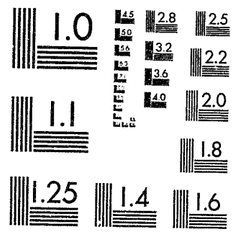

REMOVAL OF ROOF-MOUNTED EMERGENCY LIGHTING FROM POLICE PATROL VEHICLES: AN EVALUATION

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Administration

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REMOVAL OF ROOF-MOUNTED EMERGENCY LIGHTING FROM POLICE PATROL VEHICLES: AN EVALUATION

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ABSTRACT

In 1982, based on a study of fuel use and accidents, the Illinois Department of Law Enforcement began a test of removing roof-mounted emergency lights from police patrol vehicles. This test consisted of 120 vehicles, one-half with and one-half without roof-mounted lights. The vehicles were issued in pairs to officers who had similar patrols in rural areas. After six months, fuel economy, accidents, and productivity of the officers were compared. Significant improvements were found for those officers driving vehicles without roof-lights. More vehicles without roof-mounted lights were placed in service in early 1983. This study compares 208 vehicles with and without roof-mounted lights for a period from April 1982 through January 1984. The officers drove these vehicles more than five and one half million miles. Prior to obtaining these cars, all officers had similar driving records. The results show that those officers driving vehicles without roof-mounted lights obtained seven percent better fuel mileage, had 25 percent better productivity in speed enforcement (but not in enforcement overall), and were involved in 65 percent fewer accidents per million vehicle miles. All results are statistically significant. The findings suggest that removing roof-mounted lights from police vehicles that patrol rural areas reduces fuel and accident costs and improves productivity.

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INTRODUCTION AND BACKGROUND

Starting in April 1982, the Illinois Department of Law Enforcement (DLE) began testing sixty marked patrol vehicles without roof-mounted emergency lights. Those vehicles were selected at random from 120 marked vehicles placed in service that year. Emergency lighting was placed inside the grille and on the back window ledge. Basis for this change was a study conducted by Stoica for the Department in 1982 which recommended removal of the light bars to save fuel.[1] That study also found that drivers of unmarked police cars (without roof-mounted lights) tended to have fewer accidents.[2]

The 120 police vehicles (squads) introduced in 1982 were divided evenly into those with and those without roof-mounted emergency lights. All vehicles retained traditional state police markings including striping, decals, and words "State Police." The test cars were distributed randomly to pairs of field officers with similar patrols in each district. In Illinois, the squad remains permanently with an officer. Choice of officers receiving vehicles was made without reference to the drivers' records. At the end of the first six months, the Bureau of Planning and Development evaluated the results.[3]

Even with less than one million miles of driving, fuel savings were significant. Those vehicles without roof-mounted lights (hereafter termed "semi-marked" to

distinguish them from "unmarked" vehicles) averaged 6.4 percent better gas mileage.[4] Officers in all 120 vehicles had been involved in only 15 accidents, a base too small for statistical analysis. However, the accidents involving vehicles with roof-mounted lights were occurring at a rate twice that of those without such lights.[5] This had been expected.

In this interim evaluation, Stoica also looked at productivity. These officers wrote citations for speeding at twice the rate of the officers who drove traditional vehicles. There were no differences in other forms of traffic enforcement.[6] In a survey of officers, those driving the semi-marked vehicle expressed satisfaction with the new configuration. Only at the scene of an accident did some officers believe that the lack of roof lights presented some problems. In terms of safety, one officer's statement suffices:

> " . . . I personally like my semimarked squad. In fact, it has made me even more safety conscious knowing there is a possibility that I may not be seen."[7]

As a result of Stoica's interim evaluation, the Department began issuing vehicles without roof-mounted emergency lights. In 1984, these vehicles also began to be placed in service in the Chicago metropolitan area, a six county region. Their use will be monitored closely. Because the review of accidents of unmarked vehicles had shown minimal differences between unmarked and marked vehicles in urban areas. Fuel economy between marked and unmarked vehicles in the cities was no different. Finally the strong traditional use of roof-mounted

lights and that lack of strong evidence of improved safety in urban areas, precluded introduction into those areas. The current success has led to a change in which the standard vehicle state-wide will be semi-marked.

