Research Report
KTC-96-19

EVALUATION OF PORTABLE RETROREFLECTOMETERS

National Transportation Product Evaluation Program

prepared by

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University of Kentucky

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

Portable retroreflectometers have been used to compare the reflectivity of the various pavement marking materials. The Mirolux 12 has been used to collect reflectivity data for the products tested for the National Transportation Product Evaluation Program (NTPEP). The Mirolux 12 does not have a 30 meter geometry, and there has been a desire to explore the possibility of using a retroreflectometer which has a 30 meter geometry which may better simulate the view of a driver. The objective of this report is to compare data taken with the Mirolux 12 and two other portable retroflectometers having the 30 meter geometry.

2.0 PROCEDURE

As part of the standard data collection used at the NTPEP test decks, reflectivity data are taken monthly for a period of one year after application of the test lines. Data are taken for a second year for long-life materials.

A total of 173 materials were placed in Kentucky in 1995. When divided into specific categories, 110 materials would be classified as a paint (including 10 durable type paints), 35 as a thermoplastic, 8 as a preformed thermoplastic, 13 as a nonremovable tape, and 7 as a removable tape. A listing of the materials placed in Kentucky in 1995 is given in "Volume I. Field Evaluations; Summary of Results of 1995 Field and Laboratory Evaluations of Pavement Marking Materials."

The material is placed on both an asphalt and Portland cement concrete test deck. The test sites in Kentucky were in the eastbound lanes of Interstate 64 near Frankfort. At the test sites, Interstate 64 is a rural, four lane highway with a speed limit of 65 mph. Both sites had a daily traffic count of about 20,000. The materials were placed in June 1995.

Four transverse lines are placed in the right lane for each material except the removable tapes. Reflectivity measurements are taken in the left wheel track and center of the right lane. For the removable tapes, six transverse and six longitudinal lines were placed, with one line removed each month such that all the lines were removed by December 1995.

In addition to the monthly data collected by the Mirolux 12, data were collected using two additional portable retroreflectometers for three of the months. Data were collected using the three instruments in June 1995. This was the first measurement taken of the reflectivity for the materials. All three instruments were also used in October 1995 and May 1996. Data were also taken with a second Mirolux 12 in May 1996.

The LTL2000 and the Retro-Lux Model 1500 retroreflectometers were used as a comparison to the Mirolux 12. All three were portable types of instruments. Data were collected on each line using the Mirolux 12. As much data as possible were collected using the other two instruments. Battery life prevented data collection for all the test lines using the other instruments. Comparisons were only made using test lines where data were collected using all three instruments. Linear regression was used to determine the relationships.

3.0 DESCRIPTION OF RETROREFLECTOMETERS

All three of the devices used were portable with digital readouts. The retroreflectometers used in the tests were the Mirolux 12, LTL2000, and Retro-Lux 1500. The units of measurements were millicandelas per square foot per footcandle (or millicandelas per square meter per lux). All devices used rechargeable batteries as the power supply.

The Mirolux 12 has been used as the standard device to collect reflectivity data. It is manufactured in the United States. This instrument is 18 inches long, 6 inches wide, 9 inches high and weighs 14 pounds. It has both internal and external calibration plates. The light source is a 12 volt, 12 watt halogen lamp. The power supply is a 12 volt DC battery. Its measuring geometry consists of an 86.5 degree illumination angle and a 1.5 degree observation angle. The illuminated area dimension is 3.5 by 6.5 inches.

The LTL2000 is manufactured in Denmark. It is designed to measure data at a simulated distance of 30 meters. The information concerning this device notes it can be used on both dry and wet surfaces. All data were taken on dry surfaces. The maximum length is 28.3 inches, with a maximum width of 7.5 inches and a maximum height of 20.9 inches, and weighs 26.5 pounds. Its power supply is a 12 volt, 3 ampere battery. Its measuring geometry consists of a 1.24 degree illumination angle to the road and a 2.29 degree observation angle to the road. The field of measurement is 1.8 inches wide and 7.9 inches long.

The Retro-Lux Model 1500 is manufactured in the United States. It is also designed to collect data at a simulated distance of 30 meters. It has a fixed measurement geometry of a 1.05 degree observation angle and an 88.76 degree entrance angle. The measurement area is approximately 3.3 by 5.9 inches. The Model 1500 system has a data logger, which enables measurements in the field to be taken and recorded automatically for later transfer to a computerized system. An auxiliary battery is available to increase the number of readings that can be taken before recharging is necessary. It uses an external reference standard plaque but also has an internal reference. After placing the instrument at the proper location on the stripe and pressing the read button, it takes about 10 seconds for a reading to appear on the screen.

4.0 RESULTS

Data were collected for three different months (June 1995, October 1995, and May 1996). For each month, data were collected on both asphalt and PCC decks, and for various types of striping materials (paints, thermoplastics, and tapes). Comparisons were made between the Mirolux and the LTL2000, the Mirolux and the Retro-Lux, and the LTL2000 and Retro-Lux.. Also, the May 1996 data includes comparison of another Mirolux (referred to as the Mirolux B). Summaries of the data are given in Tables 1 through 3 for the three months. The tables show the number of data points, the best fit linear regression equation, and the correlation coefficient (R-square) value of the comparison as a function of the pavement type, retroreflectometers compared, material, and location (wheel path or centerline). The largest number of data points was for the paint due to the larger number of paint materials. The smallest number of data points was for the tapes. The number of data points for any given material varied from month to month because data collection was stopped because of either a low battery or a time constraint. The only reflectometer for which data was taken on all material for each month was the standard Mirolux.

Graphs were also prepared showing the data obtained for the various comparisons. These graphs are given in Figures 1 through 91. For each figure, the month, pavement type, type of material, location, and retroreflectometers compared are given.

The R-square values for the linear fits showed generally high values ranging from 0.65 to 0.98. The highest R-square values were found for the tapes with 23 of the 32 values over 0.90.

TABLE 1. COMPARISON OF RETROREFLECTOMETER DATA (JUNE 1995)

DECK	PRR COMPARISON	TYPE MATERIAL	LOCATION	DATA POINTS	R-SQUARE	EQUATION
Asphalt	Mirolux - Retrolux	Paint	Wheel Path	436	0.80	y = -8 + 1.04x
			Center	436	0.73	y = -7 + 0.97x
		Thermoplastic	Wheel Path	118	0.91	y = 14 + 1.02x
			Center	118	0.71	y = 43 + 0.85x
		Tapes	Wheel Path	52	0.92	y = -29 + 1.02x
			Center	52	0.88	y = 3 + 0.98x
	Mirolux - LTL2000	Paint	Wheel Path	436	0.77	y = -32 + 1.18x
			Center	436	0.77	y = -18 + 1.10x
		Thermoplastic	Wheel Path	118	0.82	y = 23 + 0.92x
			Center	118	0.83	y = 35 + 0.90x
		Tapes	Wheel Path	52	0.92	y = -53 + 1.23x
	Retrolux-LTL2000	Paint	Wheel Path	436	0.79	y = 4 + 1.02x
			Center	436	0.67	y = 44 + 0.91x
		Thermoplastic	Wheel Path	118	0.90	y = 9 + 0.91x
			Center	118	0.77	y = 44 + 0.85x
		Tapes	Wheel Path	52	0.98	y = -11 + 1.19x
PCC	Mirolux - Retrolux	Paint	Wheel Path	216	0.75	y = -13 + 1.06x
			Center	216	0.71	y = 3 + 0.96x
		Thermoplastic	Wheel Path	72	0.70	y = 19 + 0.96x
			Center	72	0.84	y = -2 + 0.91x
		Tapes	Wheel Path	51	0.90	y = -23 + 0.99x
			Center	51	0.91	y = -23 + 0.92x
	Mirolux - LTL2000	Paint	Wheel Path	216	0.71	y = -14 + 1.05x
			Center	216	0.70	y = -17 + 1.04x
		Thermoplastic	Wheel Path	72	0.65	y = 108 + 0.85x
			Center	72	0.85	y = 95 + 0.84x
		Tapes	Wheel Path	51	0.90	y -21 + 1.09x
			Center	51	0.93	y = 12 + 0.97x
	Retrolux-LTL2000	Paint	Wheel Path	216	0.84	y = 13 + 0.93x
			Center	216	0.82	y = 2 + 0.98x
		Thermoplastic	Wheel Path	72	0.94	y = 95 + 0.88x
			Center	72	0.89	y = 109 + 0.87x
		Tapes	Wheel Path	51	0.94	y = 17 + 1.07x
			Center	51	0.96	y = 50 + 1.02x

TABLE 2. COMPARISON OF RETROREFLECTOMETER DATA (OCTOBER 1995)

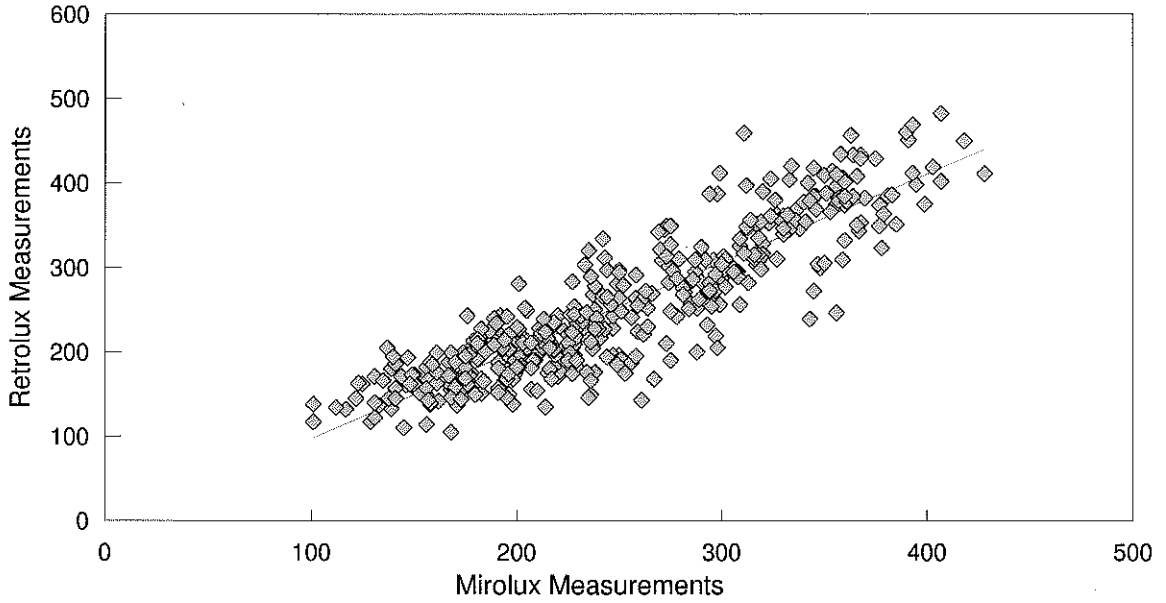
DECK	PRR COMPARISON	TYPE MATERIAL	LOCATION	DATA POINTS	R-SQUARE	EQUATION
Asphalt	Mirolux - Retrolux	Paint	Wheel Path	106	0.72	y = -5 + 0.82x
			Center	64	0.81	y = 5 + 1.02x
		Tapes	Wheel Path	26	0.94	y = -28 + 0.70x
			Center	26	0.98	y = -39 + 1.25x
	Mirolux - LTL2000	Paint	Wheel Path	204	0.88	y = 5 + 1.07x
			Center	204	0.88	y = -5 + 1.21x
		Thermoplastic	Wheel Path	40	0.90	y = 38 + 0.84x
			Center	40	0.83	y = -18 + 1.03x
		Tapes	Wheel Path	52	0.97	y = 9 + 1.20 x
			Center	52	0.98	y = -26 + 1.33x
	Retrolux-LTL2000	Paint	Wheel Path	106	0.79	y = 45 + 1.10x
			Center	64	0.82	y = 38 + 1.01x
		Tapes	Wheel Path	26	0.95	y = 45 + 1.80x
			Center	26	0.98	y = 24 + 1.09x
PCC	Mirolux - Retrolux	Paint	Wheel Path	37	0.90	y = -2 + 1.03x
			Center	21	0.96	y = 1 + 1.10x
		Tapes	Wheel Path	23	0.97	y = -16 + 1.00x
			Center	23	0.96	y = -41 + 1.12x
	Mirolux - LTL2000	Paint	Wheel Path	104	0.83	y = 7 + 1.09x
			Center	104	0.69	y = 13 + 1.06x
	Retrolux-LTL2000	Paint	Wheel Path	37	0.82	y = 23 + 1.03x
			Center	21	0.91	y = 37 + 0.94x

TABLE 3. COMPARISON OF RETROREFLECTOMETER DATA (MAY 1996)

DECK	PRR COMPARISON	TYPE MATERIAL	LOCATION	DATA POINTS	R-SQUARE	EQUATION
Asphalt	Mirolux - Mirolux B	Paint	Wheel Path	218	0.86	y = 29 + 1.07x
			Center	106	0.76	y = 55 + 0.84x
		Thermoplastic	Wheel Path	84	0.83	y = 27 + 0.95x
			Center	84	0.86	y = 34 + 0.96x
		Tapes	Wheel Path	46	0.98	y = 34 + 1.06x
			Center	44	0.96	y = 67 + 0.94x
	Mirolux - Retrolux	Paint	Wheel Path	218	0.87	y = -9 + 1.02x
		Thermoplastic	Wheel Path	84	0.87	y = -27 + 1.06x
		Tapes	Wheel Path	46	0.94	y = -7 + 0.94x
			Center	44	0.78	y = 16 + 1.12x
	Mirolux - LTL2000	Paint	Wheel Path	230	0.82	y = -11 + 0.57x
			Center	330	0.83	y = -3 + 0.64x
		Thermoplastic	Wheel Path	84	0.77	y = 3 + 0.45x
		Tapes	Wheel Path	46	0.95	y = -10 + 0.57x
			Center	44	0.87	y = 7 + 0.72x
	Retrolux-LTL2000	Paint	Wheel Path	218	0.84	y = -2 + 0.53x
		Thermoplastic	Wheel Path	84	0.80	y = 17 + 0.41x
		Tapes	Wheel Path	46	0.92	y = -1 + 0.58x
			Center	44	0.87	y = 20 + 0.57x
PCC	Mirolux - Mirolux B	Thermoplastic	Wheel Path	141	0.89	y = 19 + 0.96x
			Center	141	0.85	y = -1 + 0.93x
	Mirolux - Retrolux	Paint	Wheel Path	214	0.67	y = 4 + 0.75x
		Thermoplastic	Wheel Path	70	0.80	y = -16 + 0.98x
		Tapes	Wheel Path	42	0.74	y = 10 + 0.47x
			Center	51	0.89	y = -20 + 1.13x
	Mirolux - LTL2000	Paint	Wheel Path	431	0.86	y = -19 + 0.95x
			Center	437	0.85	y = -29 + 1.20x
		Thermoplastic	Wheel Path	141	0.85	y = -23 + 1.03x
			Center	141	0.83	y = 18 + 0.96x
		Tapes	Wheel Path	52	0.94	y = -7 + 0.75x
			Center	52	0.93	y = -21 + 1.19x
	Retrolux-LTL2000	Paint	Wheel Path	218	0.73	y = -2 + 0.53x
		Thermoplastic	Wheel Path	70	0.69	y = 8 + 0.94x
		Tapes	Wheel Path	42	0.86	y = 2 + 1.24x
			Center	51	0.93	y = 21 + 0.99x

