Epoplex LS 90 Polyurea Pavement Marking
Brattleboro/Westminster Vermont
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16. Abstract

This report documents the evaluation of a polyurea pavement marking project located on Vermont Interstate 91 in the towns of Brattleboro and Westminster. This was an 18.084-mile section of highway, and consisted of two control pavement markings and an experimental pavement marking.

Retroreflectivity and durability were documented over a three year duration to describe the markings and their condition. These results are presented herein with recommendations on possible further research studies on this topic.

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INTRODUCTION:

Cost effective and durable highway pavement markings are important for the safety of the traveling public. Longitudinal markings delineate driving lanes, segregate traffic in opposing directions and indicate where passing is permissible. Following application, the binder of the pavement markings wears away over time. Some of the reflective elements become dislodged reducing both daytime and nighttime visibility. In an effort to increase the service lives of pavement markings while maintaining acceptable visibility, the Vermont Agency of Transportation applied several experimental durable pavement markings to a newly constructed paving project located in the northbound lane of Interstate 91 between the towns of Brattleboro and Westminster in the fall of 2003. This examination focused on a new type of polyurea pavement marking, known as Epoplex LS90. In addition to assessing the pavement marking material, or binder, for resistance to abrasion, three combinations of reflective elements were utilized. This allowed for an examination of compatibility and the retention retroreflectivity over time for the different reflective elements.

The following report outlines the initial observations with regards to the application of two experimental marking materials, Epoplex LS90 and 3M LPM 1000 and one control marking, thermoplastic. This report specifically emphasizes the performance of Epoplex LS 90. In addition, the report summarizes all surveillance and testing methods, data collection results and associated findings.

PRODUCT DETAILS:

According to the manufacturer, Epoplex from Maple Shade, NJ, Epoplex LS90 polyurea is the newest addition to their family of durable pavement markings. LS90 is a two component, 100% solid polyurea coating. The product literature indicates a no track time of 7 to 10 minutes when tested in accordance with the American Society for Testing and Materials (ASTM) D-711, "Test Method for No-Pick-Up Time of Traffic Paint." According to the manufacturer, the experimental marking material provides superior durability, color retention and retroreflectivity. The marking may be applied to both portland cement and bituminous concrete highway surfaces. Other reported advantages include excellent bond strength to underlying substrate, 100% ultraviolet light stability and high reflectivity.. As reported by the manufacturer, LS90 may be applied at a minimum ambient air and surface temperature of 32^{o}F and rising.

Two specific gradations of glass beads were supplied for drop-on application. Beads were produced by two manufactures. The first type of reflective beads met the Type 1 standard maximum gradation of 850 µm in the American Association of State Highway and Transportation Officials' (AASHTO) specification M247 "Glass Beads Used in Traffic Paint." The second type of reflective beads met a maximum gradation of 2 mm (commonly called ASTM Type 4) and the standard detailed in Section 718.19 of the "Standard Specifications for Construction of Roads and Bridges on Federal Projects FP-03." Both Potters and Cataphote supplied these materials to the contractor who applied them in a single drop (designated sd) of Type 1 and a double drop (dd) of Type 1 and Type 4 beads as indicated in Table 1.

For reference, 75 to 95 percent of the type 1 beads are required to pass through a number 30 sieve (0.6 mm). 95 to 100 percent of the type 4 beads are required to pass through a number 12 sieve (1.7 mm). This indicates the type 4 beads is almost 3 times an order of magnitude larger than the type 1 beads and has been shown to require a larger binder thickness for adequate adhesion.

Brattleboro - Westminster Marking Material Locations				
Section Type	**Bead Type**	**Segment**	**Mile Marker**	**Total Length**
Ennis SG 70 Thermoplastic	AASHTO-1 sd	1	11.916 - 16.416	4.500
3M LPM 1000	AASHTO-1 sd	2	16.416 - 20.916	4.500
Epoplex LS90	Cataphote dd Type 1 & 4 Bead	3	20.916 – 23.000	2.084
Epoplex LS90	Potters dd Type 1 & 4 Bead	3	23.000 - 25.416	2.416
Epoplex LS90	Potters sd Type 1 bead	4	25.416 - 30.000	4.584

Table 1 – Pavement Marking Summary

PROJECT DETAILS:

