DoD Corrosion Prevention and Control Program

Application of Corrosion- and Fire-Resistant Coating Systems on Buildings 227 and 299 at Rock Island Arsenal

Final Report on Project FAR-13 for FY06

Susan A. Drozdz, Paul P. Greigger, Russell Fruge, and Scott D. Benton

August 2009

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Application of Corrosion- and Fire-Resistant Coating Systems on Buildings 227 and 299 at Rock Island Arsenal

Final Report on Project FAR-13 for FY06

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Abstract: Fire protective coatings have historically lacked sufficient durability to maintain the coating in good condition and protect the substrate from corrosion. New, innovative epoxy intumescent coatings are much more durable and inhibit corrosion of steel. This project demonstrated the performance of this type of coating system on two structures at Rock Island Arsenal where fire risk and corrosive conditions are significant, and included outdoor exposure testing and accelerated weathering tests at the ERDC-CERL paints and coatings laboratory. Additional research was conducted to further develop engineered siloxane-epoxy coating technology as fire protective and corrosion-resistant coating systems with improved durability. The coating system successfully demonstrated in this project has the potential to provide the benefits of this protection to many types of structures across the DoD.

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Preface

This demonstration was performed for the Office of the Secretary of Defense (OSD) under Department of Defense (DoD) Corrosion Control and Prevention Project FAR-13; Military Interdepartmental Purchase Requests MIPR6FCERB1020, 20 Mar 06; MIPR6H6AG3CPC1, 15 May 06; and MIPR6HMBHDE097, 31 May 06. The proponent was the Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics. The technical monitors were Daniel J. Dunmire (OUSD(AT&L) Corrosion), Paul M. Volkman (IMPW-E), and David N. Purcell (DAIM-FDF).

The work was performed by the Materials and Structures Branch (CF-M) of the Facilities Division (CF), Construction Engineering Research Laboratory – Engineer Research and Development Center (ERDC-CERL). The Project Officer was Vincent Hock. Portions of this work were performed under contract by Mandaree Enterprise Corporation, PPG Industries, and the Almega Company, Inc. At the time this report was prepared, the Chief of the ERDC-CERL Materials and Structures Branch was Vicki L. Vaillancic (CEERD-CF-M), the Chief of the Facilities Division was L. Michael Golish (CEERD-CF), and the Technical Director for Installations was Martin J. Savoie (CEERD-CV-ZT). The Deputy Director of ERDC-CERL was Dr. Kirankumar V. Topudurti, and the Director was Dr. Ilker Adiguzel.

The authors wish to acknowledge the primary personnel involved with the execution of this project, who were:

- PPG: Tim Figore, Tim Avampato, Terri Ziegler, and Norm Mowrer
- Rock Island Arsenal Directorate of Public Works: Hugh Halverson and Dana Johnson
- Almega (PPG Sub): George Aspiotes, and Dave Young

The Commander and Executive Director of ERDC was COL Richard B. Jenkins and the Director was Dr. James R. Houston.
Executive Summary

Fire protective coatings offer a form of passive fire protection. Many of the fire protective coating systems that have been developed over the years have not had sufficient durability to maintain the coating in good condition and protect the substrate from corrosion. The coatings can be brittle and inflexible, subject to failure over time, resulting in greater risk of damage due to corrosion or a fire. New, innovative epoxy intumescent coatings are much more durable and inhibit corrosion of steel. This project demonstrated the performance of this type of coating system on two structures at Rock Island Arsenal where fire risk and corrosive conditions are significant. A test rack for painted test panels was installed at the site, and panels placed there for long-term outdoor weathering tests. Accelerated weathering tests were conducted in the ERDC CERL laboratory.

Additional research was conducted to further develop fire protective and corrosion-resistant coating systems that exhibit improved durability, reduced environmental impact, and more rapid curing under ambient conditions. Engineered siloxane-epoxy coating technology was identified as having excellent potential to provide these features, but this resin system had not been formulated for use as corrosion resistant fire protective coatings.

The coating system demonstrated in this project has been shown to provide good corrosion protection to the steel in corrosive environments in accelerated laboratory tests and on the structures at Rock Island Arsenal. Additionally, the system is designed to protect the steel from reaching high temperatures in a fire for up to 3 hours. This system has the potential to provide the benefits of this protection to many types of structures across the DoD.

An aliphatic epoxy and siloxane resin-based prototype coating was developed which exhibits improvements in VOC, pot life, dry time, hardness, flexibility and elongation, chemical and corrosion resistance, and UV durability.
# Unit Conversion Factors

<table>
<thead>
<tr>
<th>Multiply</th>
<th>By</th>
<th>To Obtain</th>
</tr>
</thead>
<tbody>
<tr>
<td>degrees Fahrenheit</td>
<td>(F-32)/1.8</td>
<td>degrees Celsius</td>
</tr>
<tr>
<td>Feet</td>
<td>0.3048</td>
<td>meters</td>
</tr>
<tr>
<td>gallons (U.S. liquid)</td>
<td>3.785412 E-03</td>
<td>cubic meters</td>
</tr>
<tr>
<td>Inches</td>
<td>0.0254</td>
<td>meters</td>
</tr>
<tr>
<td>Mils</td>
<td>0.0254</td>
<td>millimeters</td>
</tr>
<tr>
<td>square feet</td>
<td>0.09290304</td>
<td>square meters</td>
</tr>
</tbody>
</table>
1 Introduction

1.1 Problem statement

The primary reason steel structures are painted is to protect the steel from the effects of corrosion. The aesthetic effects of color, texture, and gloss are secondary. A typical coating system has a finite service life, after which it can be renewed by cleaning, spot priming and applying a new topcoat, or it can be completely removed and replaced with a new system.

A coating system can also provide thermal protection to a structure in the event of a fire. Some of the best coating systems currently available for fire protection are intumescent epoxies that decompose when exposed to high temperatures. Gasses are released which cause the material to swell to several multiples of its original thickness, forming an insulating char. This char prevents high heat from transferring to the steel, allowing time for the egress of building occupants or for firefighting before the structure itself is threatened. Fire protective coatings are applied in much greater thicknesses than traditional paint systems, and the degree of fire protection is usually in direct proportion to the coating thicknesses. A coating system for corrosion protection of steel has a thickness on the order of 127 microns (5 mils, 0.005 inch), fire protective coatings can range from 6350 microns (.25 inch) to a full 12700 microns (1/2 inch) or greater.

This type of coating is a form of passive fire protection. In order for the coating to perform its function at the time of a fire, it must be present in good condition at the time it is needed. The thick, heavy coating must maintain its adhesion to the steel surface and withstand the effects of temperature cycles, exposure to weather (for exterior systems), and impact and abrasion.

These performance requirements are in addition to the basic function of providing corrosion protection and aesthetic appeal. Many of the fire protective coating systems that have been developed over the years have not had sufficient durability to maintain the coating in good condition and protect the substrate from corrosion. The coatings can be brittle and inflexible, subject to failure over time, resulting in greater risk of damage due to corrosion or a fire.
Intumescent coatings are based on a variety of binder systems, including water based latexes or epoxies. Water-based latex coatings are generally used in what is often referred to as thin film intumescents (approximately 1.27 mm (0.05 inches or 50 mils) in thickness when applied). These thinner films are more aesthetically pleasing in appearance, yet they still provide up to 2 hours fire protection, with thicker films providing longer protection. Because of their composition these coatings tend not to be durable and provide little corrosion protection to steel.

New, innovative epoxy intumescent coatings are much more durable and inhibit corrosion of steel. They decompose on exposure to high temperatures, releasing gasses which expand the material, forming a layer of “char” that will help to keep steel from reaching softening temperatures for up to 4 hours. This leaves a longer widow of time for the egress of personnel from the building, and for fighting the fire before significant loss of strength of the steel occurs.

Additionally it is recognized that there is a need to further develop fire protective and corrosion-resistant coating systems that exhibit improved durability, reduced environmental impact, and more rapid curing under ambient conditions. These coatings will ideally also provide direct to metal adhesion and corrosion resistance. Engineered siloxane-epoxy coating technology was identified as having excellent potential to provide these features. Coatings employing this technology have demonstrated excellent durability and may be formulated without the addition of organic solvents. Additionally, coatings of this type cure rapidly under ambient conditions and can be applied with existing application equipment. However they have not been fully characterized with respect to structure property relationships or optimized for adhesion to multiple substrates. Further these coatings have not been formulated for use as corrosion resistant fire protective coatings.

1.2 Objective

The objectives of this effort were to:

- demonstrate apply a state-of-the-art epoxy-based fire resistant coating system with improved corrosion resistance on multiple Army structures where fire risk and corrosive conditions are significant;
- monitor the corrosion performance of the coating system on the structures over time, and monitor the performance of the coating system,
standard baseline systems, and alternative systems applied to metal coupons exposed on an outdoor rack and in accelerated testing in the laboratory; and
• further develop the coating performance by evaluating modified paint formulations in the laboratory.

1.3 Approach

A demonstration site was sought that had at least two different types of corrosive environments on structures where fire risk is a concern. Candidate structures for consideration included manufacturing facilities, heat or energy plants, or vehicle or aircraft maintenance facilities. The ideal structures would have exposed steel support columns and beams. The site also needed to have a suitable location for the placement of a corrosion test rack facing south, not shaded by other structures or foliage, and in the corrosive environment.

A separate laboratory study was performed to identify possible ways to further improve coating performance for military structure requirements.

Additional details about this study are provided in the following appendices:

• Appendix A: Project Management Plan for CPC Project AR-F-318
• Appendix B: Contractor Work and Safety Documents
• Appendix C: Laboratory and Coupon Test Data
• Appendix D: Suggested Implementation Guidance.
2 Technical Investigation

2.1 Project overview

A contract for the field application of the coating systems on Buildings 227 and 299 at Rock Island Arsenal was awarded to Mandaree Enterprise Corporation, and subcontractors PPG Industries, Inc. (coating materials and technical oversight), and Almega Company, Inc. (surface preparation and coating application). Site support for the work was provided by the staff at the Directorate of Public Works at Rock Island Arsenal. Additional laboratory work was performed by PPG to further develop fire-protective coatings systems with enhanced resistance to corrosion.

Two structures were selected for this work at Rock Island Arsenal. Building 227, a coal-fired heating plant, is known for having a corrosive environment due to the plant emissions. At Building 227 interior steel support columns in the two baghouses and exterior stair tower support columns were blast cleaned and protected with a 3-coat system including a primer, the intumescent fire protective coating, and a polyurethane topcoat. Adjacent structural members were cleaned and topcoated for aesthetic appeal and added protection. A fire and corrosion-resistant coating system was also applied to interior steel support columns in a section of Building 299, a manufacturing facility where the interior steel can be exposed to corrosive chemicals and chemical fumes. In both of the facilities a new corrosion-resistant fire protective coating system will to provide additional personnel and asset protection. The coating system was applied to selected surfaces on each building as shown in Table 1.

<table>
<thead>
<tr>
<th>Surface</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Bldg 227 Heating Plant West Baghouse</td>
<td>Apply epoxy intumescent coating to baghouse steel support columns and stair tower support columns on exterior of baghouse. Apply topcoat to the adjacent structural members. See drawings in Appendix B.</td>
</tr>
<tr>
<td>2. Bldg 227 Heating Plant East Baghouse</td>
<td>Apply epoxy intumescent coating to baghouse steel support columns and stair tower support columns on exterior of baghouse. Apply topcoat to the adjacent structural members. See drawings in Appendix B.</td>
</tr>
<tr>
<td>3. Bldg 299 – Interior Support Columns, Southwest Interior</td>
<td>Apply epoxy intumescent coating to interior steel support columns. Apply coating in increments of 1 high bay at a time, 2 high bays total. See drawings in Appendix B.</td>
</tr>
</tbody>
</table>
The surface preparation and coating systems were selected to provide long-term corrosion resistance and to provide up to 3 hours of protection to the steel in the event of a fire.

A test panel exposure rack was installed outside on the sunny south side of Building 227 and painted test panels were prepared and mounted to the exposure rack as the work on both buildings was being completed. These are being periodically rated for the performance of a series of coating systems, including the test coatings, and various alternate coating systems, including topcoat and primer systems without the intumescent intermediate coat. Research and development was conducted to further improve the corrosion inhibition, durability, cure response, and environmental impact of siloxane-epoxy coatings for military structures.

Additionally the researchers further developed the formulation of the fire protective and corrosion-resistant coating systems to provide coatings that exhibit improved durability, reduced environmental impact, and more rapid curing under ambient conditions. The ideal system is one that will also provide direct to metal adhesion and corrosion resistance, even when over a poorly prepared surface. Engineered siloxane-epoxy coating technology was identified as having excellent potential to provide these features. Coatings employing this technology have demonstrated excellent durability and may be formulated without the addition of organic solvents. Coatings of this type cure rapidly under ambient conditions and can be applied with existing application equipment. However they have not been fully characterized with respect to structure property relationships or optimized for adhesion to multiple substrates. Further these coatings have not been formulated for use as corrosion resistant fire protective coatings.

2.2 Surface preparation and installation

Surface preparation and coating system application was performed by the coating subcontractor, The Almega Company. Onsite work began June 4 and was concluded August 3, 2007. The same coating system was applied in on the interior and exterior surfaces of Building 227, and on the interior columns of Building 299.

The surface preparation was different for interior surfaces and exterior surfaces. The exterior surfaces on Building 227 were abrasive blasted to a near-white metal grade (SSPC SP6). Interior steel surfaces of building 227 were power washed per SSPC SP1, and the interior steel surfaces of Build-
ing 299 were solvent wiped in accordance with SSPC SP1. This coating system is based on three coats of the material shown in Table 2.

Table 2. Coating system components.

<table>
<thead>
<tr>
<th>Material Type</th>
<th>Manufacturer, Name, Number</th>
<th>Coating Thickness, microns (mils)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primer two-component direct-to-rust epoxy mastic</td>
<td>PPG, Pitt-Guard DTR</td>
<td>102 to 152 (4 to 6)</td>
</tr>
<tr>
<td>Intermediate Coat 2-component flexible intumescent epoxy</td>
<td>PPG, Pitt-Char XP</td>
<td>13460 (530)</td>
</tr>
<tr>
<td>Topcoat high build, semi-gloss acrylic polyurethane</td>
<td>PPG, Pitthane 95-8800 Series</td>
<td>51 to 76 (2 to 3)</td>
</tr>
</tbody>
</table>

The intumescent epoxy coating is reinforced with a fiber mesh embedded at approximately half the total thickness. The purpose of the fiber mesh is to reinforce the layer of insulating char that forms in the event of a fire. The mesh prevents cracking to the steel substrate, which would reduce the insulating properties of the char. The procedure is as follows:

1. Apply approximately 6,350 microns (250 mils) of the material.
2. Apply the fiber mesh to the wet coating and roll in to eliminate wrinkles, gaps, and voids.
3. Apply a second coat of the intumescent epoxy to achieve the total thickness.

Figure 1 – Figure 6 show several views of Buildings 227 and 299 before and after the coating application work:
Figure 2. Building 227 exterior after coating application.

Figure 3. Building 227 exterior after coating application.
Figure 4. Building 227 interior after coating application.

Figure 5. Building 299 interior before coating application.
2.3 Performance monitoring and data collection

The set of data from the accelerated laboratory testing and the coupon test rack outside Building 227 at Rock Island Arsenal is included in Appendix C.

2.4 Formulation enhancement studies

2.4.1 Identification of coating structure property relationships

The structure property relationships of engineered siloxane epoxy coatings were studied in several ways. Variations were performed on the epoxy resins, the siloxane resins, and the aminosilane curatives that resulted in improved flexibility and impact resistance, faster dry times, increased corrosion resistance, as well as changes in hardness, adhesion and durability, depending on the variations studied.

2.4.2 Aminosilanes

The aminosilane structure was altered through the type of silane functionality, the structure and nature of the amine unit, and the type of linkages
between these reactive sites. These changes led to significant impacts on the dry times and flexibility of the system.

<table>
<thead>
<tr>
<th>Table 3. Tack-free times (ASTM D 1640*).</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Commercial Aminosilane</strong></td>
</tr>
<tr>
<td>2-3 hrs</td>
</tr>
</tbody>
</table>

*ASTM D 1640 - Standard Test Method for Drying, Curing, or Film Formation of Organic Coatings at Room Temperature

Alteration of the aminosilane structure leads to significantly faster tack free times. The tack free time can be adjusted by changing the blend ratio of the aminosilanes A and B. Humidity also plays a role in the tack-free time of the polysiloxane coatings as seen in Figure 7. Humidity was varied at a constant 30% diluent level and the diluent was varied at a constant 50% RH.

Commercially available epoxy siloxane coatings have low VOC and provide a good combination of UV durability and corrosion resistance. However, they are slow to cure, particularly in cold weather, and can not be force cured above 140 °F because of the volatility of certain constituents. Additionally, these coatings lack the flexibility required for certain applications.

The new aminosilane curatives can be used to improve the cure response and flexibility, especially with the use of a third aminosilane adduct (Ami-
nositane C) that has higher amine content and lower alkoxy silane content. A comparison of the properties of these formulas is shown in Table 4.

Table 4. Property comparison of four formulations with differing aminosilane content.

<table>
<thead>
<tr>
<th>Property/Composition</th>
<th>Commercial Polysiloxane</th>
<th>Experimental Formula I</th>
<th>Experimental Formula II</th>
<th>Experimental Formula III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epoxy</td>
<td>Epoxy</td>
<td>Epoxy</td>
<td>Epoxy</td>
<td></td>
</tr>
<tr>
<td>Siloxane</td>
<td>Siloxane</td>
<td>Siloxane</td>
<td>Siloxane</td>
<td></td>
</tr>
<tr>
<td>Commercial Aminosilane</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>Commercial Aminosilane</td>
</tr>
<tr>
<td>----</td>
<td>Aminosilane A</td>
<td>Aminosilane A</td>
<td>Aminosilane A</td>
<td></td>
</tr>
<tr>
<td>----</td>
<td>Aminosilane B</td>
<td>Aminosilane B</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>----</td>
<td>---</td>
<td>---</td>
<td>Aminosilane C</td>
<td>---</td>
</tr>
<tr>
<td>----</td>
<td>---</td>
<td>---</td>
<td>Titanate</td>
<td>---</td>
</tr>
<tr>
<td>Tack Free Times (ASTM D 1640)</td>
<td>3 hours</td>
<td>10-15 minutes</td>
<td>20-30 minutes</td>
<td>30-40 minutes</td>
</tr>
<tr>
<td>Adhesion (ASTM D 3359, Method B)</td>
<td>4B</td>
<td>3B</td>
<td>4B</td>
<td>4B</td>
</tr>
<tr>
<td>Hardness Konig (ASTM D 4366) / Pencil (ASTM D 3363)</td>
<td>74 / H</td>
<td>84 / 2H-4H</td>
<td>102 / H – 3H</td>
<td>90 /</td>
</tr>
<tr>
<td>% Elongation on Mandrel Bend (ASTM D 522)</td>
<td>&lt;3%</td>
<td>11%</td>
<td>24%</td>
<td>4.5%</td>
</tr>
<tr>
<td>Salt fog resistance, SBS, 750 hours</td>
<td>6</td>
<td>0</td>
<td>-</td>
<td>6</td>
</tr>
<tr>
<td>ASTM scribe rating (ASTM D 1654, Method A)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Referenced Test Methods:
ASTM D 1640 - Standard Test Method for Drying, Curing, or Film Formation of Organic coatings at Room Temperatures
ASTM D 3359 - Standard Test Methods for Measuring Adhesion by Tape Test
ASTM D 3363 - Standard Test Method for Film Hardness by Pencil Test
ASTM D 522 - Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings
ASTM D 1654 - Standard Test Method for Evaluation of Painted or Coated Specimens Subject to Corrosive Environments

The use of titanate in the Experimental Formula II contributed to a faster tack free time, without titanate, the coating takes ~1.5 hr to become tack free. While this formula has improved physical properties as shown above,
the drawback to this system is the decreased UV durability of aminosilane C.

The type and amount of aminosilane was also found to have a major effect on corrosion resistance, particularly on sand blasted steel substrates. Epoxy siloxane coating systems cured with blends of fast curing Aminosilane A and Aminosilane B exhibited severe blistering at the scribe and ASTM ratings of 0 while similar epoxy siloxane resin systems cured with either the slower reacting commercial aminosilane or a blend of the slower reacting commercial aminosilane and Aminosilane A exhibited excellent corrosion resistance with ASTM scribe ratings of 6 after 1,500 hours salt fog exposure.

The aminosilane curative component of the current prototype provides an optimum balance of fast dry time and high hardness with improved flexibility, excellent corrosion resistance and exceptional UV durability.

2.4.3 Epoxy resins

The effect of epoxy resin structure, functionality and molecular weight on the performance properties of formulated epoxy siloxane coating systems was also investigated. Aliphatic, cycloaliphatic and aromatic epoxy resins were studied as well as epoxy resins based modification with core shell rubber and silica nanoparticle dispersions. Functionality and molecular weight of the epoxy resins were varied from 2 to 6 and about 300 to 1,500, respectively.

All of the formulations shown in Table 5 were based on a titanium dioxide pigmented resin blend of 53% siloxane resin and 47% of the indicated epoxy resin. Each pigmented resin system was cured with a blend of commercially available aminosilane and Aminosilane A and allowed to cure 2 weeks at ambient temperature before being placed in test.

Formulations based on the aromatic epoxy, core shell rubber dispersion epoxy and silica nanoparticle modified epoxy had poor gloss retention in QUV-B accelerated weathering tests. Low functionality, low molecular weight aliphatic epoxy resins tended to be water sensitive and had poor corrosion resistance in salt fog, cyclic Prohesion and Cleveland humidity testing. Low functionality, higher molecular weight epoxy resins had excellent flexibility but tended to have limited compatibility with the siloxane resin and low initial gloss. Medium functionality, medium molecular
weight aliphatic and cycloaliphatic epoxy resins generally provided the best combination of flexibility, UV durability and corrosion resistance.

### Table 5. Epoxy resin formulation comparisons.

<table>
<thead>
<tr>
<th>Epoxy Resin Structure</th>
<th>Comm. Epoxy Siloxane</th>
<th>Aromatic Epoxy</th>
<th>Aliphatic Epoxy A</th>
<th>Aliphatic Epoxy B</th>
<th>Cyclo Aliphatic Epoxy</th>
<th>Core Shell Rubber Dispersion Epoxy</th>
<th>Silica Nanoparticle Modified Epoxy</th>
<th>Aliphatic Epoxy C</th>
</tr>
</thead>
<tbody>
<tr>
<td>MW/f</td>
<td>-</td>
<td>380/2</td>
<td>1062/6</td>
<td>1500/3</td>
<td>270/2</td>
<td>220/2</td>
<td>750/2</td>
<td>300/2</td>
</tr>
<tr>
<td>Conical Mandrel Elongation, % (ASTM D 522)</td>
<td>&lt;3%</td>
<td>&lt;3%</td>
<td>8.5%</td>
<td>22%</td>
<td>3.5%</td>
<td>3.5%</td>
<td>4.3%</td>
<td>4.5%</td>
</tr>
<tr>
<td>QUV-B, (ASTM G 154)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>60°gloss % retention (ASTM D 523)</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
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<tr>
<td>initial 2 week 4 week 6 week 8 week 10 week</td>
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<td>70</td>
<td>80</td>
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<td>10</td>
<td>60</td>
<td>100</td>
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<tr>
<td></td>
<td>Stopped Test</td>
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<tr>
<td></td>
<td>62</td>
<td>62</td>
<td>65</td>
<td>Stopped Test</td>
<td>55</td>
<td>95</td>
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</tr>
<tr>
<td>Salt Fog, 750 hr (ASTM B 117) scribe rating (ASTM D 1654, Procedure A)</td>
<td>7</td>
<td>8</td>
<td>0</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>8</td>
</tr>
</tbody>
</table>

Referenced test methods:

- ASTM D 522 - Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings
- ASTM G 154 - Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials
- ASTM D 523 - Standard Test Method for Specular Gloss
- ASTM B 117 - Standard Practice for Operating Salt Spray (Fog) Apparatus
- ASTM D 1654 - Standard Test Method for Evaluation of Painted or Coated Specimens Subject to Corrosive Environments

#### 2.4.4 Siloxane resins

Because of their high solids content, low viscosity, excellent film forming properties and inherent resistance to degradation by ultraviolet light, alkoxy functional methylphenyl siloxanes are the silicone resins of choice for
formulating durable, ambient temperature curing epoxy siloxane coatings. Siloxane resins with 6 to 22% alkoxy content, methyl/phenyl ratios from 100/0 to 37/63 and molecular weights from 1000 to 1500 were evaluated by preparing a master batch of titanium dioxide pigmented aliphatic epoxy resin, post adding the siloxane resin and then curing the blend with a mixture of Aminosilane A and commercial aminosilane. As expected, all of the siloxane resins performed well in QUV-B accelerated weathering tests. In general, coatings based on siloxane resins with low 12% alkoxy content had good flexibility but were considered too soft for coating structures exposed to repeated handling, wear or abrasion. Coatings based on siloxane resins with high alkoxy content had excellent hardness and abrasion resistance but had low elongation and flexibility. The methyl/phenyl ratio in the siloxane resin was also optimized for compatibility and corrosion performance. The prototype coating is formulated, from siloxane resins which offered the best combination of gloss, flexibility, UV durability and corrosion resistance.

