Construction Engineering Research Laboratory (ERDC-CERL). A portion of this work was performed by, or under the supervision of, Mandaree Enterprise Corporation, Warner Robins, GA. At the time this report was prepared, Ms. Vicki L. Van Blaricum was Chief, CEERD-CFM; Mr. Donald K. Hicks was Chief, CEERD-CF; and Mr. Kurt Kinnevan, CEERD-CZT, was the Technical Director for Adaptive and Resilient Installations. The Deputy Director of ERDC-CERL was Dr. Kirankumar Topudurti, and the Director was Dr. Ilker Adiguzel.

The following Fort Bragg personnel are gratefully acknowledged for their support and assistance in this project:

- Mr. Russell Castillo – Water and Wastewater UP (IMBG-PWB-U)
- Mr. Brannon Richards – Engineer, Old North Utility Systems
- Mr. James Meyers – Electrician, Old North Utility Systems

The Commander of ERDC was COL Jeffrey R. Eckstein, and the Director was Dr. Jeffery P. Holland.

Executive Summary

This OSD Corrosion Prevention and Control project demonstrated the use of a two-coat high-performance system for corrosion protection of steel infrastructure. The objective of this project is to show that savings can be realized by reducing labor and the time required for its application versus the traditional three-coat zinc primer system. The elimination of the application time and curing time of the intermediate coat of the three-coat zinc primer paint system should be significant. The coatings were manufactured by Premier Coating Systems, Inc. of Jacksonville, FL. The coating system utilizes off-the-shelf paint specifically designed for exterior use that has been formulated to prevent corrosion and to be long lasting. The Fort Bragg Directorate of Public Works (DPW) support contractor, Old North Utility Systems, contracted the preparation and application of the coatings on the fuel tanks and cranes to a subcontractor. Some of the tanks and cranes that were in better condition were scuff sanded and repaired, then over coated, and the others were abrasive blasted and repainted.

The performance of this coating system is compared to the epoxy polyamide system that currently exists in Unified Facilities Guide Specifications (UFGS) 09 97 13.27. The two-coat high-performance coating system showed no deterioration or evidence of corrosion on any of the tanks and cranes that were refinished.

The results of this project demonstrated the benefits for using the two-coat high-performance paint system in selected applications. The 20-year project return on investment was calculated to be 7.03. The coating system requires fewer coats. This will result in significant savings by decreasing the coating project duration. Additionally, this system is much more environmentally friendly with no volatile organic compounds (VOCs) and no zinc content. In areas of environmental concern, this system should be used over the existing system. It is recommended that this paint system be added to the applicable UFGS documents for new construction or structures with a long life span remaining.

Unit Conversion Factors

| Multiply | By | To Obtain |
|-----------------------|---------------|-----------------|
| degrees Fahrenheit | $(F-32)/1.8$ | degrees Celsius |
| feet | 0.3048 | meters |
| gallons (U.S. liquid) | 3.785412 E-03 | cubic meters |
| inches | 0.0254 | meters |
| mils | 0.0254 | millimeters |
| square feet | 0.09290304 | square meters |

1 Introduction

1.1 Problem statement

According to the Herzberg et al. (2007) report on the cost of corrosion to Department of Defense (DoD) facilities and infrastructure, the annual corrosion cost attributable to “General Building Maintenance” is \$627 million. This represents the DoD’s greatest corrosion-related cost. Included in general building maintenance cost is the repair, refurbishment, and replacement of steel infrastructure equipment and structures that degrade due to corrosion. Many of these steel buildings and equipment are traditionally painted with an alkyd enamel or waterborne coating for a top coat. These paint systems are low cost, are usually applied over a red oxide primer, and have only limited durability. They also perform very poorly in corrosive environments when used on steel buildings and equipment. High-value assets (e.g., water towers, bridges) are typically protected with the high-performance three-coat paint system that utilizes an inorganic zinc-rich epoxy primer, epoxy intermediate coat, and polyurethane topcoat that provides superior corrosion protection.

The three-coat paint system that uses an epoxy zinc-rich primer to provide corrosion protection to the substrate steel building, equipment, or facility infrastructure is among the best corrosion-protection paint systems that can be provided. An epoxy intermediate coat is used to seal the porous zinc-rich primer, and a urethane topcoat protects the intermediate coat from ultraviolet (UV) degradation. Use of the intermediate-coat represents a significant but necessary material cost for the three-coat system. Utilizing a two-coat high-performance system should reduce application time and labor costs required for painting and protecting steel infrastructure on U.S. military facilities versus the three-coat system. It could also potentially reduce coating system material costs by eliminating the intermediate coat.

1.2 Objective

The objective of this project was to demonstrate a selected high-performance two-coat paint system and validate its corrosion-protection capabilities and cost benefits as compared with an industry-standard high-performance three-coat system using an organic zinc-rich primer.

1.3 Approach

The site selected for the demonstration was Fort Bragg, NC, and the coatings were applied to equipment supporting the wastewater treatment system. Six diesel fuel storage tanks and two jib cranes that were corroded and located at lift stations within the sewer system were selected to be painted with the two-coat high-performance system. The Fort Bragg Directorate of Public Works (DPW) was responsible for having the equipment prepared and painted. This work was done by their support contractor, Old North Utility Systems, who subcontracted the work. The equipment with the most severe corrosion was sandblasted to bare metal. The remaining areas were spot-prepared using hand tools. The coatings used in this project were provided to the Fort Bragg DPW by ERDC-CERL through a support contractor, MEC Development LLC. (MDV). The coatings used were environmentally preferred over traditional systems (zero VOCs).

1.4 Metrics

The performance assessments of the two-coat high-performance coating system were made at the 6-month and 12-month points, following the coatings application. Performance of the two-coat system was compared to the traditional system in the UFGS with the zinc-rich epoxy primer, epoxy intermediate coat, and the high solids polyurethane topcoat. ASTM D1654 “Standard Test Methods for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments” was the established criteria used for the evaluation of both the exposure coupons and the fuel tanks and jib cranes that were painted. The scribed exposure coupons were evaluated using procedure A, Method 2 of ASTM D1654. The coating on the equipment was evaluated using Procedures B and D of ASTM1654, which reference the use of ASTM D714 and ASTM D610.

SSPC surface preparation standards were used. For areas in decent shape, SSPC SP-3 was used (power-tool cleaning). In more corroded areas, abrasive blasting was done to SSPC SP-10, which is a near white metal blast. SSPC VIS 1 was used as a visual guide for the contractor to gauge the level of surface preparation.

2 Technical Investigation

2.1 Technology overview

The two-coat high-performance coating system is an advanced-technology coating system that combines a 100% solids (zero VOCs) modified epoxy primer barrier coat with a fluoropolyurethane topcoat.

The modified 100% solids epoxy primer barrier coat provides corrosion protection to substrate steels by isolating them from the environment, rather than providing a sacrificial material as the zinc-rich primers do for corrosion protection. To provide corrosion protection, the barrier coat primer must be able to remain intact and resilient through its intended service life to prevent corrosion to the substrate steel. The Premier Coating Systems epoxy barrier coat, PCS #1111, has the capability of high build coating protection in a single coat or in multiple coats. It has good flexibility and elongation for bridging minor cracks or for surfaces that have vibration and/or movement. These qualities are necessary in a barrier coating primer for it to remain intact throughout the coating's service life. The epoxy barrier coat has excellent adhesion, high build capability, and a short cure time that facilitates top coating and shortens the paint process time.

A Premier Coating Systems topcoat, PCS #4300, was used to provide an extended service life for the coating system for this industrial coating application. The topcoat is a two-component fluoropolyurethane that is an exempt solvent-based coating (less than 50 g/l VOC). It is also an aliphatic polyisocyanate-cured paint. The fluorocopolymer has a proven history in applications on many structural and commercial uses. It develops full cure and chemical resistant capabilities in seven days at 70°F. This fluoropolyurethane has an expected service life in excess of 20 years, while providing resistance to UV degradation and corrosion resistance. The coating has excellent impact and abrasion resistance qualities as well.

Technical data sheets and materials safety data sheets (MSDSs) were provided by Premier Coating Systems of Jacksonville, FL, and are included in Appendix C. These sheets provide the chemical makeup of the coatings, including that they are 100% total solids (zero VOCs).

2.2 Application

The two-component high-performance coating system was procured by support contractor MDV from Premier Coating Systems, Inc. and provided to the Fort Bragg DPW contractor, Old North Utility Services (ONUS),¹ which in turn subcontracted the painting process.

The two-component high-performance coating system demonstrated in this project was applied to six fuel storage tanks (e.g., Figure 1) and two jib cranes at Fort Bragg (e.g., Figure 2). The fuel tanks support generators located at sanitary sewer lift stations, and the cranes are also used for support at the lift station sites. For the purpose of this project, two surface preparation processes were used on the fuel tanks and cranes. The first process was to pressure wash only (Figure 3) and then use hand power tools to remove all corrosion to bare metal (Figure 4). The second process was abrasive blasting (Figure 5), utilizing The Society for Protective Coating (SSPC) VIS 1 “Guide and Reference Photographs for Steel Surfaces by Dry Abrasive Blast Cleaning” to determine the level of cleaning. The goal with both processes was to reach SSPC SP 10 “Near White Blast Cleaning.”

¹ A subsidiary of American States Utility Services, Inc. of San Dima, CA.

Figure 1. Corroded fuel storage tank.



Figure 2. Corroded jib crane.



Figure 3. Pressure washing.



Figure 4. Hand tool corrosion removal.



To accomplish the abrasive blasting, temporary containment structures were placed over adjacent buildings and equipment to protect them during the operation, which can be seen in Figure 5. These coverings were then left in place during the painting operations to protect surrounding facilities from paint overspray.

Figure 5. Abrasive blasting of jib crane.



The epoxy barrier coat is a 100% solids coating that is best applied with a plural component spray system. However, it can be mixed and applied with an airless sprayer. When premixed and sprayed with an airless paint system, the pot life is relatively short (90 minutes). To use this technology

on larger structures (jobs over 200 gallons of paint) or on projects where mobilization is more complex and requires more time between mixing and application of the coatings, plural component equipment is required due to the short pot life. Plural component equipment costs at least \$35,000–\$50,000 for a commercial-grade system. By contrast, airless units can be obtained for commercial systems under \$5,000. Additionally, plural component application requires a higher-skilled, properly certified worker for coating application, which significantly increases the cost of labor. The SSSPC offers a hands-on skills workshop titled “Plural Component Application for Polyureas and High Solid Coatings” that should be required of all persons using the plural component equipment. The cost of the training is \$795 for the 2-day class for non-members and \$595 for members. For certification, the students must pass a written exam. This certification should be included as a contract requirement to ensure the coating is properly applied.

For this project, however, the tanks and cranes were not large enough to need the plural component equipment, and the equipment could be painted within the short pot life.

The A and B components of the epoxy barrier coat in the two-coat high-performance paint system require mechanical agitation prior to mixing due the high viscosity of the coatings. The two components of the epoxy are mixed at a 1:1 ratio, and then they require mechanical agitation for 3–5 minutes. Once mixed, the coating must be applied immediately due to the short pot life (Figure 6). As stated previously, the small size of the fuel tanks and cranes allowed them to be painted within the pot life of the coating.

Figure 6. Applying epoxy barrier coat.



The fluoropolyurethane topcoat is designed for spray application and with both component A and B mixed, the topcoat has a low viscosity for conventional or HVLP (high volume low pressure) spray application. The topcoat is mixed at a 7:1 ratio of base component A to activator component B. Component A should be agitated prior to mixing. This coating is designed to be a multiple-coat finish application to achieve the required dry film thickness. The coating went on well and produced an excellent finish (Figure 7). While fewer coats means quicker application and less down time, it also reduces the amount of times the structure is coated, providing less chance for tight or hard-to-reach areas to be coated. In general, applying more coats leads to better, more uniform coating of a structure.

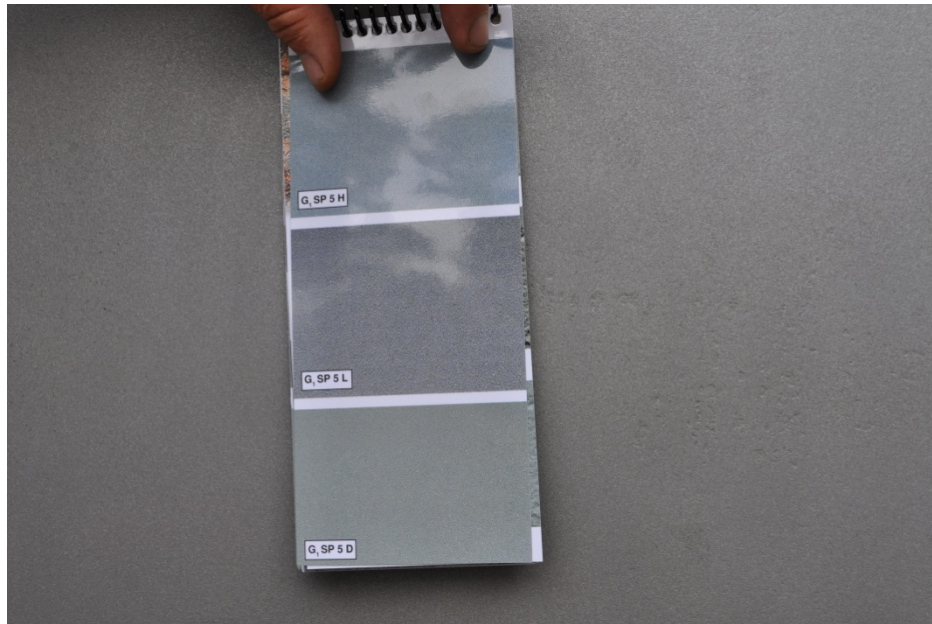
Figure 7. Finished fuel storage tank at Lift Station 7.



2.3 Performance monitoring

Preparation for painting was monitored to insure all tanks and cranes were thoroughly pressure washed. Tanks which did not receive abrasive blasting had all corrosion removed with hand power tools. The remaining tanks and all cranes were abrasive blasted, and the blasting was evaluated using SSPC VIS 1 (Figure 8) to ensure the surfaces were properly prepared and free of corrosion. The visual standard in the image below is a guide for contractors to use to determine if the level of desired surface preparation has been achieved. For this work, all surfaces were hand power tool cleaned or abrasive blasted to SSPC SP 10.

Figure 8. SSPC VIS 1 visual guide and reference photographs to determine level of steel surfaces prepared by dry abrasive blast cleaning.



When all tanks and cranes were painted, the contractor prepared 3 x 6 in. cold-rolled steel coupons for field evaluation. The coupons were abrasive blasted to SSPC SP 10 (Figure 9). The coupons were then painted with the two-coat high-performance paint system (Figure 10). Three coupons were primed and scribed (Figure 11) and placed on an exposure test rack at Fort Bragg for evaluation per ASTM Test Method D1645 at 6 and 12 months (Figure 12).

Figure 9. SSPC VIS 1 comparison with coupon.

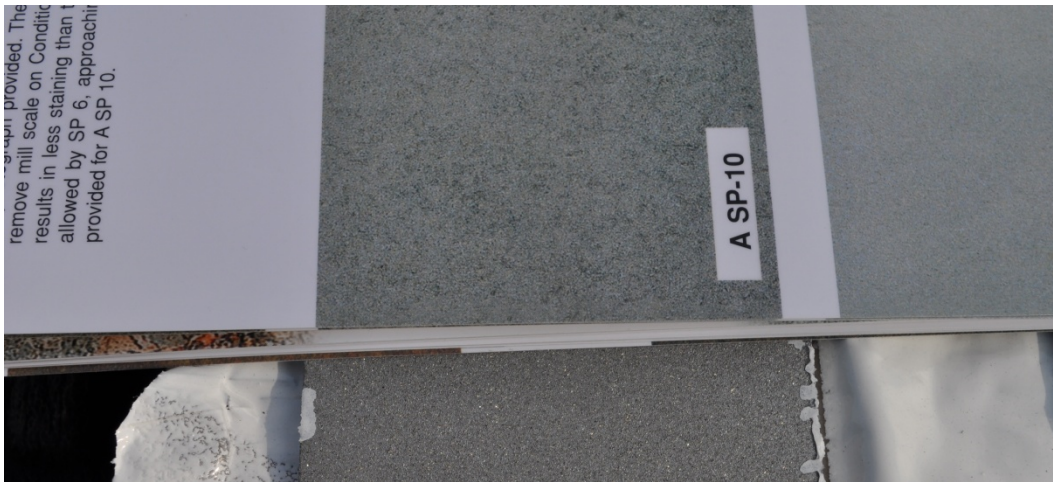


Figure 10. Primed coupons.



Figure 11. Scribed coupon.



Figure 12. Scribed coupon after 12-months of exposure.



At the six-month and twelve-month inspections of the coupons on the exposure rack, all of the fuel storage tanks and jib cranes were also inspected, and the condition of the coating system was assessed on the

equipment. Details and more photographs of the 6-month and 12-month evaluations are in Appendix A and B, respectively.