In association with the federally approved work plan, WP 2003-R-2, all pavement markings were applied to the Brattleboro/Westminster highway rehabilitation project, IM091-1(41) in the fall of 2003. This project included cold planning and resurfacing of the northbound lane and northbound interchange ramps with a leveling course and Type III Superpave wearing course, pavement markings, guardrails, signs and other incidental items. A Type III wearing course contains a nominal aggregate size of ½” resulting in a rougher a pavement surface than a Type IV Superpave wearing course which contains a nominal aggregate size of 3/8”. A roughened surface will distribute line striping substrates over a larger surface area, generating an inconsistent thickness or inadequate thickness for the larger diameter beads resulting in premature bead loss. However, this is constant for all pavement markings on this project. The 2002 average annual daily traffic (AADT) along I-91 NB averaged 16,500 at the southern end in Brattleboro, decreasing to 14,400 at the northern end in Westminster. These are moderately high AADTs for Vermont highways and may contribute to early pavement marking abrasion from vehicles tires.

As shown in Table 1, three types of durable marking binders were applied to the highway as part of the project. The control pavement marking binder consisted of Ennis SG 70 thermoplastic. Both Ennis SG 70 and 3M LPM 1000 marking materials were applied with standard AASHTO M247 Type 1 beads supplied by the marking manufacturer. The experimental marking, Epoplex LS90 was applied at a 22 wet mil thickness in association with bead combinations indicated in Table 1.

INSTALLATION:

Placement of the Epoplex LS90 began on Thursday, November 6th, 2003. Striping operations performed by Denville Line Painting from Denville, NJ, commenced at 1:00 PM. The timing allowed for the pavement surface to be dry as well as ambient air and surface temperatures within the manufactures specifications. Installation of the LS90 was completed over the course of three days and included all 6" edge and skip lines. It should be noted that roadway and weather conditions greatly affect the rate of cure and resulting performance. Table 2 provides an installation summary and daily temperature range for each marking.

Brattleboro-Westminster Installation Data				
Date - Time	Segment	Temperature	Weather	Notes
10/03/03, 9:30am	1	35^{o} F - 57^{o} F	Sunny	Segment 1 Completed
10/24/03, 11:00am	2	25^{o} F - 45^{o} F	Sunny	Segment 2 Completed
11/06/03, 1:00 pm	3 & 4	42^{o} F - 52^{o} F	Cloudy	Wet roads in AM
11/07/03, 10:00am	3 & 4	22^{o} F - 52^{o} F	Sunny	White edge not done
11/08/03, 8:30 am	3 & 4	33^{o} F - 41^{o} F	Cloudy	Segment 3&4 completed

Table 2 – Pavement Marking Application

Personnel from the Materials and Research Section conducted a site visit on the first day of placement to record any observations with respect to application. Retroreflectivity, or luminance, readings were collected randomly at test sites throughout the length of the project in accordance with ASTM E 1710, "Standard Test Method for Measurement of Retroreflective Pavement Marking Materials with CEN-Prescribed Geometry Using a Portable Retroreflectometer." All of the experimental markings were found to be in compliance with ASTM D 6359, "Minimum Retroreflectance of Newly Applied Pavement Marking Using Portable Hand-Operated Instruments" which requires a minimum retroreflectivity of 250 mcdl for white markings and 174 mcdl for yellow markings within 14 days of application. In addition, field samples of the marking material were collected in order to evaluate application thickness. All samples were found to be within the manufacturer's specifications for thickness of 20+/- wet mils film thickness. Figures 1 through 3 depict each type of LS90 pavement marking with varying bead configurations.

Figure 1 – Cataphote dd

Figure 2 – Potters dd

Figure 3 – Potters sd

SURVEILLANCE AND TESTING:

In accordance with the work plan, test sites were established throughout the length of the project for the collection of retroreflectivity readings in accordance with ASTM E 1710, and durability, in accordance with ASTM D 913, “Evaluating Degree of Resistance to Wear of Traffic Paint”. An example of the wear data collected is listed in Appendix A. Each to site was identified in an area with good sight distance on a straight away and consisted of a total length of 40 feet with data collection conducted at 10 foot intervals starting from the beginning of the test site. Each data collection location was denoted with white marking paint along the shoulder of the driving lane in order to ensure that all future readings would be collection form the same location.