### 2.4.5 Corrosion inhibitors

A range of corrosion inhibitors were screened in the experimental formulas I and II shown above. A comparison of corrosion resistance on iron phosphate treated cold rolled steel is in the Table 6.

<table>
<thead>
<tr>
<th>Pigment</th>
<th>% Loading</th>
<th>Resin Formula</th>
<th>500 hr ASTM rating</th>
<th>700 hr ASTM rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>----</td>
<td>----</td>
<td>Commercial Epoxy Siloxane</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>----</td>
<td>----</td>
<td>I</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Calcium inhibitor</td>
<td>10%</td>
<td>I</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Magnesium inhibitor</td>
<td>10%</td>
<td>I</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Calcium inhibitor</td>
<td>16%</td>
<td>I</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>Magnesium inhibitor</td>
<td>16%</td>
<td>I</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>----</td>
<td>----</td>
<td>II</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Magnesium inhibitor</td>
<td>7%</td>
<td>II</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Magnesium</td>
<td>10%</td>
<td>II</td>
<td>8</td>
<td>7</td>
</tr>
</tbody>
</table>
Magnesium oxide and calcium compounds were found to be the best corrosion inhibitors for these polysiloxane coating systems. Magnesium compounds give better performance at lower levels than the calcium compounds regardless of the resin composition.

The base resin system of experimental formula II has better corrosion resistance than the other epoxy polysiloxane coatings. When this is used in combination with magnesium oxide, superior performance is found with <1 mm scribe creep after 500 hr. The UV durability of formula II with magnesium oxide as corrosion inhibitor does not make it useful as a direct to metal topcoat, however, this formula may find utility as a primer layer.

2.4.6 UV stabilizer package

Like many coating systems, epoxy siloxane coatings can benefit from inclusion of certain additives which protect the resin backbone from degradation by ultraviolet light. Accordingly, 15 light stabilizers were evaluated in various combinations in 54 different epoxy siloxane coating formulations by following gloss and color change using QUV-A and QUV-B accelerated weathering tests. Best results were obtained using a combination of ultraviolet light absorber and hindered amine light stabilizer.

2.4.7 Prototype formula

The prototype formula that was developed is based on a proprietary blend of aliphatic epoxy and siloxane resins, inhibitive pigments, ultra violet light stabilizers and aminosilane curatives. Compared to commercially available epoxy siloxane coatings, the new coating has high solids and low VOC, longer pot life with significantly faster dry times, higher hardness, improved flexibility and elongation, excellent resistance to a wide variety of chemicals including better resistance to organic acid and better corrosion resistance and UV durability. Application and performance properties are compared in Table 7 and Figure 8.
Table 7. Comparison of commercial and experimental epoxy siloxane coating materials.

<table>
<thead>
<tr>
<th>Coating System</th>
<th>New Epoxy Siloxane</th>
<th>Commercial Epoxy Siloxane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume Solids, calculated</td>
<td>90%</td>
<td>90%</td>
</tr>
<tr>
<td>VOC, g/l, EPA Method 24</td>
<td>&lt; 100g/l</td>
<td>&lt;100g/l</td>
</tr>
<tr>
<td>Components</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Mix ratio by volume</td>
<td>1.66 to 1.0</td>
<td>4 to 1</td>
</tr>
<tr>
<td>Dry film thickness per coat, mils</td>
<td>2 to 8</td>
<td>2 to 8</td>
</tr>
<tr>
<td>Pot life, hours</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Dry times at 72F/40%RH (ASTM D 1640)</td>
<td>30 to 40 minutes</td>
<td>3 to 4 hours</td>
</tr>
<tr>
<td>dry to touch</td>
<td>60 to 75 minutes</td>
<td>7 to 8 hours</td>
</tr>
<tr>
<td>Konig hardness (ASTM D 4366, Method A)</td>
<td>90</td>
<td>74</td>
</tr>
<tr>
<td>Conical Mandrel Elongation (ASTM D 522)</td>
<td>4.5%</td>
<td>&lt;3%</td>
</tr>
<tr>
<td>(after 3 days at 72°F + 11 days at 140°F)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salt Fog Exposure, 750 hours (ASTM B 117)</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Sandblasted Steel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASTM scribe rating (ASTM D 1654)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cyclic Prohesion, 700 hour (ASTM D 5894)</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Bonderite 1000 smooth steel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASTM scribe rating (ASTM D 1654)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MEK Double Rubs (ASTM D 5402)</td>
<td>200+</td>
<td>200+</td>
</tr>
<tr>
<td>Chemical Spot Test, 24 hrs. (ASTM D 1308, Modified)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NaOH, 50%</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>HCL, conc.</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>H₂SO₄, 98%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Phenol, 85%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>H₃PO₄, 85%</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Acetone</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Ammonium Hydroxide, 28%</td>
<td>10</td>
<td>10</td>
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<tr>
<td>Ethanol</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Acetic Acid, Glacial</td>
<td>10</td>
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<tr>
<td>Cumene</td>
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<td>0</td>
</tr>
</tbody>
</table>

Methods reference in table above:
- EPA Method 24 - Determination of Volatile Matter Content, Water Content, Density, Volume Solids, and Weight Solids of Surface Coatings
- ASTM D 1640 - Standard Test Method for Drying, Curing, or Film Formation of Organic coatings at Room Temperatures
ASTM D 522 - Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings
ASTM B 117 - Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM D 1654 - Standard Test Method for Evaluation of Painted or Coated Specimens Subject to Corrosive Environments
ASTM D 5894 - Standard Practice for Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternating Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet)

Figure 8. Accelerated weathering comparison of commercial coating and experimental formulation.
3  Discussion

3.1  Metrics

3.1.1  Materials and sample preparation

To assess the corrosion protection provided by the fire-protective coating, the coating system was compared with standard coating systems for exterior steel facilities as given in Unified Facilities Guide Specification (UFGS) 09 90 00, *Paints and Coatings*. The baseline standard coating systems for exterior ferrous metal are based on coatings specifications from the Master Painters Institute, Burnaby, BC, and are listed in the guide specification are as follows:

- **System 1:**
  - Primer: MPI #23, Surface Tolerant Metal Primer
  - Intermediate and Top Coats: MPI #9, Exterior Alkyd Enamel, Gloss, MPI Gloss Level 6 (i.e., a semi-gloss)
- **System 2:**
  - Primer: MPI #23, Surface Tolerant Metal Primer
  - Intermediate and Top Coats: MPI #94, Exterior Alkyd, Semi-Gloss, MPI Gloss Level 5 (Note: this is a semi-gloss)

Coatings meeting the requirements of the MPI specifications were (1) selected from MPI’s Approved Products List, (2) all made by a single manufacturer, and (3) applied in accordance with the manufacturer’s printed instructions.

Several other coating systems were included in the exposure tests, including the primer and topcoat used on Buildings 227 and 299 (without the intumescent intermediate coat), and several alternative systems. These systems are described in Table 8.

Panels measuring 12 x 3 in. (a few prepared at ERDC CERL were 9 x 3 in.) were painted with the various systems and were scribed prior to exposure with a 2 in. long cut to bare metal parallel to the long edge and placed in the lower half of the panel.
Table 8. Coating systems included in exposure tests.

<table>
<thead>
<tr>
<th>Coating System</th>
<th>1</th>
<th>2</th>
<th>3</th>
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<th>18</th>
<th>19</th>
<th>20</th>
<th>21</th>
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</thead>
<tbody>
<tr>
<td>Epoxy Mastic Primer</td>
<td>X</td>
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<tr>
<td>Intumescent Epoxy Mid-Coat</td>
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<tr>
<td>High Build Semi-gloss Polyurethane Topcoat</td>
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<tr>
<td>Direct-to-metal Urethane Mastic</td>
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<tr>
<td>Waterbase Gloss Exterior Acrylic</td>
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<tr>
<td>Epoxy Siloxane</td>
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<td>Two-component Fluoropolymer</td>
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<tr>
<td>Aliphatic Acrylic-Polyester Polyurethane</td>
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<tr>
<td>High-Performance Acrylic</td>
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<tr>
<td>Chlorinated Rubber Micaceous Iron Oxide Topcoat</td>
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<tr>
<td>MPI Paint # 23 Surface Tolerant Metal Primer</td>
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<tr>
<td>MPI Paint #9 Exterior Alkyd Enamel, Gloss</td>
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<tr>
<td>MPI Paint #94 Exterior Alkyd, Semi-Gloss</td>
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</tbody>
</table>

Note: System 1 was the coating system installed on Buildings 227 and 299. Systems 20 and 21 are the baseline standard systems from UFGS 09 90 00.

### 3.1.2 Coupon test rack

A coupon test rack was mounted at a 45-degree angle facing south on the sunny south side of Building 227 (Figure 9). Duplicate sets of test panels were exposed in accordance with ASTM D 1014, *Standard Practice for Conducting Exterior Exposure Tests of Paints and Coatings on Metal Substrates*, the performance of the coating systems was periodically rated in accordance with ASTM D 1654, *Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments, Method 1 (Air Blow-off)*.
This panel rating period was not yet complete at the time of publication of this report. The data for the six-month rating is provided below. Additional data will be provided in a supplement to this report.

### 3.1.3 Accelerated laboratory testing

Duplicate panels were exposed to a cycle of 7 days of salt fog and 7 days of a UV light / condensation cycle in accordance with ASTM D 5895, Standard Practice for Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternating Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet) for a total of 2,000 hours.

### 3.2 Results

#### 3.2.1 Coating performance

The demonstration project to apply fire protective and corrosion resistant coatings at Rock Island Arsenal was successfully completed. Test panels of various fire and corrosion resistant systems were created and are undergoing exposure testing on an outdoor exposure rack in the corrosive environment near Building 227 at Rock Island Arsenal.
### 3.2.2 Formulation enhancement studies

An aliphatic epoxy and siloxane resin based prototype coating was developed that exhibits improvements in VOC, pot life, dry time, hardness, flexibility and elongation, chemical and corrosion resistance, and UV durability.

### 3.3 Lessons learned

This project provided the researchers with an excellent opportunity to demonstrate the application of its intumescent fire-protective coating system to the DoD facilities community; to evaluate the adhesion and corrosion resistance of several commercially available coatings systems in the corrosive environment of Building 227; and to work to develop new fire protective coating technology with improved corrosion resistance and other properties.

The process for application of the intumescent coating system is not much different than the approach taken to any industrial painting project, a process with which most facilities are familiar. Effective management of an industrial painting project must include attention to the following:

- **Bid / Contract Scope** language needs to be very specific. All parties need to agree in writing on the scope of the project.
- A coating system test panel prepared on a steel panel prior to beginning the work on the structure. This appearance test panel should be approved by all parties and be retained to serve as a reference for all work on the structures.
- The abrasive blast equipment and the heated plural component spray equipment are heavy and bulky, and the plans for movement of material and equipment must be coordinated among all parties.
- Where possible, the planned start date should take into consideration the time of year and normal temperatures ranges typically encountered. This can avoid exposing personnel to excessive heat within enclosed work area(s), and can prevent interruptions in coating application when the temperature falls outside the manufacturer’s recommended range for coating application and curing.
- Placement of waste receptacles onsite and timely pick-up of waste such as spent abrasive media and paint and solvent wastes should be coordinated in advance with an approved local waste disposal company.
4   Economic Summary

4.1   Costs and assumptions

Demonstration project costs are shown below:

<table>
<thead>
<tr>
<th>Funding Source</th>
<th>OSD</th>
<th>Matching</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor</td>
<td>150</td>
<td>175</td>
</tr>
<tr>
<td>Materials</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>Navy / Air Force Support</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Travel</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Report</td>
<td>60</td>
<td>35</td>
</tr>
<tr>
<td>Total</td>
<td>500</td>
<td>500</td>
</tr>
</tbody>
</table>

Critical steel structures and components are painted on a 15 year cycle, at a cost of $2.2M. The maintenance of the coating systems and maintenance and repair of the painted structure and components is $150K.

The annual costs of mission impact due to corrosion of the structure is $50K. In this model two fire events are included in years 15 and 30, and savings of $8M and $6M are attributed to the performance of the intumescent paint in reducing fire damage.

The new paint system will be maintained at an annual cost of $40K, commencing after year 10.

4.2   Return-on-investment computation

1) Projected Useful Life Savings (ULS) is equal to the “Net Present Value (NPV) of Benefits and Savings” calculated from the Spreadsheet shown in Appendix 1 that is based on Appendix B of OMB Circular A94.

ULS= $8,755K (from OMB Spreadsheet).

2) Project Cost (PC) is shown as “Investment Required” in OMB Spreadsheet in Appendix 1; PC= $1,000K.

3) Potential ROI – Computation
Potential ROI = \( \frac{8,755K}{1,000K} = 8.76 \)

The calculated ROI for this project, which is based on current best practices, projected maintenance and rehab cost, has the potential to increase over the multiple year implementation due to reduction in down time, which will result in increased indirect savings.

Table 9. Return-on-investment calculation.

<table>
<thead>
<tr>
<th>A Future Year</th>
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5 Conclusions and Recommendations

5.1 Conclusions

The coating system demonstrated in this project has been shown to provide good corrosion protection to the steel in corrosive environments in accelerated laboratory tests and on the structures at Rock Island Arsenal. Additionally, the system is designed to protect the steel from reaching high temperatures in a fire for up to 3 hours. This system has the potential to provide the benefits of this protection to many types of structures across the DoD.

5.2 Recommendations

5.2.1 Applicability

Within the Department of Defense, a number of possibilities exist for the improvement of asset protection by the use of fire protective corrosion resistant coatings. A non-exhaustive list of these opportunities is shown in Table 10. It should be noted that the specifications on this table are of a general nature only. Where fire protection is required, it is necessary that requirements of the specific situation to be assessed to determine the appropriate type of coating system that will provide the most effective protection.

<table>
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<th>Structure Type</th>
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<th>Specification Recommended</th>
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<td>Steel vessel</td>
<td>OTI-95-634 Chartrek 7 Jet Fire Certification</td>
<td>2 hr jet fire on vessels&lt;br&gt;2&quot; foamglas plus 8mm Flexible Epoxy Intumescent</td>
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<td>Cellulosic Fire, UL 263</td>
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Relevant standards:
UL 263 - Standard for Fire Tests of Building Construction and Materials
UL 1709 - Standard for Rapid Rise Fire Tests of Protection Materials for Structural Steel

5.2.2 Implementation

DoD criteria documents cover cementitious or fiber-based fireproofing (UFGS-07 81 00 Spray-Applied Fireproofing April 2006) and detailed design criteria (UFC 3-600-01 26 Fire Protection Engineering for Facilities, September 2006), but these documents do not address the available intumescent coating systems. These documents need to be updated to allow application of the new, flexible epoxy intumescent coating systems. Ideally, an product specification will be adopted by SSPC - The Society for Protective Coatings, or the Master Painter's Institute so that the product specification can be referenced in the UFGS as a system.

A recommendation for implementation language is included in Appendix D.
Appendix A: Project Management Plan for CPC Project FAR-13

MEMORANDUM FOR DIRECTOR, INSTALLATION MANAGEMENT AGENCY, 2511 JEFFERSON DAVIS HIGHWAY, ARLINGTON VA 22202-3928

SUBJECT: FY 06 Army Corrosion Control Program

1. OSD has tentatively allocated a total of $15.0M in FY 06 matching funds for implementation of corrosion prevention and control projects for equipment and facilities. The enclosed list of Army projects, totaling $13.3M, will be presented for approval to OSD in April 05.

2. The Army programming target is not less than $10.0M of facility related projects in an effort to obtain a minimum of $5.0M of the OSD matching funds. To participate in OSD's funding augmentation, HQIMA will reserve $5.0M in FY06 OMA funds, to be released to ERDC-CERL upon confirmation by this office that OSD matching funds are available. Further instructions on the actual distribution of funds will follow at that time.

3. POC for this action is Mr. David N. Purcell, or (703) 601-0371, David.Purcell@hqda.army.mil.

4. Quality Facilities for Quality Soldiers!

FOR THE ASSISTANT CHIEF OF STAFF FOR INSTALLATION MANAGEMENT:

Encl as

MARK A. LORING
Colonel, GS
Director, Facilities and Housing

CF DACSIM
TRI SERVICE PROGRAM
EQUIPMENT/ FACILITIES

CORROSION PREVENTION AND CONTROL PROJECT PLAN

Coating System For Corrosion Prevention and Fire Resistance
for Metal Structures (OMA)

15 June 2005

Submitted By:

Vincent F. Hock

U. S. Army Engineer Research & Development Center (ERDC)

Construction Engineering Research Laboratory (CERL)

Comm: 217-373-6753

(Project Number to be assigned by OSD when approved)
TRI SERVICE PROGRAM
DOD EQUIPMENT / FACILITIES
Coating System For Corrosion Prevention and Fire Resistance for Metal Structures

1. STATEMENT OF NEED

PROBLEM STATEMENT:

Fire protective coatings are used to protect structural elements in hangars, motor pools, fuel systems, and ships. They can be used to protect munitions and military vehicles/vessels from fire. Key infrastructure will be protected from collapse as a result of fire. Fire protective coatings include cementitious materials and organic based intumescent coatings.

Currently, organic coatings generally use resins such as solution vinyls, and latexes. Solution vinyls are slowly disappearing because of their high solvent content and the need for environmentally friendly coatings. Water-based latex coatings are generally used in what is often referred to as thin film intumescents (approximately 50 mils in thickness when applied) and provide up to 2 hours fire protection, but because of their composition tend not to be durable and provide little corrosion protection.

Now, innovative epoxy intumescent coatings are much more durable and keep structural steel from reaching 1000 deg F. In order to prevent softening of the steel and a significant loss of strength for up to 4 hours. Formulated with nano corrosion inhibitors, they provide excellent corrosion protection to the substrate.

Fire protection is a concern at the Rock Island Arsenal (RIA) maintenance facilities. The commonly used protective coatings on steel structures are susceptible to peeling and spalling, or other deterioration, due to the combined effect of exposure to sunlight, changing humidity, and hot and cold cycles experienced during weathering.

IMPACT STATEMENT: If this project is not funded, mission critical structures, such as manufacturing and storage facilities, boiler plant, vehicle maintenance facilities, and other at risk structures will remain at risk to fire damage, and will continue to corrode.

The technology proposed for implementation is not a routine maintenance technology. It is an emerging corrosion prevention and control and fire protection technology, which means that, although it is mature, it has not been widely implemented at Army installations.

The epoxy intumescent coating is a new technology that has been used in non-military applications, such as chemical plants, refineries, power plants, and other industrial applications. Use of this coating system at aircraft facilities will greatly enhance corrosion and fire protection of the structures.
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DOD EQUIPMENT / FACILITIES
Coating System For Corrosion Prevention and Fire Resistance for Metal Structures

The project has the potential for far-reaching impact across the DoD. Specifications and standards will be developed, along with a final report describing the project and its results. The corrosion and fire resistant coating technology will be available for implementation DoD wide in aircraft facilities, vehicle maintenance facilities, munitions storage facilities, and other industrial structures where a fire protective coating is needed.

2. PROPOSED SOLUTION

TECHNICAL DESCRIPTION: Coatings can serve as passive fire protection methods. Cementitious coatings and sprayed fiber systems are heavy, bulky, and inflexible. They do not adhere well to surfaces and are subject to spalling.

Intumescent coatings are based on traditional paint resins, such as solution vinyl, latex, and epoxy, and are applied as thin films like traditional paints. The resins allow the coatings to form tight bonds to structural surfaces. When exposed to fire, the intumescent coating reacts by expanding. It is transformed to a thick, ceramic-like, insulating char that provides thermal protection for the substrate.

Solution vinyls are slowly disappearing because of their high solvent content and the need for environmentally friendly coatings. Water-based latex coatings are generally used in what is referred to as thin film intumescents (approximately 50 mils in thickness when applied). These coatings provide up to 2 hours fire protection but because of their composition tend not to be durable outside and are typically used on interior structural steelwork of commercial buildings.

Epoxy coatings are very durable, can provide fire protection of 4 hours or more, but tend to be expensive and difficult to apply. The High Performance Coatings Group of PPG has been developing fire protective coatings for over 20 years. New advancements in fire protective coatings include the Pitt Char coating line.

Because the Pitt Char XP Fire Protective Coating is an epoxy, it resists solvents, acids, alkalis, salts and abrasion while retaining its fire protective properties. The coating bonds tightly and cures to form a dense, impervious barrier that blocks corrosives such as salt spray and moisture. It is a tough coating that withstands damage from impact. The coating is unique in that it is flexible, with elongation over 19%. It will adhere to structural steel and other metals, and fiberglass reinforced composites.

When applied under recommended conditions, it will stand up to conditions ranging from arctic to tropical. The coating is virtually maintenance-free.

TECHNOLOGY MATURITY: This technology is mature. The intumescent epoxy
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Coating is commercially available.

RISK ANALYSIS: This is a low risk project, as the coating system proposed for use has been in select applications by industry, though not widely implemented for DoD applications.

EXPECTED DELIVERABLES AND RESULTS/OUTCOMES: Candidate structures at Rock Island Arsenal will be assessed for application of the intumescent epoxy system. The coating system will be applied to two hangars and one additional structure selected by the installation. The coating will be monitored for one year to validate the material performance. It is expected that the corrosion and fire protective coating system will provide excellent protection against atmospheric corrosion, and extend the service life of the hangar by another 15 years, as well as reduce maintenance costs and provide the benefits of fire protection. Specifications for the coating system will be developed, including surface preparation, coating application, and maintenance painting. Training on the maintenance of the coatings will be provided to RIA personnel.

PROGRAM MANAGEMENT: The Project Manager will be Mr. Vince Hock. The Associate Project Manager is Ms. Susan Drozd. Mr. Martin Savoie is the Chief of the ERDC/CERL Materials and Structure Branch. The stakeholder will be Mr. Jerry Sechser (Rock Island Arsenal DPM POC), Mr. Tom Shields (IMA NWRO), Mr. Paul Volkman (HQ-IMA), Mr. David Purcell (HQ-ACSIM), as well as the Tri-Services WIPT representatives Ms. Nancy Coleal (AFCES/ACESM), and Mr. Tom Tehada (NFESC).

