1400

FIELD EVALUATION OF EXPERIMENTAL LOW VOC BRIDGE PAINTS

MDOT
Michigan Department of Transportation

CONSTRUCTION AND TECHNOLOGY DIVISION

This report, authorized by the transportation director, has been prepared to provide technical information and guidance for personnel in the Michigan Department of Transportation, the FHWA, and other reciprocating agencies. The cost of publishing 50 copies of this report at $4.39 per copy is $219.50 and it is printed in accordance with Executive Directive 1991-6.

Technical Report Documentation Page

1. Report No. Research Report R-1400	2. Government Accession No.	*3. MDOT Project Manager B. Beck, Project Manager.
4. Title and Subtitle Field Evaluation of Experimental Low VOC Bridge Paints		5. Report Date July 2002
7. Author(s) Byron D. Beck		6. Performing Organization Code
9. Performing Organization Name and Address Michigan Department of Transportation Construction and Technology Division P.O. Box 30049 Lansing, MI 48909		8. Performing Org Report No. R-1400
12. Sponsoring Agency Name and Address Michigan Department of Transportation Construction and Technology Division P.O. Box 30049 Lansing, MI 48909		10. Work Unit No. (TRAIS)
		*11. Contract Number:
		*11(a). Authorization Number:
15. Supplementary Notes		13. Type of Report & Period Covered Research Project G-303
		14. Sponsoring Agency Code

16. Abstract

A research project was initiated to evaluate the value of coating structural steel with products with low Volatile Organic Compounds VOCs). VOCs are substances that easily become vapors or gases, and can become pollutants in the air, water and soil. This report shows the results of the field testing of the experimental, low VOC paint systems that were applied on a few Michigan bridges from the years 1992 to 1994. Within eight years, the Berrien County structure developed areas of pinpoint rust. The Davis system applied to the Livingston County structure did not allow thick enough film builds on the edges of the bottom flange to prevent pinpoint corrosion. The testing of the coating systems used on the structures in Kent County, was flawed, due to the removal of the zinc primer mistakenly applied to the test areas. However given this potential advantage, the test systems are performing as well as the control system applied to the rest of the structures.

17. Key Words		18. Distribution Statement No restrictions. This document is available to the public through the Michigan Department of Transportation.	
19. Security Classification (report) Unclassified	20. Security Classification (Page) Unclassified	21. No of Pages	22. Price

Form DOT F 1700.7 (8-72)

MICHIGAN DEPARTMENT OF TRANSPORTATION
MDOT

FIELD EVALUATION OF EXPERIMENTAL LOW VOC BRIDGE PAINTS

BRYON D. BECK

Testing and Research Section
Construction and Technology Division
Research Project G-303
Research Report R-1400

Lansing, Michigan
July 2002

TABLE OF CONTENTS

INTRODUCTION

In 1994, a research project was initiated to evaluate the value of coating structural steel with products with low Volatile Organic Compounds (VOCs). VOCs are commonly used as solvents in paint, paint thinners, lacquer thinner, degreasers, and dry cleaning fluids. VOCs are substances containing carbon and different proportions of other elements such as hydrogen, oxygen, fluorine, chlorine, bromine, sulfur, or nitrogen. These substances easily become vapors or gases, and can become pollutants in the air, water and soil. VOCs contribute to smog formation. Some have been identified as *Hazardous Air Pollutants* or HAPs by the Clean Air Act. In limiting the quantity of VOCs in paint products, less VOCs are released into the environment.

Prior to 1994, the Michigan Department of Transportation (MDOT) did not limit the amount of VOCs used in paint systems. However, anticipating that the Environmental Protection Agency (EPA) would set maximum levels of VOC, the Department began testing coating systems with low VOCs. From 1988 through 1992, the Department tested experimental water-based and low VOC bridge coating systems. The results of this testing were discussed in an April 15, 1994, interim report (included in Appendix A), and an August 7, 1995, interim report (included in Appendix B). The interim reports discuss lab testing that was done to find the best available systems, and results of initial field testing. In 1994, the Department provided a Qualified Products List (QPL) for Paint Systems with VOCs of 2.9 lbs/gal or less. On January 1, 1996, the EPA, lowered the VOC requirement for industrial coatings to 2.9 lbs/gal and was considering a further reduction as low as 1.7 lbs/gal in the year 2003. However, on August 14, 1998, the EPA reversed the ruling by issuing a final regulation to control VOC emissions from industrial maintenance coatings at 3.8 lbs/gal. Currently (2002) MDOT requires that VOCs to be 3.3 lbs/gal or lower.

This report shows the results of the field testing of the low VOC paint systems that were applied on Michigan bridges from the years 1992 to 1994. Recommendations are given regarding the status of this research project.

