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EFFECT OF WIDTH  
ON  
EDGELINE LIFE  
  
FINAL REPORT

BY

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16. Abstract <p>The objective of this investigation was to determine the increase in the useful life of painted edgelines as a result of increasing its width. The investigation was conducted in two phases, each lasting about a year. In the first phase, test sites were striped with only the standard 4" wide edgelines as a control measure to document line wear characteristics and to identify locations exhibiting unusual line wear and paint peeling and cracking conditions. In Phase II, each of the selected test sites were restriped with sections of 4" (for control), 6" and 8" wide edgelines. Retro-reflectance data collected did not demonstrate any increase in the useful life of either the 6" or the 8" wide edgelines.</p>			
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## I. INTRODUCTION

### A. Problem Statement

Pavement edgelines are used to provide an edge of pavement reference for the guidance of drivers, especially during adverse weather and visibility conditions. Edgelines do, however, become worn and faint and have to be periodically restriped to maintain their color and reflectivity.

Although great strides have been made in the development of longer lasting paint formulations, edgelines at some high traffic density locations can become worn and faint within 4 to 6 months after application. The need for frequent restriping not only reduces the time Maintenance has to do other as important tasks, but the operation is disruptive to traffic and exposes the crew to a very hazardous condition.

### B. Background

In the spring of 1954, New Jersey became the first state in the nation to use a white reflectorized line to delineate the edge of a highway.(1) At first the lines were only painted on black top roadways, but public opinion was so strongly in favor that the program was expanded to include all state highways. Since 1954, numerous studies (summarized in NCHRP 130) have investigated the effects of edgeline on driver behavior and accident experience. These studies generally conclude that edgelines are an effective and cost-beneficial measure which stimulates a driving behavior which

increases safety and capacity. This is based on the theory that edgelines cause drivers to look further down the road and thus increase their awareness of potentially hazardous situations.(2) This additional guidance may also be an accident reduction factor.(2) Hence, because of these advantages and the strong public opinion edgelines are now a mandatory safety feature which is applied and maintained on all highways.

Although in New Jersey most edgelines are re-stripped once a year, in some high traffic density areas edgelines need to be restriped two to three times a year to maintain their effectiveness. Since it is often difficult to maintain effective delineation in some heavy traffic density locations, a longer lasting line was desired. One approach, suggested by our Maintenance Personnel to extend the effective life of edgelines, was to apply edgelines wider than the standard 4" line.

Typically, painted lines wear due to tire abrasion, cracking and chipping. This causes a decrease in reflectivity with progressive loss of beads. Use of a wider edgeline was anticipated to improve lane discipline and thus reduce wear from on-line driving for a longer period. A wider line was also expected to last longer by the simple fact that there are more beads to be worn off and most likely the edge farthest away from the traffic would not be worn as much as the edge closest to the traffic. Therefore, this narrow strip of glass beads which would remain on the pavement for a longer duration should result in an extended period of effective nighttime delineation.

Many European countries currently use wide lines to delineate the edge of pavement on the belief that wide edge delineation is even more valuable than center lines as a safety feature (NCHRP 130). A Canadian study (3) found that wider markings were seen earlier on the road and more clearly delineated the driver's path. The study examined both 8" and 12" wide lines and found that the 8" condition was preferred.

Hence it was anticipated that a wider than normal edgeline may result in extended life and improved delineation to the motoring public. A wider line was not expected to result in a cost savings. However, a moderate increase in the cost of maintaining effective edgelines would be acceptable when coupled with an increase in the edgeline life.

#### C. Study Objective

The objective of this investigation was to determine the increase in the useful life of a painted edgeline as a result of increasing its width. Since current equipment is capable of striping lines up to 8" wide, this study examined both 6" and 8" wide edgelines.

## II. STUDY PROCEDURES

#### A. Study Design

The investigation was conducted in two phases, each lasting about a year. In the first phase, test sites were striped with the standard 4" wide edgelines as a control measure to

document line wear characteristics and to identify locations exhibiting unusual line wear, paint peeling, and cracking conditions. In Phase II, each of the selected test sites were restriped with sections of 4", 6" and 8" wide edgelines.

B. Test Sites

Six test sites (figure A), each about three miles long, were selected on the basis of traffic volumes and roadway characteristics. The condition of the pavement and shoulder were considered in the site selection. Only sites with a good pavement surface were chosen to ensure that the edgeline life measured would be that due to wear from traffic induced abrasion and weathering, and not due to pavement cracking or obliteration by crack fillers and patching material. The lane width at the selected sites were 11-1/2 to 12 feet wide and shoulders averaged about 10 feet.

Two of the six sites were located on two lane undivided roads (Rt. 31 & 29) with bituminous surface. Both sites are characterized by forested surroundings, moderate hills and curves, and a posted speed limit of 50 mph. The Route 29 site, with an AADT of about 2000/lane, was selected to document the edgeline wear that occurs mainly due to environmental exposure. The Rt. 31 site, with an AADT of about 5,000/lane, was selected because of the large proportion of trucks using this road. Rapid wear was anticipated here since trucks have been observed to frequently ride over the edgeline, especially when opposing trucks pass each other.

# TEST SITE IDENTIFICATION

Figure A

PHASE I TEST LOCATIONS

PHASE II TEST LOCATIONS

	Route 29 Kingwood Twp.	Route 31 Hopewell Twp.	Route 202 (Northbound) Readington Twp.	Route 202 (Southbound) Readington Twp.	Route 22 (Westbound) Greenbrook Twp.	Route 22 Union Twp.
AADT / Lane	2000	5000	6000	6000	11,000	17,000
Number of lanes	2	2	4	4	4	4
Pavement type	Bituminous	Bituminous	Concrete	Bituminous	Bituminous	Bituminous
Lane width	12'	12'	11.5'	11.5'	12'	12'
Shoulder width	10.5'	8'	10'	10'	10'	10'
Median type	undivided	undivided	30' Grass	30' Grass	Medium Barrier	Commercial Development

Two other sites were located on a straight section of a four lane highway (Rt. 202) divided by a 30 ft. grass median. This section of road has an AADT of about 6,000 vehicles per lane and is characterized by fairly open surroundings with hilly terrain, no curves and a posted speed limit of 55 mph. This section of road was selected mainly due to the fact that the pavement in one direction is concrete, while the other side is bituminous. This allowed us to compare the edgeline wear characteristics for the two types of pavements under similar traffic and environmental conditions. In addition, wear of the median (yellow) edgelines was also investigated at these two sites.

The fifth site was also located on a four lane highway (Rt. 22 in Greenbrook) but divided by a median barrier. This section of road has an AADT of about 11,000 veh/lane and is characterized as heavily commercial with numerous driveways. Severe wear was anticipated at this site. A sixth site located on Route 22 in Union and with an AADT of 17,000 vehicles/lane was selected for evaluation during the second phase of the study..

### C. Evaluation Procedure

The edgelines were evaluated approximately every 6 weeks using procedures established in ASTM standard method D-713, titled "Conducting Road Service Tests on Traffic Paint" and by use of a retro-reflectometer. The edgelines were evaluated on the basis of their appearance, durability and nighttime visibility.

The appearance evaluation was conducted in the daytime and consisted of the complete impression conveyed by the line when viewed from a moving vehicle. The appearance was rated on a scale from 0 to 10, where 10 was considered excellent and 0 completely unsatisfactory. The appearance evaluation was estimated purely in terms of appeal to the observer.

The durability evaluation consisted of determining the percentage of paint material remaining on the pavement. This was done using reference photos prescribed by ASTM methods D-281 and D-913 for evaluating the degree of chipping and erosion wear of painted lines. A scale of 0 to 10, where 10 equals 100% intact and 0 equals complete failure, was used.

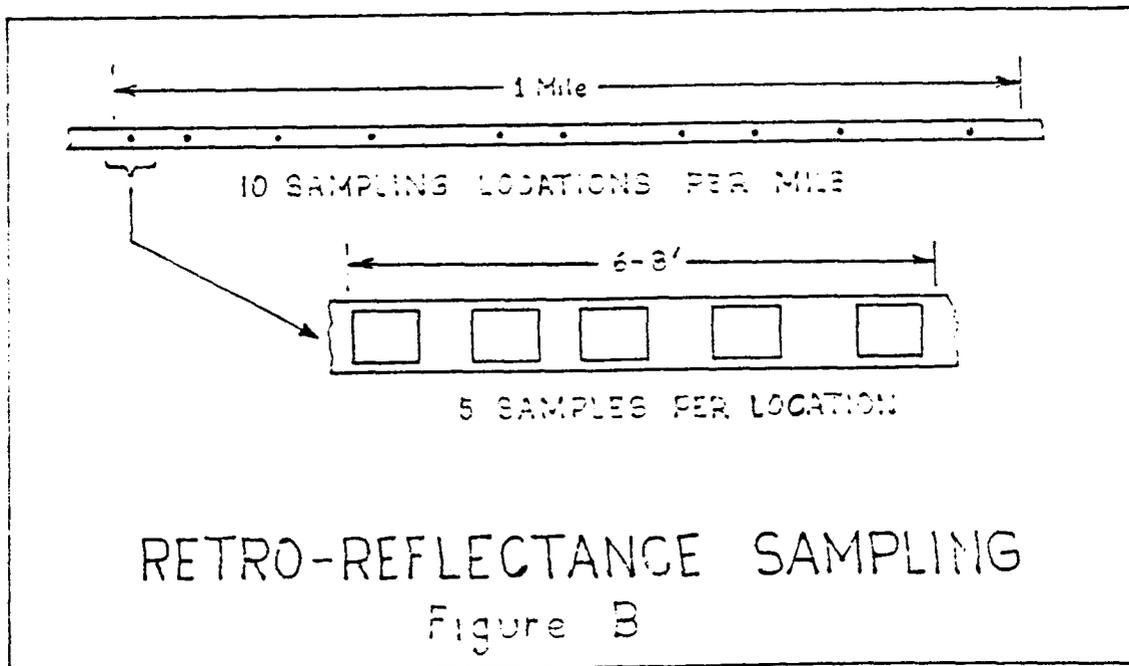
The nighttime visibility evaluation was conducted using a retro-reflectance device. This option was chosen in place of subjective human observations on the belief that a photometric device would yield more reliable results, especially when comparing the wear of the left and right side of an 8" wide line.

