US Army Corps
of Engineers
Construction Engineering
Research Laboratories

USACERL Technical Report 96/87
August 1996

Laboratory Evaluation of Commercial Epoxy Coating Systems for Civil Works Applications

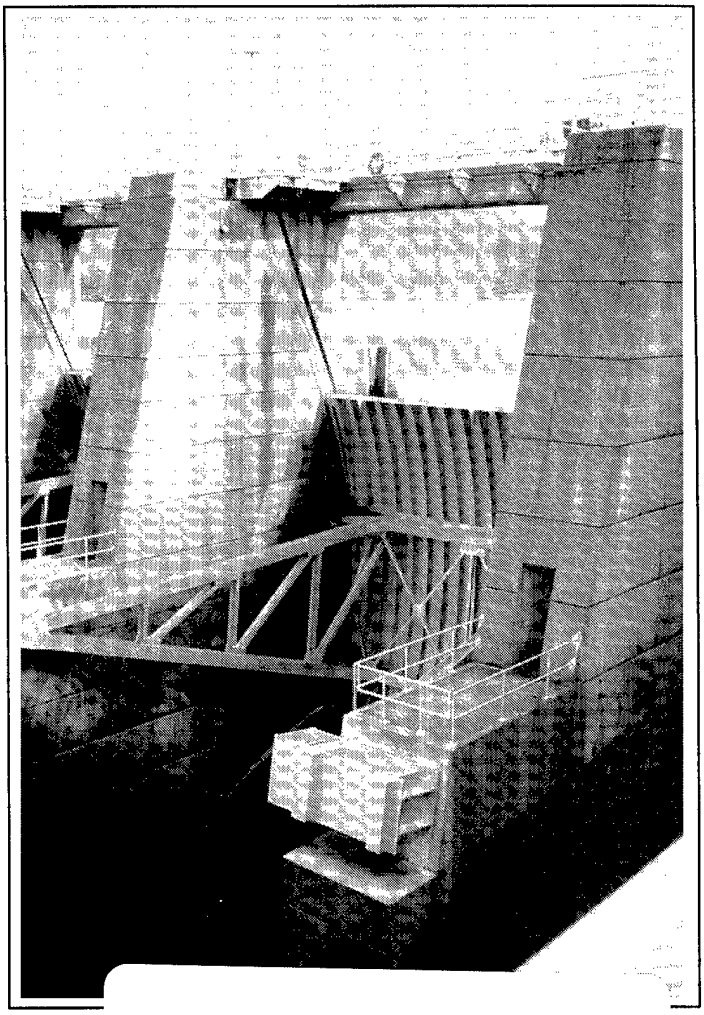
by
Timothy D. Race

Provisions of the Clean Air Act Amendments of 1990 will put new restrictions on the use of high-solvent-content paints beginning in 1997. This will require the U.S. Army Corps of Engineers to find alternatives to some coatings now used to protect steel from corrosion in civil works applications. Furthermore, defense acquisition reform will mandate the use of commercially available products in place of most (or all) military paint specifications. To address this new requirement, the U.S. Army Construction Engineering Research Laboratories (USACERL) investigated the performance of several commercially available coating systems to help the Corps develop performance-based criteria documents for purchasing commercial products.

This report documents USACERL's laboratory evaluation of the performance of commercially available zinc-rich epoxy primers and epoxy topcoats. The evaluation comprised salt water immersion, fresh water immersion, and cyclic corrosion weathering tests.

Exposed test panels were evaluated for rusting, blistering, and rust undercutting. The Corps-standard zinc-rich epoxy primer and epoxy topcoat system was used as an experimental control.

Based on the findings of this investigation, several commercial products are viable alternatives to the Corps-standard system.



USER EVALUATION OF REPORT

REFERENCE: USACERL Technical Report 96/87, *Laboratory Evaluation of Commercial Epoxy Coating Systems for Civil Works Applications*

Please take a few minutes to answer the questions below, tear out this sheet, and return it to USACERL. As user of this report, your customer comments will provide USACERL with information essential for improving future reports.

1. Does this report satisfy a need? (Comment on purpose, related project, or other area of interest for which report will be used.)

_____

_____

_____

2. How, specifically, is the report being used? (Information source, design data or procedure, management procedure, source of ideas, etc.)

_____

_____

3. Has the information in this report led to any quantitative savings as far as manhours/contract dollars saved, operating costs avoided, efficiencies achieved, etc.? If so, please elaborate.

_____

_____

4. What is your evaluation of this report in the following areas?

   a. Presentation: _____

   b. Completeness: _____

   c. Easy to Understand: _____

   d. Easy to Implement: _____

   e. Adequate Reference Material: _____

   f. Relates to Area of Interest: _____

   g. Did the report meet your expectations? _____

   h. Does the report raise unanswered questions? _____

i. General Comments. (Indicate what you think should be changed to make this report and future reports of this type more responsive to your needs, more usable, improve readability, etc.)

_____

_____

_____

_____

_____

_____

5. If you would like to be contacted by the personnel who prepared this report to raise specific questions or discuss the topic, please fill in the following information.

Name: _____

Telephone Number: _____

Organization Address: _____

_____

_____

6. Please mail the completed form to:

Department of the Army
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES
ATTN: CECER-TR-I
P.O. Box 9005
Champaign, IL 61826-9005

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave Blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	August 1996	Final

4. TITLE AND SUBTITLE
Laboratory Evaluation of Commercial Epoxy Coating Systems for Civil Works Applications

5. FUNDING NUMBERS
CWIS
31205

6. AUTHOR(S)
Timothy D. Race

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Construction Engineering Research Laboratories (USACERL)
P.O. Box 9005
Champaign, IL 61826-9005

8. PERFORMING ORGANIZATION REPORT NUMBER
TR 96/87

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Army Corps of Engineers
ATTN: CECW-EE
20 Massachusetts Ave, N.W.
Washington, D.C. 20314-1000

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES
Copies are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

Provisions of the Clean Air Act Amendments of 1990 will put new restrictions on the use of high-solvent-content paints beginning in 1997. This will require the U.S. Army Corps of Engineers to find alternatives to some coatings now used to protect steel from corrosion in civil works applications. Furthermore, defense acquisition reform will mandate the use of commercially available products in place of most (or all) military paint specifications. To address this new requirement, the U.S. Army Construction Engineering Research Laboratories (USACERL) investigated the performance of several commercially available coating systems to help the Corps develop performance-based criteria documents for purchasing commercial products.

This report documents USACERL's laboratory evaluation of the performance of commercially available zinc-rich epoxy primers and epoxy topcoats. The evaluation comprised salt water immersion, fresh water immersion, and cyclic corrosion weathering tests.

Exposed test panels were evaluated for rusting, blistering, and rust undercutting. The Corps-standard zinc-rich epoxy primer and epoxy topcoat system was used as an experimental control.

Based on the findings of this investigation, several commercial products are viable alternatives to the Corps-standard system.

14. SUBJECT TERMS
Civil Works
coatings
epoxy

15. NUMBER OF PAGES
58

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	SAR

Foreword

This study was conducted for Headquarters, U.S. Army Corps of Engineers under "Civil Works Investigations and Studies"; Work Unit 31205, "Developing High-Performance Coatings." The technical monitors were R. Kinsel and J. Gilson, CECW-EE.

The work was performed by the Materials Science and Technology Division (FL-M) of the Facilities Technology Laboratory (FL), U.S. Army Construction Engineering Research Laboratories (USACERL). Dr. Ellen G. Segan is Acting Chief, CECER-FL-M, and Donald F. Fournier is Acting Operations Chief, CECER-FL. The USACERL technical editor was Gordon L. Cohen, Technical Information Team.

COL James T. Scott is Commander of USACERL, and Dr. Michael J. O'Connor is Director.

Contents

List of Tables

Tables

1 Introduction

Background

The U.S. Army Corps of Engineers uses epoxy coating systems because their excellent barrier properties provide good long-term protection for steel structures in immersion service. Corrosion protection can be enhanced by priming the steel substrate with a zinc-rich epoxy primer such as E-303d, the Corps' current in-house specification. At the same time, epoxy topcoats enhance the performance of zinc-rich primers by providing impact- and abrasion-resistance, and they act as a barrier to corrosive water, oxygen, and salt. To achieve proper coating performance with zinc-rich epoxy primers, good surface preparation is required. Civil Works Guide Specification CWGS-09940 calls for the use of SSPC-SP-5*, *White Metal Blast Cleaning*, for coating systems using primer E-303d. The chemical composition of primer E-303d is described in CWGS-09940, *Painting: Hydraulic Structures and Appurtenant Works* (1995).

The Corps of Engineers currently uses E-303d as a primer for two types of topcoats:

- MIL-P-24441, *Paint, Epoxy-Polyamide*
- Steel Structures Painting Council (SSPC) Paint Specification No. 16, *Coal Tar Epoxy-Polyamide Black (or Dark Red) Paint* (1991).

These coating systems, designated by the Corps as systems 21-A-Z and 6-A-Z, respectively, are used for a variety of applications, including fresh water and salt water immersion, and atmospheric weathering. MIL-P-24441 has an excellent record of corrosion protection in use by the Corps of Engineers and the U.S. Navy. Its performance is often used as a performance benchmark for other coating systems.

One problem with E-303d is that it has a relatively high volatile organic compound (VOC) content—typically 500-600 grams per liter as applied. The U.S. Environmental Protection Agency (EPA) has proposed a national rule that places tighter restrictions on the VOC content of architectural and industrial maintenance coatings (PL 101-549, 104 stat 2399). The VOC content requirement for industrial

* SSPC: Steel Structures Painting Council.

maintenance coatings will likely be restricted to 450 grams per liter, so the Corps will no longer be able to apply E-303d when the national rule is implemented on 1 April 1997. Therefore, a suitable replacement is needed very soon.

Federal acquisition reform will have an impact on what the Corps selects as alternative epoxy coating systems. The revised Federal Acquisition Regulation, or FAR (60 FR 48231–48257) redefines the procurement process for Department of Defense agencies. Part 12 of the revised FAR states a clear preference for the procurement of commercial products and systems. Criteria documents (specifications) for procuring commercial products should not merely be directive, but should be based on performance data. In response to the revised FAR and other defense acquisition reforms, the Corps of Engineers has taken the initiative to eliminate the use of military specifications from all future procurements. This initiative may result in the elimination of topcoat MIL-P-24441 (used in Corps system 21-A-Z). As of this writing, MIL-P-24441 is exempt from the military specification ban, but national trends in procurement reform and environmental protection strongly indicate that the exemption cannot be expected to continue indefinitely. Therefore, it is highly advisable for the Corps to proactively investigate viable commercial alternatives to MIL-P-24441 in preparation for the likely ban on this topcoat.

The U.S. Army Construction Engineering Research Laboratories (USACERL) was tasked to determine whether there are epoxy coating systems now commercially available that conform to the requirements of the proposed national rule on VOC content while meeting the basic performance criteria for primer E-303d and topcoat MIL-P-24441 (Corps system 21-A-Z).

Part of this tasking was to evaluate the suitability of three ASTM-standard short-term laboratory tests for rapidly determining the relative (vice absolute) performance of two or more coating systems. If suitable, such tests may serve as the basis for developing a performance-based specification for commercial paint systems of the generic type investigated here.

Objectives

The primary objective of this investigation was to test the relative performance and potential utility of commercial zinc-rich epoxy primers and topcoats to determine whether the market offers suitable replacements for Corps standard primer/topcoat system 21-A-Z.

The secondary objective was to establish the suitability of three ASTM-standard test methods (salt water immersion, fresh water immersion, and cyclic corrosion) for rapidly evaluating the relative performance of this generic type of coating system.

Approach

A list of manufacturers producing low-VOC zinc-rich epoxy primer/epoxy topcoat systems was compiled from an standard coatings industry directory. Sufficient resources were provided to randomly select six coating systems for the commercial product survey.

To accomplish the primary objective of this research, the six selected coating systems were applied to steel test plates. As an experimental control, Corps standard system 21-A-Z also was applied to steel test plates. The test coatings were evaluated using ASTM-standard laboratory methods designed to simulate three exposure environments:

- 120-day fresh water immersion
- 120-day salt water immersion
- 112-day atmospheric weathering.

Test panels were evaluated periodically for degree of rusting, blistering, and rust undercutting. More information about the test procedures is provided in Chapter 2.

To accomplish the secondary objective—evaluating the effectiveness of the three test methods used in this investigation—the methods were evaluated against one criterion: the tests' ability to reliably identify the difference between suitable coatings and unsuitable ones. In this research, early blistering was considered a surrogate indicator of coating unsuitability. The laboratory samples were analyzed statistically to determine correlations (and consistency of results) between coatings and test exposures.

Scope

Neither the selection of products for testing nor the results reported here should be interpreted as an endorsement of specific products or manufacturers. The intent of this work was not to qualify or disqualify individual products, but to determine the potential suitability of commercial products as a group.