The customer representative is Mr. Robert Kalantari, Rock Island Arsenal. The technology will help RIA improve corrosion control and fire protection of their critical structures. The Army plans to provide matching funds ($500K) for FY06 through HQ-IMA (See Memorandum from ACSIM attached as Appendix 2). Coordination with the Army Corrosion Program Office will be through Mr. Hilton Mills (AMC).

This is a Tri-Service Project. Funds have been requested for Air Force, Army, and Navy representatives to participate in the evaluation of technology implementation.

3. COST/BENEFITS ANALYSIS

a. Funding ($K):

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TRI SERVICE PROGRAM
DOD EQUIPMENT / FACILITIES
Coating System For Corrosion Prevention and Fire Resistance for Metal Structures

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Development of Project Budget

The $1M budget ($500K OSD, supplemented by $500K matching funds from IMA) is realistic and adequate for the project scope. This budget had been developed based on a detailed needs assessment for the structures.

b. Return-On-Investment Computation:

1) Projected Useful Life Savings (ULS) is equal to the “Net Present Value (NPV) of Benefits and Savings” calculated from the Spreadsheet shown in Appendix 1 that is based on Appendix B of OMB Circular A64.

ULS= $8,755K (from OMB Spreadsheet in Appendix 1. Assumptions for this calculation are also given in Appendix 1).

2) Project Cost (PC) is shown as “Investment Required” in OMB Spreadsheet in Appendix 1, PC= $1,000K.

3) Potential ROI – Computation (See Appendix 1).

\[
\text{Potential ROI} = \frac{\text{ULS}}{\text{PC}} = \frac{8,755K}{1,000K} = 8.76
\]

The calculated ROI for this project, which is based on current best practices, projected maintenance and rehab cost, has the potential to increase over the multiple year implementation due to reduction in down time, which will result in increased indirect savings.

c. Mission Criticality: The operational benefits of implementation of the corrosion index for mission critical systems are: 1) enhanced life safety and reliability, 2) life extension and reduced maintenance and repair for DoD facilities and equipment.

4. SCHEDULE

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TRI SERVICE PROGRAM
DOD EQUIPMENT / FACILITIES
Coating System For Corrosion Prevention and Fire Resistance for Metal
Structures

Initiate Implementation of Corrosion And Fire Protective Coating System
Complete ROI Validation
Complete Documentation
9 18 18

a. Note: If project is approved, bi-monthly status reports will be submitted (i.e. starting the first week of the second month after contract award and every two months thereafter until final report is completed). This report will be submitted to the DoD CPC Policy & Oversight office. Report will include project number, progress summary (and/or any issues), performance goals and metrics and upcoming events.

b. Examples of performance goals and metrics: include achieving specific milestones, showing positive trend toward achieving the forecasted ROI, reaching specific performance quality levels, meeting test and evaluation parameters, and/or successfully demonstrating a new system prototype.

Development Project Schedule
This project to establish rates of corrosion and impact of corrosion damage in specific environments will be completed, including final report, within 18 months.

The goals of the project are: reducing the corrosion rate of the structural steel and increasing fire safety for the structures at Rock Island Arsenal, as well as validating the technology for other uses across the DoD. Detailed milestones are given in the schedule section. Implementation of the coating system will be accomplished by Contractors. ERDC-CERL will provide overall management, contract monitoring and provide bi-monthly reports. Existing contract mechanisms, such as IDIQ, ERDC-CERL will be able to award the contracts within 60 days of receipt of funds. Potential contractors have been identified.

5. IMPLEMENTATION

a. Transition approach: Where appropriate, Unified Facilities Guide Specifications (UFGS), Engineering Instructions (EI), Technical Instructions (TI), and Technical Manuals (TM), including updates, along with a final report describing the details of the project, will be developed and posted on the OSD Corrosion Exchange website.

It is the intent of the Project Management Plan (PMP) to implement the corrosion index at all DOD installations worldwide.

b. Final Report: A final report will be written 60 days after the project is completed. The report will reflect the project plan format as implemented and will include lessons learned.
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Projected Benefits:
Based on the results of the initial implementation of this approach for the USAF aircraft fleets, this project will be used to optimize materials selection and corrosion management approaches at the local level for DoD installations.

Operational Readiness
An understanding of the local corrosion environment, corrosion rates for various materials, and the impact of corrosion damage will allow system developers and construction managers to select materials and plan corrosion prevention and control practices that will enhance the performance, reliability and safety of DoD equipment and facilities.

Management Support
This project enjoys the support of the Rock Island Arsenal DPW Office, specifically, Mr. Jerry Sechser, Director, Public Works. IMA-NMRO has also provided its support. HQ-ACSIM plans to provide matching funds ($500K) for FY06. See the attached Memorandum from ACSIM Director for Facilities and Housing in Appendix 2.
## 6. COORDINATION SHEET

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This is a Tri-Service Project. Funds have been requested for Air Force, Army and Navy representatives to participate in the evaluation of technology implementation.
TRI SERVICE PROGRAM
DOD EQUIPMENT / FACILITIES
Testing System For Corrosion Prevention and Fire Resistance for Metal Structures

6. COORDINATION SHEET

ORGANIZATION

SIGNATURE

DATE

Program Manager

Project Manager

ERDC/CERL Branch Chief

Rock Island Arsenal DPW

MA Northwest Region

HQ ACBM

HQ AMC

Tri Service Facilities WP'T Chair

This is a Tri-Service Project. Funds have been requested for Air Force, Army
and Navy representatives to participate in the evaluation of technology
implementation.
TRI SERVICE PROGRAM

DOD EQUIPMENT / FACILITIES

Coating System For Corrosion Prevention and Fire Resistance for Metal Structures

6. COORDINATION SHEET

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This is a Tri-Service Project. Funds have been requested for Air Force, Army, and Navy representatives to participate in the evaluation of technology implementation.
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This is a Tri-Service Project. Funds have been requested for Air Force, Army and Navy representatives to participate in the evaluation of technology implementation.
TRI SERVICE PROGRAM
DOD EQUIPMENT / FACILITIES
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APPENDIX 1
POTENTIAL ROI CALCULATIONS BASED ON OMB CIRCULAR A94

1. Critical steel structures and components are painted on a 15 year cycle, at a cost of $2.2M. The maintenance of the coating systems and maintenance and repair of the painted structure and components is $150K per year.

2. The annual cost of mission impact due to corrosion of the structure is $50K. In this model two fire events are included in years 15 and 30, and savings of $8M and $6M are attributed to the performance of the intumescent paint in reducing fire damage.

3. The new paint system will be maintained at an annual cost of $40K per year, commencing after year 10.
# Return on Investment Calculation

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<th>Future Year</th>
<th>Baseline Costs</th>
<th>Benefits/Savings</th>
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**Net Present Value of Costs and Benefits/Savings:** 215,412,897,600,875,578,818
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TRI SERVICE PROGRAM
DOD EQUIPMENT / FACILITIES
Coating System For Corrosion Prevention and Fire Resistance for Metal Structures
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Coating System For Corrosion Prevention and Fire Resistance for Metal Structures

APPENDIX 2
Appendix B: Contractor’s Work and Safety Plan

PPG Industries Inc.

Final Work Plan for

Rock Island Arsenal
Fire Protective Coatings Project

February 26, 2007

Contract # W9132T-PPG-001
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PPG’s Role

PPG will provide inspection of the application at critical points as described below:

- Mobilization to the work area.
- After surface preparation, but prior to primer application.
- After primer application, but prior to fireproofing application.
- After fireproofing application, but prior to finish coat application.
- After finish coat application, but prior to de-mobilization from the work area.

Additionally, PPG will provide inspection on an as “needed basis” depending upon the results of the scheduled inspections.

PPG will provide all reports as set forth in the contract.

PPG will monitor the applied coatings approximately six months after the coating application is completed. Date shall be coordinated with the COTR.
PROTECT YOUR PEOPLE, PROPERTY, AND PRODUCT.

THE WORLD'S BEST PROTECTION AGAINST FIRE FROM PPG INDUSTRIES, ONE OF THE WORLD'S LEADING PRODUCERS OF COATINGS AND RESINS.

THE ONLY FLEXIBLE EPOXY INTUMESCENT COATING ON THE MARKET TODAY WHICH PROVIDES BOTH MAXIMUM FIRE AND CORROSION PROTECTION FOR ON-LAND AND OFF-SHORE FACILITIES.
TECHNOLOGY

Per Chir X™ XP Coating is the result of a long-term research and development effort that began in the late 1980s. This new Coating system is designed to be a multi-functional protective surface that provides high-performance protection against a wide range of environmental and mechanical stresses. The unique design of the Coating system allows it to be applied to various substrates and in a variety of conditions, making it versatile and adaptable to a wide range of applications.

INFLUENCE OF THE PROCESS

Per Chir X™ XP Coating is an innovative technology that uses a proprietary process to coat metal substrates with a high-performance, protective barrier. This Coating system is designed to be applied in a single step, eliminating the need for multiple coats and reducing installation time. The Coating system is also designed to be resistant to a wide range of environmental conditions, making it ideal for use in harsh environments.

CORROSION

Because Per Chir X™ XP Coating is a polymer-based Coating, it is highly resistant to corrosion. The Coating system is designed to be applied to metal substrates, providing a protective barrier that prevents corrosion and extends the life of the substrate.

FLEXIBILITY

Per Chir X™ XP Coating is formulated to be highly flexible, allowing it to be applied to a wide range of substrates and in a variety of conditions. The Coating system is designed to be applied in a single step, eliminating the need for multiple coats and reducing installation time. The Coating system is also designed to be resistant to a wide range of environmental conditions, making it ideal for use in harsh environments.

- The Coating system is applied in a single step, eliminating the need for multiple coats and reducing installation time.
- The Coating system is designed to be resistant to a wide range of environmental conditions, making it ideal for use in harsh environments.
- The Coating system is formulated to be highly flexible, allowing it to be applied to a wide range of substrates and in a variety of conditions.
COST EFFECTIVE, VIRTUALLY MAINTENANCE FREE
By a few simple steps, you can make your facility more effective compared to conventional alternatives. While conventional coating operations require time-consuming maintenance, Pit-1 Clear 1P coating can be applied by experienced applicators in a fraction of the time.

- **Pit-1 Clear 1P** coating is applied by a global network of trained certified applicators.
- **1PP** provides effective chemical protection, including the project-specific specification phases.
- **1PP** allows for rapid system selection, support for easy applications.
- **1PP** is used in multiple countries, including the USA, UK, Norway, and Singapore.
- **1PP** is designed to withstand harsh environments.

**PRODUCT DATA**

**Pit-1 Clear 1P** is a protective coating designed for infrastructure, including industrial facilities, tunneling, deck, and offshore platforms. **Pit-1 Clear 1P** is environmentally friendly and provides a wide range of benefits, including reduced maintenance and improved performance.

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<th>Property</th>
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<td>Service Temperature-Range</td>
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<td>Spray-Film</td>
<td>Approximately 0.0011 to 0.0017 inches in thickness at 70°F (21°C).</td>
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<td>Shear Strength</td>
<td>Minimum shear treated under proper storage conditions at 70°F (21°C) and 48% RH. 2 Years from date of manufacture.</td>
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<td>Approximately 10% at 0°F (−18°C). 2 Years from date of manufacture.</td>
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<td>Anti-Corrosion</td>
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<td>Approximately 10°F (−10°C) with 2 Years from date of manufacture.</td>
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### Physical and Mechanical Properties

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### Environmental Properties

Tests conducted by Underwater Laboratory. All thermal properties were determined at a temperature of 23°C and 50% relative humidity. For Promax XP coating, the following tests were conducted:

- Salt Spray
- Cold and Hot Water Spraying
- Humidity
- Artificial Aging of 40°C and 85% Relative Humidity
- Sunlight Exposure

### Cryogenic Exposure

A steel panel coated with Promax XP coating was exposed to liquid nitrogen and the surface temperature reached 12°F (-10.9°C) and the maximum temperature reached 17°F (-8.9°C). This material had very low conductivity, but its performance in these extreme conditions was remarkable. The panel was inspected and evaluated for any damage or performance loss. The flexibility of Promax XP coating allows the coating to remain intact under extreme cryogenic testing and handling. The coating remains intact to provide protection and longevity.
PPG High Performance Coatings

MATERIAL SAFETY DATA SHEET

SECTION 1 - PRODUCT AND COMPANY INFORMATION

PPG Industries, Inc.
One PPG Place
Pittsburgh, PA 15222

EMERGENCY NUMBERS:
(412) 434-4516 (U.S.)
(205) 434-9202 (Canada)
314-843-6245 (Missouri)
800-888-6510 (Canada)

SECTION 2 - COMPOSITION INFORMATION

The following ingredient(s) are rated with an "A", as considered hazardous under applicable U.S. federal and/or Canadian WHMIS regulations. If no quantities are listed, then there are no U.S. OSHA and/or Canadian WHMIS hazardous ingredients in this product.

EXHAUST

Name
GF Red

NO

NAME

EXHAUST

Name
GF Red

NO

SECTION 3 - HAZARDOUS IDENTIFICATION

ACUTE OVEREXPOSURE EFFECTS

EYE CONTACT:
If exposed, rinse with water and cover eyes with a device that provides protection from chemical splash.

SUN doi:10.1002/978-1-118-77781-0.ch1 (c) 2014 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim

SECTION 5 - FIRE FIGHTING MEASURES

FLAMMABILITY:
FLAMMABLE (Flash Point: 194 Degrees F (78 Degrees C))
FLASHPOINT TEST METHOD: Pendulum Method (Open Cup)
Leaves, 70°C
LOW FLAMMABILITY

EXTINGUISHING MEDIA:
Water misted by a dry chemical or Class B fire extinguishers. Water may not be used in direct contact with the burning material due to the possibility of violent reaction of hydrogen gas. Use suitable equipment to extinguish the fire by the use of an inert gas such as carbon dioxide.

PROTECTION OF FIRE FIGHTERS:
Flammable liquids should not be used in direct contact with the burning material due to the possibility of violent reaction of hydrogen gas. Use suitable equipment to extinguish the fire by the use of an inert gas such as carbon dioxide.

FIRST AID:
Care should be taken to avoid contact with the eyes, skin, or clothing. In case of contact, immediate medical attention should be sought.

PRODUCT NAME: UNIDENTIFIED COMPOUND

Page 2 of 6
U.S. TSCA: This product contains all of the components in addition to those listed in the U.S. TSCA Inventory or the inhalative exemption for TSCA inventory reporting requirements.

FEDERAL REGULATIONS

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REASON FOR REVISION: Section 11 has been updated. Section 2 has been updated. Changes to this section may also result in changes to sections 6, 11, and 13. Section 9 has been updated. Deep Edition updated 2020.

This Material Safety Data Sheet has been prepared in accordance with California's Proposition 65 and the OSHA Hazard Communication Standard (29 CFR 1910.1200); the supplier certifications requirements of SARA Title III, Section 313 and other applicable right-to-know regulations.

Additional environmental information is contained on the Environmental Data Sheet for the product, which can be obtained from your PPG representative.

**END OF SDS**

SECTION 19 OTHER INFORMATION

Hazard Rating Systems

NFPRA Rating: Z-20
HIDO Rating: 2-2C

Rating System Definitions:

- "Highest" = Hazardous, 1
- "Significant" = Moderate, 2
- "Slight" = Low, 3
- "Low" = Negligible, 4


Safe handling of this product requires that all of the information on this MSDS be reviewed for specific work environments and conditions at the place where the product is used.

PREPARED BY: Product Safety Department
PPG High Performance Coatings

SKIN CONTACT:
Skin contact with direct contact with eyes, nose, mouth, and skin may cause skin irritation and eye injury.

SKIN ABSORPTION:
Skin absorption of the eyewash solution may cause skin irritation and eye injury.

INHALATION:
Inhalation of the eyewash solution may cause skin irritation and eye injury.

SYMPTOMS OF OVEREXPOSURE:
Skin irritation and eye injury.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE:
Skin irritation and eye injury.

PRECAUTIONARY STATEMENTS:
Avoid contact with skin, eyes, and clothing.

FIRST AID MEASURES:
If skin contact occurs, immediately flush skin with plenty of water for at least 15 minutes. For eye contact, flush eyes with plenty of water for at least 15 minutes.

If swallowed, call a Poison Control Center or a hospital emergency department immediately. For first aid or emergency treatment advice, call 1-800-638-8770.

Personal Protective Equipment:
Use proper personal protective equipment when handling this product.

PHYSICAL AND CHEMICAL PROPERTIES:

ENGINEERING CONTROLS:
Use local exhaust ventilation to reduce exposure to the product.

STORAGE:
Store in a cool, dry place away from heat and direct sunlight.

DISPOSAL:
Dispose of the product according to local regulations.

HAZARDS TO PREVENT:
Skin irritation and eye injury.

PPE:
Use appropriate eye protection and disposable gloves when handling the product.

OTHER INFORMATION:
For additional information, contact the manufacturer.

ERDC/CERL TR-09-29 B14

Page 1 of 4
INHALATION:

Recovery from acute isobutylene occurs naturally. If immediate, contact a poison control center, emergency room or physician for treatment recommendations.

EYE CONTACT:

Wash out with large amounts of water. If necessary, seek medical attention.

INGESTION:

Wash out with water. If necessary, seek medical attention.

FIRST AID:

Contact a poison control center or emergency room or physician right away as treatment may be necessary.

PERSOAL PROTECTIVE EQUIPMENT:

EYES:

Wear chemical splash eyewear with side shields for eye contact. Also, wear chemical splash resistant protective clothing for use as a treatment may be necessary.

SPLASHERS:

Protective clothing to prevent eye contact. Keep and goggle should be considered as well.

WORKERS:

Wear protective clothing to prevent eye contact. Younger and goggle should be considered as well.

RESTRAINT:

Ongoing exposure may be prevented by ensuring proper respiratory control. Keep the exit at least 500 feet away from the area. A NIOSH/NIOSH-approved air purifying respirator with the appropriate carbon filter cartridge should be used. A large amount of water should be used as a treatment as necessary. Inhaling can cause respiratory distress. Use a mask with an air purifier. Avoid exposure to this product. Keep the area well-ventilated. Wear personal protective equipment (PPE) as needed. Be aware of the potential hazards associated with this product. Use a mask with an air purifier.

PROTECTION OF FIREFIGHTERS:

Wear self-contained breathing apparatus and self-contained breathing apparatus for personnel who will respond to the fire. Do not wear personal protective equipment (PPE) as needed. Be aware of the potential hazards associated with this product. Use a mask with an air purifier.

UNUSUAL FIRE AND EXPLOSION HAZARDS:

Keep the area well-ventilated. Airborne contamination can occur if exposure occurs. Wear personal protective equipment (PPE) as needed. Be aware of the potential hazards associated with this product. Use a mask with an air purifier.

SECTION 5: ACCIDENTAL RELEASE MEASURES

STEPS TO BE TAKEN DURING HANDLING AND STORAGE:

Vapor recovery: vapor recovery of the material is required. If the material is placed in a multiple containment system, the Material Safety Data Sheet (MSDS) for the material is required. If the material is placed in a single containment system, the Material Safety Data Sheet (MSDS) for the material is required. If the material is placed in a multiple containment system, the Material Safety Data Sheet (MSDS) for the material is required.

PRECAUTIONS TO BE TAKEN DURING HANDLING AND STORAGE:

Vapor recovery: vapor recovery of the material is required. If the material is placed in a multiple containment system, the Material Safety Data Sheet (MSDS) for the material is required. If the material is placed in a single containment system, the Material Safety Data Sheet (MSDS) for the material is required.
SECTION 8. PHYSICAL & CHEMICAL PROPERTIES

<table>
<thead>
<tr>
<th>FORMULA VALUES, NOTfadeOut SPECIFICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPECIFIC GRAVITY: 1.501</td>
</tr>
<tr>
<td>PHYSICAL STATE: Liquid</td>
</tr>
<tr>
<td>Percent Solid: 27.31</td>
</tr>
<tr>
<td>Percent Volatile by Volume: 24.050</td>
</tr>
<tr>
<td>ODOR THRESHOLD: Indetected</td>
</tr>
<tr>
<td>VAPOR DENSITY: 1.06</td>
</tr>
</tbody>
</table>

SECTION 9. STABILITY AND REACTIVITY

STABILITY
This product is normally stable and will not undergo spontaneous reaction. Storage conditions to avoid:
None known.

INCOMPATIBLE MATERIALS:
Avoid contact with strong acids, strong alkalis, or aqueous solvents.

Hazardous Polymerization:
None known.

Hazardous Decomposition Products:
Certain monomers or other hazardous materials can be released from this product.

SECTION 10. TOXICOLOGICAL INFORMATION

ACUTE TOXICITY

<table>
<thead>
<tr>
<th>MURITY</th>
<th>LID MORTALITY</th>
<th>LID MORTALITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute Oral LD50: 5.5 mg/kg</td>
<td>Acute Oral LD50: 5.5 mg/kg</td>
<td></td>
</tr>
<tr>
<td>Acute Skin LD50: 5.5 mg/kg</td>
<td>Acute Skin LD50: 5.5 mg/kg</td>
<td></td>
</tr>
<tr>
<td>Acute Intraperitoneal LD50: 5.5 mg/kg</td>
<td>Acute Intraperitoneal LD50: 5.5 mg/kg</td>
<td></td>
</tr>
</tbody>
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CHRONIC TOXICITY

<table>
<thead>
<tr>
<th>Ingestion Target Organ/Chronic Effects:</th>
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</thead>
<tbody>
<tr>
<td>- Carcinogenic - Chronic Reproductive - Carcinogenic - Long</td>
</tr>
</tbody>
</table>

SECTION 11. SPECIAL RECOMMENDATIONS

Supplemental Information:

- Physical Constants: 70°F (21°C) and 1 atmosphere pressure.
- Chemical Properties: None known.
- Storage Conditions: Store in a cool, dry, well-ventilated area.
- Disposal: Disposal of this product shall be in accordance with local, state, and federal regulations.

SECTION 12. ENVIRONMENTAL INFORMATION

Environmental Fate:

- No data available.
- Bioaccumulation:
- No data available.

Physical/Chemical

Hydrolysis:

- No reaction will occur.

SECTION 13. TRANSPORTATION INFORMATION

Proper Shipping Name:
RGS Technical Name: None
HAZARD Class: None
UN Number: UN1091
Packing Group: I

USA - RGS Hazardous Substance:
- Y12 - 11/12/13 - None
- 28-11/12/13 - None
- Marine Pollutant: None

USA Shipment Only - RGS Terminal: None

Material Weight:
- Weight of this product shall not be shipped to exceed the RGS quantity.
### SECTION 15 - REGULATORY INFORMATION

#### INVENTORY STATUS

* TSCA: This product and/or AT of its components are listed by OSHA under the Toxic Substances Control Act (TSCA) as a hazardous substance requiring reporting.

#### FEDERAL REGULATIONS

<table>
<thead>
<tr>
<th>US Regulations</th>
<th>Hazard Class</th>
<th>Required ATQ Comment</th>
<th>Warning</th>
<th>Requirement</th>
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<td>Yes</td>
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<tr>
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<td>127</td>
<td>Yes</td>
<td>Toxic</td>
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</table>

#### PREPARED BY:
Product Safety Department

#### REASON FOR REVISION:
Section 9 has been updated. Changes to this section may also apply to changes in sections 8, 13 and 15. Section 13, "Other Information," has been updated. The sheet is updated. Item, Section 8, Item 42, has been updated. Item, Section 8, Item 43, has been updated.