At the time this study was being planned, two types of retro-reflectometers were available. High incidence angle (86-87°) commercial devices and a low incidence angle (75°) Michigan device. The commercial high incidence angle retro-reflectometers better approximate the geometry experienced by a driver, in a typical sedan, but reportedly, had some stability problems, were sensitive to temperature changes and were heavier and more cumbersome to operate.(4) Additionally, during the planning stage of this project, several of the commer-

cial devices were still undergoing modifications which were untested at the time. Since retro-reflectance data was planned to be collected during summer and winter months the more reliable and stable Michigan design was selected for the study.

A copy of the Michigan design retro-reflectometer was assembled with assistance from the Michigan and Pennsylvania DOT's. The unit was calibrated using a cold plastic sample supplied by PennDOT. The sample was taken from the same stock previously used by PennDOT and several other agencies to calibrate their devices.

The retro-reflectance of each of the 10 locations was based on the average of 5 samples taken within a 6 to 8 foot section of the line. (fig. B) The retro-reflectance of each one mile section of test line was thus the average of 50 samples.



### III. RESULTS AND DISCUSSION

#### A. Phase I

In first phase of the study all three mile long sections at each of the five test sites were striped with the standard 4 inch wide edgeline. New Jersey DOT standard chlorinated rubber paint and moisture proof glass beads were applied using current standard paint line application procedures. Retro-reflectance data as well as durability and appearance observations were collected at 4 to 8 week intervals for a period of about a year. The data collected demonstrated that the average retro-reflectance of each section changed at about the same rate. (Figures 1 to 10) with two exceptions. One section at the Route 31 NB site, (fig. 1) and one at the Route 202 SB edge, (fig. 4), where the initial retro-reflectance was much higher, the decrease in retro-reflectance during the first 6 months was slightly more accelerated. The higher initial retro-reflectance was due to greater bead concentration on the line. As the bead application exceeds the optimum 5 lbs/gal of paint (6), the excess beads are not fully embedded in the paint. The beads which remain on the surface or become only partially embedded in the paint are then prone to being more easily dislocated by tire abrasion and hence the result is an accelerated drop of the initially higher retro-reflectance.

Although the striping crews exercised reasonable care painting the test lines in accordance with current specifications, retro-reflectometer data indicated that the glass beads are not always applied to the paint uniformly. As the retro-

reflectometer is moved along a section of painted line, the retro-reflectance continuously varies, but remains within a narrow band of upper and lower limits. The variation is more pronounced when the line is freshly painted and decreases over time as the line wears down. Since this variation is not easily detectable visually, it is accepted as being normal.

Although the retro-reflectance of the lines generally decreased gradually over time, there have been some occasional sharp drops and rises. The sharp drops were mainly due to excessive dirt and mud, caused by local construction activities, accumulating on the line and temporarily decreasing it's retro-reflectance. The retro-reflectance was usually restored, rising back up, after rain washed the dirt and mud off the line. In general, however, the retro-reflectance at each site changed at aboutg the same rate throughout the test period.

The durability rating of the lines remained unchanged throughout the one year period. No line damage due to cracks in the pavement or loss of line due to peeling of multi-layers of old paint occured. The appearance observation rating of the test lines also did not change noticeably as all lines remained relatively clean with the exception of some localized sections where the lines were temporarily dirtied by construction generated mud.

Although retro-reflectometer data indicates a gradual decrease in retro-reflectance over the one year period, from a drivers point of view the nighttime visibility of the lines remained practically unchanged. One year after application all lines could still be seen as far as a standard sedans headlights (high beams) illuminated. A rough extrapolation of retro-reflectometer data indicated an effective line life of about 2 to 3 years instead on the anticipated one year. Therefore, an additional test site with much higher AADT was selected for evaluation during phase II. This site has an AADT of 17,000 vehicles/lane, almost twice the traffic volume of the route 22 in Greenbrook or the route 202 sites. The route 29 site which had the lowest traffic volume and exhibited practically no wear, was not evaluated in the second phase. It was quite evident that edgeline life under very low traffic volume conditions will be mostly affected by the environment and aging factors rather than abrasion from tires.

B. Phase II

During the second year of the study, each test site was striped with mile long sections of 4, 6, and 8 inch wide edgelines. One exception was the new Route 22 site in Union. Where the westbound edgeline was striped with the standard 4 inch line while the Eastbound side was striped with an 8 inch wide edgeline.

The widelines were applied by raising the paint and glass bead guns and making adjustments in the flow rate of the paint

and beads and the speed of the truck. One exception to this method was the Route 31 test site where the 8 inch wide edgelines were constructed by the application of two 4 inch lines sprayed side by side in two passes. Either way the 6" and 8" wide lines were essentially 4" lines that were made 1 1/2 or 2 times as wide with a proportional application of paint and beads.

The rate of change in retro-reflectance between the 4, 6, and 8 inch wide lines remained practically the same at each test site. (Figs. 1 to 10) It was anticipated prior to the start of the study that the wider lines would wear at a slower rate. This was based on the premise that the wider lines would command more attention thus causing drivers to drive more centrally in the lane and hence reduce line wear from tire abrasion. This expectation, however, did not materialize as all lines seemed to wear at identical rates even at sites such as Route 22 in Union where both the 4" and 8" lines were completely worn down within 6 months. It was also anticipated that the right side of a wide edgeline would not be worn as much as the left side of the line which is closest to the traffic. A comparison of the retro-reflectance data of the right side vs. the left side of 8 inch wide lines (Figs. 11a to 11d) did not demonstrate any practical differences in retro-reflectance.

In visual observations of the lines in both daytime and nighttime, the 8 inch wide edgeline appeared to be bolder and more pleasing to eye. However both the 4 and 8 inch lines

were visible for as far as a vehicles headlights illuminated them at night. The one exception was Rt. 22 in Union where the lines decreased in retro-reflectance quite rapidly and visual observations were difficult because of the heavy traffic and artificial illumination at night.

#### IV. CONCLUSIONS

The evaluation did not demonstrate any practically significant difference in the reflectance of the wide edgelines compared to the standard 4" lines. The retro-reflectance of both the 6 and 8 inch wide lines changes at about the same rate as the standard 4 inch edgelines. This was true for all sites whether exposed to rapid wear ( Rt. 22 - Union) or slow wear (Rt. 31). Also, since the right, center, and left sections of 8" wide lines changed at practically identical rates, it was concluded that the wide lines did not change driving characteristics as anticipated.

Implementation of wide (6 or 8 inch) edgelines is hence not recommended as a measure for reducing the frequency of striping operations. Both 6 and 8 inch wide edgelines would need to be re-striped at the same frequency and the standad 4 inch edgeline.

Although a wide line does seem more appealing to the eye, especially the 8" wide, it's value as a safety measure is questionable as a result of some recent studies (13, 14, 20) conducted by others. A New Mexico(14) study found no practically significant differences in the lateral placement and speed of vehicles exposed to 8 inch wide edgelines. A subsequent study (20) concluded that the 8 inch edgelines also had no significant effect on Ran-off-the Raod accident frequency and the frequency of related accident types. Another study conducted in Virginia (13) found that there was no practically significant shift in lateral placement of vehicles when an 8 inch wide line was used for edgeline delineation. In consideration of the above findings and

the conclusions of our own study, one is hard pressed to justify use of 8 inch wide edgelines.

Extended delineation may, however, be achieved by use of the so called long life lines and raised pavement markers. A study is currently being conducted by the NJDOT to evaluate several types of long life markings, including two part epoxies, tapes, and raised pavement markers. The cost of using these materials will be much higher than standard paint but the expected service life being anticipated should also be much longer.

