

VERMONT AGENCY OF TRANSPORTATION

**Materials & Research Section
Research Report**



EPOPLEX GLOMARC 90 POLYUREA PAVEMENT MARKING

Initial Report 2014 – 06

June 2014

Epoplex Glomarc 90 Polyurea Pavement Marking

Initial Report 2014 – 06

June 2014

Reporting on Work Plan 2009-R-03

STATE OF VERMONT
AGENCY OF TRANSPORTATION

RESEARCH & DEVELOPMENT SECTION

BRIAN R. SEARLES, SECRETARY OF TRANSPORTATION
CHRIS COLE, DIRECTOR OF POLICY, PLANNING AND INTERMODAL DEVELOPMENT
JOE SEGALE, P.E./PTP, PLANNING, POLICY & RESEARCH
WILLIAM E. AHEARN, P.E., RESEARCH & DEVELOPMENT

Prepared By:

Devon Sanborn, Research Technician

Reviewed By:



William E. Ahearn, P.E.,

Research & Development Engineer

Date: June 18, 2014

The information contained in this report was compiled for the use of the Vermont Agency of Transportation (VTrans). Conclusions and recommendations contained herein are based upon the research data obtained and the expertise of the researchers, and are not necessarily to be construed as Agency policy. This report does not constitute a standard, specification, or regulation. VTrans assumes no liability for its contents or the use thereof.

Technical Report Documentation Page

1. Report No. 2014-06		2. Government Accession No. - - -		3. Recipient's Catalog No. - - -	
4. Title and Subtitle Epoplex Glomarc 90 Polyurea Pavement Marking				5. Report Date JUNE 2014	
				6. Performing Organization Code	
7. Author(s) Devon Sanborn				8. Performing Organization Report No. 2014-06	
9. Performing Organization Name and Address Vermont Agency of Transportation Research and Development Section 1 National Life Drive National Life Building Montpelier, VT 05633-5001				10. Work Unit No.	
				11. Contract or Grant No. 2009-R-03	
12. Sponsoring Agency Name and Address Federal Highway Administration Division Office Federal Building Montpelier, VT 05602				13. Type of Report and Period Covered Initial Report 2010	
				14. Sponsoring Agency Code	
15. Supplementary Notes					
16. Abstract <p>Pavement markings provide an important means of communication for all roadway users and must be capable of conveying information during inclement weather and evening hours when there may be little to no contribution from overhead lighting. Recently the Agency has been applying recessed polyurea markings on most interstate rehabilitation projects. Recessing has proven effective in extending the service life of pavement markings by protecting them from wear induced by tire abrasion and shearing effects generated by snow plows. This research was conducted to evaluate the application of an experimental pavement marking, known as Epoplex Glomarc 90 Polyurea, with respect to long line application.</p> <p>The Epoplex Glomarc 90 Polyurea was applied on the Derby IM 091-3(46) project, located along I-91 northbound and southbound between mile marker (MM) 169.8 and 177.4. Five test sites were established in the southbound lanes of the project, all of which were experimental. Following the placement of the markings, retroreflectivity and wear readings were collected using uniform methods. Retroreflectivity readings were taken on each line (white edge, white skip, yellow edge) within the southbound test site limits using the LTL 2000 Retroreflectometer. Each test site is 40 feet in length, with readings sampled every 10 linear feet. White skip lines that coincide transversely with any sample point were also tested.</p> <p>All markings were found to be in compliance with FHWA recommended minimum Retroreflective values, and above the Agency's required initial retroreflective values of 500 mcd/lx/m² for white, and 400 mcd/lx/m² for yellow. The most notable observation during the site visit was that on average, the yellow markings were presenting higher retroreflective values than the white lines. Research personnel will continue to monitor and collect additional information concerning the overall durability and retroreflectivity of all test sites in accordance with the work plan.</p>					
17. Key Words Key Words			18. Distribution Statement No Restrictions.		
19. Security Classif. (of this report) - - -		20. Security Classif. (of this page) - - -		21. No. Pages 17	22. Price - - -