3 Discussion

3.1 Results

3.1.1 Six-month inspection

The test coupon on the exposure rack was evaluated in accordance with ASTM D1654 on 18 February 2014, with approximately six months of exposure. Prior to exposure, the coupon was scribed and placed on an exposure rack at Fort Bragg, NC. The exposure rack position was 45 degrees from horizontal, facing south. Procedure A, Method 2 was used to evaluate the scribe. The unscribed areas were evaluated using ASTM D1654 Procedure B as well as ASTM D714 and ASTM D610 by reference.

The performance of the coatings on the structures was evaluated in accordance with ASTM D1654, Procedures B and D, as well as ASTM D714 and ASTM D610 by reference.

The results of the evaluation are listed in Table 1. It was observed that no creep existed from the scribed coupons (rating of 10 per ASTM D1654), and there was no failure of the coating in terms of rust or blisters on either the coupon or the structures.

Related photos are shown in Appendix A.

Table 1. Ratings of failure at scribe and unscribed areas in accordance with ASTM D1654.

| Area | ASTM D 1654 | | | | |
|-----------------------|-------------|-------------|-----------|-------------|-----------|
| | Procedure A | Procedure B | | Procedure D | |
| | | ASTM D714 | ASTM D610 | ASTM D714 | ASTM D610 |
| Field Coupon | 10 | 10 | 10 | N/A | N/A |
| Lift Station 1 Tank | N/A | 10 | 10 | 10 | 10 |
| Lift Station 7 Tank | N/A | 10 | 10 | 10 | 10 |
| Lift Station 9 Tank | N/A | 10 | 10 | 10 | 10 |
| Lift Station 6 Tank | N/A | 10 | 10 | 10 | 10 |
| Lift Station 8 Crane | N/A | 10 | 10 | 10 | 10 |
| Lift Station 8 Tank | N/A | 10 | 10 | 10 | 10 |
| Lift Station 11 Crane | N/A | 10 | 10 | 10 | 10 |
| Building C2517 Tank | N/A | 10 | 10 | 10 | 10 |

3.1.2 Twelve-month inspection

The test coupon on the exposure rack was evaluated in accordance with ASTM D1654 on 6 August 2014, with approximately 12 months of exposure. Prior to exposure, the coupon was scribed and placed on an exposure rack at Fort Bragg, NC. The exposure rack position was 45 degrees from horizontal facing south. Procedure A, Method 2 was used to evaluate the scribe. The unscribed areas were evaluated using ASTM D1654 Procedure B as well as ASTM D714 and ASTM D610 by reference.

The performance of the coatings on the structures were evaluated in accordance with ASTM D1654, Procedures B and D as well as ASTM D714 and ASTM D610 by reference.

The results of the evaluation are listed in Table 2. It was observed that approximately 0.5 mm of creepage existed from the scribe on the coupon (rating of 9 per ASTM D1654), and there was no failure of the coating in unscribed areas in terms of rust or blisters on either the coupon or structures.

Related photos are shown in Appendix B.

Table 2. Ratings of failure at scribe and unscribed areas in accordance with ASTM D1654.

| Area | ASTM D 1654 | | | | |
|-----------------------|-------------|-------------|-----------|-------------|-----------|
| | Procedure A | Procedure B | | Procedure D | |
| | | ASTM D714 | ASTM D610 | ASTM D714 | ASTM D610 |
| Field Coupon | 9 | 10 | 10 | N/A | N/A |
| Lift Station 1 Tank | N/A | 10 | 10 | 10 | 10 |
| Lift Station 7 Tank | N/A | 10 | 10 | 10 | 10 |
| Lift Station 9 Tank | N/A | 10 | 10 | 10 | 10 |
| Lift Station 6 Tank | N/A | 10 | 10 | 10 | 10 |
| Lift Station 8 Crane | N/A | 10 | 10 | 10 | 10 |
| Lift Station 8 Tank | N/A | 10 | 10 | 10 | 10 |
| Lift Station 11 Crane | N/A | 10 | 10 | 10 | 10 |
| Building C2517 Tank | N/A | 10 | 10 | 10 | 10 |

3.2 Lessons learned

There were no significant issues or problems involved with the coating of the fuel storage tanks and jib cranes. All sites were not closely located to facilities that would have required special protections or other special measures during abrasive blasting or painting. All work was conducted without incident.

4 Economic Summary

4.1 Costs and assumptions

Total project costs were \$280,900, as shown in Table 3. A rough breakdown of project expenses is presented in Table 4. Note that in the original Project Management Plan (PMP) for Project F12-AR06, the project total was \$510,000. Due to budget constraints, the project's scope was subsequently reduced to the final \$280,900.

Table 3. Breakdown of total project costs.

| Description | Amount, \$K |
|----------------------------------|--------------|
| Labor | 96.1 |
| Contracts | 129.8 |
| Travel | 30 |
| Reporting | 20 |
| Air Force and Navy participation | 5 |
| Total | 280.9 |

The field demonstration contract costs for this CPC project are shown in Table 4.

Table 4. Project field demonstration costs.

| Item | Description | Amount, \$K |
|------|---|--------------|
| 1 | Labor for project management and execution | 73.0 |
| 2 | Travel for project management | 21.0 |
| 3 | Cost for paint and test coupons | 9.9 |
| 4 | Cost of surface preparation and coating application | 25.9 |
| | Total | 129.8 |

4.1.1 Costs for smaller jobs (less than 200 gallons of paint)

A total of six fuel storage tanks and two jib cranes were painted for this project. The cost of the paint was \$7,880, and the contractor cost for preparing and painting the tanks and cranes was \$25,890 (labor and materials other than paint) for a total of \$33,770. There was considerable size variation between the tanks and cranes, which did not allow for breaking the costs down by the piece. The cost comparison is between the per-

square-foot materials cost of the demonstrated paint system and the organic zinc primer three-coat paint system for a small job using 200 gallons or less (Table 5). The demonstrated two-coat system cost \$98 per gallon for the epoxy primer and \$230 per gallon for the fluoropolyurethane topcoat. The three-coat system cost would have been \$89 per gallon for MIL-DTL-24441C Formula 159 Type III (zinc primer), \$45 for MIL-DTL-24441/31 Formula 152, Type III (intermediate primer), and \$79 for MIL-PRF-85285e Type II (topcoat).

Table 5. Comparison of material costs for two-coat and three-coat systems for projects using less than 200 gallons.*

| Layer | Demonstrated Two-Coat System | Existing Three-Coat System |
|--------------------------|---|---|
| Base Primer Coat | PCS-#1111 Epoxy Barrier Coating \$98/gallon Cost per square foot: \$0.68 | MIL-DTL-24441/19C, Epoxy Polyamide, Zinc-Rich Primer \$89/gallon Cost per square foot: \$0.59 |
| Intermediate Primer Coat | n/a | MIL-DTL-24441/31, Epoxy Polyamide, White \$45/gallon Cost per square foot: \$0.31 |
| Topcoat | PCS-#4300 Fluoropolyurethane, White \$230/gallon Cost per square foot: \$1.09 | MIL-PRF-85285e, Polyurethane, White \$79/gallon Cost per square foot: \$0.27 |
| | TOTAL SYSTEM Cost per square foot: \$1.77 | TOTAL SYSTEM Cost per square foot: \$1.17 |

*This table includes only the cost of the coating materials, and all numbers were provided by the manufacturer and are calculated to accommodate the blast profile, the required dry film thickness, and 25% waste.

4.1.2 Costs for larger jobs (more than 200 gallons of paint)

Although this demonstration project was relatively small, the two-coat system's material is more cost effective when used on larger projects (over 200 gallons). Table 6 is set up to make the same comparisons as Table 5, but a per-gallon price savings is noted for larger projects using more than 200 gallons of coating. For larger projects, however, the need for plural component spray equipment as well as highly skilled workers to operate it

for the two-coat system would negate any cost benefit (refer to Section 2.2).

Table 6. Comparison of material costs for two-coat and three-coat systems for projects using more than 200 gallons of paint.*

| Layer | Demonstrated Two-Coat System | Existing Three-Coat System |
|--------------------------|---|---|
| Base Primer Coat | PCS-#1111 Epoxy Barrier Coating \$93/gallon Cost per square foot: \$0.64 | MIL-DTL-24441/19C, Epoxy Polyamide, Zinc-Rich Primer \$79/gallon Cost per square foot: \$0.52 |
| Intermediate Primer Coat | | MIL-DTL-24441/31, Epoxy Polyamide, White \$36/gallon Cost per square foot: \$0.25 |
| Topcoat | PCS-#4300 Fluoropolyurethane, White \$220/gallon Cost per square foot: \$1.04 | MIL-PRF-85285e, Polyurethane, White \$69/gallon Cost per square foot: \$0.24 |
| | TOTAL SYSTEM Cost per square foot: \$1.68 | TOTAL SYSTEM Cost per square foot: \$1.01 |

*This table includes only the cost of the coating materials; all numbers were provided by the manufacturer and are calculated to accommodate the blast profile, the required dry film thickness, and with 25% waste.

In comparing these two paint systems, the surface preparation cost would be the same, and the difference in coating application labor cost would involve the need for applying the additional intermediate primer only for the three-coat system. This difference was estimated to be about 15% of the total labor or \$3,000 (total labor being \$20,000). This time savings would increase as the job size increases. Additionally, the new system is significantly more environmentally friendly, making it a better choice in some cases.

Alternative 1 (Baseline Scenario). The baseline costs will consider use of the zinc-rich primer, epoxy intermediate coating, and the urethane topcoat (three-coat system). It is reasonable to assume that the three-coat system (or one equivalent to it being used for corrosion protection of steel tanks and cranes) will be applied annually on 50 small painting projects across the Army. The cost of each application is \$34,099 (\$5,209 for the

coatings, \$5,890 for surface preparation, and \$23,000 labor), or \$1,704,950 total for 50 projects. This Army-wide 50 project painting process will continue for 10 years. After 10 years, the coatings will need maintenance recoating at one-third the initial cost (\$11,366 per job, or \$568,300 total for 50 projects). After year 20, the costs and benefits repeat so no further analysis is needed. These costs are included in the Baseline Costs column of the ROI spreadsheet in Table 7 below. Periodic inspections will be the same for both Alternative 1 and Alternative 2 (below), so their cost is not included.

Alternative 2 (Demonstrated Technology). As stated earlier in this Chapter, the cost for applying the two-coat system that was demonstrated in this project was \$33,770 (\$8,330 for the coatings, \$5,890 for surface preparation, and \$19,550 for labor). This cost is included in the Project Investment Costs, so the cost is not shown in year one of the New System Costs. Starting in Year 2, it is assumed that the demonstrated two-coat system will be used on 50 painting projects Army-wide at a total cost of \$1,688,500. As with the three-coat system, maintenance recoating is performed after 10 years of service at one-third the initial cost. The cost is \$11,257 per job, or \$562,850 for 50 projects. (Note that \$11,257 is shown for Year 11 since only one painting job was completed in Year 1.) These costs are included in the New System Costs column of the ROI spreadsheet in Table 7 below. As in the Baseline Scenario, after Year 20, the costs and the benefits repeat so no further analysis is needed. Costs for inspection are not included because they would be the same for both Alternative 1 and Alternative 2.

4.2 Projected return on investment (ROI)

The return on investment (ROI) for this technology was computed using methods prescribed by Office of Management and Budget (OMB) Circular No. A-94, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*. Comparing the costs and benefits of the two alternatives, the 20-year ROI after implementing the new technology (Alternative 2) is projected to be 7.03 as shown in Table 7.

This ROI calculation is based solely on coating tanks and equipment as was done under this demonstration, which was a relatively small job (less than 200 gallons). The ROI would be expected to increase somewhat if it compared use of the systems on larger steel structures. Intangible environmental benefits for using the zinc-free and low-VOC two-coat system over

the three-coat system were not factored in, nor were benefits of the two-coat system relative to time savings. For certain types and sizes of facilities, the time savings of not having to apply an additional coat could be significant for labor as well as infrastructure downtime and associated costs.

**Table 7. ROI analysis.
Return on Investment Calculation**

| | | | |
|---|------------|------------|-----------|
| Investment Required | | | 280,900 |
| Return on Investment Ratio | 7.03 | Percent | 703% |
| Net Present Value of Costs and Benefits/Savings | 12,028,477 | 14,003,604 | 1,975,128 |

| A Future Year | B Baseline Costs | C Baseline Benefits/Savings | D New System Costs | E New System Benefits/Savings | F Present Value of Costs | G Present Value of Savings | H Total Present Value |
|---------------------|---------------------|-----------------------------------|--------------------------|-------------------------------------|--------------------------------|----------------------------------|-----------------------------|
| 1 | 1,704,950 | | | | | 1,593,446 | 1,593,446 |
| 2 | 1,704,950 | | 1,688,500 | | 1,474,736 | 1,489,103 | 14,367 |
| 3 | 1,704,950 | | 1,688,500 | | 1,378,323 | 1,391,751 | 13,428 |
| 4 | 1,704,950 | | 1,688,500 | | 1,288,157 | 1,300,706 | 12,550 |
| 5 | 1,704,950 | | 1,688,500 | | 1,203,901 | 1,215,629 | 11,729 |
| 6 | 1,704,950 | | 1,688,500 | | 1,125,048 | 1,136,008 | 10,961 |
| 7 | 1,704,950 | | 1,688,500 | | 1,051,429 | 1,061,672 | 10,243 |
| 8 | 1,704,950 | | 1,688,500 | | 982,707 | 992,281 | 9,574 |
| 9 | 1,704,950 | | 1,688,500 | | 918,375 | 927,322 | 8,947 |
| 10 | 1,704,950 | | 1,688,500 | | 858,265 | 866,626 | 8,362 |
| 11 | 568,300 | | 11,257 | | 5,348 | 269,999 | 264,651 |
| 12 | 568,300 | | 562,850 | | 249,905 | 252,325 | 2,420 |
| 13 | 568,300 | | 562,850 | | 233,583 | 235,845 | 2,262 |
| 14 | 568,300 | | 562,850 | | 218,273 | 220,387 | 2,114 |
| 15 | 568,300 | | 562,850 | | 203,977 | 205,952 | 1,975 |
| 16 | 568,300 | | 562,850 | | 190,637 | 192,483 | 1,846 |
| 17 | 568,300 | | 562,850 | | 178,198 | 179,924 | 1,725 |
| 18 | 568,300 | | 562,850 | | 166,547 | 168,160 | 1,613 |
| 19 | 568,300 | | 562,850 | | 155,628 | 157,135 | 1,507 |
| 20 | 568,300 | | 562,850 | | 145,440 | 146,849 | 1,408 |
| 21 | | | | | | | |
| 22 | | | | | | | |
| 23 | | | | | | | |
| 24 | | | | | | | |
| 25 | | | | | | | |
| 26 | | | | | | | |
| 27 | | | | | | | |
| 28 | | | | | | | |
| 29 | | | | | | | |
| 30 | | | | | | | |

The original ROI estimate (from the original Project PMP) was 9.24. However, that estimate was developed using annual inspection and maintenance/repair costs of \$100,000 per year that were determined to be unrealistic per the executed demonstration project.

5 Conclusions and Recommendations

5.1 Conclusions

The two-coat high-performance paint system used on the fuel storage tanks and jib cranes was easy to apply and eliminated the intermediate coat required when the typical three-coat with zinc-based primer paint system is used. Evaluation of the performance of the paint system showed it was effective in preventing the onset of corrosion and showed no degradation during the monitoring period. The 20-year project return on investment was projected to be 7.03.

Surface preparation and the coating work were done properly and according to schedule. Utilizing this paint system instead of the zinc primer paint system on static equipment and facility infrastructure will reduce both the time and environmental hazard to repaint. It also reduces the paint consumables that are required for accomplishing this work. The projected service life of this environmentally friendly paint system will extend service life of the equipment and infrastructure as well as extend the repaint cycle time. Additionally, the paint system should offer sufficient corrosion protection so that spot corrosion repair would only be necessary instead of complete abrasive blasting for paint and corrosion removal. The paint system also provides for spot corrosion removal and recoat when applying over an existing paint system, something that can't be done with the three-coat zinc-based primer paint system. Any coating containing zinc has trace amounts of other potentially harmful metals such as lead. Removing the zinc from the coating process eliminates any other trace metals that exist with it.

5.2 Recommendations

5.2.1 Applicability

The demonstrated coating system is applicable for specialized requirements, but it is not a recommended replacement for three-coat system currently found in the guidance criteria. Critical high-value steel infrastructure such as water towers and bridges should continue to be maintained using the zinc-based primer three-coat system, because Paint Lab experience and current guidance show that it provides the maximum corrosion protection. However, there is a large amount of steel infrastructure and equipment that would benefit from the excellent performance of the two-

coat high-performance paint system in lieu of the three-coat high-performance paint system. For example, high UV exposures and areas of environmental concern would be good targets for this system.

The assessment performed on this project was not sufficient to base a conclusive determination on the applicability of the two-coat system over the three-coat system, and long-term evaluation and validation would be necessary before a definitive determination of superior performance could be made.