Retroreflectivity readings and visual assessments were collected on a periodic basis through the spring of 2006 utilizing a LTL 2000 retroreflectometer which employs 30 meter geometry. Photographic documentation was also gathered at individual test site locations during each field visit. All retroreflectivity and durability readings were recorded onto the appropriate field forms and then compiled into a dedicated spreadsheet. The data collection process was carried out year round, including winter months when the ambient air temperature fell below the minimum temperature specified within the ASTM testing procedures of 40^{o}F. However, care was taken to maintain the testing equipment above the minimum specifications during travel and between test sites. Where warranted, the pavement markings were cleaned with a mixture of water and windshield washer fluid to remove any salt, dirt or other debris and then thoroughly dried prior to data collection in accordance with the “Protocol for the Cleaning of Line Striping to Test for Retroreflectivity.” A copy of the protocol is provided in Appendix B.

The first site visit was conducted on Tuesday, November 18th, ten to twelve days following application of the LS90 pavement markings. All pavement markings were found to be intact. A summary of initial retroreflectivity readings are provided below in Table 3. Please note that all LS90 markings were found to be in complaint with ASTM D 6359-99. However, compliance with the ASTM standard could not be assessed with reference to the thermoplastic and LPM 1000 markings as the initial data was collected in excess of 14 days.

Brattleboro - Westminster: Initial Retroreflectivity Readings ($mcdl/m^2/lux$)					
Material	**Test Site**	**Mile Marker**	**White Edge Line**	**White Skip Line**	**Yellow Edge Line**
Epoplex with Cataphote DD	1	21.00	597	741	328
	2	21.24	569	784	349
	3	21.40	547	762	304
	4	22.30	589	797	374
	5	22.55	673	797	297
	6	22.80	656	806	239
		Average:	**605**	**781**	**315**
		Standard Deviation:	**49**	**25**	**47**
Epoplex with Potters DD	1	23.75	527	602	260
	2	24.30	615	637	363
	3	25.00	638	705	190
		Average:	**593**	**648**	**271**
		Standard Deviation:	**59**	**52**	**87**
Epoplex with Potters SD	1	25.60	428	510	199
	2	26.00	456	678	182
	3	26.30	491	612	206
	4	28.00	515	486	213
		Average:	**473**	**572**	**200**
		Standard Deviation:	**38**	**90**	**13**
Thermoplastic with AASHTO M-247	1	12.75	360	375	97
	2	13.60	398	381	91
	3	14.60	337	380	96
	4	15.00	329	378	88
		Average:	**356**	**379**	**93**
		Standard Deviation:	**31**	**3**	**4**
3M LPM 1000 with AASHTO M-247	1	16.65	492	705	286
	2	16.75	444	792	315
	3	16.90	396	677	245
	4	18.50	434	427	231
	5	19.45	388	436	286
		Average:	**431**	**607**	**273**
		Standard Deviation:	**42**	**166**	**34**

Table 3 – Initial Retroreflectivity Readings

In examining the data sets, initial results from the LS90 pavement markings are promising and were found to be well above minimum standards. On average, Epoplex with Cataphote double drop on beads appears to exhibit the highest retroreflectivity for both white and yellow markings closely followed by the Epoplex with Potters double drop area. Both polyureas with single drop on beads also performed similarly when compared with each other. As expected, thermoplastic was found to display the lowest reflectance. However, it was also applied one month previously to the LS90 markings. This means that the pavement may not have had an adequate cure time prior to the placement of the thermoplastic markings which may have potentially altered the pigment of the binder thereby reducing overall retroreflectivity. Standard deviations were found to vary greatly between the various markings and similar markings with different pigments. A greater standard deviation suggests inconsistent reflectance along the length the pavement marking. 3M LPM 1000 was found to have the greatest average standard deviation followed by Epoplex with Potters SD. Surprisingly thermoplastic displayed the lowest standard deviation. However, it is also important to consider the magnitude of the retroreflectivity readings as well.

In addition to verifying initial retroreflectivity compliance with ASTM D 6359, all markings were monitored for performance over time. The service lives of pavement markings were used to compare durability and degradation rates to a predefined benchmark in order to evaluate and determine life cycle costs. To date, the Federal Highway Administration, or FHWA, and other federal and state authorities have not established a minimum requirement for retroreflectivity of pavement markings. However, FHWA has compiled recommended retroreflectivity guidelines for white and yellow pavement marking for different classes of roads as shown in Table 4.