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APPENDIX

- A. Retro-reflectance plots - Figures 1-10
- B. Wear pattern of 8" wide lines - Figures 11a-11d

Note: The retro-reflectance scale used in the following plots is a relative scale which allowed for a comparison of the lines performance over time to be made. This is not an absolute scale.

Figure 1  
Rt. 31 SB - Hopewell Twp.

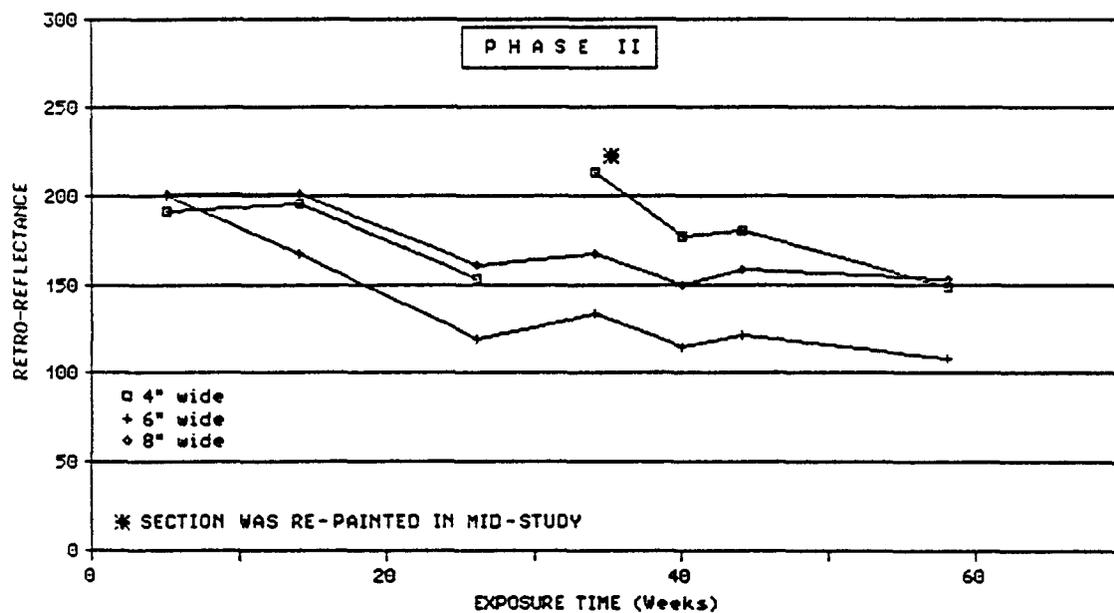
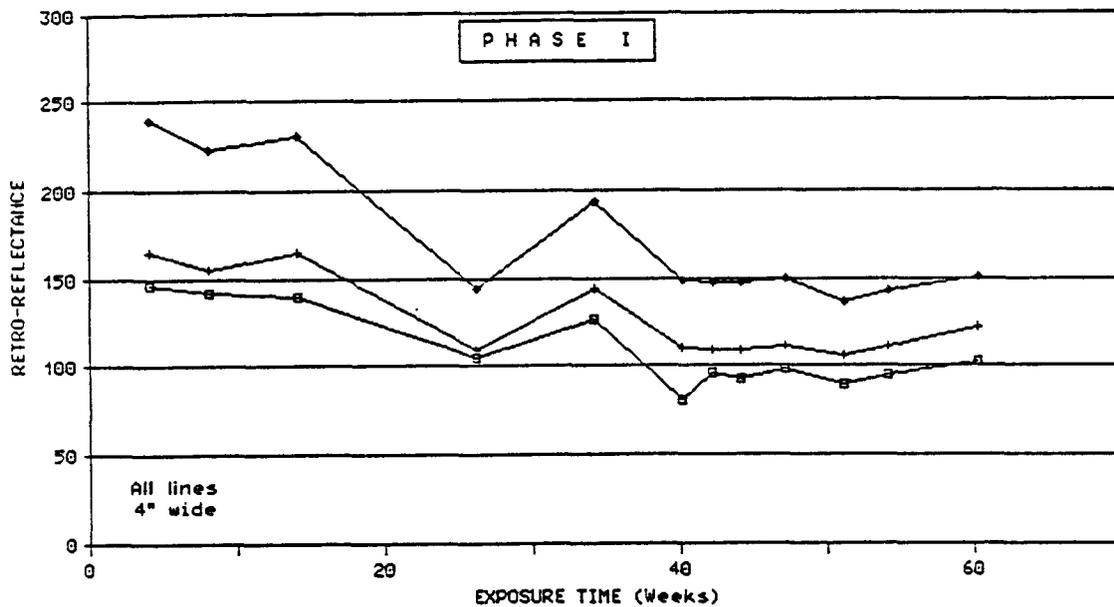


Figure 2

Rt. 31 SB - Hopewell Twp.

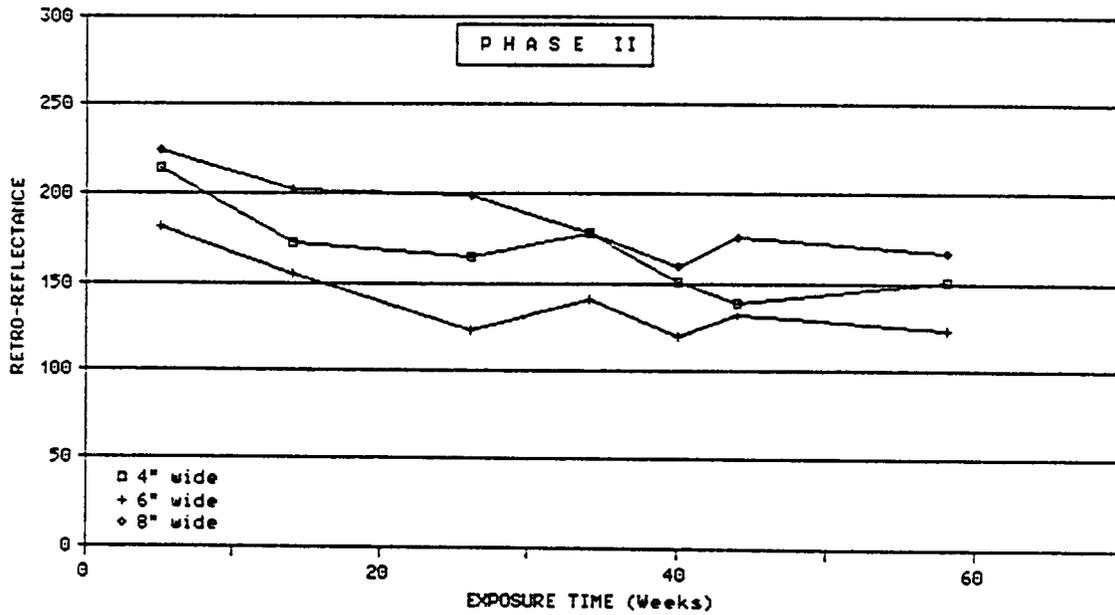
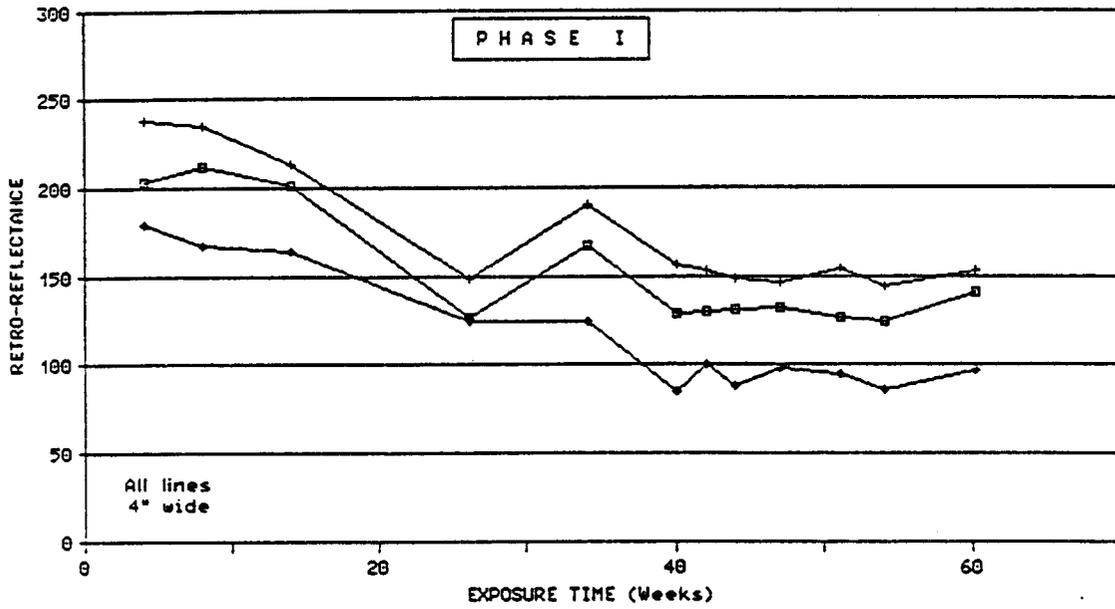


Figure 3  
Rt. 202 NB (EDGE) - Readington Twp.

