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Development of Product Descriptions for Lead-Immobilizing Overcoating Systems

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Final Report

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ABSTRACT: This report evaluates the performance of selected commercially available moisture cure urethane (MCU) and calcium sulfonate coating systems. It includes product descriptions for each type of system. The primary purpose of these coating systems is as overcoat materials for aged lead-containing paints.

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Conversion Factors

Non-SI* units of measurement used in this report can be converted to SI units as follows:

Multiply	By	To Obtain
degrees Fahrenheit	(5/9) x (°F – 32)	degrees Celsius
gallons (U.S. liquid)	0.003785412	cubic meters
inches	0.0254	meters
mil	25.4	micrometers
pounds (mass)	0.4535924	kilograms
pounds per square inch	6.89	kiloPascals

*_Système International d'Unités_ ("International System of Measurement"), commonly known as the "metric system."

Preface

This study was conducted for the U.S. Army Corps of Engineers (USACE) under the High-Performance Materials and Systems (HPM&S) Research Program Work Unit 33294, "CID (Commercial Item Description) for Overcoating Lead-Based Paint." The technical monitor was Andy Wu, CECW-EI.

The work was performed by the Materials and Structures Branch (CF-M) of the Facilities Division (CF), Construction Engineering Research Laboratory (CERL). The CERL Principal Investigator was Susan A. Drozdz. Part of this work was done by Timothy Race, Corrosion Control Consultants and Labs, Inc., under DACW 42-01-P-0389. The technical editor was Linda L. Wheatley, Information Technology Laboratory — Champaign. Vicki Van Blaricum is Acting Chief, CF-M, and L. Michael Golish is Chief, CF. The Technical Director for the Durable Materials for Civil Works Facilities business area was Dr. Paul Howdyshell. The Director of CERL is Dr. Alan W. Moore.

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1 Introduction

1.1 Background

The revised Federal Acquisition Regulation requires that government agencies procure commercial services and products to the greatest extent practicable. Procurement of commercial products should be based on performance rather than composition. The U.S. Army Corps of Engineers is in the process of developing product descriptions for paint systems that will be used for overcoating aged lead-based paint systems.

1.2 Objective

The objective of this work was to evaluate the performance of selected commercially available moisture cure urethane (MCU) and calcium sulfonate coating systems and to develop product descriptions for each type of system. The primary purpose of these coating systems will be as overcoat materials for aged lead-containing paints.

1.3 Approach

In order to accomplish this work, a market survey was conducted, coating systems were tested, data were compiled and analyzed, and draft product descriptions were developed.

1.4 Mode of Technology Transfer

Information from this report, and a subsequent report on the development of product descriptions for overcoating systems, will be incorporated into Unified Facilities Guide Specification (UFGS) 09965, *Painting: Hydraulic Structures*.

2 Summary of Research

2.1 Market Survey

A market survey was conducted to determine the commercial availability and general properties of MCU and calcium sulfonate coating systems. Coatings manufacturers were surveyed and data were compiled on nine MCU and six calcium sulfonate coating systems. The data were compiled from the manufacturers' published data sheets and are descriptive of the coating systems' performance and other salient properties including but not limited to dry time, hardness, flexibility, gloss, and impact, corrosion, water, and hydrocarbon resistances. The market survey also establishes the number of coats and the specific products comprised by the systems. Tables 1, 2, and 3* provide the results of the market survey for MCU prime, intermediate, and topcoats, respectively. Table 4 shows calcium sulfonate market data.

2.2 Laboratory Evaluation

Three MCU and three calcium sulfonate coating systems were selected for evaluation in accelerated laboratory testing. MCU and calcium sulfonate systems are described in Tables 5 and 6, respectively.

2.2.1 Test Panel Preparation

Test panels of American Society for Testing and Materials (ASTM) A36 steel measuring 3 x 6 x 0.25 inches were solvent and blast cleaned in accordance with Society for Protective Coatings (SSPC) standards SP 1 and SP 5. A nonmetallic blast medium (DuPont Starblast®) was used to impart an average profile of 2.1 mils.