### ADDITIONAL INFORMATION

#### CALIFORNIA PROPER 65 WARNING:
This product contains a chemical known in the State of California to cause cancer.

#### EPHRAIM WASTE CLASSES:
- Class 5: Division A - Class 5: Division A - Class 5: Division A - Class 5: Division A - Class 5: Division A - Class 5: Division A - Class 5: Division A - Class 5: Division A

#### STABILITY AND REACTIVITY:

<table>
<thead>
<tr>
<th>Substance</th>
<th>Type</th>
<th>Stability</th>
<th>Reactivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>AE</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>B</td>
<td>AE</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>C</td>
<td>AE</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>D</td>
<td>AE</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>E</td>
<td>AE</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

#### SECTION 16 - OTHER INFORMATION

**Hazard Rating Systems**
- NFPA: Rating 2.00
- HMIS: Rating 3.00
PIT-C-GUARD®

97-145 Series

HPC Industrial Maintenance

Non-Skid Epoxy Type Coatings

PIT-C-GUARD® Direct-To-Rust Epoxy Mastic Coatings

General Description

PIT-C-GUARD® products are intended for use where non-skid, non-slip surfaces are required. Non-skid type protection is required for properly prepared steel, or below decks where steel, aluminum or wood is shipped in areas that could be used in properly prepared surfaces. They are excellent waterfront protective and corrosion coating for marine and industrial applications. These products have been formulated for use in all types of adverse weather conditions and will not require your usual protective coating.

Recommended Uses

Aluminum

Barnwood

Cement

Concrete

Epoxy

Fiberglass

Steel

Wood

Features & Benefits

Non-slip surfacing protection

Excellent adhesion to minimally prepared surfaces

Ease of application with the component Permcoat 105

Non-upsetting for corrosion protection

Easily Mixed Colors for identification

Limitations of Use

For Professional Use Only; Not Intended for Household Use. Apply only when material temperature is above 60°F (16°C) and an air temperature is above 50°F (10°C) and wind at an exposure of 5 mph (8 kph) or below. Avoid direct sun exposure. Do not paint in areas exposed to rain or snow or any extreme temperatures. This product is not recommended for use on non-metallic surfaces. This product should be applied only by professional painters with experience in this type of work. Care and caution should be exercised when applying this product to ensure proper surface preparation.

Product Data

Color: Semi-Gloss, Tintable

VOC: 1.27 lb/gal (12.8 lb per 100 sq ft)

Coverage: 195 sq ft per gal (31 sq ft per 100 lb)

Dry film thickness: Not recommended for direct application on a floor to be used in a 4.0 minimum to 7.5 extremely corrosive environment

Volume solids: 34.4% (27.0%)

Weight Solids: 95.6% (0%)

Mix Ratio: 1 part Component A to 1 part Component B

Cure Time: 24 hours

Drying Time: 8 hours

To Handle: 16 hours

To Remov: 16 hours

Acid-Resistant: Yes

Dust Free: 30 minutes

Rub Life: 4 hours

Induction Time: 30 minutes

Flash Point: 97°F (36°C), 64°C (141°F)

97°F (36°C), 103°F (39°C)
PPG High Performance Coatings

SECTION 1 - PRODUCT AND COMPANY INFORMATION

PPG Industries, Inc.
Cera PPG Place
Pittsburgh, PA 15222

EMERGENCY PHONE NUMBERS:
(800) 313-9600 (U.S.)
(724) 685-4000 (Canada)
(01) 3821-9250 (Mexico)
(02) 9814-8584, 984-0667 (China)

TECHNICAL INFORMATION:
PRODUCT SAFETY /EMERGENCY INFORMATION:
1-800-313-9600 (U.S.)
(724) 685-9666 (Canada)

ISSUE DATE:
04/05/2005

SECTION 2 - COMPOSITION INFORMATION

The following ingredients were used in an end-use product and are identified under applicable U.S. OSHA and Canadian Hazard Communication regulations. If no ingredients are listed, then there are no U.S. OSHA and/or Canadian Hazard Communication requirements associated with this product.

| Ingredient | Percent | CAS Number | Material Safety Data Sheet
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Zinc Phosphate</td>
<td>15-40</td>
<td>11330-74-7</td>
<td>1330-67-8</td>
</tr>
<tr>
<td>Titanium Dioxide</td>
<td>30-35</td>
<td>1344-38-5</td>
<td>1330-58-9</td>
</tr>
<tr>
<td>Silica (Ceramic)</td>
<td>15-40</td>
<td>11073-27-7</td>
<td>1330-48-3</td>
</tr>
<tr>
<td>(Also, a Zinc Phosphate)</td>
<td>1330-67-8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SECTION 3 - HAZARDS IDENTIFICATION

ACUTE OVEREXPOSURE EFFECTS

EYE CONTACT:
Clean eye irritation. Redness, itching, burning and excessive eye contact. Follow normal emergency medical procedures.

SKIN CONTACT:
May cause mild redness, dryness, itching, swelling, burning, irritation, and swelling. If symptoms persist, see healthcare provider.

SKIN ABSORPTION:
Skin exposure not expected to occur. Exposure to repeated contact may cause allergic skin reaction.

INHALATION:
Vapor exposure may not be hazardous. Inhalation of vapors or mists may produce minor respiratory irritation.

SECTION 4 - FIRST AID MEASURES

INHALATION:
If breathing is difficult, remove to fresh air. If breathing stops, call emergency medical services. If nausea or vomiting occurs, have person lie down and move to fresh air. If symptoms persist, see healthcare provider.

SECTION 5 - FIRE FIGHTING MEASURES

FLAMMABLE PROPERTIES

FLASH POINT: Not available

FLAMMABILITY:
Not a fire hazard under normal conditions.

EXTINCTION MEDIA:
Water mist, carbon dioxide, dry chemical or universal extinguishing agent. Avoid contact with skin, eyes, and clothing. High pressure water may cause splashing.

PROTECTION OF FIRE FIGHTERS:
Firefighters should use all available means of protection.

SECTION 6 - STABILITY AND REACTIVITY

STORAGE:
Store in a cool, dry place. Protect from direct sunlight. Keep away from heat, incompatible materials, and ignition sources.

DISPOSAL:
Disposal must be in accordance with federal, state, and local regulations.

SECTION 7 - REGULATORY INFORMATION

OSHA:
This product complies with the OSHA Hazard Communication Standard.

NFPA:
This product complies with the NFPA 704 Standard for the Use of Pictograms on Material Safety Data Sheets.

SECTION 8 - TRANSPORT INFORMATION

DOT:
Not subject to the U.S. DOT Transportation of Dangerous Goods Regulations.

IATA:
Not subject to the International Air Transport Association (IATA) Dangerous Goods Regulations.

ICAO:
Not subject to the International Civil Aviation Organization (ICAO) Dangerous Goods Regulations.

SECTION 9 - INGREDIENTS

GHS:
This product complies with the Globally Harmonized System of Classification and Labelling of Chemicals (GHS).

This product is subject to the OSHA Hazard Communication Standard and the NFPA 704 Standard for the Use of Pictograms on Material Safety Data Sheets.
PRODUCT NAME: PET 10 MIX COMPONENT A

USA Shipments Only - RQ Total Solids Weight: This is the total weight of the package that must be reported when shipping the RQ quantity. USA Shipments Only - TCS Material contains a U.S. DOT Hazardous Substance and is only regulated for shipment in or from the USA by Environmental Protection Agency's Hazardous Substance Reporting (HSR) Rule.

SECTION 6 - REGULATORY INFORMATION

INVENTORY STATUS

MARPOL: This product and/or all of its components are listed in the U.S. TSCA inventory list and are therefore exempt from TSCA inventory reporting requirements.

FINANCIAL REGULATIONS

U.S. Regulations

<table>
<thead>
<tr>
<th>Metric</th>
<th>RQ</th>
<th>RQ1</th>
<th>RQ2</th>
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<tbody>
<tr>
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</tr>
<tr>
<td>Unit of Weight</td>
<td>t</td>
<td>t</td>
<td>t</td>
</tr>
<tr>
<td>Unit of Temperature</td>
<td>K</td>
<td>K</td>
<td>K</td>
</tr>
<tr>
<td>Unit of Odor</td>
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<td>ppm</td>
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SARA 313/12

<table>
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<tr>
<th>Hazard Class</th>
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<tbody>
<tr>
<td>Health Hazard</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Fire Hazard</td>
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<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Reactivity</td>
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<td>No</td>
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<tr>
<td>NIMS MOSH/MRO:</td>
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<td>Class 4</td>
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</tr>
</tbody>
</table>

STATE/PROVINCIAL REGULATIONS

CALIFORNIA PROHIBITIVE STATE, NO EXEMPTION - This product contains a chemical known to the State of California to cause cancer.

Additional Information

- RCRA, Resource Conservation and Recovery Act:
- CERCLA, Comprehensive Environmental Response, Compensation, and Liability Act:
- RQ, Risk-Based Quantities:
- TSCA, Toxic Substances Control Act:
- TSCA Inventory:
- U.S. DOT, U.S. Department of Transportation:
- TSCA Inventory:
- OSHA, Occupational Safety and Health Administration:

SECTION 14 - OTHER INFORMATION

Hazard Rating Systems

<table>
<thead>
<tr>
<th>Rating System</th>
<th>1-Minor</th>
<th>2-Moderate</th>
<th>3-Major</th>
</tr>
</thead>
<tbody>
<tr>
<td>NFPA Rating</td>
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<td>2</td>
<td>2</td>
</tr>
<tr>
<td>RIS Rating</td>
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<td>2</td>
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</tr>
</tbody>
</table>

*Chemical Name*
PPG Industries, Inc. 
One PPB Place 
Pittsburgh, PA 15272

PRODUCT NAME: PVC CHAN COMPONENT

PREPARED BY: Paulette Claytor 
Department: Engineered Systems
REASON FOR REV: Section I has been updated. Date: Effective Updated 08/25/2025

This Material Safety Data Sheet has been prepared in accordance with the Performance and Hazardous Materials Information System (PHMSIS) and the OSHA Hazard Communication Standard (29 CFR 1910.1200), the asbestos notification requirements of OSHA Title 31, Section 313 and other applicable Code of Federal regulations.

Additional environmental information is contained on the Environment Data Sheet for this product, which can be obtained from your PPG representative.

01/14 06/01/14 06/01/14 05/01/14

**END OF SHEET**
PPG High Performance Coatings

SECTION 1 - PRODUCT AND COMPANY INFORMATION

Emergency Phone Numbers

- 412-444-8828 (Local)
- 1-800-444-8828 (8:00 am to 5:00 pm EST)

Technical Information

- 412-444-8828 (8:00 am to 5:00 pm EST)

Product Name: PPG-CHAR COMP B

Trade Name: None

Edition No.: B

Chemical Family: POLYURETHANE

Emergency Overview

Carcinogenicity Classification: You may cause skin burn, which may result in severe damage. May cause skin irritation. May be harmful if inhaled.

SECTION 2 - COMPOSITION INFORMATION

The following ingredients are used in this product. See the Material Safety Data Sheet for additional information.

- Isocyanates
- Polyol
- Solvents
- Additives

SECTION 3 - HAZARDS IDENTIFICATION

Acute Overexposure Effects

Eye Contact

- The product contains isocyanates, which can cause eye irritation.  Immediate eye washout should be performed.

Skin Contact

- The product contains isocyanates, which can cause skin irritation.  Immediate eye washout should be performed.

SECTION 4 - PREVENTIVE MEASURES

Fire Fighting Measures

- Special fire-fighting equipment and procedures may be necessary when handling flammable materials.

Personal Protective Equipment

- Use appropriate personal protective equipment when handling the product.

SECTION 5 - FIRE FIGHTING MEASURES

Precautionary Information

- Special fire-fighting equipment and procedures may be necessary when handling flammable materials.

Flashpoint Test Method

- The product is non-flammable.

Autoignition Temperature

- N/A

Extinguishing Media

- Use water or foam to extinguish potential fire.

SECTION 6 - STABILITY AND REACTIVITY

Stability

- The product is stable under normal conditions of storage and use.

Reactivity

- The product is stable under normal conditions of storage and use.

SECTION 7 - DISPERSAL MEASURES

Handling and Storage

- Store in a cool, dry area away from direct sunlight.

Disposal

- Disposal of the product shall be in accordance with federal, state, and local regulations.

SECTION 8 - EXPOSURE LIMITS

OSHA PEL

- Not applicable

SECTION 9 - HANDLING GUIDELINES

Handling

- Use appropriate personal protective equipment when handling the product.

Exposure Control

- Use appropriate ventilation systems and local exhaust hoods when working with the product.

SECTION 10 - TOXICITY DATA

Acute Toxicity

- Oral: LD₅₀ > 5000 mg/kg
- Inhalation: LC₅₀ > 5000 mg/m³

Reproductive Toxicity

- Not applicable

Teratogenicity

- Not applicable

Carcinogenicity

- Not applicable

Mutagenicity

- Not applicable

Nomecotoxicity

- Not applicable

Sensitization

- Not applicable

SECTION 11 - ENVIRONMENTAL INFORMATION

Biodegradability

- Not applicable

Toxicity to Aquatic Life

- Not applicable

Toxicity to Aquatic Ecosystems

- Not applicable

SECTION 12 - DISPOSAL CONSIDERATION

Disposal Consideration

- The product should be disposed of in accordance with federal, state, and local regulations.

SECTION 13 - TRANSPORT INFORMATION

包装

- Not applicable

Section 14 - REGULATORY INFORMATION

Regulatory Information

- The product is not regulated by any federal, state, or local agencies.

SECTION 15 - OTHER INFORMATION

Other Information

- Not applicable

SECTION 16 - REFERENCES

References

- Not applicable

SECTION 17 - ADDITIONAL INFORMATION

Additional Information

- Not applicable
PROTECTION OF FIREIGHTERS:

There may be fire, heat wave, and smoke hazards. Avoid flames used to burn materials, and toxic substances may be present. Chemicals may be();++

SECTION 6 - EXPOSURE CONTROLS & PERSONAL PROTECTION

- Wear self-contained self-rescuer equipment.
- Use ventilation equipment and material protective equipment.
- Use personal protective equipment.

- Use respiratory protection equipment.
- Use eye protection equipment.
- Use protective clothing and gloves.

SECTION 7 - HANDLING & STORAGE

- Store in a cool, dry, well-ventilated area.
- Store in a cool, dry, well-ventilated area.
- Keep away from heat, sparks, and flame.
- Keep away from heat, sparks, and flame.

- Keep away from heat, sparks, and flame.
- Keep away from heat, sparks, and flame.

- Keep away from heat, sparks, and flame.
- Keep away from heat, sparks, and flame.

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SECTION 16 - OTHER INFORMATION

Marine Rating System:
- NFPA Rating: 3-10
- HMR Rating: 3-10

Rating Systems in America:
- 1-Spiky, 2-Moderate, 3-Sidewall, 4-Service
- A-Contact Effects

NFPA-Hazardous Materials Identification System:
- NFPA-National Fire Protection Association

Sizing of this product requires that all the information on the MSDS be included in objective work environments and conditions of use.

PREPARED BY: Product Safety Department
REASON FOR REVISION: Date: 08/01/94
Update: 10/01/94

The Material Safety Data Sheet has been prepared in accordance with the OSHA (Occupational Safety and Health Administration) Hazard Communication Standards, 29 CFR 1910.1200, and the GHS (Global Harmonization System) OSHA standards and the applicable requirements of OSHA. This material is in accordance with the other applicable regulations and other applicable regulations. Additional environmental information is contained on the Environmentally Critical Data Sheet for this product which can be obtained from the distributor.

OEM 750 000 and 001, 002358, 0001902503

**END OF IDS**
PPG High Performance Coatings

SECTION 3 - PRODUCT AND COMPANY INFORMATION

PPG Industries, Inc.
One PPG Place
Pittsburgh, PA 15272

EMERGENCY PHONE NUMBERS: (412) 434-4515 (USA)
Canada: (514) 244-3200
Mexico: 01-800-00-2149
(China 5633-600500)

TECHNICAL INFORMATION:
PRODUCT NAME: B5-40101 (2511)
SYNONYMS: None
ISSUE DATE: 01/01/99
EDITION NO.: 1

CHART No.:

EMERGENCY OVERVIEW:
Flammables. Keep away from heat, sparks, flames, and other sources of ignition. Do not smoke. Indifference to first-aid measures and first-aid equipment should be made. In case of accident, should be used. Do not inhale, avoid chronic exposure, or contact with eyes or skin. May cause slight skin irritation. May cause mucous membrane irritation. Use of a face mask or respirator may be necessary. Contact your local health professional for more information on first-aid and treatment. If inhaled, do not attempt to inhale. If swallowed, call your local health professional for more information on first-aid and treatment.

SECTION 2 - COMPONENrS INFORMATION

The following ingredients meet with the “F” are classified hazardous under hazardous under applicable U.S. OSHA and Canadian WHMIS regulations. If no ingredients are listed, then there are no U.S. OSHA or Canadian WHMIS hazardous ingredients in this product.

SECTION 3 - HAZARDS IDENTIFICATION

ACUTE OVEREXPOSURE EFFECTS

EYE CONTACT:
Flush eyes with large quantities of water for at least 15 minutes. Use water or saline solution. Avoid contact with eyes. Skin contact:
Wash exposed area with large quantities of water. Avoid contact with eyes. Skin contact:
Wash exposed area with large quantities of water. Avoid contact with eyes. Avoid contact with eyes. Avoid contact with eyes.

SECTION 4 - FIRST AID MEASURES

SECTION 5 - FIRE-FIGHTING MEASURES

SECTION 6 - STORAGE AND DISPOSAL
EXTINGUISHING MEDIA:
Use National Fire Protection Association (NFPA) Class B extinguishers for solid, dry chemical, or aerosol suppressant agents to extinguish NFPA Class B extinguishable fires. Water may not be effective.

PROTECTION OF FIGHTERS:
Firefighters should self-contained breathing apparatus and full protective clothing.

UNUSUAL FIRE AND EXPLOSION HAZARDS:
Keep this product away from heat sources, flames, and other sources of ignition (i.e., lighters, electric heaters, etc.). We recommend that you place this product in a heated area away from direct sunlight and from sources of heat. This product contains hazardous substances, some of which are known to cause cancer, birth defects, or other reproductive harm. For more information, see the Material Safety Data Sheet.

SECTION 3 - ACCIDENTAL RELEASE MEASURES:
STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED:
Provide adequate ventilation. Do not allow breathing of vapors. Avoid breathing of steam generated by overheating. Remove contaminated clothing. Wash any exposed skin with soap and water. Remove any clothing that may be contaminated. Do not allow ingestion. If swallowed, contact a Poison Control Center or seek medical attention.

FIRE FIGHTING:
Do not use water, foam, or carbon dioxide (CO2) extinguishers. Use dry chemical or Class B extinguishers for solid, dry chemical, or aerosol suppressant agents to extinguish NFPA Class B extinguishable fires. Water may not be effective.

SECTION 4 - HANDLING AND STORAGE:
PRECAUTIONS TO BE TAKEN DURING HANDLING AND STORING:
Avoid prolonged contact with the material or its fumes. Evacuate the area. Never mix with water, other solvents, or other substances. Wear protective clothing and respirators when handling.

STORAGE:
Store in a cool, dry place. Keep away from heat sources, flames, and other sources of ignition. Do not place near flammable materials or sources of heat. Keep out of reach of children.

SECTION 5 - EXPOSURE CONTROLS & PERSONAL PROTECTION:
CONVENTIONAL CONTROLS:
Ventilation systems should be used to reduce the concentration of the material to below 10 ppm. If ventilation systems are not available, provide adequate personal protective equipment (PPE) for workers.

PERSONAL PROTECTIVE EQUIPMENT:
Respirators: Use an approved air-purifying respirator or self-contained breathing apparatus (SCBA) for any exposure to this material. Wear a gas mask or respirator with an approved filter if the concentration of the material reaches 10 ppm.

Skin Protection: Wear protective gloves and protective clothing to prevent contact with the material. Wear eye protection to prevent eye contact.

GLOVES:
Chemical-resistant gloves are recommended, such as neoprene, nitrile, or latex. Avoid contact with skin, eyes, or mouth.

Eye Protection:
Wear chemical-resistant eye protection, such as a goggles or face shield. Avoid contact with eyes.

OSHA/PERM/g

\[ \text{Formula} \]

\[ \text{Chemical Name} \]

\[ \text{CAS Number} \]

\[ \text{Molecular Weight} \]

\[ \text{Boiling Point} \]

\[ \text{Melting Point} \]

\[ \text{Density} \]

\[ \text{Flash Point} \]

\[ \text{Hazard Rating} \]

\[ \text{Fire Hazard} \]

\[ \text{Health Hazard} \]

\[ \text{Environment Hazard} \]

\[ \text{Other Hazard} \]

\[ \text{Handling Precautions} \]

\[ \text{Storage Precautions} \]

\[ \text{Incompatibility} \]

\[ \text{Preventive Measures} \]

\[ \text{Special Handling} \]

\[ \text{Emergency Procedures} \]

\[ \text{Disposal Procedures} \]

\[ \text{Other Information} \]

\[ \text{References} \]

Additional information is available from the manufacturer.

SECTION 6 - PHYSICAL AND CHEMICAL PROPERTIES:

\[ \text{Formula} \]

\[ \text{Chemical Name} \]

\[ \text{CAS Number} \]

\[ \text{Molecular Weight} \]

\[ \text{Boiling Point} \]

\[ \text{Melting Point} \]

\[ \text{Density} \]

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Additional information is available from the manufacturer.

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\[ \text{Disposal Procedures} \]

\[ \text{Other Information} \]

\[ \text{References} \]

Additional information is available from the manufacturer.
STATE PROVINCIAL REGULATIONS

Additional information

RRP: 90 ppm unleaded furniture

American Conference of Governmental Industrial Hygienists (ACGIH)

American Chemistry Council (ACC) - Product Stewardship Program

Environmental Protection Agency (EPA) - National Pollutant Discharge Elimination System (NPDES)

Occupational Safety and Health Administration (OSHA)

SECTION 18 - OTHER INFORMATION

Human Rating Systems

NHF: Rating 2 (50)

HMS Rating: 2 (10)

Rating System: 1-Insignificant, 2-Moderate, 3-Serious, 4-Catastrophic

Health hazard category: 1-Low; 2-Moderate; 3-High


Hazardous communication regulations of Chrona Title 29, Section 1910.1200 and other applicable health and safety regulations.

PRODUCED BY: Product Safety Department

REASON FOR REVISED: Section 7 has been updated

UPD: 02/18/2011

The material safety data sheet has been prepared in accordance with the OSHA Hazard Communication Standard (29 CFR 1910.1200) and the CIHHA Hazard Communication Standard (29 CFR 1910.1200) and other applicable health and safety regulations.

Additional information: The material safety data sheet for the product, which can be obtained from the manufacturer's representative.
**PTITHANE®**

**HIGH BUILD SEMI-GLOSS URETHANE ENAMELS**

**GENERAL DESCRIPTION**

PTITHANE® High Build Semi-Gloss is a durable high build, acrylic urethane that is recommended for use where a professional appearance and delayed cure of swelling are desired. Easy to apply, the PTITHANE High Build Semi-Gloss can be brushed, roller or sprayed and offers excellent color and gloss retention. Available in both white and neutral bases, this product has infinite color capability through our PERFORMANCE® tint system. In addition, faster dry time (30 min to fully dry) makes it ideal for application in confined or indoor areas.

**RECOMMENDED USES**

- Aluminum
- Galvanized Steel
- Concrete
- Steel

**FEATURES AND BENEFITS**

- Virtually infinite color capability
- Exceptionally good chemical resistance
- Excellent gloss and color retention
- High build characteristics

**RECOMMENDED PRIMERS**

- Aluminum: 97-245, 97-145, 97-465, 97-865
- Concrete/Masonry: 97-217, 97-285
- Concrete/Masonry Primer: 97-217, 97-395
- Masonry/other: 97-465
- Epoxy Primer: 97-245, 97-145, 97-395
- Galvanized Steel: 97-245, 97-395, 97-465

**PACKAGING**

- 1 Gallon (3.78L)
- 5 Gallon (18.9L)
- Pint (473 ml)

All products are available in all sizes. Not all containers are full.