5.2.2 Implementation

The two-coat high-performance paint system should be implemented as one of the choices for a performance-based paint system in UFGS 09 97 13.27, Exterior Coating of Steel Structures. Section 2.2 of the UFGS should be appended to incorporate the two coat system. The two-coat system should not replace the coatings currently in the document, but should appear alongside them. The current zinc system will perform better in highly corrosive or impacted areas due to the galvanic protection. However, it is believed that the fluoropolyurethane topcoat will perform better in high-UV environments. The higher cost of the new system would not be logical for maintenance of older structures nearing the end of their life span, but it would be a logical choice for new construction or in areas of environmental concern.

5.2.3 Further study

It is also recommended that the fluoropolyurethane topcoat of the two-coat high-performance system be further evaluated to determine if it provides a longer service life than the standard MIL-PRF-85285e polyurethane used with the three-coat high-performance paint system. Evaluation of the manufacturer's technical literature industry knowledge on fluoropolyurethane and its performance indicates that it may be superior to the MIL-PRF-85285e as a topcoat for static steel facilities and structures used in military base infrastructure.

References

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Appendix A: Six-Month Evaluation of Two-Coat High-Performance Coating System

A test coupon on the exposure rack was evaluated in accordance with ASTM Test Method D 1654 on 18 February 2014, with approximately six months of exposure. Prior to exposure, the coupon was scribed and placed on an exposure rack at Fort Bragg, NC. The exposure rack is position 45 degrees from horizontal. Procedure A, Method 2 was used to evaluate the scribe. The unscribed areas were evaluated using procedure B which references ASTM D714 and ASTM D610. The performance of the coatings on the structures were evaluated in accordance with ASTM D1654, Procedures B and D. The results of the evaluation are listed in Table A1 and shown in Figures A1–A13. It was observed that no creep existed from the scribed coupons, and there was no failure of the coating in terms of rust or blisters on either the coupon or structures.

Table A1. Ratings of failure at scribed and unscribed areas in accordance with ASTM D1654.

| | ASTM D1654 | | | | |
|-------------------------|-------------|-------------|-----------|-------------|-----------|
| | Procedure A | Procedure B | | Procedure D | |
| | | | ASTM D714 | ASTM D610 | ASTM D714 |
| Coupon | 10 | 10 | 10 | N/A | N/A |
| Lift Station 1 Tank | N/A | 10 | 10 | 10 | 10 |
| Lift Station 7 Tank | N/A | 10 | 10 | 10 | 10 |
| Lift Station 9 Tank | N/A | 10 | 10 | 10 | 10 |
| Lift Station 6 Tank | N/A | 10 | 10 | 10 | 10 |
| Lift Station 8 Crane | N/A | 10 | 10 | 10 | 10 |
| Lift Station 8 Tank | N/A | 10 | 10 | 10 | 10 |
| Lift Station 11 Crane | N/A | 10 | 10 | 10 | 10 |
| Lift Station C2517 Tank | N/A | 10 | 10 | 10 | 10 |

Figure A1. Scrape (top) and scribe (bottom) tools.



Figure A2. Scribed test coupons after 6 months of exposure.

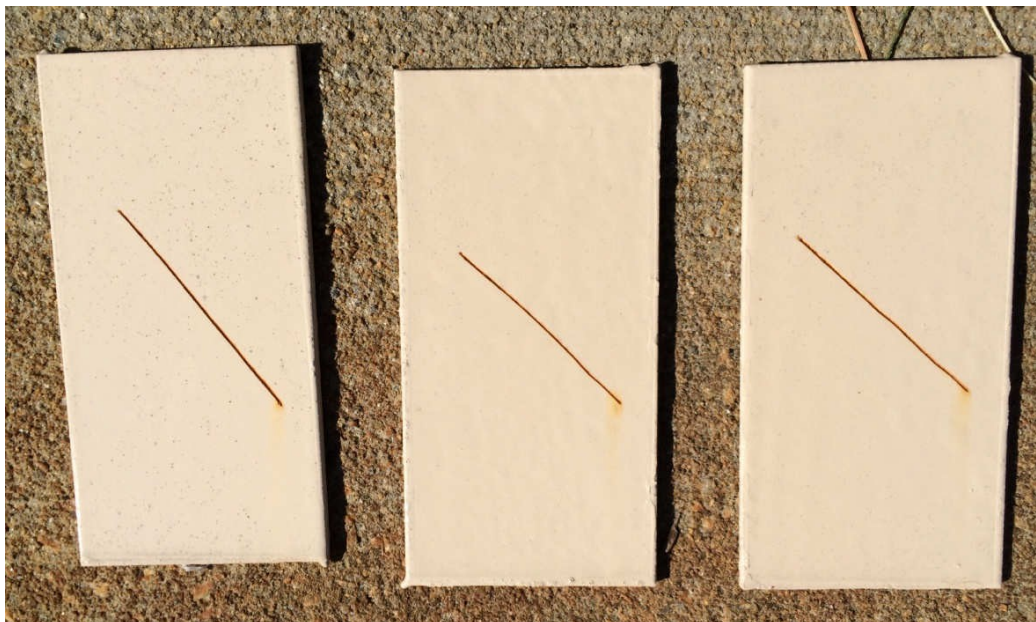


Figure A3. Scribed test coupons prior to exposure.

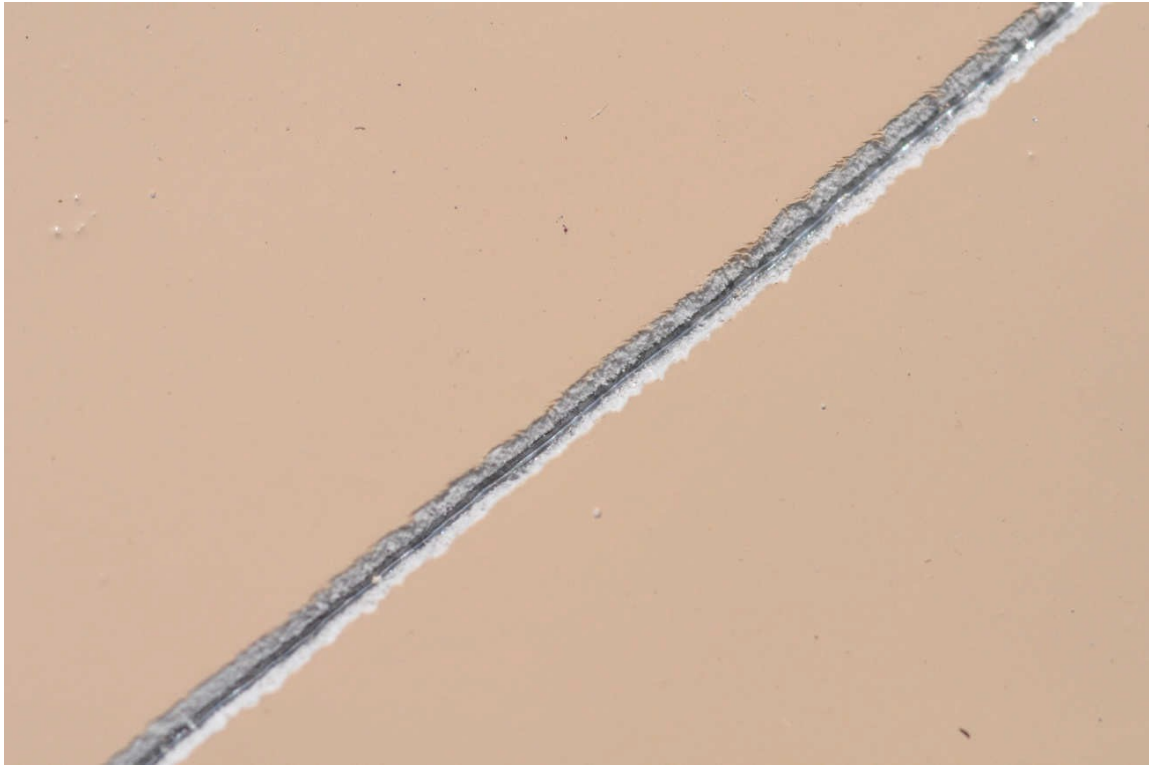


Figure A4. Scribed test coupons after 6 months of exposure, prior to evaluation.

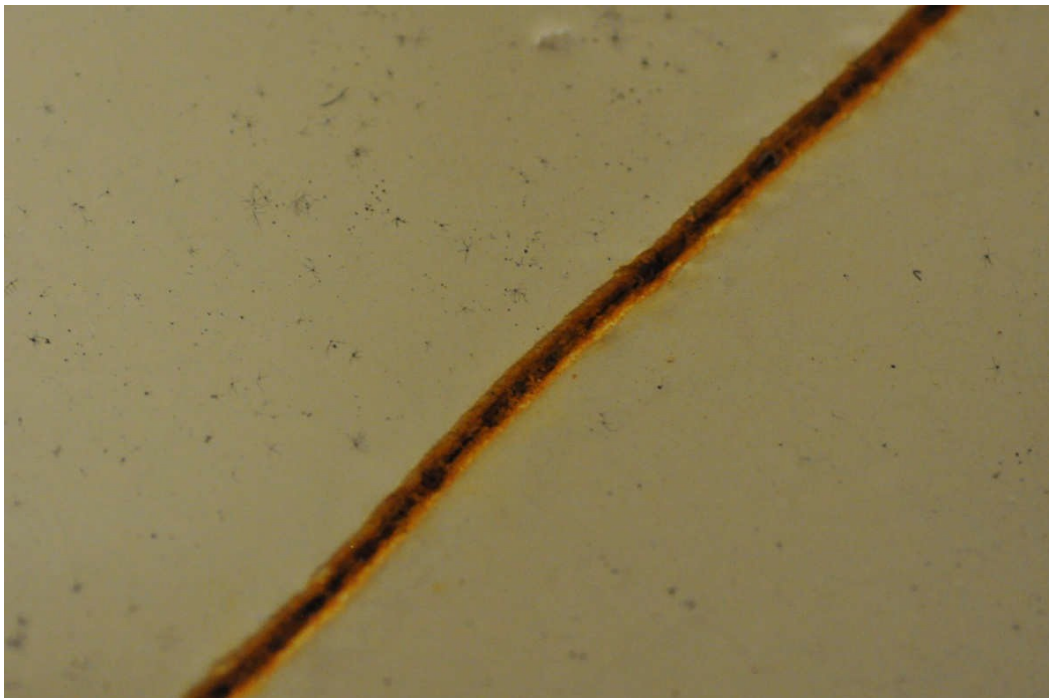


Figure A5. Scribed test coupons after 6 months of exposure, after evaluation.

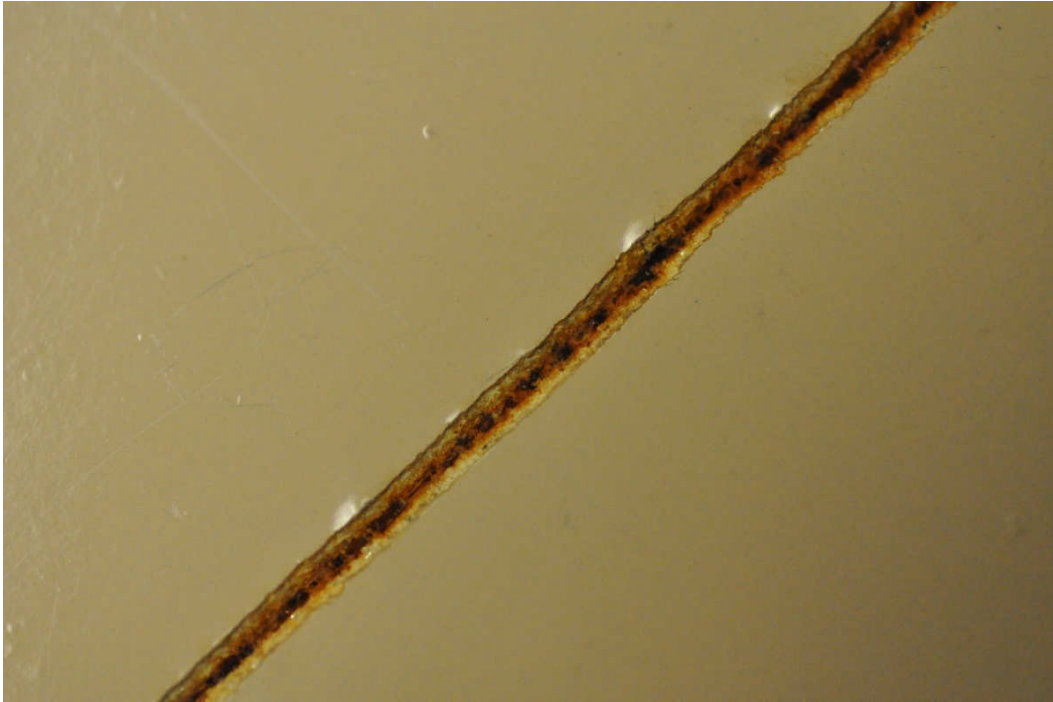


Figure A6. Lift Station 8 fuel tank after 6 months of exposure.



Figure A7. Lift Station 8 crane after 6 months of exposure.



Figure A8. Lift Station C2517 fuel tank after 6 months of exposure.



Figure A9. Lift Station 11 crane after 6 months of exposure.



Figure A10. Lift Station 1 fuel tank after 6 months of exposure.



Figure A11. Lift Station 6 fuel tank after 6 months of exposure.



Figure A12. Lift Station 9 fuel tank after 6 months of exposure.



Figure A13. Lift Station 7 fuel tank after 6 months of exposure.



Appendix B: Twelve-Month Evaluation of Two-Coat High-Performance Coating System

A test coupon on the exposure rack was evaluated in accordance with ASTM Test Method D 1654 on 6 August 2014, with approximately 12 months of exposure. Prior to exposure, the coupon was scribed and placed on an exposure rack at Fort Bragg, NC. The exposure rack was positioned 45 degrees from horizontal. Procedure A, Method 2 was used to evaluate the scribe. The unscribed areas were evaluated using procedure B which references ASTM D714 and ASTM D610. The performance of the coatings on the structures were evaluated in accordance with ASTM D1654, Procedures B and D. The results of the evaluation are listed in Table B1 and Figures B1–B13. It was observed that approximately 0.5 mm of creepage existed from the scribed coupons, and there was no failure of the coating in terms of rust or blisters on either the coupon or structures.

Table B1. Ratings of failure at scribe and unscribed areas in accordance with ASTM D1654.

| Area | ASTM D1654 | | | | |
|-------------------------|-------------|-------------|-----------|-------------|-----------|
| | Procedure A | Procedure B | | Procedure D | |
| | | ASTM D714 | ASTM D610 | ASTM D714 | ASTM D610 |
| Coupon | 9 | 10 | 10 | N/A | N/A |
| Lift Station 1 Tank | N/A | 10 | 10 | 10 | 10 |
| Lift Station 7 Tank | N/A | 10 | 10 | 10 | 10 |
| Lift Station 9 Tank | N/A | 10 | 10 | 10 | 10 |
| Lift Station 6 Tank | N/A | 10 | 10 | 10 | 10 |
| Lift Station 8 Crane | N/A | 10 | 10 | 10 | 10 |
| Lift Station 8 Tank | N/A | 10 | 10 | 10 | 10 |
| Lift Station 11 Crane | N/A | 10 | 10 | 10 | 10 |
| Lift Station C2517 Tank | N/A | 10 | 10 | 10 | 10 |

Figure B1. Scribed test coupons after 12 months of exposure.

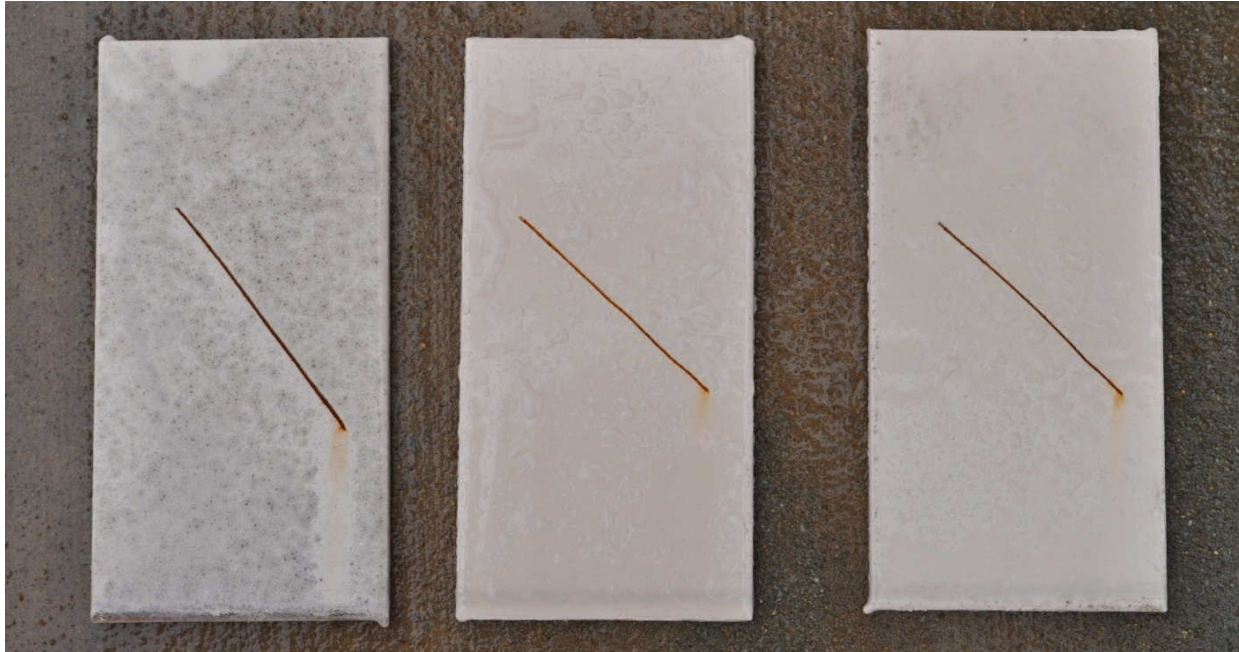


Figure B2. Close-up of scribed test coupon after 12 months of exposure.