* Tables are shown beginning at the end of this chapter.

2.2.2 Paint Application

The coatings were applied by conventional spray in accordance with the manufacturers' recommendations. Tables 5 and 6 show the dry times between coats.

2.2.3 Coating Thickness

Dry film thicknesses (DFTs) were measured and recorded for each coat of paint on each test panel using a magnetic DFT gage calibrated and used in accordance with ASTM D 1186. Tables 5 and 6 show average DFTs.

2.2.4 Drying of Test Panels

Coated MCU test panels were allowed to air dry under standard laboratory conditions for a minimum of 7 days prior to testing. Calcium sulfonate coated panels were dried for 14 days.

2.2.5 Scribing of Test Panels

Prior to exposure, two scribes (each 6-cm long) were made through the coating to the substrate at 45 degrees to the long axis of the test panels. The scribes were equally spaced from each other and from the edges of the panels and were centered on the upper and lower halves of the panels. Scribing was performed with the tool specified in ASTM D 1654.

2.2.6 Cyclic Corrosion Testing

The corrosion resistances of the coating systems were evaluated by 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)*. All panels were exposed in the ultraviolet (UV) exposure cabinet to begin the first cycle. Triplicate panels for each coating system were exposed for a total of 2688 hours.

2.2.7 Test Panel Evaluation and Data Reporting

Each test panel was evaluated at the end of the exposure period for rusting, blistering, and undercutting at the scribe in accordance with ASTM D 610, D 714, and D 1654, respectively, except that for undercutting the coating was completely removed adjacent to the scribe to the extent that it was necessary to reveal the entire area subject to undercutting. Table 7 lists the degree of rusting, blister size, density and location, and maximum undercutting on each side of each scribe for each test panel.

2.2.8 Data Analysis

The scribe parameter, or upper limit of the mean maximum undercutting at the 95-percent confidence level, was calculated for each coating system and is reported in Table 7. The scribe parameter is calculated as the sum of the mean maximum undercutting and two standard deviations.

2.3 Draft Product Descriptions

Draft product descriptions were developed to provide a generic description of the coating system, salient characteristics, and performance requirements. Salient characteristics are those necessary to adequately describe the coatings system. Selected performance criteria are descriptive of the better performing coatings of each type. Draft product descriptions are attached as Appendices A and B.

Table 1. Zinc-pigmented MCU primer – market survey data.