TABLE OF CONTENTS

Abstract 1

Introduction..... 2

Project Location Summary 2

Material Description 4

Performance and Observations 4

Cost Analysis 8

Summary and Recommendations 9

References..... 9

ABSTRACT

Pavement markings provide an important means of communication for all roadway users and must be capable of conveying information during inclement weather and evening hours when there may be little to no contribution from overhead lighting. Recently the Agency has been applying recessed polyurea markings on most interstate rehabilitation projects. Recessing has proven effective in extending the service life of pavement markings by protecting them from wear induced by tire abrasion and shearing effects generated by snow plows. This research was conducted to evaluate the application of an experimental pavement marking, known as Epoplex Glomarc 90 Polyurea, with respect to long line application.

The Epoplex Glomarc 90 Polyurea was applied on the Derby IM 091-3(46) project, located along I-91 northbound and southbound between mile marker (MM) 169.8 and 177.4. Five test sites were established in the southbound lanes of the project, all of which were experimental. Following the placement of the markings, retroreflectivity and wear readings were collected using uniform methods. Retroreflectivity readings were taken on each line (white edge, white skip, yellow edge) within the southbound test site limits using the LTL 2000 Retroreflectometer. Each test site is 40 feet in length, with readings sampled every 10 linear feet. White skip lines that coincide transversely with any sample point were also tested.

All markings were found to be in compliance with FHWA recommended minimum Retroreflective values, and above the Agency's required initial retroreflective values of 500 mcdl/lx/m² for white, and 400 mcdl/lx/m² for yellow. The most notable observation during the site visit was that on average, the yellow markings were presenting higher retroreflective values than the white lines. Research personnel will continue to monitor and collect additional information concerning the overall durability and retroreflectivity of all test sites in accordance with the work plan.

INTRODUCTION

Pavement markings provide an important means of communication for all roadway users and must be capable of conveying information during inclement weather and evening hours when there may be little to no contribution from overhead lighting. However, traffic markings are often subject to abrasion from vehicle tires and winter maintenance practices as well as ultraviolet sunlight and fading pigments following application. These deterioration mechanisms result in a loss of binder and reflective elements. Durable markings are often applied to newly constructed pavements in the state of Vermont and restriped with waterborne paint when markings no longer adequately delineate the roadway. In accordance with “2006 Standard Specification for Construction”, “durable pavement markings are classified as pavement marking tape, epoxy paint, thermoplastic markings, polyurea paint, and methyl-methacrylate.” Each of the referenced markings, comprised of various elements, has displayed unique characteristics and varying life cycles.

Recently the Agency has been applying recessed polyurea markings on most interstate rehabilitation projects. The process of recessing includes the removal of a small portion of the surface of the wearing course prior to the application of permanent markings. Recessing has proven effective in extending the service life of pavement markings by protecting them from wear induced by tire abrasion and shearing effects generated by snow plows.

The following report outlines the final observations concerning the application of an experimental pavement marking, known as Epoplex Glomarc 90 Polyurea, with respect to long line application. In addition, the report contains information pertaining to field data collection to assess the luminance, durability, and the ability to uphold the retroreflectivity requirements over time.

PROJECT LOCATION SUMMARY

The Epoplex Glomarc 90 Polyurea was applied on the Derby project, IM 091-3(46), located along I-91 northbound and southbound between mile marker (MM) 169.8 and 177.4 by L&D Safety Markings Corporation (See Figure 1). According to the project plans, work to be performed includes cold planing and resurfacing of the northbound and southbound travel and passing lanes, interchange 27, 28, and 29 ramps, maintenance u-turns, and the welcome center with a leveling course, wearing course, milled rumble strips, new pavement markings, guardrail improvements, signs, and other incidental items. The average annual daily traffic (AADT) ranges from 5,000 at the start of the project to 2,100 at the end of the project. These are considered moderate to low AADTs for Vermont.