1998 FHWA Research-Recommended Pavement Marking Values			
Type	**Non-Frwy**	**Non-Frwy**	**Freeway**
Option 1	<= 40 mph	>= 45 mph	>= 55 mph
Option 2	<= 40 mph	>= 45 mph	>= 60 mph, >10K ADT
Option 3	<= 40 mph	45-55 mph	>= 60 mph
White	85	100	150
Yellow	55	65	100

Table 4 – FHWA Recommendations

WHITE EDGE LINES

As recommended by the FHWA, a minimum recommended retroreflectivity of 150 mcdl was selected as the benchmark for evaluating white interstate markings. Table 5, as shown below, contains a summary of average reflectance for each composition of white edge lines. Please note that any readings below 150 mcdl are highlighted in red.

Brattleboro - Westminster: White Line Retroreflectivity Averages Mcdl/m^2/lux								
Marking Type:	**Date of Collection**							
	Nov-03	Apr-04	May-04	July-04	Oct-04	Jun-05	Aug-05	Mar-06
LPM 1000	431	127	133	105	105	70	68	48
Thermoplastic	356	133	157	180	168	104	106	125
LS90 (Cata DD)	605	223	251	218	204	130	141	111
LS90 (Potters DD)	538	212	218	207	204	171	107	124
LS90 (Potters SD)	473	231	236	236	226	160	159	138

Table 5 – Retroreflectivity Summary for White Edge Line

As anticipated, a significant drop in retroreflectivity, 295 mcdl on average, is evident across all markings following the first winter season. This is most likely attributed to shearing effects resulting from winter maintenance practices. Specifically, while the double drop method provides the greatest initial retroreflectivity, it also displays the highest response to plowing during the first winter season with an average loss of 382 mcdl for Cataphote beads and 326 mcdl for Potters beads. Wear readings collected during this time frame were found to be between 8 and 9. In addition, the Epoplex pavement markings with a single drop of Potters beads appear to maintain the best performance over time as compared to all other markings. Given that the type 4 beads applied to the experimental pavement markings are larger in diameter, it may be surmised that larger diameter beads enhance retroreflectivity but may not adhere to the binder or may require additional binder thickness.

YELLOW CENTER LINE

A similar analysis was performed with the yellow pavement markings with a minimum acceptable retroreflectivity of 100 mcdl as displayed in Table 5.

Brattleboro - Westminster: Yellow Line Retroreflectivity Averages Mcdl/m^2/lux								
Marking Type	Date of Collection							
	Nov-03	Apr-04	May-04	July-04	Oct-04	Jun-05	Aug-05	Mar-06
LPM 1000	272	85	85	76	77	50	48	37
Thermoplastic	93	69	83	106	103	61	66	44
LS90 (Cata DD)	315	174	186	168	177	91	105	94
LS90 (Potters DD)	271	171	175	165	137	89	86	81
LS90 (Potters SD)	200	103	107	110	107	66	69	63

Table 6 – Retroreflectivity Summary for Yellow Edge Line

As with the white lines, the double drop of Cataphote beads had the highest initial readings, but all lines dropped significantly after the first winter plowing season. It is also interesting to note the consistency in the results between the white and yellow markings. The only highly discernable difference is the LS90 marking with a single drop of Potters beads. This marking composition was found to fall below the minimum recommendation in June of 2005, almost one year before the white marking in March of 2206. As with the white edge lines, the Epoplex markings (with the various bead combinations) had a longer service life better than the other two marking materials.

SERVICE LIFE

Service life estimates for each white line pavement marking could not be determined from Table 5 due to the large extent of time between data collection events. Therefore, a scatter plot of the data was generated in order to establish the approximate amount of elapsed time before retroreflectivity values fell below 150 mcdl, as shown in Figure 4. Please note that only white lines are modeled for this analysis due to the inherent variability of yellow pavement markings.