This report compares the performance of the two types of vehicles from April 1982 through January 1984. Three comparisons are presented: fuel consumption, productivity of the officers, and accidents. The findings of this evaluation show greater differences than those initially stated in the interim report, thereby enhancing those findings.

SOURCES OF DATA AND HYPOTHESES TESTED

Data and Tests Used

The data used for this evaluation derive from three sources maintained by the Department: first, a vehicle cost file which contains information about monthly expenditures for fuel and maintenance, fuel used, and miles driven; second, an on-line data base known as the Traffic Information Planning System (TIPS) which shows activity for officers, and finally, reports of accidents. The latter are not contained in a data processing file; thus, analysis of information has been limited because of the difficulty in obtaining data rapidly. All data cover a period from January 1976 through January 1984.

Three statistical tests were employed. Because miles per gallon is a skewed function and because of the method of recording fuel used and miles driven, parametric analysis of variance was not practical. A Wilcoxon or Kruskal-Wallis Test of analysis variance (automatically chosen by the Statistical Analysis System -

SAS) therefore was employed.[8] Chi-square was used for the contingency tables. Occassionally applied was a "t" test. This test was supportive of the nonparametric tests. Three null hypotheses are examined:

1. The vehicles with roof-mounted lights have the same fuel economy as those without such lighting systems.
2. Productivity of the officers in each type of vehicle does not differ.
3. There are no differences in the number of accidents between the two types of vehicles.

Description of the Vehicles and Drivers

Since the first marked and semi-marked vehicles were placed in service in 1982, DLE has operated 208 vehicles marked as Division of State Police (DSP) squads in line patrol. This excludes vehicles issued to officers in District 3, 4, and 15 (Chicago and Cook County) and those used by officers other than the rank of Trooper or for other types of patrol such as truck law enforcement. Of the 208 vehicles, 128 or 61.5 percent are semi-marked. During this same period, 235 officers of the rank of Trooper have driven the vehicles on patrol. There are more officers than vehicles because transfers, promotions, and changes in assignment have resulted in some officers changing vehicles. The 208 vehicles have been driven 5.7 million miles, used 484.9 thousand gallons of fuel, and have been involved in 49 accidents. These data are summarized in Table 1.

TABLE 1

SUMMARY OF BASES OF
DATA USED FOR EVALUATION

(Vehicles Placed in Service Since 1982)*

Lighting Configuration	Number of Vehicles	Percent	Number of Officers	Percent	Miles Driven (000's)	Gasoline Used	Accidents
Roof-mounted	80	38.5%	102	43.4%	2,937.5	260,900	37
Semi-marked**	128	61.5	133	56.6	2,728.3	224,000	12
Total	208	100.0%	235	100.0%	5,665.8	484,900	49

*All 208 vehicles are white with Illinois State Police markings.
**No roof-mounted lights.

Drivers of the first 60 pairs of vehicles issued in 1982 were chosen randomly. Each district scheduled to receive a vehicle submitted names of officers, paired with similar patrols (all officers rotate through three shifts and the only consideration was the geography of the patrol). The Bureau of Planning and Development selected one of each pair to receive the semi-marked vehicle. If the officer refused the vehicle, the entire pair was eliminated.

All of the statistical tests described in the remainder of this paper divide the officers into two categories, those driving the vehicles with roof-mounted lights (marked vehicles) and those driving vehicles without the roof-mounted emergency lights (semi-marked vehicles). For the three measures - fuel consumption, productivity, and accidents - a separate comparison also is drawn for the new vehicles as well as when the officers drove older marked vehicles. (All marked vehicles driven prior to 1982 had roof-mounted lights.) Fewer officers comprise the base for historic comparison because some drove unmarked (plain color) vehicles.

