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Evaluation of Polyester Pavement Markings

RONALD A. LORINI

SPECIAL REPORT 102

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EVALUATION OF POLYESTER PAVEMENT MARKINGS

Ronald A. Lorini, Civil Engineer I (Physical Research)

Fifth Interim Report on Research Project 157-1
Conducted in Cooperation With
The U.S. Department of Transportation
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16. Abstract

This report describes in-service performance of about 240 miles of white and yellow polyester pavement markings on four striping-contract projects. They were installed on low-volume roadways, on both existing asphalt concrete surfaces over worn paint lines and on new asphalt surfaces at least a month old. Most striping was in good to fair condition after 2½years of service, providing acceptable daytime delineation. Although the white markings had good nighttime reflectivity, most of the yellow striping was rated only fair. Based on this evaluation, polyester appears capable of providing effective pavement markings for up to 2½ years on low-volume roads (AADTs less than 4000).

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METRIC (SI*) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
in	inches	2.54	millimetres	mm
ft	feet	0.3048	metres	m
yd	yards	0.914	metres	m
mi	miles	1.61	kilometres	km
AREA				
in²	square inches	645.2	millimetres squared	mm²
ft²	square feet	0.0929	metres squared	m²
yd²	square yards	0.836	metres squared	m²
mi²	square miles	2.59	kilometres squared	km²
ac	acres	0.395	hectares	ha
MASS (weight)				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
VOLUME				
fl oz	fluid ounces	29.57	millilitres	mL
gal	gallons	3.785	litres	L
ft³	cubic feet	0.0328	metres cubed	m³
yd³	cubic yards	0.0765	metres cubed	m³

NOTE: Volumes greater than 1000 L shall be shown in m³.

TEMPERATURE (exact)

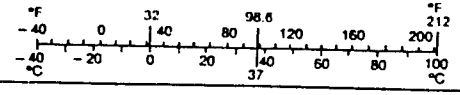
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
mm	millimetres	0.039	inches	in
m	metres	3.28	feet	ft
m	metres	1.09	yards	yd
km	kilometres	0.621	miles	mi
AREA				
mm²	millimetres squared	0.0016	square inches	in²
m²	metres squared	10.764	square feet	ft²
km²	kilometres squared	0.39	square miles	mi²
ha	hectores (10 000 m²)	2.53	acres	ac
MASS (weight)				
g	grams	0.0353	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams (1 000 kg)	1.103	short tons	T
VOLUME				
mL	millilitres	0.034	fluid ounces	fl oz
L	litres	0.264	gallons	gal
m³	metres cubed	35.315	cubic feet	ft³
m³	metres cubed	1.308	cubic yards	yd³

TEMPERATURE (exact)

°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



These factors conform to the requirement of FHWA Order 5190.1A.

* SI is the symbol for the International System of Measurements

CONTENTS

Table 1. Polyester projects and test sites.

Region	Site No.	Route (& Location)	Lanes Striped	Two-Way AADT	Asphalt Pavement		Paint Mfr	Contractor
					New	Old		
STRIPED 1982								
4	1	CR 120 (Irondeqoit)	2	11,160	x		A	1
	2	CR 132 (Greece)	2	3,600	x			
	3	CR 142 (Greece)	2	4,000	x			
	4	CR 441 (Rochester)	2	5,200	x			
STRIPED 1985								
3	1	79 (Slaterville Springs)	2	5,200	x		B	1
STRIPED 1987								
3	1	79 (Ithaca)	2	2,600	x		B	1
STRIPED 1987								
3	1	414 (Seneca Falls)	2	1,400		x	B	2
	2	414 (Watkins Glen)	2	4,300		x		
	3	96A (Geneva)	2	1,000		x		
	4	96A (Waterloo)	4	5,200		x		
	5	89 (Seneca Falls)	2	900		x		
	6	89 (Magee)	2	1,300		x		
	7	318 (Seneca Falls)	2	4,000		x		
	8	5&20 (Syracuse)	4	12,400		x		

I. INTRODUCTION

A. Background

The New York State Department of Transportation uses several pavement marking materials to delineate highways. Traffic paints applied by state maintenance personnel are commonly used to stripe lower-volume secondary roadways. Contract-installed durable markings -- including two-component epoxy, thermoplastic, and preformed marking tape -- are applied to interstates and high-volume urban arterials and expressways. More durable markings may also be used on low-volume highways in remote areas that are difficult to access for maintenance personnel.