	Tnemec 90-97 Tnemec Zinc	Tnemec Omnithane Series 594	Sherwin Williams Corothane I Zinc Primer	Xymax MonoZinc ME III	Xymax MonoZinc 390	Wasser MC-Zimc	Wasser MC-Miozinc	Insl-X Insl-Tron Zinc Rich Primer MC-P365	Insl-X Insl-Tron MIO Zinc Primer MC-P375
Salient Characteristics									
Binder	NA	Aromatic	NA	Aromatic	Aromatic	NA	NA	Aromatic	Aromatic
Pigment	Zinc	MIO/Zinc	MIO/Zinc	Zinc	MIO/Zinc	Zinc	MIO/Zinc	Zinc	MIO/Zinc
Zinc Content (%)	83.0	NA	60	83	65	83	NA	NA	NA
Number Components	2	1	2	1	1	1	1	1	1
Volume Solids (%)	63.0	62.0	62.0	61	62	62.0	62.0	62	62
VOC Unthinned (g/L)	323	332	<340	337	340	<340	<340	329	335
VOC Thinned (g/L)	373	381	NA	420	420	NA	NA	NA	NA
Dry to Recoat (hours)	4	4	4 – 6	4 – 6	4 – 6	4	4	4 – 6	4 – 6
Density (lb/gallon)	22.86	20.90	22.05	24 – 26	14 – 16	24.3	20.6	24.62	17.97
FP – Closed Cup (°F)	78	85	98	108	86	85	85	105	105
Shelf Life (months)	9	9	12	NA	NA	12	12		6
Application Characteristics									
Brush Application	Y	Y	Y	Y	Y	Y	Y	Y	Y
Roller Application	Y	Y	Y	Y	Y	Y	Y	N	N
Spray Application	Y	Y	Y	Y	Y	Y	Y	Y	Y
Maximum DFT (mils)	3.5	3.5	4.0	4.0	4.0	5.0	5.0	3.0	3.0
Minimum DFT (mils)	2.5	2.5	3.0	3.0	3.0	3.0	3.0	2.0	2.0
Maximum Thinning (%)	10	10	NA	NA	NA	10	10	NA	NA
Pot Life (hours)	24	24	NA	NA	NA	NA	NA	3 – 4	3 – 4
Dew Point (+°F)	5	5	NA	0	0	0	0	NA	NA
Maximum Humidity (%)	NA	NA	99	99	99	99	99	85	85
Min Material Temp (°F)	NA	NA	45	NA	NA	Dew Point +5 °F	Dew Point +5 °F	NA	NA
Max Surface Temp (°F)	120	120	100	NA	NA	NA	NA	90	90
Min Surface Temp (°F)	40	35	20	20	20	NA	NA	NA	NA
Maximum Air Temp (°F)	NA	NA	100	NA	NA	NA	NA	NA	NA
Minimum Air Temp (°F)	NA	NA	20	20	20	<32	<32	20	20
Performance Attributes									
Adhesion D 4541 (psi)	800	NA	1000	NA	NA	NA	NA	NA	NA
Adhesion D 3359	5	NA	NA	NA	NA	NA	NA	NA	NA

DFT = dry film thickness

FP =

MIO = micaceous iron oxide

VOC = volatile organic content

Table 2. MCU intermediate – market survey data.

	Tnemec Omnithane Series 596	Sherwin Williams Corothane I – Mastic	Xymax MonoGuard	Wasser MC-Miomastic	Environmental Protective Coatings E-500 M.I.O.	Insl-X Insl-Tron MIO R/T Polyurethane MC-P312
Salient Characteristics						
Binder	Aromatic	NA	Aromatic	NA	NA	Aromatic
Volume Solids (%)	63.7	62	63	62.0	65.53	66
VOC Unthinned (g/L)	329	<340	340	<340	301	335
VOC Thinned (g/L)	378	NA	NA	NA	NA	NA
Dry to Recoat (hours)	4	6	4 – 6	6	4 – 24	NA
Density (lbs/gallon)	18.86	18.0	10 – 12	18.0	13.11	13.19
FP – Closed Cup (°F)	89	>93	108	>77	NA	105
Shelf Life (months)	6	12	NA	12	12	9
Application Characteristics						
Brush Application	Y	Y	Y	Y	Y	Y
Roller Application	Y	Y	Y	Y	Y	Y
Spray Application	Y	Y	Y	Y	Y	Y
Maximum DFT (mils)	3.5	3.5	8.0	5.0	6.5	2.0
Minimum DFT (mils)	2.5	2.5	5.0	3.0	3.5	1.0
Maximum Thinning (%)	10	10	NA	10	NA	NA
Pot Life (hours)	8	NA	NA	NA	3 – 6	3 – 4
Dew Point (+ °F)	5	NA	0	0	NA	NA
Max Humidity (%)	NA	99	99	99	NA	85
Min Material Temp (°F)	NA	NA	NA	Dewpoint +5 °F	NA	NA
Max Surface Temp (°F)	120	NA	NA	NA	NA	90
Min Surface Temp (°F)	35	NA	NA	NA	NA	NA
Maximum Air Temp (°F)	NA	NA	NA	NA	NA	NA
Minimum Air Temp (°F)	NA	20	20	<32	NA	20
Performance Attributes						
Impact G14 (in-lb)	NA	160	NA	NA	NA	NA
Flexibility D522 (dia.)	NA	0.125 in.	NA	NA	NA	NA

DFT = dry film thickness

FP = flash point

MIO = micaceous iron oxide

VOC = volatile organic content

Table 3. MCU finish – market survey data.