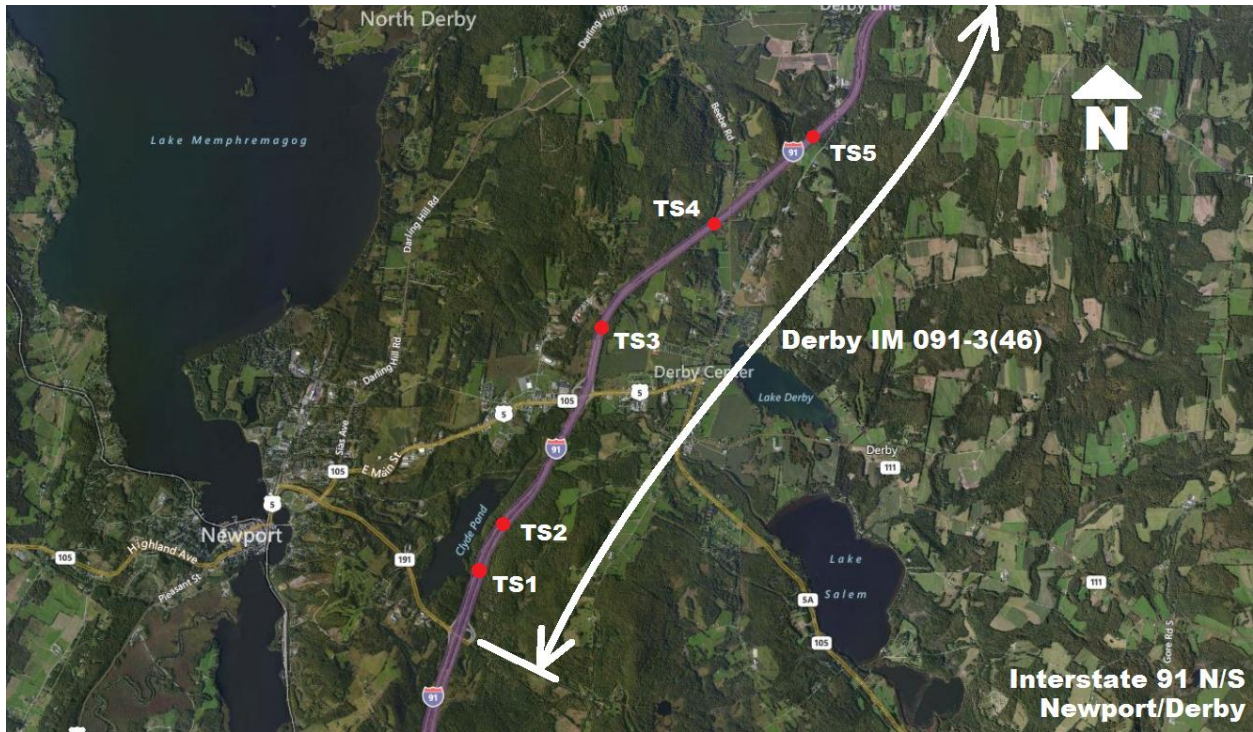


Figure 1 Project Location - I91 in Derby

Five test sites were established, all of which were experimental. All test site locations are summarized in Table 1 and shown in Figure 1. Each test site is 40 feet in length, with readings sampled every 10 linear feet for a total of five readings per line. White skip lines that coincide transversely with any sample point are also tested. A typical test site should have five white edge line readings, 5 yellow edge line readings, and between one and four white skip line readings.