The Department has established a pavement-marking policy with the goals of providing effective year-round delineation on all highways, and accomplishing this in the most cost-effective manner (1). To meet this objective the Department has evaluated and reported on performance of numerous pavement markings (2,3,4,5,6,7,8,9).

Polyester markings were first placed in New York in 1980 and included 20,000 ft of yellow centerline in Rochester, on older asphalt pavement with traffic volumes ranging from 10,000 to over 30,000 vehicles daily. The material provided two years of service even in these areas of heavy traffic.

Based on this favorable performance, additional installations were initiated. This report documents performance of polyester pavement markings on four other projects striped in 1982, 1984, and 1987.

B. Project Descriptions and Methods of Evaluation

The projects included in this evaluation are described in Table 1 and included about 240 miles of while and yellow polyester markings. All were applied on asphalt pavements. New asphalt was allowed to cure for about 30 days before striping. On older asphalt, at least one year or more old, it was normally applied over worn traffic paint. Because other states had reported that polyester does not adhere well on concrete, no markings were applied on concrete pavements.

The four projects had two-way AADTs ranging from about 12,000 to less than 1,000 vehicles per day. On all four, snow-and-ice control was performed using chemical deicers such as sodium and calcium chloride, but no sand or other harsh abrasives.

The polyester markings in this evaluation were supplied by two different manufacturers, and installed by two different contractors as noted in Table 1. Each project was inspected periodically by a research team experienced in rating

pavement marking performance. Markings were grouped for inspection by color (white edgeline or yellow centerline) and by route. On each project at least one site was selected for evaluation. The number of sites ranged from one (on two of the projects) to four and eight on the other two projects. In most cases each site included both white and yellow markings. In all, a total of 14 sites were evaluated.

The same observations were made for each site. Durability and appearance evaluations were based on a subjective rating scale, and reflectivity was measured with retroreflectometers. The rating criteria were as follows:

1. Durability

   This was rated subjectively to indicate the condition or extent of imperfections in a given marking line. Durability included percent of pavement still covered by polyester, together with discoloration and other imperfections in the line. A subjective durability rating was assigned as follows:

   Excellent: lines essentially "like new."

   Good: line visually effective, with no more than minor imperfections or small areas of worn, abraded, or chipped polyester.

   Fair: line visually effective, but worn or missing areas apparent. No more than 30 percent of the painted line area missing.

   Poor: line marginally effective or ineffective, large areas missing. Up to 50 percent of the painted line area missing.

2. Appearance

   This is a subjective rating representing overall daytime visual effectiveness of all markings present at a given site, based on all stripes visible at that location, with white and yellow colors each grouped together. A subjective rating of "good," "fair," or "poor" was assigned as follows:

   Good: marking essentially new with only minor imperfections or discoloration, and small areas of line missing.

   Fair: marking still visually effective, but imperfections, discoloration, and worn or missing areas readily apparent.

   Poor: marking only marginally effective or ineffective, widespread imperfections, badly discolored, large areas missing.

3. Reflectivity

   This was measured using two different retroreflectometers. Earlier surveys were performed with one built by research personnel, patterned after a device built by Michigan Department of Transportation (10). Later measurements used a commercially available retroreflectometer, the

"Mirolux 12" manufactured by Miro-Bran Assemblers, Inc. of Paterson, New Jersey.

Both include an internal light source and photocell and provide a digital readout representing brightness of a few square inches of line. The research-built retroreflectometer does not measure in absolute units, but does provide a means for judging difference in reflectivity between two markings. The other retroreflectometer measures in units of millicandles per square foot per foot-candle.

Reflectometer measurements and subjective nighttime visibility ratings have not been formally correlated. However, based on past experience of subjectively rating marking materials at night and measuring their corresponding reflectivity values, the following relationships between measured reflectivity and subjective nighttime visibility have been developed:

Subjective Rating	Measured Reflectivity			
	Research Meter		Mirolux 12	
	White	Yellow	White	Yellow
Excellent	>300	>250	>275	>225
Good	>225	>175	>200	>150
Fair	>140	>110	>120	>100
Failed	≤140	≤110	≤120	≤100

At each of the four locations within each test site, ten reflectivity measurements were taken on each line. Average reflectivity was then calculated for each location, and then the average of the four locations then calculated to determine reflectivity of the entire test site.