FIELD APPLICATIONS

Structure Number S14 of 11015 - Livingston Road over I-94 in Berrien County

In October 1992, two experimental systems were applied to portions of the bridge carrying Livingston Road over I-94 in Berrien County. A Glidden system was applied to the fascia beams over the right lane of west bound I-94, and a Davis system was applied to the fascia beams over the center lane of west bound I-94. Both systems had low VOCs and limited amounts of hazardous metals. The Davis system consisted of a zinc-rich epoxy primer with water-based vinyl acrylic intermediate and top coat. The VOCs for the Davis System were 3.2 lbs./gal for the primer, 1.8 lbs./gal for the intermediate and 1.3 lbs./gal for the top coat. The Glidden system consisted of a three coat water-based vinyl system. The VOCs for the Glidden System were 0.4 lbs./gal for the primer and the intermediate and 0.7 lbs./gal. for the top coat. The results of the early performance were discussed in the August 7, 1995, interim report (included in Appendix A). These systems were inspected in July 2001, and after nine years the Glidden system has areas of pinpoint rust and the Davis system has one area of pinpoint rust over the skip line between the center and right lanes of WB on the north fascia. The pinpoint rust is on the web of both fascia beams, near the top flange on the south fascia (see Figure 1) and random areas of the web of the north fascia (see Figure 2).

Figure 1 - South Fascia Pinpoint rust over right lane which is Glidden system.

Figure 2- Close up of north fascia pinpoint rust over skip line between center and right lanes.

Due to the two year performance of the Glidden and Davis systems on S14 of 11015, it was decided to evaluate the systems on structure number S11 of 45065.

Structure Number S11 of 45065 - Flint Road over I-96 in Brighton

In 1994, the Glidden system used on S14 of 11015 was applied to the west half of the structure. These systems were inspected in August, 2001 and after seven years, is performing adequately, with only a few areas of pinpoint rust (see Figure 3). The Davis system was mistakenly changed from an epoxy zinc-rich primer and two coats of water-based acrylics, to a three-coat vinyl acrylic system and applied to the east half of the structure. VOCs for the primer and the topcoat were 1.6 lbs/gal and 1.5 lbs/gal for the intermediate coat. The modified system did not allow for thick enough film builds on the edges of the bottom flange to prevent pinpoint rusting, and it began failing after only two years. Figures 4, 5, and 6 show areas of pinpoint rust on the Davis system as of August 7, 2001. Figure 7 shows the performance difference between the two systems.

Figure 3- Glidden system showing small area of pinpoint rust on bottom flange - lower center of photograph.

Figure 4- Closeup of Davis system on the south fascia.

Figure 5- Incorrect Davis system pinpoint rust.

Figure 6- Closeup of pinpoint rust in Davis system on north fascia.

Figure 7- North fascia Davis left, Glidden right.

Structure Numbers S08, S12, S13 of 41025 over I-96 Leonard St, EB and WB M-21

Five different coating systems were applied to three structures over I-96 in Kent County in 1994. The five systems were three coat systems, which included a system by Porter (International) consisting of two coats of a water-based epoxy and a urethane top coat. The VOCs for both products was 1.0 lbs/gal. Carboline had two test systems. One consisted of three coats of water-based acrylics with VOCs of 1.3 lbs./gal. for the primer and 1.1 lbs./gal., for the top coats. The other system used was an organic zinc-rich primer (VOCs of 2.5 lbs/gal.) followed by two coats of water-based acrylic (VOC of 2.4 lbs/gal.). A system was supplied by Southern Coatings, consisting of a water-based zinc-rich primer (VOCs of 0.4 lbs/gal.), water-based epoxy (VOCs of 0.6 lbs/gal.) and a water-based acrylic (VOCs of 15 lbs/gal). The fifth system, from Tnemec, consisted of an organic zinc rich primer, a solvent-based epoxy, and solvent-based urethane. All five systems are performing as well as the standard QPL system used on the majority of the structures for the two-year and seven year inspection. However, the systems applied to this structure may not be representative, since the test areas were contaminated with zinc before the systems were applied; i.e., - The Contractor, after the initial blast cleaning, coated the test surfaces with the zinc-rich primer used on the rest of the contracted project, then sandblasted a second time to remove the newly applied zinc rich primer prior to Maintenance applying the test system's primer for each of the five test sections. A coating system applied over an area of structural steel that is double abrasive blasted and has zinc particles driven into the steel will likely perform better than steel surfaces blasted only once.

Conclusions

The Glidden system consisting of a three coat water-based vinyl system, performed better than the Davis system used on Structure Number S11 of 45065 (Flint Road over I-96 in Brighton). The Davis system, which used a zinc rich primer, performed better than the three coat water-based vinyl system of Glidden on S14 of 11015 (Livingston Road over I-94 in Berrien County). The EPA has since revised their proposed VOC requirements, currently allowing products with higher VOCs (3.8 pounds per gallon) than products on the Department's QPL (3.3 lbs/gal).

Recommendations

The Department should follow EPA requirements for volatile organic requirements and periodically evaluate low VOC products. An increase in the allowable VOCs to 3.8 lbs/gal for bridge paints is recommended.