Figure 1. Mirolux vs. Retrolux Measurements, June 1995

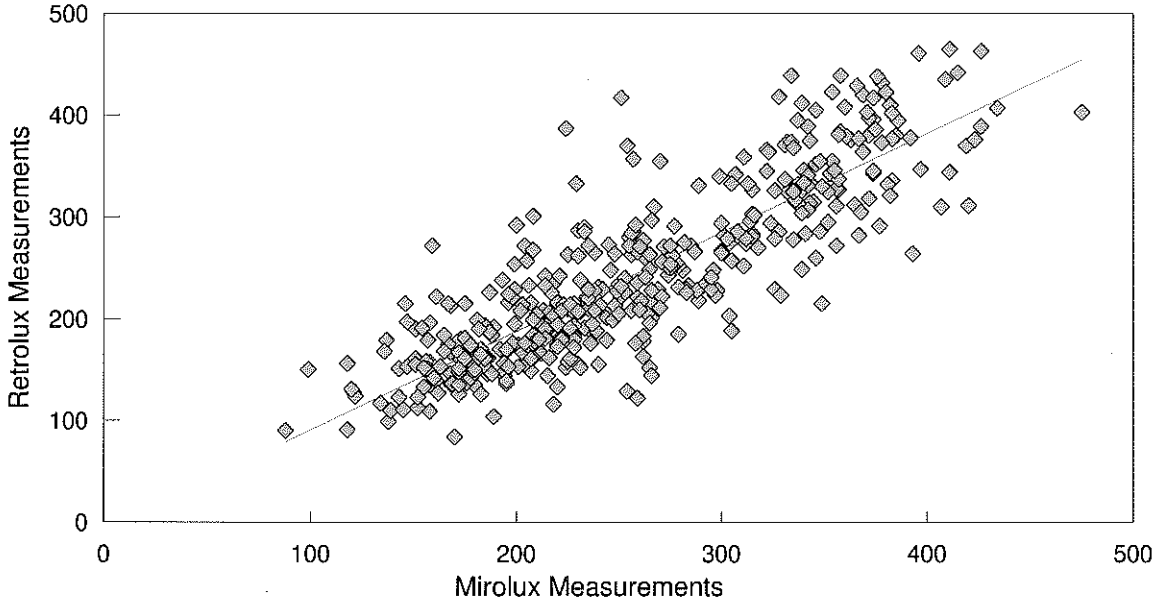
Asphalt Deck, Paint Lines, Wheel Track



R^2 = 0.80

Figure 2. Mirolux vs. Retrolux Measurements, June 1995

Asphalt Deck, Paint Lines, Center



R^2 = 0.73

Figure 3. Mirolux vs. Retrolux Measurements, June 1995

Asphalt Deck, Thermoplastics, Wheel Track

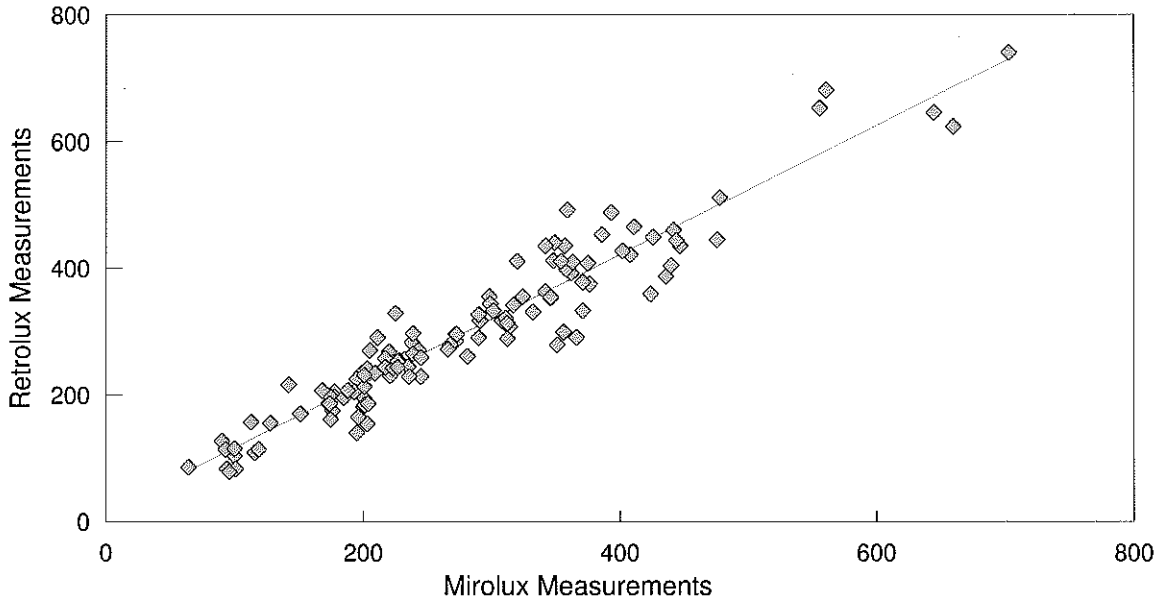


Figure 4. Mirolux vs. Retrolux Measurements, June 1995

Asphalt Deck, Thermoplastics, Center

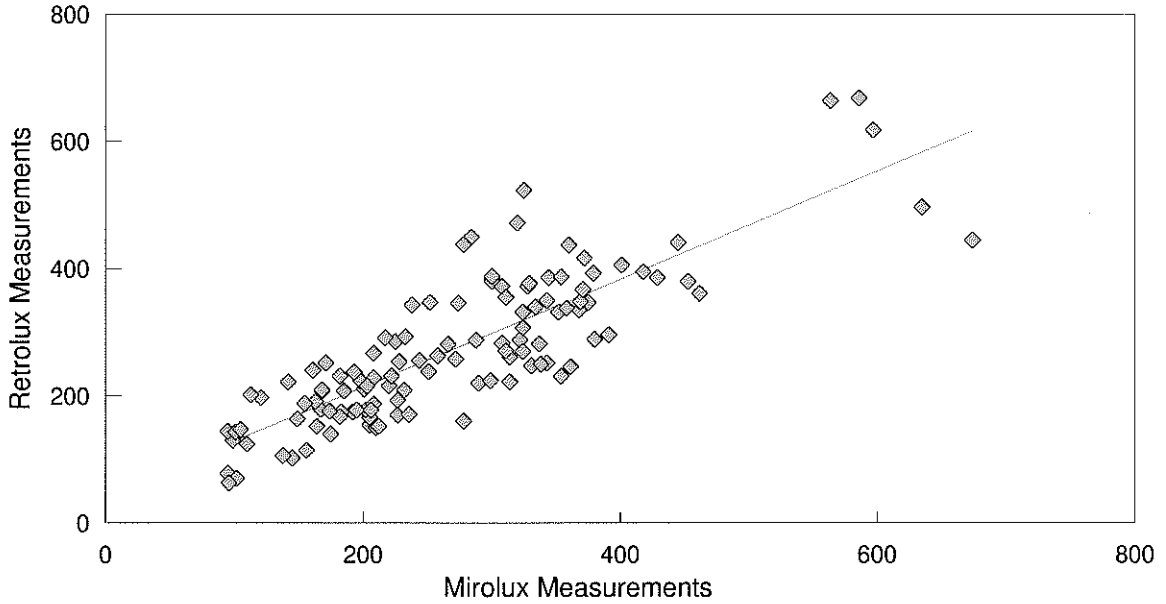


Figure 5. Mirolux vs. Retrolux Measurements, June 1995

Asphalt Deck, Permanent Tapes, Wheel Track

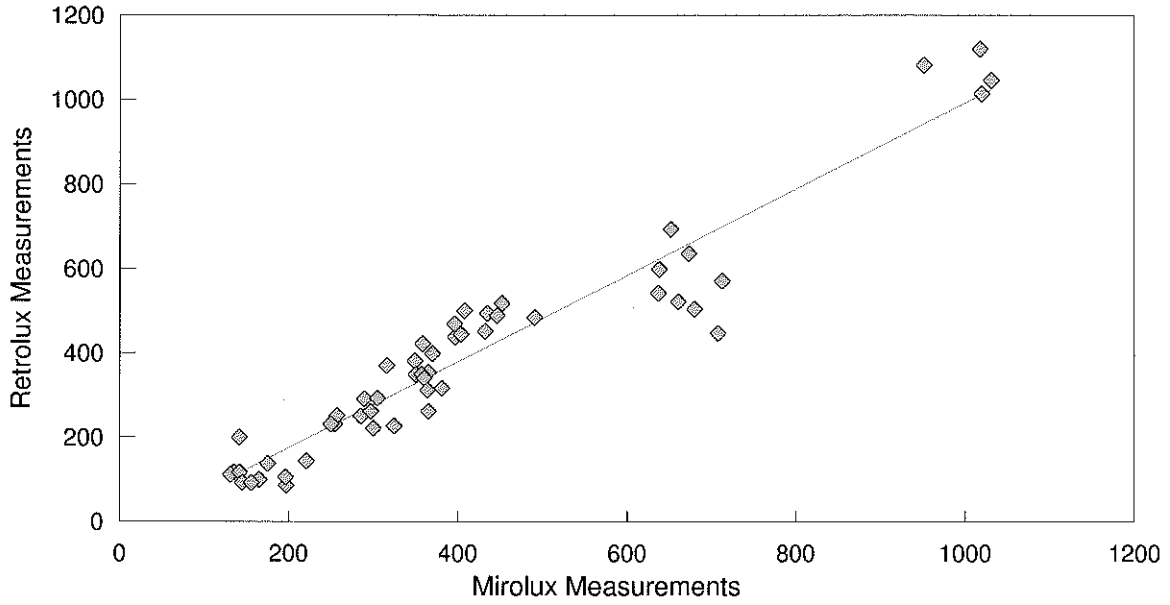


Figure 6. Mirolux vs. Retrolux Measurements, June 1995

Asphalt Deck, Permanent Tapes, Center

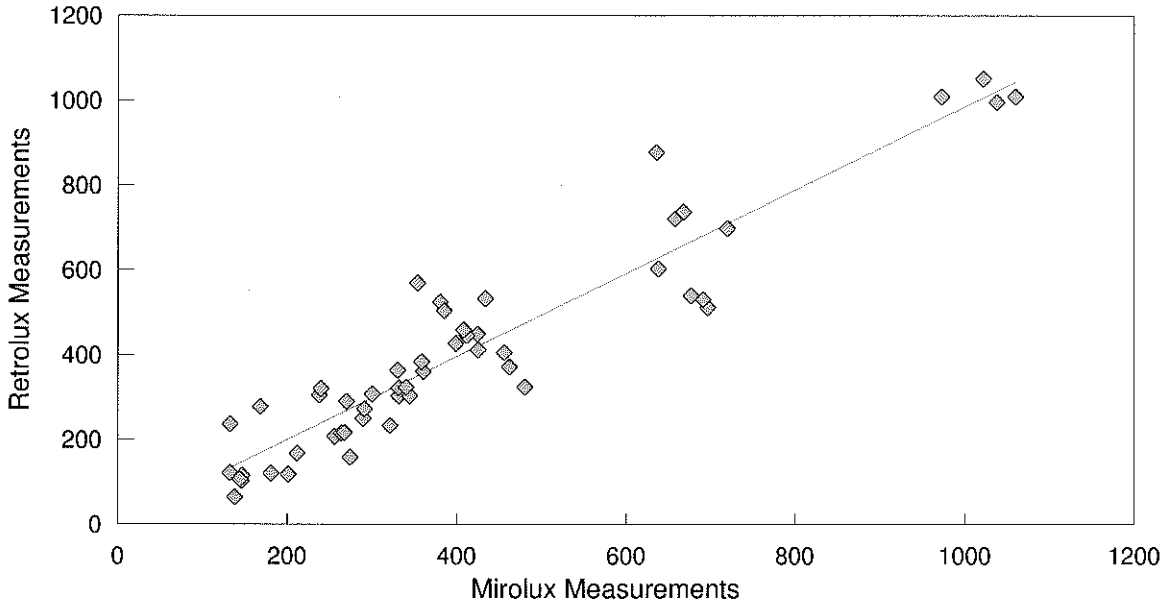


Figure 7. Mirolux vs. LTL2000 Measurements, June 1995

Asphalt Deck, Paint Lines, Wheel Track

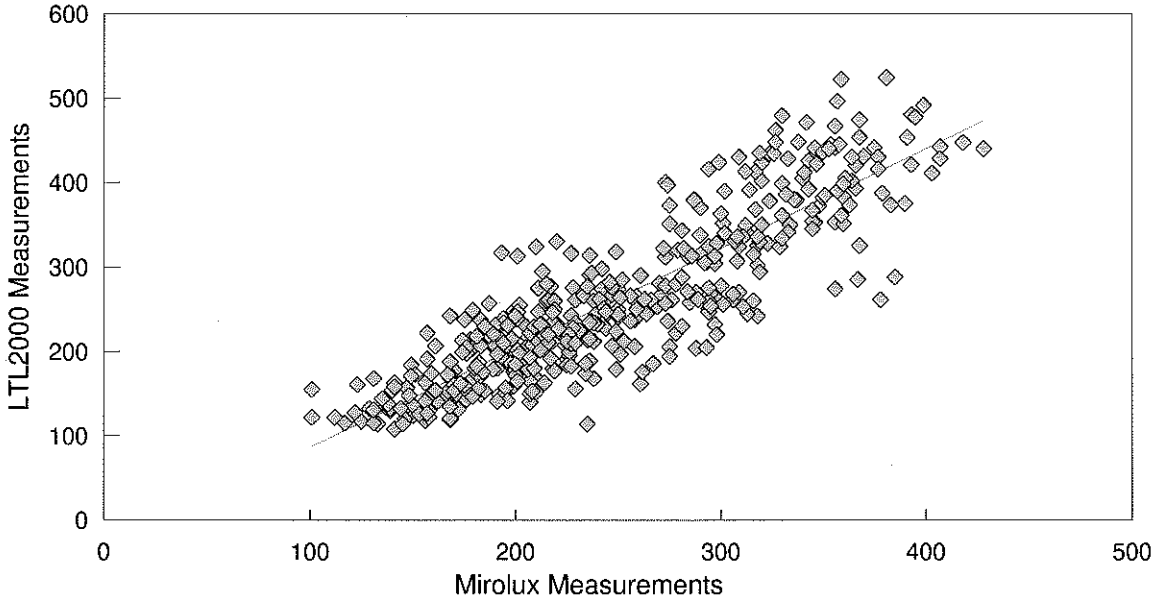


Figure 8. Mirolux vs. LTL2000 Measurements, June 1995

Asphalt Deck, Paint Lines, Center

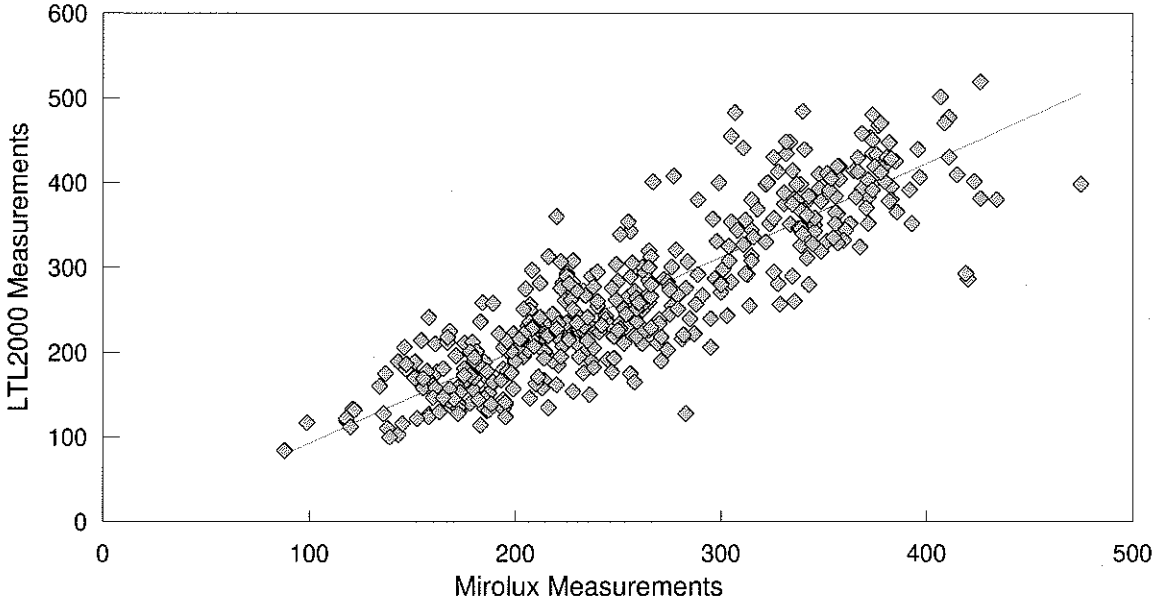


Figure 9. Mirolux vs. LTL2000 Measurements, June 1995

Asphalt Deck, Thermoplastics, Wheel Track

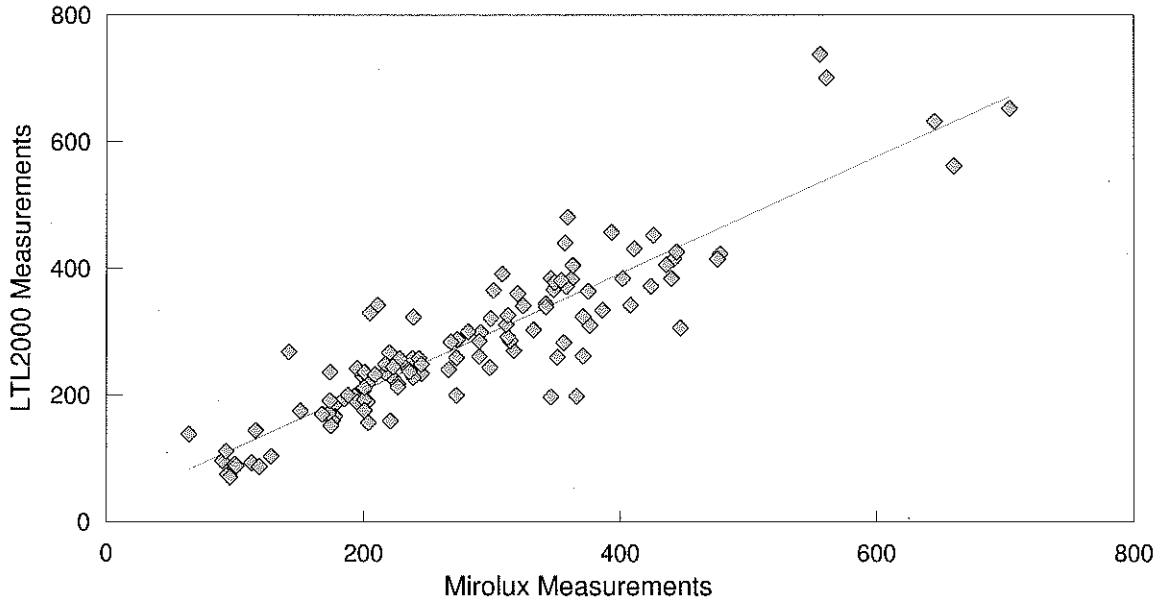


Figure 10. Mirolux vs. LTL2000 Measurements, June 1995

Asphalt Deck, Thermoplastics, Center

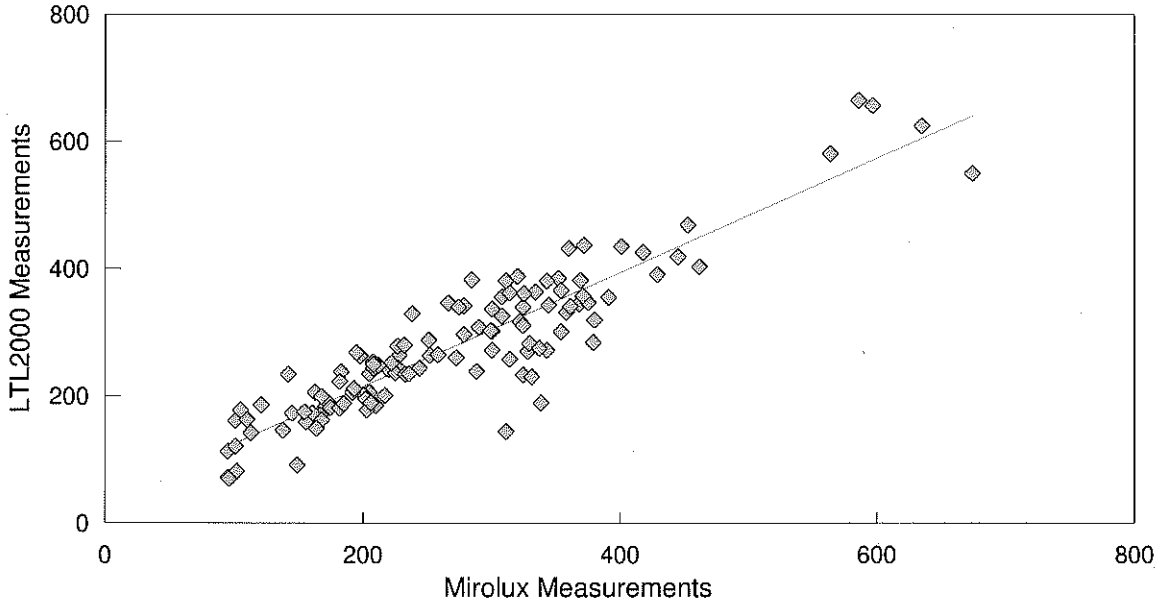
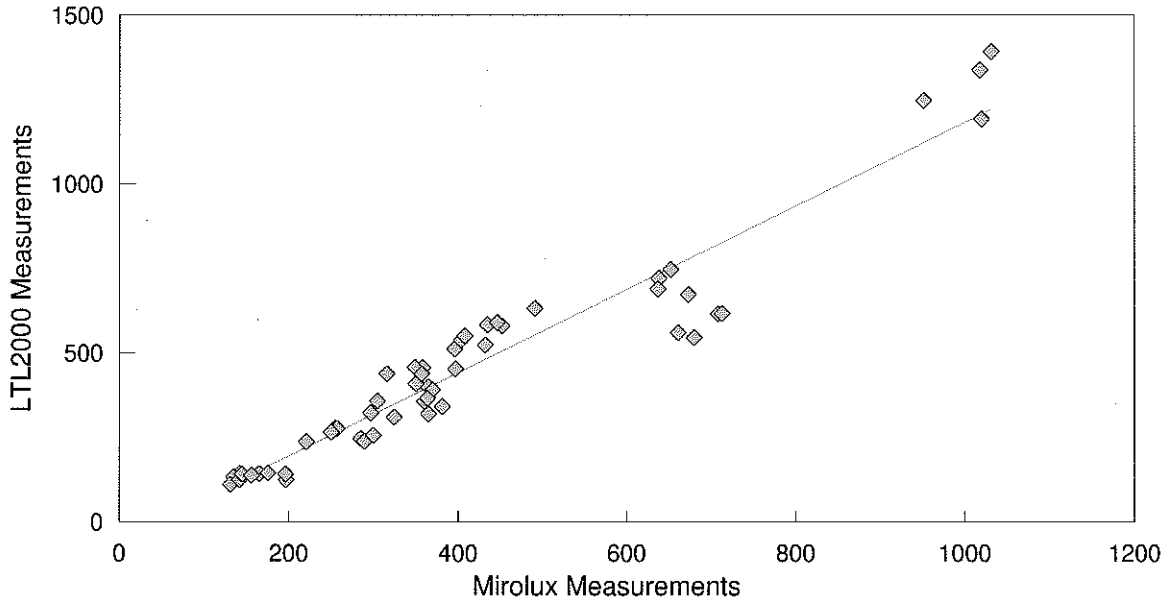


Figure 11. Mirolux vs. LTL2000 Measurements, June 1995

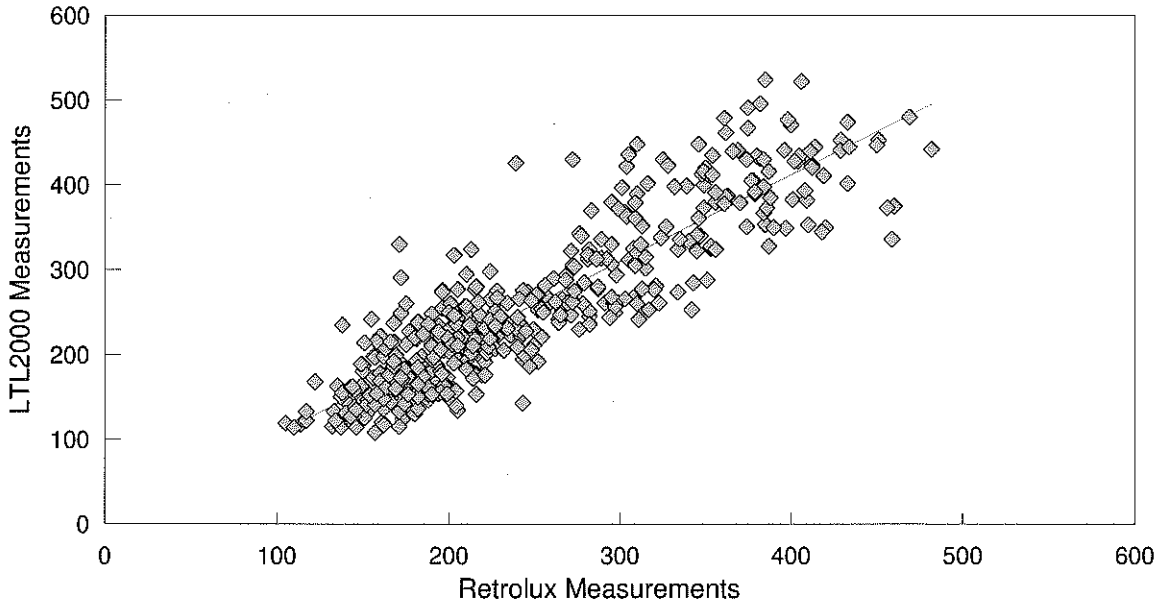
Asphalt Deck, Permanent Tapes, Wheel Track



R^2 = 0.92

Figure 12. Retrolux vs. LTL2000 Measurements, June 1995

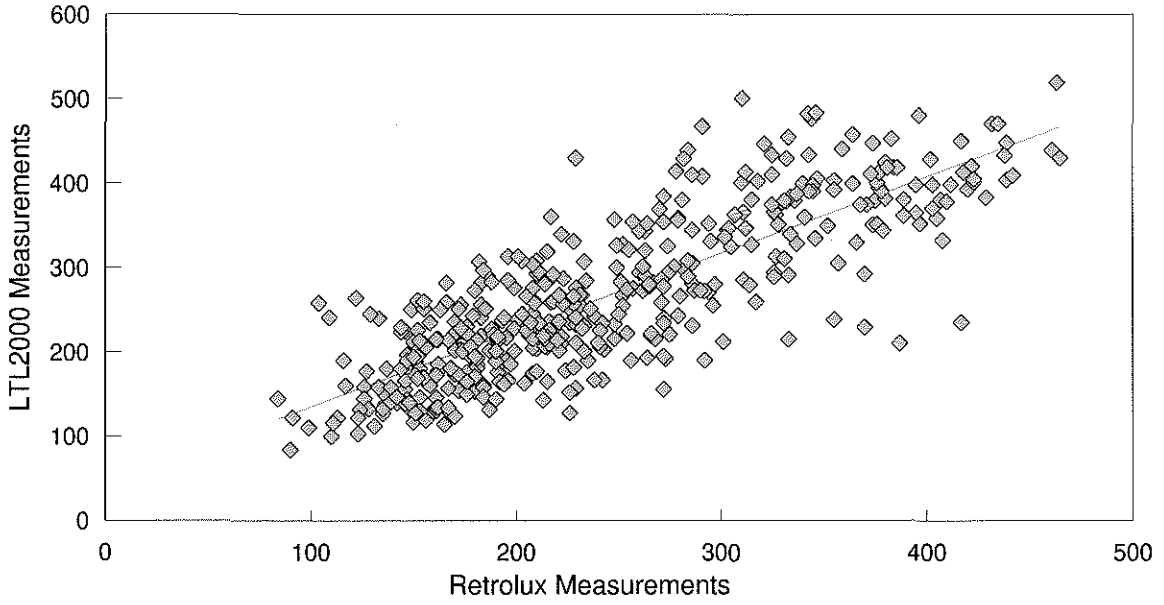
Asphalt Deck, Paint Lines, Wheel Track



R^2 = 0.79

Figure 13. Retrolux vs. LTL2000 Measurements, June 1995

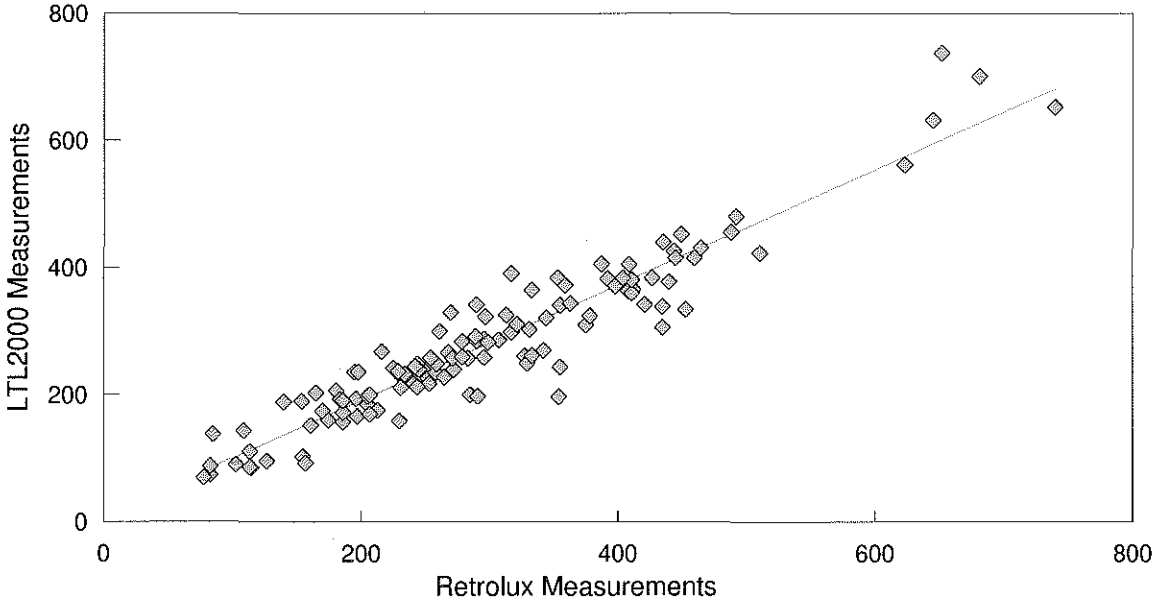
Asphalt Deck, Paint Lines, Center



R^2 = 0.67

Figure 14. Retrolux vs. LTL2000 Measurements, June 1995

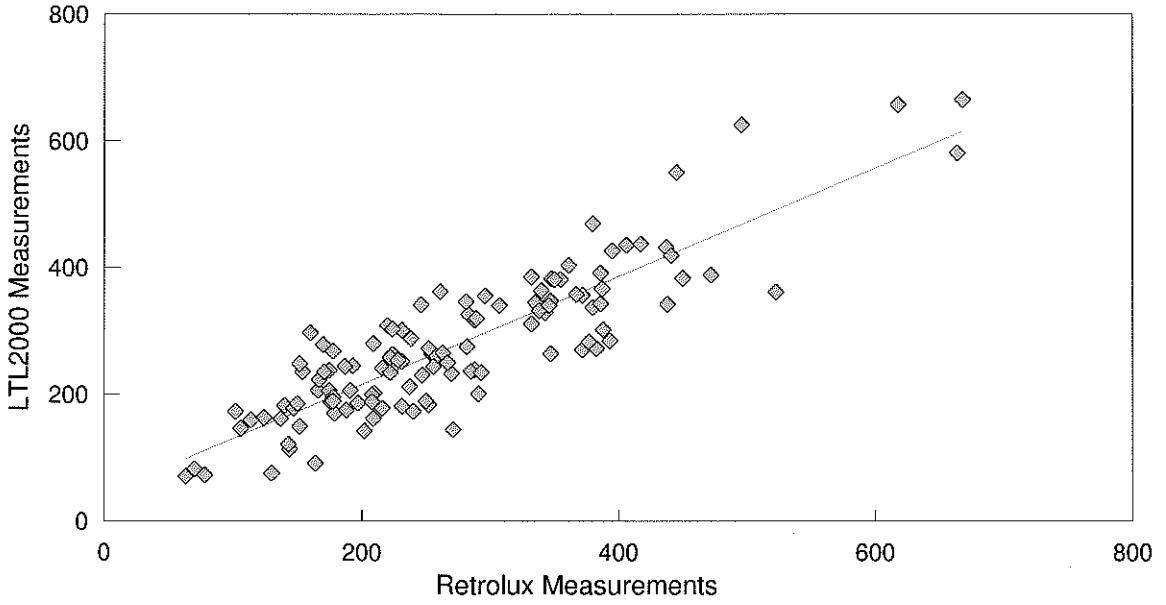
Asphalt Deck, Thermoplastics, Wheel Track



R^2 = 0.90

Figure 15. Retrolux vs. LTL2000 Measurements, June 1995

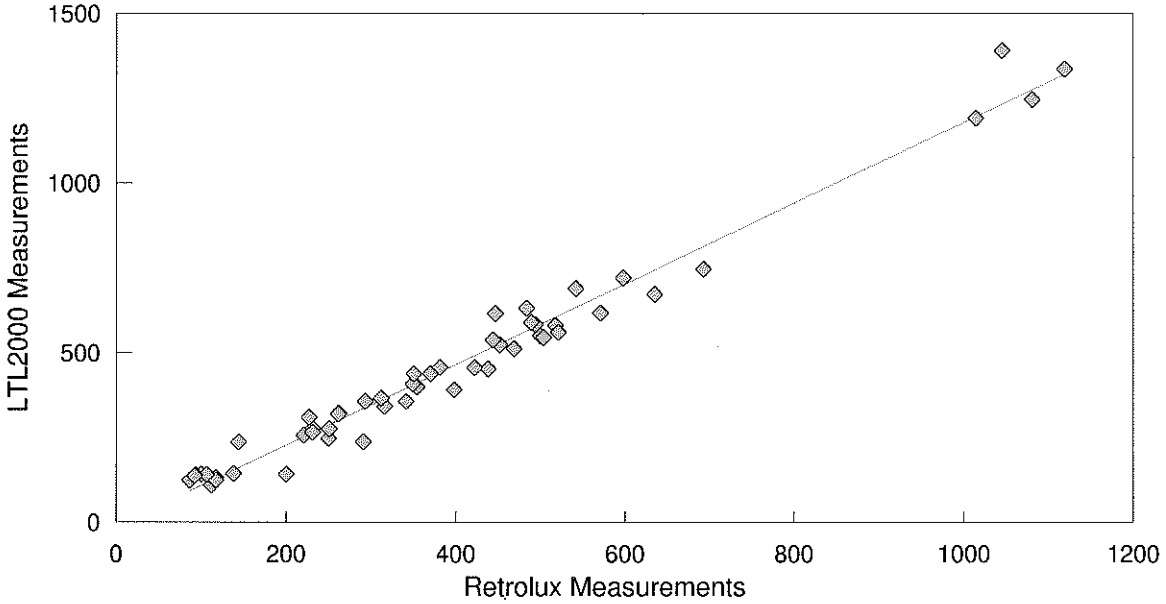
Asphalt Deck, Thermoplastics, Center



R^2 = 0.77

Figure 16. Retrolux vs. LTL2000 Measurements, June 1995

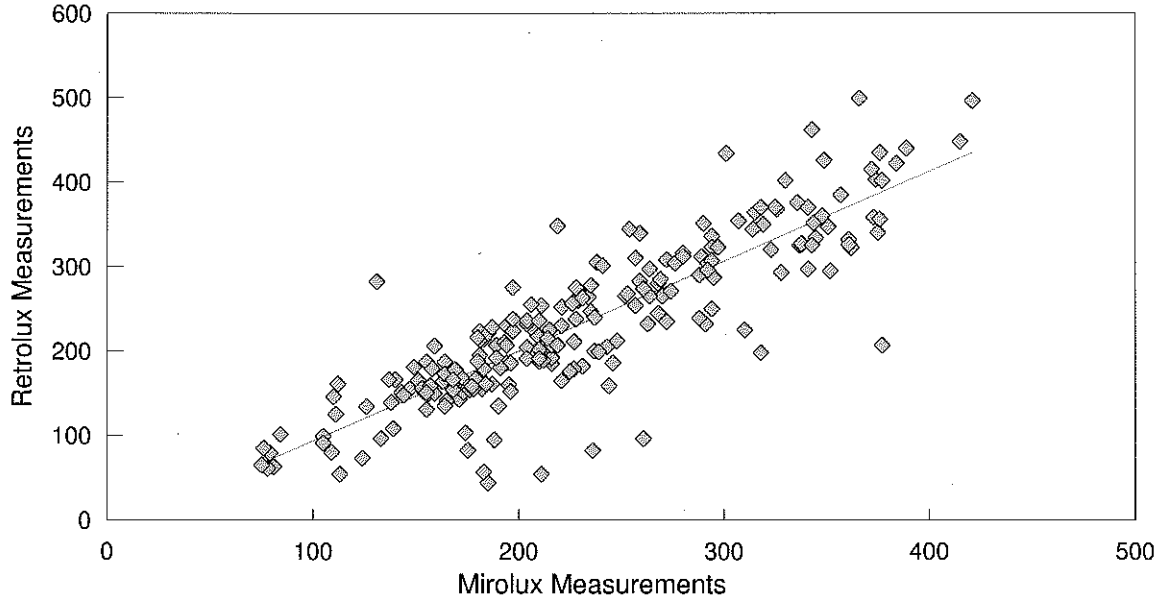
Asphalt Deck, Permanent Tapes, Wheel Track



R^2 = 0.98

Figure 17. Mirolux vs. Retrolux Measurements, June 1995

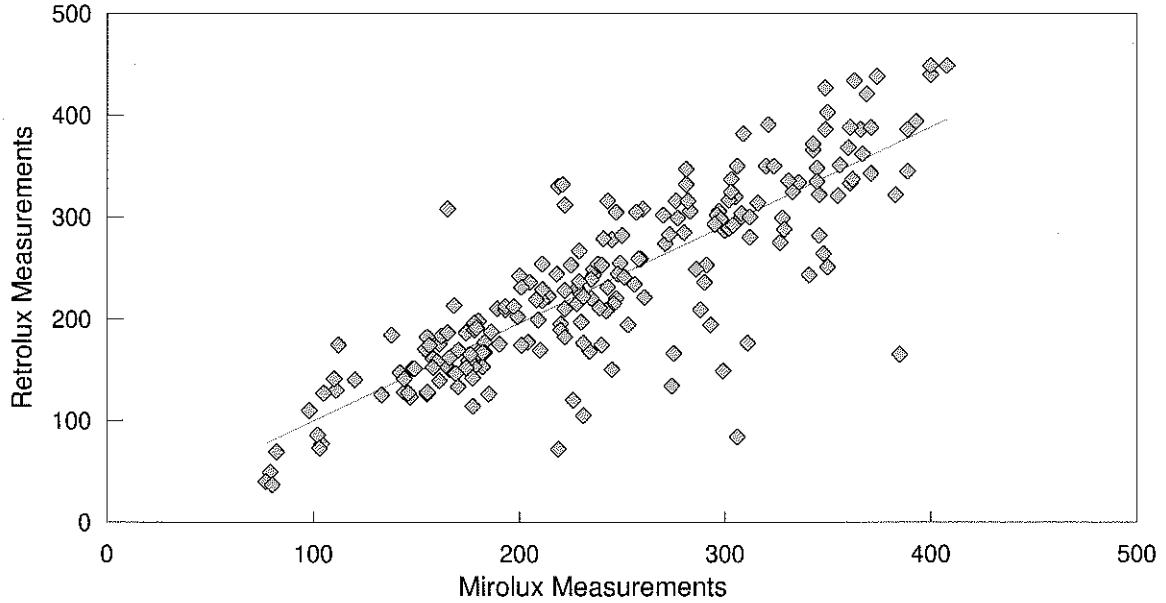
Concrete Deck, Paint Lines, Wheel Track



R^2 = 0.75

Figure 18. Mirolux vs. Retrolux Measurements, June 1995

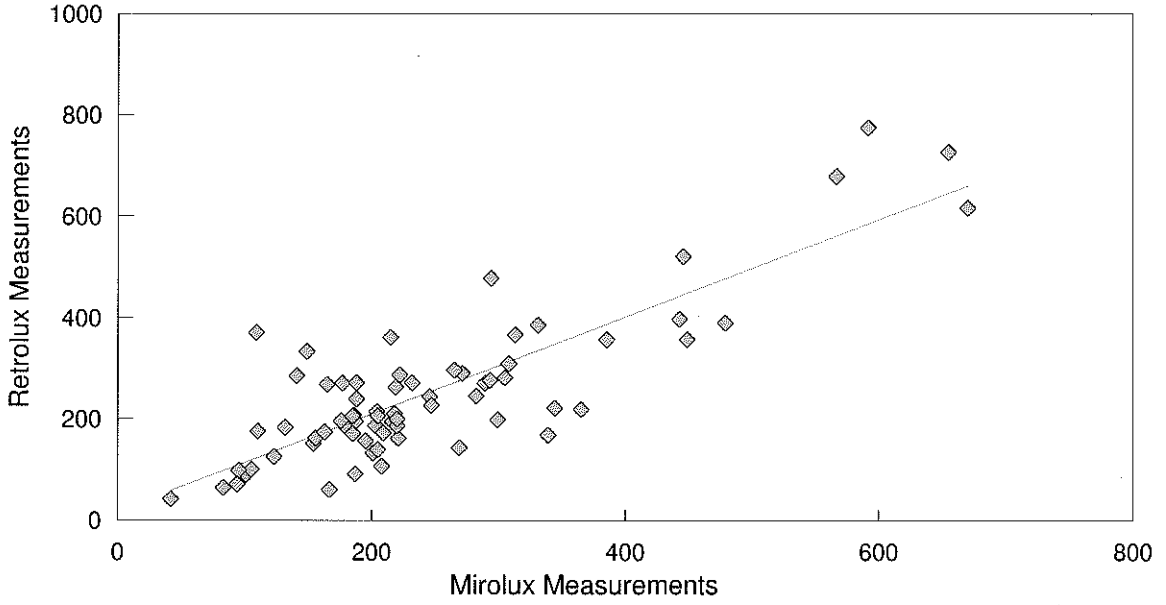
Concrete Deck, Paint Lines, Center



R^2 = 0.71

Figure 19. Mirolux vs. Retrolux Measurements, June 1995

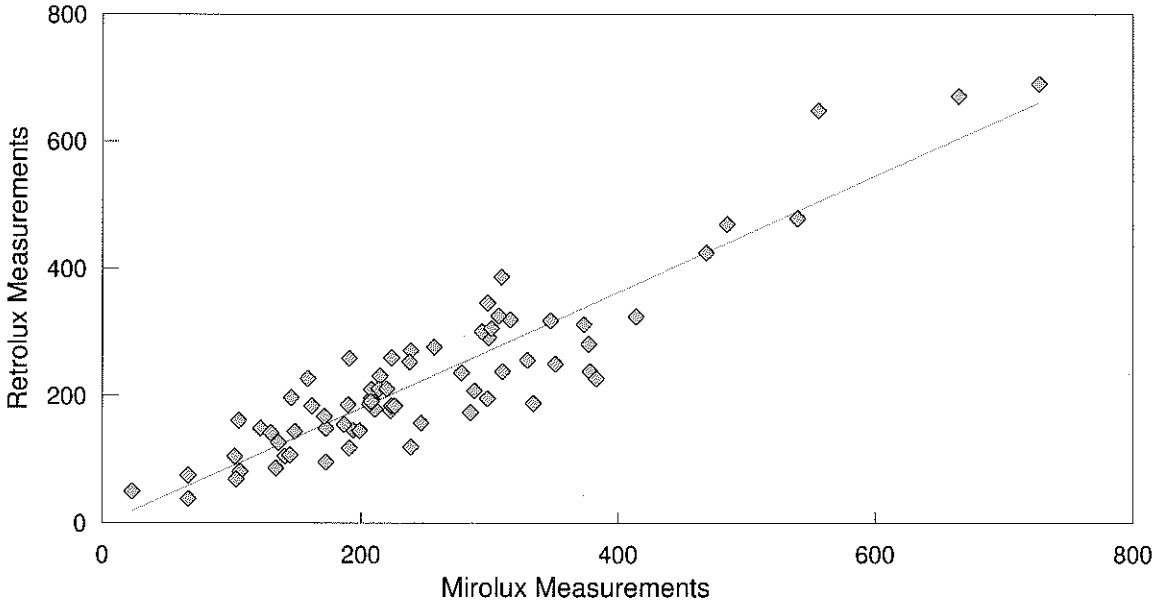
Concrete Deck, Thermoplastics, Wheel Track