C. Material and Application Requirements

The polyester materials evaluated were supplied by two manufacturers and applied by two contractors. The Department's specifications for installation are included in the Appendix.

The material had two components -- a polyester resin and a methyl-ethyl-keytone peroxide (MEKP) catalyst. The mixing ratio was about 50:1 (polyester resin: catalyst). The components were mixed externally by means of separate spray nozzles that combined them as they reached the pavement. An airless-spray system kept the components moisture-free. The MEKP catalyst is an active oxidizing agent requiring special handling precautions. Its separate spray system requires chemical-resistant storage containers and supply lines.

Polyester markings are normally applied at a thickness of 15 mils (0.015 in.). Because polyester paints contain no solvents, the hardened line retains 15 mils of binder and pigment, plus the additional thickness of drop-on beads. Typical polyester paints dry to a no-track condition in about 10 to 30 minutes depending on weather conditions. "No-track" is defined as the time required for a paint to dry to a state where none is picked up and redeposited by traffic. Glass beads are applied at a rate of 15 to 20 lb/gal. Coning is often required to protect the wet line until it sets.

Table 2. Durability.

Route	AADT	Years in Service[1]											
		New		½ Yr		1 Yr		1½ Yr		2 Yr		2½ Yr	
		W	Y	W	Y	W	Y	W	Y	W	Y	W	Y
CR 120	11,160	-	E	-	G	-	G	-	G	-	-	-	G
CR 132	3,600	-	E	-	G	-	G	-	G	-	-	-	G
CR 142	4,000	-	E	-	G	-	G	-	G	-	-	-	G
CR 441	5,200	E	E	G	G	G	G	G	G	-	-	G	G
79	5,200	E	E	E	E	-	-	G	G	G	F	F	F
79	2,600	E	E	E	E	G	G	-	-	-	-	G	G
414	1,400	E	E	G	G	G	G	G	G	-	-	G	F
414	4,300	E	E	G	G	G	G	G	G	-	-	F-P	F
96A	1,000	E	E	G	G	G	G	G	G	-	-	F	F
96A	5,200	E	E	G	G	G	G	G	G	-	-	Painted Over[2]	
89	900	E	E	G	G	G	G	G	G	-	-	G	G
89	1,300	E	E	E	E	G	G	G	G	-	-	G	G
318	4,000	E	E	G	G	G	G	G	G	-	-	F	F
5&20	12,400	E	E	G	G	F	F	F	F	-	-	Painted Over[2]	

[1]W = White, Y = Yellow, E = Excellent, G = Good, F = Fair, P = Poor.
[2]After 1½ years, but before 2½ years.

Table 3. Appearance.

Route	AADT	Years in Service[1]					
		New	½ Yr	1 Yr	1½ Yr	2 Yr	2½ Yr
		W&Y	W&Y	W&Y	W&Y	W&Y	W&Y
CR 120	11,160	G	G	G	G	-	G
CR 132	3,600	G	G	G	G	-	G
CR 142	4,000	G	G	G	G	-	G
CR 441	5,200	G	G	G	G	-	G
79	5,200	G	G	-	F	F	F
79	2,600	G	G	G	-	-	G
414	1,400	G	G	G	G	-	G
414	4,300	G	G-F	G-F	G-F	-	P
96A	1,000	G	G	G	G	-	F
96A	5,200	G	G	F	F	-	Painted Over[2]
89	900	G	G	G	G	-	G
89	1,300	G	G	G-F	G	-	G
318	4,000	G	G	G	G	-	F
5&20	12,400	G	G	F	F	-	Painted Over[2]

[1]W = White, Y = Yellow, E = Excellent, G = Good, F = Fair, P = Poor.
[2]After 1½ years, but before 2½ years.

II. RESULTS

Four projects including 14 sites were surveyed in this study. All polyester markings were placed on asphalt pavement surfaces, either over worn paint lines or on new asphalt that was at least 30 days old.

A. Durability

Table 2 summarizes results of the durability surveys. AADT information for each test location is also included. Most marking samples were in good-to-fair condition after 2½ years service. Most sites had moderate material losses, but lines were judged sufficient to provide good daytime delineation. Abrasion wear by traffic was the predominant failure mode. Restriping was needed at some high-volume locations, but at others durability was not a problem.