This investigation was limited to laboratory testing. Care should be taken not to extrapolate the results of laboratory experiments to actual field performance. Field tests must be conducted to fully validate the utility of any coating technology.

Mode of Technology Transfer

It is recommended that the findings of this research be incorporated into any new Corps of Engineers criteria documents for commercial epoxy coating systems, as developed in accord with the revised FAR.

2 Testing Procedures

Test Coating Application

Six commercial epoxy zinc-rich primer/epoxy topcoat systems were mixed and applied in accordance with the manufacturers' recommendations. Corps of Engineers paint system 21-A-Z was used as an experimental control. System 21-A-Z consists of two coats of E-303d primer and two coats of MIL-P-24441, Formula 152, Type IV, epoxy-polyamide topcoat. Coatings were spray-applied to SP 1 and SP 5 cleaned, hot-rolled commercial grade carbon steel test panels measuring 3 x 9 x 0.125 in.* Table 1 lists the test and control coatings, and Appendix A lists additional information about the coating manufacturers.

The dry film coating thicknesses of the test and control coatings were measured in accordance with ASTM D 1186, *Standard Test Methods for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Base* (1987). The average dry film thicknesses for each coating system are listed in Table 2. Dry film thicknesses for individual test panels can be found in Appendix B, Tables B1–B7.

Table 1. Test and control coatings (with VOC content in grams/liter).

Manufacturer	*Primer*	*Topcoat*	*VOC Primer/Topcoat (g/l)*
Ameron	Amercoat 68HS Zinc	Amercoat 385 Multi-Purpose	288 / 276
Carboline	Carboline 858	Carboline 890	302 / 214
Gavlon Industries	Gavlon 9198-6129 Primer	Gavlon 9888-0008LF	324 / 168
Keeler & Long	Kolor-Poxy 1-11 Solid Zinc Rich Primer No. 7600	Kolor-Poxy 3500 S/P Surfacing Enamel	260 / 72
Poly-Carb	Mark 59.3	Mark 83.3	0 / N/A
Sherwin-Williams	Zinc Clad IV	Kem Cure MW Hi-Build	308 / 340
Corps specification	E-303d	MIL-P-24441 Formula 152, Type IV	500-600 / 340

* 1 in. = 2.54 cm

Table 2. Paint dry film thicknesses.

	Dry Film Thickness of System Components (expressed in thousandths of an inch)			
Coating System	*Zinc Primer*	*Epoxy Topcoat*	*Epoxy Topcoat*	***Total System***
Ameron	4.8	4.1	4.9	13.8
Carboline	5.1	6.1	N/A	11.2
Gavlon	5.3	3.5	5.0	13.8
Keeler & Long	2.6	10.4	N/A	13.0
Poly-Carb	5.8	3.3	3.8	12.9
Sherwin-Williams	5.0	6.1	4.6	15.7
21-A-Z (control)	1.7	6.5	N/A	8.2

Selection of Test Methods

The selected laboratory test methods simulate the expected service environments for epoxy coated-steel. Each is an ASTM-standard methodology shown to produce results that correlate with actual outdoor exposures. Consequently, they are especially useful in quickly ranking a set of coatings.

Salt Water Immersion

Six test panels of each control and experimental system were immersed for 120 days in synthetic sea water prepared in accordance with Section 7, Salt Solution, of ASTM B 117 *Standard Test Method of Salt Spray (Fog) Testing* (1990). All test panels were scribed before immersion, exposing an area approximately 1/8 x 2 in. The purpose of the scribing is to simulate coating film defects that inevitably occur due to damage during handling, erection, and service life. Test panels were evaluated after 7, 60, and 120 days for degree of rusting and blistering in accordance with ASTM D 610, *Standard Method for Evaluating Degree of Rusting on Painted Surfaces* (1989) and ASTM D 714, *Standard Test Method for Evaluating Degree of Blistering of Paints* (1987). Degree of undercutting was measured after 120 days in accordance with ASTM D 1654, *Standard Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments* (1992).

Fresh Water Immersion

This test employed the same test and evaluation procedures used in the salt water test. The test panels were immersed in aerated tap water.

Cyclic Corrosion Weathering

Six scribed test panels of each control and experimental system were subjected to 16 weeks of cyclic corrosion testing. The test cycle comprised 1 week in an ultraviolet condensation cabinet per ASTM G 53, *Standard Practice for Operating Light- and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials* (1991) using UV-A bulbs (4 hours UV at 60 °C, 4 hours condensation at 50 °C), followed by 1 week of hourly cycling through salt spray at 30 °C (4.0 g/L ammonium sulfate, 0.5 g/L sodium chloride) and forced air drying at 40 °C (modified ASTM G 85 Annex A5). The test panels were evaluated for degree of rusting and blistering after 1, 2, 4, 8, 12, and 16 weeks. The degree of undercutting was measured after 16 weeks.

3 Results and Discussion

Salt Water Immersion

Degree of blistering adjacent to the scribe and rusting were determined for the test and control coatings after 7, 60, and 120 days in salt water immersion. Rust undercutting at the scribe was measured after 120 days. The results are summarized in Table 3. The rust undercutting data have been converted to integer values from 0 to 10, as described in ASTM D 1654. The blistering data are similarly converted by taking the average of the sum of the blister size and the converted blister density. The converted blister density is an integer value from 0 to 10 with very dense blistering equal to zero and no blistering equal to 10. Rust, blister, and undercut values are the averages of six test specimens for each coating system. The composite score, shown in the last column, is the sum of numerical rust, blister, and undercut ratings at 120 days. A composite score of 30 corresponds to no coating degradation. The raw data for the salt water immersion tests are presented in Appendix B.

Blistering

Early blistering adjacent to the scribe is a good indicator of poor long-term performance for salt water immersion applications. Blistering not associated with the area near the scribe is less likely to occur, but when it does it indicates more serious performance problems. Most of the commercial epoxy systems showed good resistance to blistering in salt water immersion. However, one of the commercial systems

Table 3. 120-day salt water immersion test results.

Coating System	*Rust*	*Blister*	*Undercut*	***Total***
Ameron	10	10	10	30.0
Carboline	10	10	10	30.0
Gavlon	10	8.2	1.8	20.0
Keeler & Long	10	2	0	12.0
Poly-Carb	10	10	10	30.0
Sherwin-Williams	10	10	10	30.0
21-A-Z (control)	9.7	10	9	28.7

showed some minor blistering not associated with the scribe, and another system exhibited severe blistering over the entire coated surface.

Undercutting

The degree of rust undercutting measured at the scribed area is an important measure of long-term coating performance. Four of the commercial epoxy systems had no undercutting, but the two systems that had blistered did show severe undercutting. The control system (21-A-Z) exhibited minor undercutting at the scribe.

Surface Rusting

Visible rusting is typically associated with broken blisters, pinholes, and holidays. Only the control system had any visible surface rust. Two of the six test panels had minor pinpoint rusting associated with pinholes in the coating.

Composite Scores

The control system (21-A-Z) showed minor degradation after 120-days and had a composite score of 28.7. In a previous investigation of commercial zinc-rich epoxy primers (Race 1996), system 21-A-Z showed no degradation and had a composite score of 30 for 120-days salt water immersion. Of the six epoxy test systems, four had perfect composite scores and two had relatively poor scores. Five of the primers evaluated in this study were also evaluated in Race 1996. Table 4 compares the performance of these materials topcoated with MIL-P-24441 in the previous study against their performance when topcoated with the manufacturer's own commercial

Table 4. Comparison of zinc-rich epoxy performance with commercial vs military specification topcoats in salt water immersion.

Coating System		*Rust*	*Blister*	*Undercut*	***Total***
Ameron	MIL-P-24441	10	10	10	30
	Commercial	10	10	10	30
Carboline	MIL-P-24441	10	10	10	30
	Commercial	10	10	10	30
Gavlon	MIL-P-24441	10	10	10	30
	Commercial	10	8.2	1.8	20
Keeler&Long	MIL-P-24441	10	10	10	30
	Commercial	10	2	0	12
Poly-Carb	MIL-P-24441	10	10	10	30
	Commercial	10	10	10	30

topcoat in this work. Three of the primers had perfect scores both with MIL-P-24441 and their manufacturer's commercial topcoat. Two of the primers showed markedly inferior results with their respective commercial topcoats.

Paint system 21 (MIL-P-24441, Formulas 150 and 152)—an epoxy topcoat system without zinc—was evaluated in another previous study by Race and Boy (1995). In that study, system 21 showed both blistering (4.0) and undercutting (8.5) at the scribe, and a composite score of only 22.5 after 112-days in salt water immersion (Race and Boy 1995). All of the commercial primers as well as Corps standard E-303d improved the performance of system 21 in salt water immersion. However, two of the commercial epoxy systems in the current study exhibited a lower degree of protection—in spite of their zinc-rich primer—than did system 21 without a zinc-rich primer in the 1995 Boy and Race study.

Fresh Water Immersion

Rusting, Blistering, and Undercutting

Degree of rusting and blistering were determined for the test and control coatings after 7, 60, and 120 days in fresh water immersion. Rust undercutting at the scribe was measured after 120 days. The results are shown in Table 5, and the raw data are presented in Appendix B. The composite score for each test panel is presented in the last column of the table.

Composite Scores

With the exception of the two coatings that performed poorly in salt water immersion, the commercial epoxy systems performed well in fresh water immersion. Table 6 compares the performance of five primers that were evaluated with both the

Table 5. 120-day fresh water immersion test results.

Coating System	*Rust*	*Blister*	*Undercut*	***Total***
Ameron	10	10	10	30.0
Carboline	10	10	10	30.0
Gavlon	10	10	4.2	24.2
Keeler & Long	10	2.0	0	12.0
Poly-Carb	10	10	10	30.0
Sherwin-Williams	10	10	10	30.0
21-A-Z (control)	10	10	10	30.0

Table 6. Comparison of zinc-rich epoxy performance with commercial vs military specification topcoats in fresh water immersion.

Coating System		*Rust*	*Blister*	*Undercut*	***Total***
Ameron	MIL-P-24441	10	10	10	30
	Commercial	10	10	10	30
Carboline	MIL-P-24441	10	10	10	30
	Commercial	10	10	10	30
Gavlon	MIL-P-24441	10	10	10	30
	Commercial	10	10	4.2	24.2
Keeler&Long	MIL-P-24441	10	10	10	30
	Commercial	10	2	0	12
Poly-Carb	MIL-P-24441	10	10	10	30
	Commercial	10	10	10	30

commercial and military specification topcoats. Again, as in the salt water test, three of the fresh water exposed primers showed the same high level of performance with both topcoats. Furthermore, the same two primers that performed poorly in other tests also showed markedly inferior results with their own commercial topcoats. As in other tests, the two poorly performing primer/topcoat systems did not equal the performance of MIL-P-24441 without a primer; after 112-days system 21 had a perfect composite score of 30 (Race and Boy 1995).

Cyclic Corrosion Weathering

Rusting, Blistering, and Undercutting

Test panels were evaluated for rusting and blistering after 1, 2, 4, 8, 12, and 16 weeks. Rust undercutting at the scribe was measured at the completion of the 16 week test. The results are summarized in Table 7. Appendix B contains the raw data for the cyclic corrosion testing.

Five of the six test systems had perfect blister and rust ratings at the completion of the cyclic corrosion test. The control exhibited extensive blistering along the scribe, but no surface rusting. All but one of the coating systems exhibited some degree of undercutting at the scribe. The control system and one of the test systems were undercut severely.

Table 7. 112-day cyclic corrosion test results.

Coating System	*Rust*	*Blister*	*Undercut*	***Total***
Ameron	10	10	9.8	29.8
Carboline	10	10	8.7	28.7
Gavlon	10	10	6.7	26.7
Keeler & Long	10	4.3	2.0	16.3
Poly-Carb	10	10	9	29.0
Sherwin-Williams	10	10	10	30.0
21-A-Z (control)	10	2.3	2.7	15.0

Composite Scores

In Race and Boy (1995), system 21 without a zinc-rich primer showed blistering (3.7) and undercutting (4.3), and achieved a composite score of 18.1. In the current study, all but one of the commercial epoxy systems performed better in cyclic corrosion testing than did system 21 in Race and Boy (1995). Cyclic corrosion testing of the zinc-rich primers topcoated with MIL-P-24441 was also conducted previously. Table 8 compares the results of the previous tests with those from the current study.

Analysis of Variance

Standard deviations were computed for each performance attribute (i.e., rusting, blistering, undercutting, and total), paint system, and test exposure. Table 9 lists these values.

Table 8. Comparison of zinc-rich epoxy performance with commercial vs military specification topcoats in cyclic corrosion.