R^2 = 0.70

Figure 20. Mirolux vs. Retrolux Measurements, June 1995

Concrete Deck, Thermoplastics, Wheel Track



R^2 = 0.84

Figure 21. Mirolux vs. Retrolux Measurements, June 1995

Concrete Deck, Permanent Tapes, Wheel Track

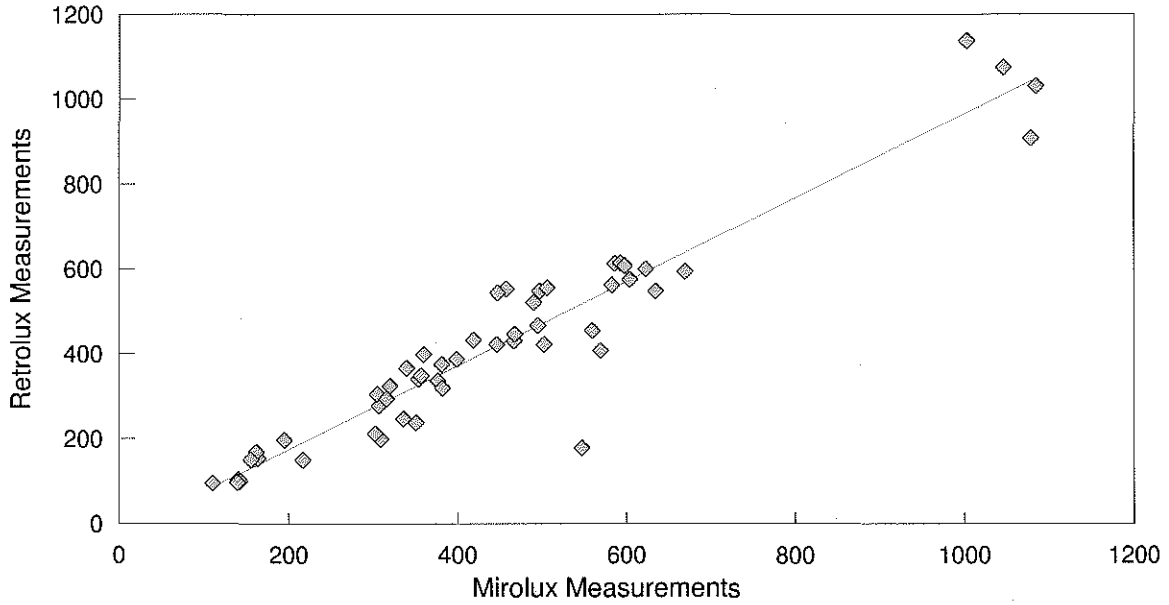


Figure 22. Mirolux vs. Retrolux Measurements, June 1995

Concrete Deck, Permanent Tapes, Center

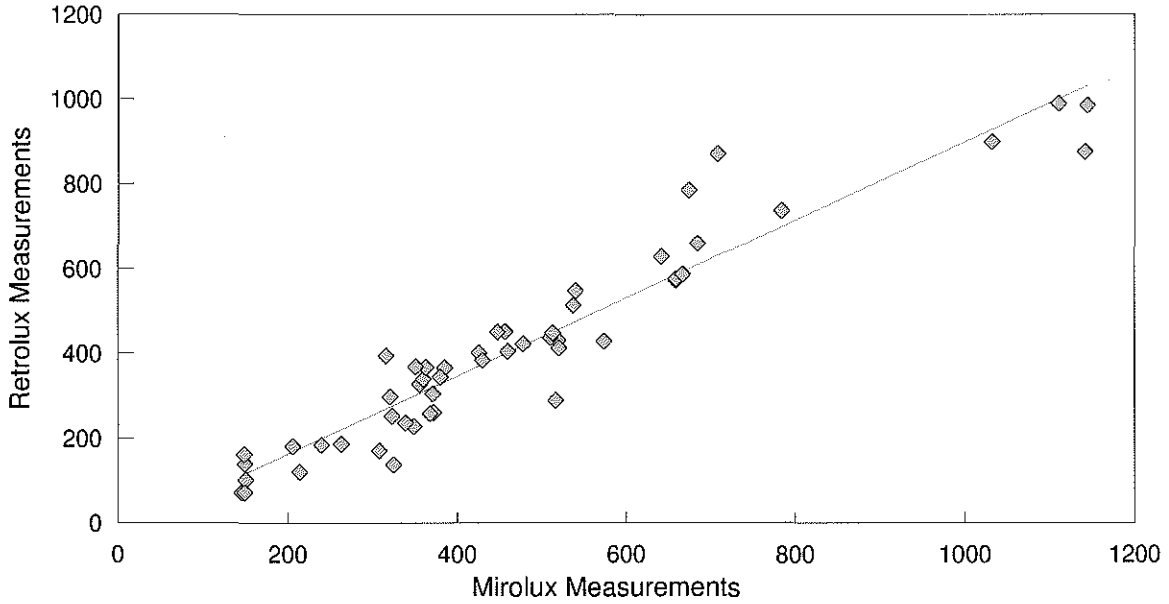


Figure 23. Mirolux vs. LTL2000 Measurements, June 1995

Concrete Deck, Paint Lines, Wheel Track

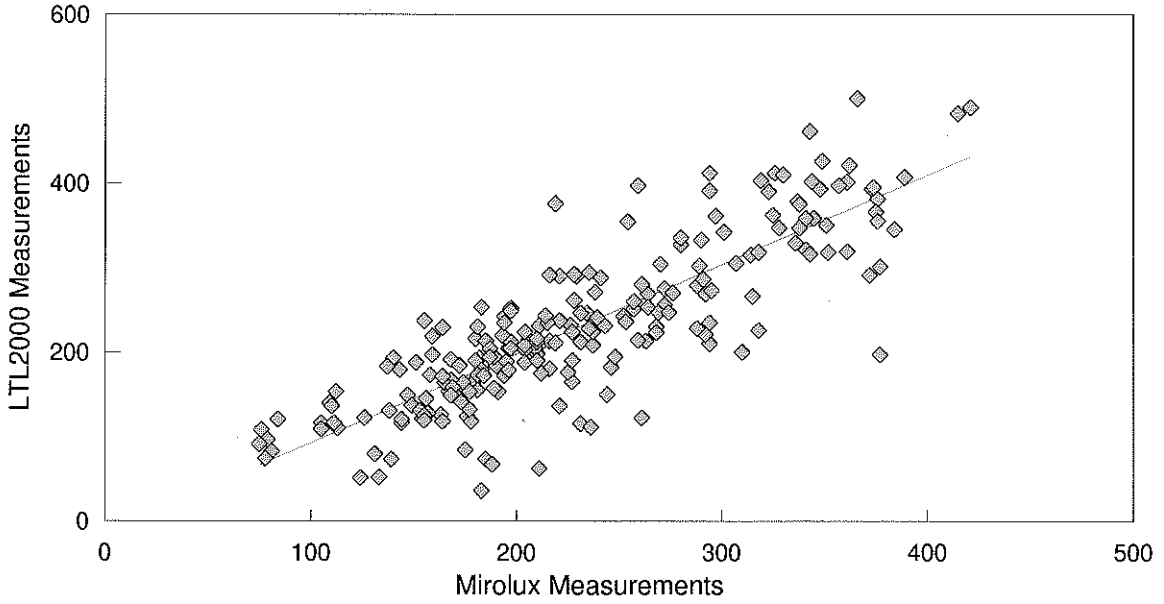


Figure 24. Mirolux vs. LTL2000 Measurements, June 1995

Concrete Deck, Paint Lines, Center

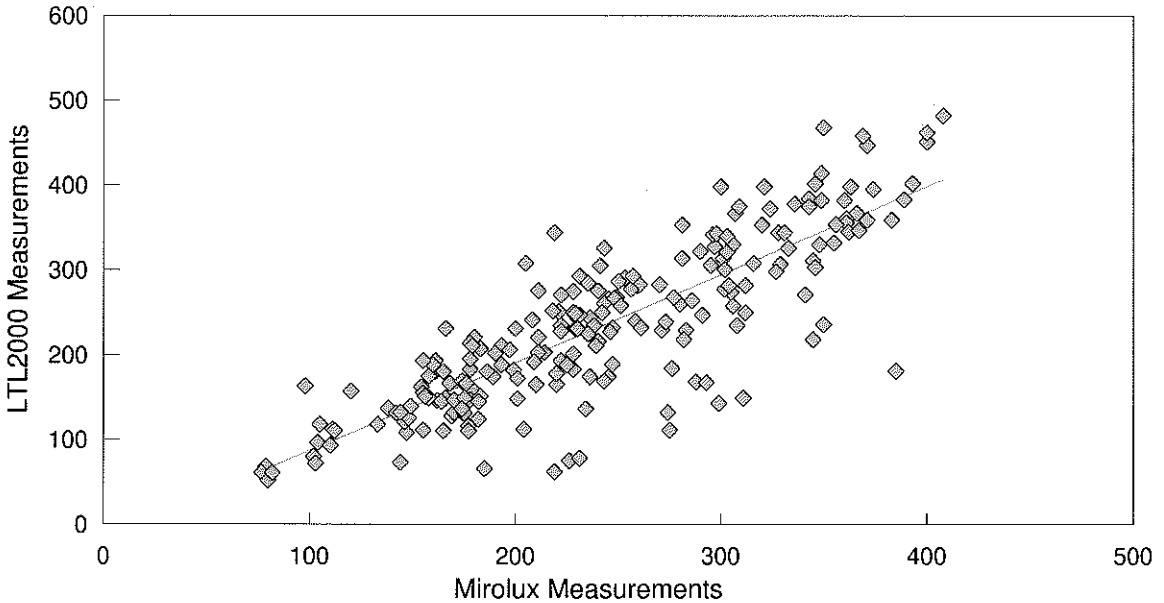
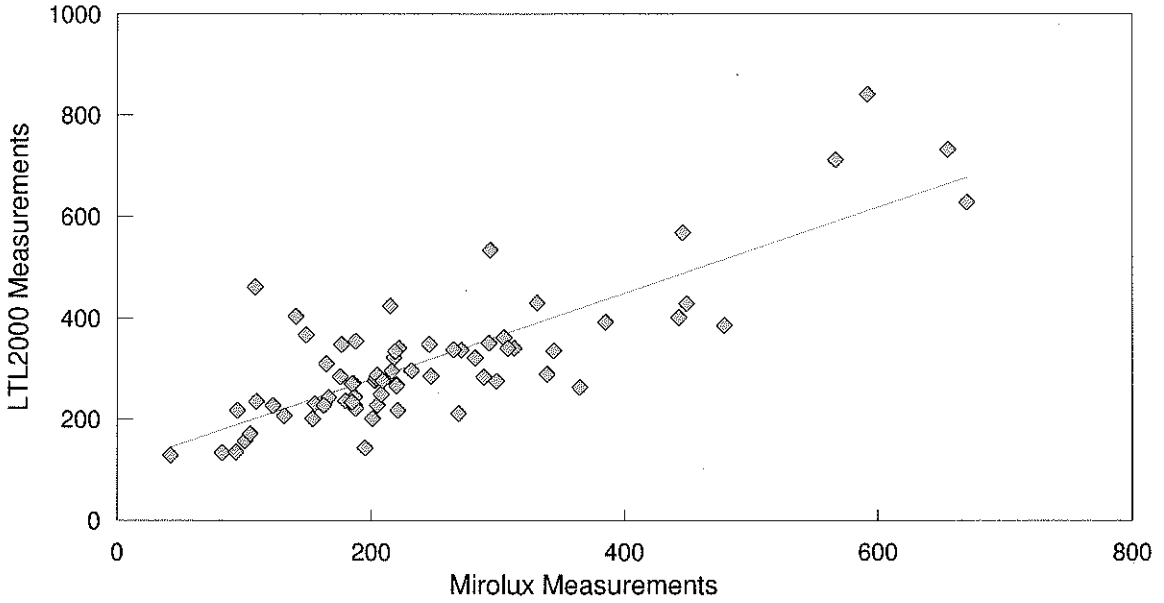


Figure 25. Mirolux vs. LTL2000 Measurements, June 1995

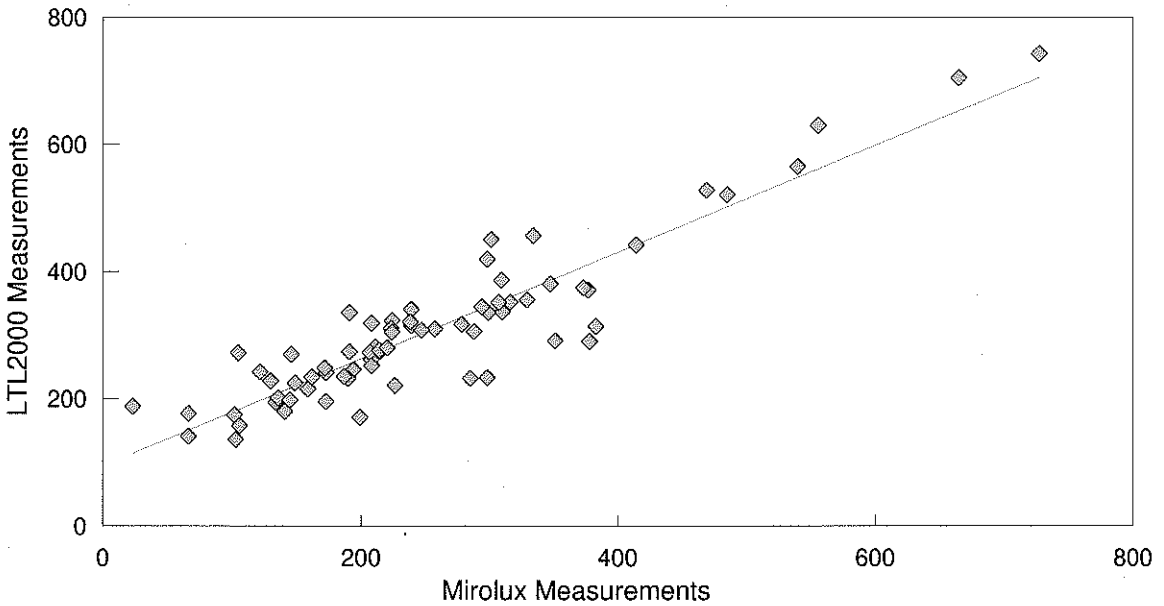
Concrete Deck, Thermoplastics, Wheel Track



R^2 = 0.65

Figure 26. Mirolux vs. LTL2000 Measurements, June 1995

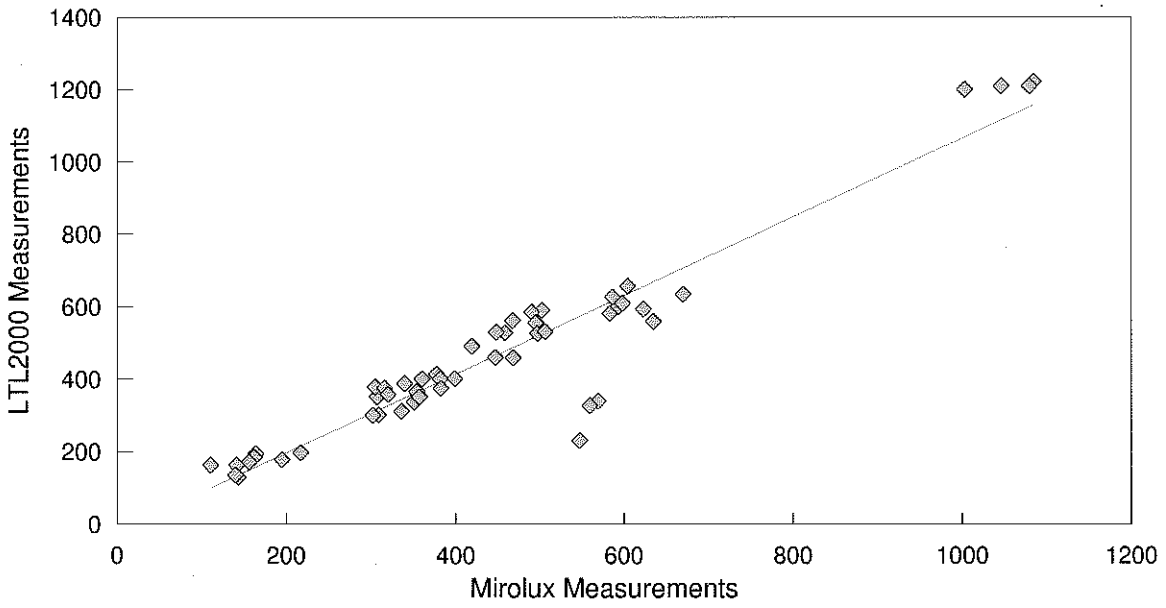
Concrete Deck, Thermoplastics, Center



R^2 = 0.85

Figure 27. Mirolux vs. LTL2000 Measurements, June 1995

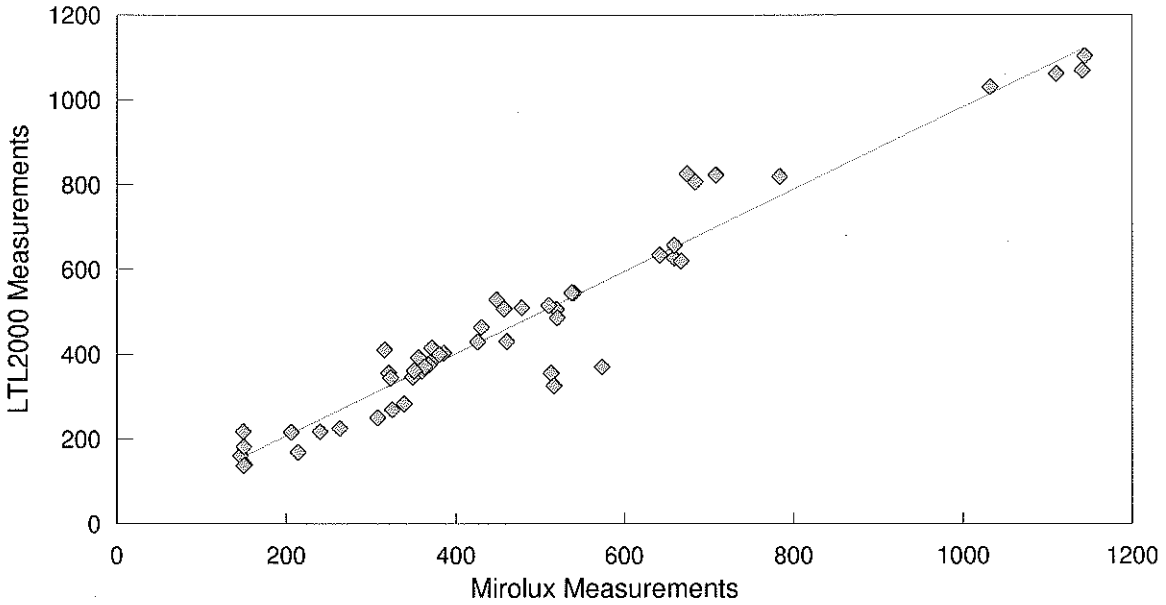
Concrete Deck, Permanent Tapes, Wheel Track



R^2 = 0.90

Figure 28. Mirolux vs. LTL2000 Measurements, June 1995

Concrete Deck, Permanent Tapes, Center



R^2 = 0.93

Figure 29. Retrolux vs. LTL2000 Measurements, June 1995

Concrete Deck, Paint Lines, Wheel Track

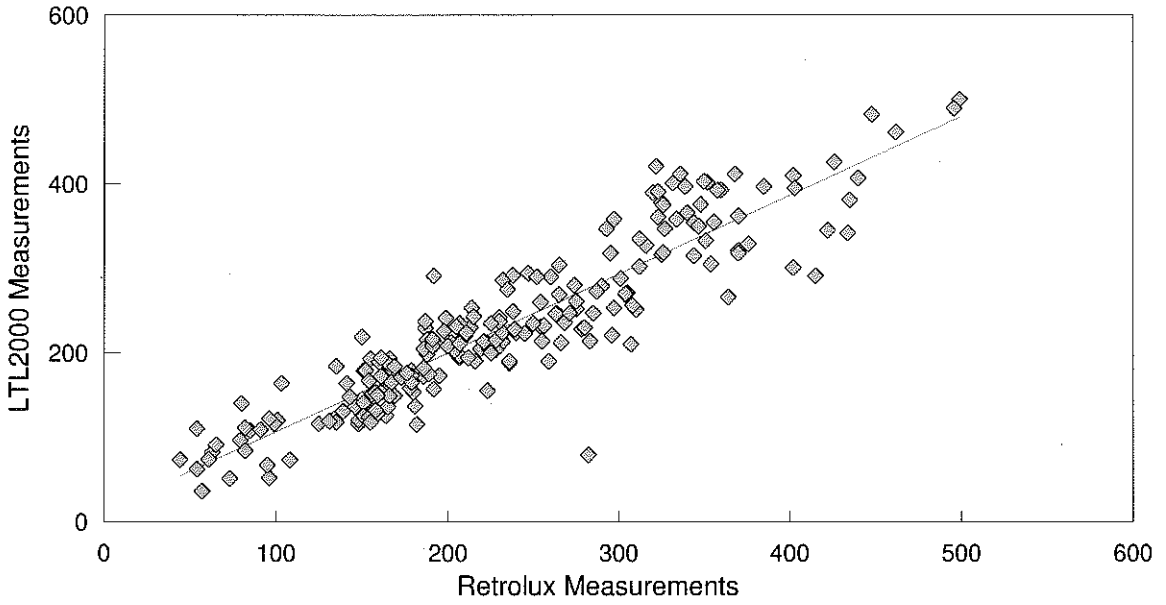


Figure 30. Retrolux vs. LTL2000 Measurements, June 1995

Concrete Deck, Paint Lines, Center

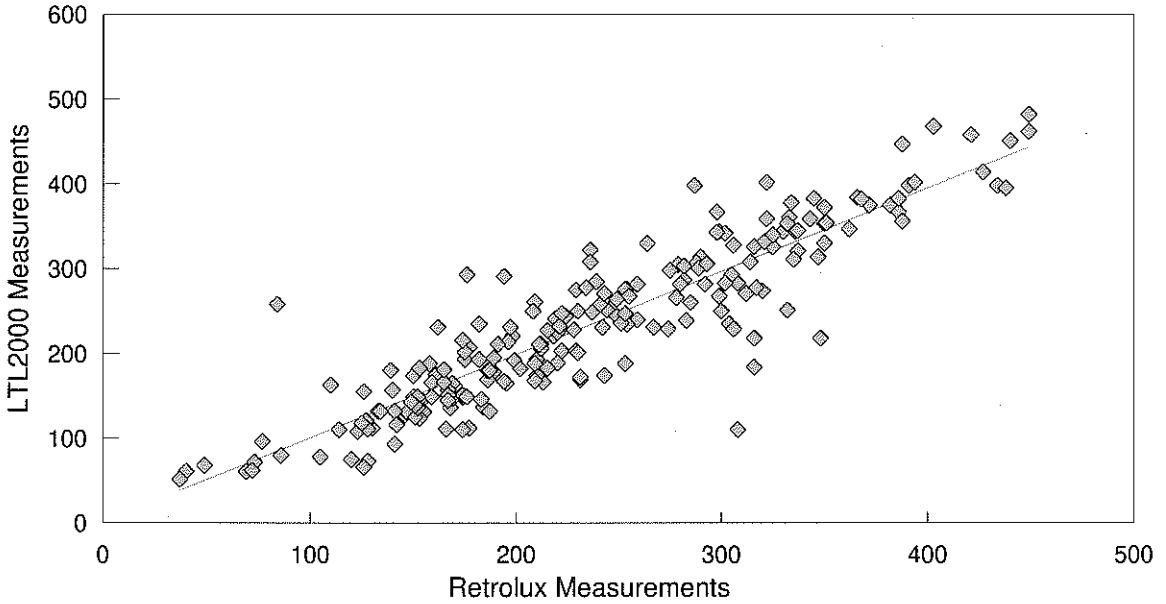
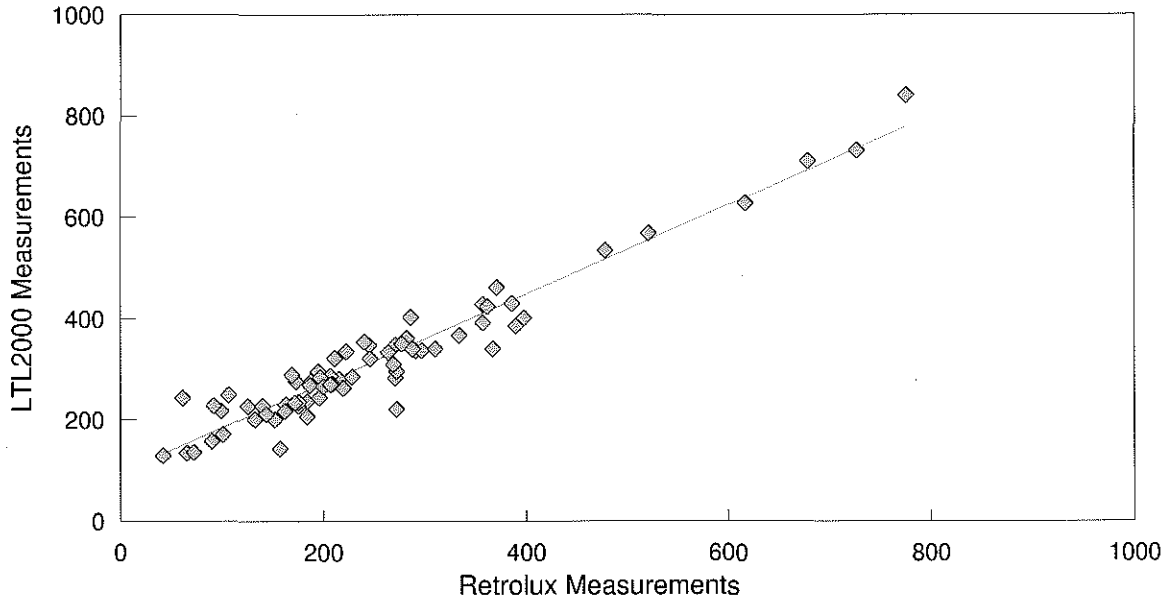