Appendix A

OFFICE MEMORANDUM

DATE: April 15, 1994

TO: Jon W. Reincke
Engineer of Research

FROM: David C. Long
Supervisor
Chemical Technology Unit

SUBJECT: Interim Report - Research Project 94 G-303
Field Evaluation of Experimental Low VOC Bridge Paints

Since 1988, the Materials and Technology Division's Research Lab has tested almost 100 experimental water-based and low volatile organic compound (VOC) bridge paint systems, with the goal of finding an acceptable system with less than 3.5 lbs/gal VOC. The USEPA recently lowered the VOC requirement for industrial coatings to 2.9 lbs/gal effective, January 1, 1996, and is considering a further reduction to as low as 1.7 lbs/gal by 2003. Our current system can meet the 1996 level, but we have limited field experience with systems below 2.9 lbs/gal. Since it takes several years to develop and test a new system, the Research Laboratory initiated a field study to evaluate water-based products that performed well under accelerated lab conditions. As part of a 1994 project, the contractor will clean and coat five structures, leaving a nine foot section of the facia beam uncoated. MDOT maintenance forces will reblast the uncoated areas and apply a different experimental system on each of the structures. After two years, an inspection team will evaluate the performance of each system and recommend which systems should be tested further. This interim report describes the selection process and generic systems to be tested.

I reviewed laboratory results and product information for all experimental systems tested by MDOT's Coatings Group from 1988 through 1992. I used binder type, VOC and corrosion performance to select experimental systems for field testing. Although inorganic primers traditionally outperform all others in accelerated testing, they were not considered due to well known field application and delamination problems. Primer or intermediate coats containing more than 2.9 lbs/gal VOC were also eliminated from the pool of candidates. I divided the remaining products into categories based on solvent type and zinc content, and then sorted by corrosion performance (attached). Corrosion ratings at 5000 hours from the cyclic environmental test were used as the best predictor of field performance in Michigan's wet/dry, chloride-rich environment. The salt fog test is so severe, it may eliminate systems that could perform well in Michigan where there are some dry periods. Systems had to have at least a rating of 7.0 on the cyclic environmental test to be considered for further evaluation. Ultra-violet ratings were used to evaluate chalking resistance; humidity and salt fog results were used as confirmatory tests. Application ratings were not considered in detail, but on a pass/fail basis (i.e. can the product be applied). A visual inspection of laboratory test panels was the last step in selecting generic systems (i.e. urethane, epoxy, etc.) for testing (Table 1).

Table 1

Experimental Low VOC Bridge Paint Systems

Mixed (solvent/water) Zinc

Sys#	Company	Prod#	VOC	Binders	5000 Hr Ratings CE	UV	HU	SF
9204	CARBOLINE	858	2.5	S EPOXY	7.5	8.5	7.0	9.0
		3350	2.4	W ACRYLIC				
		3350	2.4	W ACRYLIC				

Solvent-based Zinc

Sys#	Company	Prod#	VOC	Binders	5000 Hr Ratings CE	UV	HU	SF
9040	TNEMEC	90-97	2.7	S URETHANE	10.0	9.0	10.0	8.5
		69	2.3	S EPOXY				
		74	2.4	S URETHANE				

Water-based Non-zinc

Sys#	Company	Prod#	VOC	Binders	5000 Hr Ratings CE	UV	HU	SF
9005	CARBOLINE	3358	1.3	W ACRYLIC	8.0	8.5	6.5	2.0
		3359	1.1	W ACRYLIC				
		3359	1.1	W ACRYLIC				
9224	PORTER	DG9300	1.0	W EPOXY	7.0	8.5	6.0	5.5
		DG9300	1.0	W EPOXY				
		3440	1.0	W ACRYLIC				

Water-based Zinc

Sys#	Company	Prod#	VOC	Binders	5000 Hr Ratings CE	UV	HU	SF
9141	SOUTHERN COATINGS	606ZN	0.4	W EPOXY	7.5	7.5	8.0	7.5
		246	0.6	W EPOXY				
		248	1.5	W ACR-EPOXY				

CE= Cyclic Environmental UV= Ultraviolet HU= Humidity SF= Salt Fog

Mixed Solvent/Water Zinc: Systems in this category have epoxy primers and offer the potential of combining the corrosion protection of zinc and the ease of handling of water-based products. Carboline's system 9204 has a solvent primer with water-based acrylic intermediate and top coats, and was chosen due to its superior performance on the salt fog test.

Solvent-Based Zinc: Products in this category have relatively high VOC levels and are identical to our current system, except all primers are urethane instead of epoxy. As the only urethane system, regardless of solvent, which met performance requirements, Tnemec's 9040 was chosen to see how this binder compares to our current epoxy system.

Water-Based Non-Zinc: These barrier type systems have the most environmental advantages of any system tested and actually outperformed many sacrificial zinc binders. The technology for mixing zinc into water-based primers is still being perfected and may yield better performing systems as improvements are made in the future. Primer types in this category are vinyl, acrylic and epoxy. Glidden's three coat vinyl system (9019) is already being field tested (applied in 1992 by Maintenance); therefore, it is not included in this study. Porter's epoxy system 9224 and Carboline's acrylic system 9005 were selected as the best candidates in this category. Carboline's system was selected to see how well a system performs in the field that had good cyclic environmental ratings (8.0), and poor salt fog ratings (2.0). Porter had two similar systems, with 9224 having the best appearing test panels. PPG's system was not chosen because the scribe did not penetrate to bare metal, which voided the results.