FUEL ECONOMY, PRODUCTIVITY, AND ACCIDENTS

Fuel Consumption

The first hypothesis tested is that the fuel usage of those officers driving vehicles without light bars is no different from those officers driving vehicles with the light bars. As shown in Table 2, marked vehicles travelled slightly more miles and used more gasoline. The officers in semi-marked squads averaged 12.4 miles per gallon. This is 6.9 percent better than the 11.6 miles per gallon obtained by officers in vehicles with light bars on the roof. The difference is significant at the .001 level. Total cost of operation, of which fuel was the largest component, was 14.3 cents per mile for marked vehicles and 13.0 cents per mile for semi-marked units. This difference of ten percent also was significant at the .001 level. The hypothesis that fuel usage is the same for vehicles with and without roof-mounted light bars is rejected.

Did the officers drive differently before they received the new vehicles? Table 3 shows the average gas mileage and average total costs per mile for police vehicles driven by these officers prior to receiving the new vehicles. Since 1976, each officer has driven more than one vehicle; therefore, the "N" in each category does not equal the number of officers. For the analysis, the officers were separated into two categories: those currently driving vehicles with roof-mounted emergency lighting and those driving vehicles without the light bars on the roof. Because officers originally drove both marked and unmarked cars, the data are shown separately for each type. Although those persons currently driving semi-

TABLE 2

COSTS, MILEAGE, AND
FUEL ECONOMY OF
THE TESTED VEHICLES
(1982 Vehicles)

Lighting Configuration	Vehicles	Miles Driven (000's)	Average Mileage	Gasoline Used	Average Mpg*	Average Cost Per Mile (Cents)*
Roof-mounted	80	2,937.5	36,720	260,900	11.6	14.3
Semi-marked	128	2,728.3	21,310	224,000	12.4	13.0
Total	208	5,665.8	27,240	484,900	12.1	13.5
Wilcoxon z					-3.628	+4.955
significance					$p < .001$	$p < .001$

*Average of miles per gallon and cents per miles per vehicle.

marked vehicles historically had obtained slightly better gas mileage and had lower operating costs, the differences between them and the other group of officers was not significant.

TABLE 3

FUEL CONSUMPTION BY
OFFICERS PRIOR TO 1982
(1976 to 1982)

Type Vehicle Currently Driven	Average Miles per Gallon: Marked Units Number Driven	Marked Units Average	Unmarked Units* Number Driven	Unmarked Units* Average
Roof-mounted	105	10.25 mpg	19	10.51 mpg
Semi-marked	118	10.66	10	11.08
Wilcoxon z significance		-1.254 n.s.		-0.425 n.s.

Type Vehicle Currently Driven	Average Total Costs of Operation in Cents: Marked Units Average	Unmarked Units* Average
Roof-mounted	18.28 cents	17.17 cents
Semi-marked	18.08	16.73
Wilcoxon z significance	0.120 n.s.	0.232 n.s.

*No police markings and no roof-mounted lights.

Other factors such as location of patrol or distance driven which could have influenced the current findings had no effect. The vehicles with and those without light bars were distributed evenly throughout the state principally because the first 120 test vehicles were distributed randomly. Also removed prior to analysis were patrols in the urban areas surrounding Chicago. Those State Police patrols outside Cook County primarily are rural. While the total miles driven differed slightly, these differences were not significant.

Vehicles in this study are limited to Fords and Dodges manufactured in 1982 and 1983. Because of the initial findings, the standard issue starting in 1984 is a vehicle without roof-mounted lights. This has now been extended to all areas including the urban areas of Cook County.

Therefore, based on the differences in fuel mileage, 12.4 mpg versus 11.6 mpg, the vehicles without roof-mounted lights will require less fuel to operate. If the vehicles average 20,980 miles of patrol per year (based on data for marked vehicles from Table 2), removal of roof-mounted lights will save 116.7 gallons of gasoline per vehicle. At 1.30 dollars per gallon, this is a savings of 152 dollars per year per vehicle. Use of vehicles without roof-mounted lights, then, is less costly. Interestingly, the emergency lighting installed in the grille and on the rear deck also is less costly than any roof-mounted lighting, especially the aerodynamic ones.