Table 1: Test Site Location Summary

Test Site	Mile Marker (MM)
TS 1	MM 170.8
TS 2	MM 171.3
TS 3	MM 172.95
TS 4	MM 174.3
TS 5	MM 175.45

MATERIAL DESCRIPTION

According to the manufacturer, Epoplex of Maple Shade, NJ, Epoplex Glomarc 90 is a highly reflective pavement marking system designed for use on concrete or bituminous concrete roadways and highways as a long-lasting striping material for both edging and centerline markings, as well as all intersection markings. The product consists of a two-component polyurea based durable highway marking system that provides superior reflectivity during both day and night under both dry and wet weather conditions. The first component is Epoplex LS90 polyurea binder, which is formulated to provide a simple volumetric mixing ratio of two volumes of Component A (amine) to one volume of Component B (isocyanate). The second component of the marking system is the VISIMAX™ Bead System, which is designed to achieve superior wet night reflective characteristics. According to the manufacturer, VISIMAX™ is a VISIBEAD core with High-Index beads on the coated exterior shell.

In accordance with the manufacturer's specifications, Glomarc 90 should be applied only when atmospheric and surface temperatures are 32°F or higher using mobile, truck mounted and self-contained equipment. The equipment shall be capable of spraying both white and yellow polyurea through an airless static tube or impingement mixing guns to accommodate a volumetric ratio of two to one to satisfy manufacturer recommendations. The applicator must be of sufficient size and stability with adequate hydraulic and air power supplies to produce uniform line dimensions and have a high-pressure air blast cleaning system capable of cleaning the pavement surface immediately prior to applying the markings.

The Vermont General Special Provisions require that polyurea pavement markings be recessed whenever applied to provide longevity of the marking. This specification requires that polyurea be applied to create a uniform wet film thickness of 22 mils (+/- 2mils). The recessing specification for polyurea markings requires that the recess be 60 mils (+/- 2 mils) in depth. For all recessed markings, the markings must not be applied for a minimum of 24 hours after the recess is completed.

PERFORMANCE AND OBSERVATIONS

Table 2 provides a timeline summary of recessing and the application of all marking types. A site visit was conducted on September 1, 2010 during the application of the white and yellow lines in the northbound lanes. Figure 2, Figure 3, and Figure 4 demonstrate the application process.



Figure 2: Spray Application of Northbound Yellow Line Delineation



Figure 3: Close-Up View of Glomarc 90 Spray-Applied with VISIBEAD™



Figure 4: Overview of Glomarc 90 Northbound Yellow Line

Table 2: Application Timeline

White Edge	White Skip	Yellow Edge
Recess		
7/22/10 and 8/25/10 to 8/27/10		
Marking		
8/30/10 - 9/1/10	8/30/10 - 9/1/10	9/1/10 - 9/2/10

Retroreflectivity readings were taken on each line (white edge, white skip, yellow edge) within the southbound test site limits with the LTL 2000 Retroreflectometer. The retroreflective results of all markings are displayed in Table 3.

Table 3: Average Retroreflectivity Readings

Test Site	Date	Yellow Edgeline	White Skip Line	White Edgeline
TS 1	9/2/2010	730.6	545.5	821.8
TS 2	9/2/2010	749.6	591	741.6
TS 3	9/2/2010	772.8	584	670.4
TS 4	9/2/2010	660.4	559.5	707.8
TS 5	9/2/2010	717.8	564	706.8
Average		726.24	568.80	729.68

Included in Figure 5 are the average retroreflective values for each line per test site. There is also a project average included for each line. Each test site has very similar values to the project average, which indicates a uniform application throughout the project.