Water-Based Zinc: All systems in this category have epoxy primers with acrylic intermediate and top coats. Inspection of the test panels showed Southern Coatings system 9141 had the best corrosion resistance, but had poor chalking due to the acrylic-epoxy top coat. Southern Coatings will provide an acrylic top coat for the field test to improve chalk resistance. Sherwin-Williams, the only other possible supplier, performed well one out of four years.

Systems selected from the above categories represent solvent and primer combinations that meet our selection criteria. Additional field and laboratory testing will concentrate on generic systems that perform well on this initial test. Once a generic system has been approved based on field testing, a Qualified Products List will be developed from the annual laboratory test program.

MATERIALS & TECHNOLOGY DIVISION

DC Long

DCL:kat

Attachment

cc: R. E. Nordlund
E. M. Phifer
K. F. Whelton

1988-1992
EXP Bridge Paint Results

Mixed (solvent/water) Zinc

Sys#	Company	Prod#	VOC	Binders	Perf	5000 Hr Ratings CE	UV	HU	SF
9217	KEELER & LONG	7600	2.1	S EPOXY	7.8	8.0	8.5	9.0	6.5
		9400H2O	2.2	W ACR-LATEX					
		WSERIES	2.8	W ACR-LATEX					
9207	DEVOE	303H	2.7	S EPOXY	7.6	8.0	9.0	4.0	6.5
		600	0.4	W ACRYLIC					
		604	1.8	W ACRYLIC					
9201	AMERON	68HS	2.6	S EPOXY	7.6	8.0	9.0	6.0	6.8
		220WB	1.5	W ACRYLIC					
		220WB	1.5	W ACRYLIC					
9210	DUPONT	825ZF	2.9	S EPOXY	6.3	8.0	8.5	4.5	6.0
		76P	1.8	W EPOXY-ACR					
		72P	1.9	W ACRYLIC					
9140	SOUTHERN COATINGS	606ZN	0.4	W EPOXY	8.1	7.5	8.0	8.0	7.5
		246	0.6	W EPOXY					
		214	3.4	S URETHANE					
9204	CARBOLINE	858	2.5	S EPOXY	8.4	7.5	8.5	7.0	9.0
		3350	2.4	W ACRYLIC					
		3350	2.4	W ACRYLIC					

CE= Cyclic Environmental UV= Ultra Violet HU= Humidity SF= Salt Fog

Solvent-based Zinc

Sys#	Company	Prod#	VOC	Binders	Perf	5000 Hr Ratings CE	UV	HU	SF
9040	TNEMEC	90-97	2.7	S URETHANE	9.5	10.0	9.0	10.0	8.5
		69	2.3	S EPOXY					
		74	2.4	S URETHANE					
9006	CARBOLINE	858	2.5	S EPOXY	9.6	9.5	9.0	10.0	9.0
		890	1.8	S EPOXY					
8945	TNEMEC	90-97	2.7	S URETHANE	9.4	9.0	10.0	9.0	8.5
		66	3.1	S EPOXY					
		73	3.1	S URETHANE					
8802	AMERON	68HS	2.6	S EPOXY	8.3	8.5	8.0	9.0	6.0
		SHIELD	2.5	S URETHANE					
8946	TNEMEC	90-97	2.7	S URETHANE	9.0	8.5	9.5	9.0	7.5
		74	2.4	S URETHANE					
8947	TNEMEC	90-97	2.7	S URETHANE	9.5	8.5	9.5	10.0	9.0
		104	1.3	S EPOXY					
		74	2.4	S URETHANE					
9039	TNEMEC	90-97	2.7	S URETHANE	8.2	8.5	9.0	10.0	6.0
		74	2.4	S URETHANE					
9218	KEELER & LONG	9700	2.5	S URETHANE	8.3	8.0	8.5	5.0	9.0
		1800	0.7	S EPOXY					
		Y6792	3.5	S ACR-URE					
8837	TNEMEC	90-97	2.7	S URETHANE	7.9	7.0	8.0	8.0	5.0
		74	2.4	S URETHANE					