**PRODUCT DATA**

- **PRODUCT TYPE:** Acrylic Aliphatic Urethane
- **Gloss:** Semi-Gloss
- **VOC:** 243 lbs/gal (901.8 g/l)
- **Coverage:** 500 to 510 sq. ft./gallon
- **Sheen:** 16 to 17FG (45-766)

**Product Data Calculated on (9-688) Mixed**

- **Viscosity:** 500 to 510 sq. ft./gallon
- **Dry Film Thickness:** 5 mils
- **Suggested:** 2-3 coats
- **Use Temps:** 40°F to 90°F
- **Storage:** 5 degrees F to 75 degrees F
- **Drying Time:** 5 hours
- **Tack Free:** 6 hours
- **Full Cure:** 18 hours

**Drying Time Accelerated with 6 fl. oz./gal 97-722**

- **Temperature:** 50°F to 70°F
- **Drying Time:** 2 hours
- **Tack Free:** 2 hours
- **Flash Point:** 200°F
- **CUT-OFF:** (10.5°C)
- **Mixed Life:** 2.5 hours
- **Clean Up:** 97-727, 97-739, 97-734 PPG Thinners
PPG High Performance Coatings

SECTION 1 - PRODUCT AND COMPANY INFORMATION

PPG Industries, Inc.
One PPG Place
Pittsburgh, PA 15222

EMERGENCY PHONE NUMBERS (412) 434-4315 (U.S.)
(24 Hours)
(866) 861-1535 (Canada)
(800) 669-1410 (Mexico)
(505) 824-9599 (China)

TECHNICAL INFORMATION
1-866-41-0055 (8:00 a.m. to 5:00 p.m. EST)

PRODUCT NAME: PPG BRILLIANC 30 COMPB
SYNONYM: None
ISSUE DATE: 16/10/2006
EDITION NO.: 2
CHEMICAL: POLYPHOSPHATE

SECTION 2 - COMPOSITION/INFORMATION

The following ingredients are listed with an "X" and are considered hazardous under applicable U.S. OSHA and/ or Canadian WHMIS regulations. If reagents are added, then these are also per U.S. OSHA and/or Canadian Whmis Hazardous Ingredients in this product. Details

SECTION 3 - HAZARDS IDENTIFICATION

ACUTE OVEREXPOSURE EFFECTS

EYE CONTACT: Causes severe eye irritation. Redness, itching, burning sensations and visual disturbances may indicate excessive eye contact.

SKIN CONTACT: May cause moderate skin irritation. Dryness, itching, cracking, scaling, redness, and swelling are possible, accompanied with associated irritation.

INHALATION: Skin irritation not expected to occur. If irritation to the skin occurs, wash with soap and water for at least 20 minutes. If irritation persists, seek medical attention.

SECTION 4 - FIRST-AID MEASURES

IF INGESTED, INHALATION, OR SKIN ABSORPTION:

EYES: Rinse eyes with plenty of water for at least 15 minutes. If irritation persists, seek medical attention.

SKIN: Remove contaminated clothing and wash parts thoroughly with soap and water. If irritation persists, seek medical attention.

INHALATION: Remove victim to fresh air. If irritation persists, seek medical attention.

SECTION 5 - FIRE FIGHTING MEASURES

FLAMMABLE PROPERTIES
FLASHPOINT: 33° F (0.6° C) (106 Degrees C)
FLASHPOINT TEST METHOD: FMH/M-sc/201
Flash Point: Monitored Closed Cup
UL: Not Applicable
LBB: Not Applicable
MINIMUM AUTOPHORATION TEMPERATURE: Not Applicable

EXTINGUISHING MEDIA: Use pressure water spray for extinguishing. Use a fire extinguisher that is rated for Class B fires. Do not use water, dry chemical, or foam. If a fire occurs, wear personal protective equipment.

PROTECTION OF FIRE FIGHTERS: Wear self-contained breathing apparatus for fire fighting operations.
UNUSUAL FIRE AND EXPLOSION HAZARDS:
Keep this product ready away from heat, sparks, flames, and other ignition sources. Follow standard laboratory practices when using this product. Keep containers tightly closed when not in use. Closed containers may explode when over-pressurized. Do not allow to reach temperatures greater than 50°C (122°F).

SECTION 6 - ACCIDENTAL RELEASE MEASURES:
RTEMP TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED:
Provide maximum ventilation. Do not attempt to recapture or clean up spills with incompatible solvents. Wear appropriate personal protective equipment. Ventilate area to prevent spill from accumulating near the floor. Do not smoke or allow flames or sparks in the vicinity. Keep away from ignition sources. If exposure occurs, immediately remove contaminated clothing and wash affected areas with soap and water. As long as the material remains in its original container, the material is not considered hazardous.

SECTION 7 - HANDLING AND STORAGE:
PRECAUTIONS TO BE TAKEN WHEN HANDLING AND STORAGE:
This material is part of a multiple component system. Read the material safety data sheet (MSDS) for each component prior to mixing. This material must be stored and handled in an upright position. Do not expose to temperatures greater than 50°C (122°F). Do not use in the presence of incompatible materials. Keep out of reach of children. Use in a well-ventilated area. Do not breathe the fumes. Keep away from heat, sparks, and flames. Avoid contact with skin and eyes. Wear appropriate personal protective equipment. Do not store with other incompatible materials. Store in a cool, dry, well-ventilated area. Avoid contact with skin and eyes. Wear appropriate personal protective equipment. Do not store with other incompatible materials.

SECTION 8 - EXPOSURE CONTROLS & PERSONAL PROTECTION:
ENGINEERING CONTROLS:
Provide general and local exhaust ventilation to reduce and remove vapors to keep concentrations of inorganic acids in Section 9 below the lower explosive limit limit. The lowest suggested exposure limit, the ELS, below the study limit, and a recommended concentration during welding or fume blowing.

PERSONAL PROTECTIVE EQUIPMENT:
EYES: Use chemical-resistant safety goggles and face shields when necessary. Best protection is face shields. Young children or children who are not capable of understanding safety precautions should not be allowed to handle this product. The lowest suggested exposure limit, the ELS, below the study limit, and a recommended concentration during welding or fume blowing.

SKIN/GLOVES:
When applying this material, use protective clothing and equipment. Use durable gloves that are resistant to the material. Avoid contact with skin and eyes. Wear appropriate personal protective equipment. Do not breathe the fumes. Keep away from heat, sparks, and flames. Avoid contact with skin and eyes. Wear appropriate personal protective equipment. Do not store with other incompatible materials. Store in a cool, dry, well-ventilated area. Avoid contact with skin and eyes. Wear appropriate personal protective equipment. Do not store with other incompatible materials.

SECTION 9 - PHYSICAL & CHEMICAL PROPERTIES:
FORMULA, MAJOR & NON-SHITEX SPECIFICATIONS:
SPECIFIC GRAVITY: 1.5
PHYSICAL STATE: Liquid
Percent Solids: 80%
Percent Volatile by Volume: 80%
PH: Not Available
ODOR THRESHOLD: Not available
VAPOR PRESSURE: Not available
COHOMENIC: Not available
VAPOR DENSITY: 1.5
BOILING POINT OR RANGE: Not Available
MELTING POINT OR RANGE: Not Available
THERMAL EXPANSION: Not Available
WEIGHT PER GALLON: 9.75 (US) / 11.10 (IMP.)

SECTION 10 - STABILITY AND REACTIVITY:
STABILITY:
This product is very stable but may undergo spontaneous exothermic decomposition at extremely high temperatures and pressures.

CONDITIONS TO AVOID:
Avoiding excess heat.

INCOMPATIBLE MATERIALS:
Avoid contact with strong alkalis, strong oxidizing acids, or strong reducing agents. Avoid water and moisture.

HAZARDOUS POLYMERIZATION:
None known.

HAZARDOUS COMPOSITION PRODUCTS:

Page 2 of 4
SECTION 11. TOXICOLOGICAL INFORMATION

ACUTE TOXICITY

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CHRONIC TOXICITY

- Reproductive Toxicity:
  - This product has not been tested for reproductive toxicity.

SUPPLEMENTAL HEALTH INFORMATION:

SECTION 12. ECOLOGICAL INFORMATION

- Exposure to this product may result in the following effects:
  - No information available.

SECTION 13. DISPOSAL CONSIDERATIONS

- Disposal of this product must be done in accordance with federal, state, local, and environmental control regulations. Empty containers should be properly labeled and disposed of as hazardous waste.

SECTION 14. TRANSPORTATION INFORMATION

- Proper shipping name:
  - None (Non-Hazardous Substance)

- UN Number:
  - None (Non-Hazardous Substance)

- Marine Polutant Name:
  - None (Non-Hazardous Substance)

SECTION 15. REGULATORY INFORMATION

- Inventory Status:
  - None (Non-Hazardous Substance)
Surface Preparation

1. Steel that is damaged or corroded must be repaired or replaced before the coating system is applied. Any necessary repair work will be performed by a third party and is not included within the scope of these surface preparation activities.

2. All surfaces to be coated shall be clean and dry prior to performance of any coating work.

3. Surfaces indicating oil and/or grease contamination, and all galvanized surfaces, shall be cleaned in accordance with SSPC SP 1 "Solvent Cleaning". The preferred method of solvent cleaning shall be degrease washing using a solution of Alconox 400 followed by a thorough fresh water rinsing or by wiping surfaces with rags saturated with mineral spirits. This shall be accomplished prior to any other surface preparation that has been specified.

4. Existing chalking coatings that are to be over coated shall be high pressure washed with 3500 psi minimum pressure fresh water and allowed to dry prior to coating application.

5. All sharp edges, corners, and rough welds should be ground to a 1/8" radius. Weld spatter, brass and any other sharp surface irregularities shall be ground smooth prior to any abrasive blast cleaning and as part of any other surface preparation specified for surfaces to be coated.

6. Surface preparation shall be to the degree specified by the manufacturer's Product Data Sheet and shall fully conform to any referenced SSPC standards.

7. Prior to initiating abrasive blasting operations, the contractor shall wear suitable Shields, respirators, or other barriers to protect surfaces from damage by abrasives and paint overspray. The entire area shall be contained sufficiently to prevent objectionable debris and dust from escaping.

8. All metal surfaces to be coated, unless otherwise specified, shall be abrasive blasted in accordance with the approved work plan. The contractor shall use a suitable abrasive to produce an angular profile with a depth of 1.5 in 3.0 mils as measured at accordance with ASTM D4417 "Field Measurement of Surface Profile of Blast Cleaned Steel", Method C "Replate Tape". Within 8 hours after cleaning and prior to the deposition of any detectable moisture, contaminants, or corrosion, all blast cleaned surfaces shall be cleaned of dust and abrasive particles and given the first coat of paint. For exterior surfaces this cleaning may be accomplished by blowing the surface off with clean, oil, and moisture free air. For interior surfaces, sweeping and vacuuming is required.

9. Care should be taken to avoid contamination of the prepared surface by perspiration, fingerprinting, or by introduction of other contaminants from the workers or their equipment (example: dirty shoes or oily hands).
10. After preparation as given above, the steel shall be inspected for sharp edges caused by improperly prepared welds or edge creation and corrosion. Such areas shall be ground down to a round contour (1/4" radius approximately) using a Rapid Disc, 3M Clean and Strip Wheel or Grinding Wheel. This work activity may be done prior to final surface preparation or after.

11. Previously painted surfaces that will not be coated with Pin-Chair XP Coating, may be overcoated without removing the old coating and sandblazing the metal. The original paint and substrate must be in good condition, with good paint adhesion and no substrate corrosion. A test patch must be prepared where the old paint is overcoated with the epoxy primer and urethane topcoat. The system must be tested for adhesion after 7 and 90 days. If adhesion is acceptable, this overcoating may be proposed. Minimally, the old finish must be clean, dry, and smooth before overcoating.
**Coatings Application**

1. All corners, angles, bolt heads and threads and other difficult access areas shall receive one brush applied stripe coat of the material specified after the application of the primer coat. This shall be done in addition to the specified number of coats.

2. Areas inaccessible by spray equipment shall be coated by brush application.

3. When blasting and coating is to be done by section, coating of the blast cleaned surface should extend no closer than 6 inches from the cleaned surface.

4. When coating is applied adjacent to previously coated surface, the application should extend over the previous application by 6 inches.

5. Runs, drops, sags, excessive overspray, and other application related conditions that adversely affect performance of the coating shall be corrected before approval. Coating thickness for each coat shall meet the specified requirements for each product as measured in accordance with SSPC PA 2 “Measurement of Dry Film Thickness with Magnetic Gauges”. Any area of primer not meeting the minimum thickness requirement shall be removed to meet specification requirements before any topcoating or topcoat product is applied. Any coat found to be defective due to excessive thickness, dry spray, runs, pinholes, blisters or other defects shall be removed and reapplied.

6. Ambient and surface conditions shall be within limits stated in the manufacturer’s Data Sheet during application, and should be forecast or expected to remain so for at least 4 hours after application. Surface temperature shall be a minimum of 5 deg.F. above the dew point for application. Coating materials shall be mixed, thinned, applied and cured in accordance with the manufacturer's latest printed instructions.

Coating shall be applied under the following prevailing conditions:
- a) Surface free of moisture
- b) Air temperature and surface temperature between 45°F and 120°F unless otherwise stated in technical literature.
- c) Surface temperature at least 3°F above the temperature of the dew point.
- d) Work area free from moisture or dust that would contaminate prepared surfaces or damage freshly applied coatings.

**Material Preparation:**

1. Only complete premeasured units as supplied by the manufacturer shall be mixed. Individual liquid components shall be mixed separately before combining and mixing together.

2. Mixed material shall be used before the manufacturer’s pot life has expired or shall be discarded after the pot life has been exceeded.

3. Coating material shall be mixed until thoroughly dispersed. Mechanical mixing or boxing between two containers or both can accomplish this.

Recoat time, dry to handle time and cure times shall be observed carefully. Additional time, as required shall be allowed when coatings are applied below the reference temperature on the manufacturer’s Data Sheet (77 Deg.F).
Project Schedules:

BAR CHART SCHEDULE
BUILDING 296

<table>
<thead>
<tr>
<th>Operation</th>
<th>DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobilize</td>
<td>1</td>
</tr>
<tr>
<td>Set-Up</td>
<td>2</td>
</tr>
<tr>
<td>Cover-Up</td>
<td>3</td>
</tr>
<tr>
<td>Clean</td>
<td>4</td>
</tr>
<tr>
<td>Prime</td>
<td>5</td>
</tr>
<tr>
<td>Fireproof &amp; Paint</td>
<td>6</td>
</tr>
<tr>
<td>Finish Coat</td>
<td>7</td>
</tr>
<tr>
<td>Clean Up</td>
<td>8</td>
</tr>
<tr>
<td>De-Mobilize</td>
<td>9</td>
</tr>
</tbody>
</table>

NOTE: Schedule based on working 5 days per week and up to 10 hours per day.

DEFINITIONS OF OPERATIONS

Mobilize: Transport personnel, equipment, supplies to work site.
Set-Up: Move in and set-up equipment, storage, and office facilities.
Cover-Up: Move in and set-up additional support to achieve 100% watertight.
Clean:拆除所有家具和设备并进行彻底的清洁。
Prime: Apply primer according to manufacturer's application guidelines using brush & roller.
Fireproof & Paint: Apply Fireproof & Paint as per customer's application guidelines.
Finish Coat: Apply top coat of Fireproof & Paint as per customer's application guidelines.
Clean-Up: Thorough cleaning, signs, etc. Cleanup costs not included in mobilization.
De-Mobilize: Removal of personnel, equipment, stores from work site.
BAR CHART SCHEDULE
AREA 227 BAGHOUSES

OPERATION
Set Up
Contain
Sandblast
Clean up
Power Wash
Prime
Cover Up
Fireproof & Mesh
Finish Coat

- One day (up to 10 hours per day)
- Half a day

NOTE: Schedule based on working 6 days per week and up to 10 hours per day

DEFINITIONS OF OPERATIONS
Set Up: Setup equipment, storage, and office facilities.
Contain: Hang large tarps over materials stored and avoid sandblasting.
Sandblast: Sandblast outside columns on exterior of each building.
Clean up: Clean up street areas with brooms & hoppers to a color/finish standard.
Power Wash: Power wash exterior and interior steel using 3,500 psi pressurized water.
Prime: Apply primer to all surfaces using hand & roll techniques.
Cover Up: Mask all areas adjacent to sections to receive PCBlair XP coating, exceptional and drip coats.
Fireproof & Mesh: Apply PCBlair XP per manufacturer’s approval & guidelines.
Finish Coat: Apply finish coat per manufacturer’s recommendation using hand & roll techniques.
Almega Company Site Specific Safety Plan

For Fireproofing and painting work to be performed at the Rock Island Arsenal in the area 227 Bag House and Building 299, we have determined that the following safety measures will need to be addressed in order to provide our workers and those around them with a safe working environment.

EM85 1.1

Section 1: Program Management
All employees working for the Almega Company are OSHA 10 certified and have completed the company safety program included in this report. For this project, our site foreman will conduct weekly safety meetings and keep the site contact informed on work operations with the mandated work safety forms. Prior to commencement of work, our foremen will identify and discuss with all employees any hazards associated with work to be performed on arsenal property.

Section 4: Temporary Facilities
While on site, Almega will have a trailer to be used as an office, break room and storage for small equipment. The trailer will be set up and secured by the rental company representative as per their safety specifications.

Section 5: Personal Protective Equipment
All Almega Company employees are issued standard personal protective equipment, including safety harnesses and harnessed or another appropriate fall arrest system, safety glasses, hearing protection, hard hats, respirator with required filters and cartridges, rubber gloves and face shields. They will also be provided with any site-specific equipment required.
Employees are expected to provide their own safety used work boots, work clothing and gloves.

Prior to the start of work, all employees will receive proper training in the use of all necessary personal protective equipment and respirator fitters. We will also have all applicable medical information available to ensure respirator fitness.

During sandblast operations, any worker operating a sandblast nozzle will be equipped with an OSHA approved air fed sandblast helmet. Air flow and quality will be monitored at all times with approved CO monitor.

While solvent cleaning surfaces where lead is present, workers will be required to wear protective Tyvek suits, rubber gloves and respirators equipped with HEPA filters.

Section 6: Hazardous Substances, Agents and Environment
Almega Company and PPG will provide MSDS sheets for all material to be brought on site. This information will be reviewed with employees and proper safety steps will be taken to ensure a safe work environment.

In Building 299, where solvent cleaning will take place to clean structural steel, the area will be well ventilated and workers will be issued rubber gloves, respirators with appropriate chemical cartridges and eye protection. Wash stations will be maintained in the event a worker is exposed to solvent.

During sandblasting operations, Black Beauty sand will be used. Spent abrasives will be collected and disposed of accordingly.

Disposal of any waste solvent, spent abrasives, unused paint, used material buckets and waste water will be handled by PPG.

The coating on the steel in Building 299 has been identified as containing lead. Surface will be prepared for coating with a solvent cleaning/ wipe down. In order to protect our workers and those around them, operations will be air monitored for one day in order to establish that levels of lead exist, comply with
OSHA standards. The area will be cordoned off and signs will be posted to modify others of the presence of lead work. Please refer to our attached lead safety compliance program for further procedural information.

Section 7: Lighting
While performing inside work, all permanent light fixtures will be protected from exposure to coating material.
While working in Area 237, additional lighting may be required to provide a safe work environment.

Section 8: Accident Prevention Signs, Tags, Labels, etc.
During the course of work, all work sites and equipment will be properly barricaded and all appropriate signs shall be posted.

Section 9: Fire Prevention
Prior to beginning work, all fire hazards will be identified and fire extinguishers will be placed accordingly.
Potential fire extinguisher locations include, but are not limited to, the company trailer, fire proofing trailer, in close proximity to the air compressor, hoses and materials.
Foremen and employees will also familiarize themselves with all site specific fire procedures and locations of fire alarms, hoses and extinguishers.
Work area will be kept clean as to prevent the build up of any potential fire hazards.
All electrical cords shall be equipped with GFI’s.

Section 10: Hand and Power Tools
When needed for surface preparation in Building 209, all pneumatic power tools shall be inspected prior to each use. Any worker using a power tool will use proper personal protective equipment at all times.
Foremen shall review section 10.1 on pneumatic power tools prior to their use.
For hand blasting set-ups, all hoses will be secured using tie wires and OSHA approved whip checks. Sand blast equipment will be supervised at all times during blasting operations.

Section 11: Material Handling, Storage and Disposal
All materials will be kept in appropriate locations. Paint and thickeners will be kept in steel boxes when not being used and fire protective coverings will be kept in a storage trailer.

Section 12: Motor Vehicles
Corporate vehicles will only be operated by employees with valid drivers licenses.
Any company vehicle or trailer brought on site will have all necessary Pennsylvania inspections and registrations.
All tanks will be inspected by drivers before they are moved and drivers will comply with all federal traffic laws.

Section 13: Pressurized Equipment and Systems
All pressurized air and sandblast lines shall be inspected prior to each use in order to prevent any breaks.

Section 14: Safe Access and Fall Protection
Scaffolding will be utilized in both work areas. It will be constructed in accordance with the vendor’s specifications and inspected prior to each use to ensure its compliance with applicable OSHA standards.
When workers are working from scaffolds or ladders, they will be required to use their safety harness and the appropriate fall arrest system. All fall arrest systems will be inspected at the beginning of each work day. All work safety training includes a section dedicated to fall protection and no worker will be allowed to work above 6 feet before they receive this company training.

Fiber glass ladders will be used and all extension ladders will be tied off and anchored in accordance with OSHA standards.

Section 22: Work Platforms
See company plan for Section 21.
Almega Lead Safety Policy

Almega Company, Inc.
Safety and Health Program

4.0 LEAD

4.1 PURPOSE

4.1.1 The purpose of this program is to establish and implement corporate practices and procedures to:

a) protect the health of Almega Company, Inc.'s employees exposed to lead on the job;

b) comply with the OSHA Construction Industry Lead Standard, 29 CFR 1926.62.

4.2 APPLICABILITY AND SCOPE

4.2.1 This program applies to all Almega Company, Inc.'s projects involving the disturbance of lead paint.

4.2.2 This Lead Protection Plan establishes methods for complying with the OSHA Construction Industry Lead Standard, 29 CFR 1926.62. Project-specific requirements are identified in Attachment 1.

4.2.3 Implementation of this program is under the direct control of the Competent Person assigned to the project.

4.2.4 This program also applies to all subcontractors working under the direct control of Almega Company, Inc., involved with lead-based paint removal projects and activities. Subcontractors must provide all necessary supplies, equipment, training, and medical examination and testing necessary to comply with this program.

4.3 DEFINITIONS

4.3.1 Action Level: Employee exposure, without regard to the use of respirators, to an airborne concentration of lead in micrograms per cubic meter of air (µg/m³) calculated as an eight-hour time-weighted average (TWA). The Action Level for lead is 30 µg/m³.

4.3.2 Competent Person: One who is capable of identifying existing and predictable lead hazards in the surroundings or working conditions and who has the authority to take prompt corrective measures to eliminate them.

4.3.3 Lead: the word "lead" when used in this program, means elemental lead, all inorganic lead compounds, and a class of organic lead compounds called lead soaps. Lead is a heavy metal at room temperature and pressure and is a basic chemical element. It can combine with various other substances to form lead compounds.

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4.3.4 Lead-based Paint - Definitions vary depending upon industry or use. Per 16 CFR 1926.1200, "Lead and Lead-Containing Paint and Certain Consumer Products Bearing Lead-Containing Paint", a paint cannot be manufactured for consumer use if it contains 0.05% (600 ppm) or greater lead by weight. Abatement in public housing is triggered at 6.5% (800 ppm) or 1.5 mg/m³. For the purpose of this program, its requirements shall be implemented when lead is at any amount, or reflected in the paint.