Coating System		*Rust*	*Blister*	*Undercut*	***Total***
Ameron	MIL-P-24441	10	10	10	30
	Commercial	10	10	9.8	29.8
Carboline	MIL-P-24441	10	10	10	30
	Commercial	10	10	8.7	28.7
Gavlon	MIL-P-24441	10	10	9	29.0
	Commercial	10	10	6.7	26.7
Keeler&Long	MIL-P-24441	10	10	10	30
	Commercial	10	4.3	2	16.3
Poly-Carb	MIL-P-24441	10	10	10	30
	Commercial	10	10	9	29.0

Table 9. Standard deviations for salt water (SW) , fresh water (FW), and cyclic corrosion (CC) tests.

Coating System	*Rust* SW / FW / CC	*Blister* SW / FW / CC	*Undercut* SW / FW / CC	***Total*** ***SW / FW / CC***
Ameron	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0.41	0 / 0 / 0.41
Carboline	0 / 0 / 0	0 / 0 / 0	0 / 0 / 1.03	0 / 0 / 1.03
Gavlon	0 / 0 / 0	2.86 / 0 / 0	0.75 / .41 / .82	2.9 / .41 / .82
Keeler & Long	0 / 0 / 0	0 / 0 / 1.75	0.75 / 0 / 1.67	0 / 0 / 3.27
Poly-Carb	0 / 0 / 0	0 / 0 / 0	0 / 0 / 1.55	0 / 0 / 1.55
Sherwin-Williams	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0
21-A-Z (control)	0.52 / 0 / 0	0 / 0 / 1.03	0 / 0 / 1.03	0.52 / 0 / 1.26

There is very little variance in the rusting data, primarily because rusting was detected on only one coating system in one test exposure. There is also little variance in the blistering data, again because very few paint systems exhibited any blistering. In general, the more severe the blistering (lower score) the lower the variance. The relatively high blistering variances noted for two samples were coincidental with the onset of blistering, which can vary significantly from panel to panel in its early stages. These differences tend to level out over time. Undercutting was by far the most variable performance attribute measured, especially in the cyclic corrosion test. There also does not appear to be any correlation between degree of undercutting and the magnitude of the standard deviation. In other words, the observed variability in degree of undercutting does not appear to be time-dependent (as appears to be the case for blistering). Significant variability also was noted for the composite (total) scores, especially for the cyclic corrosion test.

Significance Testing and Rank Order Performance

Salt Water Test

The t-test was used to determine the significance of the test results. For salt water immersion there was no observed degradation or variance for the best four coating systems. The observed differences between these products and each of the other materials are significant at the 99.9 percent confidence level. The rank order performance, then, is Ameron = Carboline = Poly-Carb = Sherwin-Williams > 21-A-Z > Gavlon > Keeler&Long. This rank order correlates perfectly with that derived from the composite scores. The 120-day test is not long enough to be able to identify differences between the better products, although poor products are readily identified within this period. A longer exposure period is needed to qualify the performance

of coatings for use in salt water immersion, but 120 days is considered adequate to determine fitness for purpose.

Fresh Water Test

For fresh water immersion, as for salt water immersion, there was no observed degradation or performance variance among the four best coating systems. The observed differences between these products and each of the other materials are significant at the 99.9 percent confidence level. The rank order performance is Ameron = Carboline = Poly-Carb = Sherwin-Williams = 21-A-Z > Gavlon > Keeler&Long. This rank order correlates perfectly with that derived from the composite scores. The 120-day test was not long enough to be able to identify differences between the better products. Poor products are readily identified in 120 days. A longer exposure period is needed to qualify coatings for use in fresh water immersion, but 120 days is considered adequate to determine fitness for purpose.

Cyclic Corrosion Test

For the cyclic corrosion test there were no significant differences in the performance of the four highest scoring materials at the 95 percent confidence level. At the 95 percent confidence level the materials are ranked Ameron = Carboline = Poly-Carb = Sherwin-Williams > Gavlon > Keeler&Long > 21-A-Z. At the 70 percent confidence level the rank order comes closer to approximating that given by the composite scores: Sherwin-Williams > Ameron > Poly-Carb = Carboline > Keeler&Long > 21-A-Z. The 112-day test period is adequate to determine the differences between poor and good performing products. The differences between the highest-performing paints are not statistically significant. The data suggest that a minimum composite score of 27 to 28 would be an appropriate acceptance criterion for qualifying coating systems of the type evaluated in this study by these test methods.

Modes of Degradation and Failure

Early blistering at the scribe in all three exposures correlates well with poor overall performance. Blistered panels also have the lowest (worst) undercutting scores. Undercutting without blistering was observed for one system in salt water, one system in fresh water, and four systems in cyclic corrosion.

4 Conclusions and Recommendations

Conclusions on Coatings Systems

For the fresh and salt water immersion exposures, most commercial systems tested in this study performed well. The top-performing commercial products are equal to or better than the standard Corps coating system 21-A-Z. The better commercial systems perform as well with the commercial topcoats as they do with MIL-P-24441. The better commercial and standard Corps systems should provide similar long-term performance in fresh and salt water immersion applications.

The top commercial systems performed significantly better than system 21-A-Z in the cyclic corrosion test. However, system 21-A-Z performed much worse than in a previous study, achieving a composite score of just 15.0 in the current test as compared to 30.0 in the earlier one. These differences are probably due to the relatively low primer and total system thicknesses applied in this study (1.7 and 8.2 mils, respectively) compared to those in the previous study (3.1 and 11.1 mils, respectively). Batch variations also may have been a factor in the reduced cyclic corrosion resistance of the control samples. MIL-P-24441 is produced by a number of different manufacturers, and significant variations in material quality and composition have been noted by USACERL when conducting quality-control tests for Corps field activities. Nevertheless, it is concluded that the better commercial systems tested in this study are suitable alternatives to Corps system 21-A-Z for atmospheric exposures in corrosive environments.

The four top-performing commercial coating systems exhibited superior performance in all three test exposures. The other two commercial systems performed poorly in all test exposures. The uniformly good results for the four top performers in both immersion and atmospheric exposures is encouraging because most Corps applications for these materials involve structural components that are simultaneously immersed in water and exposed to the atmosphere.

Conclusions on Test Methods

It is concluded that the test methods and evaluation procedures used in this study are capable of distinguishing between the adequate and inadequate coating systems at or above the 95 percent confidence level. Because fitness for purpose correlates well with the presence or absence of early blistering on test panels, the experimental results support the overall finding that each test method was adequate for determining minimum performance requirements. Poor performers are readily identified or screened out by the test methods. However, it must be noted again that the 120-day immersion tests are not long enough to determine the actual long-term durability of the coating systems in these exposures, nor are they long enough to distinguish between the better-performing products. Laboratory exposures of a year or longer would be useful in identifying differences among the higher-performing products, but, longer exposures are impractical from the standpoint of qualifying coatings based on their performance.

Recommendations

It is recommended that field tests of the most promising commercial systems (Amercoat, Carboline, Sherwin-Williams, Poly-Carb) be conducted to determine the long-term performance of these products under real-world conditions. Field test applications should include structures exposed to the same exposure conditions simulated in this laboratory test.

It is recommended that, upon field verification of these laboratory tests, the test and evaluation procedures reported here should be used to develop a performance-based criteria document for a commercial zinc-rich epoxy primer/epoxy topcoat system. Such a document should be issued as a commercial item description by the General Services Administration.

References

ASTM B 117, *Standard Test Method of Salt Spray (Fog) Testing* (ASTM, Philadelphia, PA, 1990).

ASTM D 610, *Standard Method for Evaluating Degree of Rusting on Painted Surfaces* (ASTM, 1989).

ASTM D 714, *Standard Test Method for Evaluating Degree of Blistering of Paints* (ASTM, 1987).

ASTM D 1186, *Standard Test Methods for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Base* (ASTM, 1987).

ASTM D 1654, *Standard Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments* (ASTM, 1992).

ASTM G 53, *Standard Practice for Operating Light- and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials* (ASTM, 1991).

CWGS-09940, *Painting: Hydraulic Structures and Appurtenant Works* (Army Engineer Division, Hunstville, AL, 1995).

Federal Register (FR), vol 60, pp 48231–48257.

MIL-P-24441, *Paint, Epoxy-Polyamide, General Specification for* (Naval Sea Systems Command, Alexandria, VA, 1991).

Public Law (PL) 101-549, 104 stat 2399, sec 183(e) (15 November 1990).

Race, Timothy D., *Laboratory Evaluation of Commercial Epoxy Zinc-Rich Primers for Civil Works Applications*, Technical Report (TR) 96/39/ADA306450 (U.S. Army Construction Engineering Research Laboratories [USACERL], February 1996.)

Race, Timothy D., and Jeffrey H. Boy, *Laboratory Evaluation of Fusion-Bonded Epoxy Coatings for Civil Works Applications*, TR FM-95/06/ADA291876 (USACERL, January 1995).

SSPC SP-1, *Solvent Cleaning* (Steel Structures Painting Council [SSPC], Pittsburgh, PA, 1982).

SSPC SP-5, *White Metal Blast Cleaning* (SSPC, 1991).

SSPC SP-6, *Commercial Blast Cleaning* (SSPC, 1991).

SSPC Paint Specification No. 16, *Coal Tar Epoxy-Polyamide Black (or Dark Red) Paint* (SSPC, 1991).

Appendix A: Manufacturers of Coatings Tested in This Study

Ameron–Protective Coatings Group
201 N. Berry St.
Brea, CA 92622

Carboline Co.
350 Hanley Industrial Court
St. Louis, MO 63144

Sherwin-Williams Co.
101 Prospect Ave. NW
Cleveland, OH 44115-1075

Gavlon Industries, Inc.
10531 W. Little Yonk Rd.
Houston, TX 77041

Keeler & Long, Inc.
856 Echo Lake Rd.
Watertown, CT 06795

Poly-Carb, Inc.
33095 Bainbridge Rd.
Cleveland, OH 44139

Appendix B: Raw Data for In-Laboratory Coating Tests

Table B1. Test data for E303d/MIL-P-24441 system (Corps system 21-A-Z).

TEST COATING SPECS (U.S. ARMY CORPS OF ENGINEERS)			
COATING SYSTEM DATA	**1ST COAT**	**2ND COAT**	**3RD COAT**
COATING I.D.	Epoxy Zinc-Rich Paint E303d Epoxy Zinc-Rich Paint	MIL 24441	N/A
MANUFACTURER	Reference Material	Reference Material	
VOLUME % SOLIDS	See attached	See attached	
VOC (unthinned)	See attached	See attached	
POT LIFE (unaccelerated)	See attached	See attached	
INDUCTION TIME	See attached	See attached	
DRYING TIME MINIMUM TO RECOAT	See attached	See attached	
RECOMMENDED FILM THICKNESS, DRY	See attached	See attached	
MIXING RATIOS	Kit	See attached	
THINNING, Maximum	MEK Approx. 15%	See attached	
APPLICATION			
DATE	5/13/95	5/14/95	
RH	56%	52%	
TEMPERATURE	72°F	75°	
SUBSTRATE CONDITION	SSPC-SP10	E303d Epoxy Zinc Rich	
COATING BATCH NUMBERS	Base: 17682/Cure: 17681/Zn Dust: 3/95	Not Legible	
THINNING	MEK Approx. 15%	None	
EQUIPMENT	DEVILBISS MBC	Density MBC	

DRY FILM THICKNESS, MILS	SALT	FRESH	U.V.	SALT	FRESH	U.V.	SALT	FRESH	U.V.
SAMPLE NO. 10-1	1.9	1.6	1.5	7.0	7.8	5.5			
SAMPLE NO. 10-2	2.1	1.3	2.0	5.9	4.8	7.0			
SAMPLE NO. 10-3	1.8	1.3	2.1	7.0	6.6	7.1			
SAMPLE NO. 10-4	1.8	1.3	1.8	7.0	5.5	6.3			
SAMPLE NO. 10-5	2.0	1.3	1.5	7.5	4.7	6.5			
SAMPLE NO. 10-6	1.7	1.6	1.9	8.0	6.1	6.1			

SAMPLE TOTALS	SALT	FRESH	U.V.
SAMPLE 10-1 TOTAL (COATS 1 & 2)	8.9	9.4	7.0
SAMPLE 10-2 TOTAL (COATS 1 & 2)	8.0	6.1	9.0
SAMPLE 10-3 TOTAL (COATS 1 & 2)	8.8	7.9	9.2
SAMPLE 10-4 TOTAL (COATS 1 & 2)	8.8	6.8	8.1
SAMPLE 10-5 TOTAL (COATS 1 & 2)	9.5	6.0	8.0
SAMPLE 10-6 TOTAL (COATS 1 & 2)	9.7	7.7	8.0

Table B1. Continued.