CE= Cyclic Environmental UV= Ultra Violet HU= Humidity SF= Salt Fog

Water-based Non-zinc

Sys#	Company	Prod#	VOC	Binders	Perf	5000 Hr Ratings CE	UV	HU	SF
8936	PPG	WBPRI	0.6	W EPOXY	9.1	9.0	8.0	8.5	9.5
		WBINT	0.6	W EPOXY					
		WBFIN	0.9	W EPOXY					
9019	GLIDDEN	5571	0.4	W VINYL	8.6	8.0	8.0	8.0	8.0
		5572	0.4	W VINYL					
		5573	0.7	W VINYL					
8925	GLIDDEN	5571	0.4	W VINYL	7.9	8.0	8.5	7.0	7.0
		5572	0.4	W VINYL					
		5573	0.7	W VINYL					
9005	CARBOLINE	3358	1.3	W ACRYLIC	7.0	8.0	8.5	6.5	2.0
		3359	1.1	W ACRYLIC					
		3359	1.1	W ACRYLIC					
8921	FLOTECH	PPWB	1.2	W ACRYLIC	7.3	8.0	8.5	4.0	6.0
		ISOCLD	0.7	W RUBBER					
		ISOCLD	0.7	W RUBBER					
8817	GLIDDEN	5571	0.4	W VINYL	7.8	8.0	6.5	7.0	6.5
		5572	0.4	W VINYL					
		5573	0.7	W VINYL					
9121	GLIDDEN	5571	0.4	W VINYL	7.6	8.0	8.0	5.0	7.0
		5572	0.4	W VINYL					
		5573	0.7	W VINYL					
8934	PORTER	DG9300	1.0	W EPOXY	6.7	7.5	8.5	7.0	3.0
		DG9361	0.9	W EPOXY					
		3410	1.0	W ACRYLIC					
8902	AMERON	148WB	1.9	W ACRYLIC	7.7	7.0	8.0	7.0	6.0
		148WB	1.9	W ACRYLIC					
		335	2.1	W EPOXY					
8926	GLIDDEN	6970	1.4	W ACRYLIC	5.6	7.0	8.5	6.0	1.0
		6925	2.1	W ACRYLIC					
		6900	2.1	W ACRYLIC					
8815	GLIDDEN	6970	1.4	W ACRYLIC	6.0	7.0	7.5	7.0	1.0
		6925	2.1	W ACRYLIC					
		6900	2.1	W ACRYLIC					
9102	AMERON	148WB	1.9	W ACRYLIC	5.9	7.0	9.0	6.0	2.0
		220WB	1.5	W ACRYLIC					
		220WB	1.5	W ACRYLIC					

CE= Cyclic Environmental UV= Ultra Violet HU= Humidity SF= Salt Fog

9224	PORTER	DG9300	1.0	W	EPOXY	7.3	7.0	8.5	6.0	5.5
		DG9300	1.0	W	EPOXY					
		3440	1.0	W	ACRYLIC					
9020	GLIDDEN	6970	1.4	W	ACRYLIC	6.0	6.5	9.0	8.0	1.0
		6925	2.1	W	ACRYLIC					
		6900	2.1	W	ACRYLIC					
9214	GLIDDEN	6970	1.4	W	ACRYLIC	5.7	6.5	8.5	6.0	4.0
		5440	1.5	W	ACRYLIC					
		5440	1.5	W	ACRYLIC					
9221	PLAS-CHEM	8154	0.5	W	ACRYLIC	5.4	6.0	7.0	6.0	3.0
		8140W	1.0	W	ACRYLIC					
		8140B	1.0	W	ACRYLIC					
9122	GLIDDEN	6970	1.4	W	ACRYLIC	6.1	6.0	8.5	6.0	5.0
		6925	2.1	W	ACRYLIC					
		6900	2.1	W	ACRYLIC					

CE= Cyclic Environmental UV= Ultra Violet HU= Humidity SF= Salt Fog

Water-based Zinc

Sys#	Company	Prod#	VOC	Binders	Perf	5000 Hr Ratings CE	UV	HU	SF
9033	SHERWIN WILLIAMS	ZNCLA8	0.7	W EPOXY	7.3	8.0	9.0	9.5	2.0
		DTM	1.9	W ACRYLIC					
		DTM	1.9	W ACRYLIC					
9141	SOUTHERN COATINGS	606ZN	0.4	W EPOXY	7.9	7.5	7.5	8.0	7.5
		246	0.6	W EPOXY					
		248	1.5	W ACR-EPOXY					
8942	SHERWIN WILLIAMS	ZNCLA8	0.7	W EPOXY	8.0	7.0	8.5	7.0	7.0
		WBEP	1.4	W EPOXY					
		DTM	1.9	W ACRYLIC					
8941	SHERWIN WILLIAMS	ZNCLA8	0.7	W EPOXY	7.7	6.0	9.0	7.5	6.0
		DTM	1.9	W ACRYLIC					
		DTM	1.9	W ACRYLIC					
9136	SHERWIN WILLIAMS	ZNCLA8	0.7	W EPOXY	6.2	6.0	6.0	4.5	5.0
		DTM	1.9	W ACRYLIC					
		DTM	1.9	W ACRYLIC					

CE= Cyclic Environmental UV= Ultra Violet HU= Humidity SF= Salt Fog

Appendix B

OFFICE MEMORANDUM

DATE: August 7, 1995

TO: Jon W. Reincke
Engineer of Research

FROM: Eileen M. Phifer
Coatings Engineer
Chemical Technology Unit

SUBJECT: Summary of G-303 Interim Report No. 2

Attached is a report, which documents and describes the information gathered for a portion of the subject research project. It is limited to the field evaluation of the work completed on the District 7 Livingston Road over I-94 project.