4.4 MCL - micrograms per liter of water. Common units for reporting concentrations of lead in blood samples. Also reported as ug/L or mg/L (micrograms per liter or milligrams per liter).

3.6 mg/m³ - micrograms per cubic meter of air. Common units for reporting airborne concentrations of lead.

MSHA - Mine Safety and Health Administration. Federal agency which enforces and certifies compliance.

OSHA - Occupational Safety and Health Administration. Federal agency which enforces and enforces safety and health standards.

NIOSH - National Institute for Occupational Safety and Health. Federal agency which conducts research on safety and health issues.

4.4.4 TWA - Time Weighted Average. The time weighted average concentration of airborne contaminants. This is the employee's average airborne exposure in any eight-hour workday. A formula is used to calculate the TWA, if an employee is exposed to lead for more than 8 hours in any workday. The employee's allowable exposure to lead, as a time weighted average (TWA) for that day, is reduced according to the following formula:

\[
\text{ Allowable Exposure (in ng/mL)} = \frac{400 \times \text{Number of Hours Worked}}{8 \times \text{Day}}
\]

4.4 ACTION LEVEL

4.4.1 The Action Level refers to employee exposure, without regard to the use of respirators, to an airborne concentration of lead of 50 micrograms per cubic meter (μg/m³), calculated as an 8-hour time weighted average (TWA).
4.4.2 Whenever worker's airborne lead exposures exceed or are expected to exceed the action level, the following portions of this program are implemented for the work project:

a) Competent Person
b) Employee Information and Training
c) Employee Medical Surveillance and Medical Removal Protection
d) Initial and Periodic Exposure Assessment
e) Record Keeping
f) Regulated Areas

4.4.3 The action level may be exceeded where lead containing materials are present and the following activities are performed: abrasive blasting, cleanup of spent abrasives, containment movement and removal, spray painting with lead paint, manual scraping, manual sanding, power tool cleaning with and without dust collection systems, water jetting, chemical stripping, and heat gun applications. Some non-painting related activities that may result in exposures above the action level include material demolition of structures, welding, cutting, torch burning, or rivet bonding, installation, removal or demolition of lead containing materials, lead burning, and lead contamination emergency cleanup operations.

4.4.4 Almgren Company, Inc. provides hand washing facilities in near proximity to the workplace on all jobs where employees are potentially exposed to lead at any level.

4.5 PERMISSIBLE EXPOSURE LIMIT

4.5.1 The Permissible Exposure Limit (PEL) for airborne lead exposure is 50 
μg/m³ as an 8-hour TWA concentration. This is the maximum 8-hour average concentration of lead that an employee may be exposed to during each workday. For workdays longer than 8 hours or on a given day, the PEL is reduced using the following formula:

Permissible Exposure Limit (PEL – 8) = (8 x 8) / (hours worked in a day)

4.5.2 Whenever workers' airborne lead exposures exceed or are expected to exceed the PEL, without resort to the use of respirators, in addition to the requirements of Section 4.4.2, the following portions of this program are implemented for the work project:

a) Compliance Program
b) Engineering/Work Practice Controls

c) Respiratory Protection

d) Protective Clothing and Equipment

e) Hygiene Facilities and Practices

f) Warning Signs

g) Housekeeping Procedures

4.5.3 The following methods are used as feasible and effective, for maintaining airborne lead exposures below the PEL.

a) Engineering controls to minimize dust generation during the coating removal process.

b) Work practices, such as wearing protective clothing, using hygiene facilities, and effective housekeeping procedures.

c) Respiratory protection is worn in work areas where the PEL may be exceeded.

d) No eating, drinking, smoking, or chewing of tobacco products is permitted in work areas or anywhere that lead exposures may exceed the PEL.

4.5.4 During the period that respirators are worn, the protection factor of the specific respirator may be used to determine employees' exposures to airborne lead and to achieve compliance with the PEL. The protection factors listed in the respirator selection guide of Section 7.0 of Attachment 2 may be used. For example:

- Measured airborne lead concentrations in the worker's breathing zone: 300 µg/m³, 8-hour TWA

- Half mask, air-purifying, negative pressure respirator with HEPA filters worn all day: protection factor of 10

- Employees daily lead exposure (measured exposure divided by the protection factor): 30 µg/m³
4.6 COMPETENT PERSON

4.6.1 The competent person is involved in both the planning and performance of projects where employee airborne lead exposure may exceed the Action Level.

4.6.2 The competent person is a designated Allsage Company Inc. employee or an authorized third party with training and experience in conducting jobs involving lead exposure. The competent person has the capability of identifying hazards and the authority to take immediate corrective action.

4.6.3 The competent person will be at the work site at all times while lead exposure activities are in progress. He or she may have other job duties, but will inspect the work on a frequent and regular schedule for hazards or deficiencies and complete site inspection forms (see Form 1) and/or ensure that oversight work performed by others has been appropriately performed.

4.7 EXPOSURE ASSESSMENT

4.7.1 Allsage Company, Inc. (or its agents) determines worker exposures to lead through historical data or by instrument monitoring in order to establish the specific worker protective measures necessary for the project.

4.7.2 When previously collected sampling data of the same operations under similar conditions has conclusively determined that current job condition exposure levels will be less than the Action Level, initial exposure monitoring is not performed.

4.7.3 When previously collected sampling data of the same operations under similar conditions has conclusively established the exposure levels that will occur on a project, initial monitoring is not performed. Protection and work practices are implemented consistent with the pre-established exposure levels.

4.7.4 When conclusive historical monitoring data is not available, personal air samples are collected on a job-basis to determine airborne lead exposures for employees performing tasks which may involve lead exposure. Representative full-shift (or at least 7 hours) air samples are collected for each job activity or work classification. Sampling information is recorded on Form 2.

4.7.5 A chain-of-custody form is completed to accompany samples to the laboratory.

4.7.6 Allsage Company, Inc. implements employee protective measures for the following activities until results of the employee exposure assessment are received. These protective measures include but are not limited to, protective clothing, regulatory training, change areas, medical surveillance, and
implementation of good personal hygiene practices (e.g., washing of hands, forearms and face). The protective measures are modified, as necessary, according to the results of the monitoring. The work activities involved and associated exposure levels are:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Exposure Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Manual demolition of structures (e.g., drywall, floor joists, etc.)</td>
<td>5 to 500 µg/m³</td>
</tr>
<tr>
<td>Manual scraping</td>
<td></td>
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<tr>
<td>Manual sanding</td>
<td></td>
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<tr>
<td>High-pressure water jetting</td>
<td></td>
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<tr>
<td>Power tool cleaning, with dust collection systems</td>
<td></td>
</tr>
<tr>
<td>Spray painting with lead paint</td>
<td></td>
</tr>
<tr>
<td>b) Using lead-containing mortar</td>
<td>500 to 2,500 µg/m³</td>
</tr>
<tr>
<td>Lead burning</td>
<td></td>
</tr>
<tr>
<td>Roof burning</td>
<td></td>
</tr>
<tr>
<td>Power tool cleaning without dust collection systems</td>
<td></td>
</tr>
<tr>
<td>Cleaning activities where dry-exhaustable</td>
<td></td>
</tr>
<tr>
<td>Abrasive blasting</td>
<td></td>
</tr>
<tr>
<td>Abrasive blasting, enclosure movement and</td>
<td></td>
</tr>
<tr>
<td>removal</td>
<td></td>
</tr>
<tr>
<td>Abrasive blasting, welding</td>
<td>In excess of 2,200 µg/m³</td>
</tr>
<tr>
<td>Welding</td>
<td></td>
</tr>
<tr>
<td>Torch cutting of burning</td>
<td></td>
</tr>
</tbody>
</table>

4.7.1 Where initial monitoring indicates that exposures are below the Action Level and where work activities and conditions will remain the same as at the time of initial sampling, additional monitoring is not required for that work activity. In addition, the initial protective measures implemented can be discontinued with the exception of the hand wash facility.

4.7.2 For processes where initial monitoring indicates that lead exposures are at or above the Action Level but below the PEL, additional representative exposure monitoring is conducted at least once every six (6) months for that work activity.

4.7.3 Where initial monitoring indicates that lead exposures are at or above the PEL, additional representative exposure monitoring is conducted at least once every three (3) months.
4.7.10 All air samples are collected and analyzed according to NIOSH Method 7900, or an equivalent method. All samples are analyzed by laboratories successfully participating (at least in the previous twelve months) in the ELPAT Program or accredited by the American Industrial Hygiene Association (AIHA) for metals analysis.

4.7.11 All exposed employees are notified in writing of the monitoring results within 5 days after receiving the results (See Form 3). In addition Allegra Company, Inc. will notify all other workers whose exposures are represented by the data. When the results indicate that employees are exposed to lead above the PEL Allegra Company, Inc. includes in the written notification a description of the corrective measures to be taken to ensure the employee is adequately protected.

4.8 ENGINEERING AND WORK PRACTICE CONTROLS

4.8.1 Allegra Company, Inc. utilizes engineering and work practice controls to reduce employee exposures to the lowest feasible level.

4.8.2 Where high levels of lead dust are generated (e.g. abrasive blast-cleaning) inside of a container, ventilation systems are used. Alternate methods of control are considered and may involve the use of wet removal methods to minimize dusting, vacuum systems, or others. Decisions are based on cost, effectiveness of ventilation systems and productivity, quality of surface preparation, and other factors.

4.8.3 When mechanical ventilation systems are used to control lead exposure, Allegra Company, Inc. evaluates the performance of the system to maintain its effectiveness in accordance with the following information:

a. Visual Inspection:
   - Visual inspections may include periodic assessments of the following items:
     - Inspecting the inside of ductwork for clogging or plugging by material
     - Inspecting ductwork for deterioration
     - Inspecting flexible ductwork for excessive burn or chafing
     - Checking exhaust fans, dampers, and related components including the fan belt
     - Checking exhaust system filters
b. Air Velocity Measurements

- Measurements of air velocity are made with velocimeters inside the ductwork or container for comparison with accepted or design criteria. Velocimeters are used in accordance with the manufacturer's instructions.

- Since air velocity through a container is not uniform, several measurements are made in equal subsections of the cross-sectional area. These air velocity measurements are averaged and multiplied by the cross-sectional area at the point of measurement to determine the total volume of air exhausted in cubic feet of air per minute (cfm). A similar procedure is followed inside ductwork, however, a centerline velocity measurement result is multiplied by 360 to approximate the average air velocity through the duct. This data is then compared to design criteria to assess the exhaust system effectiveness.

- In the event that measured air velocities or calculated total exhaust air volumes are detected significantly below the design criteria (e.g., 80% or less of design or specified performance), work activities are immediately stopped until corrective measures are implemented.

c. Static Pressure Measurements

- Periodic measurements of static pressure using a manometer or gauge are made to assess negative pressure inside the container. Static pressure measurements are also used to identify malfunctioning equipment, clogged ducts, dirty or broken filters, and damaged exhaust system components. These measurements are made through small holes drilled into the side wall of ductwork.

- In the event that the static pressure measurements across the containment are below the specified criteria typically from...
4.01 0.01 to 0.03 inches of water, work activities are immediately stopped until corrective measures are implemented.

d. Reporting/Record Keeping

The results of the visual inspections are reported on Form 4. Results of instrument verifications are reported on Form 5. Records are maintained for the length of the project plus 3 years.

4.8.4 When welding, painting or burning, Almea Company, Inc. considers the removal of paint in advance to reduce exposures. When this approach is utilized, the lead containing coating is stripped a distance of approximately 4 inches on both sides of the area of heat application.

4.9 RESPIRATORY PROTECTION

4.9.1 Respirators are worn by all Almea Company, Inc. employees who may be exposed to airborne lead at or above the Permissible Exposure Limit.

4.9.2 The respiratory protection program for lead exposure activities shall be implemented in accordance with Part B - Section 2.0 Respiratory protection program criteria specified in 29 CFR 1926.62 for respirator users are also contained in Attachment 2.

4.9.3 Compressed air respirator cartridges are disposed of as hazardous or non-hazardous, as appropriate.

4.10 PROTECTIVE CLOTHING AND EQUIPMENT

4.10.1 Protective clothing and equipment are worn by all employees whose airborne lead exposures may exceed the PEL. Protective clothing and equipment are provided at no cost to the employee.

4.10.2 Protective clothing includes washable or disposable work clothing and/or full body coveralls. Other protective equipment includes glove protection, face shields, hats, gloves, shoes or disposable shoe covers, and hearing protection, as appropriate.

4.10.3 Clean work clothes are provided daily to employees whose airborne exposure levels (without regard to use of a respirator) are over 200 µg/m³ of lead as an 8-hour TWA. Employees whose exposure levels are less than 200 µg/m³ are provided clean work clothing at least weekly.

4.10.4 Disposable protective clothing is used for no more than one work day. It is disposed of as hazardous or non-hazardous waste as appropriate.
4.10.5 Reusable clothing is collected at the end of each work day in closed bags or containers. Reusable clothing which is contaminated with lead is cleaned according to applicable federal, state, or local regulations pertaining to lead-contaminated laundry and waste disposal. If the clothing is not washed on-site, it is sent to an authorized laundry. All containers of lead-contaminated laundry are labeled as follows:

**CAUTION: CLOTHING CONTAMINATED WITH LEAD. DO NOT REMOVE DUST BY BLOWING OR SHAKING. DISPOSE OF LEAD CONTAMINATED WASTE WATER IN ACCORDANCE WITH APPLICABLE LOCAL, STATE OR FEDERAL REGULATIONS.**

4.10.6 Lead contaminated clothing, shoes, socks, gloves or equipment do not go home with any employee unless decontaminated at the end of the day. Removal of any contaminated items from the site by any employee is strictly prohibited. HEPA vacuums or wet methods may be used to clean worker's personal items before leaving the site.

4.11 HOUSEKEEPING

4.11.1 Employees are not permitted to remove lead-containing dust from protective clothing or equipment by blowing, shaking, or by any other means which disperses lead into the air.

4.11.2 HEPA equipped vacuum cleaners are used for cleaning heavy dust contamination from protective clothing and equipment. HEPA vacuum cleaners and/or wet methods are used to maintain good housekeeping practices in the change areas and designated eating areas.

4.11.3 The use of compressed air for clean up around the work area is strictly prohibited.

4.11.4 Along with Company, Inc. prohibits the use of compressed air for cleaning in the work area, unless it is used in conjunction with a ventilation system.

4.12 PERSONAL HYGIENE FACILITIES AND PRACTICES

4.12.1 All employees whose airborne lead exposures exceed the PEL wear overalls into work areas to prevent any contamination of personal clothing, or are provided with separate work clothing which allows the employee to work without wearing street clothing beneath.

4.12.2 Clean change areas are provided for all projects where employee airborne lead exposures may exceed the Permissible Exposure Limit. The clean change areas are equipped with storage facilities for street clothing and a separate area...
for the removal and storage of lead-contaminated clothing and equipment.

The change areas are designed and used so that contamination of street clothing does not occur. Airborne lead exposures in the change area are maintained below the Action Level.

4.12.4 When employee lead exposures exceed the Permissible Exposure Limit, shower facilities are provided where feasible. Shower facilities comply with the OSHA Standard, 29 CFR 1910.1005, Subpart K. All showers are provided. All employees whose airborne lead exposures exceed the PEL, shower at the end of each work shift. Shower facilities are provided with hot and cold running water.

4.12.5 Hand-wash facilities are made available on all jobs involving potential exposure to lead. Hand-wash facilities are placed in most proximity to the work site and are equipped with running water, cleansing agents, and towels. In addition to washing, all employees remove or clean their protective clothing and equipment before eating, drinking, or smoking.

4.12.6 All employees exposed to any amount of lead on the job thoroughly wash their hands, face and forearms before eating, drinking, or smoking and at the end of each work shift.

4.12.7 Eating, drinking, smoking, or chewing tobacco are prohibited in work areas and in any area where lead exposure may exceed the PEL.

4.13 MEDICAL SURVEILLANCE

4.13.1 All employees who may be exposed to lead above the Action Level on any single day of the year are provided with initial biological monitoring in the form of blood sampling and analysis for lead and zinc protoporphyrin (ZPP).

4.13.2 All exposed employees are notified in writing of the biological monitoring results within 5 days after receiving the results. When the results indicate that employees are exposed to lead above 40 micrograms per deciliter (μg/dL), Alwega Company, Inc. notifies the medical examiner, a description of the medical examination program procedures.

4.13.3 Employees are provided a complete medical exam annually if:

a) a blood sampling test at any time during the preceding 12 months indicates a blood level of 40 micrograms of lead per deciliter.

b) the employee notifies the supervisor (or competent person) that he/she has signs/symptoms of lead intoxication.

c) the employee desires medical advice concerning the effect of past or current lead exposure on the ability to procreate a healthy child.
d) the employee is pregnant.

e) the employee demonstrates difficulty in breathing during a respiratory
function test or during use.

4.13.4 The specific contents, requirements, and frequencies of medical examinations,
blood lead tests, and medical removal protection benefits are provided in
Attachment 3 of the Medical Surveillance/Examination Program.

4.13.5 All employees are removed from lead exposure above the Action Level due to:

a) elevated blood lead levels (at or above 90 μg/dL; confirmed by a follow up test
within 2 weeks of the first), or

b) at the recommendation of a physician.

4.13.6 Removed employees may be reassigned to other job duties that do not involve
exposure to lead above the Action Level. They are returned to lead exposure
work above the Action Level only when their blood lead drops below 40 μg/dL,
measured by two tests taken at least two weeks apart, or when the
physician indicates that it is no longer necessary to limit exposure when the
removal was not caused by elevated blood lead levels. Almage Company, Inc.
provides employees up to eighteen (18) months of medical removal
protection benefits on each occasion that an employee is removed from exposure to lead. The benefits are provided for up to 18 months or as long as
the job the employee was removed from continues and it is determined that
they cannot be reassigned to other job duties that do not involve exposure to
lead.

4.14 EMPLOYEE INFORMATION AND TRAINING

4.14.1 All employees who work on projects where airborne lead exposures are
known to be or expected to be at or above the Action Level on any single day
are provided information and training on the hazards of lead and measures for
controlling these hazards and protecting their health.

4.14.2 Employees receive initial comprehensive lead training before performing
work that may involve airborne lead exposure. This training is repeated
annually as a refresher course.

4.14.3 The content of lead training includes:

a) An overview of the OSHA Construction Industry Lead Standard and the
adverse health effects of lead, with particular emphasis on reproductive
hazards.
Atenga Company, Inc.
Safety and Health Program
Revision No. 5
November 1998

4.14.4 Training records (see Foot 7) of all employees are maintained and kept on
file in accordance with the requirements outlined in the section entitled
Record Keeping.

4.15 WARNING SIGNS

4.15.1 Warning signs are posted around work area activities where lead exposures
may exceed the Action Level. (Note: this exceeds the OSHA immediate hazard level of
the Permissible Exposure Limit.) The work areas are demarcated by ropes,
tape, walls, containers, or other visible means, and are designated as
regulated areas or zones.

4.15.2 The signs are posted in locations that are easily visible from a distance,
allowing employees or bystanders to take necessary protective measures.

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before entering the work area. Signs read as follows: "WARNING, LEAD WORK AREA, PERSON, NO SMOKING OR EATING"

4.15.3 The Competent Person controls access of persons into work areas.

4.15.4 Persons entering work areas where warning signs are posted must comply with the requirements of this or a comparable program, and wear appropriate protective clothing and respirators.

4.16 RECORD KEEPING

4.16.1 All records relating to training, medical examinations, blood lead monitoring, exposure monitoring, and project-specific requirements are maintained by Almega Company, Inc. for the employees' length of employment plus 30 years.

4.17 OBSERVATION OF MONITORING

4.17.1 Almega Company, Inc. provides affected employees or their designated representatives (assuming adequate training, medical surveillance and PPE are documented) an opportunity to evaluate the monitoring of the lead exposure. The employee or designated representative is entitled to an explanation of the monitoring procedures observed at the site related to the monitoring, and record the results obtained or receive copies of the results when returned by the laboratory.

4.18 PROJECT-SPECIFIC REQUIREMENTS

4.18.1 The specific worker protection requirements for each lead removal project are determined by Almega Company, Inc. in accordance with this program and project specifications. Job-specific requirements are outlined in the Site Specific Lead Compliance Program (Attachment 1). This attachment is posted at the job site and maintained with the work records of the project.

4.19 OTHER RELEVANT INFORMATION

4.19.1 The compliance program is available for examination by all employees or authorized person/agency.

4.19.2 Each site-specific lead compliance program is reviewed and updated at least every 6 months.
Almega Employee Test Examples

THE ALMEGA COMPANY, INC.
INDUSTRIAL & COMMERCIAL PAINTING CONTRACTORS

1537 McCarran Hunt Road
Pittsburgh, PA 15241

HAZARD COMMUNICATION TRAINING TEST

Please write the information presented in the following questions, then fill in the box by following along with the answers. Additional time will be provided at the end of the test. Do not leave any question you have blank. Remember the answers to the questions are provided during the test.

1. The two main types of hazards associated with chemicals include: ________

2. Material Safety Data Sheets don’t really provide good information? True False ________

3. MSDS provide ________ information.

4. Chemicals must contain labels with basic information about the materials? True False ________

5. What type of material ignites below 120 degrees? Flammable or Combustible ________

6. MSDS are not required at a job site? True False ________

7. It is not important how you dispose of chemicals or used materials? True False ________

8. What are the four chemical hazards? ________

9. What is the most common way you are exposed to a chemical? (A) Skin absorption (B) Inhalation (C) Injection ________

10. What does PEL stand for? ________
LEAD SAFETY TRAINING TEST

1. Who can be exposed to lead? True False
2. Children are affected more adversely than adults? True False
3. Symptoms of overexposure include: ________________________________
4. Lead builds up in what parts of the body (4)? _____________________
5. How is your exposure determined? ________________________________
6. What is the PEL for LEAD? 45 mg/m³ 30 mg/m³ 60 mg/m³
7. The Action Level for lead exposure is ______________________ ug/m³.
8. Engineering controls are the first step in controlling lead exposure? True False
9. Personal Protective Clothing and Equipment are used when levels aren't lowered below the PEL by engineering controls? True False
10. A ______________________________ filter is used in a respirator for lead protection.
11. The filter on a respirator is changed when ____________________________ in breathing resistance is noticed by the wearer.
12. Lead contaminated Personal Protective Clothing is removed when leaving the work area? True False
13. Contaminated PPE is disposed of by normal means? True False
14. Eating, smoking, and chewing is ____________________________ in lead area.
15. Blood testing is done prior to starting the job? True False
16. Medical Monitoring is done when exposed to lead for at least 30 days below the PEL? True False
17. The action level for lead in the blood is ____________________________ ug/dL.
18. ____________________________ indicates medical removal from lead exposure projects.
19. The employee should review his or her blood test results? True False
20. Employee has the most control of exposure levels? True False
FALL PROTECTION TRAINING TEST

Please work the information presented on the video tape. Answer the questions on the test by following along with the video tape. Additional time will be provided at the end of the tape to review any questions you have left blank. Remember the answers to the questions are presented during the tape.

1. Fall protection equipment should be inspected ________________________________

2. When working above ground, you must use a fall arrest system? True □ False □

3. Your fall protection equipment must include a __________ foot shock absorbing lanyard.

4. Your can substitute another equipment? True □ False □

5. You can loop your lanyard around the anchor point? True □ False □

6. __________ Snap hook must be used.

7. The snap hook can be attached directly to a vertical lifeline? True □ False □

8. The location of the anchor point should be directly above you at its highest point? True □ False □

9. Fall protection must always be worn correctly to function properly? True □ False □

10. The correct fall distance is critical for fall protection equipment to work properly? True □ False □
PERSONAL PROTECTIVE EQUIPMENT TEST

Please view the information presented in the video tape. Answer the questions in the test by following along with the video tape. Additional time will be provided at the end of the tape to review any questions you have left blank. Remember the answers to the questions are presented during the tape.