PANEL EVALUATION - U.V./PROHESION (U.S. ARMY CORPS OF ENGINEERS

ASTM D714 DEGREE OF BLISTERING

SAMPLE NO.	EXPOSURE TIME (HOURS)											
	168		336		672		1344		2016		2688	
	Frequency	Size	Frequency	Size	Frequency	Size	Frequency	Size	Frequency	Size	Frequency	Size
10-1	0	0	F	6	M	4	MD	4	MD	4	D	2
10-2	0	0	F	6	M	4	MD	4	MD	4	MD	2
10-3	F	4	M	4	MD	2	D	2	D	2	D	2
10-4	0	0	F	4	M	2	MD	2	MD	2	D	2
10-5	0	0	0	0	F	6	MD	4	MD	4	D	4
10-6	0	0	0	0	0	0	M	6	M	6	D	2

ASTM D610 DEGREE OF RUSTING

SAMPLE NO.	EXPOSURE TIME (HOURS)											
	168		336		672		1344		2016		2688	
	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade
10-1	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10
10-2	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10
10-3	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10
10-4	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10
10-5	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10
10-6	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10

ASTM D1654 - EVALUATION OF COATED SPECIMENS SUBJECTED TO CORROSIVE ENVIRONMENTS

SAMPLE NO.	UNSCRIBED AREA - EXPOSURE TIME (HOURS)											
	168		336		672		1344		2016		2688	
	% Failed	Rating	% Failed	Rating	% Failed	Rating	% Failed	Rating	% Failed	Rating	% Failed	Rating
10-1	0	10	0	10	0	10	0	10	0	10	0	10
10-2	0	10	0	10	0	10	0	10	0	10	0	10
10-3	0	10	0	10	0	10	0	10	0	10	0	10
10-4	0	10	0	10	0	10	0	10	0	10	0	10
10-5	0	10	0	10	0	10	0	10	0	10	0	10
10-6	0	10	0	10	0	10	0	10	0	10	0	10

SAMPLE NO.	MEAN CREEPAGE FROM SCRIBE EXPOSURE TIME - 2688 HOURS		COMMENTS:
	mm	Rating	All blistering is along scribe edges. No blistering is seen in unscribed areas as of 672 hours.
10-1	7-10	3	Some yellowing is noted at 672 hours.
10-2	7-10	3	Blisters at 1344 hours are confined to scribe edges.
10-3	10-13	2	
10-4	13-16	1	
10-5	7-10	3	
10-6	5-7	4	

Table B1. Continued.

PANEL EVALUATION - FRESH WATER IMMERSION (U.S. ARMY CORPS OF ENGINEERS)

ASTM D714 DEGREE OF BLISTERING

SAMPLE NO.	EXPOSURE TIME (DAYS) 7		60		120	
	Frequency	Size	Frequency	Size	Frequency	Size
10-1	0	0	0	0	0	0
10-2	0	0	0	0	0	0
10-3	0	0	0	0	0	0
10-4	0	0	0	0	0	0
10-5	0	0	0	0	0	0
10-6	0	0	0	0	0	0

ASTM D610 DEGREE OF RUSTING

SAMPLE NO.	EXPOSURE TIME (DAYS) 7		60		120	
	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade
10-1	<0.01%	10	<0.01%	10	<0.01%	10
10-2	<0.01%	10	<0.01%	10	<0.01%	10
10-3	<0.01%	10	<0.01%	10	<0.01%	10
10-4	<0.01%	10	<0.01%	10	<0.01%	10
10-5	<0.01%	10	<0.01%	10	<0.01%	10
10-6	<0.01%	10	<0.01%	10	<0.01%	10

ASTM D1654 - EVALUATION OF COATED SPECIMENS SUBJECTED TO CORROSIVE ENVIRONMENTS

SAMPLE NO.	UNSCRIBED AREAS - EXPOSURE TIME (DAYS) 7		60		120	
	% Failed	Rating	% Failed	Rating	% Failed	Rating
10-1	0	10	0	10	0	10
10-2	0	10	0	10	0	10
10-3	0	10	0	10	0	10
10-4	0	10	0	10	0	10
10-5	0	10	0	10	0	10
10-6	0	10	0	10	0	10

SAMPLE NO.	MEAN CREEPAGE FROM SCRIBE EXPOSURE TIME - 120 DAYS		COMMENTS:
	mm	Rating	
10-1	0	10	
10-2	0	10	
10-3	0	10	
10-4	0	10	
10-5	0	10	
10-6	0	10	

Table B1. Continued.

PANEL EVALUATION - SALT WATER (U.S. ARMY CORPS OF ENGINEERS)

ASTM D714 DEGREE OF BLISTERING

SAMPLE NO.	EXPOSURE TIME (DAYS) 7		60		120	
	Frequency	Size	Frequency	Size	Frequency	Size
10-1	0	0	0	0	0	0
10-2	0	0	0	0	0	0
10-3	0	0	0	0	0	0
10-4	0	0	0	0	0	0
10-5	0	0	0	0	0	0
10-6	0	0	0	0	0	0

ASTM D610 DEGREE OF RUSTING

SAMPLE NO.	EXPOSURE TIME (DAYS) 7		60		120	
	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade
10-1	<0.01%	10	<0.01%	10	<0.01%	10
10-2	<0.01%	10	<0.01%	10	<0.01%	10
10-3	<0.01%	10	<0.01%	10	<0.01%	10
10-4	<0.01%	10	<0.01%	10	<0.01%	10
10-5	<0.01%	10	<0.03%	9	<0.03%	9
10-6	<0.01%	10	<0.03%	9	<0.03%	9

ASTM D1654 - EVALUATION OF COATED SPECIMENS SUBJECTED TO CORROSIVE ENVIRONMENTS

SAMPLE NO.	UNSCRIBED AREAS - EXPOSURE TIME (DAYS) 7		60		120	
	% Failed	Rating	% Failed	Rating	% Failed	Rating
10-1	0	10	0-1	9	0-1	9
10-2	0	10	0-1	9	0-1	9
10-3	0	10	0-1	9	0-1	9
10-4	0	10	0-1	9	0-1	9
10-5	0	10	0-1	9	0-1	9
10-6	0	10	0-1	9	0-1	9

SAMPLE NO.	MEAN CREEPAGE FROM SCRIBE EXPOSURE TIME - 120 DAYS mm	Rating	COMMENTS:
10-1	0-0.5	9	
10-2	0-0.5	9	
10-3	0-0.5	9	
10-4	0-0.5	9	
10-5	0-0.5	9	
10-6	0-0.5	9	

Table B2. Test data for Americoat epoxy system.

TEST COATING SPECS (AMERON)

COATING SYSTEM DATA	1ST COAT	2ND COAT	3RD COAT
COATING I.D.	Amercoat 68HS Zinc Rich Epoxy Primer	Amercoat 385 Multi-Purpose Epoxy	Amercoat 385 Multi-Purpose Epoxy
MANUFACTURER	Ameron	Ameron	Ameron
VOLUME % SOLIDS	70% +/- 3%	66% +/- 3%	66% +/- 3%
VOC (unthinned)	2.4 lbs/gal	2.3 lbs/gal	2.3 lbs/gal
POT LIFE (unaccelerated)	16 hours @ 70°F	3 hours @ 70° F	3 hours @ 70° F
INDUCTION TIME	None	None	None
DRYING TIME MINIMUM TO RECOAT	2 hours @ 70 ° F	8 hours @ 70°F	8 hours @ 70°F
RECOMMENDED FILM THICKNESS, DRY	3 mils	4-6 mils	4-6 mils
MIXING RATIOS	Mix Kit Only	Mix Kit Only	Mix Kit Only
THINNING, Maximum	0.5 pint/gal w/Amercoat 65	6% per gal w/Amercoat 101	6% per gal w/Amercoat 101
APPLICATION			
DATE	4/25/95	4/26/95	4/27/95
RH	46%	50%	69%
TEMPERATURE	73°F	75°F	80°F
SUBSTRATE CONDITION	SSPC SP5	68HS	Amercoat 385
COATING BATCH NUMBERS	Base: L502259/Powder: G503102/Cure: L411266	Base: N407053/Cure: L502314	Base: BT-N402127/Cure: L502314
THINNING	1/2 pint	None	None
EQUIPMENT	Devilbiss MBC	Devilbiss MBC	Devilbiss MBC

DRY FILM THICKNESS, MILS	SALT	FRESH	U.V.	SALT	FRESH	U.V.	SALT	FRESH	U.V.
SAMPLE NO. 1-1	5.6	6.5	4.4	4.1	4.7	4.6	3.6	5.4	4.6
SAMPLE NO. 1-2	4.6	4.0	4.2	4.9	4.0	5.4	4.1	5.2	5.4
SAMPLE NO. 1-3	5.1	4.6	3.6	3.9	3.7	4.7	6.0	4.2	4.9
SAMPLE NO. 1-4	5.0	5.7	4.1	2.7	4.3	4.4	6.3	4.6	4.9
SAMPLE NO. 1-5	4.1	6.1	3.9	4.9	2.9	3.1	4.0	5.7	4.9
SAMPLE NO. 1-6	4.7	5.6	3.9	3.7	4.4	3.1	5.2	4.5	5.2

SAMPLE TOTALS	SALT	FRESH	U.V.
SAMPLE 1-1 TOTAL (COATS 1, 2 & 3)	13.3	16.6	13.6
SAMPLE 1-2 TOTAL (COATS 1, 2 & 3)	13.6	13.2	15.0
SAMPLE 1-3 TOTAL (COATS 1, 2 & 3)	15.0	12.5	13.2
SAMPLE 1-4 TOTAL (COATS 1, 2 & 3)	14.0	14.6	13.4
SAMPLE 1-5 TOTAL (COATS 1, 2 & 3)	13.0	14.7	11.9
SAMPLE 1-6 TOTAL (COATS 1, 2 & 3)	13.6	14.5	12.2

Table B2. Continued.

PANEL EVALUATION - U.V./PROHESION (AMERON)

ASTM D714 DEGREE OF BLISTERING

SAMPLE	EXPOSURE TIME (HOURS)											
	168		336		672		1344		2016		2688	
NO.	Frequency	Size	Frequency	Size	Frequency	Size	Frequency	Size	Frequency	Size	Frequency	Size
1-1	0	0	0	0	0	0	0	0	0	0	0	0
1-2	0	0	0	0	0	0	0	0	0	0	0	0
1-3	0	0	0	0	0	0	0	0	0	0	0	0
1-4	0	0	0	0	0	0	0	0	0	0	0	0
1-5	0	0	0	0	0	0	0	0	0	0	0	0
1-6	0	0	0	0	0	0	0	0	0	0	0	0

ASTM D610 DEGREE OF RUSTING

SAMPLE	EXPOSURE TIME (HOURS)											
	168		336		672		1344		2016		2688	
NO.	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade
1-1	<0.1%	10	<0.1%	10	<0.1%	10	<0.01%	10	<0.01%	10	<0.01%	10
1-2	<0.1%	10	<0.1%	10	<0.1%	10	<0.01%	10	<0.01%	10	<0.01%	10
1-3	<0.1%	10	<0.1%	10	<0.1%	10	<0.01%	10	<0.01%	10	<0.01%	10
1-4	<0.1%	10	<0.1%	10	<0.1%	10	<0.01%	10	<0.01%	10	<0.01%	10
1-5	<0.1%	10	<0.1%	10	<0.1%	10	<0.01%	10	<0.01%	10	<0.01%	10
1-6	<0.1%	10	<0.1%	10	<0.1%	10	<0.01%	10	<0.01%	10	<0.01%	10

ASTM D1654 - EVALUATION OF COATED SPECIMENS SUBJECTED TO CORROSIVE ENVIRONMENTS

SAMPLE	UNSCRIBED AREA - EXPOSURE TIME (HOURS)											
	168		336		672		1344		2016		2688	
NO.	% Failed	Rating	% Failed	Rating	% Failed	Rating	% Failed	Rating	% Failed	Rating	% Failed	Rating
1-1	0	10	0	10	0	10	0	10	0	10	0	10
1-2	0	10	0	10	0	10	0	10	0	10	0	10
1-3	0	10	0	10	0	10	0	10	0	10	0-1	9
1-4	0	10	0	10	0	10	0	10	0	10	0	10
1-5	0	10	0	10	0	10	0	10	0	10	0	10
1-6	0	10	0	10	0	10	0	10	0	10	0	10

SAMPLE	MEAN CREEPAGE FROM SCRIBE EXPOSURE TIME - 2688 HOURS		COMMENTS:
NO.	mm	Rating	
1-1	0	10	
1-2	0	10	
1-3	0	10	
1-4	0	10	
1-5	0.5	9	
1-6	0	10	

Table B2. Continued.