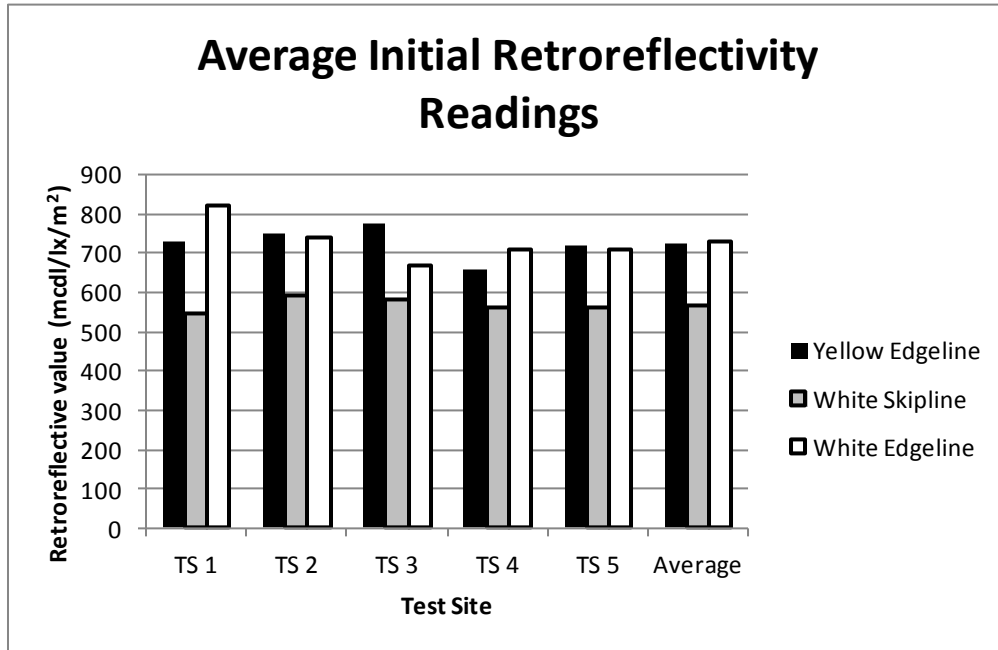


Figure 5: Average Initial Retroreflectivity Readings

During the site visit, it was noted that the yellow markings were, on average, registering higher retroreflective values than the white. This is not typical with line striping. White markings typically provide higher retroreflective values due to the nature of pigments in white paint as compared to yellow. Figure 6 illustrates the average retroreflective values per line of the entire project, as well as line type averages from other polyurea paint application research projects. Figure 6 demonstrates the atypical higher yellow reflectivity values as compared with other typical applications. This figure also helps exhibit the difference between the yellow and white lines within the project itself.

All markings were noted as well above the FHWA recommended minimum Retroreflective values but also above the required initial retroreflective values of 500 mcdl/lx/m² for white and 400 mcdl/lx/m² for yellow as specified in the contract. All markings were noted to be in excellent condition at the time of the site visit. Typical images of each marking are displayed in Figure 7, Figure 8, and Figure 9.