Figure 31. Retrolux vs. LTL2000 Measurements, June 1995

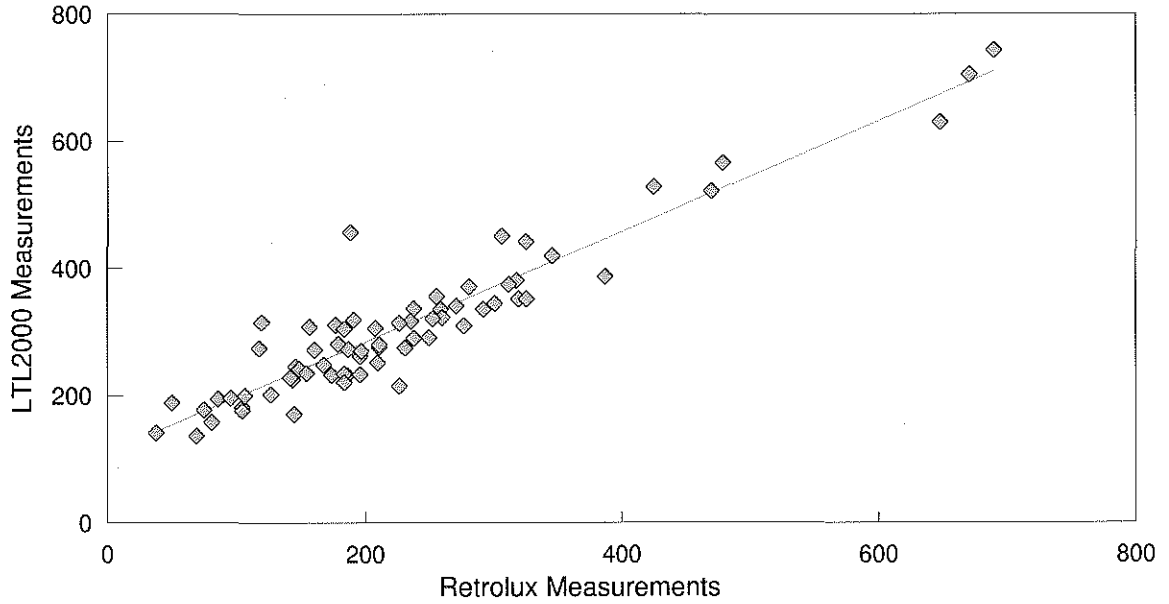
Concrete Deck, Thermoplastics, Wheel Track



R^2 = 0.94

Figure 32. Retrolux vs. LTL2000 Measurements, June 1995

Concrete Deck, Thermoplastics, Center



R^2 = 0.89

Figure 33. Retrolux vs. LTL2000 Measurements, June 1995
Concrete Deck, Permanent Tapes, Wheel Track

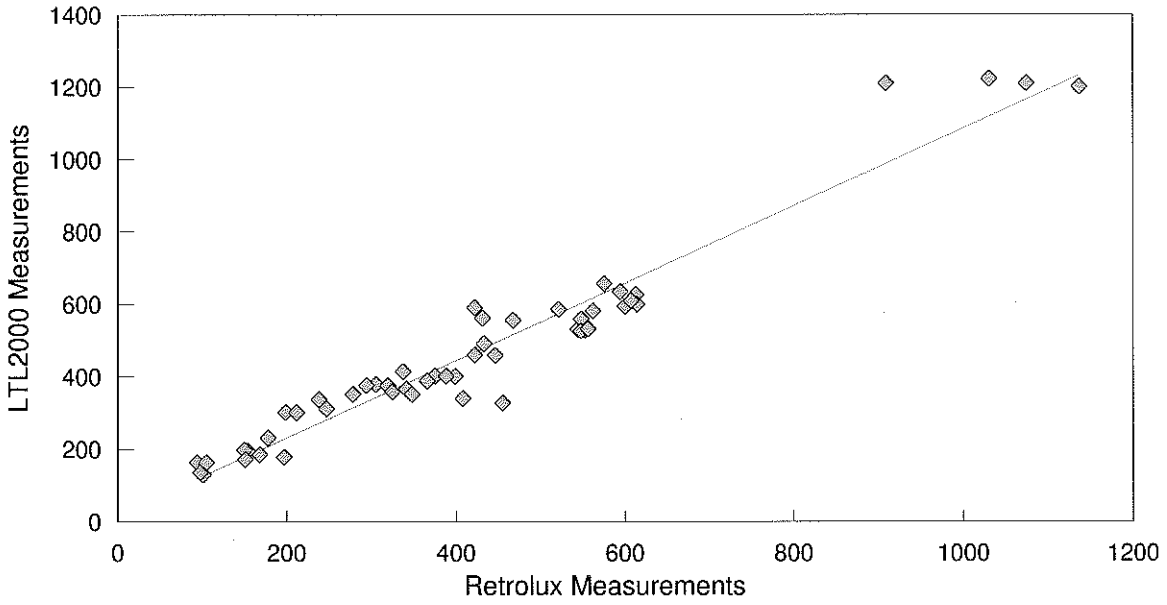


Figure 34. Retrolux vs. LTL2000 Measurements, June 1995
Concrete Deck, Permanent Tapes, Center

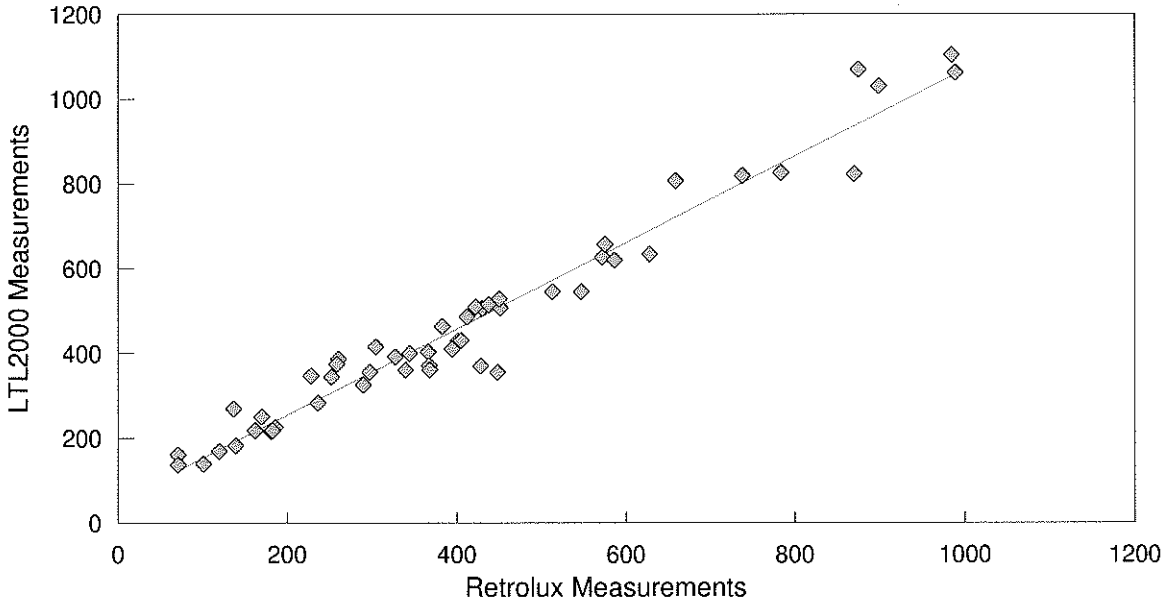


Figure 35. Mirolux vs. Retrolux Measurements, October 1995

Asphalt Deck, Paint Lines, Wheel Track

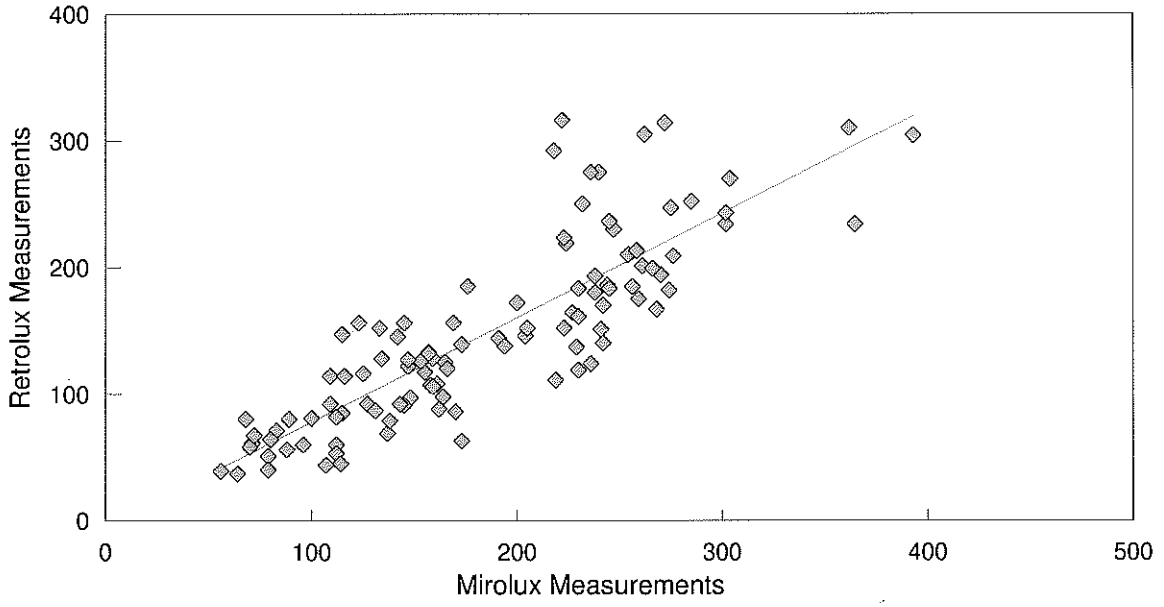


Figure 36. Mirolux vs. Retrolux Measurements, October1995

Asphalt Deck, Paint Lines, Center

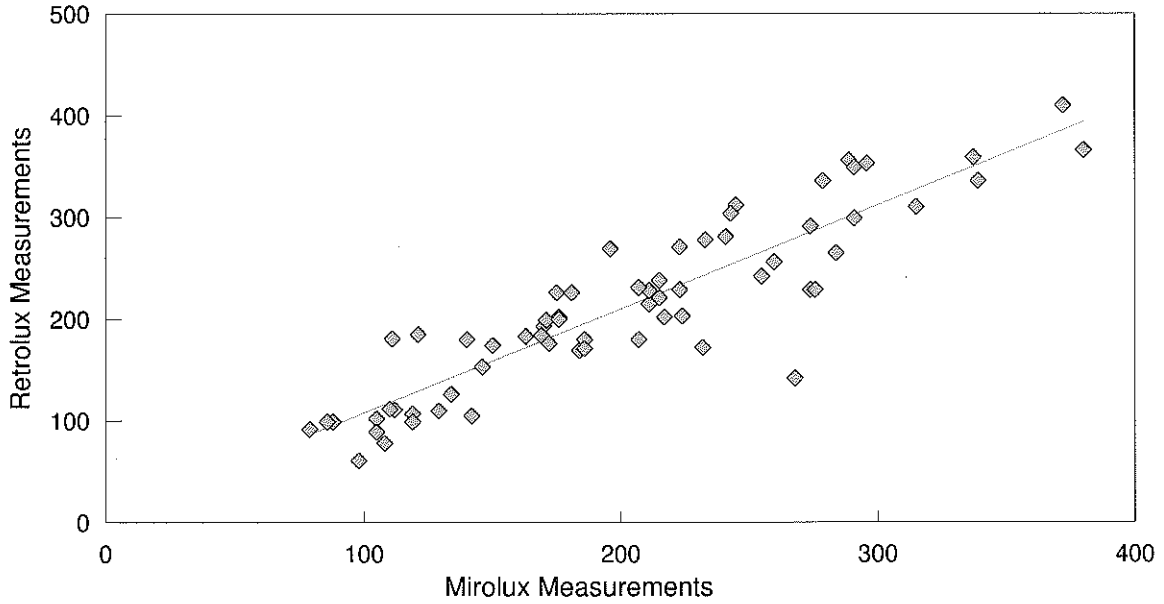


Figure 37. Mirolux vs. Retrolux Measurements, October 1995

Asphalt Deck, Permanent Tapes, Wheel Track

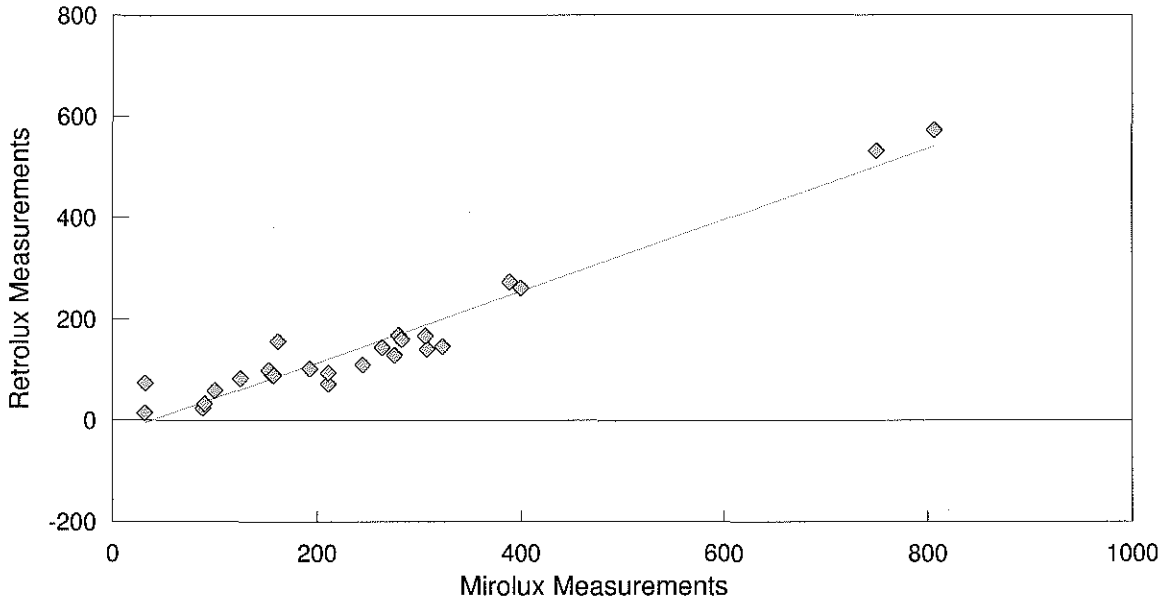


Figure 38. Mirolux vs. Retrolux Measurements, October 1995

Asphalt Deck, Permanent Tapes, Center

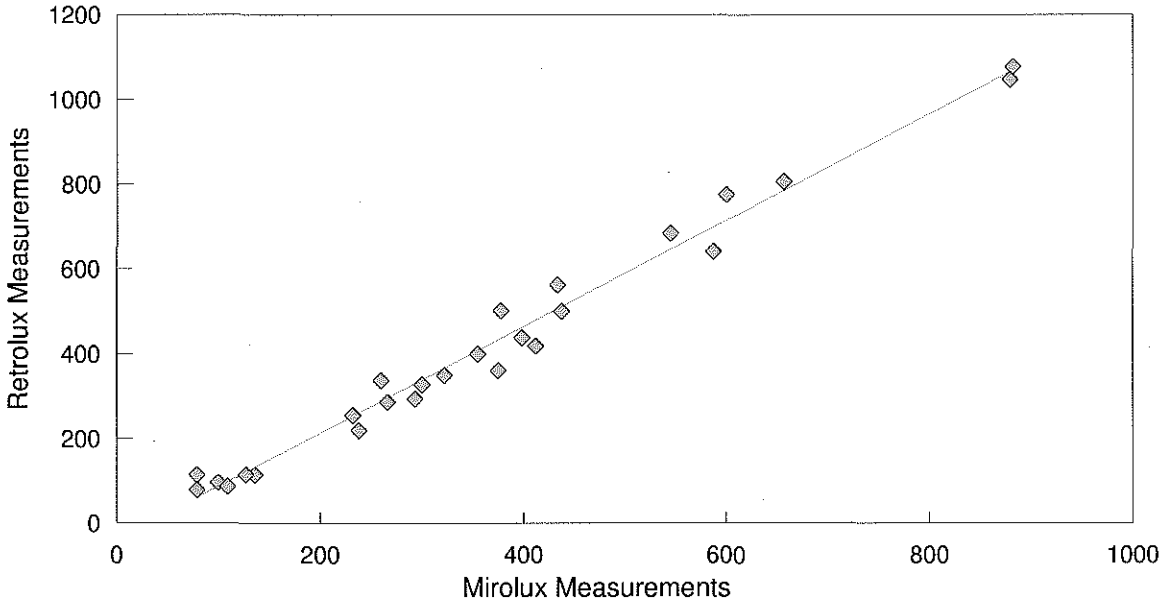


Figure 39. Mirolux vs. LTL2000 Measurements, October 1995

Asphalt Deck, Paint Lines, Wheel Track

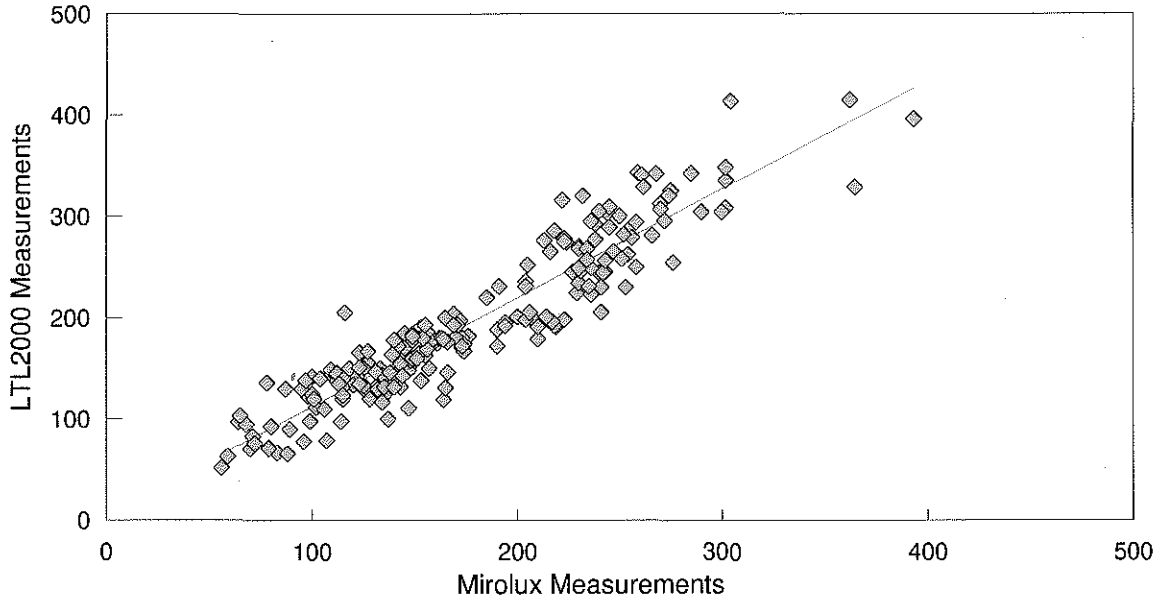


Figure 40. Mirolux vs. LTL2000 Measurements, October 1995

Asphalt Deck, Paint Lines, Center

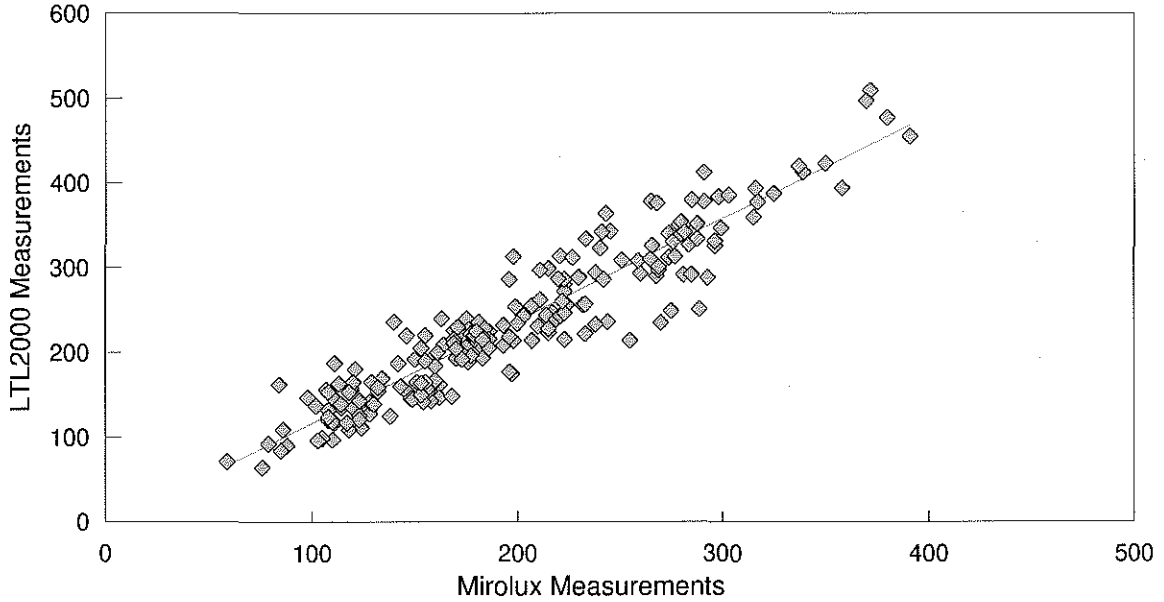
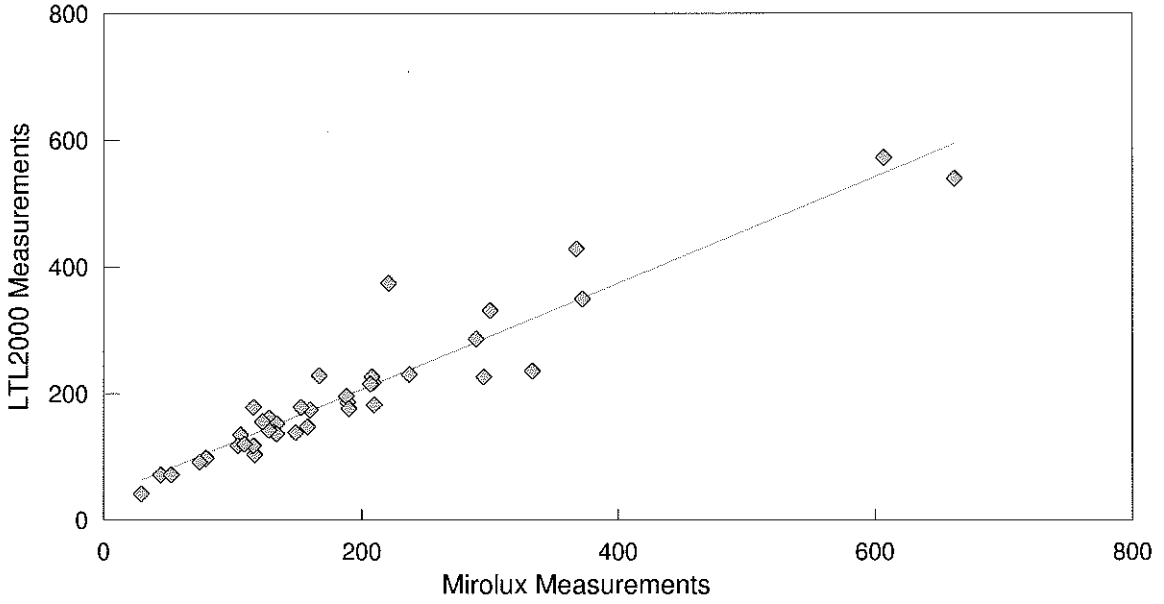


Figure 41. Mirolux vs. LTL2000 Measurements, October 1995

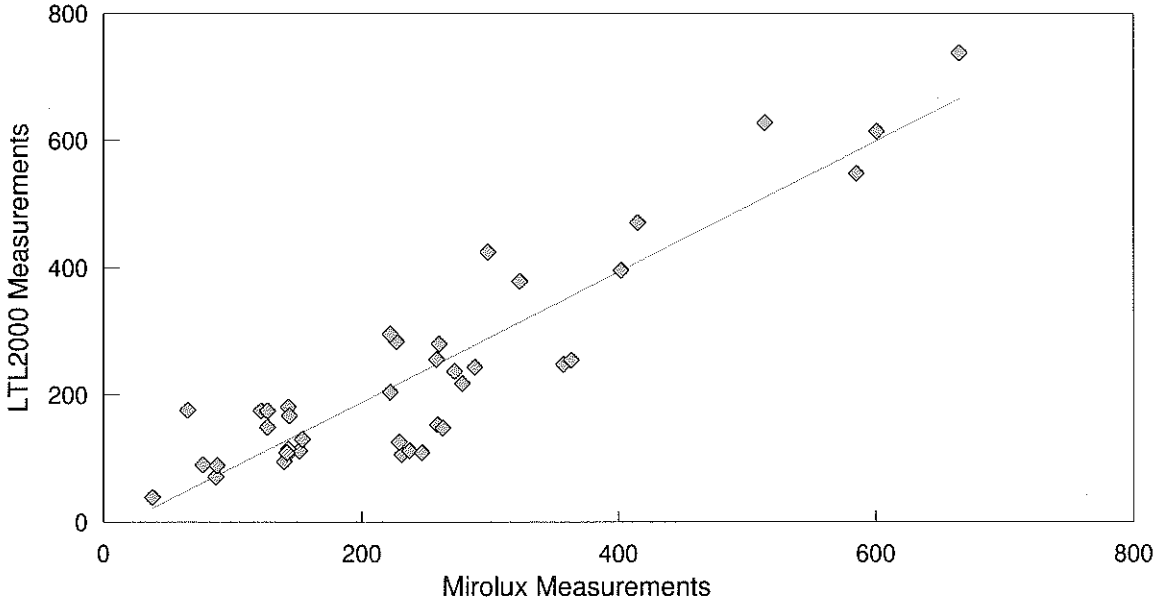
Asphalt Deck, Thermoplastics, Wheel Track



R^2 = 0.90

Figure 42. Mirolux vs. LTL2000 Measurements, October 1995

Asphalt Deck, Thermoplastics, Center



R^2 = 0.83

Figure 43. Mirolux vs. LTL2000 Measurements, October 1995
Asphalt Deck, Permanent Tapes, Wheel Track

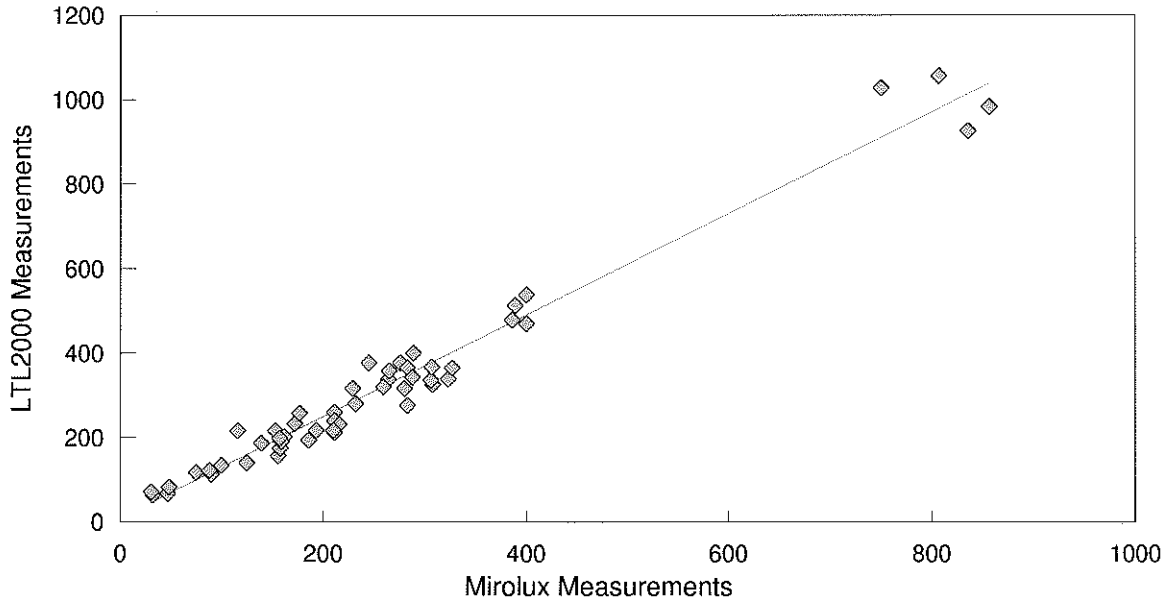


Figure 44. Mirolux vs. LTL2000 Measurements, October 1995
Asphalt Deck, Permanent Tapes, Center