PANEL EVALUATION - FRESH WATER IMMERSION (AMERON)

ASTM D714 DEGREE OF BLISTERING

SAMPLE NO.	EXPOSURE TIME (DAYS) 7 Frequency	7 Size	60 Frequency	60 Size	120 Frequency	120 Size
1-1	0	0	0	0	0	0
1-2	0	0	0	0	0	0
1-3	0	0	0	0	0	0
1-4	0	0	0	0	0	0
1-5	0	0	0	0	0	0
1-6	0	0	0	0	0	0

ASTM D610 DEGREE OF RUSTING

SAMPLE NO.	EXPOSURE TIME (DAYS) 7 % Rusted	7 Rust Grade	60 % Rusted	60 Rust Grade	120 % Rusted	120 Rust Grade
1-1	<0.01%	10	<0.01%	10	<0.01%	10
1-2	<0.01%	10	<0.01%	10	<0.01%	10
1-3	<0.01%	10	<0.01%	10	<0.01%	10
1-4	<0.01%	10	<0.01%	10	<0.01%	10
1-5	<0.01%	10	<0.01%	10	<0.01%	10
1-6	<0.01%	10	<0.01%	10	<0.01%	10

ASTM D1654 - EVALUATION OF COATED SPECIMENS SUBJECTED TO CORROSIVE ENVIRONMENTS

SAMPLE NO.	UNSCRIBED AREAS - EXPOSURE TIME (DAYS) 7 % Failed	7 Rating	60 % Failed	60 Rating	120 % Failed	120 Rating
1-1	0	10	0	10	0	10
1-2	0	10	0	10	0	10
1-3	0	10	0	10	0	10
1-4	0	10	0	10	0	10
1-5	0	10	0	10	0	10
1-6	0	10	0	10	0	10

SAMPLE NO.	MEAN CREEPAGE FROM SCRIBE EXPOSURE TIME - 120 DAYS mm	Rating	COMMENTS:
1-1	0	10	
1-2	0	10	
1-3	0	10	
1-4	0	10	
1-5	0	10	
1-6	0	10	

Table B2. Continued.

PANEL EVALUATION - SALT WATER IMMERSION (AMERON)

ASTM D714 DEGREE OF BLISTERING

SAMPLE NO.	EXPOSURE TIME (DAYS) 7		60		120	
	Frequency	Size	Frequency	Size	Frequency	Size
1-1	0	0	0	0	0	0
1-2	0	0	0	0	0	0
1-3	0	0	0	0	0	0
1-4	0	0	0	0	0	0
1-5	0	0	0	0	0	0
1-6	0	0	0	0	0	0

ASTM D610 DEGREE OF RUSTING

SAMPLE NO.	EXPOSURE TIME (DAYS) 7		60		120	
	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade
1-1	<0.01%	10	<0.01%	10	<0.01%	10
1-2	<0.01%	10	<0.01%	10	<0.01%	10
1-3	<0.01%	10	<0.01%	10	<0.01%	10
1-4	<0.01%	10	<0.01%	10	<0.01%	10
1-5	<0.01%	10	<0.01%	10	<0.01%	10
1-6	<0.01%	10	<0.01%	10	<0.01%	10

ASTM D1654 - EVALUATION OF COATED SPECIMENS SUBJECTED TO CORROSIVE ENVIRONMENTS

SAMPLE NO.	UNSCRIBED AREAS - EXPOSURE TIME (DAYS) 7		60		120	
	% Failed	Rating	% Failed	Rating	% Failed	Rating
1-1	0	10	0	10	0	10
1-2	0	10	0	10	0	10
1-3	0	10	0	10	0	10
1-4	0	10	0	10	0	10
1-5	0	10	0	10	0	10
1-6	0	10	0	10	0	10

SAMPLE NO.	MEAN CREEPAGE FROM SCRIBE EXPOSURE TIME - 120 DAYS		COMMENTS:
	mm	Rating	
1-1	0	10	
1-2	0	10	
1-3	0	10	
1-4	0	10	
1-5	0	10	
1-6	0	10	

Table B3. Test data for Carboline epoxy system.

TEST COATING SPECS (CARBOLINE)

COATING SYSTEM DATA	1ST COAT	2ND COAT	3RD COAT
COATING I.D.	Carboline 858	Carboline 890	
	Primer	High Build Epoxy	
MANUFACTURER	Carboline	Carboline	
VOLUME % SOLIDS	64% +/- 2%	75% +/- 2%	
VOC (unthinned)	2.52 lbs/gal	1.78 lbs/gal	
POT LIFE (unaccelerated)	4 hours @ 72° F	3 hours @ 75° F	
INDUCTION TIME	None Stated	None Stated	
DRYING TIME MINIMUM TO RECOAT	3 hours @ 75° F	8 hours @ 75° F	
RECOMMENDED FILM THICKNESS, DRY	3 mils	7 mils	
MIXING RATIOS	Mix kit only	1 part base to 1 part converter	
THINNING, Maximum	#2	#2	

APPLICATION			
DATE	5/1/95	5/2/95	
RH	56%	56%	
TEMPERATURE	72° F	72° F	
SUBSTRATE CONDITION	SSPC SP10	Primed	
COATING BATCH NUMBERS	Not Legible	Base: 5B7999L	
THINNING	None	#2	
EQUIPMENT	Devilbiss MBC	Devilbiss MBC	

DRY FILM THICKNESS, MILS	SALT	FRESH	U.V.	SALT	FRESH	U.V.	SALT	FRESH	U.V.
SAMPLE NO. 6-1	4.4	5.6	5.2	5.6	6.0	4.4			
SAMPLE NO. 6-2	5.2	6.0	5.0	5.1	5.6	5.0			
SAMPLE NO. 6-3	6.0	5.0	5.0	7.0	4.0	3.6			
SAMPLE NO. 6-4	5.8	6.0	5.0	6.2	7.3	7.0			
SAMPLE NO. 6-5	5.2	4.3	4.0	8.4	8.7	5.3			
SAMPLE NO. 6-6	5.3	4.6	5.0	9.7	5.4	4.6			

SAMPLE TOTALS	SALT	FRESH	U.V.
SAMPLE 6-1 TOTAL (COATS 1 & 2)	10.0	11.6	9.6
SAMPLE 6-2 TOTAL (COATS 1 & 2)	10.3	11.6	10.0
SAMPLE 6-3 TOTAL (COATS 1 & 2)	13.0	9.0	8.6
SAMPLE 6-4 TOTAL (COATS 1 & 2)	12.0	13.3	12.0
SAMPLE 6-5 TOTAL (COATS 1 & 2)	13.6	13.0	9.3
SAMPLE 6-6 TOTAL (COATS 1 & 2)	15.0	10.0	9.6

Table B3. Continued.

PANEL EVALUATION - U.V./PROHESION (CARBOLINE)

ASTM D714 DEGREE OF BLISTERING

SAMPLE NO.	EXPOSURE TIME (HOURS)											
	168		336		672		1344		2016		2688	
	Frequency	Size	Frequency	Size	Frequency	Size	Frequency	Size	Frequency	Size	Frequency	Size
6-1	0	0	0	0	0	0	0	0	0	0	0	0
6-2	0	0	0	0	0	0	0	0	0	0	0	0
6-3	0	0	0	0	0	0	0	0	0	0	0	0
6-4	0	0	0	0	0	0	0	0	0	0	0	0
6-5	0	0	0	0	0	0	0	0	0	0	0	0
6-6	0	0	0	0	0	0	0	0	0	0	0	0

ASTM D610 DEGREE OF RUSTING

SAMPLE NO.	EXPOSURE TIME (HOURS)											
	168		336		672		1344		2016		2688	
	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade
6-1	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10
6-2	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10
6-3	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10
6-4	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10
6-5	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10
6-6	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10

ASTM D1654 - EVALUATION OF COATED SPECIMENS SUBJECTED TO CORROSIVE ENVIRONMENTS

SAMPLE NO.	UNSCRIBED AREA - EXPOSURE TIME (HOURS)											
	168		336		672		1344		2016		2688	
	% Failed	Rating	% Failed	Rating	% Failed	Rating	% Failed	Rating	% Failed	Rating	% Failed	Rating
6-1	0	10	0	10	0	10	0	10	0	10	0	10
6-2	0	10	0	10	0	10	0	10	0	10	0	10
6-3	0	10	0	10	0	10	0	10	0	10	0	10
6-4	0	10	0	10	0	10	0	10	0	10	0	10
6-5	0	10	0	10	0	10	0	10	0	10	0	10
6-6	0	10	0	10	0	10	0	10	0	10	0	10

SAMPLE NO.	MEAN CREEPAGE FROM SCRIBE EXPOSURE TIME - 2688 HOURS		COMMENTS:
	mm	Rating	
6-1	2	8	
6-2	0.5	9	
6-3	0-0.5	9	
6-4	0	10	
6-5	1-2	7	
6-6	0-0.5	9	

Table B3. Continued.

PANEL EVALUATION - FRESH WATER IMMERSION (CARBOLINE)

ASTM D714 DEGREE OF BLISTERING

SAMPLE NO.	EXPOSURE TIME (DAYS)					
	7		60		120	
	Frequency	Size	Frequency	Size	Frequency	Size
6-1	0	0	0	0	0	0
6-2	0	0	0	0	0	0
6-3	0	0	0	0	0	0
6-4	0	0	0	0	0	0
6-5	0	0	0	0	0	0
6-6	0	0	0	0	0	0

ASTM D610 DEGREE OF RUSTING

SAMPLE NO.	EXPOSURE TIME (DAYS)					
	7		60		120	
	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade
6-1	<0.01%	10	<0.01%	10	<0.01%	10
6-2	<0.01%	10	<0.01%	10	<0.01%	10
6-3	<0.01%	10	<0.01%	10	<0.01%	10
6-4	<0.01%	10	<0.01%	10	<0.01%	10
6-5	<0.01%	10	<0.01%	10	<0.01%	10
6-6	<0.01%	10	<0.01%	10	<0.01%	10

ASTM D1654 - EVALUATION OF COATED SPECIMENS SUBJECTED TO CORROSIVE ENVIRONMENTS

SAMPLE NO.	UNSCRIBED AREAS - EXPOSURE TIME (DAYS)					
	7		60		120	
	% Failed	Rating	% Failed	Rating	% Failed	Rating
6-1	0	10	0	10	0	10
6-2	0	10	0	10	0	10
6-3	0	10	0	10	0	10
6-4	0	10	0	10	0	10
6-5	0	10	0	10	0	10
6-6	0	10	0	10	0	10

SAMPLE NO.	MEAN CREEPAGE FROM SCRIBE EXPOSURE TIME - 120 DAYS		COMMENTS:
	mm	Rating	
6-1	0	10	
6-2	0	10	
6-3	0	10	
6-4	0	10	
6-5	0	10	
6-6	0	10	

Table B3. Continued.

PANEL EVALUATION - SALT WATER IMMERSION (CARBOLINE)

ASTM D714 DEGREE OF BLISTERING

SAMPLE NO.	EXPOSURE TIME (DAYS) 7		60		120	
	Frequency	Size	Frequency	Size	Frequency	Size
6-1	0	0	0	0	0	0
6-2	0	0	0	0	0	0
6-3	0	0	0	0	0	0
6-4	0	0	0	0	0	0
6-5	0	0	0	0	0	0
6-6	0	0	0	0	0	0

ASTM D610 DEGREE OF RUSTING

SAMPLE NO.	EXPOSURE TIME (DAYS) 7		60		120	
	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade
6-1	<0.01%	10	<0.01%	10	<0.01%	10
6-2	<0.01%	10	<0.01%	10	<0.01%	10
6-3	<0.01%	10	<0.01%	10	<0.01%	10
6-4	<0.01%	10	<0.01%	10	<0.01%	10
6-5	<0.01%	10	<0.01%	10	<0.01%	10
6-6	<0.01%	10	<0.01%	10	<0.01%	10

ASTM D1654 - EVALUATION OF COATED SPECIMENS SUBJECTED TO CORROSIVE ENVIRONMENTS

SAMPLE NO.	UNSCRIBED AREAS - EXPOSURE TIME (DAYS) 7		60		120	
	% Failed	Rating	% Failed	Rating	% Failed	Rating
6-1	0	10	0	10	0	10
6-2	0	10	0	10	0	10
6-3	0	10	0	10	0	10
6-4	0	10	0	10	0	10
6-5	0	10	0	10	0	10
6-6	0	10	0	10	0	10

SAMPLE NO.	MEAN CREEPAGE FROM SCRIBE EXPOSURE TIME - 120 DAYS		COMMENTS:
	mm	Rating	
6-1	0	10	
6-2	0	10	
6-3	0	10	
6-4	0	10	
6-5	0	10	
6-6	0	10	

Table B4. Test data for Gavlon epoxy system.