MATERIALS & TECHNOLOGY DIVISION

EMP:nc
Attachments
cc R. E. Nordlund
D. C. Long

Interim Report No. 2 for G-303
FIELD EVALUATION OF LOW VOC BRIDGE PAINTS
LIVINGSTON ROAD OVER I-94 IN DISTRICT 7

This interim report describing the Livingston Road project includes a summary of the application of the experimental systems, the two-year inspection results, and conclusions from that work. This portion of the research is only the first step in developing a different type of coating system for low VOC material. Future projects will include small-scale work with new systems followed by larger field trials of those systems. Other work already started include the larger field trial of the paint systems used on the Livingston Road project and the small-scale field trial on five experimental coating systems. District Maintenance personnel will complete the small-scale work, and the Construction Division will supervise the large-scale field projects. The Materials & Technology Division (M&T) will supervise all technical work and selection of material for both types of work.

Background

For this project, district maintenance personnel completed the cleaning and coating portion of the work after the bridge was hit by a high load. M&T specified materials and preparation methods for this location and plan future inspections at 5 and 10-year intervals to review the long-term field performance of these low VOC systems. Informal inspections between the fifth and tenth years will be used to monitor the performance of the coating systems.

For the Livingston Road project, M&T chose material to reduce the amount of volatile solvents emitted into the environment as well as limiting hazardous metals in the coating materials. We looked at materials which had benefits of using water-based coatings for total system VOC levels and thinning and clean-up with water instead of a more hazardous solvent (reference: G-230 report--Evaluation of Experimental Low Volatile Organic and Non-Zinc Paint Systems and G-303 Interim Report No. 1) and accelerated laboratory results that indicated acceptable performance.

Application

In October 1992, the District 7 paint crew applied two experimental systems, the Davis system, a zinc-rich epoxy primer with water-based acrylic intermediate coat and top coat, and the Glidden system, a non-zinc water-based vinyl for each of three coats, (see attachment A) to S14 of 11015 (Livingston Road over I-94) in Berrien County. The crew applied the Glidden vinyl system to the north and south facia beams of the driving lane, the Davis mixed solvent/water-based system to the north and south facia beams of the middle lane, and the control system, a zinc-rich epoxy primer with an epoxy intermediate coat and an urethane top coat, to the remaining portions of the facia beams.

The primer went on very smoothly and evenly in a consistent pattern as well as providing a build that was thick enough after one coat, which dried to a red tint quite quickly. The Glidden company lists the re-coat time at four hours. The clean up with water went quickly and was not expensive. The crew applied the intermediate coat after verifying the primer's dry film thickness (DFT) was within the specified amount. For all DFT readings the crew used a magnetic thickness gage. The second coat was thinned slightly with water to improve flow and went on very smoothly and with a consistent, even flow. This coat dried very quickly, and the crew applied an additional coat to ensure the proper total DFT which was verified and within acceptable range. In addition, the clean up was the same as the primer. The top coat was applied, but the application was slightly more time consuming and the clean up required more water than the first two coats. Overall, Maintenance personnel felt that this system was easier to apply and clean up than the control system.

The three-component, solvent-based Davis primer was somewhat difficult to mix as compared to the one-component Glidden primer, but similar to the control primer. The primer application was uneven and had a tacky consistency after being sprayed. The spray pattern was uneven and gave an irregular coverage, which resulted in a less consistent DFT. The crew felt that the clean up was more time consuming and needed a considerable amount of solvent, but they felt it was comparable to our control system for clean up. The water-borne intermediate was applied after DFT readings were documented and met the specified amount for the primer. The crew carefully monitored the spray pattern to uniformly apply the second coat, but it dried quickly and seemed to take more clean-up time with water than the Glidden system. The top coat was applied after total DFT readings were verified and recorded to meet the specified amount for the intermediate coat. The crew felt that the top coat went on evenly and with good coverage, but they had some equipment problems with the spray gun's needle which seemed to be related to paint adhering to the tip since it was drying so quickly. The clean up was the same as the intermediate coat. Overall, this system applied and cleaned up only slightly better than our control system and not as well as the Glidden system.

<u>The Two-Year Inspection</u>

The inspection revealed that the Glidden system faded on the south outside facia beam and had some limited pinpoint rust as well as rust staining from tack welds on the inside portion of the beam as described in the field inspection report and photographs (see attachment B and C). This staining occurred on all areas of the bridge including the Davis and the control portions. Inspectors saw a flat appearance on the north outside facia but no chalking was evident. The inner beams were spot painted with this system as well, but were not part of the original evaluation and will not be discussed in this report. They are mentioned in the field inspection report. Inspectors did not see any performance problems with the Davis system, but, again, it showed staining from the tack weld as did the rest of the structure. The topcoat was not fading, but has a flat appearance as compared to the polyurethane used in our current system.

Interim Report No. 2 for G-303
FIELD EVALUATION OF LOW VOC BRIDGE PAINTS
LIVINGSTON ROAD OVER I-94 IN DISTRICT 7

Conclusion

Since the performance of both systems was adequate, M&T dècided to proceed to the next step which is to use these two coating systems on a larger field project through the Construction Division to gain information on how the system performs under production conditions and contractor's needs. The contractor planned to applied these two systems to Flint Road over I-96 in Livingston County in August and September of 1994, and will be reported separately.