	Tnemec Omnithane Series 571	Sherwin Williams Corothane I HS	Xymax MaxCoat HB	Wasser MC-Luster	Insl-X Insl-Tron Gloss Polyurethane MCO-110	Lifelast SealCoat 1000	Cornerstone Corrosion Coating
Salient Characteristics							
Binder	Aliphatic	Aliphatic	Aliphatic	Aliphatic	Aliphatic	Aliphatic	NA
Volume Solids (%)	61.27	61	62	62	66	70	54
VOC Unthinned (g/L)	329	335	336	<340	332	204	NA
VOC Thinned (g/L)	340 @ 2.5%	360 @ 5%	NA	<420	NA	NA	NA
Dry to Touch (hours)	1	2	2	0.5	1	2	2
Density (lb/gal)	NA	11.79	10 – 11	11.0	12.47	8.4 – 8.6	9.0
FP – Closed Cup (°F)	99	101	75	NA	105	NA	NA
Gloss, 60-degree (units)	Semi-gloss	Gloss	Semi-gloss	20 – 60	Satin or Gloss	85	Semi-gloss
Shelf Life (months)	9	12	NA	12	9	12	NA
Application Characteristics							
Brush Application	Y	Y	NA	Y	Y	Y	Y
Roller Application	Y	Y	NA	Y	Y	Y	Y
Spray Application	Y	Y	Y	Y	Y	Y	Y
Maximum DFT (mils)	2.5	3.0	4.0	3.0	3.0	2.1	3.0
Minimum DFT (mils)	1.8	2.0	2.0	2.0	2.0	1.4	2.5
Maximum Thinning (%)	15	NA	NA	10	NA	NA	none
Pot Life (hours)	NA	NA	NA	unlimited	3 – 4	unlimited	NA
Dew Point (+°F)	5	NA	0	0	NA	NA	NA
Max Humidity (%)	NA	99	99	99	85	unlimited	99
Min Material Temp (°F)	NA	45	NA	Dewpoint +5 °F	NA	NA	NA
Max Surface Temp (°F)	120 spray 100 other	100	NA	NA	90	90	NA
Min Surface Temp (°F)	35	20	NA	NA	NA	50	NA
Maximum Air Temp (°F)	NA	100	NA	NA	NA	90	NA
Minimum Air Temp (°F)	NA	20	20	<32	20	40	20
Performance Attributes							
Impact D2794 (in.-lb)	NA	70	NA	NA	NA	NA	NA
Flexibility D522 (diameter)	NA	0.125 in.	NA	NA	NA	0.125	NA

DFT = dry film thickness

FP =

VOC = volatile organic content

Table 4. Calcium sulfonate coatings – market survey data.