TEST COATING SPECS (GAVLON)

COATING SYSTEM DATA	1ST COAT	2ND COAT	3RD COAT
COATING I.D.	Zinc Rich Epoxy Primer Gavlon 9198-6129 Primer	Epoxy Polyamide Primer/Topcoat Gavlon 9888-0008LF	Epoxy Polyamide Primer/Topcoat Gavlon 9888-0008LF
MANUFACTURER	Gavlon Industries, Inc.	Gavlon Industries, Inc.	Gavlon Industries, Inc.
VOLUME % SOLIDS	60.50%	81%	81%
VOC (unthinned)	2.7 lbs/gal	1.40 lbs/gal	1.40 lbs/gal
POT LIFE (unaccelerated)	4-6 hours @ 77° F	4 hours @ 77° F	4 hours @ 77° F
INDUCTION TIME	20 minutes @ > or = to 70°F	30 minutes @ 77° F	30 minutes @ 77° F
DRYING TIME MINIMUM TO RECOAT	45 minutes @ 77° F	4 hours - 7 days @ 77° F	4 hours - 7 days @ 77° F
RECOMMENDED FILM THICKNESS, DRY	5 mils	5 mils	4 mils
MIXING RATIOS	1 part base to 1 part converter	4 parts B to 1 part A by volume	4 parts B to 1 part A by volume
THINNING, Maximum	Gavlon 5130	Gavlon 5130	Gavlon 5130
APPLICATION			
DATE	4/29/95	5/1/95	5/2/95
RH	56%	56%	56%
TEMPERATURE	73°F	72° F	72° F
SUBSTRATE CONDITION	SSPC SP5	Primed	Primed
COATING BATCH NUMBERS	Base: 2-5-02-050/Cure: 2-5-01-020	Base: 2-5-04-68/Cure 2-5-04-069	Base: 2-5-04-68/Cure 2-5-04-069
THINNING	Gavlon 5130	Gavlon 5130	Gavlon 5130
EQUIPMENT	Devilbiss MBC	Devilbiss MBC	Devilbiss MBC

DRY FILM THICKNESS, MILS	SALT	FRESH	U.V.	SALT	FRESH	U.V.	SALT	FRESH	U.V.
SAMPLE NO. 5-1	5.0	6.6	5.6	4.5	2.7	3.0	6.0	7.2	3.8
SAMPLE NO. 5-2	3.0	5.3	4.6	4.3	1.7	4.0	5.2	7.7	4.6
SAMPLE NO. 5-3	5.2	3.0	5.6	2.1	2.7	4.7	6.0	6.9	3.7
SAMPLE NO. 5-4	4.6	5.6	5.0	4.9	2.4	4.0	5.6	6.0	3.6
SAMPLE NO. 5-5	6.0	6.2	5.6	3.0	4.8	3.4	5.5	3.5	3.6
SAMPLE NO. 5-6	6.0	7.0	5.3	4.0	3.0	3.2	4.5	3.6	3.8

SAMPLE TOTALS	SALT	FRESH	U.V.
SAMPLE 5-1 TOTAL (COATS 1, 2 & 3)	15.5	16.5	12.4
SAMPLE 5-2 TOTAL (COATS 1 ,2 & 3)	12.5	14.7	13.2
SAMPLE 5-3 TOTAL (COATS 1, 2 & 3)	13.3	12.6	14.0
SAMPLE 5-4 TOTAL (COATS 1, 2 & 3)	15.1	14.0	12.7
SAMPLE 5-5 TOTAL (COATS 1, 2 & 3)	14.5	14.5	12.6
SAMPLE 5-6 TOTAL (COATS 1, 2 & 3)	14.5	13.6	12.1

Table B4. Continued.

PANEL EVALUATION - U.V./PROHESION (GAVLON)

ASTM D714 DEGREE OF BLISTERING

SAMPLE	EXPOSURE TIME (HOURS)											
	168		336		672		1344		2016		2688	
NO.	Frequency	Size	Frequency	Size	Frequency	Size	Frequency	Size	Frequency	Size	Frequency	Size
5-1	0	0	0	0	0	0	0	0	0	0	0	0
5-2	0	0	0	0	0	0	0	0	0	0	0	0
5-3	0	0	0	0	0	0	0	0	0	0	0	0
5-4	0	0	0	0	0	0	0	0	0	0	0	0
5-5	0	0	0	0	0	0	0	0	0	0	0	0
5-6	0	0	0	0	0	0	0	0	0	0	0	0

ASTM D610 DEGREE OF RUSTING

SAMPLE	EXPOSURE TIME (HOURS)											
	168		336		672		1344		2016		2688	
NO.	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade
5-1	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10
5-2	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10
5-3	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10
5-4	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10
5-5	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10
5-6	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10

ASTM D1654 - EVALUATION OF COATED SPECIMENS SUBJECTED TO CORROSIVE ENVIRONMENTS

SAMPLE	UNSCRIBED AREA - EXPOSURE TIME (HOURS)											
	168		336		672		1344		2016		2688	
NO.	% Failed	Rating	% Failed	Rating	% Failed	Rating	% Failed	Rating	% Failed	Rating	% Failed	Rating
5-1	0	10	0	10	0	10	0	10	0-1	9	0-1	9
5-2	0	10	0	10	0	10	0	10	0-1	9	0-1	9
5-3	0	10	0	10	0	10	0	10	0-1	9	0-1	9
5-4	0	10	0	10	0	10	0	10	0-1	9	0-1	9
5-5	0	10	0	10	0	10	0	10	0-1	9	0-1	9
5-6	0	10	0	10	0	10	0	10	0-1	9	0-1	9

SAMPLE	MEAN CREEPAGE FROM SCRIBE EXPOSURE TIME - 2688 HOURS		COMMENTS:
NO.	mm	Rating	
5-1	1-2	7	
5-2	1-2	7	
5-3	1-2	7	
5-4	3-5	5	
5-5	1-2	7	
5-6	1-2	7	

Table B4. Continued.

PANEL EVALUATION - FRESH WATER IMMERSION (GAVLON)

ASTM D714 DEGREE OF BLISTERING

SAMPLE NO.	EXPOSURE TIME (DAYS) 7		60		120	
	Frequency	Size	Frequency	Size	Frequency	Size
5-1	0	0	0	0	0	0
5-2	0	0	0	0	0	0
5-3	0	0	0	0	0	0
5-4	0	0	0	0	0	0
5-5	0	0	0	0	0	0
5-6	0	0	0	0	0	0

ASTM D610 DEGREE OF RUSTING

SAMPLE NO.	EXPOSURE TIME (DAYS) 7		60		120	
	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade
5-1	<0.01%	10	<0.01%	10	<0.01%	10
5-2	<0.01%	10	<0.01%	10	<0.01%	10
5-3	<0.01%	10	<0.01%	10	<0.01%	10
5-4	<0.01%	10	<0.01%	10	<0.01%	10
5-5	<0.01%	10	<0.01%	10	<0.01%	10
5-6	<0.01%	10	<0.01%	10	<0.01%	10

ASTM D1654 - EVALUATION OF COATED SPECIMENS SUBJECTED TO CORROSIVE ENVIRONMENTS

SAMPLE NO.	UNSCRIBED AREAS - EXPOSURE TIME (DAYS) 7		60		120	
	% Failed	Rating	% Failed	Rating	% Failed	Rating
5-1	0	10	0	10	0	10
5-2	0	10	0	10	0	10
5-3	0	10	0	10	0	10
5-4	0	10	0	10	0	10
5-5	0	10	0	10	0	10
5-6	0	10	0	10	0	10

SAMPLE NO.	MEAN CREEPAGE FROM SCRIBE EXPOSURE TIME - 120 DAYS		COMMENTS:
	mm	Rating	
5-1	7	4	
5-2	7	4	
5-3	4	5	
5-4	7	4	
5-5	7	4	
5-6	7	4	

Table B4. Continued.

PANEL EVALUATION - SALT WATER IMMERSION (GAVLON)

ASTM D714 DEGREE OF BLISTERING

SAMPLE NO.	EXPOSURE TIME (DAYS) 7		60		120	
	Frequency	Size	Frequency	Size	Frequency	Size
5-1	0	0	0	0	0	0
5-2	0	0	F	2	M	2
5-3	0	0	0	0	0	0
5-4	0	0	F	2	F	2
5-5	0	0	0	0	0	0
5-6	0	0	0	0	0	0

ASTM D610 DEGREE OF RUSTING

SAMPLE NO.	EXPOSURE TIME (DAYS) 7		60		120	
	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade
5-1	<0.01%	10	<0.01%	10	<0.01%	10
5-2	<0.01%	10	<0.01%	10	<0.01%	10
5-3	<0.01%	10	<0.01%	10	<0.01%	10
5-4	<0.01%	10	<0.01%	10	<0.01%	10
5-5	<0.01%	10	<0.01%	10	<0.01%	10
5-6	<0.01%	10	<0.01%	10	<0.01%	10

ASTM D1654 - EVALUATION OF COATED SPECIMENS SUBJECTED TO CORROSIVE ENVIRONMENTS

SAMPLE NO.	UNSCRIBED AREAS - EXPOSURE TIME (DAYS) 7		60		120	
	% Failed	Rating	% Failed	Rating	% Failed	Rating
5-1	0	10	0	10	0	10
5-2	0	10	0	10	0	10
5-3	0	10	0	10	0	10
5-4	0	10	0	10	0	10
5-5	0	10	0	10	0	10
5-6	0	10	0	10	0	10

SAMPLE NO.	MEAN CREEPAGE FROM SCRIBE EXPOSURE TIME - 120 DAYS	
	mm	Rating
5-1	12	2
5-2	14	1
5-3	14	1
5-4	9	3
5-5	11	2
5-6	12	2

COMMENTS:
Viewed on 9/22/95. Few #2 blisters in unscribed areas on panels 2 & 4.

Table B5. Test data for Kolor-Poxy system.

TEST COATING SPECS (KEELER & LONG			
COATING SYSTEM DATA	**1ST COAT**	**2ND COAT**	**3RD COAT**
COATING I.D.	Kolor-Poxy 1-11	Kolor-Poxy 3500	
	Solid Zinc Rich Primer No. 7600	S/P Surfacing Enamel	
MANUFACTURER	Keeler & Long	Keeler & Long	
VOLUME % SOLIDS	72% +/- 3%	92%	
VOC (unthinned)	2.17 lbs/gal	0.6 lbs/gal	
POT LIFE (unaccelerated)	8 hours @ 72°F	8 hours @ 72°F	
INDUCTION TIME	None stated	None	
DRYING TIME MINIMUM TO RECOAT	24 hours @ 72°F	24-48 hours @ 72°F	
RECOMMENDED FILM THICKNESS, DRY	2-4 mils	8-55 mils	
MIXING RATIOS	5:1	Kit 4:1	
THINNING, Maximum	No 3700	20%	
APPLICATION			
DATE	5/6/95	5/10/95	
RH	56%	56%	
TEMPERATURE	70° F	70°F	
SUBSTRATE CONDITION	White blast	Clean	
COATING BATCH NUMBERS	Base: 12/Cure:12	Base: 723/Cure: 723	
THINNING	None	20%	
EQUIPMENT	Devilbiss MBC	Devilbiss MBC	

DRY FILM THICKNESS, MILS	SALT	FRESH	U.V.	SALT	FRESH	U.V.	SALT	FRESH	U.V.
SAMPLE NO. 8-1	3.0	2.4	2.2	14.2	11.1	10.1			
SAMPLE NO. 8-2	3.2	2.6	3.0	11.3	9.9	9.0			
SAMPLE NO. 8-3	2.9	2.4	2.8	11.6	8.6	10.0			
SAMPLE NO. 8-4	2.7	2.8	2.5	12.2	8.0	9.5			
SAMPLE NO. 8-5	2.0	2.3	2.7	11.9	8.9	8.8			
SAMPLE NO. 8-6	2.6	2.3	2.7	12.4	9.7	10.3			

SAMPLE TOTALS	SALT	FRESH	U.V.
SAMPLE 8-1 TOTAL (COATS 1 & 2)	17.2	13.5	12.3
SAMPLE 8-2 TOTAL (COATS 1 & 2)	14.5	12.5	12.0
SAMPLE 8-3 TOTAL (COATS 1 & 2)	14.5	11.0	12.8
SAMPLE 8-4 TOTAL (COATS 1 & 2)	14.9	10.8	12.0
SAMPLE 8-5 TOTAL (COATS 1 & 2)	13.9	11.2	11.5
SAMPLE 8-6 TOTAL (COATS 1 & 2)	15.0	12.0	13.0

Table B5. Continued.