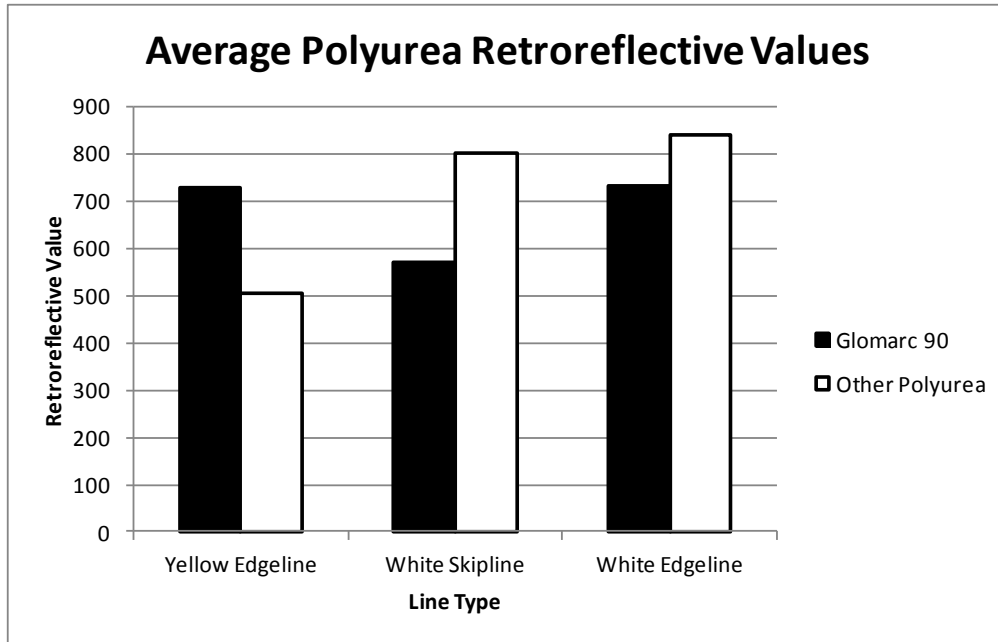


Figure 6: Average Polyurea Retroreflective Value Comparison



Figure 7: Test Site 5, Yellow Edge Line



Figure 8: Test Site 5, White Skip Line



Figure 9: Test Site 5, White Edge Line

All test sites were rated using ASTM D 913-03: Standard Test Method for Evaluating Degree of Resistance to Wear of Traffic Paint. There are four photographic references within the standard representing the percentage of the marking left intact. The four are represented by intact percentages of 97%, 92%, 77%, and 60%. At the time of placement, all markings averaged a

rating of 97% intact. A value of 97% suggests the marking is fully intact. The appearance ratings for test sites one through five is shown in Table 4.

Table 4: Average Appearance Ratings

Date	Yellow Edge	White Skip	White Edge
9/2/2010	97	97	97

According to historical data found on Weather Underground (www.wunderground.com), all markings were applied within required temperature and climate recommendations. Table 5 summarizes average climate conditions over the four application days.

Table 5: Average Climate Conditions

Date	Temperature (°F)	Dew Point (°F)	Precipitation (in.)
8/30/2010	72	53	0.00
8/31/2010	76	62	0.00
9/1/2010	78	61	0.00
9/2/2010	78	60	0.00

COST ANALYSIS

The reported cost of Epoplex Glomarc 90 polyurea binder is \$65 per gallon. One gallon at 22 mils thick and 6 inch wide would extend 145.83 linear feet. The VISIMAX™ beads are \$6.00 per pound. The Type I beads are \$0.31 per pound. According to the manufacturers' specified application rates the polyurea binder is \$0.45 per linear foot, the VISIMAX™ beads are \$0.21 per linear foot, and the Type I beads are \$0.03 per linear foot for material costs. The quantities specified in the project plans were 117,000 linear feet of 6" white polyurea, 95,000 linear feet of 6" yellow polyurea, and 5,200 linear feet of 12" white polyurea. For this amount of material needed, at \$0.69 per linear foot, the total estimated material cost for the project is \$151,232.00. This cost does not include recessing the markings or application costs.

SUMMARY AND RECOMMENDATIONS

In an effort to explore the durable and retroreflective capabilities of Epoplex Glomarc 90 with VISIMAX™ Beads, the Vermont Agency of Transportation applied the product to a newly surfaced Interstate Highway 91 in the town of Derby.

Following the placement of the markings, retroreflectivity and wear readings were collected using uniform methods. All markings were found to be in compliance with FHWA recommended minimum Retroreflective values, but also above the Agency's required initial retroreflective values of 500 mcdl/lx/m² for white and 400 mcdl/lx/m² for yellow. The most notable observation during the site visit was that on average, the yellow markings were presenting higher retroreflective values than the white lines.

At the time of installation, it was too early to draw any strong conclusions from the readings. Research personnel will monitor and collect additional information concerning the overall durability and retroreflectivity of all test sites in accordance with the work plan. Following a determination of service life, a final report will be published to summarize the findings.