	Watson Armor-Shield 8300/8301	Bridgecote Bridgcote 8100	Environmental Protective Coatings Oxi-Bloc	Praxis Technologies Prax-Ten Penetrant and Prax-TenSealer	CPC Bridge Coat 4100	Simco Coatings Versakote-2002 H.S.
Salient Characteristics						
Weight per Gallon (lb)	9.5 / 9.5	10.95	NA	8.8 / 7.9	9.9	10.0
Solids, Weight (%)	70 / 70	74	72.9	50 / 66	74	NA
Solids, Volume (%)	66 / 64	63.5	66.3	NA	60	67.0
VOC (g/L)	312 / 312	270 – 310	276	382 / 264	250 – 265	264
Viscosity (KU)	90-120/90-120	NA	108	NA	75 – 120	90 – 100
Gloss, D 522 (units)	Flat / Flat or Semi-Gloss	15 – 25	20 – 30	NA	Flat	Matte
Pencil Hardness, D 3363	6B / 6B	4B	6B	NA	4B	NA
Shelf Life (months)	NA	12	NA	NA	36	12
Flash Point, CC (°F)	125	108	120	105 / 105		105
DFT, 1st coat, min/max (mils)	3.0 – 5.0	3.0 – 5.0	8	5 – 8 WFT	3.0 – 5.0	3.0 – 4.0
DFT, 2nd coat, min/max (mils)	5.0 – 7.0	5.0 – 7.0	NA	8 – 12 WFT	5.0 – 7.0	3.0 – 4.0
Dry to Recoat, min (hours)	immediate	immediate	immediate	4	NA	NA
Dry Dust Free (hours)	1	NA	NA	NA	NA	NA
Dry to Touch	NA	NA	24	NA	8 – 12	4.0
Application Characteristics						
Brush	Y	Y	Y	Y	Y	Y
Roller	Y	Y	Y	Y	Y	Y
Spray	Y	Y	Y	Y	Y	Y
Maximum Thinning (%)	10	10	0	NA	0	NA
Air Temperature, min/max (°F)	NA	NA	NA	NA	NA	NA
Surface Temp, min/max (°F)	NA	NA	NA	35	Dew point +5 °F	NA
Material Temp, min (°F)	NA	NA	NA	NA	NA	NA
Dew Point Restrictions (+°F)	NA	NA	NA	NA	NA	NA
Performance Attributes						
Adhesion, D 3359	5B	NA	NA	NA	NA	NA
Humidity Resistance, D 2247	5 mil DFT, 1500 h, no rust, no blisters	NA	NA	NA	NA	NA

DFT = dry film thickness

FP =

VOC = volatile organic content

Table 5. MCU paint systems evaluated.

Manufacturer	Primer	Intermediate	Topcoat	System	Dry Time (primer/ intermediate)
Wasser	MC MioZinc 3.4 mils	MC Miomastic 5.4 mils	MC Luster 3.6 mils	12.4 mils	4 hours 6 hours
Sherwin Williams	Corothane I Galvapac 3.6 mils	Corothane I Mastic 3.3 mils	Corothane I HS Aliphatic 3.0 mils	9.9 mils	8 hours 4 hours
Tnemec	Omnithane 594 2.7 mils	Omnithane 596 4.1 mils	Omnithane 571 3.1 mils	9.9 mils	4 hours 4 hours

Table 6. Calcium sulfonate paint systems evaluated.

Manufacturer	Primer	Topcoat	System	Dry Time (after primer)
Watson	Armor-Shield 8300 3.6 mils	Armor-Shield 8301 6.4 mils	10.0 mils	2 hours
Bridgecote	Ferroguard 8100 3.8 mils	Ferroguard 8100 6.2 mils	10.0 mils	2 hours
CPC	Bridgecoat 4100 3.5 mils	Bridgecoat 4100 6.2 mils	9.7 mils	2 hours

Table 7. Laboratory performance data.e data.

System	Rust	Blistering	Maximum UC Values (mm)	Mean Maximum UC (mm)	UC Parameter (mm)
Wasser	None	None	0.5, 0.5, 0.5, 0.5, 1, 1, 1, 2, 2, 2, 4, 4	1.6	4.1
Sherwin Williams	None	None	0.5, 0.5, 0.5, 1, 1, 1, 1, 1.5, 2, 2, 2.5, 3	1.4	3.0
Tnemec	None	None	0.5, 0.5, 1, 1.5, 1.5, 1.5, 2, 2, 2, 2, 2, 2.5	1.6	2.9
Watson	None	None	None	0	0
Bridgecote	None	None	None	0	0
CPC	None	None	None	0	0

UC = undercutting

mm = millimeters

3 Conclusion

A market survey of commercially available MCU and calcium sulfonate overcoating coating systems was completed. Three systems of each type were selected for laboratory evaluation and accelerated testing. These results were used to develop product descriptions describing the general and salient characteristics, and the performance requirements are given in Appendices A and B.