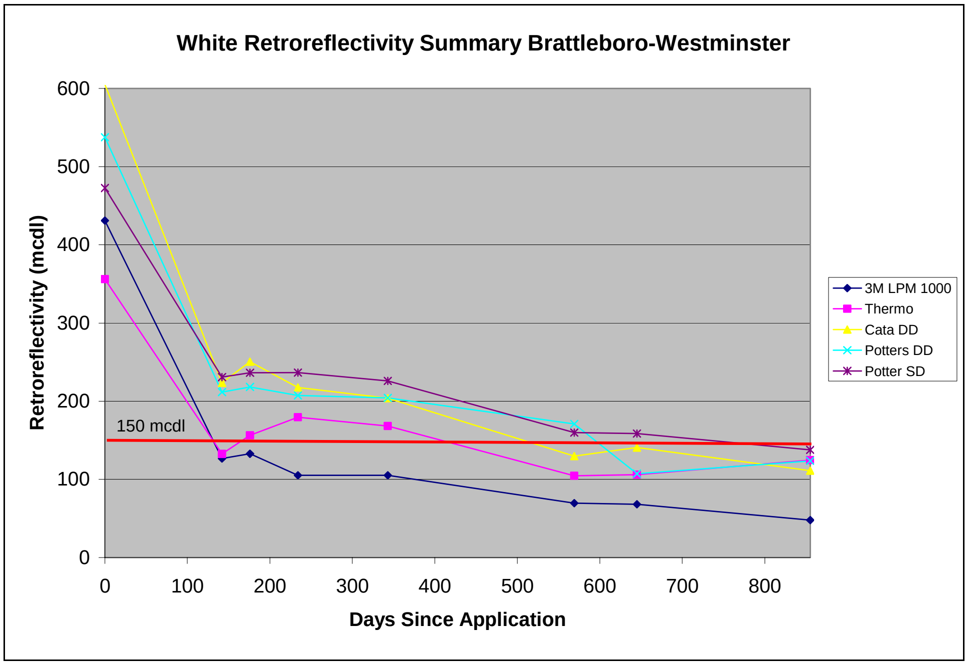

Figure 4 – Retroreflectivity Results White Lines

Estimated service lives for the white pavement markings are as follows in ascending order:

- 3M LPM 1000 – 140 days
- Ennis SG 70 Thermoplastic – 400 days
- Epoplex LS 90 with Cataphote DD – 500 days
- Epoplex LS 90 with Potters DD – 600 days
- Epoplex LS 90 with Potters SD – 710 days

COST ANALYSIS:

All costs for the application of the various pavement markings were paid as a part of the Brattleboro – Westminster construction project. The application cost for all Epoplex markings was roughly $1.10/linear foot. It is important to note that the cost of the various beads and two application methods most likely differed. However, these costs are unavailable. The cost for the application of the thermoplastic was $0.37/linear foot. The cost for the 3M LPM markings was not supplied with the work plan; therefore an estimate derived from historical bid records of $0.68/linear were utilized in the calculations for life cycle cost. The cost per month for each marking was calculated by dividing the total cost of application per linear foot by the estimated service lives in months. The cost analysis is shown in Table 7.

Brattleboro - Westminster Cost Analysis				
	Elapsed Time			
Marking Type	Days	Months	Cost	Cost/Month
Ennis SG 70 Thermoplastic	400	13	$0.37/LF	$0.03
Epoplex with Potters SD	710	23	$1.10/LF	$0.05
Epoplex with Potters DD	600	20	$1.10/LF	$0.06
Epoplex with Cataphote DD	500	16	$1.10/LF	$0.07
3M LPM 1000	140	5	$0.68/LF	$0.15

Table 7 – Cost Estimate

Thermoplastic was found to have the lowest material cost per month, though it had the second shortest life. 3M LPM 1000 had the least acceptable service life along with being the most expensive material over time. Both Epoplex LS90 applications with Potters beads were found to have similar costs and service life. When compared with the other materials, the Epoplex/Potters single drop-on exhibited the longest service life and second lowest cost per month. Please note that the number of test sites, or sample population, varied by marking material influencing the statistical significance of any results or conclusions. The value of increased safety, by virtue of fewer pavement marking events has been discounted in this analysis. The effect of adding the safety value to the longer service life marking improves marking value.

FINDINGS / SUMMARY:

Data collection on these different markings were gathered using uniform methods, collected on the same days and weather conditions and without favoring one type of material over another. After three years of service all the white and yellow edge lines on this project have fallen below the FHWA Recommendations. In general, Epoplex LS 90 polyurea, with the various bead applications performed better when compared with the other products over the length of the study.

The data evidenced a large drop in readings on all materials following the first winter season. As concurrent studies have shown, larger diameter glass beads generally require a larger binder film thickness to provide compatibility and adequate bond to the surrounding substrate. Additionally, lower ambient air temperatures may have increased the time needed for proper cure potentially resulting insufficient bonding. In association with shearing effects produced by winter maintenance practices, the larger diameter glass beads may have become dislodged resulting in a great loss of retroreflectivity. However, this does not consider any associated benefits from retroreflectivity results above the minimum recommendations although investigations have shown the importance of bright markings for older drivers and inclement weather conditions. Overall, Epoplex LS90 with a single drop on of type 1 beads was shown to retain its retroreflectivity capability longer than all other combinations. Thermoplastic proved to be the most cost effective, neglecting additional safety values. However the LS90 markings remained above the minimum retroreflectivity recommendation for one to two years longer.