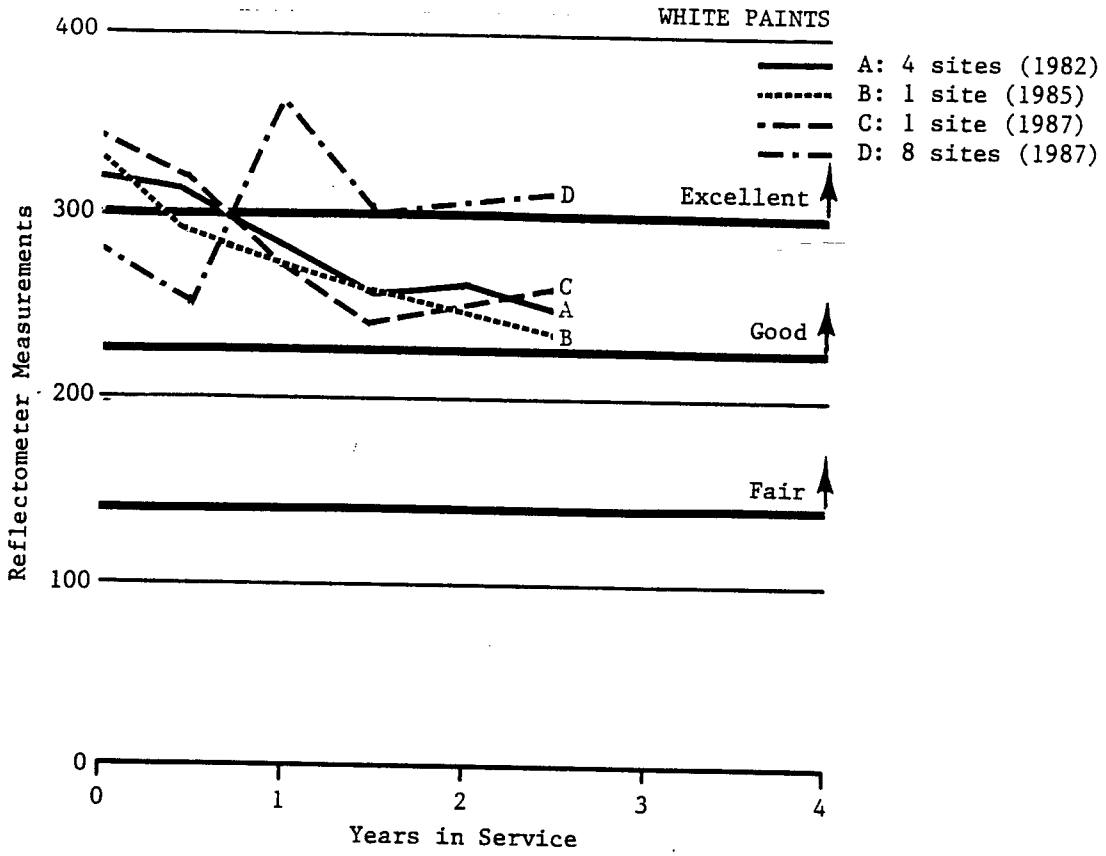
The surveys indicate that traffic volume affects line life, although this observation was not consistent at all sites evaluated. The 1985 and 1987 polyester projects in Region 3 included five sites with AADTs over 4000 vehicles daily (Rtes 79, 414, 96A, 318, and 5&20). After 2½ years white and yellow lines at two of these sites were rated fair. At a third, yellow lines were fair, but whites were rated only fair-to-poor. At the other two, polyester lines had been restriped earlier, sometime after 1½ years but before the 2½ year survey. However, performance of the Region 4 yellow markings installed in 1982 under similar traffic densities was rated good after 2½ years.

B. Appearance

Table 3 summarizes the field inspections. Markings at 11 of the 14 sites were rated as good-to-fair after 2½ years and still considered visually effective. One site was rated poor and needed restriping, and two sites were restriped before the 2½ year survey. Again, poor performance of markings at these three sites may have been due to greater traffic volumes -- these samples had AADTs over 4000 vehicles daily.

After 2½ years, some gray discoloration of the white markings had occurred, but daytime appearance was judged fair-to-good. The yellows were no longer bright after 2½ years but were providing adequate delineation.

Figure 1. Reflectometer readings.