PANEL EVALUATION - U.V./PROHESION (KEELER & LONG)

ASTM D714 DEGREE OF BLISTERING

SAMPLE NO.	EXPOSURE TIME (HOURS)											
	168		336		672		1344		2016		2688	
	Frequency	Size	Frequency	Size	Frequency	Size	Frequency	Size	Frequency	Size	Frequency	Size
8-1	0	0	0	0	F	4	F	4	F	4	M	4
8-2	0	0	0	0	0	0	0	0	0	0	F	6
8-3	0	0	0	0	0	0	F	6	F	4	M	2
8-4	0	0	0	0	0	0	F	8	F	8	M	4
8-5	0	0	0	0	F	4	F	4	F	4	MD	2
8-6	0	0	0	0	F	4	F	4	F	4	D	2

ASTM D610 DEGREE OF RUSTING

SAMPLE NO.	EXPOSURE TIME (HOURS)											
	168		336		672		1344		2016		2688	
	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade
8-1	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10
8-2	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10
8-3	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10
8-4	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10
8-5	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10
8-6	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10

ASTM D1654 - EVALUATION OF COATED SPECIMENS SUBJECTED TO CORROSIVE ENVIRONMENTS

SAMPLE NO.	UNSCRIBED AREA - EXPOSURE TIME (HOURS)											
	168		336		672		1344		2016		2688	
	% Failed	Rating	% Failed	Rating	% Failed	Rating	% Failed	Rating	% Failed	Rating	% Failed	Rating
8-1	0	10	0	10	0	10	0	10	0	10	0	10
8-2	0	10	0	10	0	10	0	10	0	10	0	10
8-3	0	10	0	10	0	10	0	10	0	10	0	10
8-4	0	10	0	10	0	10	0	10	0	10	0	10
8-5	0	10	0	10	0	10	0	10	0	10	0	10
8-6	0	10	0	10	0	10	0	10	0	10	0	10

SAMPLE NO.	MEAN CREEPAGE FROM SCRIBE EXPOSURE TIME - 2688 HOURS		COMMENTS:
	mm	Rating	
8-1	5-7	4	Blistering on panels 8UV1, 8UV5 and 8UV6 at 672 hours is along the scribe edges There are no blisters found in the unscribed areas. Blisters at 1344 hours are confined to scribe edges. * Blistering is confined to scribe edges.
8-2	5-7	4	Coating along scribe is beginning to lift.
8-3	13-16	1	At 672 hours, there is considerable yellowing of all panels in this set.
8-4	13-16	2	
8-5	>16	0	
8-6	13-16	1	

Table B5. Continued.

PANEL EVALUATION - FRESH WATER IMMERSION (KEELER & LONG)

ASTM D714 DEGREE OF BLISTERING

SAMPLE NO.	EXPOSURE TIME (DAYS) 7		60		120	
	Frequency	Size	Frequency	Size	Frequency	Size
8-1	0	0	D	6	D	2
8-2	0	0	MD	6	D	2
8-3	0	0	M	4	D	2
8-4	0	0	D	6	D	2
8-5	0	0	MD	6	D	2
8-6	0	0	D	6	D	2

ASTM D610 DEGREE OF RUSTING

SAMPLE NO.	EXPOSURE TIME (DAYS) 7		60		120	
	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade
8-1	<0.01%	10	<0.01%	10	<0.01%	10
8-2	<0.01%	10	<0.01%	10	<0.01%	10
8-3	<0.01%	10	<0.01%	10	<0.01%	10
8-4	<0.01%	10	<0.01%	10	<0.01%	10
8-5	<0.01%	10	<0.01%	10	<0.01%	10
8-6	<0.01%	10	<0.01%	10	<0.01%	10

ASTM D1654 - EVALUATION OF COATED SPECIMENS SUBJECTED TO CORROSIVE ENVIRONMENTS

SAMPLE NO.	UNSCRIBED AREAS - EXPOSURE TIME (DAYS) 7		60		120	
	% Failed	Rating	% Failed	Rating	% Failed	Rating
8-1	0	10	0	10	>75 (B)	0
8-2	0	10	0	10	>75	0
8-3	0	10	0	10	>75	0
8-4	0	10	0	10	>75	0
8-5	0	10	0	10	>75	0
8-6	0	10	0	10	>75	0

SAMPLE NO.	MEAN CREEPAGE FROM SCRIBE EXPOSURE TIME - 120 DAYS	
	mm	Rating
8-1	>16	0
8-2	>16	0
8-3	>16	0
8-4	>16	0
8-5	>16	0
8-6	>16	0

COMMENTS:
(B) Blisters on unscribed areas, but not broken (rusted) through; active corrosion

Table B5. Continued.

PANEL EVALUATION - SALT WATER IMMERSION (KEELER & LONG)

ASTM D714 DEGREE OF BLISTERING

SAMPLE NO.	EXPOSURE TIME (DAYS) 7		60		120	
	Frequency	Size	Frequency	Size	Frequency	Size
8-1	0	0	M	8	D	4
8-2	0	0	MD	8	D	4
8-3	0	0	M	8	D	4
8-4	0	0	MD	8	D	4
8-5	0	0	M	6	D	4
8-6	0	0	D	8	D	4

ASTM D610 DEGREE OF RUSTING

SAMPLE NO.	EXPOSURE TIME (DAYS) 7		60		120	
	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade
8-1	<0.01%	10	<0.01%	10	<0.01%	10
8-2	<0.01%	10	<0.01%	10	<0.01%	10
8-3	<0.01%	10	<0.01%	10	<0.01%	10
8-4	<0.01%	10	<0.01%	10	<0.01%	10
8-5	<0.01%	10	<0.01%	10	<0.01%	10
8-6	<0.01%	10	<0.01%	10	<0.01%	10

ASTM D1654 - EVALUATION OF COATED SPECIMENS SUBJECTED TO CORROSIVE ENVIRONMENTS

SAMPLE NO.	UNSCRIBED AREAS - EXPOSURE TIME (DAYS) 7		60		120	
	% Failed	Rating	% Failed	Rating	% Failed	Rating
8-1	0	10	0	10	>75 (B)	10
8-2	0	10	0	10	>75	10
8-3	0	10	0	10	>75	10
8-4	0	10	0	10	>75	10
8-5	0	10	0	10	>75	10
8-6	0	10	0	10	>75	10

SAMPLE NO.	MEAN CREEPAGE FROM SCRIBE EXPOSURE TIME - 120 DAYS mm	Rating	COMMENTS:
8-1	<16	0	At 120 days, there are blisters over 100% of coating surface #4 dense; active black corrosion under blisters. (B) Blisters on unscribed areas, but not broken through; active corrosion
8-2	<16	0	
8-3	<16	0	
8-4	<16	0	
8-5	<16	0	
8-6	<16	0	

Table B6. Test data for Poly-Carb epoxy system.

TEST COATING SPECS (POLY-CARB)

COATING SYSTEM DATA	1ST COAT	2ND COAT	3RD COAT
COATING I.D.	Zinc rich coating	Polyamide Epoxy	Polyamide Epoxy
MANUFACTURER	Mark 59.3	Mark 83.3	Mark 83.3
VOLUME % SOLIDS	Poly-Carb	Poly-Carb	Poly-Carb
VOC (unthinned)	55% +/- 2%	68-72%	68-72%
POT LIFE (unaccelerated)	Not Given	Not Given	Not Given
INDUCTION TIME	6 hours @ 75° F	6 hours @ 70° F	6 hours @ 70° F
DRYING TIME MINIMUM TO RECOAT	15-30 minutes @75° F	30 minutes @ 75° F	30 minutes @ 75° F
RECOMMENDED FILM THICKNESS, DRY	12-18 hours @ 75° F	12-18 hours @ 75° F	12-18 hours @ 75 ° F
MIXING RATIOS	5-6 mils	3-5 mils	3-5 mils
THINNING, Maximum	Kit	Kit	Kit
	None	None	None

APPLICATION			
DATE	7/14/95	7/17/95	7/18/95
RH	47%	51%	56%
TEMPERATURE	72° F	73° F	73° F
SUBSTRATE CONDITION	SSPC SP10	Primer	Epoxy
COATING BATCH NUMBERS	Not Legible	Not Legible	Not Legible
THINNING	None	None	None
EQUIPMENT	Devilbiss MBC	Devilbiss MBC	Devilbiss MBC

DRY FILM THICKNESS, MILS	SALT	FRESH	U.V.	SALT	FRESH	U.V.	SALT	FRESH	U.V.
SAMPLE NO. 13-1	6.5	6.5	5.6	1.9	2.4	4.0	3.6	3.6	4.2
SAMPLE NO. 13-2	5.6	6.0	5.0	3.0	3.6	4.4	3.6	3.5	4.1
SAMPLE NO. 13-3	6.7	5.1	5.7	1.6	5.7	3.9	3.5	3.7	0.9
SAMPLE NO. 13-4	6.8	5.5	5.6	1.4	4.1	4.4	3.5	4.2	5.0
SAMPLE NO. 13-5	6.5	5.8	5.0	2.4	4.0	3.2	3.2	4.2	4.0
SAMPLE NO. 13-6	6.6	5.4	4.2	2.1	4.4	3.3	3.5	4.3	6.5

SAMPLE TOTALS	SALT	FRESH	U.V.
SAMPLE 13-1 TOTAL (COATS 1, 2 & 3)	12.0	12.5	13.8
SAMPLE 13-2 TOTAL (COATS 1, 2 & 3)	12.2	13.1	13.5
SAMPLE 13-3 TOTAL (COATS 1, 2 & 3)	11.8	14.5	10.5
SAMPLE 13-4 TOTAL (COATS 1, 2 & 3)	11.7	13.8	15.0
SAMPLE 13-5 TOTAL (COATS 1, 2 & 3)	12.1	14.0	12.2
SAMPLE 13-6 TOTAL (COATS 1, 2 & 3)	12.2	14.1	14.0

Table B6. Continued.

PANEL EVALUATION - U.V./PROHESION (POLY-CARB)

ASTM D714 DEGREE OF BLISTERING

SAMPLE NO.	EXPOSURE TIME (HOURS)											
	168		336		672		1344		2016		2688	
	Frequency	Size	Frequency	Size	Frequency	Size	Frequency	Size	Frequency	Size	Frequency	Size
13-1	0	0	0	0	0	0	0	0	0	0	0	0
13-2	0	0	0	0	0	0	0	0	0	0	0	0
13-3	0	0	0	0	0	0	0	0	0	0	0	0
13-4	0	0	0	0	0	0	0	0	0	0	0	0
13-5	0	0	0	0	0	0	0	0	0	0	0	0
13-6	0	0	0	0	0	0	0	0	0	0	0	0

ASTM D610 DEGREE OF RUSTING

SAMPLE NO.	EXPOSURE TIME (HOURS)											
	168		336		672		1344		2016		2688	
	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade
13-1	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10
13-2	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10
13-3	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10
13-4	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10
13-5	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10
13-6	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10

ASTM D1654 - EVALUATION OF COATED SPECIMENS SUBJECTED TO CORROSIVE ENVIRONMENTS

SAMPLE NO.	UNSCRIBED AREA - EXPOSURE TIME (HOURS)											
	168		336		672		1344		2016		2688	
	% Failed	Rating	% Failed	Rating	% Failed	Rating	% Failed	Rating	% Failed	Rating	% Failed	Rating
13-1	0	10	0	10	0	10	0	10	0	10	0	10
13-2	0	10	0	10	0	10	0	10	0	10	0	10
13-3	0	10	0	10	0	10	0	10	0	10	0	10
13-4	0	10	0	10	0	10	0	10	0	10	0	10
13-5	0	10	0	10	0	10	0	10	0	10	0	10
13-6	0	10	0	10	0	10	0	10	0	10	0	10

SAMPLE NO.	MEAN CREEPAGE FROM SCRIBE EXPOSURE TIME - 2688 HOURS		COMMENTS:
	mm	Rating	
13-1	0	10	
13-2	0	10	
13-3	1-2	7	
13-4	1-2	7	
13-5	0	10	
13-6	0	10	

Table B6. Continued.

PANEL EVALUATION - FRESH WATER IMMERSION (POLY-CARB)

ASTM D714 DEGREE OF BLISTERING

SAMPLE NO.	EXPOSURE TIME (DAYS) 7		60		120	
	Frequency	Size	Frequency	Size	Frequency	Size
13-1	0	0	0	0	0	0
13-2	0	0	0	0	0	0
13-3	0	0	0	0	0	0
13-4	0	0	0	0	0	0
13-5	0	0	0	0	0	0
13-6	0	0	0	0	0	0

ASTM D610 DEGREE OF RUSTING

SAMPLE NO.	EXPOSURE TIME (DAYS) 7		60		120	
	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade
13-1	<0.01%	10	<0.01%	10	<0.01%	10
13-2	<0.01%	10	<0.01%	10	<0.01%	10
13-3	<0.01%	10	<0.01%	10	<0.01%	10
13-4	<0.01%	10	<0.01%	10	<0.01%	10
13-5	<0.01%	10	<0.01%	10	<0.01%	10
13-6	<0.01%	10	<0.01%	10	<0.01%	10

ASTM D1654 - EVALUATION OF COATED SPECIMENS SUBJECTED TO CORROSIVE ENVIRONMENTS

SAMPLE NO.	UNSCRIBED AREAS - EXPOSURE TIME (DAYS) 7		60		120	
	% Failed	Rating	% Failed	Rating	% Failed	Rating
13-1	0	10	0	10	0	10
13-2	0	10	0	10	0	10
13-3	0	10	0	10	0	10
13-4	0	10	0	10	0	10
13-5	0	10	0	10	0	10
13-6	0	10	0	10	0	10

SAMPLE NO.	MEAN CREEPAGE FROM SCRIBE EXPOSURE TIME - 120 DAYS		COMMENTS:
	mm	Rating	
13-1	0	10	
13-2	0	10	
13-3	0	10	
13-4	0	10	
13-5	0	10	
13-6	0	10	

Table B6. Continued.