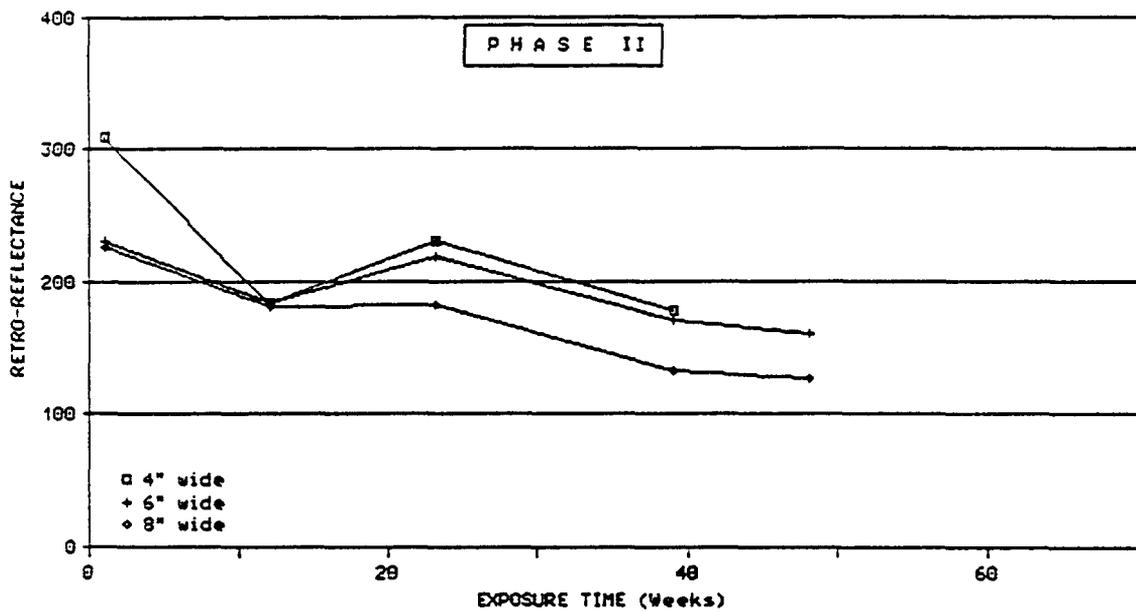
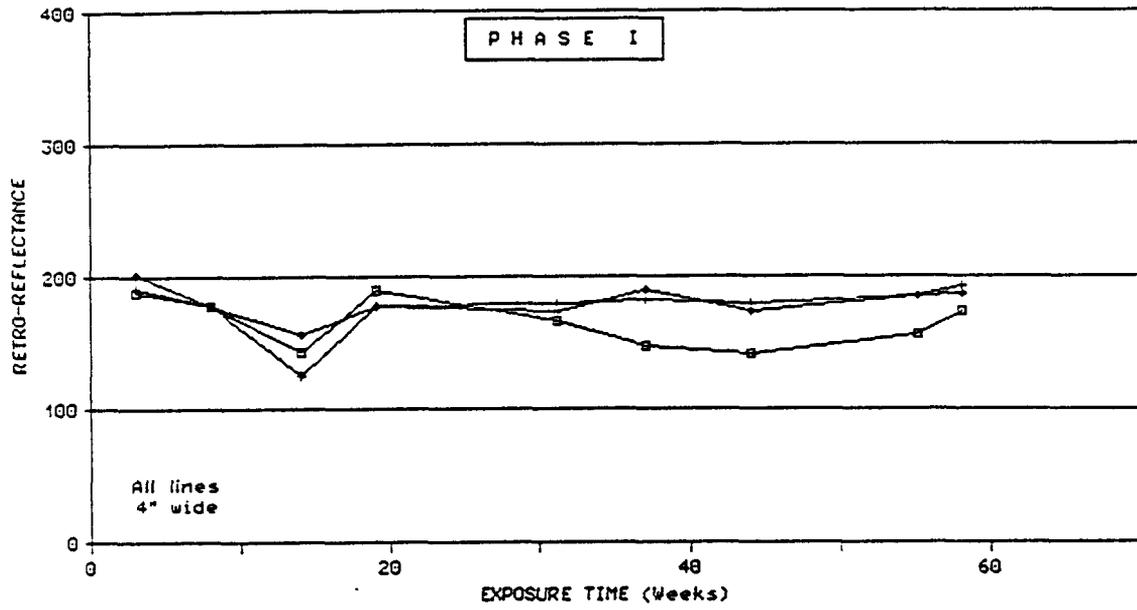


Figure 4  
Rt. 202 SB (EDGE) - Readington Twp.

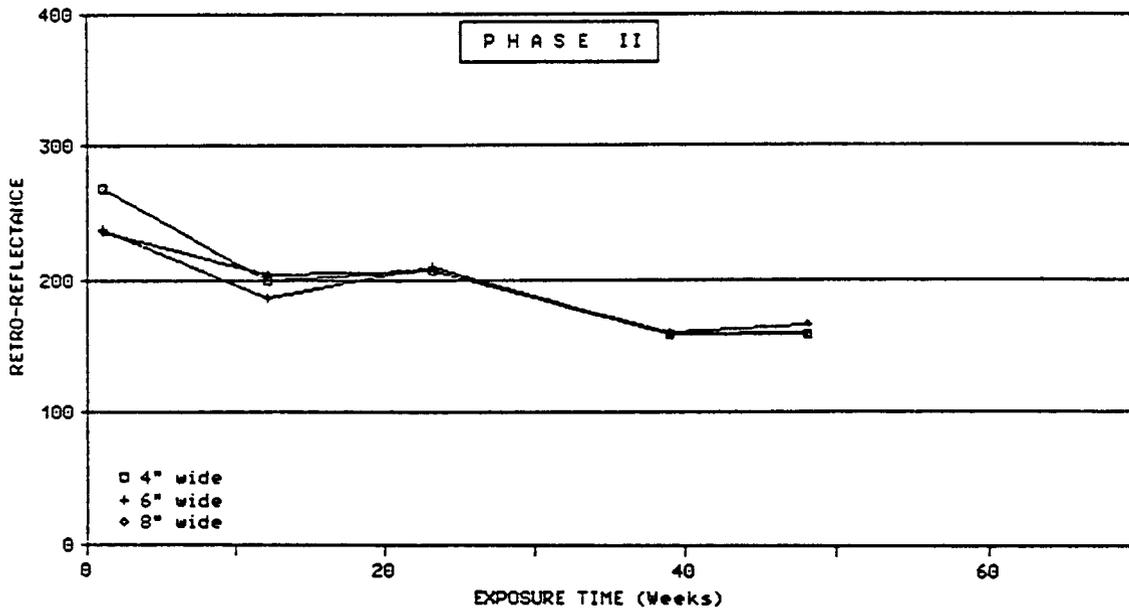
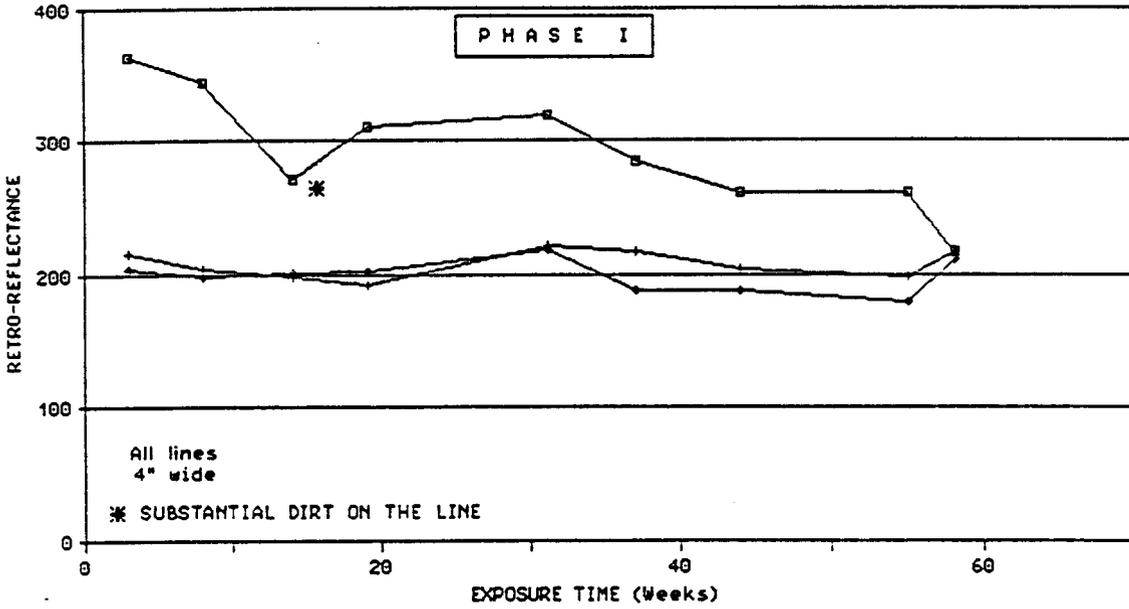


Figure 5  
Rt. 202 NB (MEDIAN) - Readington Twp.