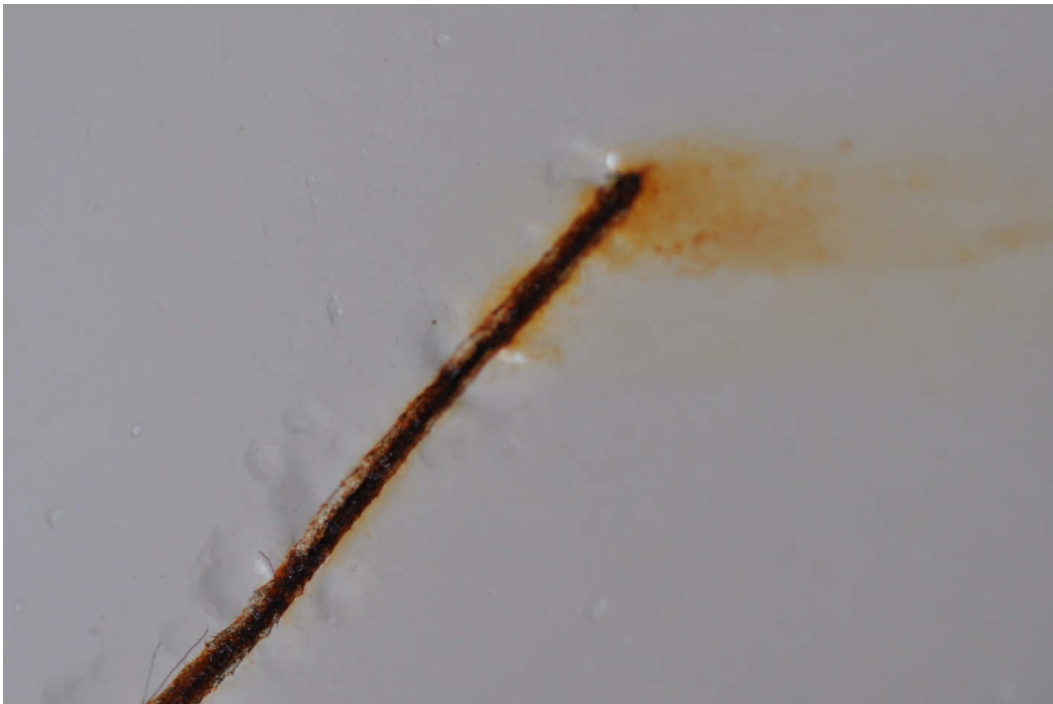


Figure B4. Lift Station 1 fuel tank after 12 months of exposure.



Figure B5. Lift Station 6 fuel tank after 12 months of exposure.



Figure B6. Lift Station 7 fuel tank after 12 months of exposure.



Figure B7. Lift Station 8 fuel tank after 12 months of exposure.



Figure B8. Lift Station 8 jib crane after 12 months of exposure.



Figure B9. Lift Station 9 fuel storage tank after 12 months of exposure.



Figure B10. Lift Station 11 jib crane after 12 months of exposure.



Appendix C: Technical Data Sheets and MSDS for Two-Coat High-Performance Coating System

The following pages include Technical Data Sheets and Materials Safety Data Sheets (MSDS) for the coating products used in the two-coat high-performance system demonstrated with this work. The documents were provided by the manufacturer.



Premier Coating Systems, Inc.

Product Information

(Material Development under CERL Project)

PCS #1111 - EPOXY BARRIER COATING

GENERAL DESCRIPTION

Premier Coating Systems, PCS #1111 Epoxy Barrier Coating is a 100% solids two component, high performance modified epoxy coating which offers high build protection in a single or multiple coat system. PCS #1111 exhibits good flexibility and elongation with exceptional strength for bridging minor cracks or for substrates that have low to moderate vibration and/or movement. It is designed for application to properly prepared or sandblasted steel or concrete and is suitable for interior or exterior surface applications. The reinforcement of this modified epoxy coating with glass flake accompanied with its inherent abrasion resistance, moisture resistance and high solids (literally no VOC) allows PCS #1111 to be a desirable and practical high performance coating system. A topcoat of Urethane is recommended for most exterior applications to extend UV resistance, longevity and performance.

RECOMMENDED USES

Premier Coating Systems, PCS #1111 Epoxy Barrier Coating offers excellent resistance for immersion in fuels, fresh and salt water, detergents, and many chemicals as well as offering good resistance to other industrial fumes and the spillage of most organic solvents, acids and alkalis, consult a representative for your particular need. Typical uses include industrial and commercial application as a protective maintenance coating on bulkheads, miter gates, tainter gates, storage tanks and containment, piping, various structural steel and concrete surfaces, machinery, plant equipment, marine vessels and barges, offshore structures and other surfaces exposed to humidity, fuel, chemicals and corrosive environments.

Typical Product Data:

Volume Solids: 100% ± 0.5%
Weight Solids: 100% ± 0.5%
Mix Ratio: 1 : 1 by Volume
Colors: Green, Off White & Gray (Standard)
 (Other colors available upon request, may be subject to minimum orders)
Weight per gallon:
 9.9 lbs. ± 1% - Part A (Base)
 12.3 lbs. ± 1% - Part B (Activator)
Cure Time @ 75° F:
 Re-coat - Vertical Surfaces 8 Hours or
 Dry to Touch
 (No transfer of wet material upon touch pressure)
 Foot Traffic and/or Service 24 Hour
 Full Cure 7 Days
 (+18°F should decrease the above times by ½)
 (-18°F should increase the above times by ½)
 Re-coat maximum 5 Days
Pot Life: (600 grams @ 70°F) 90 minutes
Viscosity (cPs) #3 Spindle: Mixed 7,600

Physical Properties: 7 Day Cure @75°F (24° C)

(1 - 8 to 10 mil coat)
Tensile Strength, psi, ASTM D2370-98:
 > 600
Elongation % @ Break, ASTM D2370-98:
 50 +
Adhesion, psi (Test Method E), ASTM D4541:
 2,000 +
Direct Impact Resistance in/lbs, ASTM D2794:
 100 +
Hardness, Shore D, ASTM D2240:
 > 35
Taber Abrasion Wear, ASTM D4060:
 20-25 mg/1000 Cycles
Flash Point: > 200° F (93° C)
Shelf Life: 1 Year from DOM

APPLICATION INSTRUCTIONS (PCS-#1111)

Limitations: Apply in good weather when air and surface temperature are above 50°F. For optimum application properties, material should be between 90 to 110°F prior to mixing and application. Maintain unmixed material in closed containers in protected storage at 40 to 100°F.

Surface Preparation: Good surface preparation is essential to a satisfactory coating system. Surfaces to be coated should be clean and dry. Remove all oil, grease, mildew or other contamination by solvent or detergent cleaning or other effective means.

New or Unfinished Surfaces - Ferrous Metal: For best performance, application to abrasive blasted surface is recommended. "Commercial Blast Cleaning" SSPC-SP6 is recommended as the minimum. For immersion service "Near White Blast Cleaning" SSPC-SP10 is considered minimum. Proper blast media and blasting equipment shall be used to produce an average profile depth of 2.5 to 4 mils minimum. Do not reuse abrasive media. Remove blasting dust and grit from surfaces before painting. On previously coated or blasted surfaces a high pressure water wash (10,000 to 40,000 psi) cleaning may achieve surface preparation adequate for application. Allow to dry. Blasted surfaces should be coated within 8 hours after blasting or before contamination of the surface occurs. If blasting or high pressure water washing is not feasible, remove rust by "Hand or Power Tool Cleaning" (SSPC-SP2 or SP3).

Concrete: Must be clean, dry, properly cured (minimum 28 days) and free from all surface contaminants. "Brush Off Blast" (SSPC-SP7) to provide an etched surface and to remove contaminants and laitance. Remove dust before coating. Prime with PCS-#200 Sealer, preferably, or apply PCS #1111 directly to prepared surface. Consult a Technical Representative for recommendation.

Previously Finished Surfaces: Repair all damaged areas. Remove gloss from previous paint by sanding or "Brush Blasting" (SSPC-SP7). Remove rust, heavy corrosion, heavy chalk, loose or peeling paint and any surface contaminants by "Commercial Blast Cleaning" SSPC-SP6 or "Hand or Power Tool Cleaning" (SSPC-SP2 or SP3) or high pressure water wash (10,000 to 40,000 psi) cleaning may achieve surface preparation adequate for application.

NOTE: If doubt exists concerning compatibility or surface preparation methods of this coating with the previous system, apply coating to a representative area (25 square feet minimum) and allow to cure and age several weeks. Then inspect for adhesion failure, wrinkling, lifting, blistering or any other sign of incompatibility, if there are no signs, coating work can proceed.

Mixing: This is a two component coating supplied in two containers as a unit. Always mix a complete unit in the proportions supplied. (1) Mix contents of PCS-#1111 (Component A) thoroughly with a power agitator. (2) Mix contents of PCS-#1111 (Component B) thoroughly with a power agitator. (3) Apply coating with the use of "Plural Component" equipment capable of heating and sustaining temperatures of 110°F - 120°F up until final mix and application.

Hand Mixing for Small or Touch-up Application:

(1) Recommend not to mix more than can be hand applied in 10 to 15 minutes. Mix contents of PCS-#1111 (Component A) thoroughly with a power agitator. (2) Mix contents of PCS-#1111 (Component B) thoroughly with a power agitator. (3) Combine the entire contents of Component A and Component B and mix thoroughly with a power agitator until uniform in consistency and color. Pay special attention to the bottom and sides of the containers to insure complete mixing. Due to the high viscosity of this material, mechanical agitation is preferred. Mix 3 to 5 minutes until uniform in color. Apply immediately. Usable pot life depends on the temperature of the material. "Exothermal Heat" created during the mixing process can considerably shorten the pot life. Mixing Time at 50-100°F thoroughly mix 3 to 5 minutes and apply immediately

Thinning: Material is supplied at application viscosity for specified normal mil requirements.

Application: Plural Component spray application is preferred for proper film build and best performance. Brush application is acceptable for touch up and small areas.

Equipment:

Optimum Airless Spray- Plural Component Equipment

Pump: 75:1 (Graco "Premier")

Heater Capable of maintaining material at 120° F minimum at tip

Fluid Hose: 3/8" I.D. x 100' length max.

(For longer hose, to avoid excessive pressure drop, use 1/2" I.D. up to 200" with 3/8" I.D. x 25' Whip)

Lily Corp. "CD-120 Proportioner" or equal to assure accurate 1:1 mix ratio.

Airless Gun: 207-945 (Graco)

Tips: 0.033" - 0.039"

Note: Minimum pressure, 3000 psi at the nozzle, to avoid fingering

NOTE: During lunch, breaks or any period of work stoppage, material should be removed from hoses and equipment. Release pressure from equipment and flush hoses and equipment with MEK or MIBK. Do not repressurize equipment until ready to resume work.

Cleanup: Clean all equipment immediately after use with MEK or MIBK. Completely flush all spray equipment with this solvent. Occasional flushing of spray equipment during the course of the working day helps prevent buildup and possible clogging.

Safety: Safe storage, handling and use dictate that adequate health and safety precautions are observed with this product and any recommended thinners. User is specifically directed to consult the current Material Safety Data Sheet for this product as well as precautions contained on product labeling.

Notice: The technical data contained herein are true and accurate to the best of our knowledge. All products are offered and sold subject to Premier Coating Systems, Inc., Standard Conditions of Sale. Published technical data and instructions are subject to change without prior notice.

8/12 (PCS-#1111)

Material Safety Data Sheet

{DEVELOPMENTAL MATERIAL - PRELIMINARY M.S.D.S.}

Product Name: **PCS-1111 EPOXY BARRIER COATING, Component B (Activator)**

HMIS Codes: H F R P

Product Code: PCS-1111B

3 1 0 J

----- SECTION I - MANUFACTURER IDENTIFICATION -----

Manufacturer Name: **Premier Coating Systems, Inc.**

Address: **205 Seven Doors Lane, St. Augustine, FL 32095**

Emergency Phone: **(904) 824-1799**

Information Phone: **(904) 824-1799**

Date Revised: **2-20-07**

Name of Preparer: **R. Fake**

Reason Revised: **Revised Respiratory Protection**

--- SECTION II - PRODUCT INGREDIENTS / COMPOSITION / SARA III INFORMATION ---

Occupational Exposure Limits

| Components / Information on Ingredients | CAS Number | OSHA/ PEL | ACGIH/TLV | Other | Vapor Pressure mmHg @ F | Weight Percent |
|---|-------------|----------------------|----------------------|--------------------------|-------------------------|----------------|
| Modified Polysulfide | 686611-50-7 | N/E | N/E | | N/D | 25 - 35 |
| Cycloaliphatic Amine | Mixture | N/E | N/E | | .70 @ 70°F | 30 - 40 |
| Titanium Dioxide | 13463-67-7 | 10 mg/m ³ | 10 mg/m ³ | | N/A | 20 - 30 |
| TRIS-2,4,6-(Dimethylaminomethyl) Phenol | 90-72-2 | N/E | N/E | | <0.01 @ 70°F | 1 - 5 |
| Benzyl Alcohol | 100-51-6 | N/E | N/E | TWA: 10 ppm AIHA WEEL | 13.3 @ 212°F | ** |
| Aromatic Hydrocarbon | 64742-95-6 | 100 ppm | 100 ppm | | 2.0 @ 68°F | ** |
| Non-hazardous & other Ingredients below reportable levels | Proprietary | N/A | N/A | | N/A | Balance |

*Indicates chemical(s) subject to the reporting requirements of section 313 Title III and 40 CFR 372.65 C.

**Indicates - Trace Amount - (Contains less than 1%). [N/A - Not Available; N/D - Not Determined; N/E - Not Established]

----- SECTION III - PHYSICAL/CHEMICAL CHARACTERISTICS -----

Boiling Point: **Not Available**

Specific Gravity (H₂O=1): **1.47**

Vapor Density: **Heavier Than Air**

Evaporation Rate: **Slower Than Ether**

Material VOC: **Approximately - (7 Gram/Liter)**

Coating VOC: **Approximately - (7 Gram/Liter)**

Solubility in Water: **Negligible**

Appearance and Odor: **Slight Off White Viscous Liquid; Mercaptan Odor**

----- SECTION IV - FIRE AND EXPLOSION HAZARD DATA -----

Flash Point: **> 200° F**

Method Used: **PMCC**

Flammable Limits in Air by Volume Lower: **Not Determined** Upper: **Not Determined**

Extinguishing Media: **Dry Chemical Powder, Carbon Dioxide (CO₂), Foam, Water Spray, Sand**

SPECIAL FIREFIGHTING PROCEDURES/EQUIPMENT:

FULL EMERGENCY EQUIPMENT WITH A NIOSH APPROVED POSITIVE PRESSURE SELF-CONTAINED BREATHING APPARATUS (SCBA) AND FULL PROTECTIVE CLOTHING. AVOID SPREADING BURNING LIQUID WITH WATER. FIGHT FIRE FROM SAFE DISTANCE. SHUT OFF ALL POWER TO THE AREA. EMERGENCY LIGHTS MUST BE TURNED ON. COOL CLOSED CONTAINERS WITH WATER SPRAY. DURING EMERGENCY CONDITIONS OVEREXPOSURE TO COMBUSTION OR DECOMPOSITION OF PRODUCTS MAY CAUSE A HEALTH HAZARD. IRRITATING AND HIGHLY TOXIC GASES, SMOKE, SOOT AND FUMES (I.E., CARBON DIOXIDE, CARBON MONOSIDE, ETC.) MAY BE GENERATED DURING COMBUSTION. SYMPTOMS MAY NOT BE IMMEDIATELY APPARENT, OBTAIN MEDICAL ATTENTION, KEEP CONTAINERS TIGHTLY CLOSED, ISOLATE FROM HEAT, SPARKS, AND OPEN FLAME. FIREFIGHTING EQUIPMENT SHOULD BE THOROUGHLY DECONTAMINATED AFTER USE.