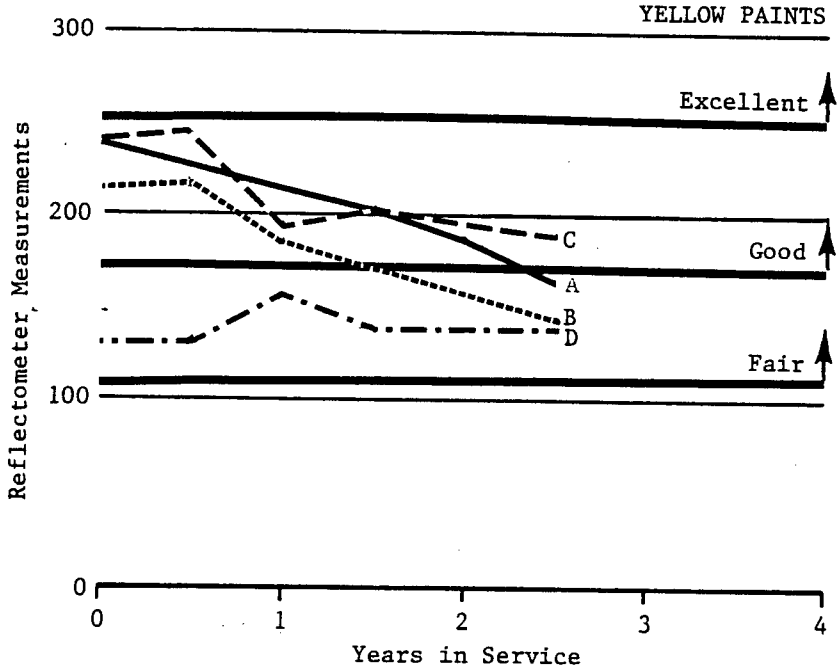


Table 4. Reflectivity.

		Years in Service*											
		New		½ Yr		1 Yr		1½ Yr		2 Yr		2½ Yr	
Route	AADT	W	Y	W	Y	W	Y	W	Y	W	Y	W	Y
CR 120	11,160	-	135	-	140	-	146	-	145	-	-	-	149
CR 132	3,600	-	136	-	130	-	150	-	143	-	-	-	145
CR 142	4,000	-	132	-	134	-	162	-	146	-	-	-	144
CR 441	5,200	287	130	254	118	362	174	305	123	-	-	313	123
Sub-Average		-	133	-	131	-	158	-	139	-	-	-	140
79	5,200	321	237	318	227	-	-	260	203	264	187	238	166
79	2,600	336	211	294	216	275	185	-	-	-	-	251	154
414	1,400	340	242	252	230	279	223	236	220	-	-	287	213
414	4,300	352	225	393	262	213	179	271	235	-	-	254	210
96A	1,000	308	243	232	131	200	168	198	192	-	-	203	187
96A	5,200	362	232	292	284	298	188	244	200	-	-	Painted Over	
89	900	369	256	419	240	353	203	314	226	-	-	294	145
89	1,300	353	265	352	298	307	211	266	212	-	-	265	202
318	4,000	395	248	398	269	308	210	255	193	-	-	260	176
5&20	12,400	288	204	225	182	171	144	159	134	-	-	Painted Over	
Sub-Average		346	239	320	245	374	191	243	201	-	-	261	188
Overall Average		323	205	297	205	304	178	269	181	-	-	266	162

*W = White, Y = Yellow.

C. Reflectivity

Survey results are given in Table 4. Location and AADT for each site are given along with reflectivity measurements for the while and yellow lines.

Reflectivity is plotted in Figure 1. After 2½ years of service, white polyester reflectivity was rated as good or excellent at all but two locations that had been restriped after 1½ years of service. The yellows were rated good-to-fair after 2½ years. All reflectivity readings (except for the two restriped sites) remained above the approximate minimum values of 120 (white) and 100 (yellow) that are acceptable for nighttime visibility.

III. DISCUSSION AND FINDINGS

Polyester markings in this evaluation were placed over wornout lines on existing asphalt pavement or on new asphalt at least a month old. No polyester markings were placed on concrete. Asphalt roadways in this study had two-way AADTs ranging from about 12,000 to less than 1,000 vehicles daily. Snow-and-ice control involved sodium and calcium chloride deicers, and sand and other harsh abrasives were not used. Twelve of the 14 sites provided adequate service for 2½ years in terms of durability, daytime appearance, and reflectivity. Two sites required restriping after 1½ years. Based on overall performance of the polyester markings in this evaluation, findings were as follows:

1. The results indicate that effective pavement markings lasting 2½ years on low-volume roads (AADTs less than 4000) can be obtained using polyester pavement markings.