Productivity of the Officers

Officers are not expected to be more productive because of the vehicle driven. However, Stoica had indicated that officers driving vehicles without roof-

mounted lights wrote more citations for speeding.[9] Moreover, a study by the International Association of Chiefs of Police also indicated that police in unmarked vehicles were more effective at enforcing the 55-mph speed limit than those in marked vehicles.[10]

Shown in Table 4 are data for traffic enforcement for the period April 1982 through January 1984. The only area in which officers driving semi-marked vehicles were more productive was in the issuance of citations for speeding. Their rate of 21.9 speeding citations per 100 hours of patrol is significantly higher than the 17.7 per 100 hours for officers in vehicles with roof-mounted lights. However, these same officers issued fewer citations for other violations. Therefore, with the exception of citations for speeding, the null hypothesis of no difference in productivity holds.

An examination of activity before the introduction of new vehicles, from 1979 to 1982, also showed no statistical differences between these officers, even for speeding citations. While all the vehicles in this study have the traditional State Police markings, those without lights bars on the roof do not readily appear to be police vehicles, particularly to approaching motorists. Because most of the officers use moving radar for enforcement of the speed limit, detection of approaching, speeding motorists might be easier from police vehicles without roof-mounted lights.

TABLE 4

AVERAGE PRODUCTIVITY OF OFFICERS
IN 1982 AND 1983 MARKED UNITS

Type of Emergency Lighting Equipment	Number of Officers	Hours of Patrol	Speeding Citations Number	Speeding Citations Rate/100 Hours	All Citations Number	All Citations Rate/100 Hours	(Including Warnings) Number	(Including Warnings) Rate/100 Hours	DUI Citations
Roof-mounted	91	2,509	444.0	17.7	667.9	26.6	1894.6	75.5	15.8
Semi-marked	99	2,162	474.4	21.9	641.3	29.7	1615.4	74.7	14.9
Total	190	2,328	459.8	19.8	654.0	28.1	1749.1	75.1	15.3
t test				-2.42*		-0.41		+0.45	
significance				$p < .02$		n.s.	-	n.s.	

*Deviations are not shown, but have been used for all t tests.

Accidents

According to the analysis of accidents occurring to officers in 1980, those who drove marked vehicles (all with roof-mounted lights) were twice as likely to be involved in accidents than those who drove unmarked vehicles.[11] The experience is summarized in Table 5. For every 100 marked vehicles, 26.9 were involved in accidents. The rate for unmarked vehicles was 11.7, or one accident for every 2.3 involving marked vehicles. Each of these vehicles had been driven on patrol for approximately the same number of miles.

TABLE 5

INVOLVEMENT OF POLICE VEHICLES IN ACCIDENTS DURING 1980

Type Vehicle	Accidents Number	Accidents Percent	Vehicles Number	Vehicles Percent	Rate of Accidents Per 100 Vehicles
Marked	199	87.7%	741	75.6%	26.9
Unmarked	28	12.3	239	24.4	11.7
Total	227	100.0%	980	100.0%	23.2

Chi-square = 15.54 d.f. = 1 $p < .001$

The null hypothesis states that there should be no difference in the number of accidents for vehicles with and vehicles without light bars. Table 6 shows a comparison similar to Table 5. Of the 49 accidents involving all vehicles issued

since 1982 (1982 Fords and 1983 Dodges), 37 or 75.5 percent involved marked vehicles and 12 involved semi-marked vehicles. However, more vehicles had no roof-mounted light bars than those that did. As a result, the rate of accidents for vehicles with roof-mounted lights was 46.3 per 100 vehicles compared to 9.4 per 100 semi-marked vehicles. These data cover a 21-month period from April 1982 through January 1984. Therefore, the yearly rate of accidents per 100 marked vehicles was 26.5 This is similar to the accident rate for marked vehicles in 1980. On the other hand, the yearly rate of 5.4 per 100 semi-marked vehicles is lower than unmarked vehicles in 1980. The differences in rates are statistically significant at the .001 level.

TABLE 6

INVOLVEMENT OF VEHICLES WITH AND WITHOUT LIGHT BARS IN ACCIDENTS DURING 1982 AND 1983 (21 Months)

Lighting Configuration	Accidents Number	Accidents Percent	Vehicles Number	Vehicles Percent	Rate of Accidents Per 100 Vehicles
Roof-mounted	37	75.5%	80	38.5%	46.3
Semi-marked	12	24.5	128	61.5	9.4
	49	100.0%	208	100.0%	23.1

Chi-square = 12.14 d.f. = 1 $p < .001$

In 1980, the ratio of accidents between vehicles with roof-mounted and those without such lights was 2.3 to 1. This ratio increased to 4.7 to 1 in the 1982-1983 period. The null hypothesis is rejected. Officers driving vehicles without roof-mounted lights have substantially fewer accidents.