August 1995

ATTACHMENT A

The Glidden System–

Y-5571 Rustmaster Pro primer (red) Non-zinc, Water-based vinyl — Rec. DFT 4.5 mil
Y-5572 Rustmaster Pro intermediate (gray) Water-based vinyl — Rec. DFT 4.5 mil
Y-5573 Rustmaster Pro finish (blue) Water-based vinyl — Rec. DFT 3.0 mil

DATE 1992	COATING	VOC's (#/gal)	DFT (mils)	AIR TEMP.	WET BULB	REL. HUMIDITY	DEW PT.	BEAM TEMP.
10/6	Y-5571	0.4	3-5	57F	50F	60%	43F	43-58F
10/12	Y-5572	0.4	5-7	N/A	N/A	56%	N/A	50F
10/13	Y-5573	0.7	7-11	56F	43F	34%	37F	51F

The Davis System–

P-281 Epoxy zinc rich primer solvent-based — Rec. DFT 4 mil
LS-5434 Water-Based White acrylic intermediate — Rec. DFT 2 mil
LS-5435 Water-Based Blue acrylic topcoat — Rec. DFT 2 mil

DATE 1992	COATING	VOC's (#/gal)	DFT (mils)	AIR TEMP.	WET BULB	REL. HUMIDITY	DEW PT.	BEAM TEMP.
10/7	P-281	3.2	3-5	69F	59F	55%	52F	65F
10/12	LS-5434	1.8	5-7	N/A	N/A	56%	N/A	50F
10/13	LS-5435	1.3	7-11	56F	43F	34%	37F	51F

The Control System–

Carboline 658 zinc-rich solvent-based epoxy primer — Rec. DFT 4 mil
Carboline 190HB solvent-based epoxy intermediate — Rec. DFT 3.5 mil
Porter 4600 Series solvent-based urethane topcoat — Rec. DFT 1.0 mil

DATE 1992	COATING	VOC's (#/gal)	DFT (mils)	AIR TEMP.	WET BULB	REL. HUMIDITY	DEW PT.	BEAM TEMP.
10/7	658	3.5	3-5	69F	59F	55%	52F	65F
10/12	190HB	2.7	5-7	N/A	N/A	56%	N/A	50F
10/13	4600	4.0	7-11	56F	43F	34%	37F	51F

ATTACHMENT B

FIELD INSPECTION REPORT

PROJECT #: 11052

STRUCTURE #: S14

DATE INSPECTED: 7 /6 /94

LOCATION: Livingston Rd Over I-94

INSPECTORS: Beck/Phifer

PROJECT ENGINEER OR REPRESENTATIVE: Sharon Dekker (Maint. - District 7)

SUPPLIER OF COATING SYSTEM: Davis (P-281, LS5434, LS5435) & Glidden (5571, 5572, & 5573)

PURPOSE: Two year evaluation of experimental low VOC materials (applied by Maintenance).

FAILURE TYPES:	DAVIS NO	DAVIS YES	GLIDDEN NO	GLIDDEN YES	LOCATION
FADING	X			X	Glidden - Southside facia.
PEELING	X		X		
BLISTERING	X		X		
RUNS AND SAGS	X		X		
PINPOINT RUST	X			X	Glidden - Inside south facia and on inner beams.
DAMAGED COATING	X		X		
PAINT OVER DEBRIS	X		X		
DEFICIENT PRIMER	X			X	*Glidden -On some inside spots only.
DEFICIENT TOPCOAT	X			X	*Glidden -On some inside spots only.

EVALUATION: *The deficient primer and topcoat were on the inside beams only. the crew was running out of time because of weather problems and therefore some areas were not finished. Also, they only did spot repair on inside beams.
Glidden: Rust stains from skip welds, as well as pinpoint rust on inside south facia at the top flange (east of diaphragm) and on spot repairs of inner beams. Slight chalking on south facia and "flat" gloss appearance on both facias.
Davis: Rust stains from skip welds (also note that the control section had the same rust staining from other skip welds). The topcoat is not chalking, but has a "flat" appearance.

FOLLOW UP NEEDED: Continue to inspect every two years.

FINAL COMMENTS: These two systems are now being applied to Flint Road over I-96 in Livingston County (each on one-half of the bridge) by Atsalis Brothers.

SIGNATURE: Bryon D. Beck

DATE: 7 / 26 / 94

cc: J. W. Reincke (94 G-303)
R. E. Nordlund
E. M. Phifer

ATTACHMENT C

Photo 1. Livingston Rd. over I-94 (S14 of 11052)
North side: Three systems on facia beam.