References

Federal Specifications and Standards

FED-STD-141 Paint, Varnish, Lacquer, and Related Materials: Methods of Inspection, Sampling, and Testing

Method 4321 Brushing Properties

Method 4331 Spraying Properties

Method 4541 Working Properties and Appearance of Dried Film

Unified Facilities Guide Specification 09965A, Painting: Hydraulic Structures

American Society for Testing and Materials-International (ASTM) Standards

A 572 Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel

D 523 Test Method for Specular Gloss

D 562 Test Method for Consistency of Paints Measuring Krebs Unit (KU) Viscosity Using a Stormer-Type Viscometer

D 610 Test Method for Evaluating Degree of Rusting on Painted Steel Surfaces

D 714 Test Method for Evaluating Degree of Blistering of Paints

D 1186 Test Methods for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to a Ferrous Base

D 1640 Test Methods for Drying, Curing, or Film Formation of Organic Coatings at Room Temperature

D 1654 Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

D 2369 Test Methods for Volatile Content of Coatings

D 2697 Test Method for Volume Nonvolatile Matter in Clear or Pigmented Coatings

D 3278 Test Methods for Flash Point of Liquids by Small Scale Closed-Cup Apparatus

D 3359 Test Methods for Measuring Adhesion by Tape Test

D 3363 Test Method for Film Hardness by Pencil Test

D 5894 Practice for Cyclic Salt Fog / UV Exposure of Painted Metal (Alternating Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet)

Society for Protective Coatings (SSPC) Specifications

SP 1 Solvent Cleaning

SP 5 White Metal Blast Cleaning

Appendix A: Calcium Sulfonate Overcoat System Description

General Description

This paint system consists of commercially available primer and topcoat products containing calcium sulfonate, solvent, pigment, and additives. The products shall be suitable for overcoating aged alkyd coatings. Wide latitude is afforded the formulator provided the products meet the specified requirements. The paints shall not contain lead, cadmium, chromium, or chlorinated solvents. The products shall be suitable for application at temperatures of 35 °F (2 °C) and above. Thinning shall be permitted up to a maximum of 10 percent by volume.

Requirements

The coatings shall comply with the following requirements:

(1) **Working Properties**. The paints shall be readily applied by brush, roller, or spray when tested in accordance with Federal Standard (FED-STD)-141, Methods 4321, 4331, and 4541. The paint shall not streak, run, or sag during or after application.

(2) **Dry Time**. When tested in accordance with American Society for Testing and Materials (ASTM) D 1640, set-to-touch and recoat times shall not be greater than 24 h and 1 h, respectively, when applied at the manufacturer's maximum recommended dry film thickness.

(3) **Weight Solids**. When determined in accordance with ASTM D 2369, the solids by weight shall not be less than 66 percent.

(4) **Volume Solids**. When determined in accordance with ASTM D 2697, the volume solids shall not be less than 60 percent.

(5) **Viscosity**. When determined in accordance with ASTM D 562, the viscosity shall be in the range of 80 to 120 Krebs Units.

(6) **Flash Point**. When determined in accordance with ASTM D 3278, the flash point shall not be less than 105 °F (40 °C).

(7) **Adhesion**. When determined in accordance with ASTM D 3359 Method B, the adhesion shall be 5B.

(8) **Gloss**. When determined in accordance with ASTM D 523, the 60-degree specular gloss shall be in the range of 5 to 30 units.

(9) **VOC**. When determined in accordance with U.S. Environmental Protection Agency (EPA) Method 24, the maximum volatile organic content (VOC) shall be 320 g/L.

(10) **Color**. The color shall conform to the specified FED-STD-595 color number or other color as specified on the schedule.