Shown in Table 7 is the number of accidents per million vehicle miles. There were 12.6 accidents per million vehicle miles for marked vehicles and 4.4 for semi-marked vehicles. Accidents involving vehicles with roof-mounted lights resulted in higher repair costs and in more injuries (although the differences were not significant statistically). No attempt was made to assign a cost to the injuries, but a comparison would not have been meaningful because there were no injuries to officers involved in accidents while driving semi-marked vehicles.

A detailed tabulation of accidents by type is shown in Table 8. Excluding accidents involving vehicles on patrol, used for miscellaneous business, and left unattended leaves a base of 13 accidents to both types of vehicles. Of these, ten or 77 percent involved units with roof-mounted lights. The base is too small for adequate statistical analysis.

One concern expressed in the survey of officers undertaken by Stoica was that the vehicles without roof emergency lights might be more vulnerable when parked at the scene at an accident. Only one accident involved a semi-marked vehicle. None occurred to a semi-marked vehicle stopped behind a violator. For marked vehicles, two accidents occurred while the officer was handling an accident, and 3 involved traffic stops. Therefore, most of the accidents involving a vehicle from which an officer was conducting police business and that had the emergency lights turned on, involved vehicles with roof-mounted lights.

TABLE 7

ACCIDENTS INVOLVING VEHICLES WITH AND WITHOUT ROOF-MOUNTED LIGHTS: OTHER CHARACTERISTICS

Lighting Configuration	Accidents	Accidents Police Services Excluding Patrol	Miles Driven (000's)	Accidents Per One Million Vehicle Miles	
				All	Police Services
Roof-mounted	37	10	2,937.5	12.6	3.4
Semi-marked	12	3	2,728.3	4.4	1.1
Total	49	13	5,665.8	8.7	2.3

Lighting Configuration	Average Costs	Injury to Officer		Average Number of Vehicles Involved
		None	Injury	
Roof-mounted	$1,020	31	6	1.7
Semi-marked	730	12	0	1.7
Total	$ 950	43	6	1.7
	n.s.	not computed		n.s.

TABLE 8

TYPES OF ACCIDENTS INVOLVING MARKED AND SEMI-MARKED VEHICLES

Lighting Configuration	Total	Policing Functions			Other Functions		
		Accidents/ Violators	Emergency	Pursuit	Patrol	Unattended	Other
Roof-mounted	37	5	3	2	13	8	6
Semi-marked	12	1	1	1	3	1	5
Total	49	6	4	3	16	9	11

Officer involvement in accidents prior to the issuance of new vehicles must be considered. Were those officers who drove vehicles with roof-mounted lights during the time of the study also involved in more accidents when they previously drove other cars? As shown in Table 9, there were records for 207 of these 235 officers. They were involved in 106 accidents, all in marked vehicles from January 1976 to April 1982. Even though the rate of accidents per 100 officers operating vehicles with roof-mounted emergency lighting during this study is higher than the accident rate for the other officers, the difference is not statistically significant. An analysis of variance of repair costs also showed no statistical difference.

TABLE 9

OFFICER INVOLVEMENT IN ACCIDENTS PRIOR TO ISSUE OF NEW VEHICLES

Current Vehicle Configuration	Officers in Base	Accidents in Marked Units		Per 100 Officers
		Number	Percent	
Roof-mounted	102	57	53.8%	55.9
Semi-marked	105	49	46.2	46.7
	207	106	100.0%	51.2

Chi-square = 1.29 d.f. = 1 n.s.

As was shown previously, those officers currently driving semi-marked vehicles were less likely to be involved in accidents during policing functions. When examining accidents prior to receiving the new vehicles, the same patterns are not as evident. Table 10 shows that those officers currently driving semi-

marked vehicles also had a slightly better driving record. However, the mileage driven relative to the number of accidents is not known for these historic data.