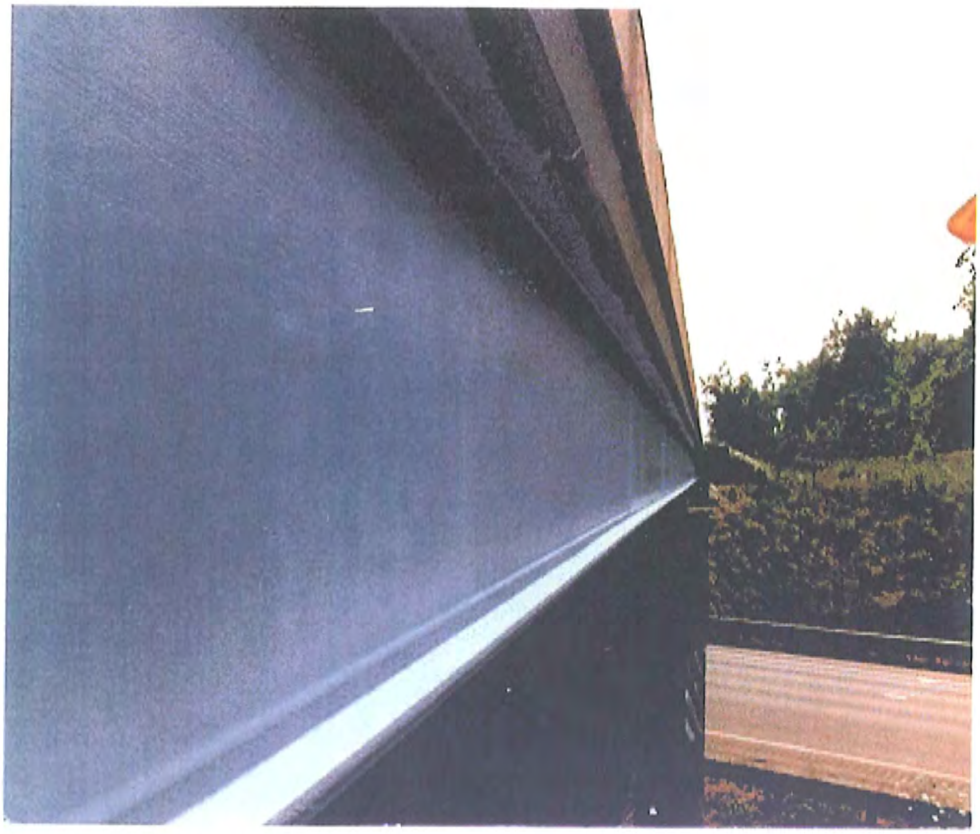

Photo 2. Livingston Rd. over I-94 (S14 of 11052)
South side: Three systems on fiacia beam.

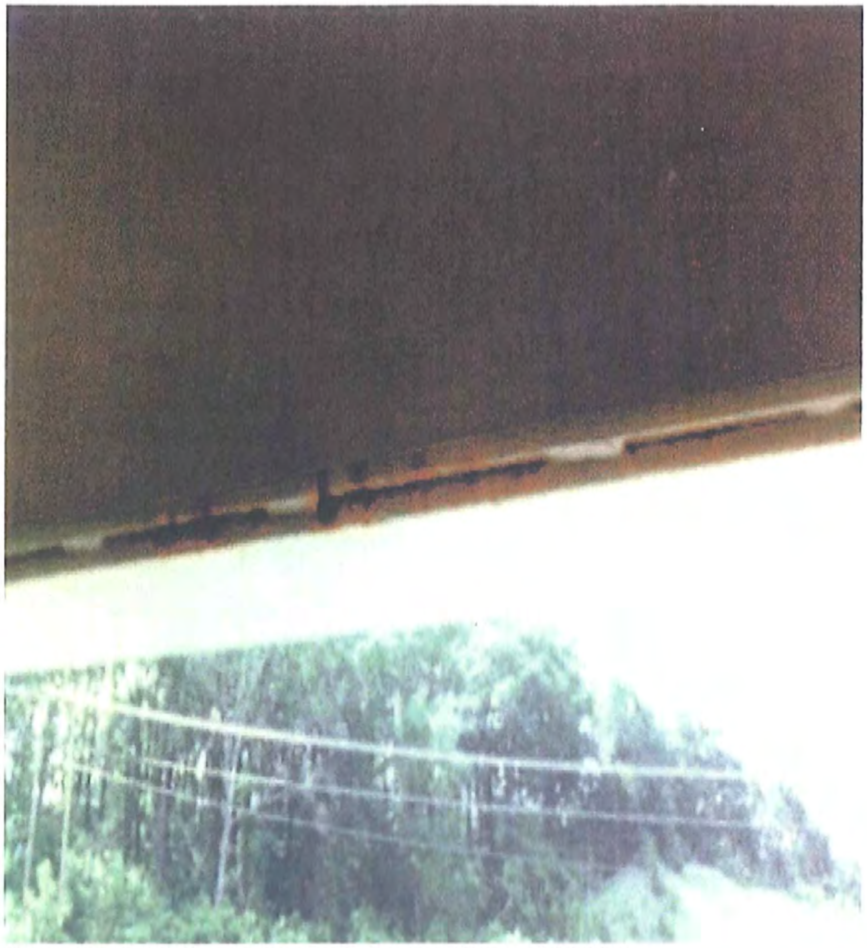

Photo 3. Livingston Rd. over I-94 (S14 of 11052)
Typical cover plate staining.