REFERENCES

1. Vermont Agency of Transportation. (2006). *2006 Standard Specifications for Construction*. Montpelier, VT
2. Ellis, Wendy. *Work Plan for Research Investigation Epoplex Glomarc 90 Polyurea Pavement Marking*. Work Plan No. WP 2009-R-03. January 27, 2010
3. Potters Europe. (2014). *VISIMAX Wet Night Has Never Been So Bright*. PQ Corporation. <http://www.potterseurope.org/documents/Files/Documentation/VisiMAX%20GB.pdf>

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS AND RESEARCH SECTION

WORK PLAN FOR
RESEARCH INVESTIGATION
Epoplex Glomarc 90 Polyurea Pavement Marking
Work Plan No. WP 2009-3

OBJECTIVE OF STUDY:

Pavement markings provide an important means of communication for all roadway users and must be capable of conveying information during inclement weather and evening hours when there may be little to no contribution from overhead lighting. However, traffic markings are often subject to abrasion from vehicle tires and winter maintenance practices as well as ultraviolet sunlight and fading pigments following application. These deterioration mechanisms result in a loss of binder and reflective elements. Durable markings are often applied to newly constructed pavements in the state of Vermont and restriped with waterborne paint when markings no longer adequately delineate the roadway. In accordance with “2006 Standard Specification for Construction”, “durable pavement markings are classified as pavement marking tape, epoxy paint, thermoplastic markings, polyurea paint, and methyl-methacrylate.” Each of the referenced markings, comprised of various elements, has been shown to display unique characteristics and varying life cycles.

Over the past few years, the Agency has been applying recessed polyurea markings on most interstate rehabilitation projects. The process of recessing includes the removal of a small portion of the surface of the wearing course prior to the application of permanent markings. Recessing has proved effective in extending the service life of our pavement markings by protecting them from wear induced by tire abrasion and shearing effects generated by snow plows. However, there have been some complaints during rain events as water ponds over the marking materials causing a change in the indices of refraction between the optical elements and surrounding medium thereby reducing retroreflective properties. In an effort to enhance visibility during evening rain events, the Agency is interested in evaluating traffic markings with “wet night” properties.

The purpose of this study is to examine and evaluate the wet-night reflective capability of recessed Epoplex Glomarc 90 Polyurea pavement markings. Research personnel will also assess the product's durability and ability to uphold the retroreflectivity requirements. Efforts will be made to provide a comparative analysis with regards to standard polyurea recessed markings without wet reflective elements.

LOCATION:

The Epoplex Glomarc 90 Polyurea will be applied on the Derby project, IM 091-3(46), located along I-91 northbound and southbound between mile marker (MM) 169.8 to 177.4. According to the project plans, work to be performed includes cold planing and resurfacing of the northbound and southbound travel and passing lanes, interchange 27, 28, and 29 ramps, maintenance u-turns, and the welcome center with a leveling course, wearing course, milled rumble strips, new pavement markings, guardrail improvements, signs, and other incidental items. The average annual daily traffic (AADT) ranges from 5,000 from the start of the project to 2,100 at the end of the project. These are considered moderate to low AADTs for Vermont.

MATERIAL:

According to the manufacturer, Epoplex of Maple Shade, NJ, Epoplex Glomarc 90 is a highly reflective pavement marking system designed for use on concrete or bituminous concrete roadways and highways as a long-lasting striping material for both edging and centerline markings, as well as all intersection markings. The product consists of a two component polyurea based durable highway marking system that provides superior reflectivity during both day and night under both dry and wet weather conditions. The first component is Epoplex LS90 polyurea binder which is formulated to provide a simple volumetric mixing ratio of two volumes of Component A (amine) to one volume of Component B (isocyanate). The second component of the marking system is the VISIMAX™ Bead System which is designed to achieve superior wet night reflective characteristics.