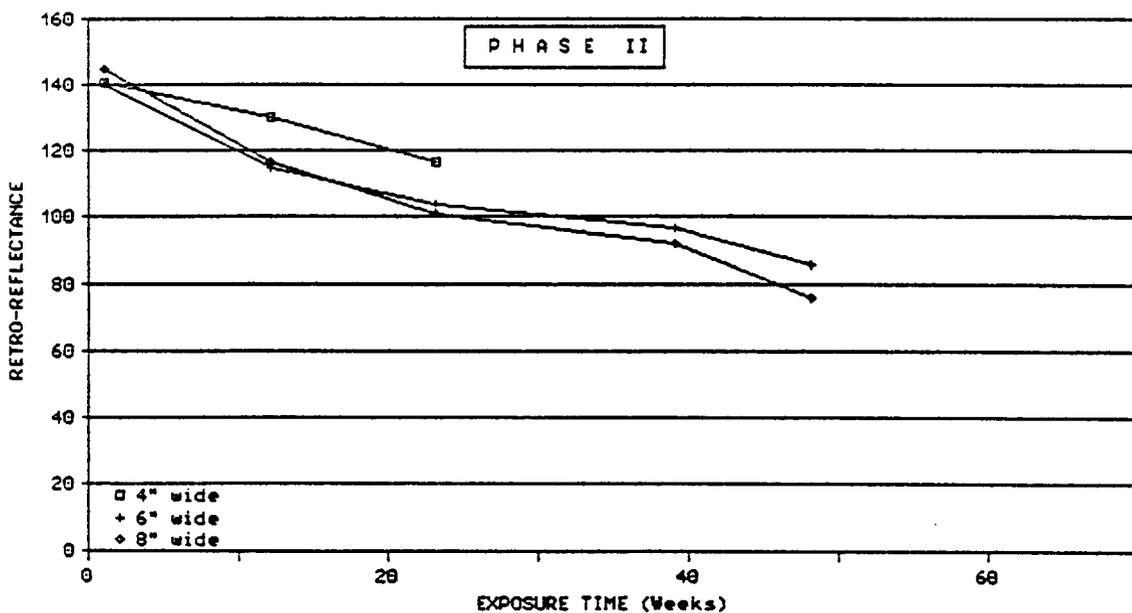
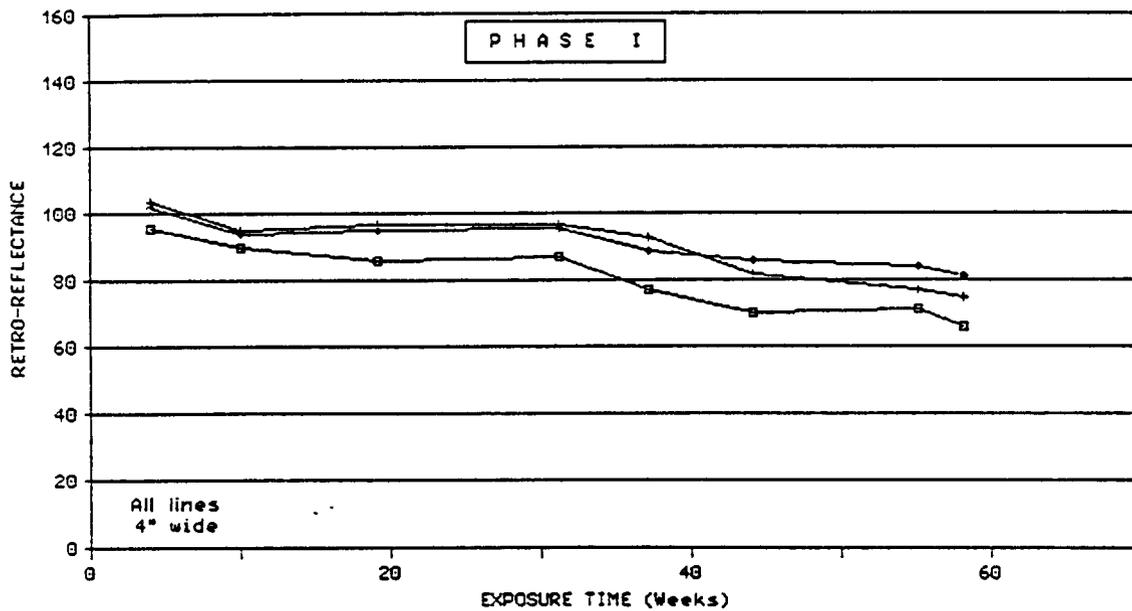


Figure 6  
Rt. 202 SB (MEDIAN) - Readington Twp.

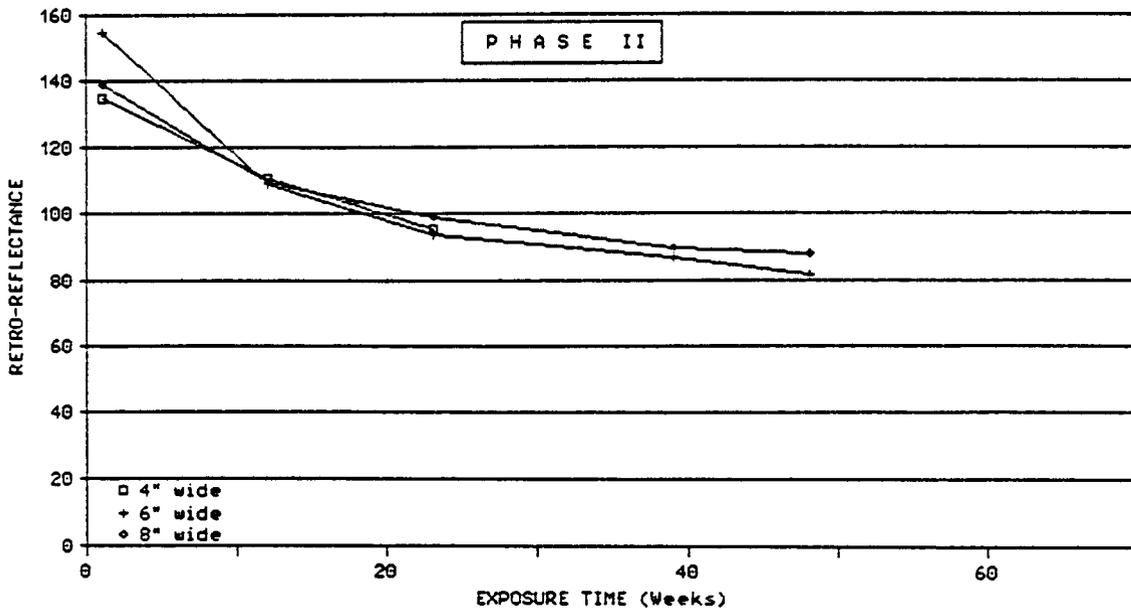
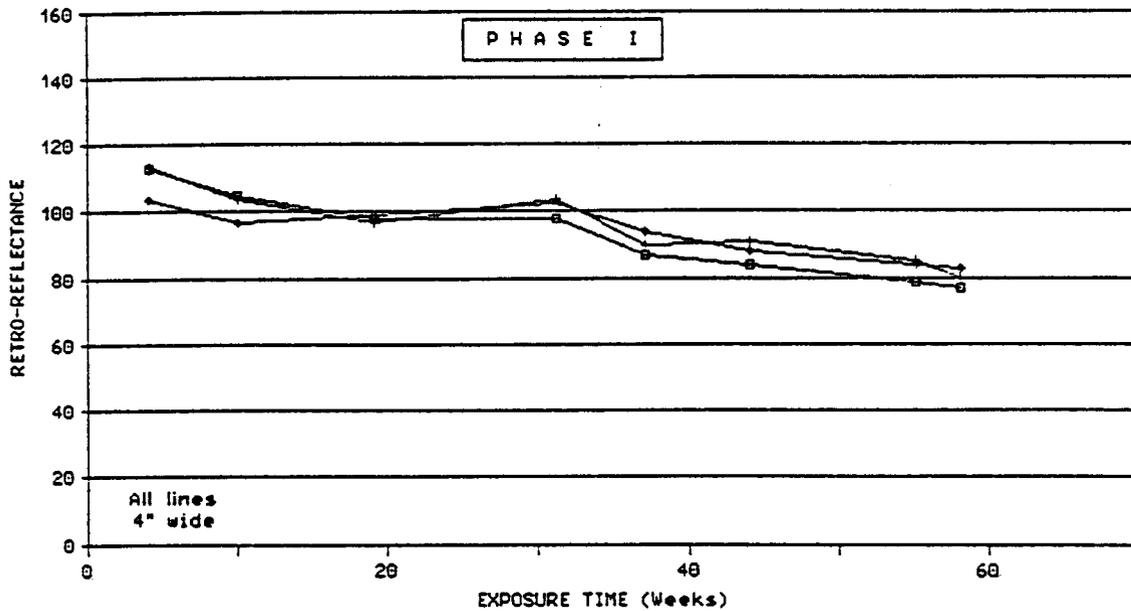


Figure 7  
Rt. 22 - Greenbrook Twp.