2. Polyester lines experienced long no-track times, averaging 10 to 30 minutes. These times may require coning to increase line protection and minimize wet-line tracking by traffic.

3. Most sites were in fair-to-good condition. Even where stripes exhibited some failure and/or discoloration, they still provided acceptable daytime delineation.

4. Most sites provided fair reflectivity and about one-third provided good reflectivity. Mostly, lower brightness readings were on yellow centerlines.

5. Polyester can be applied on asphalt pavement surfaces only two weeks to a month old. Also, they can be placed over existing paint stripes and provide good service.

6. No apparent problems occurred during installation. The only disadvantage was an objectionable odor behind the striping truck.

ACKNOWLEDGMENTS

This project was performed under supervision of James E. Bryden, Civil Engineer III (Physical Research). This report was prepared under supervision of Gerald R. Perregaux, Associate Soils Engineer, and David R. Brewster, Civil Engineer II (Materials).

Installation and performance were surveyed under supervision of Gary F. Gurney, Civil Engineer II (Physical Research), Ronald A. Lorini, Civil Engineer I (Physical Research), and Peter D. Kelly, Civil Engineer I (Physical Research). Technicians assisting include William G. Roth and Richard D. Wright, Principal Engineering Technicians, and Steven L. Roden and William D. Nolan, Senior Engineering Technicians.

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REFERENCES

1. Bryden, J. E. Development of a Statewide Pavement Marking Policy. Research Report 143, Engineering Research and Development Bureau, New York State Department of Transportation, July 1988.

2. Bryden, J. E., and Gurney, G. F. Pavement Marking Materials: New York's Experience. Research Report 112, Engineering Research and Development Bureau, New York State Department of Transportation, April 1984.

3. Bryden, J. E., and Lorini, R. A. Traffic Paint Performance in Accelerated Wear Tests. Research Report 137, Engineering Research and Development Bureau, New York State Department of Transportation, May 1987.

4. Bryden, J. E., Lorini, R. A., and Kelly, P. D. Reflectivity and Durability of Epoxy Pavement Markings. Research Report 127, Engineering Research and Development Bureau, New York State Department of Transportation, October 1985.

5. Bryden, J. E., and Lorini, R. A. Test Installation of Chlorinated-Rubber Traffic Paint. Research Report 125, Engineering Research and Development Bureau, New York State Department of Transportation, April 1985.

6. Bryden, J. E., and Gurney, G. F. Performance of Thermoplastic Pavement Markings. Research Report 120, Engineering Research and Development Bureau, New York State Department of Transportation, June 1984.

7. Bryden, J. E., and Gurney, G. F. Evaluation of Long-Life Pavement Markings. Research Report 114, Engineering Research and Development Bureau, New York State Department of Transportation, June 1984.

8. Bryden, J. E., Lorini, R. A., and Gurney, G. F. Performance of Preformed Pavement Marking Tapes. Research Report 104, Engineering Research and Development Bureau, New York State Department of Transportation, November 1983.

9. Bryden, J. E., and Lorini, R. A. Experimental Pavement Delineation Treatments. Research Report 87, Engineering Research and Development Bureau, New York State Department of Transportation, June 1981.

10. Research Notes, Testing and Research Division, Michigan Department of Transportation, No. 7, December 1979.

APPENDIX

SPECIFICATIONS FOR POLYESTER MARKINGS

ITEM 91685.07XXXX - POLYESTER REFLECTORIZED PAVEMENT MARKINGS

DESCRIPTION. Under this work, the contractor shall furnish and apply polyester reflectorized pavement markings at the locations and in accordance with the patterns indicated on the plans, or as directed by the Engineer, and in accordance with these specifications.

The polyester pavement marking material shall be spray applied at ambient temperatures onto bituminous pavement surfaces. Following a application of glass bends and upon drying, the resultant polyester marking shall be an adherent reflectorized stripe of the specified thickness and width that is capable of resisting deformation by traffic.

MATERIALS.