In accordance with the manufacturer's specifications, Glomarc 90 should be applied only when atmospheric and surface temperatures at 32°F or higher using a mobile, truck mounted self contained, capable of spraying both white and yellow polyurea through an airless static tube or impingement mixing guns to accommodate a volumetric ratio of two to one according to manufacturer recommended proportions. The applicator must be of sufficient size and stability with adequate hydraulic and air power supplies to produce uniform line dimensions and have a high-pressure air blast cleaning system capable of cleaning the pavement surface immediately prior to applying the markings.

RETROREFLECTIVITY REQUIREMENTS

According to the Agency's special provisions, polyurea markings shall have a minimum retroreflectivity of 500 and 400 mcdl/lx/m² for white and yellow markings, respectively when tested in accordance with ASTM D 6359-99, "Specification for Minimum Retroreflectance of Newly Applied Pavement Marking Using Portable Hand-Operated Instruments."

COST:

The reported cost of Epoplex Glomarc 90 polyurea binder is \$65 per gallon. At 22 mils thick and 6 inch wide, this is equivalent to 145.83 linear feet. The VISIMAX™ beads are \$6.00 per pound. The Type I beads are \$0.31 per pound. According to the manufacturers' specified application rates the polyurea binder is \$0.45 per linear foot, the VISIMAX™ beads are \$0.21 per linear foot, and the Type I beads are \$0.03 per linear foot. The quantities in the project plans specify that 117,000 linear feet of 6" white polyurea, 95,000 linear feet of 6" yellow polyurea, and 5,200 linear feet of 12" white polyurea be used on the project. For this amount of material needed, at \$0.69 per linear foot, the total estimated material cost for the project is \$151,232.00. Please note that this cost does not include recessing the markings or application costs.

SURVEILLANCE AND TESTING:

The experimental durable marking will be monitored during placement in accordance with our Standard Specifications as well as with the manufacturer's specifications. Designated test sections will be visually inspected and tested on a periodic basis throughout the duration of the study. The evaluation shall include the following:

1. At the time of the application, temperature, relative humidity, precipitation/cloud cover, wind condition, ambient air, and pavement temperatures will be recorded. The roughness of the recess will be measured and recorded prior to placement of the pavement marking.
2. A minimum of three, forty foot test sites will be established from MM 169.8 to MM 177.432 in both the north and southbound lanes. Data collection will be conducted along prescribed intervals for ease of future duplication. The test sites will be established as according to mile marker for easy identification purposes. Each data collection location will be marked with white marking paint along the shoulder of the driving lane and freshened as appropriate.
3. Retroreflectivity measurements, in accordance with ASTM E 1710-97, "Standard Test Method for Measurement of Retroreflective Pavement Marking Materials with CEN-Prescribed Geometry Using a Portable Retroreflectometer," and durability, in accordance with ASTM D 913-03, "Evaluating Degree of Resistance to Wear of Traffic Paint" will be collected at the following times:

- a) Immediately following installation.
 - b) One month after installation.
 - c) Bimonthly for the remainder of the evaluation.
4. Retention of elements will also be documented by the use of photographic methods at sufficient resolution to observe the elements and their condition. Photographs of each test site will be gathered during each site visit. Additional observations regarding the inspection including marking variability or changes in roadside activities near test sections will be recorded. Surface roughness of the paints will be measured at the initial inspection.
5. Efforts will be made to conduct site visits as night during rain events to visually compare the retroreflective properties of markings with wet night properties as compared to standard marking materials.

STUDY DURATION:

The duration of this study will be no more than three years or until final conclusions can be drawn from the observations and retroreflectivity readings.

REPORTS:

An initial report will be prepared once installation is complete. Interim reports will be prepared and submitted as needed, but not less than biennially. A final report will be published once the evaluation is complete.

Agency of Transportation
Materials and Research Section

Reviewed By:

William Ahearn P.E.
Materials and Research Engineer
Date:

Approved by Material and Research on Date (02/01/10)
Approved by Federal Highway Administration on Date (CPJ)