(11) **Corrosion Resistance**. When tested in accordance with the following protocol the test panels coated with primer and topcoat shall show no blistering or rust when evaluated in accordance with ASTM D 714 and D 610, respectively. The upper limit of the mean maximum undercutting at the 95-percent confidence level shall not be greater than 0 (zero) mm.

(a) *Test panel preparation*. Test panels shall be ASTM A 36 steel measuring 3 x 6 x 0.125 inches. Prior to applying the paint systems, the test panels shall be solvent and blast cleaned in accordance with SSPC-SP 1 and SP 5. Nonmetallic blast media shall be used to impart an angular profile of between 1.5 and 2.5 mils.

(b) *Paint application*. The coatings shall be spray applied using the manufacturer's recommended equipment and application parameters. Unless otherwise designated by the manufacturer, the dry time between the primer and topcoat shall be 4 h.

(c) *Coating thickness*. Dry film thicknesses (DFTs) shall be measured and recorded for each coat of paint on each test panel using a magnetic DFT gage calibrated and used in accordance with ASTM D 1186. Unless otherwise specified, the average DFT of each coat on each panel shall be the manufacturer's recommended thickness ± 20 percent. For coatings with a recommended DFT range, the manufacturer's recommendation shall be assumed to be the median of the range. Test panels not meeting the dry film requirements shall not be used.

(d) *Drying*. Coated test panels shall be allowed to air dry under standard laboratory conditions for a minimum of 14 days prior to testing.

(e) *Scribing*. Prior to exposure, two scribes (each 6-cm long) shall be made through the coating to the substrate at 45 degrees to the long axis of the test panels. The scribes shall be equally spaced from each other and from the edges of the panels so they are centered on the upper and lower halves of the panels. Scribing shall be performed with the tool specified in ASTM D 1654.

(f) *Cyclic corrosion testing*. The corrosion resistance of the coating system shall be evaluated by ASTM D 5894. Test panels shall be exposed in the ultraviolet (UV) exposure cabinet to begin the first cycle. Triplicate panels for each coating system shall be exposed for a total of 2,688 h.

(g) *Test panel evaluation and data reporting*. Each test panel shall be evaluated at the end of the specified exposure period for rusting, blistering, and undercutting at the scribe in accordance with ASTM D 610, D 714, and D 1654, respectively, except that for undercutting the coating shall be completely removed adjacent to the scribe to the extent that it is necessary to reveal the entire area subject to undercutting. Degree of rusting, blister size, density and location, and maximum undercutting on each side of each scribe shall be reported for each test panel.

Appendix B: Moisture Cure Urethane (MCU) Overcoat System Description

General Description

This paint system consists of commercially available MCU primer, intermediate, and topcoat products containing solvent, pigment, and additives as necessary to meet the stated requirements. Products comprised by a system shall all be produced by the same manufacturer. The topcoat shall be an aliphatic MCU. Intermediate and topcoat paints shall be single-pack products. Primers shall be either one- or two-pack products containing zinc or zinc and micaceous iron oxide (MIO). The system shall be suitable for overcoating aged alkyd coatings as well as properly prepared bare steel. Wide latitude is afforded the formulator provided the products meet the specified requirements. The paints shall not contain added lead, cadmium, chromium, or chlorinated solvents. The products shall be suitable for application at temperatures as low as 45 °F (7 °C) and up to 95-percent relative humidity. Thinning shall be permitted up to a maximum of 10 percent by volume unless otherwise limited by the manufacturer.

Requirements

The coatings shall comply with the following requirements:

(1) **Working Properties**. The paints shall be readily applied by brush, roller, or spray when tested in accordance with FED-STD-141, Methods 4321, 4331, and 4541. The paints shall not streak, run, or sag during or after application.

(2) **Dry Time**. When applied at the manufacturer's maximum recommended dry film thickness and tested in accordance with ASTM D 1640, dry to recoat times shall not be greater than 4 and 6 h for the primer and intermediate coats, respectively, and the topcoat shall dry set-to-touch in not more than 2 h.