A. White and Yellow Polyester Compound. The polyester compound shall be specifically formulated for use as a pavement marking material and for spray application at ambient temperatures. The compound shall be supplied as a two-component system, consisting of a polyester resin and a catalyst, the amounts and types of which shall be at the option of the manufacturer.

White and yellow polyester compound shall be as manufactured by one of the following at the contractor's option, except that no manufacturer's system may be substituted for another(s), once payment marking work has begun.

1. Baltimore Paint & Chemical Co.
   2325 Hollins Ferry Road
   Baltimore, MD 21230

2. DeSantis Coatings, Inc.
   4580 Beidler Road
   Willoughby, Ohio 44094

3. Glidden-Durkee Div. of SCM Corp.
   900 Union Commerce Building
   Cleveland, Ohio 44115

The physical properties of the mixed (resin and catalyst) compound shall conform to the following requirements:

1. Color

   a. White - the daylight directional reflectance (45°) shall not be less than 80%, relative to a magnesium oxide standard, when tested in accordance with Method 6121 of Federal Test Method Standard No. 141.

b. Yellow - shall conform to Highway Yellow Color Tolerance Chart, PR #1, as issued by the U.S. Department of Transportation, Federal Highway Administration, Washington, DC 20590 (December, 1972).

2. Dry Time - when applied under actual operating conditions on a dry pavement during daylight hours, with a ratio of 15 pounds of glass beads to one gallon of polyester compound, the pavement marking shall dry to "no-pick-up" under average traffic conditions in approximately 30 minutes, when ambient temperatures are 60°F or higher. Dry to "no-pick-up" shall be determined by driving a passenger vehicle over a line. No marking material shall be removed from the line and deposited on the adjacent pavement in a form that is visible at a distance of 50 feet.

B. Reflective glass spheres for Drop-On. Reflective glass spheres for drop-on shall conform to the following requirements:

The glass spheres shall be colorless; clean, transparent, free from milkiness or excessive air bubbles, and essentially clean from surface scarring or scratching. They shall be spherical in shape and at least 70% of the glass beads shall be true spheres when tested in accordance with ASTM D1155.

The refractive index of the spheres shall be a minimum of 1.50 as determined by the liquid immersion method at 25°C.

The silica content of the glass spheres shall not be less than 60%.

The crushing resistance of the glass spheres shall be as follows: A forty (40) pound dead weight, for 20 to 30 mesh spheres, shall be the average resistance when tested in accordance with ASTM D1213.

The glass spheres shall have the following gradation when tested in accordance with ASTM D1214.

U.S. Standard Sieve	Mass % Passing
No. 20	100
No. 30	79-95
No. 50	15-60
No. 80	0-15

Glass spheres for drop-on shall be treated with a moisture-proof coating.

C. Packaging and Shipment. Polyester pavement marking materials (resin and catalyst) shall be shipped and packaged in accordance with commercially accepted standards. The following information shall be plainly marked on each container: the name of the product, the name and address of the manufacturer, the NYSDOT Item Number, the date of expiration or shelf life, and instructions for use.

Reflective glass spheres for drop-on shall be shipped in moisture resistant bags. Each bag shall be marked with the name and net weight of the material.

D. Basis of Acceptance. White and yellow polyester compound shall be accepted on the basis of the specified container markings.

Reflective glass spheres for drop-on may be accepted at the job site on the basis of the Manufacturer's Certification; or they may be submitted to the Materials Bureau for testing.

POLYESTER APPLICATING EQUIPMENT. Applicating equipment for the placement of polyester reflectorized pavement markings shall be approved by the Deputy Chief Engineer (Technical Services) prior to the start of work.

In general, the applicating equipment shall be a mobile, truck mounted and self-contained pavement marking machine, specifically designed to apply polyester marking material and reflective glass spheres in continuous and skip-line patterns. In addition, the truck mounted unit shall be provided with accessories to allow for the markings of legends, symbols, crosswalks, and other special patterns.

The applicator shall be capable of installing up to 20,000 lineal feet of polyester reflectorized pavement markings in an 8-hour day and include the following features:

1. The applicator shall be equipped with all the necessary spray equipment, pressure tanks, mixers, compressors and other appurtenances to allow for the placement of polyester reflectorized markings.

2. The applicator shall be equipped with a glass bead dispensing equipment capable of applying drop-on type glass spheres at a minimum rate of 20 pounds per gallon of polyester compound.