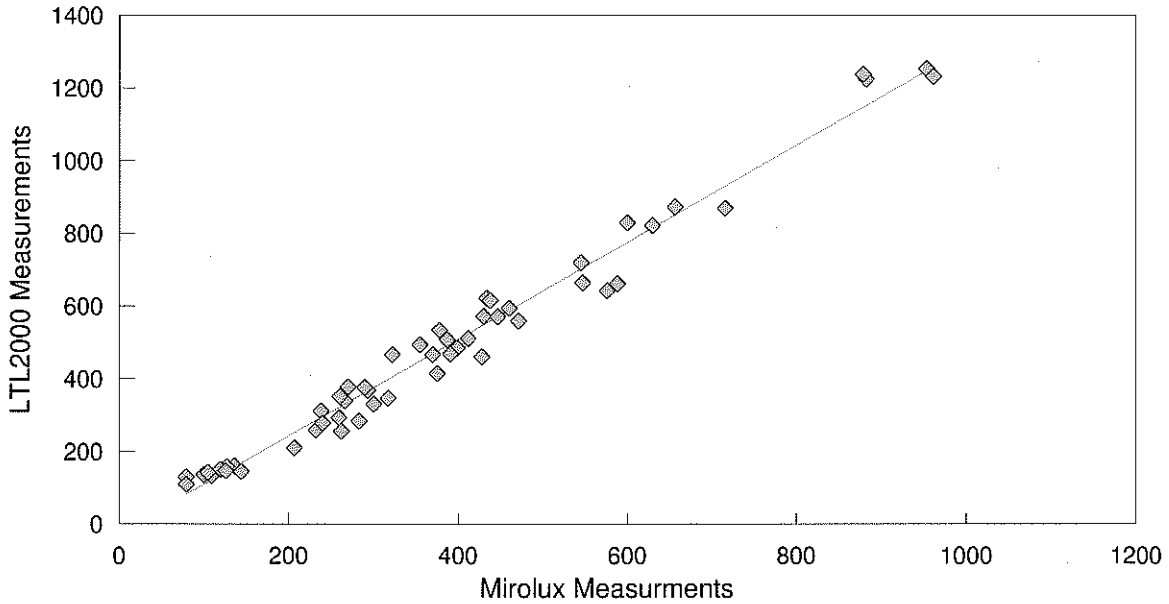
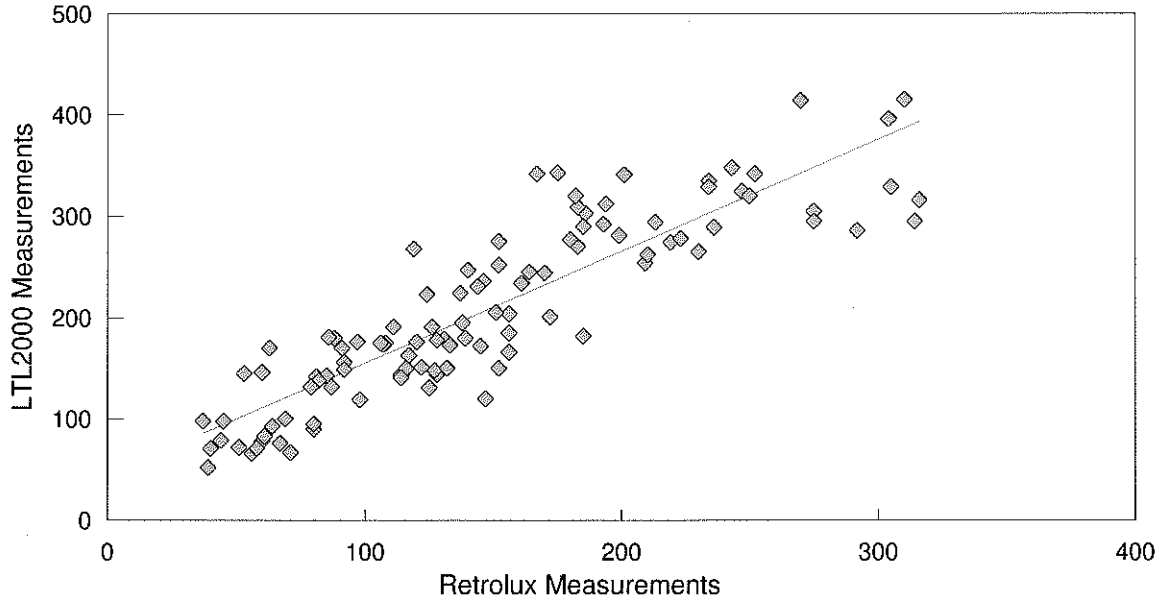


Figure 45. Retrolux vs. LTL2000 Measurements, October 1995

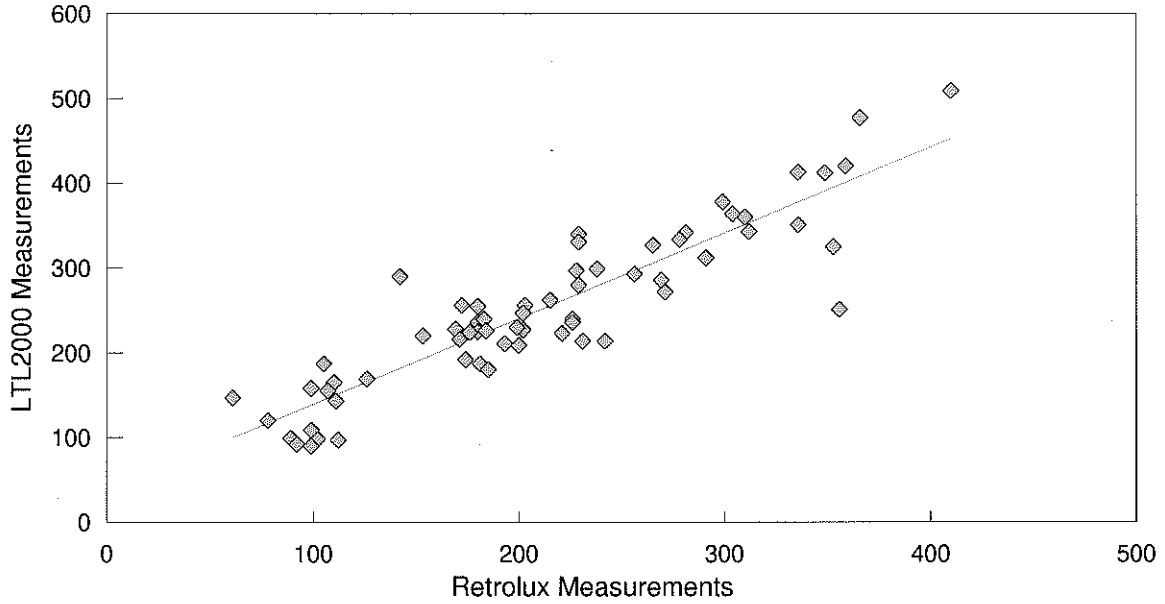
Asphalt Deck, Paint Lines, Wheel Track



R^2 = 0.79

Figure 46. Retrolux vs. LT2000 Measurements, October 1995

Asphalt Deck, Paint Lines, Center



R^2 = 0.82

Figure 47. Retrolux vs. LTL2000 Measurements, October 1995

Asphalt Deck, Permanent Tapes, Wheel Track

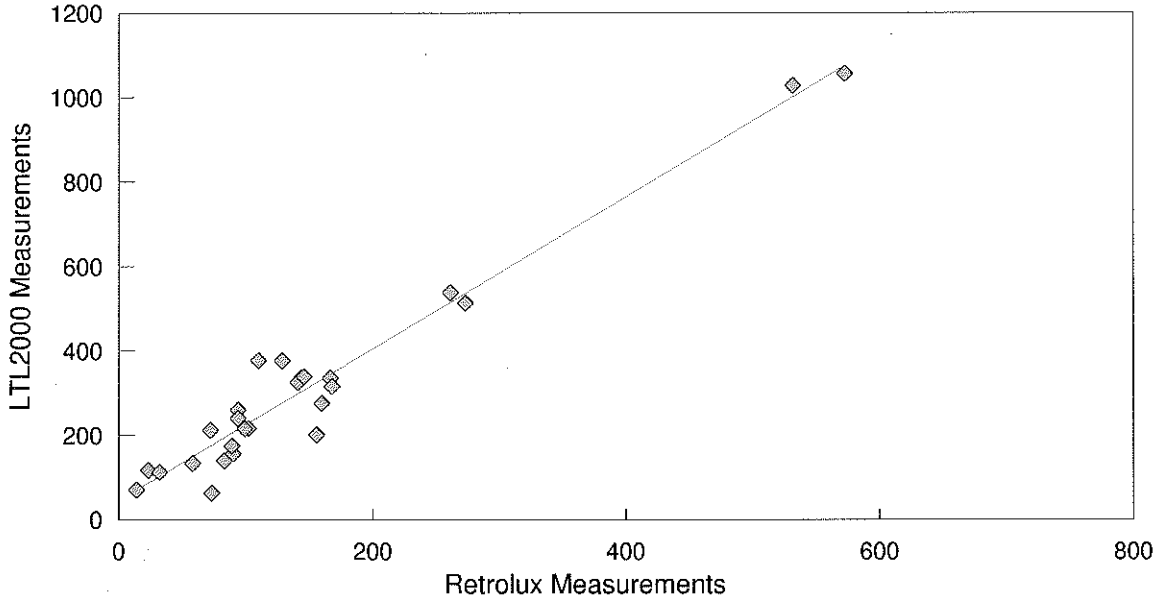


Figure 48. Retrolux vs. LTL2000 Measurements, October 1995

Asphalt Deck, Permanent Tapes, Center

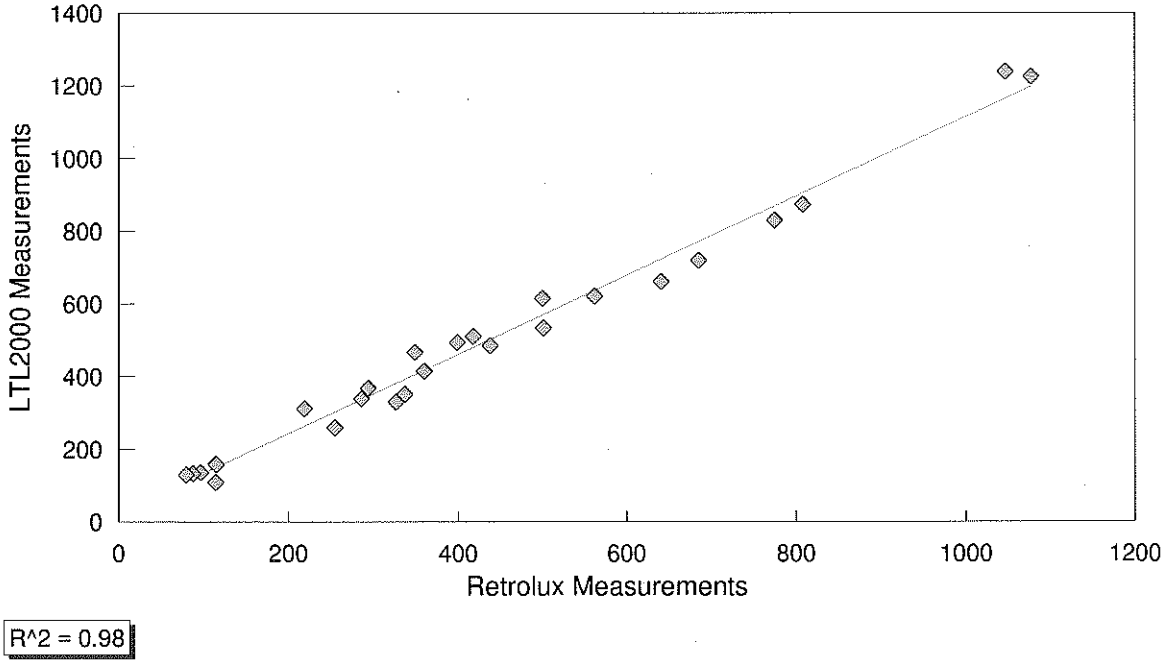


Figure 49. Mirolux vs. Retrolux Measurements, October 1995

Concrete Deck, Paint Lines, Wheel Track

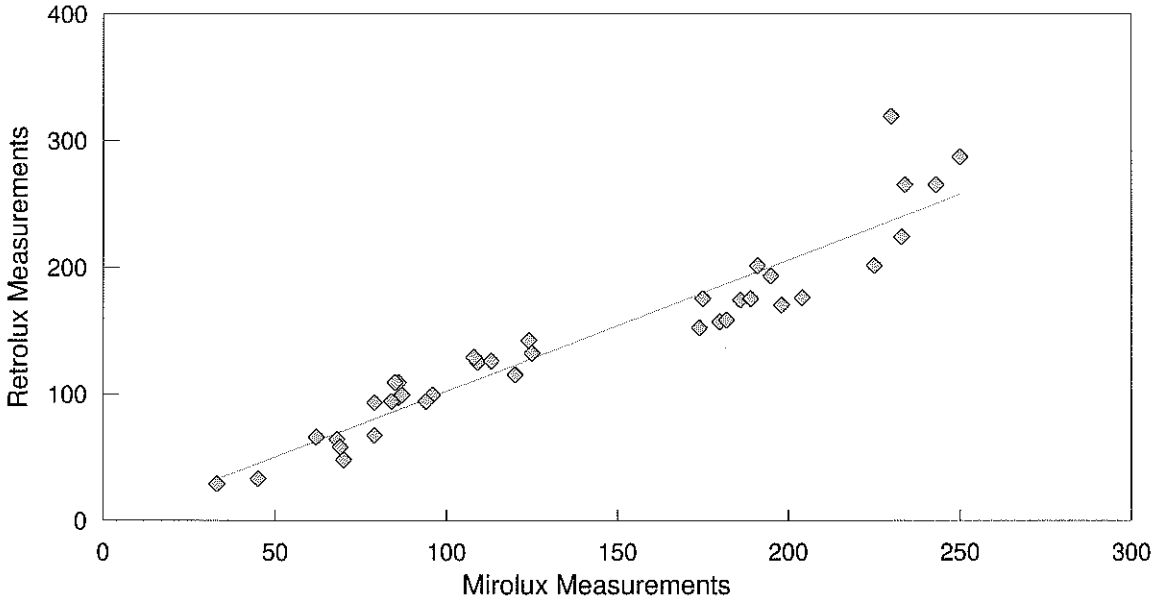


Figure 50. Mirolux vs. Retrolux Measurements, October 1995

Concrete Dack, Paint Lines, Center

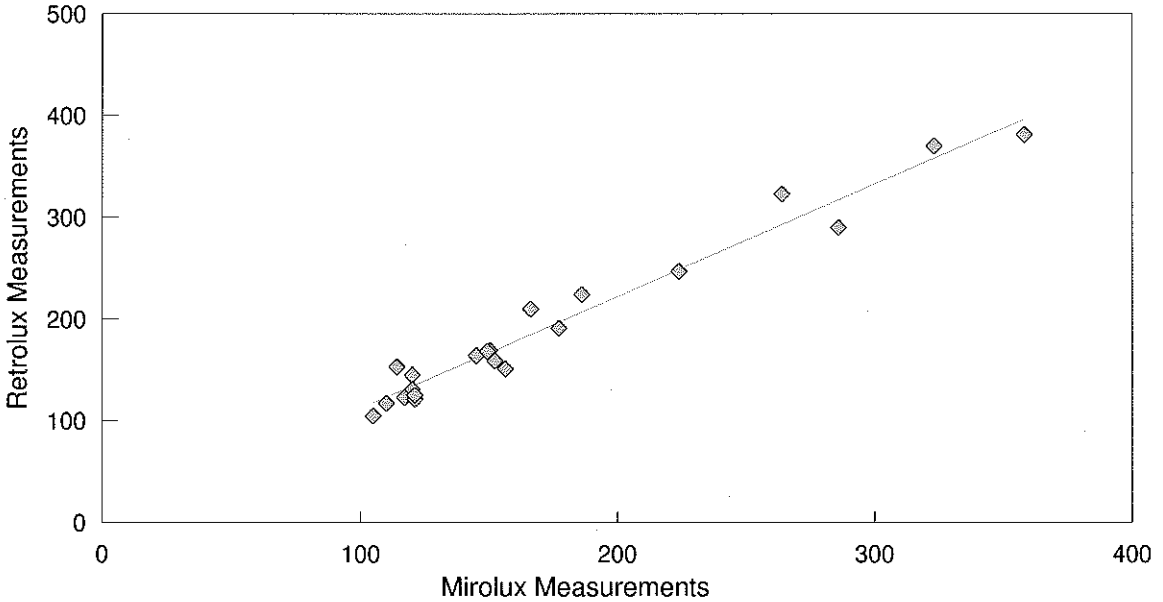


Figure 51. Mirolux vs. Retrolux Measurements, October 1995

Concrete Deck, Permanent Tapes, Wheel Track

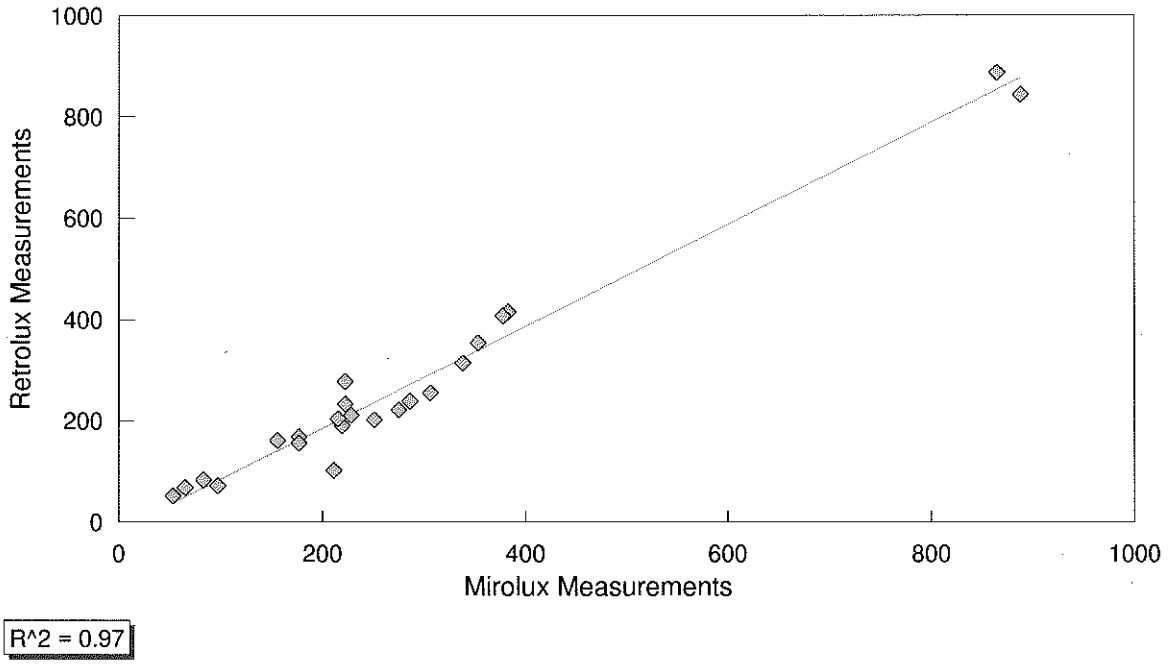


Figure 52. Mirolux vs Retrolux Measurements, October 1995

Concrete Deck, Permanent Tapes, Center

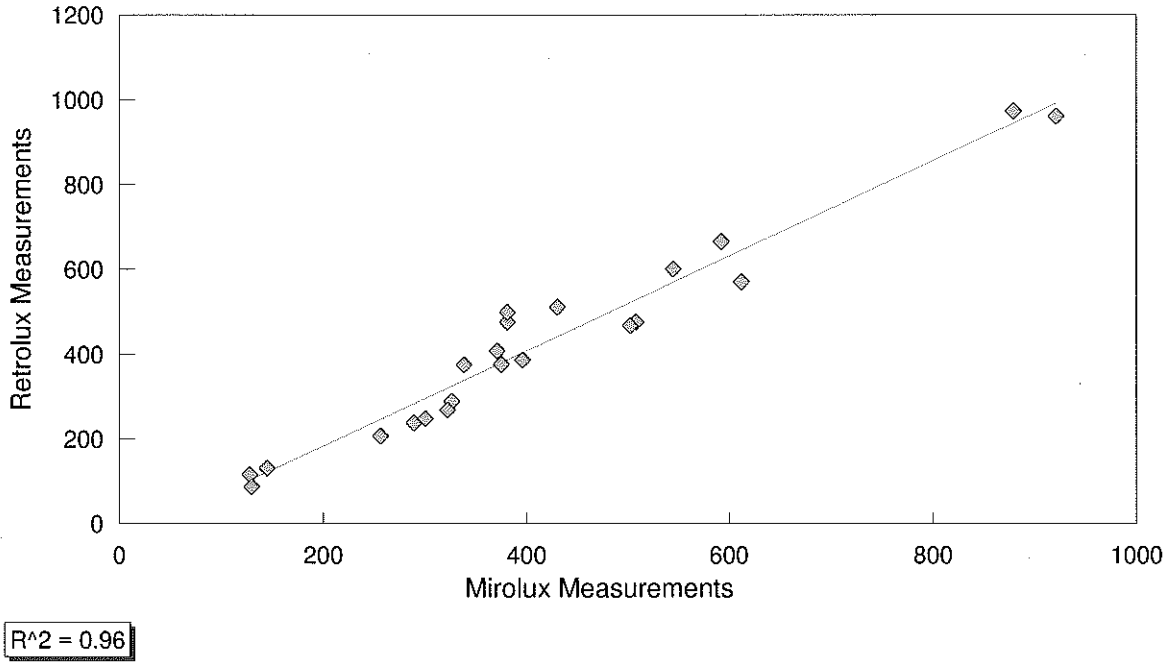


Figure 53. Mirolux vs. LTL2000 Measurements, October 1995

Concrete Deck, Paint Lines, Wheel Track

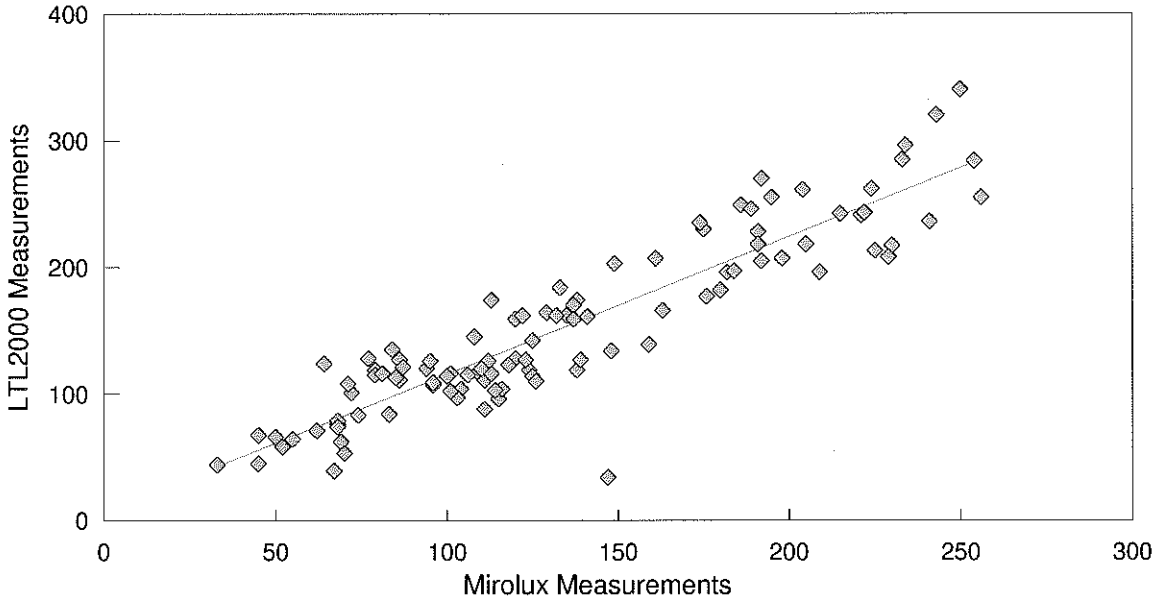


Figure 54. Mirolux vs. LTL2000 Measurements, October 1995

Concrete Deck, Paint Lines, Center

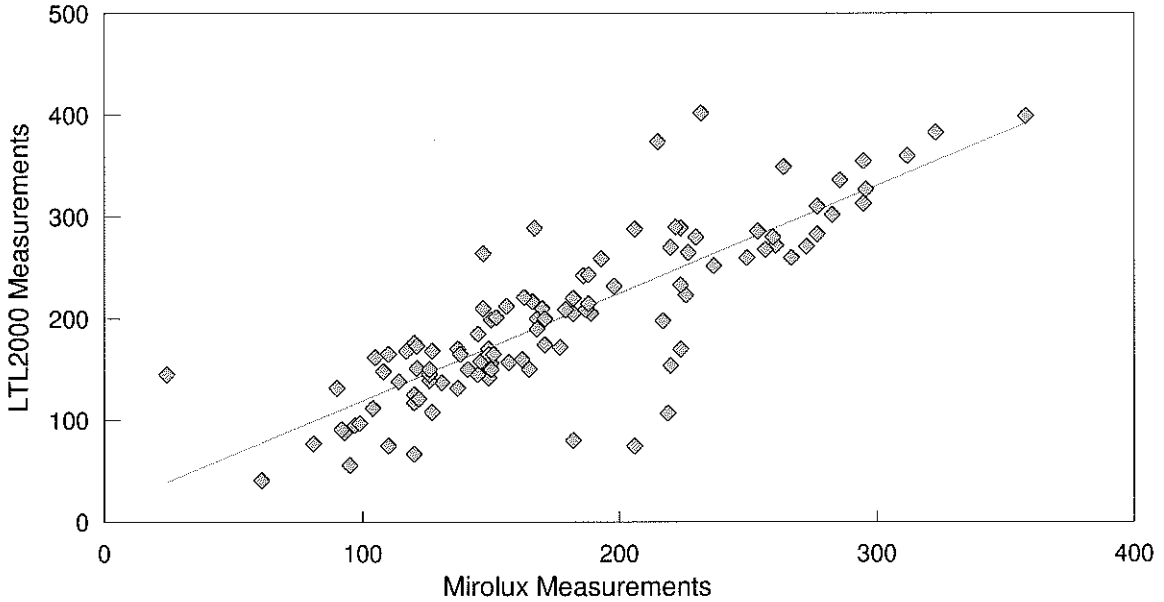
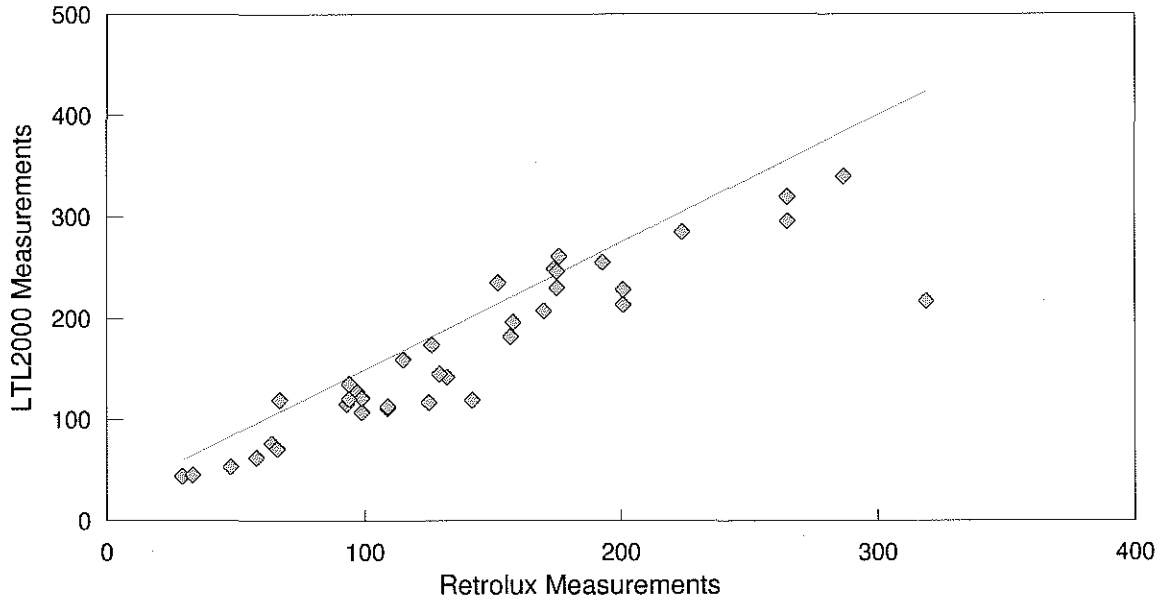