Data collection on all these pavement markings has been completed at this time. If type 4 glass beads are to be applied, consideration should be taken to verify the necessary film thickness of the pavement marking binder.

<u>**References:**</u>

American Association of State Highway and Transportation Officials' (AASHTO)."Glass Beads Used in Traffic Paint." *Standard Specifications for Transportation Materials and Methods of Sampling and Testing* June 2004: M247-1 – M247-3.

American Society for Testing and Materials (ASTM). "D 711-89, Test Method for No-Pick-Up Time of Traffic Paint." *Volume 06.02 Paint-Products and Applications; Protective Coatings; Pipeline Coatings* 2007: 20 – 21.

American Society for Testing and Materials (ASTM). "D 913-03, Evaluating Degree of Resistance to Wear of Traffic Paint." *Volume 06.02 Paint-Products and Applications; Protective Coatings; Pipeline Coatings* 2007: 29 – 31.

American Society for Testing and Materials (ASTM). "E 1710-97, Standard Test Method for Measurement of Retroreflective Pavement Marking Materials with CEN-Prescribed Geometry Using a Portable Retroreflectometer." *Volume 06.01 Paint – Tests for Chemical, Physical, and Optical Properties; Appearance* 2007: 1086 – 1091.

American Society for Testing and Materials (ASTM). "D 6359-99, Minimum Retroreflectance of Newly Applied Pavement Marking Using Portable Hand-Operated Instruments." *Volume 04.03 Road and Paving Materials; Vehicle-Pavement Systems* 2006: 712 – 714.

Federal Highway Administration. "Section 718, Traffic Signing and Marking Material." *Standard Specification for Construction of Roads and Bridges on Federal Highway Projects, FP-03* 2003: 678.

Appendix A

Brattleboro - Westminster: White Line Wear Summary								
Marking Type	Date of Collection							
	Nov-03	Apr-04	May-04	Jul-04	Oct-04	Jun-05	Aug-05	Mar-06
Epoplex with Potters SD	10	9	10	8	7	7	5	3
	10	10	9	8	7	7	8	9
	10	10	10	7	7	7	8	9
	10	10	10	8	7	7	8	5
Epoplex with Potters DD	10	10	10	9	8	7	8	7
	10	10	10	9	6	8	8	6
Epoplex DD Cataphote	8	10	10	9	7	8	8	6
Epoplex DD Cataphote	10	10	10	9	7	8	7	6
	8	10	10	6	7	7	7	5
	8	10	10	7	7	8	7	5
3M LPM-1000	10	10	10	8	7	6	7	4
	10	10	10	8	7	8	7	5
	10	10	10	7	7	7	7	5
3M LPM-1000	10	8	8	6	5	4	6	3
	10	8	8	3	5	4	5	3
Ennis SG 70 Thermoplastic	10	8	8	4	5	5	6	3
	10	9	9	6	7	4	6	4
	10	8	8	7	7	5	7	4
Ennis SG 70 Thermoplastic	10	10	10	9	9	9	7	5
	10	10	9	9	8	9	8	6
	10	10	10	9	7	8	7	6
	10	10	10	8	6	8	7	5

Wear/Durability Readings

Appendix B

Protocol for the cleaning of line striping to test for retroreflectivity.

Equipment needed:

1. Windshield washer fluid
2. Water
3. Two liquid dispensers
4. Towels or rags
5. Squeeze mop and/or sponges
6. Gas powered leaf blower

Procedure

Step 1 – Mix ½ water and ½ windshield washer fluid into the first liquid dispenser. The other liquid dispenser should have water only.

Step 2 – Thoroughly clean the lines with the windshield washer fluid mixture using the dispenser to spray away as much salt, dirt and other debris as possible.

Step 3 – Thoroughly clean the lines with the water dispenser, spraying away the windshield washer mixture. * Note: Make sure you start at the highest point of the surface to be cleaned and wash down to the lowest point.

Step 4 – Using the squeeze mop and sponges clean away as much excess water as possible. Wipe the line surfaces with a towel or rag to get the surfaces as dry as possible.

Step 5 – Utilizing a gas powered leaf blower or similar device blow the lines off until completely dry.

Step 6 – Begin Retroreflectometer Testing.