UNUSUAL FIRE AND EXPLOSION HAZARDS:

NO UNUSUAL HAZARDS. WATER SPRAY MAY BE INEFFECTIVE. WATER OR FOAM MAY CAUSE FROTHING. IF WATER IS USED, FOG NOZZLES ARE PREFERABLE. WATER MAY BE USED TO COOL CLOSED CONTAINERS TO PREVENT PRESSURE BUILD-UP.

Material Safety Data Sheet

PCS-1111B

Page 2 of 3

SECTION V - REACTIVITY DATA

Stability: Stable under normal conditions and use

Conditions to Avoid: Can react vigorously with Mineral Acids, Alkalis, Organic Acids, Reducing Agents, Oxidizing Agents, Reactive Metals, Sodium or Calcium Hypochlorite. A reaction accompanied by large heat release occurs when the product is mixed with acids. Heat generated may be sufficient to cause vigorous boiling creating a hazard due to splashing or splattering of hot material.

Incompatibility (Material to Avoid): Acids, Oxidizing Agents, Cleaning Solutions Containing Acids

Hazardous Decomposition or Byproducts (from burning, heating, or reaction with other materials): Carbon Monoxide, Carbon Dioxide, Nitrogen Oxides, Nitric Acid in a fire. Ammonia when heated. Irritating and toxic fumes at elevated temperatures. Nitrogen Oxide can react with water vapors to form corrosive nitric acid (TLV=2 ppm).

Hazardous Polymerization: Will not Occur.

SECTION VI - HEALTH HAZARD DATA

Inhalation Health Risks and Symptoms of Exposure: Excessive inhalation can cause irritation of the respiratory tract, characterized by headaches, dizziness, staggering gait, vomiting and confusion.

Skin and Eye Contact Health Risks and Symptoms of Exposure:

Skin: Moderate irritation, defatting, rash, dermatitis. May cause allergic skin reaction and sensitization in some individuals.

Eyes: Severe irritation may cause redness, tearing, blurred vision, may be a sensitization in some individuals.

Ingestion Health Risks and Symptoms of Exposure: Irritating to the mouth, throat and stomach. May cause Gastrointestinal irritation, nausea, vomiting and diarrhea. Aspiration into the lungs during ingestion or vomiting may cause mild to severe pulmonary injury.

Health Hazards (Acute and Chronic): Reports have associated repeated and prolonged occupational overexposure to solvents with permanent brain and nervous system damage. Intentional misuse by deliberately concentrating and inhaling the contents may be harmful or fatal.

Carcinogenicity: ACGIH - No NTP - No IARC Monographs - No OSHA Regulated - No

SECTION VII - EMERGENCY AND FIRST AID PROCEDURES

Inhalation: Remove to fresh air. Administer oxygen if breathing is difficult. Restore breathing if necessary. Treat symptomatically. Consult a physician.

Skin: Wash affected areas with soap and water. Remove and launder contaminated clothing. Consult a physician if needed. Contaminated leather articles, including shoes, cannot be decontaminated and should be destroyed to prevent reuse.

Eyes: Flush immediately with large amounts of water for at least 15 minutes. Take to a physician for medical treatment.

Ingestion: Drink 1 or 2 glasses of water to dilute. Do not induce vomiting. Get medical attention immediately. Never give anything by mouth to an unconscious person.

Note to Physicians: Remove stomach contents by gastric suction if possible. Treatment should be directed at preventing absorption administering to symptoms (if they occur) and providing supportive therapy.

SECTION VIII - TOXICITY INFORMATION

Modified Polysulfide: Possible Skin and Respiratory Sensitizer.

Benzyl Alcohol:

| | |
|-------------------------------------|----------------------------------|
| Eye, Skin irritant. ORAL LD50 (Rat) | 1230-3100 mg/kg (Slightly toxic) |
| DERMAL LD50 (Rabbit) | >2000 mg/kg (Slightly toxic) |

Cycloaliphatic Amine:

Severe Eye and Skin irritant. May cause skin sensitization. Has caused allergic sensitization in humans.

| | |
|----------------------------|-------------------------|
| ACUTE ORAL LD50 (Rat) | >1000 mg/kg (No Deaths) |
| ACUTE DERMAL LD50 (Rabbit) | >2000 mg/kg (No Deaths) |

TRIS-2,4,6-(Dimethylaminomethyl) Phenol:

Severe Eye and Skin irritant. May cause skin sensitization, disorders and allergies.

| | |
|----------------------------|------------|
| ACUTE ORAL LD50 (Rat) | 2169 mg/kg |
| ACUTE DERMAL LD50 (Rabbit) | 1280 mg/kg |

Material Safety Data Sheet

PCS-1111B

Page 3 of 3

----- SECTION IX - PRECAUTIONS FOR SAFE HANDLING AND USE -----

Steps to be Taken in Case Material is Released or Spilled: Remove all sources of ignition (flame, hot surfaces, and electrical, static, or frictional sparks). Safely stop discharge, if possible. Avoid breathing vapors, ventilate area, contain and remove with inert absorbent, clay, sand or other suitable material and non-sparking tools. Use cautious judgment when cleaning up spills. Clean up personnel must be equipped with self-contained breathing apparatus, butyl rubber gloves, protective clothing, boots and eye protection, for large spills.

Waste Disposal Method: Dispose of in accordance with local, state and federal regulations. Incinerate in approved facility. Do not incinerate closed containers. Of the methods of disposal currently available, it is recommended that an alternative be selected according to the following order of preference, based upon environmental acceptability: (1) recycle or rework, if feasible; (2) incinerate at an authorized facility; or (3) treat at an acceptable waste treatment facility. Be sure to contact the appropriate government environmental agencies if further guidance is required.

Precautions to be Taken in Handling and Storage: Do not store above 120°F. Store large quantities only in buildings designed to comply with OSHA 1910.106. Keep closures tight and container upright to prevent leakage. Do not store or use near heat, sparks or flame. Never use pressure to empty. Drum must not be washed out or used for other purposes. Drums of this material should be grounded when in use.

Other Precautions: Do not get in eyes. Avoid skin contact. Can cause allergic respiratory reaction. Prevent prolonged or repeated breathing of vapors or spray mist. Avoid breathing of sanding dust. Wash contaminated clothing thoroughly. Wash skin thoroughly with soap and water after handling. Close container after each use. Do not transfer this product to unlabeled containers. Do not handle until the manufacturer safety precautions have been read and understood. Keep out of the reach of children.

----- SECTION X - CONTROL MEASURES -----

Respiratory Protection: Use an NIOSH-approved respirator to prevent overexposure, when exposure exceeds occupational exposure limits (Section II). Use either an atmosphere-supplying respirator or an air-purifying respirator for organic vapors in compliance with 29 CFR 1910.134, with provision for mist removal if conditions so indicate.

Ventilation: All application areas should be ventilated in accordance to OSHA regulation 29 CFR 1910.107, 1910.108. Remove decomposition products formed during welding or flame cutting on surface coated with this product. If baking vent fumes.

Protective Gloves: Recommended.

Eye Protection: Safety eyewear including splashguards or side shields recommended.

Other Protective Clothing or Equipment: Use protective outerwear and prevent prolonged skin contact with contaminated clothing.

Work/Hygienic Practices: Avoid breathing vapors and contact with skin, if possible. Wash skin thoroughly before breaks and meals and at end of work period.

----- SECTION IX - DISCLAIMER -----

USER: This bulletin cannot be expected to possibly cover all individual situations. The recipients and users of this product must determine that the information is current and suitable for the protection of the environment and the health / safety of the employees in all aspects of their individual operation or application.

DISCLAIMER: The information provided in this MSDS has been obtained from sources believed to be accurate and reliable. It is furnished without warranty of any kind, express or implied regarding the accuracy of this data or the results to be obtained from the use thereof. The manufacturer assumes no responsibility for injury from the use of the product described herein and makes no guarantee of results or assumes no liability for damages incurred by use of this material. Final determination of the suitability of the product is the sole responsibility of the user. The manufacture or its agents make no representations or warranties, expressed or implied, in connection with the use of this product and all implied warranties of merchantability and fitness for a particular purpose are excluded and shall not apply to the goods supplied. It is the responsibility of the user to comply with all applicable federal, state and local laws and regulations.

Material Safety Data Sheet

{DEVELOPMENTAL MATERIAL - PRELIMINARY M.S.D.S.}

Product Name: **PCS-1111 EPOXY BARRIER COATING, Component A (Base)**

HMIS Codes: H F R P

Product Code: PCS-1111A

1 1 0 J

----- SECTION I - MANUFACTURER IDENTIFICATION -----

Manufacturer Name: **Premier Coating Systems, Inc.**

Address: **205 Seven Doors Lane, St. Augustine, FL 32095**

Emergency Phone: **(904) 824-1799**

Information Phone: **(904) 824-1799**

Date Revised: **2-20-07**

Name of Preparer: **R. Fake**

Reason Revised: **Revised Respiratory Protection**

--- SECTION II - PRODUCT INGREDIENTS / COMPOSITION / SARA III INFORMATION ---

Occupational Exposure Limits

| Components / Information on Ingredients | CAS Number | OSHA/ PEL | ACGIH/TLV | Other | Vapor Pressure mmHg @ F | Weight Percent |
|--|-------------|-----------|-----------|-------|-------------------------|----------------|
| Bisphenol F / Epichlorohydrin Epoxy & Phenol Novolac Resin | 028064-14-4 | N/E | N/E | | N/A | 60 - 70 |
| Alkyl (C12-C14) Glycidyl Ether | 68609-97-2 | N/E | N/E | | <0.1 @ 60°F | 10 - 20 |
| Aromatic Hydrocarbon | 64742-95-6 | 100 ppm | 100 ppm | | 2.0 @ 68°F | 1 - 2 |
| *Epichlorohydrin | 106-89-8 | N/E | N/E | | N/A | ** |
| Non-hazardous & other Ingredients below reportable levels | Proprietary | N/A | N/A | | N/A | Balance |

*Indicates chemical(s) subject to the reporting requirements of section 313 Title III and 40 CFR 372.65 C.

**Indicates - Trace Amount - (Contains less than 1%). [N/A - Not Available; N/D - Not Determined; N/E - Not Established]

----- SECTION III - PHYSICAL/CHEMICAL CHARACTERISTICS -----

Boiling Point: **Not Available**

Specific Gravity (H₂O=1): **1.19**

Vapor Density: **Heavier Than Air**

Evaporation Rate: **Slower Than Ether**

Material VOC: **Approximately - (13 Gram/Liter)**

Coating VOC: **Approximately - (13 Gram/Liter)**

Solubility in Water: **Negligible**

Appearance and Odor: **Gray, Blue, or Off White Viscous Liquid; Aromatic Odor**

(Depending on Base Color Ordered)

----- SECTION IV - FIRE AND EXPLOSION HAZARD DATA -----

Flash Point: **> 200° F**

Method Used: **PMCC**

Flammable Limits in Air by Volume

Lower: **Not Determined**

Upper: **Not Determined**

Extinguishing Media: **Foam, Sand, Dry Chemical, Water Spray**

SPECIAL FIREFIGHTING PROCEDURES/EQUIPMENT:

FULL EMERGENCY EQUIPMENT WITH A NIOSH APPROVED POSITIVE PRESSURE SELF-CONTAINED BREATHING APPARATUS (SCBA) AND FULL PROTECTIVE CLOTHING. AVOID SPREADING BURNING LIQUID WITH WATER. FIGHT FIRE FROM SAFE DISTANCE. SHUT OFF ALL POWER TO THE AREA. EMERGENCY LIGHTS MUST BE TURNED ON. COOL CLOSED CONTAINERS WITH WATER SPRAY. DURING EMERGENCY CONDITIONS OVEREXPOSURE TO COMBUSTION OR DECOMPOSITION OF PRODUCTS MAY CAUSE A HEALTH HAZARD. IRRITATING AND HIGHLY TOXIC GASES, SMOKE, SOOT AND FUMES (I.E., CARBON DIOXIDE, CARBON MONOSIDE, ETC.) MAY BE GENERATED DURING COMBUSTION. SYMPTOMS MAY NOT BE IMMEDIATELY APPARENT, OBTAIN MEDICAL ATTENTION, KEEP CONTAINERS TIGHTLY CLOSED, ISOLATE FROM HEAT, SPARKS, AND OPEN FLAME.

UNUSUAL FIRE AND EXPLOSION HAZARDS:

NO UNUSUAL HAZARDS. WATER SPRAY MAY BE INEFFECTIVE. IF WATER IS USED, FOG NOZZLES ARE PREFERABLE. WATER MAY BE USED TO COOL CLOSED CONTAINERS TO PREVENT PRESSURE BUILD-UP.

Material Safety Data Sheet

PCS-1111A

Page 2 of 3

SECTION V - REACTIVITY DATA

Stability: Stable under normal conditions and use

Conditions to Avoid: Can react vigorously with strong oxidizing agents. Strong Lewis or mineral acids and strong mineral and organic bases / especially primary and secondary aliphatic amines.

Incompatibility (Material to Avoid): Oxidizers, Reducers, Strong bases.

Hazardous Decomposition or Byproducts: May produce hazardous fumes when heated to decomposition as in welding.

Hazardous Polymerization: Will not occur.

SECTION VI - HEALTH HAZARD DATA

Inhalation Health Risks and Symptoms of Exposure: Excessive inhalation can cause irritation of the respiratory tract, characterized by headaches, dizziness, staggering gait, vomiting and confusion.

Skin and Eye Contact Health Risks and Symptoms of Exposure:

Skin: Moderate irritation, defatting, dermatitis. May cause allergic skin reaction and sensitization in some individuals.

Eyes: Moderate irritation, may cause redness, tearing, blurred vision, may be a sensitization in some individuals.

Ingestion Health Risks and Symptoms of Exposure: Irritating to the mouth, throat and stomach. May cause gastrointestinal irritation, nausea, vomiting and diarrhea. Aspiration into the lungs during ingestion or vomiting may cause mild to severe pulmonary injury.

Health Hazards (Acute and Chronic): Reports have associated repeated and prolonged occupational overexposure to solvents with permanent brain and nervous system damage. Intentional misuse by deliberately concentrating and inhaling the contents may be harmful or fatal.

Carcinogenicity: ACGIH - **No** NTP - **No** IARC Monographs - **No** OSHA Regulated - **No**

SECTION VII - EMERGENCY AND FIRST AID PROCEDURES

Inhalation: Remove to fresh air. Administer oxygen if breathing is difficult. Restore breathing if necessary. Treat symptomatically. Consult a physician.

Skin: Wash affected areas with soap and water. Remove and launder contaminated clothing. Consult a physician if needed. Contaminated leather articles, including shoes, cannot be decontaminated and should be destroyed to prevent reuse.

Eyes: Flush immediately with large amounts of water for at least 15 minutes. Take to a physician for medical treatment.

Ingestion: Drink 1 or 2 glasses of water to dilute. Do not induce vomiting. Get medical attention immediately.

Note to Physicians: In general, emesis induction is unnecessary in high viscosity, low volatility products, E.G., neat epoxy resins. Treatment should be directed at preventing absorption administering to symptoms (if they occur) and providing supportive therapy.

SECTION VIII - TOXICITY INFORMATION

Bisphenol F / Epichlorohydrin Epoxy & Phenol Novolac Resin:

Eye, Skin and respiratory tract irritant.

Alkyl (C12-C14) Glycidyl Ether: Eye, Skin and respiratory tract irritant.

ACUTE ORAL LD50 (Rat)

>17.0 G/KG

SECTION IX - PRECAUTIONS FOR SAFE HANDLING AND USE

Steps to be Taken in Case Material is Released or Spilled: Remove all sources of ignition (flame, hot surfaces, and electrical, static, or frictional sparks). Safely stop discharge, if possible. Avoid breathing vapors, ventilate area, contain and remove with inert absorbent, clay, sand or other suitable material and non-sparking tools. Use cautious judgment when cleaning up spills. Clean up personnel must be equipped with self-contained breathing apparatus, butyl rubber gloves, protective clothing, boots and eye protection, for large spills.

Material Safety Data Sheet

PCS-1111A

Page 3 of 3

----- SECTION IX - PRECAUTIONS FOR SAFE HANDLING AND USE (Con't) -----

Waste Disposal Method: Dispose of in accordance with local, state and federal regulations. Incinerate in approved facility. Do not incinerate closed containers. Of the methods of disposal currently available, it is recommended that an alternative be selected according to the following order of preference, based upon environmental acceptability: (1) recycle or rework, if feasible; (2) incinerate at an authorized facility; or (3) treat at an acceptable waste treatment facility. Be sure to contact the appropriate government environmental agencies if further guidance is required.

Precautions to be Taken in Handling and Storage: Do not store above 120°F. Store large quantities only in buildings designed to comply with OSHA 1910.106. Keep closures tight and container upright to prevent leakage. Do not store or use near heat, sparks or flame. Never use pressure to empty. Drum must not be washed out or used for other purposes. Drums of this material should be grounded when in use.

Other Precautions: Do not get in eyes. Avoid skin contact. Can cause allergic respiratory reaction. Prevent prolonged or repeated breathing of vapors or spray mist. Avoid breathing of sanding dust. Wash contaminated clothing thoroughly. Wash skin thoroughly with soap and water after handling. Close container after each use. Do not transfer this product to unlabeled containers. Do not handle until the manufacturer safety precautions have been read and understood. Keep out of the reach of children.