Figure 55. Retrolux vs. LTL2000 Measurements, October 1995

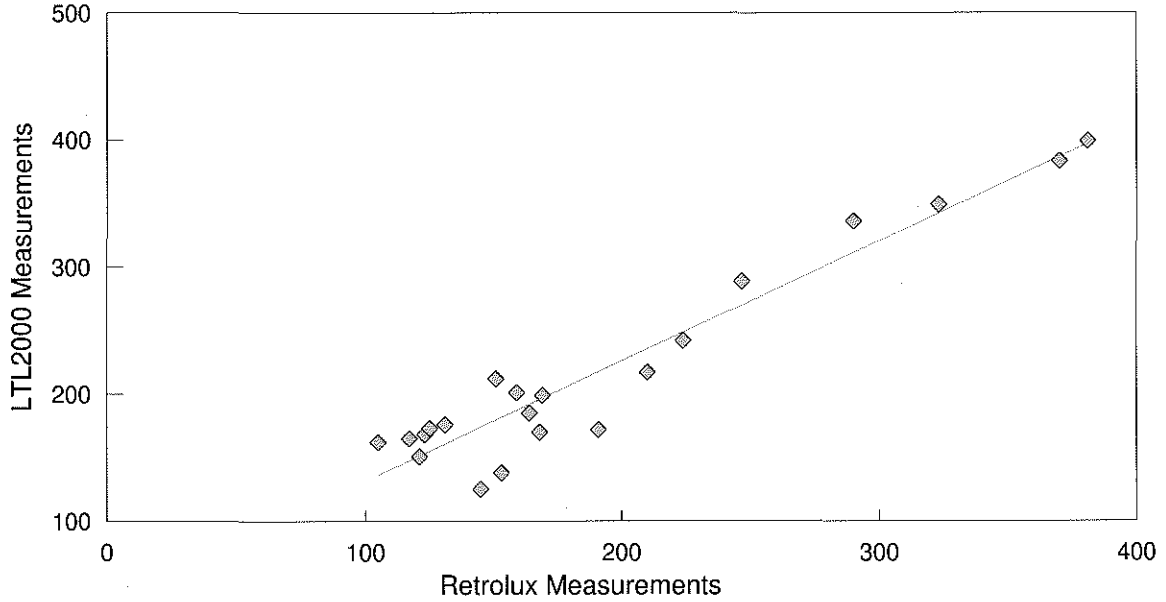
Concrete Deck, Paint Lines, Wheel Track



R^2 = 0.82

Figure 56. Retrolux vs. LTL2000 Measurements, October 1995

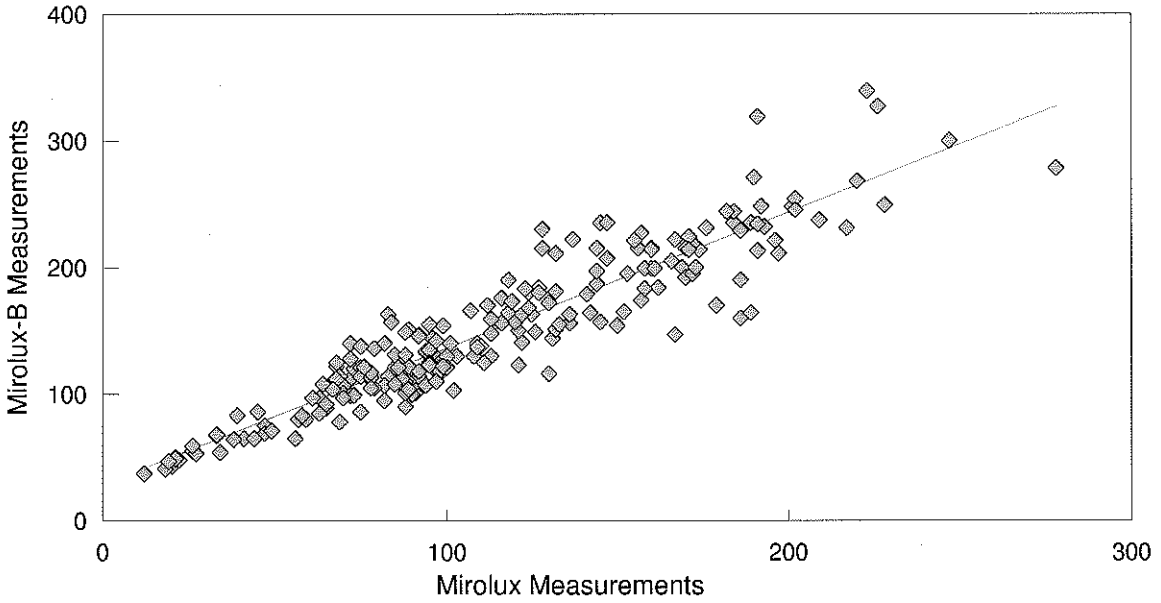
Concrete Deck, Paint Lines, Center



R^2 = 0.91

Figure 57. Mirolux vs. Mirolux-B Measurements, May 1996

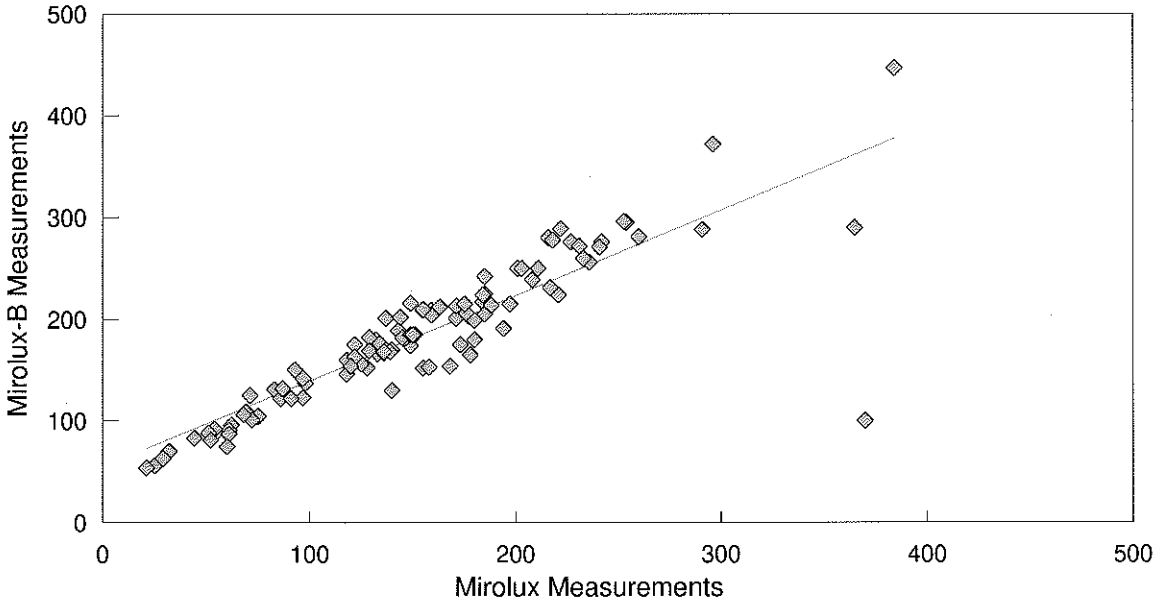
Asphalt Deck, Paint Lines, Wheel Track



R^2 = 0.86

Figure 58. Mirolux vs. Mirolux-B Measurements, May 1996

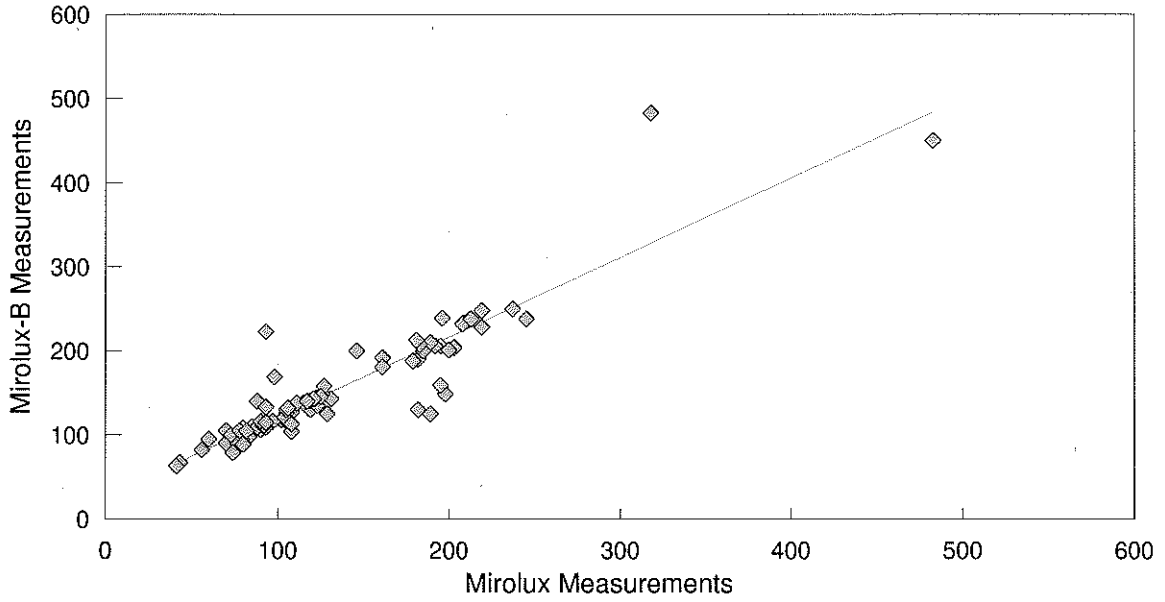
Asphalt Deck, Paint Lines, Center



R^2 = 0.76

Figure 59. Mirolux vs. Mirolux-B Measurements, May 1996

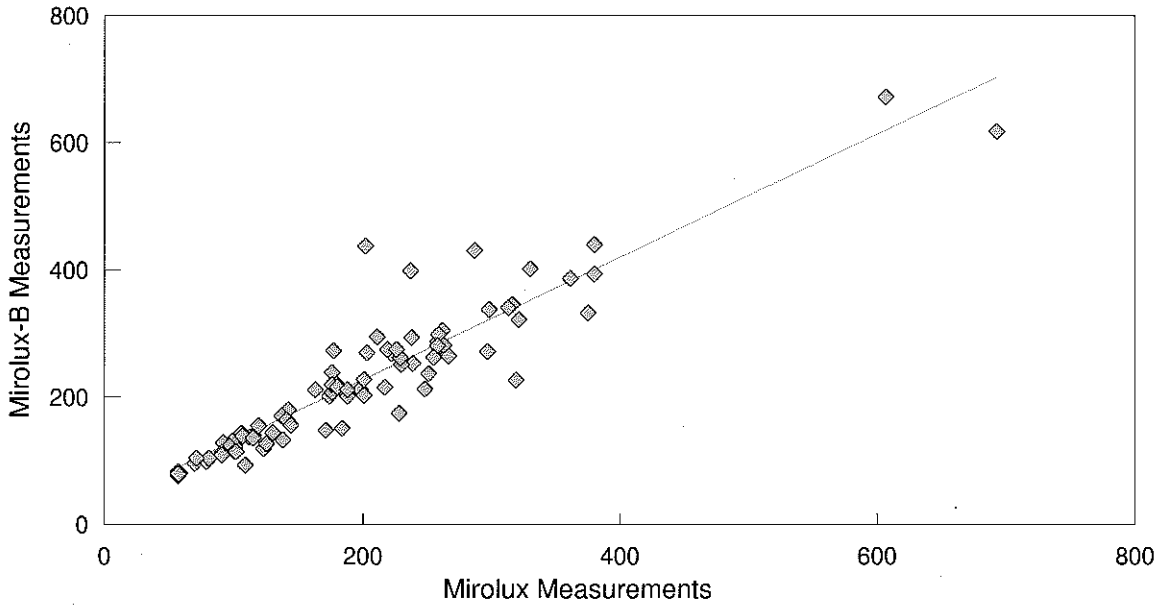
Asphalt Deck, Thermoplastics, Wheel Track



R^2 = 0.83

Figure 60. Mirolux vs. Mirolux-B Measurements, May 1996

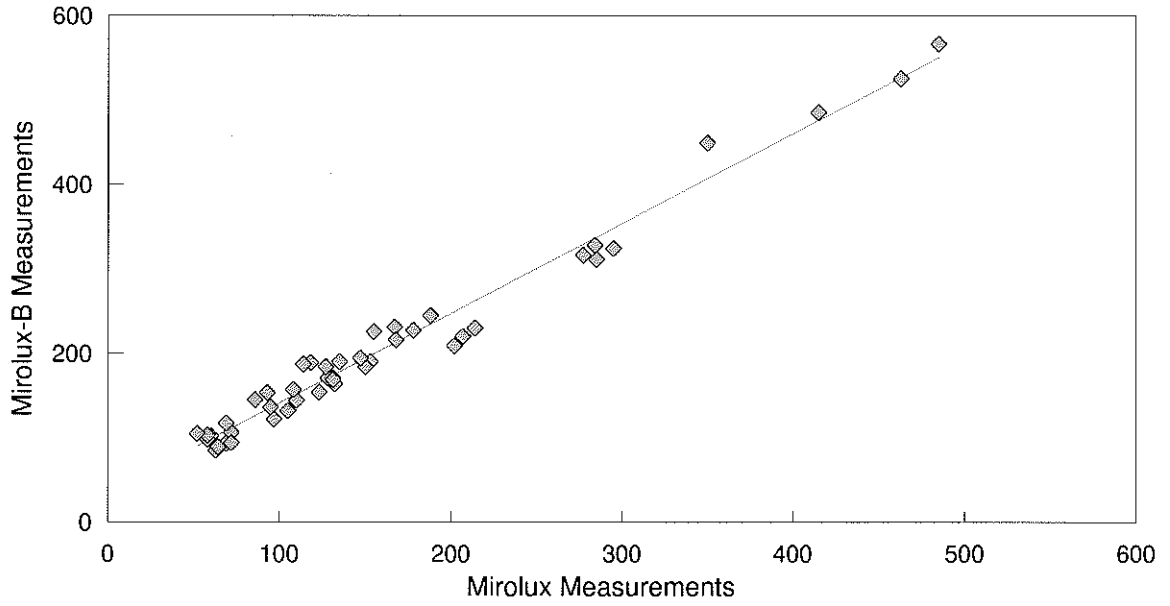
Asphalt Deck, Thermoplastics, Center



R^2 = 0.86

Figure 61. Mirolux vs. Mirolux-B Measurements, May 1996

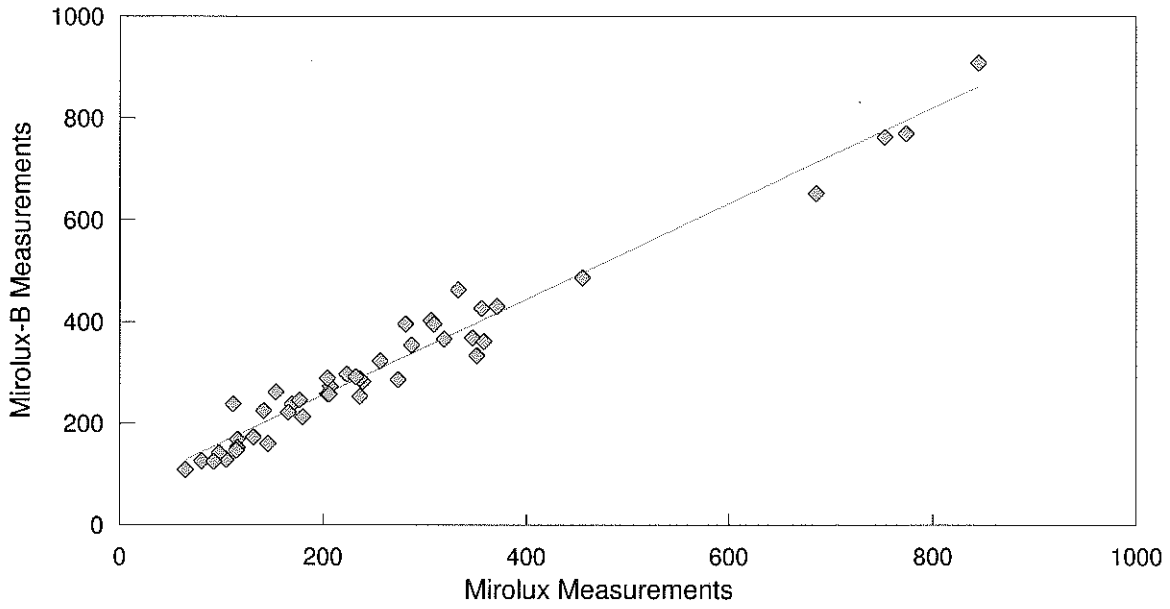
Asphalt Deck, Permanent Tapes, Wheel Track



R^2 = 0.98

Figure 62. Mirolux vs. Mirolux-B Measurements, May 1996

Asphalt Deck, Permanent Tapes, Center



R^2 = 0.96

Figure 63. Mirolux vs. Retrolux Measurements, May 1996

Asphalt Deck, Paint Lines, Wheel Track

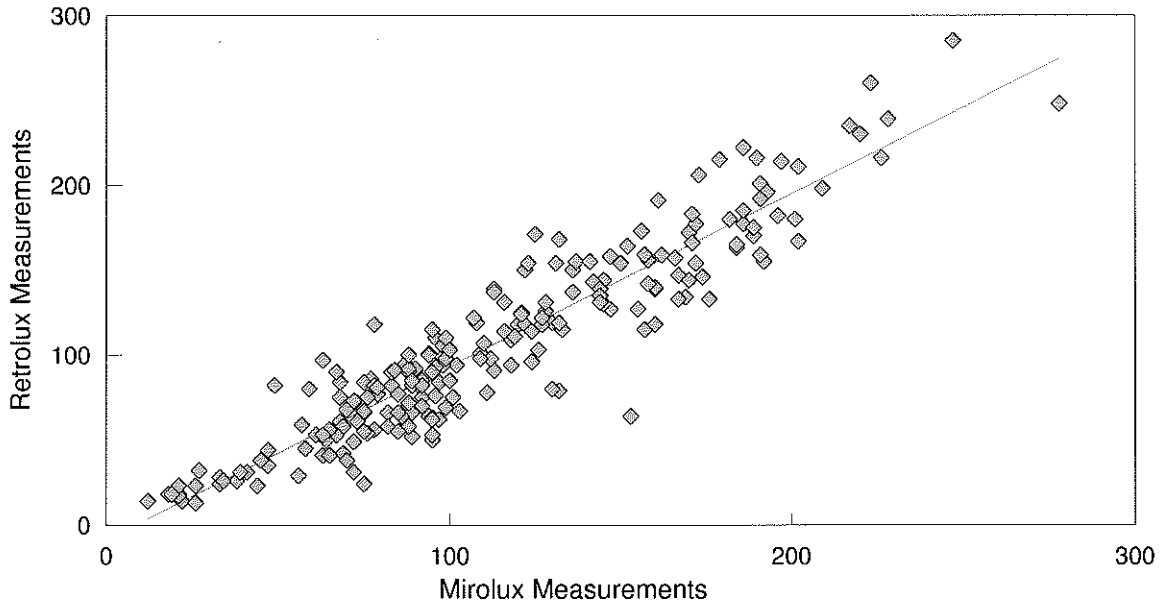


Figure 64. Mirolux vs. Retrolux Measurements, May 1996

Asphalt Deck, Thermoplastics, Wheel Track

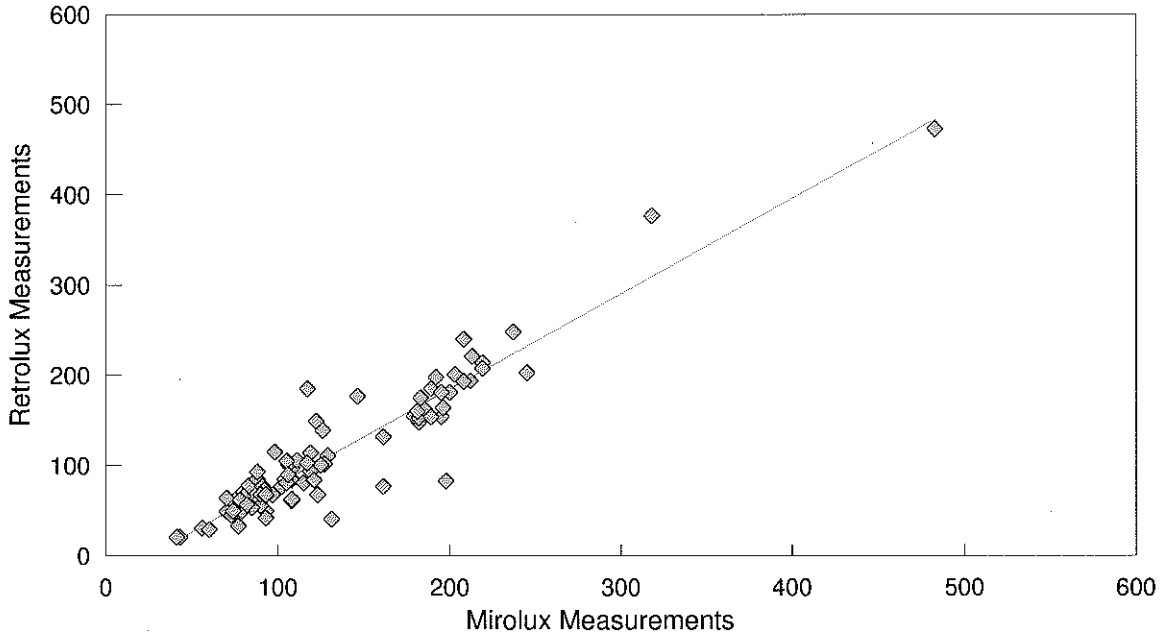
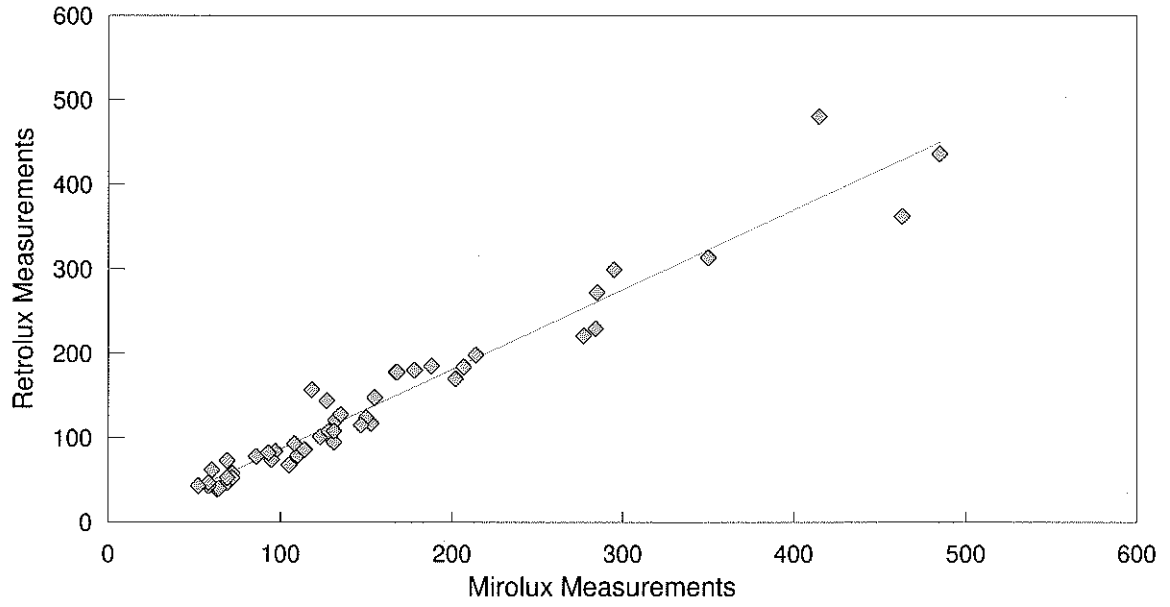
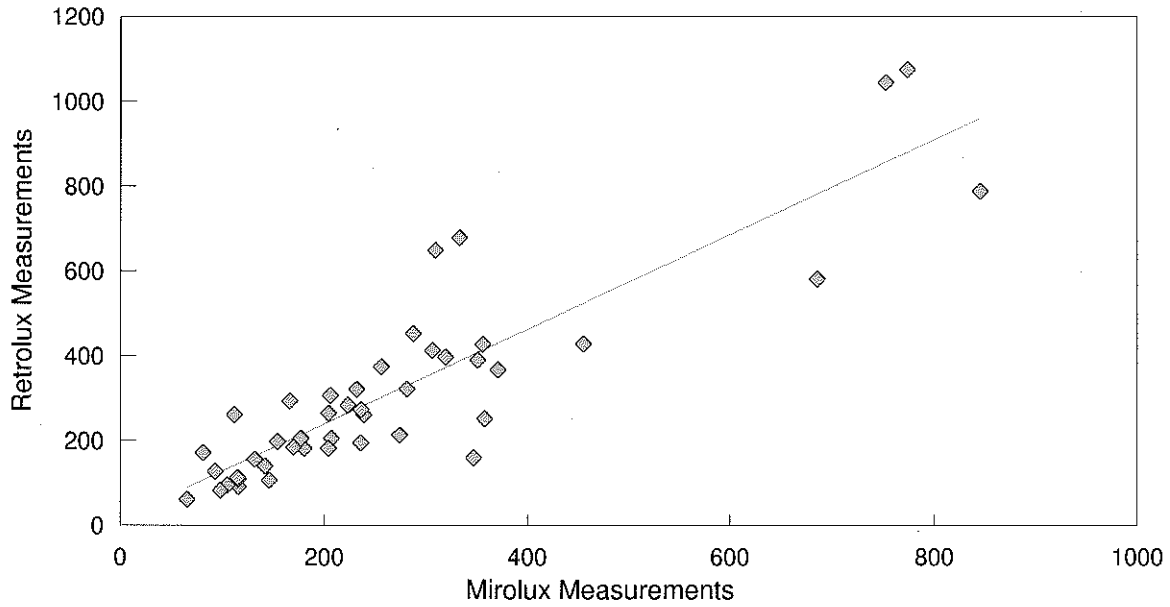


Figure 65. Mirolux vs. Retrolux Measurements, May 1996
Asphalt Deck, Permanent Tapes, Wheel Track



R^2 = 0.94

Figure 66. Mirolux vs. Retrolux Measurements, May 1996
Asphalt Deck, Permanent Tapes, Center