1. If you don't know what PPE to use

2. Personal Protective Equipment includes (name three)

3. One respirator cartridge will protect you from all hazards? True False

4. Ladders are placed using the 8-to-1 rule from the wall? True False

5. Always face the ladder while climbing or descending the ladder? True False

6. Ladders must extend _______ feet above the landing

7. Housekeeping is very important to your job safety? True False

8. Lift with your ___________ not your ___________

9. Always ___________ electrical equipment.

10. Ground fault circuit interrupters must be used when using electrical equipment? True False

11. Emergency numbers should be clearly posted at the job site? True False

12. Report all ___________ and ___________ no matter how small or minor you may think they are.

13. Who is the person most responsible for your safety?
Name ____________________________ Date ____________________________

**RESPIRATOR TRAINING TEST**

Please review the information presented in the video, or. Answer the questions on the test by following along with the video. Additional time will be provided at the end of the tape to review any questions you have left blank. Remember the answers to the questions are presented during the tape.

1. A field test is required for proper usage? True False
2. Positive and negative field tests are adequate if leaks do not occur? True False
3. Qualitative fit test consists of _______and negative, pressure test and _______.
4. Correct type of cartridge/filters must be used for proper protection? True False
5. Filters/Cartridges should be replaced when? ____________________________
6. Your respirator should fit comfortably? True False
7. A full beard is acceptable when using a respirator? True False
8. A regular _______and _______of the respirator should be conducted?
9. Solvents should not be used to clean respirators? True False
10. Who is the most responsible for the condition and use of your respirator? ____________________________

FORM #02

Page 5
Almega Employee References

For work to be completed at the Rock Island Viaduct, we will utilize a four man crew.

Foreman: Dave Young, will be on site company representative, 22 years experience in the application of PPG Pitt-Clair.

Workers: Mark Lorenz - 22 years experience with PPG Pitt-Clair.

We do not currently know who the final two workers will be as they will most likely come from the local union hall.
Estimated Waste Quantities

- Black Beauty Sand: 2 Tons
- Waste Thinner: 15 gal.
- Paint: 20 gal.
Maintenance and Repair:

Should paint repair become necessary, utilize the following procedure for 97-145 and 95-8800 series primers and topcoats.

Solvent clean, per SSPC SP-1, the substrate to remove any contamination that may be present.

Abrade substrate to remove gloss and to obtain a surface profile for adhesion of the repair coating. This can be accomplished by following the standards of SSPC SP 2/3 Hand and/or Power Tool Cleaning. Feather sand any edges to allow for a smooth surface to repaint. Care should be taken not to abrade the surface too aggressively as surface defects may be visible when coated. Spot prime any bare metal with 97-145 series coating.

Prior to coating, solvent wipe substrate to remove dust and residual contamination. Use 95-8800 to overcoat the epoxy primer or the existing urethane topcoat.

If a repair is desired in an area where the product is subjected to immersion, remove all material by appropriate means. It is not recommended to touch up damaged coatings that are subjected to immersion.
Subject: Repair Procedure for Pitt-Char XP Coating

1. Outline damage area and cut through existing Pitt-Char XP coating and mesh reinforcement with a disc grinder. Remove damaged coating with hammer and chisel or pneumatic chisel. A sharp 1-2" wide chisel is used to split the coating at the primer level. Care shall be taken not to gouge or damage the steel substrate. Remove any loose or damaged coating and reinforcement material. The repair border of existing Pitt-Char XP coating shall be checked to ensure good adhesion to the substrate. The lead edge of the repair shall be beveled to a 45° angle.

2. Abrade entire repair area and a 1/2 inch boundary using either a brush blast, disc grinding or wire cup brush. For small areas use a hand wire brush or coarse grit sand paper. Remove any top coat to achieve a whitened, non-glossy surface of the existing Pitt-Char XP coating in the repair area. All bare metal exposed shall be spot primed according to project specifications. Follow primer manufacturer recommendations for application and cure time.

3. Application of Pitt-Char XP shall achieve the original coating thickness and reinforcement as specified for the project. This may be accomplished by spray or hand trowel application as suitable. Repair areas smaller than 6 x 6 inches do not require mesh replacement.

4. New Pitt-Char XP coating shall be feathered onto abraded boundary area to achieve a uniform appearance in accordance with original Pitt-Char XP coating application. It shall not be applied to non-abraded areas.

Pitt-Char XP Trowel Procedure

1. Material shall be warmed to 75 - 100°F. The mix ratio by weight is 3:2.5 parts component A (97-194) to 1.00 parts component B (97-195).

2. Add 2-3% solvent (PN Acetate, Toluene, or Methylene Chloride) to component A and mix until uniform.

3. Apply component B to component A and mix with a paddle or high lift mix blade until coating is of uniform gray color, 3-5 minutes is normal. Do not over mix as this will reduce heat and shorten pot life.

4. Apply coating with rectangular and pointed trowels using standard plastering techniques. Coating shall be applied in 100-200mil coats applications until desired film thickness is achieved. After coating has started to stiffen it may be rolled smooth using a short nap roller dipped in the same mixing solvent. Remove excess solvent from roller as added solvent may cause coating to slump. Allow sufficient time for cure between coats, depending on ambient temperature, 4-6 hours as a minimum.

5. Large areas shall be applied using spray technique as described in application manual.
PITT-CHAR XP REPAIR PROCEDURE

- Repairs shall be conducted by certified applicators.
- Remove all damaged and loose fire protection.
- Remove and replace all damaged primer with approved system.
- Replace Pit-Char XP to specified thickness by approved methods.
- Replace existing reinforcing mesh to original specification. Mesh reinforcement is not required on repairs less than 6 x 6 inches (150 x 150mm).
- Surface finish of Pit-Char XP shall be as agreed by Project Team and PPG Industries.
- Replace topcoat system per specification where required.
Rock Island Building 227
Typical stair tower (1 of 2) for Pitt-Char XP application on structural steel from ground to 16 ft. elevation of third landing
Rock Island Building 229
Typical high bay for Pitt-Char XP column application from floor to 18 ft. elev.
Pitt-Char XP application for Rock Island Arsenal
Hollow sections (Detail 1)

- Surface preparation is SSPC SP 6 (NACE 3) for exterior steel and SP 1 for interior steel consisting of solvent wipe for 30 min and power wash for 5 min. Rusty areas shall be chipped per SP 1 as required.
- Apply 6 mil DFT Pitt-Guard DTR primer.
- Apply approximately half the specified thickness of Pitt-Char XP coating.
- Install fiber mesh over "wet" coating. Overlap fiberglass 1 inch minimum and stagger mesh to eliminate all wrinkles, gaps and air voids.
- Apply second coat to achieve specified film thickness (0.53")
- Surface must be finished off per approved reference sample prior to project startup.

Pitt-Char XP application for Rock Island Arsenal
W sections (Detail 2)

- Surface preparation is SSPC SP 6 (NACE 3) for exterior and SP 1 for interior steel.
- Bidg 289 shall have solvent wipe, bidg 227 shall be power washed, both shall have power tool SP 3 where required.
- Apply Pitt-Guard DTR primer 4-6 mil DFT.
- Apply approximately half the specified thickness of Pitt-Char XP coating.
- Install mesh into "wet" first coat and wrap mesh around fillet edge.
- Mesh shall extend halfway to web from flange edge. Lap all mesh seams 2", Roll mesh for 100% contact.
- Apply second coat (s) to achieve specified thickness (0.53") Topcoat with Pittane urethane
Rock Island Arsenal

Construction Procedure
January 2007
Section I

General Description

1.1 THICKNESS
1.2 MESH
1.3 APPLICATION
1.1 Thickness

The project will use UL thickness of Pitt-Char XP for 3 hour, E119 rating protection 0.530”

1.2 Reinforcement

The reinforcement system shall be fiberglass mesh 238-2/66. Mesh shall be applied to the flange edges. Precut mesh sections shall be applied after approximately half the specified coating thickness has been applied. The mesh shall be installed onto uncured Pitt-Char XP coating and completely rolled to provide 100% contact with the coating. The mesh shall not have any wrinkles, gaps or airvoids. It shall be lapped 2-inch minimum at all seams.

1.3 Application

“1” Columns: Vertical columns and diagonal braces shall be coated on all four sides. Please refer to Section VI for details. Typical application is 2-3 coats using plural airless equipment. Pitt-Char XP terminations shall be tapered to a 45° angle and rolled to a feathered edge with tight adhesion to substrate. Stop fiberglass mesh approximately 2 inches from terminations to allow for tapered edge. No mesh shall be exposed after specified thickness has been applied.
Fire Resistance Ratings - ANSI/UL 263

Design No. X623
December 05, 1999

Ratings — 1, 1-1/2, 2, and 2-1/2 Hr, 3 Hr (See Item 3)

1. Steel Column — Min size W10x10. The column surfaces shall be free of dirt, loose scale and oil. Steel surfaces to be primed with polynamide-epoxy and zinc rich primers to an approximate dry film thickness of 0.003 in.

2. Glass Fiber Mesh — 6 in. wide, weighing 4.5 oz per sq yd, embedded at approximately mid-depth of mastic coating. Glass fiber mesh must be applied for the 1-1/2, 2, 2-1/2 and 3 hr ratings.

3. Mastic Coating* — Coating spray applied directly from containers to the appropriate thicknesses shown in the table below.

<table>
<thead>
<tr>
<th>Rating Hr</th>
<th>Material Thickness In.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.19</td>
</tr>
<tr>
<td>1.5</td>
<td>0.26</td>
</tr>
<tr>
<td>2</td>
<td>0.34</td>
</tr>
<tr>
<td>2.5</td>
<td>0.42</td>
</tr>
<tr>
<td>3</td>
<td>0.53</td>
</tr>
</tbody>
</table>

PPG INDUSTRIES INC — Type Pitt-Char XP. Investigated for Exterior Use.

*Bearing the UL Classification Mark

Revised 1/07
Rock Island Arsenal
Section II

Application Disciplines

QA/QC
FOREMAN
PUMP MECHANIC
SPRAYER
MESH INSTALLER
ROLL/TROWEL
Pitt-Char XP Disciplines

This outline describes the minimal requirements to be certified in the various disciplines as a Pitt-Char XP coating applicator. Candidates will be certified according to the following categories:

I. QA/QC
II. Supervisor
III. Pump Mechanic
IV. Pitt-Char XP Coating Sprayer
V. Mesh Installer
VI. Roll/Trowel

All supervisors, QA/QC, pump mechanics and sprayers at job startup must be formally trained by PPG. After formal training, supervisors are permitted to train new personnel. Non-certified personnel may perform trowel/rolling, and mesh installation.

A Pitt-Char XP fire proofing project will require at least one certified individual from each of the 6 categories. Some categories may be done by one person.

I. QA/QC MANAGER

Scope: The QA/QC Inspector is responsible for the verification that all quality control aspects of the application are being met. This person will have the responsibility of completing all daily application logs and has final approval on all QC documents required from the contractor by the client. The QA/QC Inspector will order repairs and/or stop production if deviations from the quality plan are observed.

Requirements: This position requires the person to be fully knowledgeable and experienced in all other job categories including supervisor, pump mechanic, mesh installer, and roller/trowel.

It is recommended that the QA/QC manager have a minimum of 1 year experience as a Pitt-Char XP coating supervisor.

II. SUPERVISOR

Scope: The supervisor or foreman is responsible for the application of Pitt-Char XP coating. He will direct the activities of each crew, organize the operation for efficiency and ensure that all work is carried out according to both PPG’s and the client’s specifications.

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Rock Island Arsenal
Requirements: This position requires the person to be certified in the following disciplines: roller/trowel, mesh installer, sprayer and pump mechanic.

It is recommended that the supervisor have a minimum of 2 years field experience in the application of fire protective coatings.

The qualified supervisor will have demonstrated the ability to train personnel as roller/trowel, mesh installers, sprayers, and pump mechanics. He shall be certified by PPG Industries in this capacity.

III. PUMP MECHANIC

Scope: The pump mechanic is responsible for the operation, maintenance and repair of the Pitt-Char XP spray equipment.

Requirements: The certified pump mechanic will demonstrate the knowledge required to operate, maintain, and repair the spray equipment. The pump mechanic must have a basic understanding of electrical and pneumatic systems. He must be knowledgeable of the correct spray parameters. He must fully understand start up and stop procedures. He will be knowledgeable of Pitt-Char XP material handling and loading into the equipment. The pump mechanic will prepare a daily log of all areas coated and material batches used such as the daily log attached.

The qualified person must demonstrate knowledge of troubleshooting procedures. The certified pump mechanic will be trained by a supervisor or a PPG technical service representative.

IV. Pitt-Char XP SPRAYER

Scope: The certified Pitt-Char XP Sprayer will have demonstrated the ability to apply the fireproofing by the correct spray methods and with the proper thickness and surface appearance.

Requirements: A certified sprayer will have demonstrated his ability to apply Pitt-Char XP coating. He will be able to spray apply Pitt-Char XP with no sags but with an acceptable surface appearance and uniform thickness. The sprayer will fully understand how parameters such as heat, pressure, and spray tip size effect film build, appearance and overspray. He will understand the requirements for surface preparation and priming. The certified sprayer will be trained by a trained supervisor or a PPG technical service representative.

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Rock Island Arsenal
V. MESH INSTALLER

Scope: The certified mesh installer will demonstrate the ability to cut and install fiber or steel meshing.

Requirements: The certified mesh installer will be trained by a certified supervisor or a PPG technical service representative.

VI. TROWEL/ROLLER

Scope: The certified trowel/roller will demonstrate the ability to trowel or roll the spray applied material to achieve a uniform thickness and final surface appearance. The trowel/roller will also carry out wet film thickness measurements.

Requirements: The certified trowel/roller will be trained by a certified supervisor or a PPG technical service representative.
SECTION III

SURFACE PREPARATION

3.1 SURFACE PREPARATION

3.2 PRIMER ADHESION
   A. ASTM D-3359 “X” Cut
   B. ASTM PULL-OFF STRENGTH D4541-93

3.3 PRIMER

3.4 PRIMER REPAIR

Revised 1/07
Rock Island Arsenal
3.1 SURFACE PREPARATION

Building 227 East & West Baghouse
Exterior Stair Towers
Steel surfaces shall be degreased to remove any grease, oil or soluble contamination prior to blasting and/or power tool cleaning per SSPC SP1. This may be accomplished by power detergent wash followed by fresh water rinse or solvent wipe with mineral spirits. The entire area to be fireproofed shall be blasted to SSPC SP6 with 1.5-3.0 mil anchor pattern with angular grit and primed with recommended primer. The surface shall be clean, dry and free of contamination prior to application of Pitt-Char XP coating.

Interior support columns
Steel surfaces shall be degreased to remove any grease, oil or soluble contamination prior to priming per SSPC SP1. This may be accomplished by power detergent wash followed by fresh water rinse or solvent wipe with mineral spirits. All corroded areas shall be power tool cleaned per SSPC SP11 prior to primer application. The surface shall be clean, dry and free of contamination prior to application of Pitt-Char XP coating.

Building 299 Interior support columns of 2 high bays
Steel surfaces shall be degreased to remove any grease, oil or soluble contamination by solvent wipe per SSPC SP1. This shall be accomplished by solvent wipe with mineral spirits and primed with recommended primer system. Existing coating contains lead. Appropriate procedures shall be followed for all removal of the existing coating. The surface shall be clean, dry and free of contamination prior to application of Pitt-Char XP coating.

3.2 PRIMER

Entire area to be fireproofed shall be primed with PPG Pitt-Guard DTR Epoxy Mastic Coating 97-145 series. The dry film thickness shall be 4-6 mils. Follow the recommended application procedure as outlined on TD-P11.

3.3 Primer Adhesion

To verify the primer adhesion, an adhesion test must be carried out. After the primer has cured and before the application of the Pitt-Char XP coating, the primer should be tested for proper adhesion. Two test methods are acceptable for checking primer adhesion. Random areas shall be checked on all exterior and interior areas. Minimum of 4 checks per building are recommended.
3.3A ASTM D-3359 X Cut

A scalpel blade or knife is used to cut the primer. An "X" is cut into the primer with 2 cuts. Each cut is 1.5 inches long. The cut should penetrate and reach the substrate. A 3-inch length of semi-transparent tape with good adhesive strength (such as Permacel 99) is placed over the center of the "X" and pressed firmly on the cut. The tape is removed in 1.2 minutes in a manner such that it is pulled back on itself (as close to 180° from the point of contact) The primer should show adhesion of 4A or better. An adhesion result of 4A means that only slight peeling or removal of paint occurred from the cut lines. If test fails run the ASTM pull-off strength test below to qualify primer adhesion.

3.3B ASTM PULL-OFF STRENGTH D4541-93

The general pull-off is performed by securing a loading fixture (dolly) normal (perpendicular) to the surface of the coating with an adhesive. After the adhesive has cured, a testing apparatus is attached to the loading fixture and aligned to apply tension normal (perpendicular) to the test surface. The force applied to the loading fixture is then gradually increased and monitored until either a plug of coating material is detached, or a specific value is reached. When a plug of material is detached, the exposed surface represents the plane of limiting strength within the system. The nature of the failure is qualified in accordance with the percent of adhesive and cohesive failures, and the actual interfaces and layers involved. The pull-off strength is computed based on the maximum indicated load, the instrument calibration data and the original surface area stressed. Epoxy primer shall have a minimum of 500psi pull strength.

3.4 PRIMER REPAIR

Any contamination such as dirt, dust, grease or oils shall be removed prior to primer application. Repair primer per PPG Industries recommended procedure.
Section IV

Application

4.1 Description
4.2 Airless Equipment
4.3 Airless Application
   a. Initial Setup
   b. Air/power
4.4 Surface Inspection
4.5 Adjacent Surface Protection
4.6 Release Agents
4.7 Site Storage
4.8 Shelf Life
4.9 Shipping
4.10 Material handling (airless)
4.11 Thickness
4.12 Appearance
4.13 Surface Finish
4.14 Temperature
4.15 Removal
4.16 Repair
4.17 Recut
4.18 Trowel

Revised 1/07
Rock Island Arsenal
4.19 Cleanup

Photos

4A. Approved Surface Finish

4B. Unacceptable Surface Finish

4C. Application Tools
4.1 SPRAYING PITT-CHAR XP COATINGS DESCRIPTION

Pitt-Char XP Coating is a high viscosity mastic material that can be applied without sagging, under most conditions, up to 250 mils in one continuous application. When shear and heat are applied, the viscosity brakes and the liquid flows easily. As soon as the shear is removed or the material cooled, the material returns to its high viscosity state. The equipment used for mixing and application of Pitt-Char XP Coating makes use of these properties to a great extent.

4.2 AIRLESS SPRAY EQUIPMENT

As part of the continuing effort to provide higher production rates and smoother applications of Pitt-Char XP Coating, equipment has been designed to permit airless application. The equipment makes use of heat and high pressure to apply Pitt-Char XP Coating through conventional airless spray tips. Application is at 100% volume solids, no thinner is used to reduce viscosity. These are plural component units with product mixing occurring in a mixing block located approximately 12-15 feet from the spray gun.

Spray-Quip Inc.
1754 Des Jardines
Houston, Texas, 77023
Tel: 713 923 2771
Fax: 713923 7822
Attn: Herb Chilman

4.3 AIRLESS APPLICATION OF 100% SOLIDS

PITT-CHAR XP FIRE PROTECTIVE COATING

4.3A Initial Set-Up

To assure successful and profitable application of Pitt-Char XP Coating, the application contractor must be prepared to: (1) provide a crew large enough and arrange equipment rigging and work, if possible, to allow the spray man to spray continuously with a minimum of flushing; (2) have on-site at all times during spray operation, a supervisor/technician who thoroughly understands the basics of the application, material, and equipment; (3) the supervisor is to assure that the Pitt-Char XP coating is properly stored, heated and applied by the crew; (4) the supervisor will supervise the application crew regarding daily use, cleanup, and maintenance of the spray unit. THIS PERSON IS THE KEY TO THE SUCCESSFUL AND PROFITABLE APPLICATION OF PITT-CHAR XP COATING.

The applicator should have on-site before start-up the necessary safety gear for the personnel - masks, gloves, suits, etc. Also needed are cleanup tools including an assortment of brushes, rubber gloves, wrenches (that fit) and preferably a work bench with a vise. Containers, a selection of pails, buckets, and or pans to soak and clean the spray gun, tips, static mixer, valves,
Etc. Tupperware type containers with sealable lids have been used successfully. Set up cleaning bench in a well lighted and ventilated area. Finishing, masking installation, or repair tools, including rollers, roller covers, masonry trowels, and brushes. A hot box insulated and thermostatically controlled to a temperature of 120 to 140°F, large enough to hold one day's anticipated spray production. A portable scale with a range of 100 lb to run weight ratio tests.

4.3B Air/Power Requirements (Per pump manufacturer)

Air 125 psi
Electrical 230V single phase, 60 amps

4.4 SURFACE INSPECTION

Surfaces primed in accordance with Section III “Surface Preparation”, shall be inspected immediately prior to the application of Pitt-Char XP Coating. The surface must be clean, dry and free of contaminants. Inspect carefully for grease contamination and remove by approved methods. Do not apply Pitt-Char XP Coating under conditions where condensation, frost, or icing is present or forming on the surface. Do not apply Pitt-Char XP Coating to surfaces where the surface temperature is below 50°F (10°C). Do not apply Pitt-Char XP coating if the surface temperature is less than 5°F (3°C) above the dew point.

4.5 PROTECTION OF ADJACENT SURFACES (MASKING, DEMASKING)

Pitt-Char XP Coating has excellent adhesion to a variety of surfaces. Overspray, drips, etc., will be difficult to remove if allowed to dry. Mask gauges, light fixtures and other mechanical or electric equipment in the area near the application. Use duct tape and plastic sheeting to prevent wind blown overspray onto other areas. Masking should be removed as soon as danger of over spraying the surfaces ceases. In a partially cured state, Pitt-Char XP Coating is rubbery. When fully cured, it is very tough, typically 50-60 on a Shore D scale. These conditions make removal of masking very difficult.

Conventional masking tape is unsatisfactory for use at the boundary of Pitt-Char XP Coating application. Pitt-Char XP Coating has the ability to wet through this tape and gain some adhesion to the protected area. Duct tape works well at such a boundary. Masking tape may be used at more remote areas not expected to receive a full, wet application of Pitt-Char XP Coating.

4.6 USE OF RELEASE AGENTS

Do not use grease, oil, silicones, etc., to prevent adhesion of Pitt-Char XP Coating to non fireproofed adjacent areas. Other areas are easily contaminated and will prevent a bond of the Pitt-Char XP Coating. The use of release agents is absolutely prohibited.

4.7 SITE STORAGE OF MATERIALS

Revised 1/07
Rock Island Arsenal
Pitt-Char*XP shall not be stored in direct sunlight. Temperature of the packaged material must be maintained in a sheltered or air conditioned area below 90°F (32°C).

Prior to application (24 hours), Pitt-Char*XP should be warmed to 120°F minimum for spray pumps. Pitt-Char*XP coating must be used after 4 days storage between 120-140°F.

4.8 SHELF LIFE

Minimum shelf life under proper storage conditions is:

- 97-194 and 97-194M: 1 year from date of manufacture
- 97-195 and 97-195M: 2 years from date of manufacture

4.9 SHIPPING

Pitt-Char*XP Coating is packaged in 100% solids containers. They contain no solvent, resulting in no restrictions for air or land transportation. The flash point for both Pitt-Char*XP components is greater than 200°F. Material must be stored below deck out of direct sunlight and below 90°F.

4.10 MATERIAL HANDLING (AIRLESS APPLICATION)

Components A and B should be supplied to plural airless units between 120 to 140°F.