----- SECTION X - CONTROL MEASURES -----

Respiratory Protection: Use an NIOSH-approved respirator to prevent overexposure, when exposure exceeds occupational exposure limits (Section II). Use either an atmosphere-supplying respirator or an air-purifying respirator for organic vapors in compliance with 29 CFR 1910.134, with provision for mist removal if conditions so indicate.

Ventilation: All application areas should be ventilated in accordance to OSHA regulation 29 CFR 1910.107, 1910.108. Remove decomposition products formed during welding or flame cutting on surface coated with this product. If baking vent fumes.

Protective Gloves: Recommended.

Eye Protection: Safety eyewear including splashguards or side shields recommended.

Other Protective Clothing or Equipment: Use protective outerwear and prevent prolonged skin contact with contaminated clothing.

Work/Hygienic Practices: Avoid breathing vapors and contact with skin, if possible. Wash skin thoroughly before breaks and meals and at end of work period.

----- SECTION IX - DISCLAIMER -----

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DISCLAIMER: The information provided in this MSDS has been obtained from sources believed to be accurate and reliable. It is furnished without warranty of any kind, express or implied regarding the accuracy of this data or the results to be obtained from the use thereof. The manufacturer assumes no responsibility for injury from the use of the product described herein and makes no guarantee of results or assumes no liability for damages incurred by use of this material. Final determination of the suitability of the product is the sole responsibility of the user. The manufacture or its agents make no representations or warranties, expressed or implied, in connection with the use of this product and all implied warranties of merchantability and fitness for a particular purpose are excluded and shall not apply to the goods supplied. It is the responsibility of the user to comply with all applicable federal, state and local laws and regulations.



Premier Coating Systems, Inc.

Product Information

(Material Development under CERL Project)

PCS-4300 - FPU (FLUOROPOLYURETHANE) PIGMENTED - EXEMPT

Product Description

PCS-4300 Fluoropolyurethane is a two component exempt solvent based (less than 50 g/L VOC) aliphatic polyisocyanate cured polymer coating that may be field applied. This type of technology is currently the ultimate advancement of a very Low VOC thin film application coating system that may be applied to a variety of properly prepared substrates. The fluoro copolymer used in this system was developed over two decades ago and has a proven service history on structural (bridges, towers) and commercial (buildings, skyscrapers) applications for more than 20 years. The finished system displays exceptional moisture, abrasion, impact and corrosion resistance while providing unsurpassed resistance to degradation from UV (ultraviolet) exposure. PCS-4300 Fluoropolyurethane provides incredible weather resistant durability, gloss retention, while allowing application of brilliant colors with outstanding appearance. PCS-4300 Fluoropolyurethane will provide extended service life in Industrial, Marine and Commercial applications with a possible expected life span in excess of 20 years.

Colors & Finishes

White and Colors

(High Gloss, ultimate protection, Semi-Gloss, and Low Sheen available)

A full range of Special Colors is available including Fed. Std. 595B

(All Special Color manufacture is subject to minimum order requirements)

Coverage

PCS-4300 is designed for spray application. Very small touch-ups may be made with an artist brush.

| | |
|------------------------|--|
| Solids Content (±2%) | 42.0% by weight ~ 39.0% by volume, mixed, Colors average |
| VOC | .40 lb. per gallon / 48 grams per liter, mixed, Colors average |
| Flash Point | 109° F / 43.2° C Component "A" - 109° F / 43.2° C Component "B" |
| Required Coats | One normally (minimum 25-50 microns / 1.5 - 2.0 mils DFT), Colors |
| Coverage (theoretical) | 626 sq. ft. / gallon @ 1 mils DFT - unthinned (including no loss factor) |
| | 15.36 m ² / liter @ 25 microns DFT - unthinned (including no loss factor) |
| Coverage (estimated) | 469 sq. ft. / gallon @ 1 mils DFT - unthinned (including 25% waste factor) |
| | 11.52 m ² / liter @ 25 microns DFT - unthinned (including 25% waste factor) |

Pot Life

4 Hours @ 21° C / 70° F

1½ Hours @ 32° C / 90° F

However these times may vary with environmental conditions.

NOTE: This material and its components are moisture sensitive. Any induction of moisture or water into the material prior to or during mixing or application may shorten the pot life drastically. The product should be kept covered at all times after mixing and during application to prevent contamination and limit exposure.

Curing

Dry Time at 21° C / 70° F ambient air cure:

| | |
|------------|---------------|
| To Touch: | 1½ to 2 Hours |
| Dry Hard: | 2½ to 3 Hours |
| Full Cure: | 48 Hours |

Mixing & Thinners

Mixing ratio 7 to 1 by volume (7 parts base component to 1 part activator)

THINNERS: PCS-100 - Thinner

This is a two component material supplied in two separate containers. Part A - Base, and Part B - Activator. Prior to mixing, Component A (base) material should be thoroughly mixed with mechanical agitation and the Component B (activator) should be lightly shook. Pour contents of Component B into Component A while under light agitation and stir well for approximately 3 to 5 minutes to ensure the products are thoroughly mixed. Use immediately. Once completely mixed the PCS-4300 coating is ready to apply, no induction time is required. Minimal field thinning for application should be required. If thinning is required use only the specified thinner and thin to a maximum of 5% by volume.

Premier Coating Systems, Inc.

For Distribution and Technical Information · Phone (904) 824-1799 · Fax (904) 824-0369

Surface Preparation

Good surface preparation and cleaning of the substrate is essential to the performance of the coating system. All surfaces to be coated should be dry, clean and free of all contaminants. For old or previously finished surfaces the degree of cleaning required prior to application is dependent upon the condition of the substrate. Consult your Premier Coating Systems representative for surface preparation required on you specific project.

Ferrous Metal: Abrasive blast to SSPC-SP6 to SSPC-SP 10 ("Commercial Blast" to "Near White Metal Blast") with a surface profile of .5 to 4 mils (15 to 100 microns) should be achieved. Brush, or for best results, Spray apply one coat of Epoxy Barrier Coating or Primer PCS-1111, PCS-EP1150 or PCS-EP1152 (these products require a minimum surface preparation of SSPC-SP 6), over welds, corners and crevices. Spray apply a full coat of chosen primer over entire area to a minimum 2.0 – 10.0 mils DFT (50 – 250 microns) above the blasted surface preparation profile. Allow a minimum 8 hours drying on these applied areas. Apply primer to all areas as soon as possible after blasting but not longer than eight hours. Apply one coat (first coat) of FPC-4300 Color Coat at an average 1.5 – 2.0 mils DFT (37 - 50 microns). If required, specified or desired, apply second coat of FPC-4300 Color Coat at an average 1.5 – 2.0 mils DFT (37 - 50 microns) to obtain a minimum DFT of the Color coats of 1.5 – 4.0 mils DFT.

Concrete: Surface must be clean, dry, properly cured and free from all contaminants. Older surfaces should be "Brush Off Blast" (SSPC-SP 7) to provide an etched surface and to remove contaminants and laitance. Remove all dust before coating. Prime with an Acrylic Block Filler, if surface is extremely porous, or with an Acrylic Primer, if relatively smooth. Allow to dry at least 48 hours. Follow primer with an intermediate coat of Epoxy Coatings of PCS-1111, PCS-EP1150, PCS-EP1152, PCS-EM1102 / PCS-EM1132 or equivalent prior to application of PCS-4300 Fluoropolyurethane as listed under Ferrous Metal.

Fiberglass: Surface must be clean, dry, properly cured and free from all contaminants. Hand or mechanically sand entire surface until smooth and to remove any gloss. Solvent wipe surface with MAK, MIBK, MEK or Acetone, turning rag continuously to remove all sanding dust. Repeat if necessary to assure a clean dry surface. Spray apply 1 or 2 coats of an Epoxy Primer or Intermediate Coat, if surface requires smoothing, followed by application of PCS-4300 Fluoropolyurethane. If surface does not require smoothing, eliminate epoxy coats and apply PCS-4300 Fluoropolyurethane directly to clean dry fiberglass as listed under Ferrous Metal.

Galvanized: Remove all oil and contaminants by solvent wiping. Lightly "Brush Off Blast" (SSPC-SP 7) to dull surface. Do not remove galvanize. Prime with Epoxy Barrier Coating PCS-1111, or Primer PCS-EP1150 or equivalent. Apply PCS-4300 Fluoropolyurethane as listed under Ferrous Metal.

Aluminum: Clean thoroughly and etch with Fluoro component etch such as "LumiBrite" or a phosphoric acid based cleaning solution. Rinse completely and allow to dry. For best results lightly "Brush Off Blast" (SSPC-SP 7) to dull surface. Prime with an Epoxy Barrier Coating, Primer or Intermediate Coat, allow to cure. Apply PCS-4300 Fluoropolyurethane as listed under Ferrous Metal.

Application

PCS-4300 is normally a multiple coat finish designed to be applied over a properly prepared and primed surface to a 3.5 to 15 mils DFT (89 to 381 microns) coating system. PCS-4300 Fluoropolyurethane Coatings are designed for spray application but small areas may be brushed. Use of conventional, airless or HVLP spray is recommended and preferred. Apply this coating system only when the temperature of the ambient air and the receiving surface is between 50° and 90° F (10° to 32° C). For optimum application properties, the temperature of the stored material should be between 60° and 75° F (15° to 24° C) prior to mixing and application. Apply the coatings to ferrous and non-ferrous surfaces only when the surface temperature is more than 5° F (3° C) above the dew point temperature of the surrounding air and the relative humidity must remain below 85%. This 5° F (3° C) differential is necessary to prevent condensation of moisture on the surface.

Storage & Handling

Hazardous Goods: Paint, Flammable Liquid, UN1263, Hazard Class 3, Packing Group III

Shipping Information: Approximately 13.5 lb. (6.1 Kg) per gallon kit, including containers

Flash Point: 109° F / 43.2° C Component "A" - 109° F / 43.2° C Component "B"

Storage - PCS-4300 Fluoropolyurethane Coatings must be stored and handled in compliance with all current local regulations applying to flammable liquids. Store in a cool, dry, protected storage, well ventilated space maintained between 40° to 95° F (5° to 35° C) and out of direct sunlight, moisture or rain. Maintain unmixed materials in sealed containers at all time.

Shelf Life - PCS-4300 Fluoropolyurethane Coatings have a minimum shelf life of 6 months from the date of manufacture if stored as indicated above, unopened in sealed containers. Ensure both components are consistent in appearance and thickness after stirring, and ensure that the activator (Part B) is clear and transparent before mixing the components together.

Do not use activator, which is not visually clear.

Precautions

WARNING: **Harmful or Fatal if Swallowed. Harmful and/or Irritating if Material or Vapors are Absorbed Through Skin. Keep Away From Heat, Open Flame and Sparks. Keep Out of Reach of Children. Use Necessary Safety Equipment, Including Air Fed Respirators if Spraying, Non Sparking Tools, Ladder, Shoes, Explosion Proof Electrical Equipment Meeting National Electrical Standards etc.**

This material is for industrial and commercial use only, requiring professional equipment and experience for safe handling and is not intended for use by the general public. Material Safety Data Sheets (M.S.D.S.) are published and available with it being the responsibility of the purchaser and the applicator to be aware of the information contained therein.

NOTICE

The technical data contained herein are true and accurate to the best of our knowledge. All products are offered and sold subject to Premier Coating Systems, Inc., Standard Conditions of Sale. Published technical data and instructions are subject to change without prior notice. 8/12 (PCS-#4300)

Material Safety Data Sheet

{DEVELOPMENTAL MATERIAL - PRELIMINARY M.S.D.S.}

Product Name: **PCS-4300 FPU (FLUOROPOLYURETHANE)** **COMPONENT A (Base)**
{Gray} HMIS Codes: H F R P
 Product Code: **PCS-4300A** **1 2 1 J**

----- SECTION I - MANUFACTURER IDENTIFICATION -----

Manufacturer Name: **Premier Coating Systems, Inc.**
 Address: **205 Seven Doors Lane, St. Augustine, FL 32095**
 Emergency Phone: **(904) 824-1799** Information Phone: **(904) 824-1799**
 Date Revised: **4-20-10** Name of Preparer: **R. Fake**
 Reason Revised: **Revised Calculations**

----- SECTION II - HAZARDOUS INGREDIENTS/SARA II INFORMATION -----

Occupational Exposure Limits

| Hazardous Components | CAS Number | OSHA/PEL | ACGIH/TLV | Other | Vapor Pressure mmHg @ F | Weight Percent |
|---------------------------------------|------------|----------------------|----------------------|-----------------------|-------------------------|----------------|
| Modified Fluoropolyol Resin | 88795-12-4 | NOT REGULATED | NOT REGULATED | | NOT ESTB | 25 - 35 |
| Benzene, 1-Chloro-4 (Trifluoromethyl) | 98-56-6 | NOT ESTB | NOT ESTB | 25 ppm 8hr TWA (CEL) | 5.3 @ 68F | 50 - 60 |
| Titanium Dioxide | 13463-67-7 | 10 mg/m ³ | 10 mg/m ³ | | N/A | 12 - 20 |
| Methyl N-Amyl Ketone | 110-43-0 | 100 ppm | 50 ppm | | 2.1 @ 68F | 1 - 5 |
| *Xylene | 1330-20-7 | 100 ppm | 100 ppm | 435 mg/m ³ | 6.0 @ 68F | ** |
| Stoddard Solvent | 8052-41-3 | 100 ppm | 100 ppm | | 4.0 @ 68F | ** |
| *Ethyl Benzene | 100-41-4 | 20 ppm | 20 ppm | | 6.86 @ 68F | ** |
| *Dibutyltin Dilauriate | 77-58-7 | NOT ESTB | NOT ESTB | 0.1 mg/m ³ | 0.2 @ 320F | ** |

*Indicates chemical(s) subject to the reporting requirements of section 313 Title III and 40 CFR 372.

**Indicates - Trace Amount - (contains less than <1%).

----- SECTION III - PHYSICAL/CHEMICAL CHARACTERISTICS -----

Boiling Point: **280°F** Specific Gravity (H₂O=1): **1.50**
 Vapor Density: **Heavier Than Air** Evaporation Rate: **Slower Than Ether**
 Material VOC: **.14 Lbs./Gal (17 Grams/Liter)**
 Coating VOC: **.34 Lbs./Gal (41 Grams/Liter)**
 Exempt Volatiles Volume: **Approximately 58%**
 Solubility in Water: **Negligible**
 Appearance and Odor: **Gray Liquid; Naphthalenic Odor**

----- SECTION IV - FIRE AND EXPLOSION HAZARD DATA -----

Flash Point: **109°F (TCC)** Lower: **0.9%** Upper: **10.5%**
 Extinguishing Media: **Dry Chemical, CO₂, Water Spray or Fog, Alcohol-Resistant Foam**

SPECIAL FIREFIGHTING PROCEDURES:

FULL EMERGENCY EQUIPMENT WITH SELF CONTAINED BREATHING APPARATUS AND FULL PROTECTIVE CLOTHING SHOULD BE WORN BY FIREFIGHTERS. AVOID SPREADING BURNING LIQUID WITH WATER. FIGHT FIRE FROM SAFE DISTANCE. SHUT OFF ALL POWER TO THE AREA. EMERGENCY LIGHTS MUST BE TURNED ON. COOL CLOSED CONTAINERS WITH WATER SPRAY. USE POSITIVE PRESSURE SELF-CONTAINED BREATHING APPARATUS (SCBA) EQUIPMENT FOR ENCLOSED AREAS. RISK OF GENERATION OF TOXIC DEGRADATION PRODUCTS SUCH AS HYDROGEN CHLORIDE, HYDROGEN FLUORIDE, CARBONYL FLUORIDE, CARBON MONOXIDE AND CARBON DIOXIDE.

UNUSUAL FIRE AND EXPLOSION HAZARDS:

OSHA/NFPA CLASS 1B FLAMMABLE LIQUID. RELEASES FLAMMABLE VAPORS BELOW NORMAL AMBIENT TEMPERATURES. CLOSED CONTAINER MAY EXPLODE WHEN EXPOSED TO EXTREME HEAT. SOLVENT VAPORS MAY BE HEAVIER THAN AIR. UNDER CONDITIONS OF STAGNANT AIR, VAPORS MAY BUILD UP AND TRAVEL ALONG THE GROUND TO AN IGNITION SOURCE WHICH MAY RESULT IN A FLASH BACK TO THE SOURCE OF THE VAPORS. LIQUID IS IRRITATING TO EYES AND SKIN. "EMPTY" PRODUCT CONTAINERS RETAIN PRODUCT RESIDUE. DO NOT WELD, CUT, OR EXPOSE TO FLAME OR SPARK. THEY MAY EXPLODE, CAUSING INJURY OR DEATH. FLAMMABLE LIQUID. DRIED FILM MAY BURN IN A FIRE.