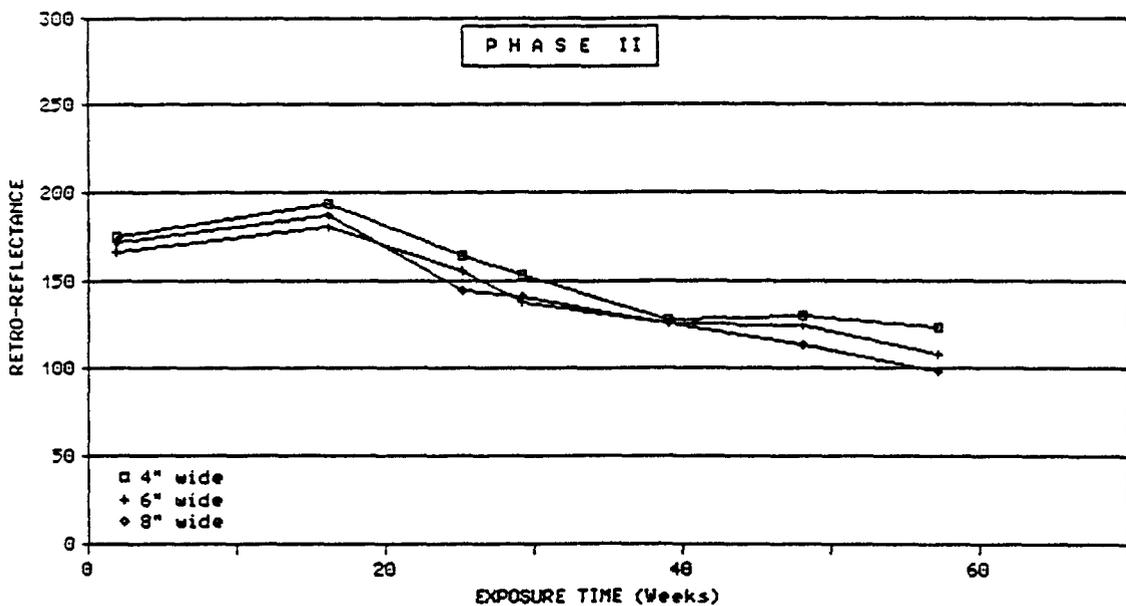
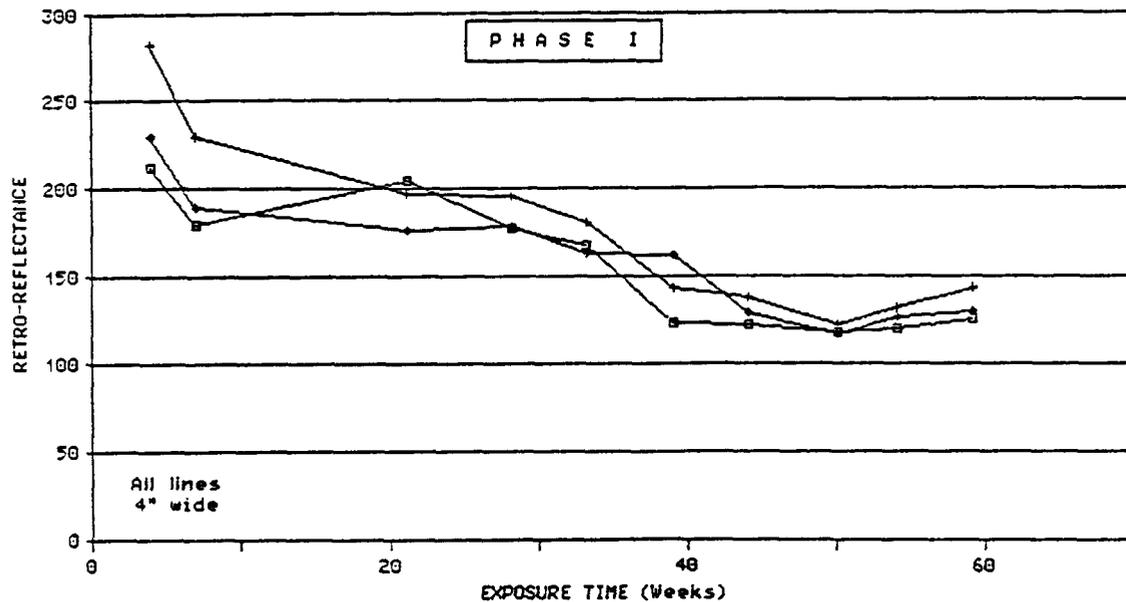


Figure 8  
Rt. 29 NB - Kingwood Twp.

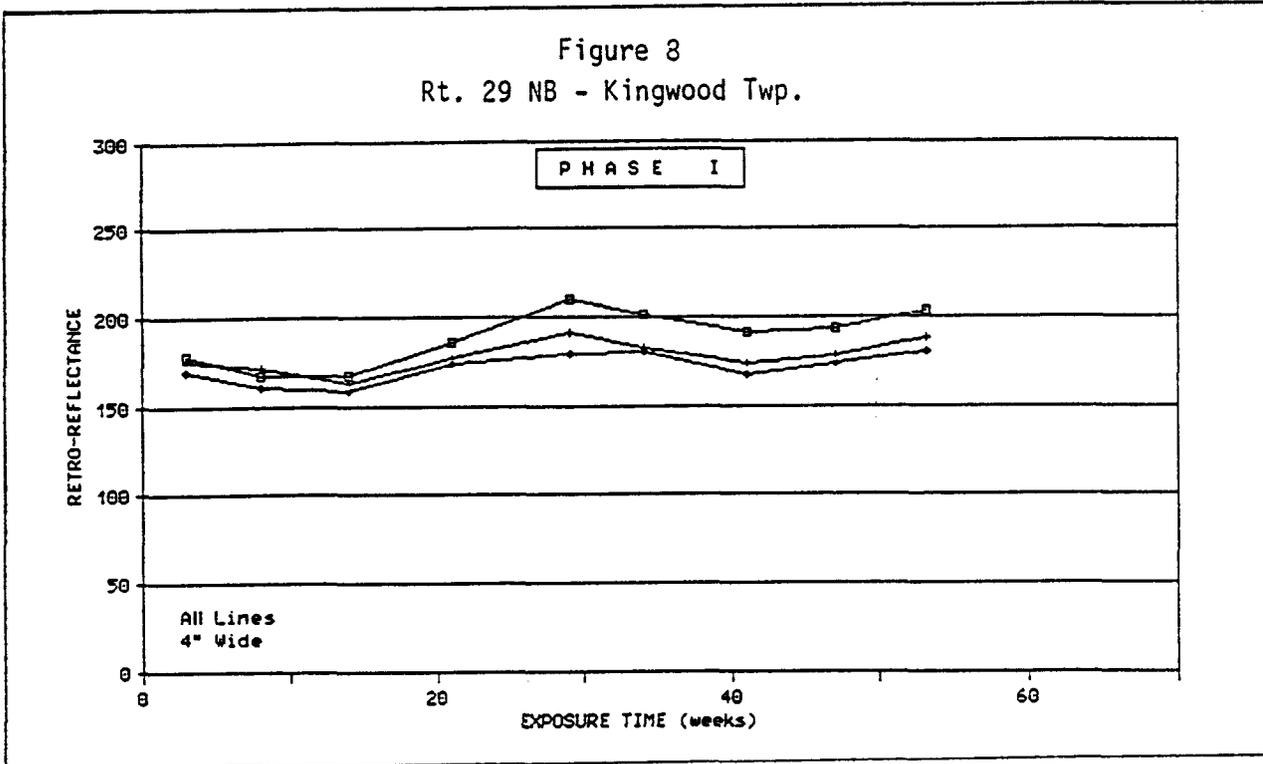


Figure 9  
Rt. 29 SB - Kingwood Twp.