Pitt-Char*XP Coating is a two-component material whose volumetric ratio is 2.33:1. The "A" (white) part is packaged in a tall pail. The "B" (black) part is packaged in a standard 5 gallon pail. The pails are filled at the factory so that mixing two parts "A" with 1 part of "B" produces the proper volume ratio. The spray ratio of the pump can be verified by a weight check if component A and B pails are not emptying at a 2 : 1 rate. This can be accomplished by disconnecting the hoses before the mixing block. The hose openings should be reduced to 1/4" to simulate back pressure of the mixer and spray tip. One hot pail of each component should be pumped through prior to the weight check. The pump is turned on at low pressure (1500 – 2000 psi) and the individual components are collected in separate clean pre-weighted pails. The weights of each component should be 3.25 "A" to 1.00 part "B". Tolerance of 10% off-ratio in either direction is acceptable. Acceptable A to B range is 2.93-3.58: 1. The material used for the weight check may be reused if kept clean.

For proper metering and spray fan to be achieved, "A" and "B" must be preheated to reduce the viscosity before use in a plural airless unit. Begin pre-heating the number of pails of "A" and "B" needed for the next shift approximately 24 hours ahead of time. Put pails in the hot box with space between the pails for proper air circulation. The heat must be thermostatically controlled and evenly distributed. DO NOT HOLD PAILS AT TEMPERATURES OVER 140°F OVER 4 DAYS. Component A’s viscosity reduces, but is not pour readily. Component B will pour when preheated. If material has been properly preheated and will not achieve a proper fan pattern, consult your PPG Technical Representative. The representative may suggest mechanical agitation or substituting a different batch. If the components are too viscous, mass-metering and loss of fan pattern will occur.

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READ START-UP AND OPERATION INSTRUCTIONS IN EQUIPMENT MANUAL PROVIDED BY SPRAY PUMP MANUFACTURER.

When applying Pitt-Char XP Coating 97-194/97-195, two pails of component A (97-194) will be emptied for one pail of Component B (97-195).

4.11 FIRE PROTECTION THICKNESS

The applicator must endeavor to meet the material thickness shown on the passive fire protection drawings issued by the project. Applied thickness shall average specified thickness with no one measurement lower than 90% of specified thickness of 530 mils.

Thin areas will need to be recoated to achieve specified thickness. Thickness checks will be conducted using either an Elcometer, non-destructive probe or 1/8" filled hole and calibrated probe. Structural steel sections will be checked every 4–6 linear feet minimum. Areas under the tolerance will be quantified by additional thickness checks every foot. QA/QC is responsible for thickness checks and documentation, which shall be available to the company.

4.12 APPEARANCE OF PITT-CHAR XP COATING

Pitt-Char XP Coating must be applied in a manner such that no air voids, pinholes, lap seams, loose fibers, or “birdnesting” are present in the cured film. These situations may occur during application from a variety of reasons such as: cold material, worn spray tips, dirty mixer or valves, and poor access to substrate. The proper technique to eliminate these problem areas is to immediately trowel the surface using either pointed or rectangular masonry trowels. This technique will provide good wetting through reinforcing mesh, and also eliminate any imperfections mentioned above. Close-up rollers with a minimum amount of PM Acetate solvent are then used to remove trowel marks and achieve desired finished appearance. A poor spray fan pattern or application angle will result in additional trowel and touch-up work. See Figure A and B for examples of approved and unacceptable surface finish.

4.13 FINAL SURFACE FINISH

The spray applied finish of Pitt-Char XP Coating has a matted or “orange peel” appearance. The desired cured coating texture will be agreed upon between the applicator and client prior to actual job start-up. A sample will be documented and signed off by both parties prior to job startup. A “Reference Sample Approval” form is supplied. The reference sample will be a small area of the job, which represents a typical beam or column application using recommended reinforcement.

4.14 TEMPERATURE CONDITIONS AFFECTING APPLICATION

The ambient temperature range of 70° - 90°F is the optimum condition for applying and cure of Pitt-Char XP Coatings. Applications above 90°F require some extra attention. Avoid heavy

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film builds over, which could cause some sag problems initially, and a faster cure rate for rolling and mesh application. A slower evaporating solvent such as PM Acetate should be used for rolling. If temperatures drop below 50°F, temporary shelters should be erected and heated to enclose steel and the spray pump. In extreme cases flexible ducts can be run from forced air heaters and applied directly to steel just prior to fireproofing and afterward to accelerate cure.

**APPROXIMATE CURE RATES (TO SHORE A 50)**

<table>
<thead>
<tr>
<th>Ambient Temperature</th>
<th>Hours PITT-CHAR XP Coating</th>
</tr>
</thead>
<tbody>
<tr>
<td>50°F</td>
<td>48</td>
</tr>
<tr>
<td>60°F</td>
<td>36</td>
</tr>
<tr>
<td>75°F</td>
<td>10</td>
</tr>
<tr>
<td>100°F</td>
<td>4</td>
</tr>
</tbody>
</table>

Humidity and direct sunlight will affect cure rates.

### 4.15 REMOVAL PROCEDURE

Sometimes there is a need to remove cured PITT-CHAR XP coating from a surface because of damage or to allow attachments for supports, brackets etc. This can be accomplished by using a grinder with an abrasive disc or wire cup to remove small sections. For larger sections, use a high rpm cutting wheel or die grinder to outline area and remove coating with an air chisel. After removal follow repair procedure below.

### 4.16 REPAIR PROCEDURE FOR PITT-CHAR XP

The following procedure is to be used for damaged PITT-CHAR XP coatings or when increasing the film build on fully cured PITT-CHAR XP coating.

1. Remove all damaged PITT-CHAR XP per removal procedure 4.15 above. Material should show no evidence of damage and have tight adhesion to substrate. Lead edge of PITT-CHAR XP coating should be tapered to 45° angle.

2. Blast exposed steel to SSPC SP6 specification and abrade 2-inch boundary of original PITT-CHAR XP coating around repair area. A white, non-glossy surface should be achieved.

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3. Spot prime to original primer specification or apply mesh and Pitt-Char XP coating directly to blasted steel within 4 hours of blast completion if a rust bloom has not developed.

4. Application of reinforcing mesh and Pitt-Char XP to the repair area must be applied to achieve the original specified thickness. Areas less than 1 ft² do not require mesh replacement. This application may be made using trowel or spray application, as suitable.

5. The Pitt-Char XP application should be feathered into the abraded boundary area to aid in obtaining a uniform appearance. It should not be lapped onto the non-abraded adjacent surface.

6. Please consult your PPG Technical Representative for any questions concerning above procedure.

4.17 RECOATING

1. Primer system must be fully cured before Pitt-Char XP coating is applied. Follow manufacturers recoat recommendations.

2. Airless applications of more than 0.31" (8mm) must be done in multiple coats for plural airless pumps. Solvent thinned applications shall be 0.11-0.2" (3-5mm) per coat. The first coat must be sufficiently cured to support the weight of additional Pitt-Char XP coating or sagging will occur. Generally 8 hours at 70°F are necessary. It is recommended that recoating should be done within 24 hours of previous application. If recoat is done later than 48 hours, clean surface of any dirt, grease, or chalking with a solvent wipe and/or hot water/detergent wash if necessary. When recoat is done later than 14 days after first coat, brush blast or hand sand surface with #50 grit sandpaper to remove shine from surface and blow off dust with clean, dry, compressed air.

4.18 TROWEL APPLICATION

Trowel application of Pitt-Char XP coating may be a cost effective method to do small jobs, tie-ins or repairs. Pitt-Char XP coating 97-194/195 has a weight ratio of 3.25 epoxy to 1.00 catalyst. Sufficient amounts of each should be weighed out separately. This will be accomplished easier if the material is preheated to 80-100°F. Add catalyst to epoxy with up to 5% PM Acetate. The solvent will extend the pot life and also promote easier mixing. Mix the batch using suitable heavy duty air or electric mixer and a paddle type blade capable of scraping the sidewalls and bottom of container. Agitate coating until a uniform gray color is obtained. Over mixing will induce excess heat greatly reducing pot life. Apply coating using standard plastering techniques in 0.1" (3mm) coats. Pitt-Char XP 97-194/195M is packaged in a two pail kit for solvent thinned applications.

4.19 EQUIPMENT CLEANUP

Pitt-Char XP coatings are chemical resistant, two component epoxy materials. When allowed to cure in or on equipment, it obtains excellent adhesion. This is detrimental to subsequent functioning of moving
parts. Allowing *Pitt-Char XP* coating to cure in or on equipment can result in substantial downtime and equipment loss. Steam or high pressure hot water are the most effective means for removing *Pitt-Char XP* coatings from application equipment and over sprayed areas. Using this method before full cure takes place is highly recommended.
4A Approved *Pitt-Char* XP Coating Finish

Rolled Finish

Sprayed Finish
4B Non Acceptable *Pitt-Char XP* Coating Finish

“Birdnesting” Poor Fan Pattern

“Roll over” Poor Spray Angle
Application Tools

Photo Removed

- Solvent Resistant short nap (3/16-1/4") rollers 1-2" diameter
- Paint brush
- Various trowels for coating touch-up and removing residual Pitt-Char XP coating from pails

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Section V

REINFORCEMENT

5.1 GENERAL DESCRIPTION
5.2 MESH TYPE
5.3 "I" SECTIONS
5.4 TERMINATIONS

Drawing - "I" Sections

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Taiwan Power Company
REINFORCEMENT FOR PITT-CHAR XP FIRE PROTECTIVE COATING

5.1 GENERAL DESCRIPTION

Pitt-Char XP fire protective coating has been formulated to be used in conjunction with fiber mesh for structural steel reinforcement.

5.2 MESH TYPE

Mesh is a fiberglass fabric specifically tested and supplied by PPG Industries

<table>
<thead>
<tr>
<th>Description</th>
<th>Roll Size</th>
<th>Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiberglass Mesh</td>
<td>4 x 150 ft</td>
<td>All areas</td>
</tr>
<tr>
<td>238-2/66</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5.3 “I” SECTIONS

Columns shall have flange edges covered with mesh. A first coat of Pitt-Char XP, approximately half the specified thickness shall be applied to the steel and completely troweled to ensure good wetting to the substrate. The fabric mesh is then applied to the uncured Pitt-Char coating which acts as an adhesive. The mesh shall completely cover the outer edges and extend half the distance to the web on both sides of the flange face as a minimum. The mesh shall be lapped 2 inches at all seams. Short nap paint rollers dipped in solvent may be used to roll the mesh. Rolling is required to provide 100% contact with coating. Wrinkles, gaps and air voids under the mesh are not acceptable. Apply second coat to achieve total film thickness. See attached drawing.

5.4 TERMINATIONS

All coating terminations shall have the mesh stopped 2 inches prior to the termination point. The lead edge of Pitt-Char XP coating should be tapered to a 45° angle. This pertains to all block-out areas and tie-in areas.
Section VI

Application QA/QC Procedures

6.1 SURFACE INSPECTION
6.2 SHELF LIFE
6.3 PRODUCT APPLICATION TEMPERATURE
6.4 PUMP RATIO CHECK
   A. Volume
   B. Weight
6.5 REFERENCE SAMPLE PREPARATION
6.6 INSPECTION EQUIPMENT
   A. Bridge Gauge
   B. Digital Thermometer
   C. Dry Film Primer Thickness Gauge
   D. Hygrometer
   E. Elicometer
   Tool Photo
6.7 FORMS
   a. Reference Sample Approval
   b. Daily Application Log

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6.1 SURFACE INSPECTION

Surfaces painted in accordance with Surface Preparation shall be inspected immediately prior to the application of Pitt-Char XP coating. The surface must be clean and dry. All contaminants must be removed. Inspect carefully for oil or grease contamination and remove by solvent cleaning using a PPG approved thinner. Do not apply Pitt-Char XP coating under conditions where condensation, frost or icing is present or forming on the surface. Do not apply Pitt-Char XP coating to surfaces where the surface temperature is below 40°F or when surface temperature is less than 5°F above the dew point.

6.2 SHELF LIFE

97-194/97-194M  18 months from date of manufacture
97-195/97-195M  24 months from date of manufacture

Store below 90°F. Keep material out of direct sunlight.

Pitt-Char XP coating is a stable material; however, material aged over its recommended shelf life must be quality checked by PPG and approved for use.

6.3 PRODUCT APPLICATION TEMPERATURE

Plural Airless Applied: For proper metering and spray fan to be achieved, "A" and "B" must be pre-heated to a minimum of 120°F to reduce viscosity before use in plural airless spray units. Begin pre-heating the number of pails "A" and "B" needed for the next shift approximately 24 hours ahead of time. Put pails in hotbox with space between the pails for proper air circulation. The heat should be thermostatically controlled and evenly distributed. DO NOT HOLD PAILS AT 140°F OVER 4 DAYS.

In cold conditions, pre-heat to 60°C. "A"'s viscosity reduces but it is not readily pourable. "B"'s viscosity reduces and is readily pourable. At 140°F, if "A" remains extremely stiff and "B" is not easily pourable, do not use before consulting with your PPG Tech Representative. The representative may suggest mechanical agitation or using a different batch of "A" or "B". When they are too viscous, miss metering and loss of spray fan pattern usually occurs.

6.4 PUMP RATIO CHECK (Plural Airless Pump)

A. VOLUME

Pitt-Char XP coating is a two-part material whose volumetric ratio is 2.3:1. The "A" (white) part is packaged in a tall pail. The "B" (black) part is packaged in a standard 5 gallon pail. The pails are filled at the factory so that mixing 2 pails of "A" with 1 pail of "B" produces the proper 2.3:1 volume ratio. The spray ratio of the pump should be verified. This can be accomplished by confirming that 2 pails of component A and 1 pail of component B are emptied at the same time.
B. WEIGHT

Pitt-Char XP coating 97-194/97-195 has a weight ratio of 3.25 parts by weight epoxy base 97-194 to 1.0 part by weight catalyst, 97-195. A full hot can of each should be pumped through before checking weight to ensure any cold material is cleared from lines and material is flowing freely. Follow weight ratio check as stated in "Material Handling (Airless Application).

6.5 REFERENCE SAMPLE PREPARATION

A section of the project will be prepared at startup to represent the surface finish of the fireproofing. The sample shall be approved by all parties. This area shall be documented on the reference sample form attached.

6.6 INSPECTION EQUIPMENT

A. BRIDGE GAUGE

A bridge gauge is used to monitor wet thickness during spraying operation. It is made by notching a piece of metal to the desired depth and continually probing the Pitt-Char XP coating while wet. This made be made from a 1” putty knife.

B. DIGITAL THERMOMETER

A thermometer should be used to measure the surface temperature of the substrate before Pitt-Char XP is applied and also measure the temperature of the hotbox and pre-heated material. It should be calibrated to the manufacturer's specification and have a hand held probe.

C. DRY FILM PRIMER THICKNESS GAUGE

This gauge is used to measure the dry film thickness of paint on a steel substrate.

D. HYGROMETER

This device is used to determine relative humidity. A hygrometer consists of two thermometers in a frame. One is a wet bulb and the other dry.

The wet and dry readings are then taken and a circular or slide rule type of guide is consulted to give the relative humidity.

E. ELCOMETER

This gauge is a portable microprocessor that measures dry coating thickness by the electromagnetic induction principles. It is a convenient device for checking the finished job. Only trained inspectors should use this tool. It cannot be used on areas where metal mesh reinforcement has been installed.

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QA/QC Tools

Photo Removed

- Elcometer dry film gauge, 500 mil range for primer and Pitt-Char XP coating (nondestructive)
- Hydra-cone thickness gage for drilled thickness testing (destructive)
- Bridge gauge - Custom made from scriber cut to 150 mil thickness.
- Psychrometer for RH measurement
- Digital thermometer to measure hotbox and coating temperature
- Wet film gauge for primer or topcoat measurement

6.7 FORMS

See attached.
<table>
<thead>
<tr>
<th><strong>PITT-CHAR XP® COATING</strong></th>
<th><strong>DATE</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>REFERENCE SAMPLE APPROVAL</strong></td>
<td><strong>PAGE ___ OF ____</strong></td>
</tr>
<tr>
<td><strong>PROJECT:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>LOCATION:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>APPLICATOR:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>DESCRIPTION OF SAMPLE:</strong></td>
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</tr>
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</table>

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**Daily Application Log**

<table>
<thead>
<tr>
<th>Customer</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Applicator</td>
</tr>
<tr>
<td>Project</td>
<td>Report By</td>
</tr>
</tbody>
</table>

**Personnel**

<table>
<thead>
<tr>
<th>Site Manager</th>
<th>Foreman</th>
</tr>
</thead>
</table>

Sprayers/Pump/Trowel/Roll:

---

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Appendix C: Outdoor Coupon Tests and Accelerated Weathering Laboratory Test Data

Outdoor test panel results

Pairs of duplicate test panels of each of the coating systems were placed on the outdoor exposure rack at Building 227, Rock Island Arsenal in August 2007. These panels will remain in test for at least 2 years, and the detailed analysis of the 2-year performance will be provided in a supplementary report in late 2009. An inspection after 7 months of performance was conducted on 7 March 2008. The results are provided in Table C1.

The evaluation of the test panels was conducted in accordance with ASTM D 1654 - Standard Test Method for Evaluation of Painted or Coated Specimens Subject to Corrosive Environments. A rating of 10 for blisters and chalking indicates that no failure has occurred. The rating for rusting indicates the degree of undercutting of the coating at the scribe line, as follows:

<table>
<thead>
<tr>
<th>Rating</th>
<th>Millimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
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</tr>
<tr>
<td>9</td>
<td>0 – 0.5</td>
</tr>
<tr>
<td>8</td>
<td>0.5 – 1.0</td>
</tr>
<tr>
<td>7</td>
<td>1.0 – 2.0</td>
</tr>
<tr>
<td>6</td>
<td>3.0 – 3.0</td>
</tr>
<tr>
<td>5</td>
<td>3.0 – 5.0</td>
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<tr>
<td>4</td>
<td>5.0 – 7.0</td>
</tr>
<tr>
<td>3</td>
<td>7.0 – 10.0</td>
</tr>
<tr>
<td>2</td>
<td>10.0 – 13.0</td>
</tr>
<tr>
<td>1</td>
<td>13.0 – 16.0</td>
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<tr>
<td>0</td>
<td>1.0 – 2.0</td>
</tr>
</tbody>
</table>

Accelerated weathering test panel results

Selected systems were exposed to 2000 hours of a salt fog/UV condensation cycle in accordance with ASTM D5894 - Cyclic Salt / UV Exposure of Painted Metal (Alternating Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet). After the exposure, the panels were evaluated in accordance with ASTM D 1654. Table C2 shows these results.
### Table C1. Outdoor coupon exposure results.

<table>
<thead>
<tr>
<th>Coating System</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>17</th>
<th>18</th>
<th>19</th>
<th>20</th>
<th>21</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Gloss 20º / 60º</td>
<td>4 / 30</td>
<td>16 / 62</td>
<td>4 / 23</td>
<td>12 / 45</td>
<td>5 / 32</td>
<td>10 / 45</td>
<td>76 / 95</td>
<td>28 / 75</td>
<td>52 / 86</td>
<td>34 / 74</td>
<td>6 / 34</td>
<td>21 / 62</td>
<td>26 / 74</td>
<td>63 / 92</td>
<td>96 / 84</td>
<td>29 / 74</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20º/60º panel -1</td>
<td>10 / 10</td>
<td>10 / 10</td>
<td>10 / 10</td>
<td>10 / 10</td>
<td>10 / 10</td>
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<td>10 / 10</td>
<td>10 / 10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chalk</td>
<td>10 / 10</td>
<td>10 / 10</td>
<td>10 / 10</td>
<td>10 / 10</td>
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<tr>
<td>Rusting</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Comments</td>
<td>Panel #1 has two 1/4&quot; spots where topcoat was is gone (panel dropped). Adhesion is good</td>
<td>Slight yellowing on coating under flap</td>
<td>Slight scribe undercutting ~0.05&quot;</td>
<td>10-2 looks slightly darker. Dirt pickup?</td>
<td>Yellowing on coating under flap. 15-2 is the more yellow than 15-1</td>
<td>Scribe undercutting ~0.05&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Panels were inspected and placed back on exposure on March 7, 2008.
All panels were washed and rinsed before gloss readings and visual measurements.
All panels showed pinpoint rusting/spotting which is most likely due to metal particulates resulting from the cutting of the scribe line rather than a rust through condition.

### Table C2. Accelerated weathering laboratory results.

<table>
<thead>
<tr>
<th>Coating System</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>18</th>
<th>20</th>
<th>21</th>
</tr>
</thead>
<tbody>
<tr>
<td>20º/60º panel -1</td>
<td>3 / 23</td>
<td>14 / 54</td>
<td>2 / 10</td>
<td>8 / 44</td>
<td>6 / 31</td>
<td>4 / 28</td>
<td>58 / 86</td>
<td>2 / 24</td>
<td>26 / 75</td>
<td>22 / 74</td>
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<td>10 / 52</td>
<td>26 / 70</td>
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<td>1 / 6</td>
</tr>
<tr>
<td>20º/60º panel -2</td>
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<td>14 / 64</td>
<td>1 / 10</td>
<td>7 / 37</td>
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<td>58 / 87</td>
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</tbody>
</table>

Note: All panels were washed and rinsed before gloss readings and visual measurements.
Appendix D: Suggested Implementation Guidance

The following language is recommended for incorporation into Unified Facilities Guide Specification (UFGS) 07 81 00, Spray-Applied Fireproofing.

The fire protective coating shall be a two-component epoxy based intumescent coating. On curing it shall form a flexible and tough epoxy barrier which transforms into a ceramic-like, insulating char to provide thermal protection of the substrate in the event of a fire. When applied as a system with the manufacturer’s recommended surface preparation, primer, fire protective layer, and a topcoat if required, it shall also protect the substrate from corrosion and retain its fire protection properties under aggressive chemical environments. It shall be resistant to solvents, acids, alkalis, salts and abrasion while retaining its fire protective properties. It shall also exhibit the following properties:

<table>
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<tr>
<th>Percent Solids by Weight</th>
<th>100%</th>
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<tr>
<td>In Service Temperature Restrictions</td>
<td>Up to 150°F (65°C)</td>
</tr>
<tr>
<td>Application Method</td>
<td>Air spray or specialized plural component airless equipment approved by the manufacture. Troweling can be used for small areas or touch-up work.</td>
</tr>
<tr>
<td>Drying Time</td>
<td>Approximately 24 hours to achieve a Shore D hardness of 25.</td>
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<tr>
<td>Shelf Life</td>
<td>Minimum shelf life under proper storage condition is 1 Year from date of manufacture</td>
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<tr>
<td>Pot Life</td>
<td>At 77°F (25°C) and 50% relative humidity: Approximately 40 minutes. (Pot life is not a factor when using specialized plural component airless spray equipment.)</td>
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<tr>
<td>Flash point</td>
<td>Greater than 212°F (100°C) Pensky-Martens for each component.</td>
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### Application of Corrosion- and Fire-Resistant Coating Systems on Buildings 227 and 299 at Rock Island Arsenal

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**Abstract:**
Fire protective coatings have historically lacked sufficient durability to maintain the coating in good condition and protect the substrate from corrosion. New, innovative epoxy intumescent coatings are much more durable and inhibit corrosion of steel. This project demonstrated the performance of this type of coating system on two structures at Rock Island Arsenal where fire risk and corrosive conditions are significant, and included outdoor exposure testing and accelerated weathering tests at the ERDC-CERL paints and coatings laboratory. Additional research was conducted to further develop engineered siloxane-epoxy coating technology as fire protective and corrosion-resistant coating systems with improved durability. The coating system successfully demonstrated in this project has the potential to provide the benefits of this protection to many types of structures across the DoD.

**Subject Terms:**
corrosion prevention and control, intumescent coatings, fire-resistant coatings, Rock Island Arsenal, IL

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