Material Safety Data Sheet

PCS-4300A

Page 2 of 5

SECTION V - REACTIVITY DATA

Stability: *Stable***Conditions to Avoid:** *Extreme heat, open flames or sparks, depletion of inhibitor and oxygen.***Incompatibility (Material to Avoid):** *Avoid Strong Oxidizing Agents, Reducing Agents and Bases, Plastics, Acids, Alkalie and, Nitrates.***Hazardous Decomposition or Byproducts:** *Chlorine containing gases & Fluorine containing gases can be produced, Carbon Monoxide and Carbon Dioxide.***Hazardous Polymerization:** *Will not Occur.*

SECTION VI - HEALTH HAZARD DATA

Inhalation Health Risks and Symptoms of Exposure: *Anesthetic. Excessive inhalation can cause irritation of the respiratory tract, headaches, dizziness, staggering gait and confusion, CNS depressant..***Skin and Eye Contact Health Risks and Symptoms of Exposure:****Skin:** *Moderate irritation. Repeated or prolonged contact may result in defatting, dermatitis. Not considered a skin sensitizer.***Eyes:** *Moderate irritation, redness, tearing, blurred vision, may be a sensitizer in some individuals.***Ingestion Health Risks and Symptoms of Exposure:** *Not a likely route of exposure. Gastrointestinal irritation, nausea, vomiting and diarrhea. Aspiration into the lungs during ingestion or vomiting may cause mild to severe pulmonary injury and possibly even death.***Health Hazards (Acute and Chronic):** *Reports have associated repeated and prolonged occupational overexposure to solvents with permanent brain and nervous system damage. Intentional misuse by deliberately concentrating and inhaling the contents may be harmful or fatal.***Carcinogenicity:** NTP - *No* IARC Monographs - *No* OSHA Regulated - *No***Medical Conditions Generally Aggravated by Exposure:** *Exposure to petroleum solvents may effect the central nervous system (CNS) and /or aggravate pre-existing CNS disorders. Skin contact may aggravate preexisting dermatitis. This material or its emissions may aggravate pre-existing eye disease.*

SECTION VII - EMERGENCY AND FIRST AID PROCEDURES

Emergency and First Aid Procedures:**Inhalation:** *Remove to fresh air immediately. If breathing is difficult, have trained personnel administer oxygen. Restore breathing if necessary. Treat symptomatically. CONSULT A PHYSICIAN IMMEDIATELY.***Skin:** *Wash affected areas thoroughly with soap and water. Remove and launder contaminated clothing. If irritation occurs, consult a physician.***Eyes:** *Thoroughly flush immediately with large amounts of clean low-pressure water for at least 15 minutes, forcibly holding eyelids apart to ensure complete irrigation of all eye and lid tissue. If irritation persists, consult a physician.***Ingestion:** *DO NOT INDUCE VOMITING. This material is not soluble. DO NOT GIVE FLUIDS. If spontaneous vomiting is inevitable, PREVENT ASPIRATION by keeping the victims head below the knees. GET IMMEDIATE MEDICAL ATTENTION. A qualified physician can perform gastric lavage only when the airway (trachea) has been secured to prevent aspiration.*

Material Safety Data Sheet

PCS-4300A

Page 3 of 5

----- SECTION VIII - TOXICITY INFORMATION -----

Benzene, 1-chloro-4- (trifluoromethyl) 98-56-6: *No appropriate human data is available on the chronic health effects from prolonged or repeated exposure to this material.*

Toxicity

| | | |
|---------------------------|----------|----------------|
| ACUTE ORAL LD50 : | (rat) | >6.8 g/kg |
| ACUTE DERMAL LD50 : | (rabbit) | >2.7 g/kg |
| ACUTE INHALATION LC50 : | (rat) | 4479 ppm |
| PRIMARY SKIN IRRITATION : | (rabbit) | non-irritating |
| PRIMARY EYE IRRITATION : | (rabbit) | non-irritating |

Repeated Dose Toxicity

A 28-day range-finding inhalation study was conducted in male and female Sprague-Dawley rats exposed to 0, 100, 250, 500, or 1000 ppm for 6 hr/day, 5 days/week. Clinical signs included increased activity at 250 ppm and above. Liver and kidney weights were increased. Microscopic changes in male kidneys stained positive for alpha-2-U globulin and the effects were considered not relevant to humans. Liver cell hypertrophy was seen at all exposures in males. Liver changes were consistent with clinical chemistry and PCBTF-blood level analysis and are believed to be an adaptive response, due to increased liver metabolism.

Gavage studies in laboratory rodents for treatment periods of 14, 28, and 90 days have demonstrated significant liver and kidney toxicity at dose levels of 400 - 1000 mg/kg/day. Evidence of target organ toxicity included significant increases in relative liver and kidney weights, clinical chemistry values and histopathological findings. Renal toxicity which occurred only in male rats, was apparently due to "hyaline droplet" nephropathy and is therefore, highly unlikely to develop in man. The NOAEL's for all these studies range from 10 to 100 mg/kg/day.

CNS effects were observed in rats exposed to PCBTF at or above 2822 ppm for 4 hours.

A 90 day(13 week) rat inhalation toxicity and neurobehavioral study was conducted using exposures of 6 hrs/day, 5 days/week at concentrations of 0, 10, 50 and 250 ppm. There were no PCBTF-related macroscopic observations. Microscopically, PCBTF-related centrilobular hypertrophy was present only in the livers of males and females at the high dose (250 ppm) after 13-weeks of exposure. No centrilobular hypertrophy was observed at any level among recovery animals. There were no PCBTF-related effects on the nervous system as measured by a functional observation battery, muscular activity measurements and neuropathology. A NOEL of 50 ppm was established in this study for liver hepatocyte hypertrophy in male and female rats. If the hepatocyte hypertrophy observed is considered to be an adaptive response to PCBTF, the NOAEL for this study is 250ppm.

----- SECTION IX - EMPLOYEE PROTECTION RECOMMENDATIONS -----

Respiratory Protection: *Use an NIOSH-approved respirator to prevent overexposure, when exposure exceeds occupational exposure limits (Section II). Use either an atmosphere-supplying respirator or an air-purifying respirator for organic vapors in compliance with 29 CFT 1910.134 or ANSI Z88.2, with provision for mist removal if conditions so indicate.*

Ventilation: *All application areas should be ventilated in accordance to OSHA regulation 29 CFT 1910.107, 1910.108 to maintain levels of airborne contaminants below exposure limits. Remove decomposition products formed during welding or flame cutting on surface coated with this product. If baking vent fumes.*

Protective Gloves: *Recommended. Chemical resistant such as Butyl Rubber, Nitrile or Teflon.*

Eye Protection: *Safety eyewear including splashguards or side shields recommended.*

Other Protective Clothing or Equipment: *Use protective outerwear, depending on the conditions of use, protective gloves, apron, boots, head and face protection should be worn to prevent prolonged skin contact. The equipment must be cleaned thoroughly after each use.*

Work/Hygienic Practices: *Avoid breathing vapors and contact with skin. Wash skin thoroughly before breaks and meals and at end of work period.*

Material Safety Data Sheet

PCS-4300A

Page 4 of 5

----- SECTION X - PRECAUTIONS FOR SAFE HANDLING AND USE -----

Steps to be Taken in Case Material is Released or Spilled: *Extremely Flammable. Remove all sources of ignition (flame, hot surfaces, and electrical, static, or frictional sparks). All equipment used when handling this product must be grounded. Stop leak if you can do it without risk. A vapor suppressing foam may be used to reduce vapors. Avoid breathing vapors, ventilate area, contain and remove with inert absorbent, dry earth, sand or other non-combustible material and transfer to containers. Use clean non-sparking tools to collect absorbed material. Dike large spills and place materials in salvage containers. Water spray may reduce vapor, but may not prevent ignition in closed spaces.*

Waste Disposal Method: *Reuse when possible the residual product. Send waste product for thermal destruction using high-temperature incinerators designed to burn fluorine compounds. Dispose of in accordance with local, state and federal regulations. Do not incinerate closed containers.*

Precautions to be Taken in Handling and Storage: *Do not store above 100°F. Do not store or use near heat, sparks or flame. Use only non-sparking tools. Extinguish all ignition sources. Carefully vent any internal pressure before removing closure. Store large quantities only in buildings designed to comply with OSHA 1910.106. Keep closures tight and container upright to prevent leakage. Never use pressure to empty. This material may attack some forms of plastics, rubbers and coatings. Drums of this material should be grounded when pouring or transferring product. Drum must not be washed out or used for other purposes. Wear recommended personal protective equipment.*

Other Precautions: *Do not get in eyes. Avoid skin contact. Can cause respiratory reaction. Prevent prolonged or repeated breathing of vapors or spray mist. Avoid breathing of sanding dust. Wash contaminated clothing thoroughly. Wash skin thoroughly with soap and water after handling. Close container after each use. Do not transfer this product to unlabeled containers. Do not handle until the manufacturer safety precautions have been read and understood. Keep out of the reach of children.*

----- SECTION XI - ECOLOGICAL INFORMATION -----

Ecotoxicity

Benzene, 1-chloro-4- (trifluoromethyl) 98-56-6: No additional information available.

Aquatic Toxicity to Fish**Fish:**

LC50 (96 hr.) (Rainbow trout) 13.5 mg/L

LC50 (96 hr.) (Bluegill sunfish) 12.0 mg/L

MATC (31 day) (Fathead minnow) >0.54 <1.4 mg/L*

*Triethylene glycol used as solvent carrier

BCF (48 hr.) (Bluegill sunfish) 121.8 & 202.0

Invertebrates:

LC50 (48 hr.) (Water flea) 12.4 mg/L

MATC (21 day) (Water flea) >0.03 <0.05 mg/L*

*Acetone used as solvent carrier

Plants:

IC50 (72 hr.) (Green & Blue-green algae) 500 mg/L

TERRESTRIAL ECOTOX DATA

No data available

ENVIRONMENTAL FATE DATA**Biotic:**

Biodegradation: inconclusive due to volatility

Abiotic:

Atmospheric lifetime: estimated to be 65.9 days for OH radical reaction

Log Kow 3.7

Koc 420 - 530

Water Sol. @ 23 C 29.1

Material Safety Data Sheet

PCS-4300A

Page 5 of 5

----- SECTION XI - ECOLOGICAL INFORMATION (Continued) -----

p-Chlorobenzotrifluoride (PCBTF) will preferentially partition to the atmosphere, due to its high volatility. It has been estimated that 99.93% of a 100 Kg spill would end up in the atmosphere, while only 0.06% would partition to water (M. Garlanda, 1990). The aqueous solubility of PCBTF (29.1 mg/L) would also tend to limit its potential impact to exposed aquatic systems. PCBTF has exhibited significant toxicity to aquatic species under laboratory conditions, but is unlikely to exhibit a similar degree of acute toxicity under environmental conditions due to the aforementioned solubility and volatility issues. The moderate level of bioaccumulation measured in laboratory tests will also be subject to environmental mitigation due to PCBTF's physical/chemical properties. PCBTF should rapidly volatilize from dry and moist soils. Volatility, and relative environmental partitioning characteristics, make it unlikely that PCBTF represents a significant threat to aquatic or terrestrial environments.

----- SECTION XII - DISCLAIMER -----

USER: This bulletin cannot be expected to possibly cover all individual situations. The recipients and users of this product must determine that the information is current and suitable for the protection of the environment and the health/safety of the employees in all aspects of their individual operation or application.

DISCLAIMER: The information provided in this MSDS has been obtained from sources believed to be accurate and reliable as of the effective date shown. It is furnished without warranty of any kind, express or implied regarding the accuracy of this data or the results to be obtained from the use thereof. Regulatory requirements are subject to change and may differ from one location to another. The manufacturer assumes no responsibility for injury from the use of the product described herein and makes no guarantee of results or assumes no liability for damages incurred by use of this material. Final determination of the suitability of the product is the sole responsibility of the user (buyer). It is the buyer's responsibility to ensure that its activities comply with federal, state and/or local laws. The manufacture or its agents make no representations or warranties, expressed or implied, in connection with the use of this product and all implied warranties of merchantability and fitness for a particular purpose are excluded and shall not apply to the goods supplied. It is the responsibility of the user to comply with all applicable federal, state and local laws and regulations.

Material Safety Data Sheet

{DEVELOPMENTAL MATERIAL - PRELIMINARY M.S.D.S.}

Product Name: **PCS-4300 FPU (FLUOROPOLYURETHANE), COMPONENT B (Activator)**

HMIS Codes: H F R P

Product Code: **PCS-4300B**

1 3 0 J

----- SECTION I - MANUFACTURER IDENTIFICATION -----

Manufacturer Name: **Premier Coating Systems, Inc.**

Address: **205 Seven Doors Lane, St. Augustine, FL 32095**

Emergency Phone: **(904) 824-1799**

Information Phone: **(904) 824-1799**

Date Revised: **4-20-10**

Name of Preparer: **R. Fake**

Reason Revised: **Revised Calculations**

----- SECTION II - HAZARDOUS INGREDIENTS/SARA II INFORMATION -----

Occupational Exposure Limits

| Hazardous Components | CAS Number | OSHA/PEL | ACGIH/TLV | Other | Vapor Pressure mmHg @ F | Weight Percent |
|---------------------------------------|------------|----------|-----------|---|---------------------------------|----------------|
| Homopolymer of HDI | 28182-81-2 | NOT ESTB | NOT ESTB | 0.5 mg/m ³ TWA 1.0 mg/m ³ STEL | 7.5 X 10 ⁻⁵ @ 68F | 70 - 80 |
| Hexamethylene Diisocyanate (HDI) | 822-06-0 | NOT ESTB | .005 ppm | | | ** |
| Benzene, 1-Chloro-4 (Trifluoromethyl) | 98-56-6 | NOT ESTB | NOT ESTB | 25 ppm 8hr TWA (CEL) | 5.3 @ 68F | 15 - 25 |
| Triethyl Orthoformate | 122-51-0 | NOT ESTB | NOT ESTB | | 10 HpA @ 36C (97F) | 1 - 5 |

*Indicates chemical(s) subject to the reporting requirements of section 313 Title III and 40 CFR 372.

**Indicates - Trace Amount - (contains less than <1%).

----- SECTION III - PHYSICAL/CHEMICAL CHARACTERISTICS -----

Boiling Point: **280°F**

Specific Gravity (H₂O=1): **1.19**

Vapor Density: **Heavier Than Air**

Evaporation Rate: **Slower Than Ether**

Material VOC: **.20 Lbs./Gal (24 Grams/Liter)**

Coating VOC: **.25 Lbs./Gal (30 Grams/Liter)**

Exempt Volatiles Volume: **Approximately 20%**

Solubility in Water: **Negligible**

Appearance and Odor: **Clear/Pale Liquid; Naphthalenic Odor**

----- SECTION IV - FIRE AND EXPLOSION HAZARD DATA -----

Flash Point: **109°F (TCC)**

Lower: **0.9%** Upper: **10.5%**

Extinguishing Media: **Water Spray, Dry Chemical, Carbon Dioxide (CO₂), Alcohol Foam.**

SPECIAL FIREFIGHTING PROCEDURES:

FULL EMERGENCY EQUIPMENT WITH SELF CONTAINED BREATHING APPARATUS AND FULL PROTECTIVE CLOTHING SHOULD BE WORN BY FIREFIGHTERS. AVOID SPREADING BURNING LIQUID WITH WATER. FIGHT FIRE FROM SAFE DISTANCE. SHUT OFF ALL POWER TO THE AREA. EMERGENCY LIGHTS MUST BE TURNED ON. COOL CLOSED CONTAINERS WITH WATER SPRAY. USE POSITIVE PRESSURE SELF-CONTAINED BREATHING APPARATUS (SCBA) EQUIPMENT FOR ENCLOSED AREAS. DURING A FIRE, HDI VAPORS AND OTHER IRRITATING, HIGHLY TOXIC GASES MAY BE GENERATED BY THERMAL DECOMPOSITION OR COMBUSTION (SEE SECTION VIII).

UNUSUAL FIRE AND EXPLOSION HAZARDS:

VAPORS MAY FORM EXPLOSIVE MIXTURE WITH AIR. VAPORS MAY TRAVEL AND IGNITE OR FLASHBACK. DANGEROUS WHEN HEATED. CLOSED CONTAINERS MAY EXPLODE WHEN EXPOSED TO EXTREME HEAT OR BURST WHEN CONTAMINATED WITH WATER (CO₂ EVOLVED). LIQUID IS IRRITATING TO EYES AND SKIN. "EMPTY" PRODUCT CONTAINERS RETAIN PRODUCT RESIDUE. DO NOT WELD, CUT, OR EXPOSE TO FLAME OR SPARK. THEY MAY EXPLODE, CAUSING INJURY OR DEATH. COMBUSTIBLE. FORMS PEROXIDES OF UNKNOWN STABILITY. THIS PRODUCT MAY NOT BURN, BUT MAY SPLATTER IF THE TEMPERATURE EXCEEDS THE BOILING POINT. DRIED FILM MAY BURN IN A FIRE.