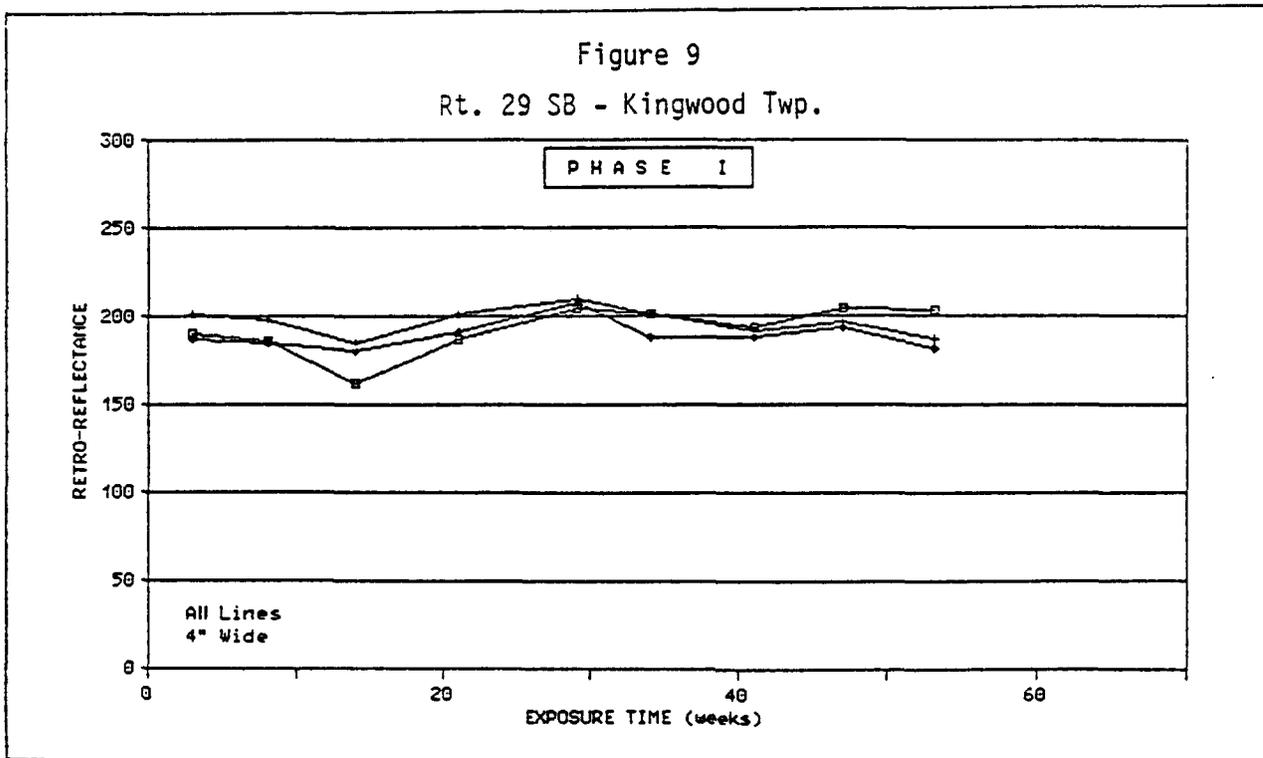


Figure 10  
Rt. 22 - Union Twp.

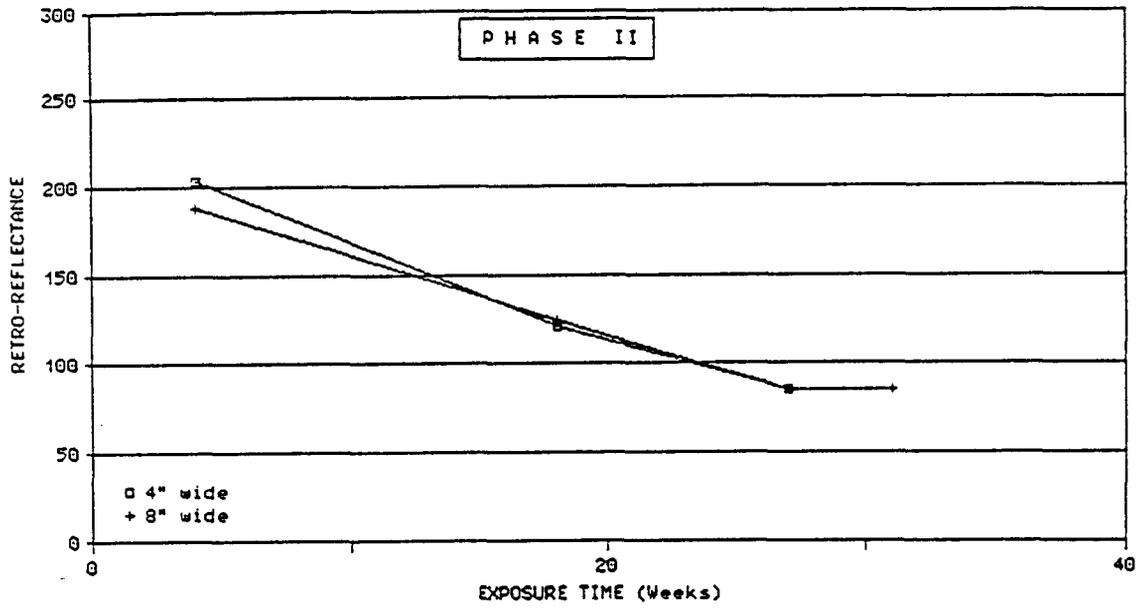


Figure 11a  
Wear Pattern of 8" Wide Lines

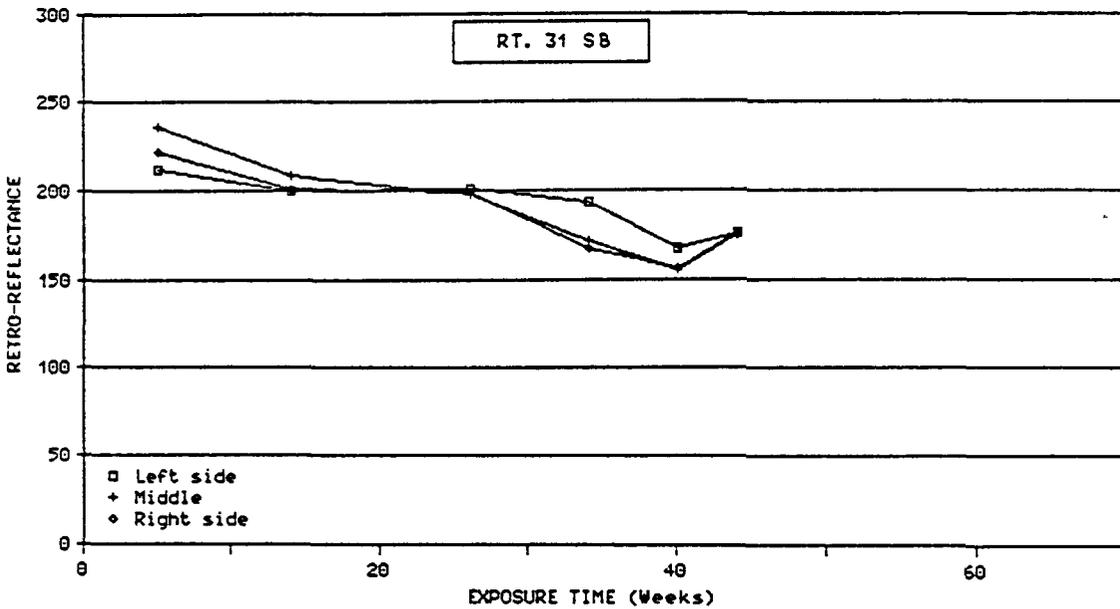
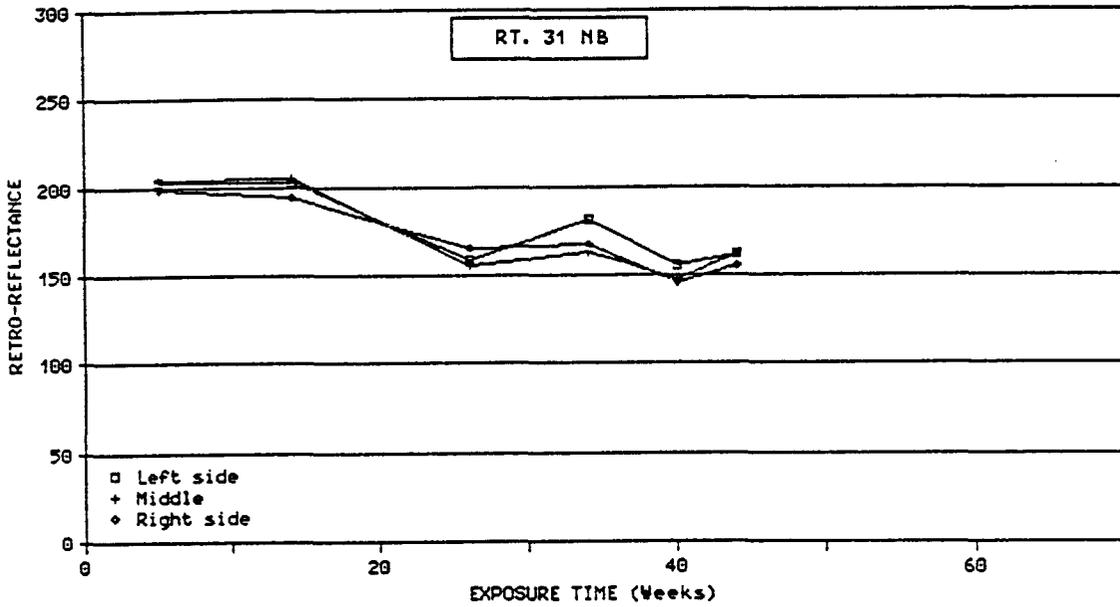