PANEL EVALUATION - SALT WATER IMMERSION (POLY-CARB)

ASTM D714 DEGREE OF BLISTERING

SAMPLE NO.	EXPOSURE TIME (DAYS) 7		60		120	
	Frequency	Size	Frequency	Size	Frequency	Size
13-1	0	0	0	0	0	0
13-2	0	0	0	0	0	0
13-3	0	0	0	0	0	0
13-4	0	0	0	0	0	0
13-5	0	0	0	0	0	0
13-6	0	0	0	0	0	0

ASTM D610 DEGREE OF RUSTING

SAMPLE NO.	EXPOSURE TIME (DAYS) 7		60		120	
	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade
13-1	<0.01%	10	<0.01%	10	<0.01%	10
13-2	<0.01%	10	<0.01%	10	<0.01%	10
13-3	<0.01%	10	<0.01%	10	<0.01%	10
13-4	<0.01%	10	<0.01%	10	<0.01%	10
13-5	<0.01%	10	<0.01%	10	<0.01%	10
13-6	<0.01%	10	<0.01%	10	<0.01%	10

ASTM D1654 - EVALUATION OF COATED SPECIMENS SUBJECTED TO CORROSIVE ENVIRONMENTS

SAMPLE NO.	UNSCRIBED AREAS - EXPOSURE TIME (DAYS) 7		60		120	
	% Failed	Rating	% Failed	Rating	% Failed	Rating
13-1	0	10	0	10	0	10
13-2	0	10	0	10	0	10
13-3	0	10	0	10	0	10
13-4	0	10	0	10	0	10
13-5	0	10	0	10	0	10
13-6	0	10	0	10	0	10

SAMPLE NO.	MEAN CREEPAGE FROM SCRIBE EXPOSURE TIME - 120 DAYS		COMMENTS:
	mm	Rating	
13-1	0	10	
13-2	0	10	
13-3	0	10	
13-4	0	10	
13-5	0	10	
13-6	0	10	

Table B7. Test data for Sherwin-Williams epoxy system.

TEST COATING SPECS (SHERWIN WILLIAMS)

COATING SYSTEM DATA	1ST COAT	2ND COAT	3RD COAT
COATING I.D.	Zinc Clad IV	Kem Cure MW	Kem Cure MW
	A 2 package zinc-rich epoxy primer	High build polyamide epoxy coating	High build polyamide epoxy coating
MANUFACTURER	Sherwin Williams	Sherwin Williams	Sherwin Williams
VOLUME % SOLIDS	64.40%	58%	58%
VOC (unthinned)	2.57 lbs/gal	2.84 lbs/gal	2.84 lbs/gal
POT LIFE (unaccelerated)	6 hours @ 77° F	10 hours @ 77° F	10 hours @ 77° F
INDUCTION TIME	30 minutes @ 77° F	30 minutes @ 77° F	30 minutes @ 77° F
DRYING TIME MINIMUM TO RECOAT	4 hours @ 77° F	12 hours @ 77° F	12 hours @ 77° F
RECOMMENDED FILM THICKNESS, DRY	3-5 mils	5-7 mils	5-7 mils
MIXING RATIOS	Kit Only	Kit Only	Kit Only
THINNING, Maximum	less than or equal to 80° F MEK	.255-C-005	.255-C-005
APPLICATION			
DATE	5/8/95	5/9/95	5/10/95
RH	58%	58%	56%
TEMPERATURE	68° F	68° F	70° F
SUBSTRATE CONDITION	SSPC 10	Primer	Epoxy
COATING BATCH NUMBERS	Base:B69A8/Cure:BA661295/Other:B69A8/B69V8	Base: 920W965/920C965	Base: 20W965/Cure: 920C965
THINNING	less than or equal to 80° F MEK	less than or equal to 80° F MEK	less than or equal to 80° F MEK
EQUIPMENT	Devilbiss MBC	Devilbiss MBC	Devilbiss MBC

DRY FILM THICKNESS, MILS	SALT	FRESH	U.V.	SALT	FRESH	U.V.	SALT	FRESH	U.V.
SAMPLE NO. 9-1	5.2	5.1	5.2	5.8	5.4	6.8	5.1	5.8	5.9
SAMPLE NO. 9-2	4.5	4.5	5.2	5.8	6.4	5.9	3.5	3.9	4.7
SAMPLE NO. 9-3	4.8	4.8	5.0	6.3	5.4	6.2	3.6	4.3	4.6
SAMPLE NO. 9-4	4.8	5.3	5.4	6.3	6.0	5.8	3.9	5.5	3.7
SAMPLE NO. 9-5	4.8	4.6	5.3	5.5	6.5	8.0	5.3	4.9	3.8
SAMPLE NO. 9-6	5.0	5.2	5.5	5.3	5.6	6.8	4.4	5.0	4.2

SAMPLE TOTALS	SALT	FRESH	U.V.
SAMPLE 9-1 TOTAL (COATS 1, 2 & 3)	16.1	16.3	17.9
SAMPLE 9-2 TOTAL (COATS 1, 2 & 3)	13.8	14.8	15.8
SAMPLE 9-3 TOTAL (COATS 1, 2 & 3)	14.7	14.5	15.8
SAMPLE 9-4 TOTAL (COATS 1, 2 & 3)	15.0	16.8	14.9
SAMPLE 9-5 TOTAL (COATS 1, 2 & 3)	15.6	16.0	17.1
SAMPLE 9-6 TOTAL (COATS 1, 2 & 3)	14.7	15.8	16.5

Table B7. Continued.

PANEL EVALUATION - U.V./PROHESION (SHERWIN WILLIAMS)

ASTM D714 DEGREE OF BLISTERING

SAMPLE NO.	EXPOSURE TIME (HOURS)											
	168		336		672		1344		2016		2688	
	Frequency	Size	Frequency	Size	Frequency	Size	Frequency	Size	Frequency	Size	Frequency	Size
9-1	0	0	0	0	0	0	0	0	0	0	0	0
9-2	0	0	0	0	0	0	0	0	0	0	0	0
9-3	0	0	0	0	0	0	0	0	0	0	0	0
9-4	0	0	0	0	0	0	0	0	0	0	0	0
9-5	0	0	0	0	0	0	0	0	0	0	0	0
9-6	0	0	0	0	0	0	0	0	0	0	0	0

ASTM D610 DEGREE OF RUSTING

SAMPLE NO.	EXPOSURE TIME (HOURS)											
	168		336		672		1344		2016		2688	
	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade
9-1	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10
9-2	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10
9-3	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10
9-4	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10
9-5	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10
9-6	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10	<0.01%	10

ASTM D1654 - EVALUATION OF COATED SPECIMENS SUBJECTED TO CORROSIVE ENVIRONMENTS

SAMPLE NO.	UNSCRIBED AREA - EXPOSURE TIME (HOURS)											
	168		336		672		1344		2016		2688	
	% Failed	Rating	% Failed	Rating	% Failed	Rating	% Failed	Rating	% Failed	Rating	% Failed	Rating
9-1	0	10	0	10	0	10	0	10	0	10	0	10
9-2	0	10	0	10	0	10	0	10	0	10	0	10
9-3	0	10	0	10	0	10	0	10	0	10	0	10
9-4	0	10	0	10	0	10	0	10	0	10	0	10
9-5	0	10	0	10	0	10	0	10	0	10	0	10
9-6	0	10	0	10	0	10	0	10	0	10	0	10

SAMPLE NO.	MEAN CREEPAGE FROM SCRIBE EXPOSURE TIME - 2688 HOURS		COMMENTS:
	mm	Rating	
9-1	0	10	
9-2	0	10	
9-3	0	10	
9-4	0	10	
9-5	0	10	
9-6	0	10	

Table B7. Continued.

PANEL EVALUATION - FRESH WATER IMMERSION (SHERWIN WILLIAMS)

ASTM D714 DEGREE OF BLISTERING

SAMPLE NO.	EXPOSURE TIME (DAYS) 7		60		120	
	Frequency	Size	Frequency	Size	Frequency	Size
9-1	0	0	0	0	0	0
9-2	0	0	0	0	0	0
9-3	0	0	0	0	0	0
9-4	0	0	0	0	0	0
9-5	0	0	0	0	0	0
9-6	0	0	0	0	0	0

ASTM D610 DEGREE OF RUSTING

SAMPLE NO.	EXPOSURE TIME (DAYS) 7		60		120	
	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade
9-1	<0.01%	10	<0.01%	10	<0.01%	10
9-2	<0.01%	10	<0.01%	10	<0.01%	10
9-3	<0.01%	10	<0.01%	10	<0.01%	10
9-4	<0.01%	10	<0.01%	10	<0.01%	10
9-5	<0.01%	10	<0.01%	10	<0.01%	10
9-6	<0.01%	10	<0.01%	10	<0.01%	10

ASTM D1654 - EVALUATION OF COATED SPECIMENS SUBJECTED TO CORROSIVE ENVIRONMENTS

SAMPLE NO.	UNSCRIBED AREAS - EXPOSURE TIME (DAYS) 7		60		120	
	% Failed	Rating	% Failed	Rating	% Failed	Rating
9-1	0	10	0	10	0	10
9-2	0	10	0	10	0	10
9-3	0	10	0	10	0	10
9-4	0	10	0	10	0	10
9-5	0	10	0	10	0	10
9-6	0	10	0	10	0	10

SAMPLE NO.	MEAN CREEPAGE FROM SCRIBE EXPOSURE TIME - 120 DAYS		COMMENTS:
	mm	Rating	
9-1	0	10	
9-2	0	10	
9-3	0	10	
9-4	0	10	
9-5	0	10	
9-6	0	10	

Table B7. Continued.

PANEL EVALUATION - SALT WATER IMMERSION (SHERWIN WILLIAMS)

ASTM D714 DEGREE OF BLISTERING

SAMPLE NO.	EXPOSURE TIME (DAYS)					
	7		60		120	
	Frequency	Size	Frequency	Size	Frequency	Size
9-1	0	0	0	0	0	0
9-2	0	0	0	0	0	0
9-3	0	0	0	0	0	0
9-4	0	0	0	0	0	0
9-5	0	0	0	0	0	0
9-6	0	0	0	0	0	0

ASTM D610 DEGREE OF RUSTING

SAMPLE NO.	EXPOSURE TIME (DAYS)					
	7		60		120	
	% Rusted	Rust Grade	% Rusted	Rust Grade	% Rusted	Rust Grade
9-1	<0.01%	10	<0.01%	10	<0.01%	10
9-2	<0.01%	10	<0.01%	10	<0.01%	10
9-3	<0.01%	10	<0.01%	10	<0.01%	10
9-4	<0.01%	10	<0.01%	10	<0.01%	10
9-5	<0.01%	10	<0.01%	10	<0.01%	10
9-6	<0.01%	10	<0.01%	10	<0.01%	10

ASTM D1654 - EVALUATION OF COATED SPECIMENS SUBJECTED TO CORROSIVE ENVIRONMENTS

SAMPLE NO.	UNSCRIBED AREAS - EXPOSURE TIME (DAYS)					
	7		60		120	
	% Failed	Rating	% Failed	Rating	% Failed	Rating
9-1	0	10	0	10	0	10
9-2	0	10	0	10	0	10
9-3	0	10	0	10	0	10
9-4	0	10	0	10	0	10
9-5	0	10	0	10	0	10
9-6	0	10	0	10	0	10

SAMPLE NO.	MEAN CREEPAGE FROM SCRIBE EXPOSURE TIME - 120 DAYS		COMMENTS:
	mm	Rating	
9-1	0	10	
9-2	0	10	
9-3	0	10	
9-4	0	10	
9-5	0	10	
9-6	0	10	

USACERL DISTRIBUTION

Chief of Engineers
ATTN: CEHEC-IM-LH (2)
ATTN: CEHEC-IM-LP (2)
ATTN: CECG
ATTN: CECC-P
ATTN: CECC-R
ATTN: CECW
ATTN: CECW-EE
ATTN: CECW-O
ATTN: CECW-P
ATTN: CECW-PR
ATTN: CEMP
ATTN: CEMP-E
ATTN: CEMP-C
ATTN: CEMP-M
ATTN: CEMP-R
ATTN: CERD-C
ATTN: CERD-ZA
ATTN: CERD-L
ATTN: CERD-M
ATTN: CERM
ATTN: DAEN-ZC
ATTN: DAIM-FDP

US Army Engr District
ATTN: Library (40)

US Army Engr Division
ATTN: Library (11)

CEWES 39180
ATTN: Library

CECRL 03755
ATTN: Library

Naval Facilities Engr Command
ATTN: Naval Facilities Engr Service Center 93043-4328

Nat'l Institute of Standards & Tech
ATTN: Library 20899

Defense Tech Info Center 22060-6218
ATTN: DTIC-O (2)

Tenneesee Valley Authority

Brazos River Authority

Federal Highway Administration

US Bureau of Reclamation

Bureau of Mines