(3) **Weight Solids Zinc**. The percent zinc in the dried primer shall not be less than 60 percent by weight.

(4) **Volume Solids**. When determined in accordance with ASTM D 2697, the volume solids of intermediate and topcoat products shall not be less than 60 percent.

(5) **Pot Life**. Material applied from an open 1-gallon container maintained at 77 °F (25 °C) and 40- to 60-percent relative humidity shall meet the requirements of Working Properties after 3 h.

(6) **Flash Point**. When determined in accordance with ASTM D 3278, the flash point of the paints shall not be less than 85 °F (29 °C).

(7) **Adhesion**. When determined in accordance with ASTM D 3359 Method B, the adhesion of the untopcoated primer shall be 5B.

(8) **Gloss**. When determined in accordance with ASTM D 523, the 60-degree specular gloss of the topcoat shall be 20 to 50 units (semi-gloss) or 50 to 85 units (gloss).

(9) **VOC**. When determined in accordance with EPA Method 24, the maximum VOC as supplied and thinned shall by 340 and 420 g/L, respectively.

(10) **Color**. The topcoat color shall conform to the specified FED-STD-595 color number or other color as specified on the schedule.

(11) **Corrosion Resistance**. When tested in accordance with the following protocol, the test panels coated with the system shall show no blistering or rust when evaluated in accordance with ASTM D 714 and D 610, respectively. The upper limit of the mean maximum undercutting at the 95-percent confidence level shall not be greater than 4.0 mm.

(a) *Test panel preparation*. Test panels shall be ASTM A 36 steel measuring 3 x 6 x 0.125 inches. Prior to applying the paint systems, the test panels shall be solvent and blast cleaned in accordance with SSPC-SP 1 and SP 5. Nonmetallic blast media shall be used to impart an angular profile of between 1.5 and 2.5 mils.

(b) *Paint application*. The coatings shall be spray applied using the manufacturer's recommended equipment and application parameters. Unless otherwise designated by the manufacturer, the dry time between coats shall be 24 h.

(c) *Coating thickness*. Dry film thicknesses shall be measured and recorded for each coat of paint on each test panel using a magnetic DFT gage calibrated and

used in accordance with ASTM D 1186. Unless otherwise specified, the average DFT of each coat on each panel shall be the manufacturer's recommended thickness ± 20 percent. For coatings with a recommended DFT range, the manufacturer's recommendation shall be assumed to be the median of the range. Test panels not meeting the dry film requirements shall not be used.

(d) *Drying*. Coated test panels shall be allowed to air dry under standard laboratory conditions for a minimum of 7 days prior to testing.

(e) *Scribing*. Prior to exposure, two scribes (each 6-cm long) shall be made through the coating to the substrate at 45 degrees to the long axis of the test panels. The scribes shall be equally spaced from each other and from the edges of the panels so they are centered on the upper and lower halves of the panels. Scribing shall be performed with the tool specified in ASTM D 1654.

(f) *Cyclic corrosion testing*. The corrosion resistance of the coating system shall be evaluated by ASTM D 5894. Test panels shall be exposed in the UV exposure cabinet to begin the first cycle. Triplicate panels for each coating system shall be exposed for a total of 2,688 h.

(g) *Test panel evaluation and data reporting*. Each test panel shall be evaluated at the end of the specified exposure period for rusting, blistering, and undercutting at the scribe in accordance with ASTM D 610, D 714, and D 1654, respectively, except that for undercutting the coating shall be completely removed adjacent to the scribe to the extent that it is necessary to reveal the entire area subject to undercutting. Degree of rusting, blister size, density and location, and maximum undercutting on each side of each scribe shall be reported for each test panel.

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14. ABSTRACT

This report evaluates the performance of selected commercially available moisture cure urethane (MCU) and calcium sulfonate coating systems. It includes product descriptions for each type of system. The primary purpose of these coating systems is as overcoat materials for aged lead-containing paints.

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