Material Safety Data Sheet

PCS-4300B

Page 2 of 5

SECTION V - REACTIVITY DATA

STABILITY: *Stable under normal conditions; however, forms peroxides of unknown stability.*

HAZARDOUS POLYMERIZATION: *May occur; Contact with moisture or other materials, which react with isocyanates or temperatures over 400 F (204 C), may cause polymerization.*

INCOMPATIBILITIES: *Water, amines, strong bases, alcohols, metal compounds and surface active materials. Material can react violently with strong oxidizing agents.*

INSTABILITY CONDITIONS: *High heat, sparks, open flame, other ignition sources and moisture.*

DECOMPOSITION PRODUCTS: *Chlorine containing gases & Fluorine containing gases can be produced. By high heat and fire: carbon dioxide, carbon monoxide, oxides of nitrogen, traces of HCN, HDI.*

SECTION VI - HEALTH HAZARD DATA

ROUTE(S) OF EXPOSURE: *Inhalation, Skin Contact, Eye Contact*

HUMAN EFFECTS AND SYMPTOMS OF OVEREXPOSURE:

ACUTE INHALATION: *HDI vapors or mist at concentrations above the TLV or MGL can irritate (burning sensation) the mucous membranes in the respiratory tract (nose, throat, lungs) causing runny nose, sore throat, coughing, chest discomfort, shortness of breath and reduced lung function (breathing obstruction). Persons with a preexisting, nonspecific bronchial hyperactivity can respond to concentrations below the TLV with similar symptoms as well as an asthma attack. Exposure well above the TLV or MGL may lead to bronchitis, bronchial spasm and pulmonary edema (fluid in lungs). These effects are usually reversible. Chemical or hypersensitive pneumonitis, with flu-like symptoms (e.g., fever, chills) has also been reported. Excessive inhalation can cause irritation of the respiratory tract, headaches, dizziness, staggering gait and confusion, CNS depressant.*

CHRONIC INHALATION: *As a result of previous repeated overexposures or a single large dose, certain individuals will develop isocyanate sensitization (chemical asthma) which will cause them to react to a later exposure to isocyanate at levels well below the TLV or MGL. These symptoms, which include: chest tightness, wheezing, cough, shortness of breath or asthmatic attack, could be immediate or delayed up to several hours after exposure. Similar to many non-specific asthmatic responses, there are reports that once sensitized an individual can experience these symptoms upon exposure to dust, cold air or other irritants. This increased lung sensitivity can persist for weeks and in severe cases for several years. Chronic overexposure to isocyanates has also been reported to cause lung damage, including decrease in lung function, which may be permanent. Sensitization may be either temporary or permanent.*

ACUTE SKIN CONTACT: *Isocyanates react with skin protein and moisture and can cause irritation. Symptoms of skin irritation may be reddening, swelling, rash, scaling or blistering. Some persons may develop skin sensitization from skin contact. Cured material is difficult to remove.*

CHRONIC SKIN CONTACT: *Prolonged contact with the isocyanate can cause reddening, swelling, rash, scaling or blistering. In those who have developed a skin sensitization, these symptoms can develop as a result of contact with very small amounts of liquid material or even as a result of vapor-only exposure.*

ACUTE EYE CONTACT: *Liquid, aerosols or vapors of this product (isocyanate) are irritating and can cause pain, tearing, reddening and swelling accompanied by a stinging sensation and/or a feeling like that of fine dust in the eyes.*

CHRONIC EYE CONTACT: *May result in corneal opacity (clouding of the eye surface)*

ACUTE INGESTION: *Can result in irritation and possible corrosive action in the mouth, stomach tissue and digestive tract.*

CHRONIC INGESTION: *None Found*

CARCINOGENICITY: *NTP: Not listed IARC: Not listed OSHA: Not Regulated*

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: *Asthma and any other respiratory disorders (bronchitis emphysema, hyperactivity), skin allergies, eczema. Exposure to petroleum solvents may effect the central nervous system (CNS) and /or aggravate pre-existing CNS disorders. Skin contact may aggravate preexisting dermatitis. This material or its emissions may aggravate pre-existing eye disease*

EXPOSURE LIMITS: *Not established for this product as a whole, refer to Section II for exposure limits of hazardous constituents.*

Material Safety Data Sheet

PCS-4300B

Page 3 of 5

SECTION VII - EMERGENCY AND FIRST AID PROCEDURES

FIRST AID FOR EYES: Flush with clean, lukewarm water (low pressure) for at least 15 minutes while lifting eyelids. Refer individual to physician or ophthalmologist for immediate follow-up.

FIRST AID FOR SKIN: Remove contaminated clothing immediately. Wash affected areas thoroughly with soap and water. Wash contaminated clothing thoroughly before reuse. For severe exposures, get under safety shower after removing clothing, then get medical attention. For lesser exposures, seek medical attention if irritation develops or persists.

FIRST AID FOR INHALATION: Move to an area free from risk of further exposure. Administer oxygen or artificial respiration as needed. Obtain medical attention. Asthmatic-type symptoms may develop and may be immediate or delayed up to several hours. Treatment is essentially symptomatic. Consult physician.

FIRST AID FOR INGESTION: **DO NOT INDUCE VOMITING.** This material is not soluble. **DO NOT GIVE FLUIDS.** If spontaneous vomiting is inevitable, PREVENT ASPIRATION by keeping the victims head below the knees. **DO NOT GIVE ANYTHING BY MOUTH TO AN UNCONSCIOUS OR CONVULSING PERSON. GET IMMEDIATE MEDICAL ATTENTION.** A qualified physician can perform gastric lavage only when the airway (trachea) has been secured to prevent aspiration.

NOTE TO PHYSICIAN:

EYES: Stain for evidence of corneal injury. If cornea is burned, instill antibiotic/steroid preparation frequently. Workplace vapors could produce reversible corneal epithelial edema impairing vision.

SKIN: This product is a known skin sensitizer. Treat symptomatically as for contact dermatitis or thermal burn.

INGESTION: Treat symptomatically. There is no specific antidote. Inducing vomiting is contraindicated because of the irritating nature of the product.

INHALATION: This product is a known pulmonary sensitizer. Treatment is essentially symptomatic. An individual having a dermal or pulmonary sensitization reaction to this material must be removed from any further exposure to any isocyanate.

SECTION VIII - TOXICITY INFORMATION

Benzene, 1-chloro-4- (trifluoromethyl) 98-56-6: No appropriate human data is available on the chronic health effects from prolonged or repeated exposure to this material.

Toxicity

| | | |
|---------------------------|----------|----------------|
| ACUTE ORAL LD50 : | (rat) | >6.8 g/kg |
| ACUTE DERMAL LD50 : | (rabbit) | >2.7 g/kg |
| ACUTE INHALATION LC50 : | (rat) | 4479 ppm |
| PRIMARY SKIN IRRITATION : | (rabbit) | non-irritating |
| PRIMARY EYE IRRITATION : | (rabbit) | non-irritating |

Repeated Dose Toxicity

A 28-day range-finding inhalation study was conducted in male and female Sprague-Dawley rats exposed to 0, 100, 250, 500, or 1000 ppm for 6 hr/day, 5 days/week. Clinical signs included increased activity at 250 ppm and above. Liver and kidney weights were increased. Microscopic changes in male kidneys stained positive for alpha-2-U globulin and the effects were considered not relevant to humans. Liver cell hypertrophy was seen at all exposures in males. Liver changes were consistent with clinical chemistry and PCBTF-blood level analysis and are believed to be an adaptive response, due to increased liver metabolism.

Gavage studies in laboratory rodents for treatment periods of 14, 28, and 90 days have demonstrated significant liver and kidney toxicity at dose levels of 400 - 1000 mg/kg/day. Evidence of target organ toxicity included significant increases in relative liver and kidney weights, clinical chemistry values and histopathological findings. Renal toxicity which occurred only in male rats, was apparently due to "hyaline droplet" nephropathy and is therefore, highly unlikely to develop in man. The NOAEL's for all these studies range from 10 to 100 mg/kg/day.

CNS effects were observed in rats exposed to PCBTF at or above 2822 ppm for 4 hours.

A 90 day (13 week) rat inhalation toxicity and neurobehavioral study was conducted using exposures of 6 hrs/day, 5 days/week at concentrations of 0, 10, 50 and 250 ppm. There were no PCBTF-related macroscopic observations. Microscopically, PCBTF-related centrilobular hypertrophy was present only in the livers of males and females at the high dose (250 ppm) after 13-weeks of exposure. No centrilobular hypertrophy was observed at any level among recovery animals. There were no PCBTF-related effects on the nervous system as measured by a functional observation battery, muscular activity measurements and neuropathology. A NOEL of 50 ppm was established in this study for liver hepatocyte hypertrophy in male and female rats. If the hepatocyte hypertrophy observed is considered to be an adaptive response to PCBTF, the NOAEL for this study is 250ppm.

Material Safety Data Sheet

PCS-4300B

Page 4 of 5

----- SECTION IX - EMPLOYEE PROTECTION RECOMMENDATIONS -----

REQUIRED WORK/HYGIENE PROCEDURES: *Precautions must be taken so that persons handling this product do not allow contact with the eyes or skin. In spray operations, protection must be afforded against exposure to both vapor and spray mist.*

SKIN PROTECTION REQUIREMENTS: *Permeation resistant gloves. Cover as much of the exposed skin area as possible with appropriate clothing. If skin creams are used, keep the area protected only by the cream to a minimum.*

RESPIRATOR REQUIREMENTS: *A respirator that is recommended or approved for use in isocyanate containing environments (air purifying or fresh air supplied) may be necessary for spray applications or other situations such as high temperature use which may produce inhalation exposures. A supplied air respirator (either positive pressure or continuous flow type) is recommended. Before an air-purifying respirator can be used, air monitoring must be performed to measure airborne concentrations of HDI monomer, HDI polyisocyanate and organic solvent(s). Observe OSHA regulations for respirator uses (29 CFR 1910.134).*

MONITORING: *Refer to Patty's Industrial Hygiene and Toxicology-Volume 1 (3rd edition) Chapter 17 and volume III (1st edition) Chapter 3-for guidance concerning appropriate air sampling strategy to determine airborne concentrations of isocyanates and solvent.*

MEDICAL SURVEILLANCE: *Medical supervision of all employees who handle or come in contact with this product is recommended. This should include reemployment and periodic medical examinations with respiratory function tests (FEV₁, FVC as a minimum). Persons with asthma-type conditions, chronic bronchitis, other chronic respiratory diseases or recurrent skin eczema or sensitization should be excluded from working with isocyanates. Once a person is diagnosed as sensitized to an isocyanate, no further exposure can be permitted.*

ADDITIONAL PROTECTIVE MEASURES: *Safety showers and eyewash stations should be available. Educate and train employees in safe use of product. Follow all label instructions. We recommend using the Geometric Mean Air Odor Threshold found in Table 5.1 of "Odor Thresholds for Chemicals with Established Occupational Health Standards," - OSHA*

----- SECTION X - PRECAUTIONS FOR SAFE HANDLING AND USE -----

SPILL OR LEAK PROCEDURES: *Evacuate nonessential personnel. Remove all sources of ignition and ventilate the area. Dike or impound spilled material and control further spillage if feasible. Notify appropriate authorities if necessary. Cover the spill with sand, vermiculite, dry earth, Fuller's earth or other non-combustible absorbent material. Pour decontamination solution over spill area and allow to react for at least 10 minutes. Collect material in open containers and add further amounts of decontamination solution. Remove containers to a safe place, cover loosely, and allow to stand for 24 to 48 hours. Wash down spill area with decontamination solutions. Decontamination solutions: nonionic surfactant Union Carbide's Tergitol TMN-10 (20%) and water (80%); concentrated ammonia (3-8%), detergent (2%) and water (90-95%). Respiratory protection is recommended during spill cleanup (See Respiratory Protection, Section VIII).*

WASTE DISPOSAL METHOD: *Waste must be disposed of in accordance with federal, state, and local environmental control regulations. Incineration is the preferred method. Empty containers must be handled with care due to product residue. Decontaminate containers prior to disposal.*

DO NOT HEAT OR CUT EMPTY CONTAINER WITH ELECTRIC OR GAS TORCH.
(See Sections IV and V)

STORAGE TEMPERATURE RECOMMENDATIONS (MIN/MAX): -30°F (-34°C) / 102°F (39°C)

SHELF LIFE: *Approximately 6 months @ 77°F (25°C)*

SPECIAL SENSITIVITY: *If container is exposed to high heat, it can be pressurized and possibly rupture explosively. HDI reacts slowly with water to form CO₂ gas. This gas can cause sealed containers to expand and possibly rupture explosively.*

HANDLING/STORAGE PRECAUTIONS: *Keep away from heat, sparks and open flame. Ground containers during storage and transfer operations. Store in tightly closed containers to prevent moisture contamination. Do not reseal if contamination is suspected. At maximum storage temperatures noted, material may slowly polymerize without hazard. Ideal storage temperature range for ease of handling is 50-81°F (10-27°C). Avoid contact with skin and eyes. Employee education and training in the safe use and handling of this compound are required under the OSHA Hazard Communication Standard.*

Material Safety Data Sheet

PCS-4300B

Page 5 of 5

SECTION XI - ECOLOGICAL INFORMATION

Ecotoxicity**Benzene, 1-chloro-4- (trifluoromethyl) 98-56-6:** No additional information available.**Aquatic Toxicity to Fish**

Fish:

LC50 (96 hr.) (Rainbow trout) 13.5 mg/L

LC50 (96 hr.) (Bluegill sunfish) 12.0 mg/L

MATC (31 day) (Fathead minnow) >0.54 <1.4 mg/L*

*Triethylene glycol used as solvent carrier

BCF (48 hr.) (Bluegill sunfish) 121.8 & 202.0

Invertebrates:

LC50 (48 hr.) (Water flea) 12.4 mg/L

MATC (21 day) (Water flea) >0.03 <0.05 mg/L*

*Acetone used as solvent carrier

Plants:

IC50 (72 hr.) (Green & Blue-green algae) 500 mg/L

TERRESTRIAL ECOTOX DATA

No data available

ENVIRONMENTAL FATE DATA

Biotic:

Biodegradation: inconclusive due to volatility

Abiotic:

Atmospheric lifetime: estimated to be 65.9 days for OH radical reaction

Log Kow 3.7

Koc 420 - 530

Water Sol. @ 23 C 29.1

p-Chlorobenzotrifluoride (PCBTF) will preferentially partition to the atmosphere, due to its high volatility. It has been estimated that 99.93% of a 100 Kg spill would end up in the atmosphere, while only 0.06% would partition to water (M. Garlanda, 1990). The aqueous solubility of PCBTF (29.1 mg/L) would also tend to limit its potential impact to exposed aquatic systems. PCBTF has exhibited significant toxicity to aquatic species under laboratory conditions, but is unlikely to exhibit a similar degree of acute toxicity under environmental conditions due to the aforementioned solubility and volatility issues. The moderate level of bioaccumulation measured in laboratory tests will also be subject to environmental mitigation due to PCBTF's physical / chemical properties. PCBTF should rapidly volatilize from dry and moist soils. Volatility, and relative environmental partitioning characteristics, make it unlikely that PCBTF represents a significant threat to aquatic or terrestrial environments.

SECTION XII - DISCLAIMER

USER: This bulletin cannot be expected to possibly cover all individual situations. The recipients and users of this product must determine that the information is current and suitable for the protection of the environment and the health/safety of the employees in all aspects of their individual operation or application.

DISCLAIMER: The information provided in this MSDS has been obtained from sources believed to be accurate and reliable as of the effective date shown. It is furnished without warranty of any kind, express or implied regarding the accuracy of this data or the results to be obtained from the use thereof. Regulatory requirements are subject to change and may differ from one location to another. The manufacturer assumes no responsibility for injury from the use of the product described herein and makes no guarantee of results or assumes no liability for damages incurred by use of this material. Final determination of the suitability of the product is the sole responsibility of the user (buyer). It is the buyer's responsibility to ensure that its activities comply with federal, state and/or local laws. The manufacture or its agents make no representations or warranties, expressed or implied, in connection with the use of this product and all implied warranties of merchantability and fitness for a particular purpose are excluded and shall not apply to the goods supplied. It is the responsibility of the user to comply with all applicable federal, state and local laws and regulations.

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| 13. SUPPLEMENTARY NOTES | | | | | | |
| 14. ABSTRACT Department of Defense (DoD) installations have many steel structures in the base infrastructure that encounter problems with atmospheric corrosion. Maintenance and repair costs due to the damage from corrosion are costly to the DoD. Paint systems are the first line of defense for protecting structures from the effects of corrosion. These structures are typically painted with the high-performance coating systems that include epoxies and polyurethanes. This demonstration utilized a two-coat high-performance system to achieve performance standards similar to the conventional high-performance three-coat system using zinc primer, while also comparing cost effectiveness. The two-coat high-performance paint system consisted of an epoxy barrier coating and a fluoropolyurethane topcoat. These coatings were applied to selected diesel fuel storage tanks and static lift cranes at Fort Bragg, NC. The demonstrated two-coat system performed very well over 12 months, and proved to be effective, faster to apply, and more environmentally friendly than the three-coat control system. The project return on investment was calculated to be 7.03. The demonstrated system is recommended for incorporation into applicable DoD guidance for coating steel structures and equipment in atmospheric exposure. | | | | | | |
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