R^2 = 0.78

Figure 67. Mirolux vs. LTL2000 Measurements, May 1996

Asphalt Deck, Paint Lines, Wheel Track

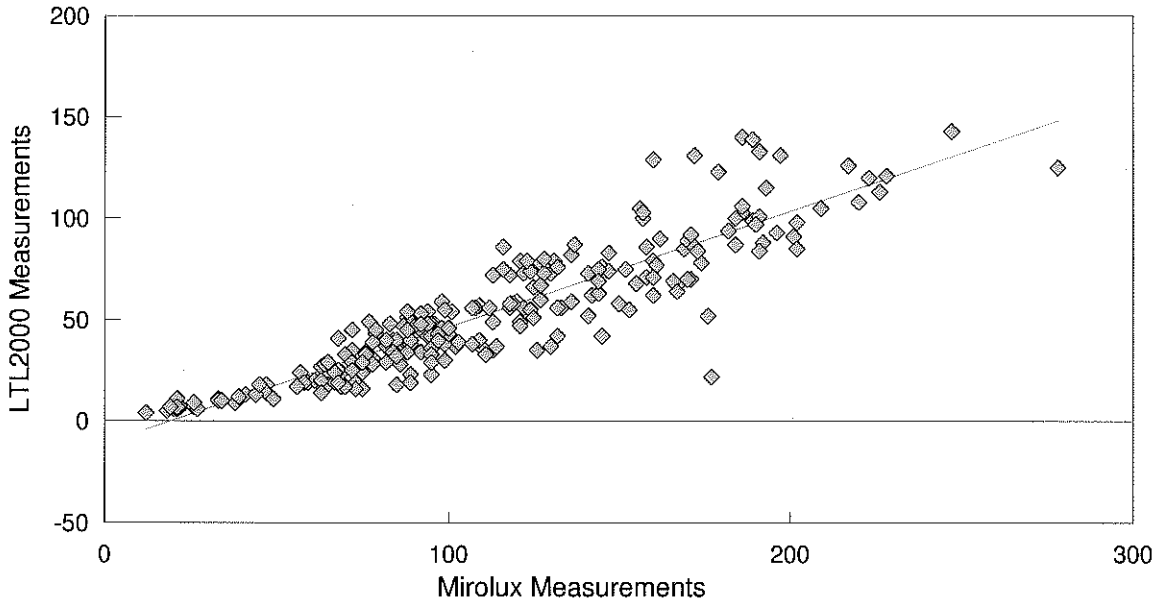


Figure 68. Mirolux vs. LTL2000 Measurements, May 1996

Asphalt Deck, Paint Lines, Center

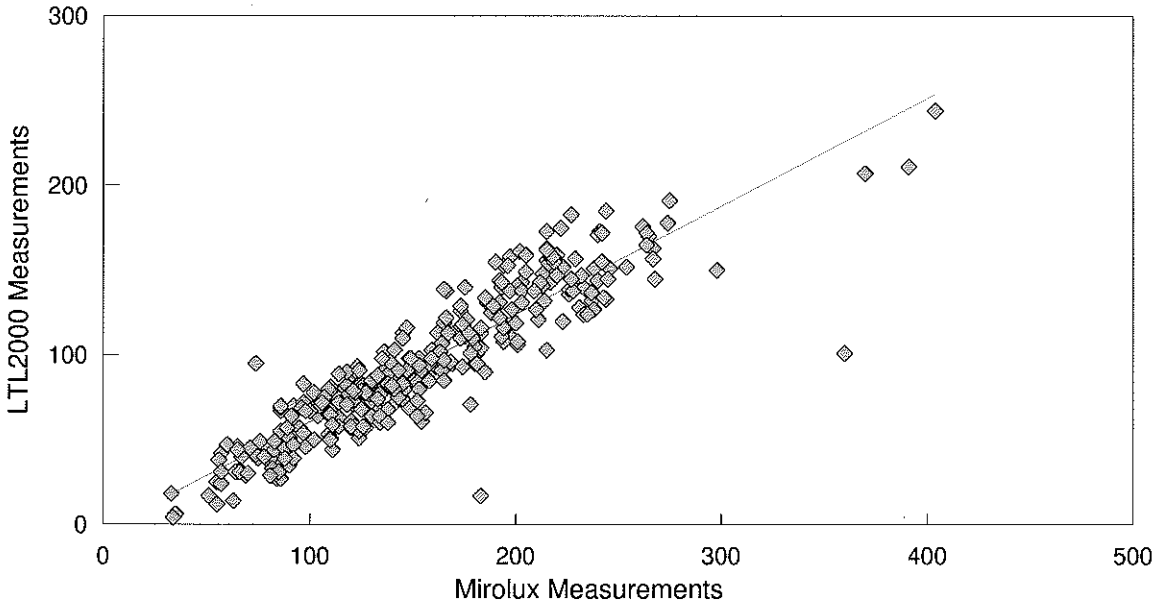
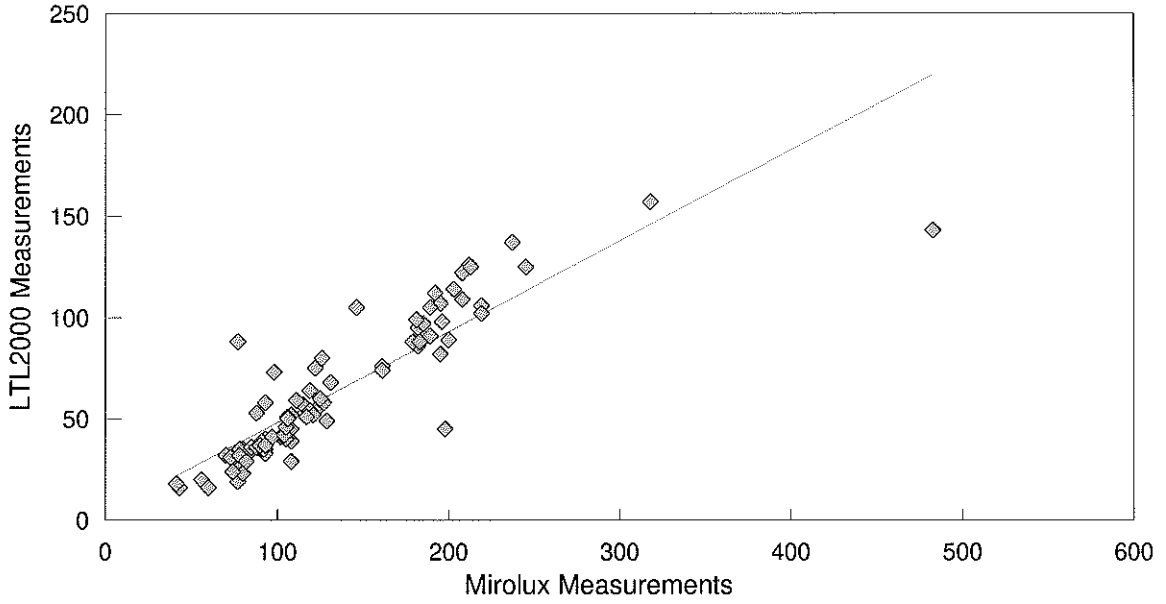


Figure 69. Mirolux vs. LTL2000 Measurements, May 1996

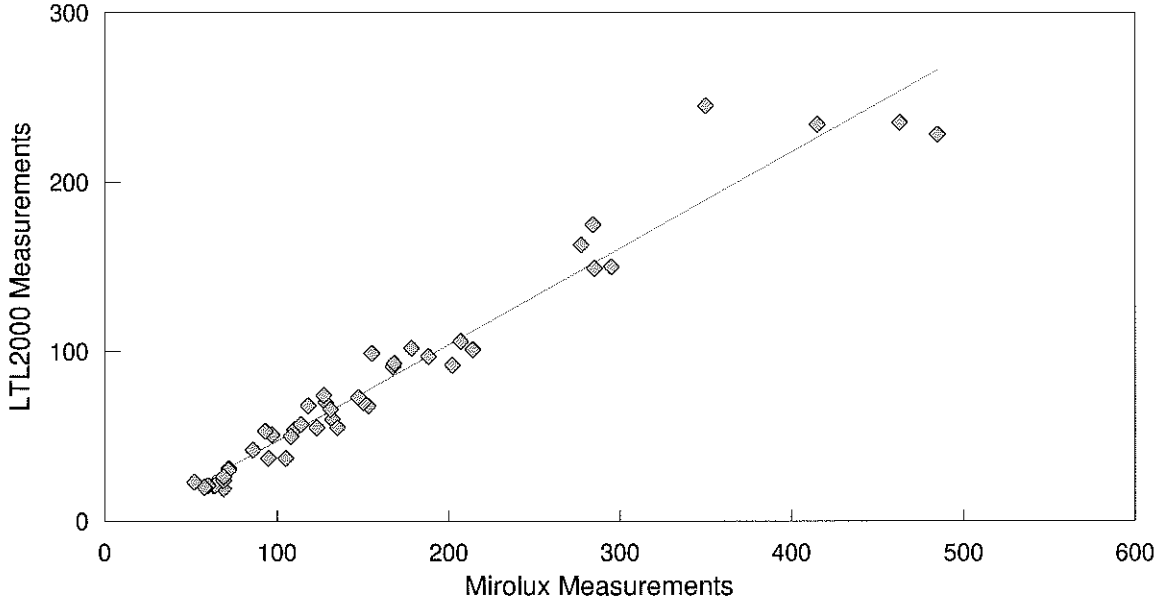
Asphalt Deck, Thermoplastics, Wheel Track



R^2 = 0.77

Figure 70. Mirolux vs. LTL2000 Measurements, May 1996

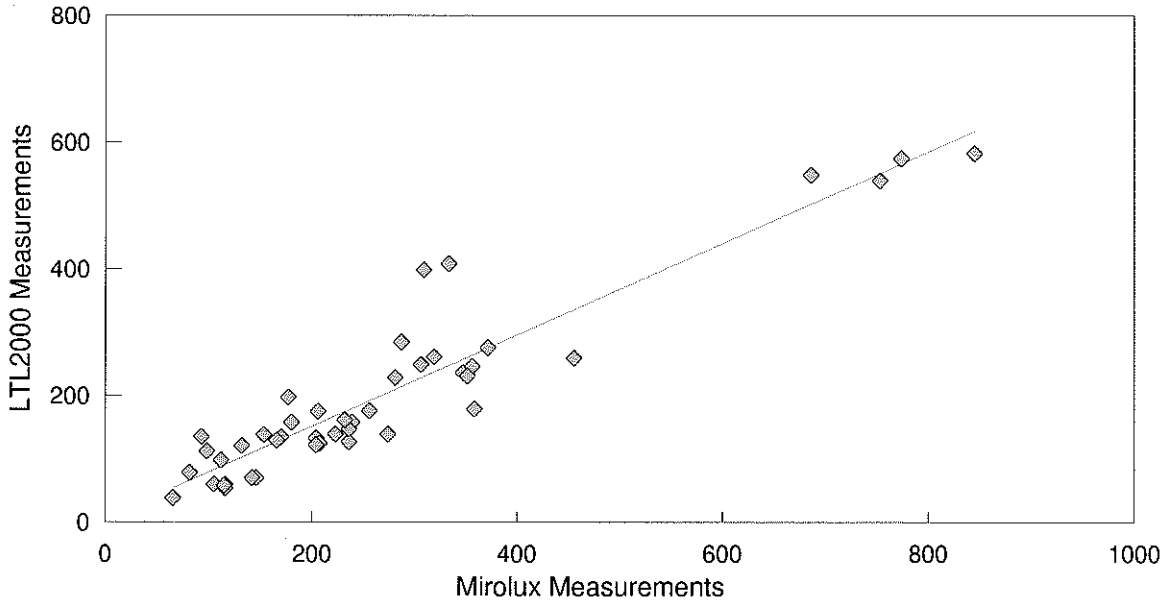
Asphalt Deck, Permanent Tapes, Wheel Track



R^2 = 0.95

Figure 71. Mirolux vs. LTL2000 Measurements, May 1996

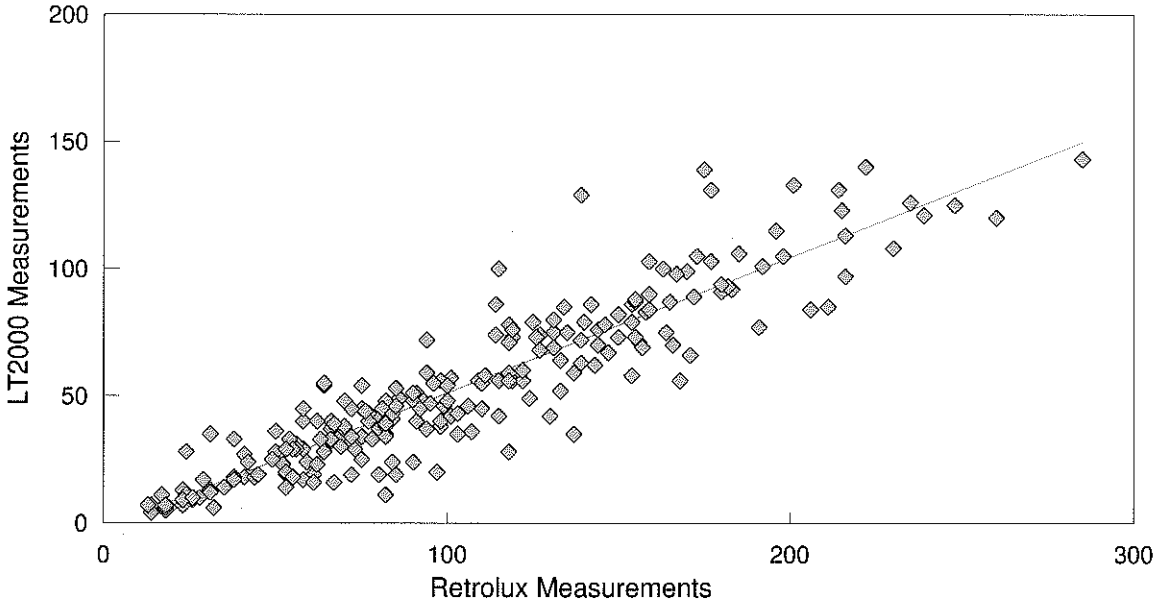
Asphalt Deck, Permanent Tapes, Center



R^2 = 0.87

Figure 72. Retrolux vs. LTL2000 Measurements, May 1996

Asphalt Deck, Paint Lines, Wheel Track



R^2 = 0.84

Figure 73. Retrolux vs. LTL2000 Measurements, May 1996

Asphalt Deck, Thermoplasics, Wheel Track

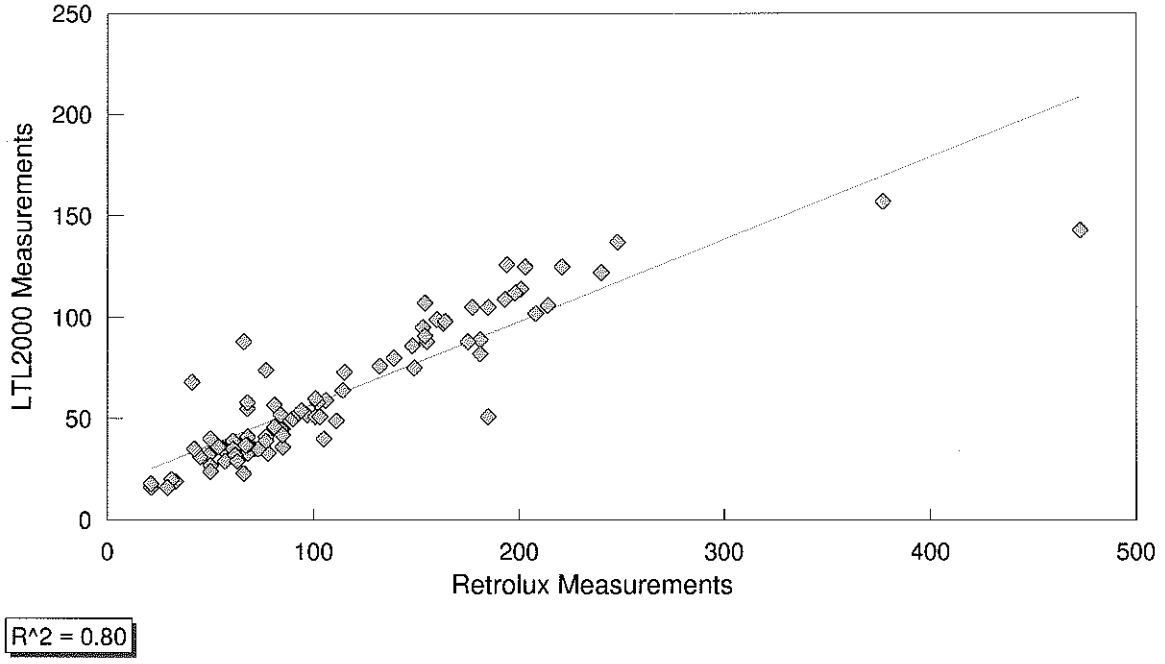


Figure 74. Retrolux vs. LTL2000 Measurements, May 1996

Asphalt Deck, Permament Tapes, Wheel Track

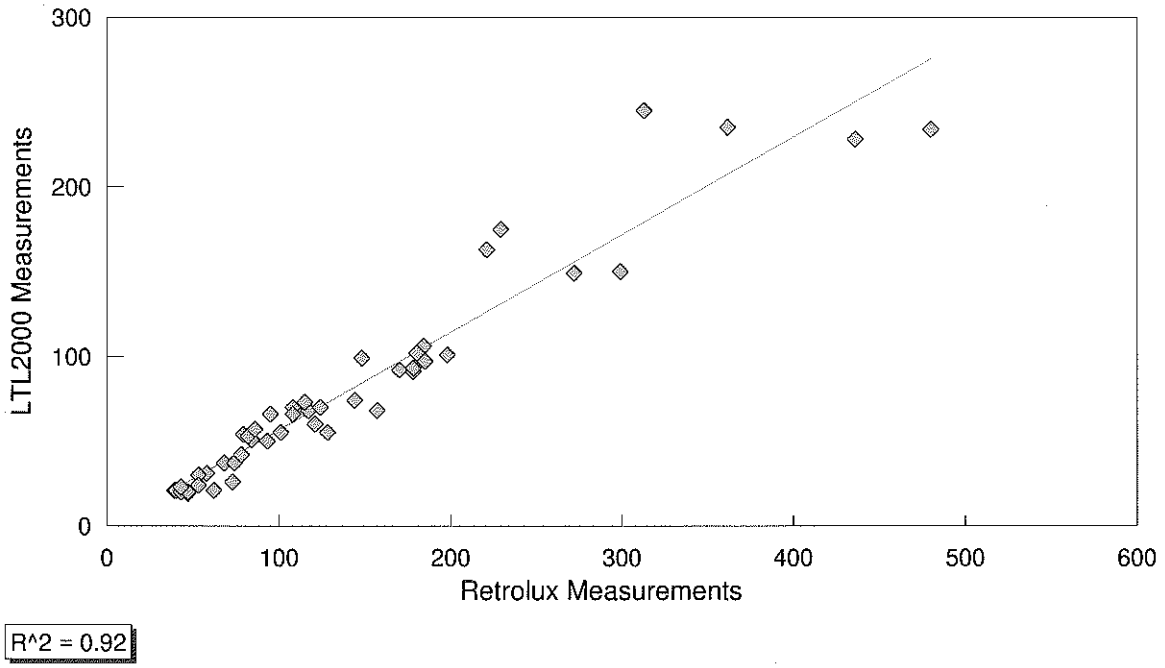
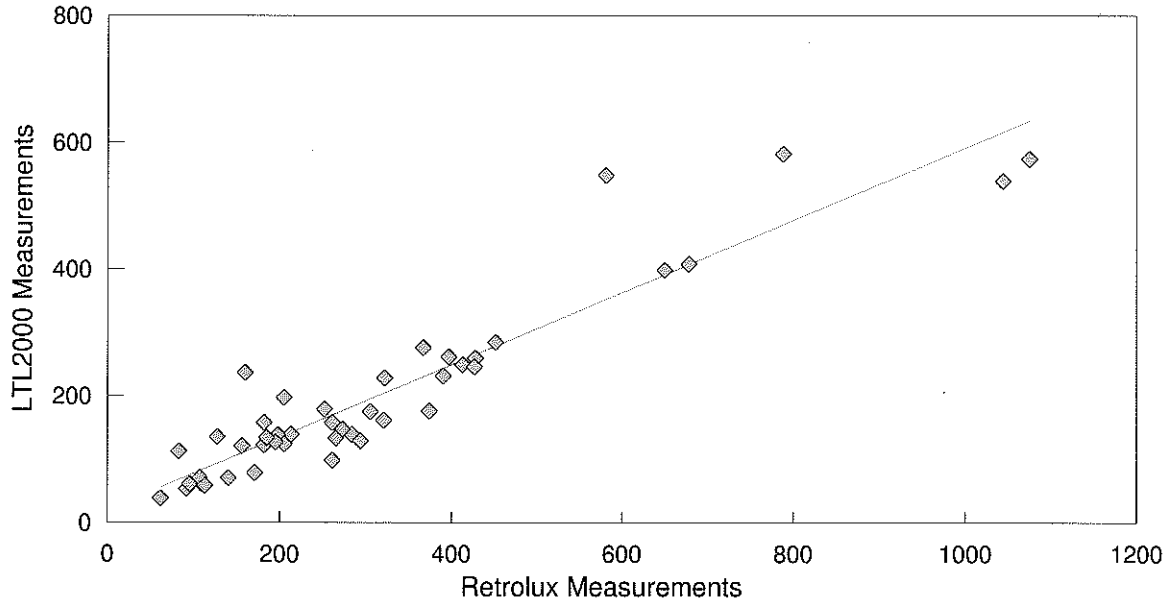