Figure 11b  
Wear Pattern of 8" wide lines

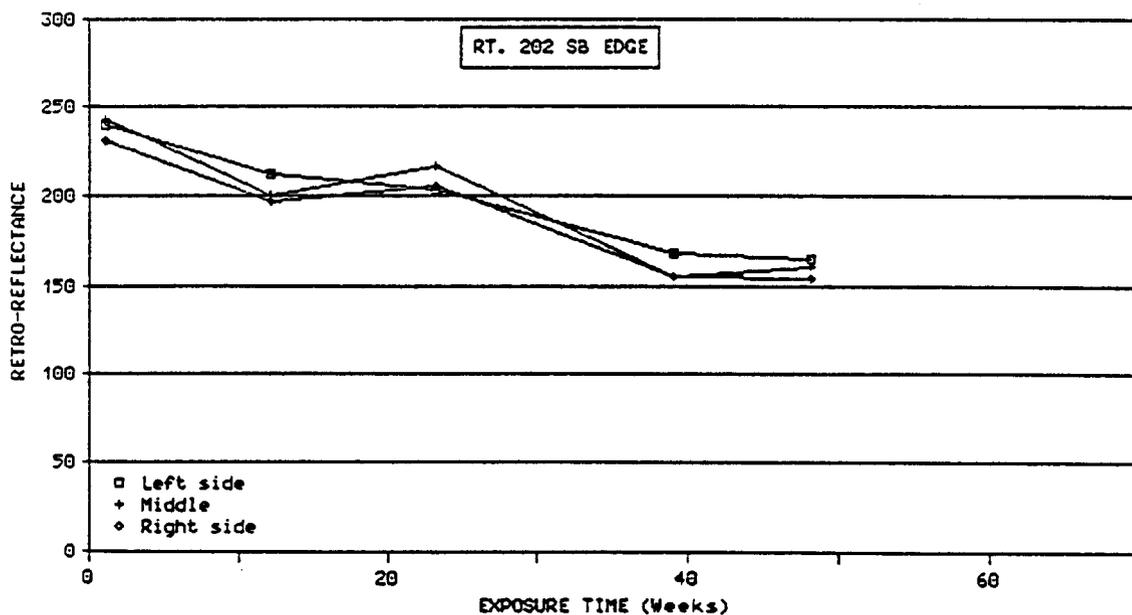
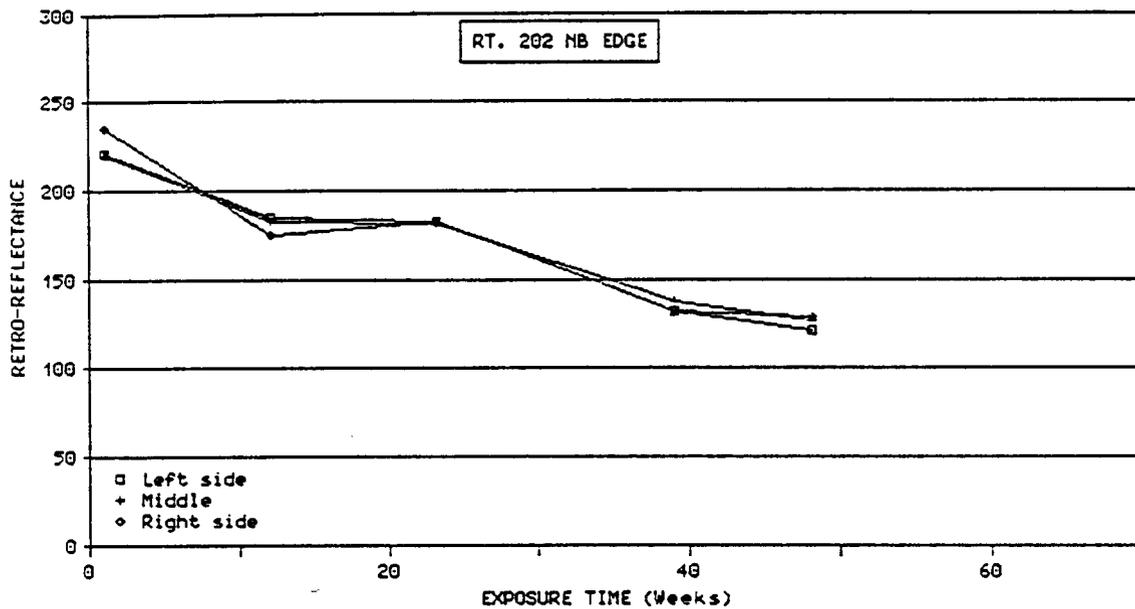


Figure 11c  
Wear Pattern of 8" Wide Lines

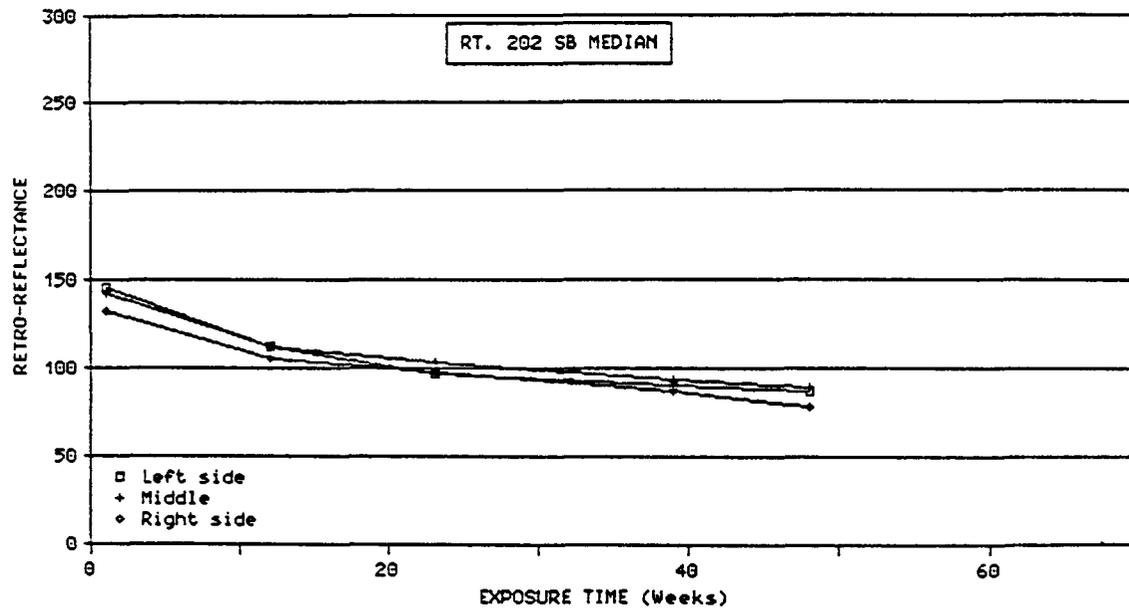
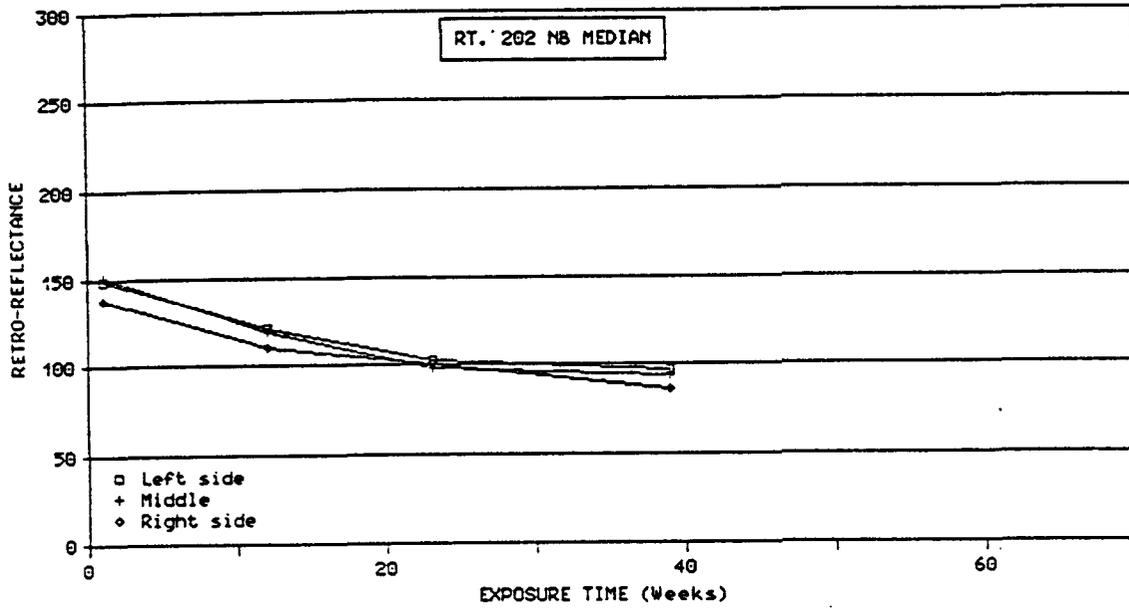


Figure 11d  
Wear Pattern of 8" Wide Lines