3. The applicator shall be equipped with a pressure regulated air jet capable of removing dirt and debris from the pavement in advance of the polyester spray gun. The air jet shall operate when the marking material is being applied and shall be synchronized with marking material application or remain "on" at all times.

CONSTRUCTION DETAILS.

A. General. All pavement markings and patterns shall be placed as shown on the plans and in accordance with the New York State Manual of Uniform Traffic Control Devices.

Before any pavement marking work is begun, a schedule of operations shall be submitted for approval of the Regional Director or his authorized representative.

When pavement markings are applied under traffic, the contractor shall provide all necessary flags, markers, signs, lanes, etc. to maintain and protect traffic, and to protect marking operations and the markings until thoroughly set.

The application of pavement markings shall be done in the general direction of traffic. Striping against the direction of traffic flow shall not be allowed.

The Contractor shall be responsible for removing, to the satisfaction of the Engineer, tracking marks, spilled polyester or polyester markings applied in unauthorized areas.

When necessary, the contractor shall establish marking line points at twenty-five (25) foot intervals throughout the length of pavement or as directed by the Engineer.

B. Atmospheric Conditions. Polyester pavement markings shall be placed upon dry pavement surfaces. At the time of installation the pavement surface temperature shall be a minimum of 50 F and the ambient temperature shall be a minimum of 50 F and rising. The Engineer shall be the sole determiner as to when atmospheric conditions are such as to produce satisfactory results.

C. Surface Cleaning and Preparation of Pavement. The contractor shall be responsible for cleaning the pavement surface to the satisfaction of the Engineer.

Surface cleaning and preparation work shall be performed only in the area of the polyester markings application.

At the time of application, all pavement surfaces shall be free of oil, dirt, dust, grease and similar foreign materials. The cost of cleaning these contaminants shall be included in the bid price of this item.

D. Application of Polyester Reflectorized Pavement Markings. When applicable surface preparation work is complete, the polyester pavement markings shall be spray applied, at ambient temperatures. If necessary the material may be heated to 100°F to improve flow and dry time.

The entire contents of each material container (resin and catalyst) shall be transferred to the applicators' tank(s) and mixed in accordance with the manufacturer's instructions for use.

The material shall be continually mixed at all times during application. Thinning shall not be permitted.

Applied markings shall have clean-cut edges, true and smooth alignment and a uniform wet film thickness of not less than 15 mils nor more than 20 mils. Immediately after application drop-on reflective glass spheres shall be uniformly applied over and into the wet marking at a minimum rate of 20 lbs. per gallon of polyester compound.

The resin/catalyst ration shall be adjusted by the contractor in such a manner that the applied markings dry to a "no-pick-up" condition in approximately 30 minutes. Over-use of the catalyst resulting in bleeding of bituminous material and/or oil to the top surface of the pavement marking material shall not be allowed. Under-use of the catalyst resulting in excessively long dry times and increased changes for tracking of the pavement marking material shall not be allowed.

METHOD OF MEASUREMENT. Pavement striping will be measured by linear feet along the centerline of the pavement stripe, and will be based on a 4-inch wide stripe. Measurement for striping with a plan width greater or less than the basic 4 inches as shown on the plans or as directed by the Engineer, will be made by the following method:

$$\frac{\text{Plan Width of Striping (inches) X Linear Feet}}{\text{4 (inches)}}$$

No payment will be made for the number of linear feet of skips in the dashed line.

Letters and symbols will be measured by each unit applied. A unit will consist of one letter or one symbol. Example: "SCHOOL" would be measured as six units.

BASIS OF PAYMENT. The accepted quantities of markings will be paid for at the contract unit price, which shall include the cost of furnishing all labor, materials and equipment to satisfactorily complete the work. The cost for maintaining and protecting traffic during the marking operations shall be included in the price bid. The cost for removal of existing pavement markings will be paid under separate items and are not included in this item.

Payment will be made under:

Item No.	Item	Pay Unit
91685.0705	White Polyester Reflectorized Pavement Stripes	Linear Feet
91685.0706	Yellow Polyester Reflectorized Pavement Stripes	Linear Feet
91685.0707	White Polyester Reflectorized Pavement Letters	Each
91685.0708	White Polyester Reflectorized Pavement Symbols	Each