Figure 75. Retrolux vs. LTL2000 Measurements, May 1996

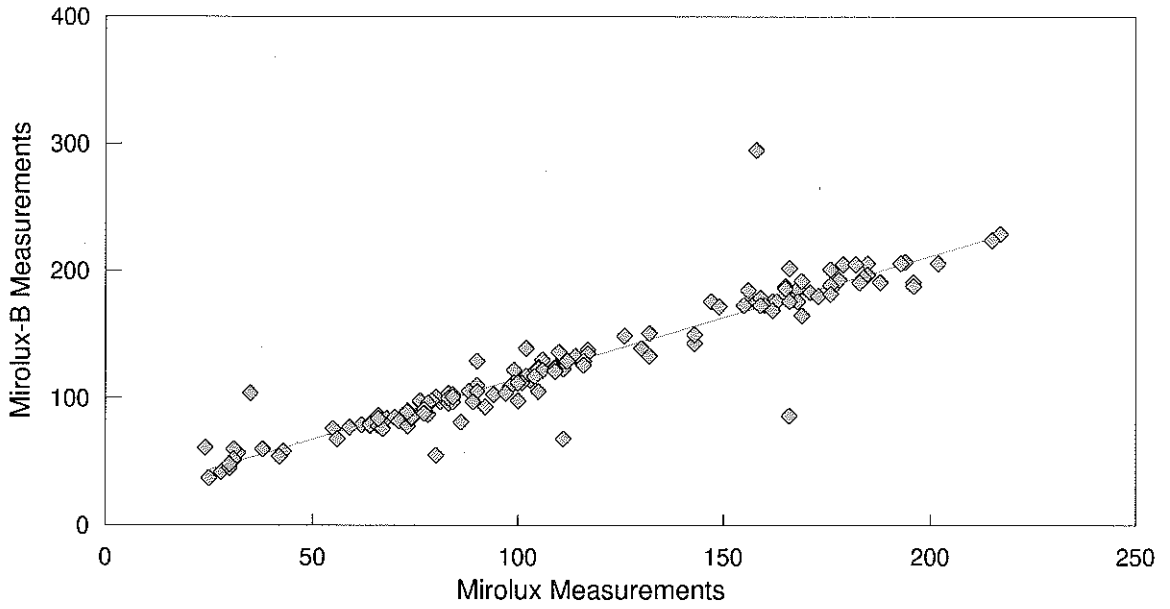
Asphalt Deck, Permanent Tapes, Center



R^2 = 0.87

Figure 76. Mirolux vs. Mirolux-B Measurements, May 1996

Concrete Deck, Thermoplastics, Wheel Track



R^2 = 0.89

Figure 77. Mirolux vs. Mirolux-B Measurements, May 1996

Concrete Deck, Thermoplastics, Center

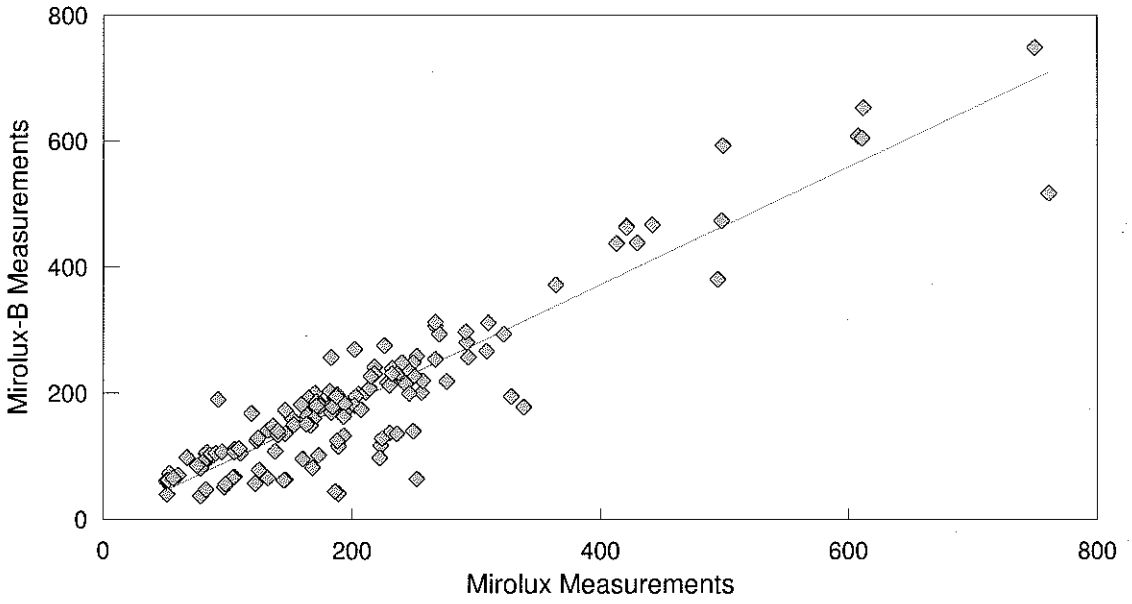


Figure 78. Mirolux vs. Retrolux Measurements, May 1996

Concrete Deck, Paint Lines, Wheel Track

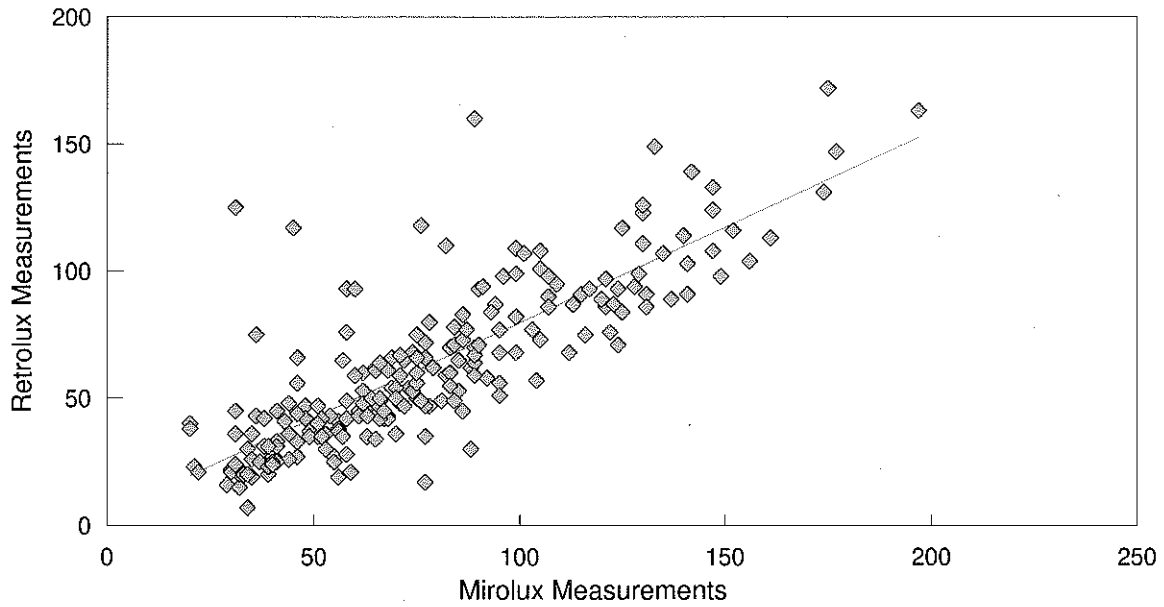


Figure 79. Mirolux vs. Retrolux Measurements, May 1996

Concrete Deck, Thermoplastics, Wheel Track

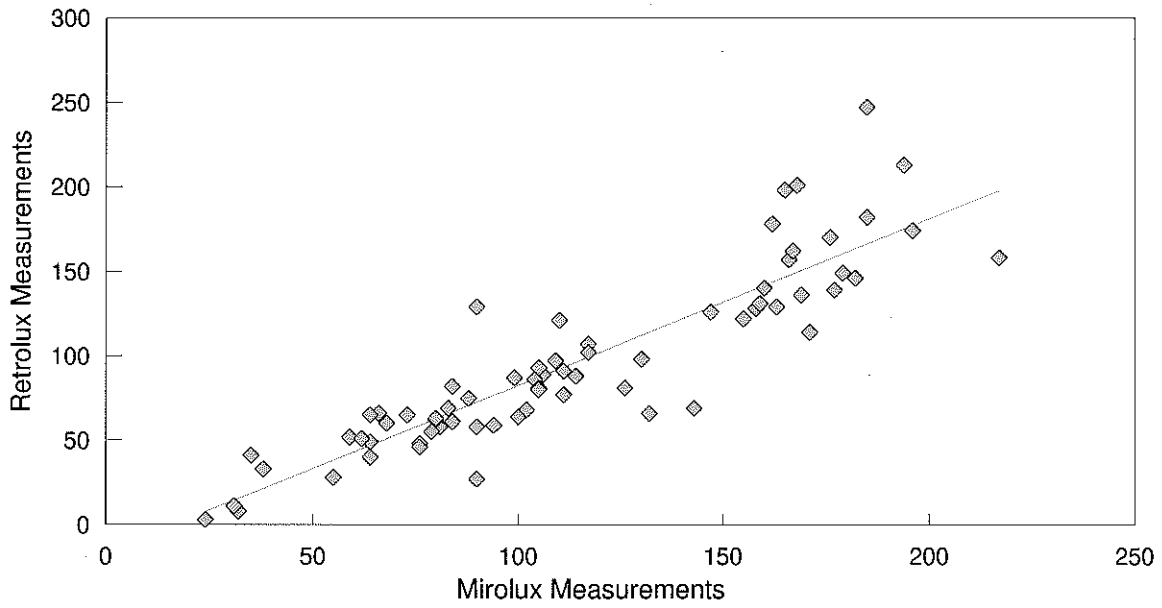


Figure 80. Mirolux vs. Retrolux Measurements, May 1996

Concrete Deck, Permanent Tapes, Wheel Track

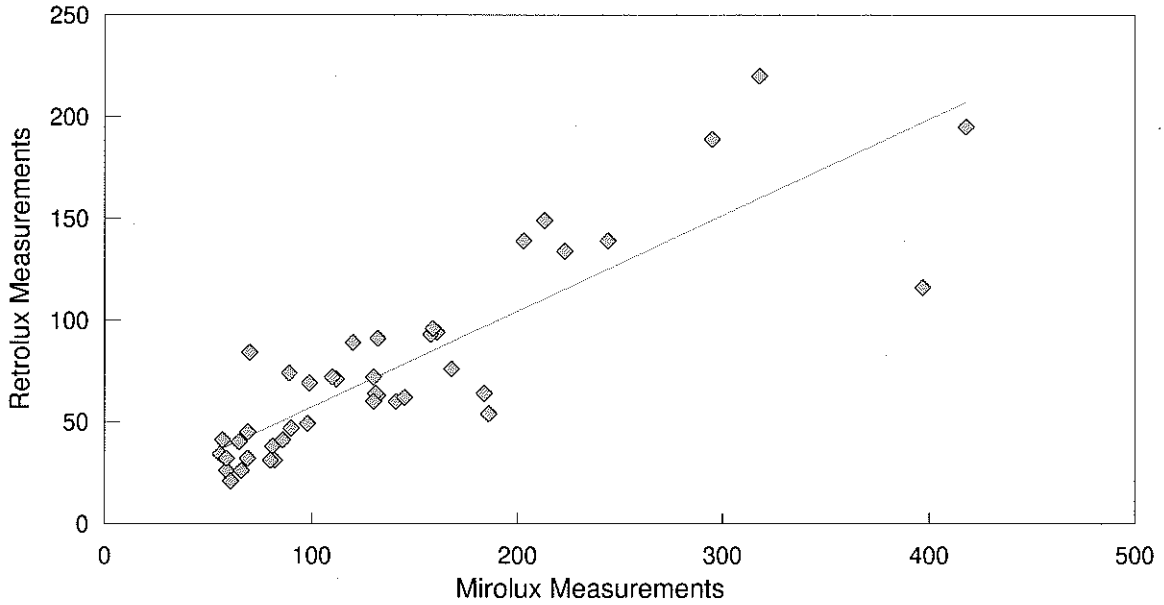


Figure 81. Mirolux vs. Retrolux Measurements, May 1996

Concrete Deck, Permanent Tapes, Center

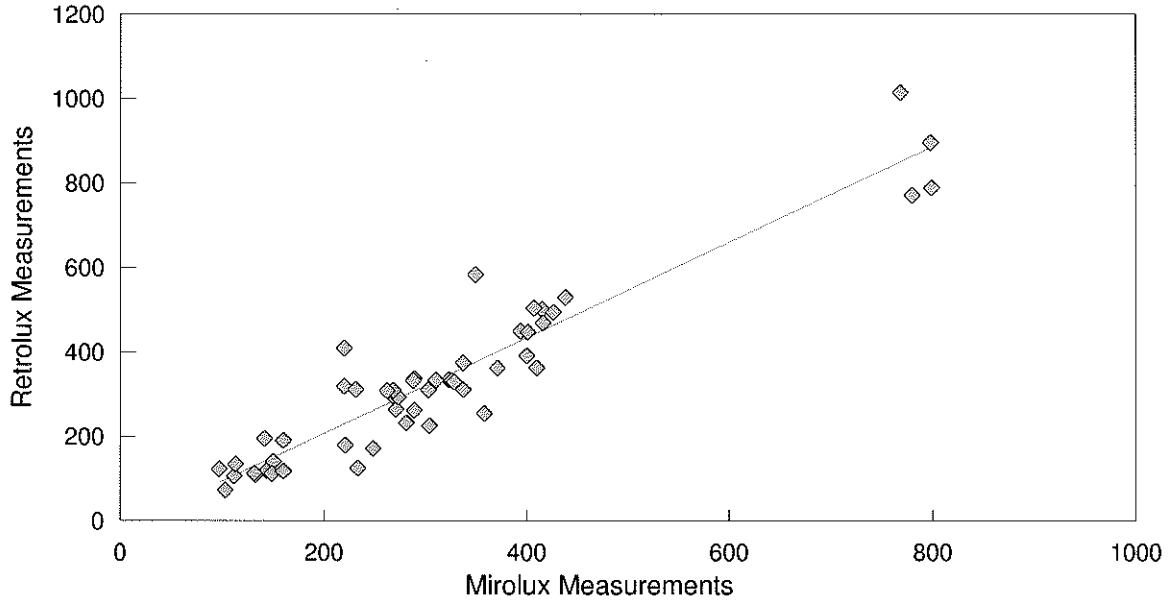


Figure 82. Mirolux vs. LTL2000 Measurements, May 1996

Concrete Deck, Paint Lines, Wheel Track

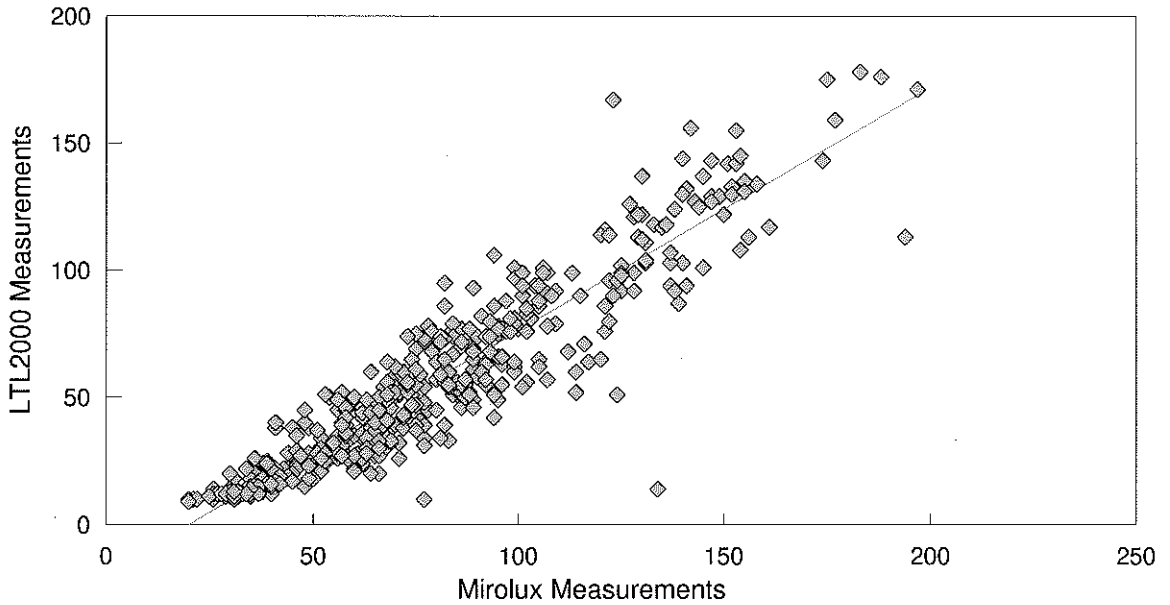


Figure 83. Mirolux vs. LTL2000 Measurements, May 1996
Concrete Deck, Paint Lines, Center

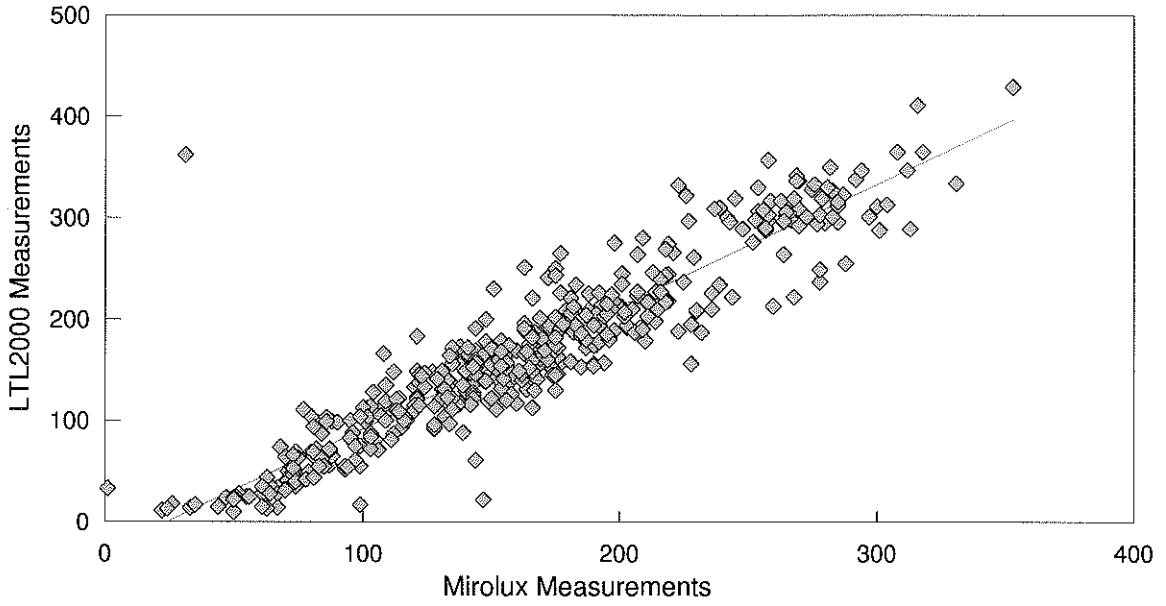


Figure 84. Mirolux vs. LTL2000 Measurements, May 1996
Concrete Deck, Thermoplastics, Wheel Track

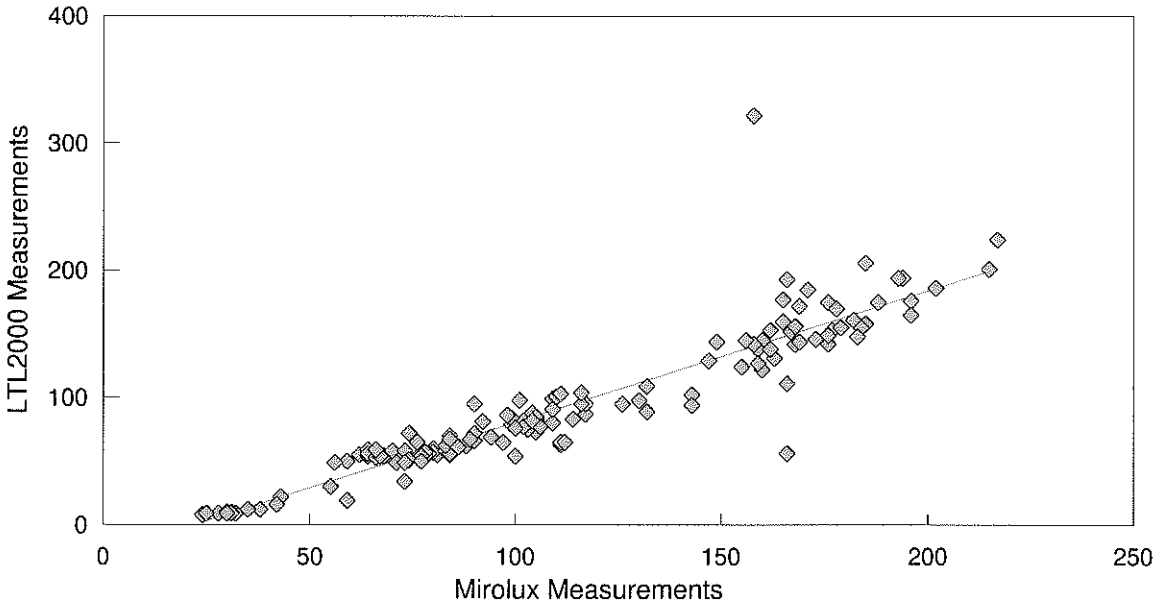
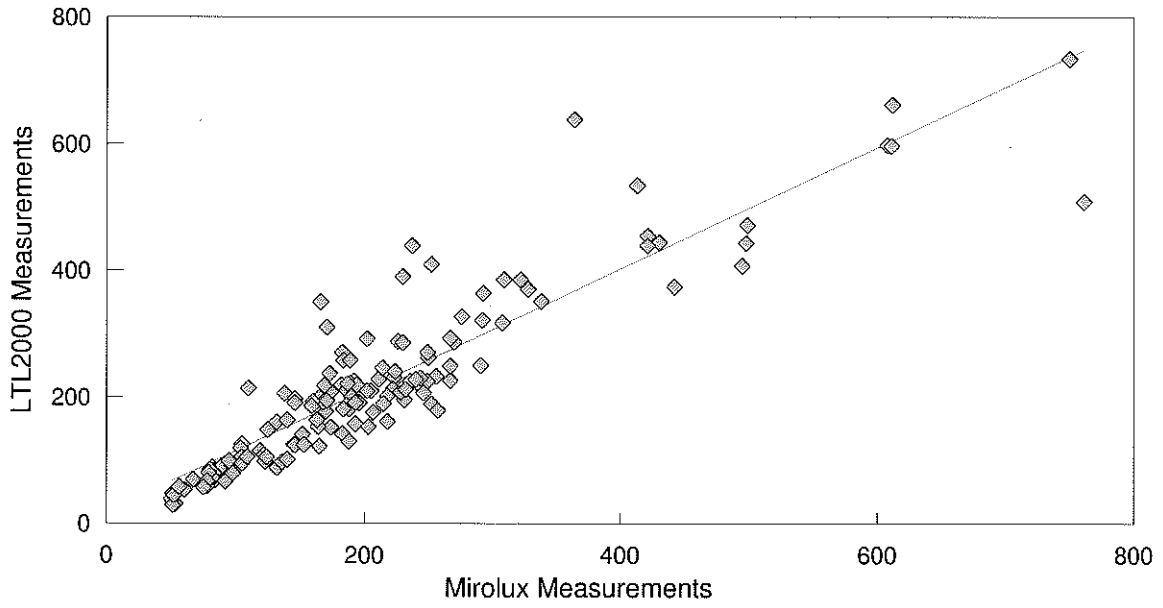


Figure 85. Mirolux vs. LTL2000 Measurements, May 1996

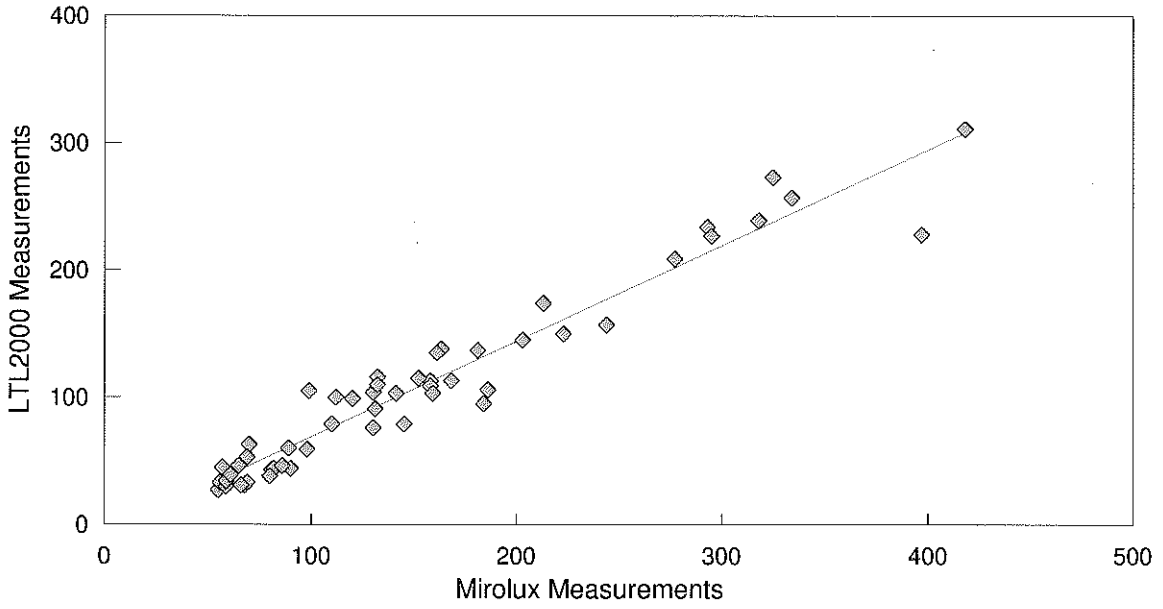
Concrete Deck, Thermoplastics, Center



R^2 = 0.83

Figure 86. Mirolux vs. LTL2000 Measurements, May 1996

Concrete Deck, Permanent Tapes, Wheel Track



R^2 = 0.94

Figure 87. Mirolux vs. LTL2000 Measurements, May 1996
Concrete Deck, Permanent Tapes, Center

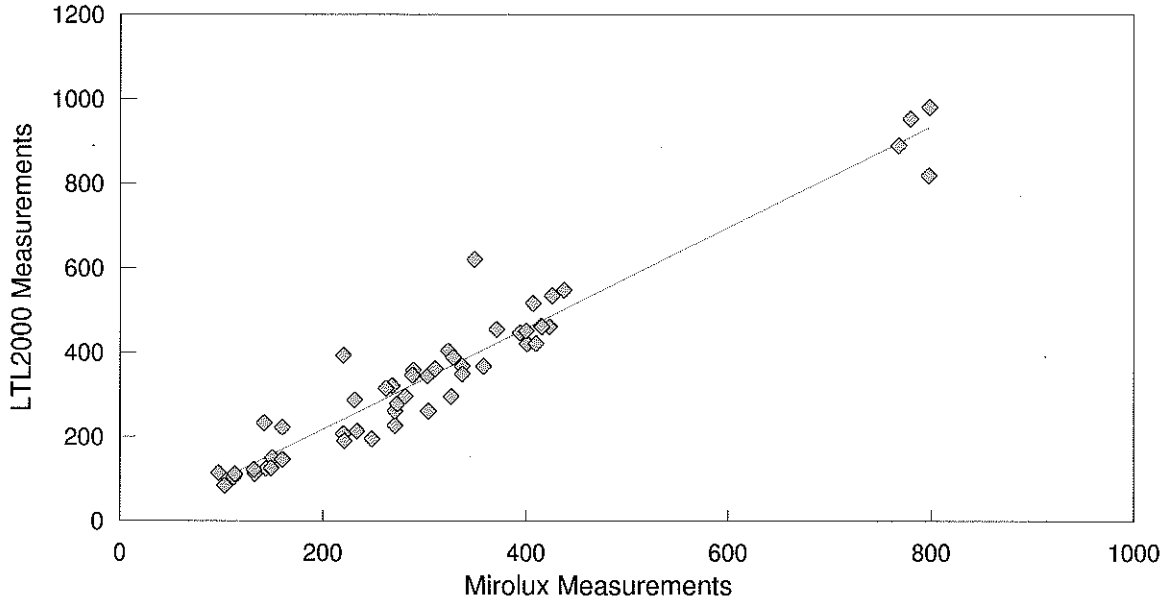


Figure 88. Retrolux vs. LTL2000 Measurements, May 1996
Concrete Deck, Paint Lines, Wheel Track

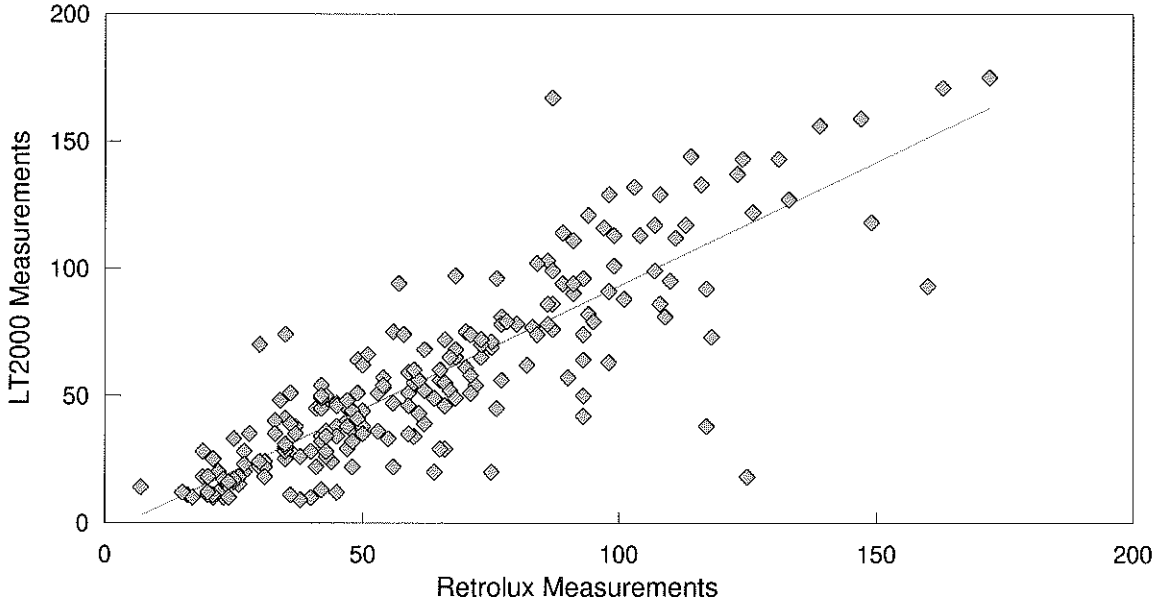
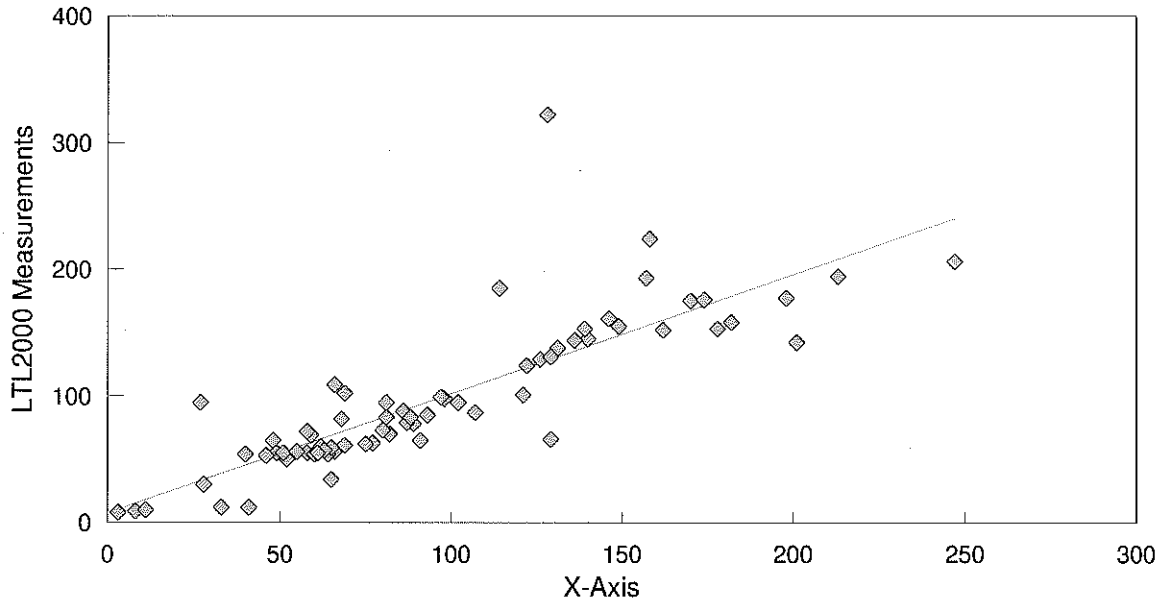


Figure 89. Retrolux vs. LTL2000 Measurements, May 1996

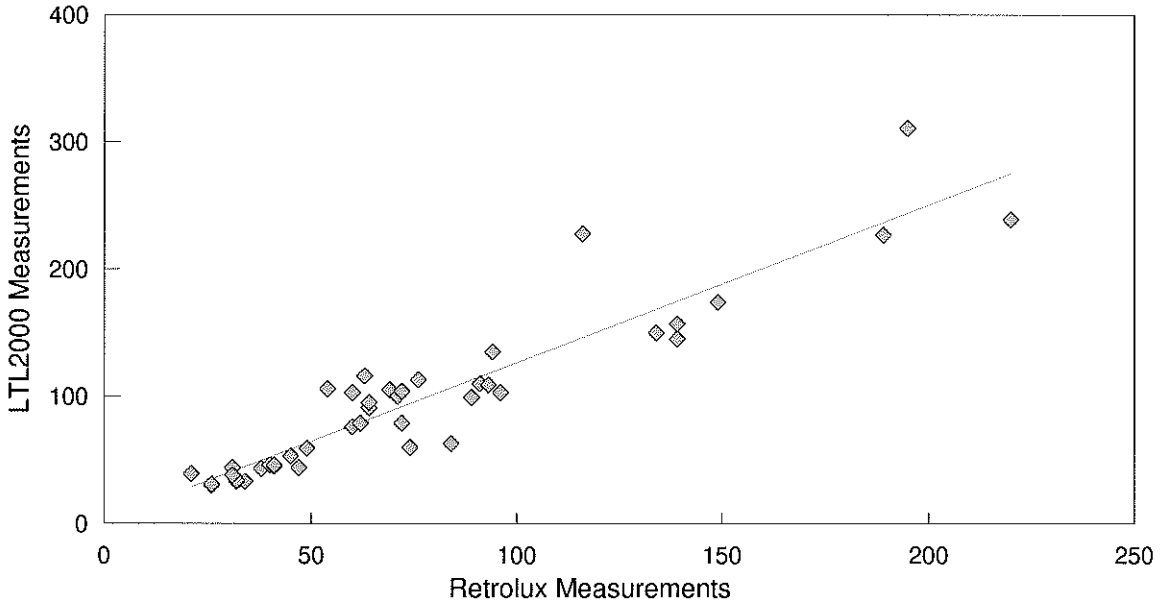
Concrete Deck, Thermoplastics, Wheel Track



R^2 = 0.69

Figure 90. Retrolux vs. LTL2000 Measurements, May 1996

Concrete Deck, Permanent Tapes, Wheel Track



R^2 = 0.86

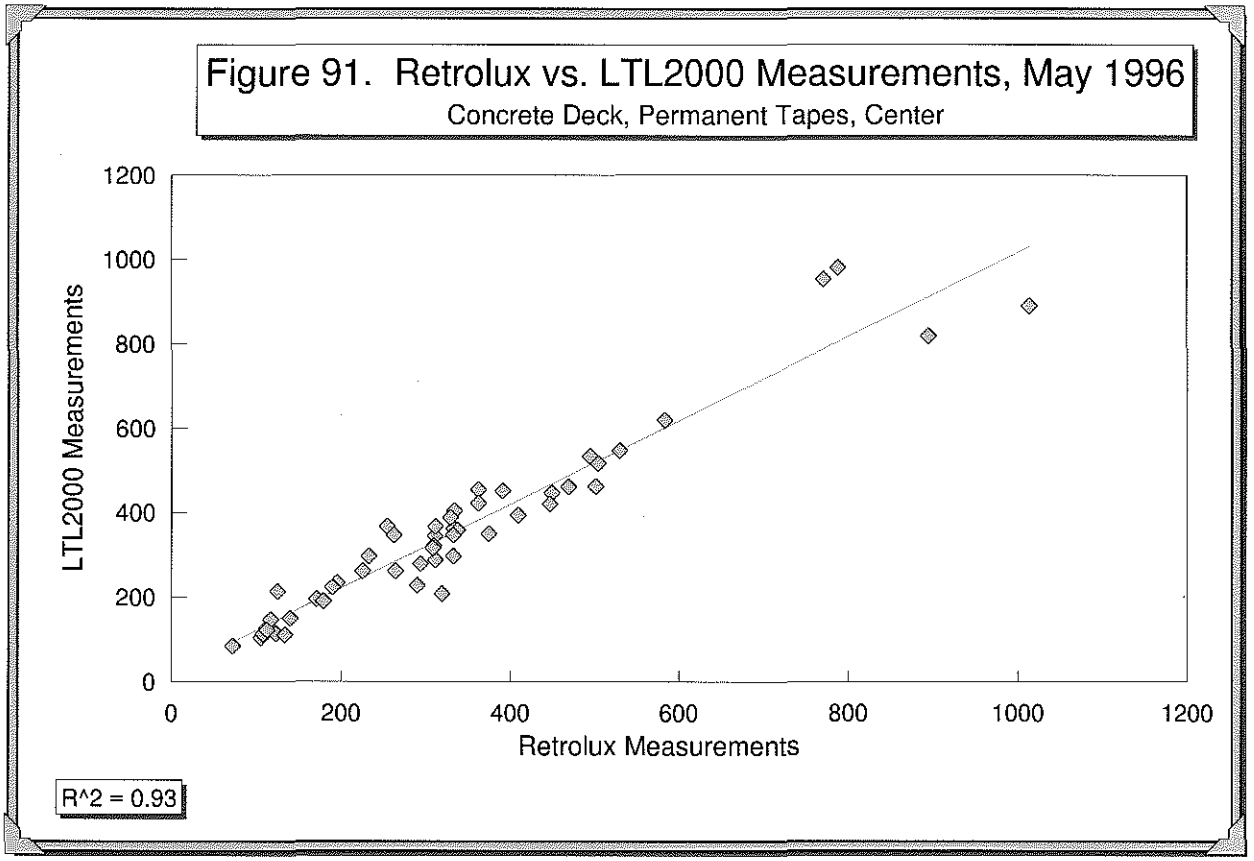


Figure 91. Retrolux vs. LTL2000 Measurements, May 1996
Concrete Deck, Permanent Tapes, Center
LTL2000 Measurements
Retrolux Measurements
0
200
400
600
800
1000
1200
R^2 = 0.93