TABLE 10

TYPES OF ACCIDENTS PRIOR TO ISSUE OF NEW VEHICLES

Current Vehicle Configuration	Total	Policing Functions			Other Functions		
		Accidents/ Violators	Emergency	Pursuit	Patrol	Unattended	Other
Roof-mounted	57	7	11	10	13	7	9
Semi-marked	49	9	4	7	13	4	12
Total	106	16	15	17	26	11	21

DISCUSSION AND CONCLUSIONS

Accidents appear more likely to occur to officers driving vehicles with roof-mounted lighting equipment. These vehicles have poorer gas mileage. There is no difference in productivity other than the officers who drive marked vehicles show lower productivity when enforcing the speed limit. Examination of fuel usage, productivity, and accidents involving these officers prior to receiving the new vehicles does not indicate bias. Those in each test group had a similar history of driving. The differences found in this study appear to be related causally to the use or lack of use of roof-mounted lighting equipment.

The findings in terms of operating costs and accident rates are important. Given an average reduction in fuel use of 116.7 gallons for a fleet of 1,100 patrol

vehicles, at a cost of 1.30 dollars per gallon, will produce a savings of approximately 166,900 dollars per year. This is enough to purchase at least 16 new vehicles at the current market price. Additionally, the cost of grille-mounted and rear window lights installed is less than 100 dollars installed. Aerodynamic lighting systems can exceed 300 dollars per vehicle.

More critical is the finding in terms of reduced accidents. One of the strongest original arguments against removal of light bars was officer safety. Roof emergency lighting was supposed to help protect the officer. Yet, accidents involving vehicles without roof-mounted lights have resulted in substantially fewer injuries to the officers driving those vehicles (as was shown in Table 7) than to officers driving vehicles with traditional lighting systems. No cost was attached to an injury for this study (there have been too few for adequate analysis). However, any reduction in the injury rate increases the availability of manpower, reduces out-of-pocket costs, and reduces insurance costs.

Even if injuries are not considered, there is a difference in repair costs as a result of accidents between the two sets of vehicles. Given the cost per accident for marked vehicles, repairs to those 12 semi-marked vehicles involved in accidents could have cost more than 12,000 dollars. However, these 12 only cost 9,000 dollars to repair, a savings of 3,000 dollars. Therefore, given the rate of accidents for semi-marked vehicles, had all 80 marked vehicles been operated in a semi-marked configuration, the savings in accident related repair costs would have exceeded 32,150 dollars. A summary of total potential savings is shown in Table 11. The 63,360 dollars savings for 21 months represents an average savings of 450 dollars per vehicle per year based on 80 marked vehicles.

TABLE 11

POTENTIAL SAVINGS
ALL VEHICLES WITH
ROOF-MOUNTED LIGHTS
SINCE APRIL 1982
(21 Months)

Lighting Configuration	Number	Miles Driven (000's)	Gallons Used	Operating Costs Fuel	Accident	Total
Roof-mounted*	80	2,937.5	236,900	$307,960	$ 5,590	$313,550
Semi-marked	128	2,728.3	224,000	291,200	8,760	299,960
Potential Cost	-	-	460,900	$599,160	$14,350	$613,510
Actual Cost	-	-	484,900	630,370	46,500	676,870
Savings	-	-	24,000	$ 31,210	$32,150	$ 63,360

*With roof-mounted lights removed, based on costs incurred by vehicles with grille-mounted lights

Why are the vehicles without light bars safer? The quote given earlier in this paper suggests that police officers assume that roof-mounted emergency lights project unchallenged authority. However, the number of incidents in which emergency vehicles apparently collide with other vehicles challenges this assumption. When the light bars are removed, the officer has to become a more cautious driver.

Not discussed in this study is the use of light bars in urban areas. Vehicles without light bars were placed on rural patrol; none were sent to metropolitan areas. As was noted, the review of fuel economy and accidents during 1980 did not show significant differences between marked versus unmarked vehicles in urban areas. The traditionalists' argument for roof-mounted lights could not be

overcome. However, the success in rural areas with semi-marked vehicles has led to the issuing of semi-marked vehicles (starting in 1984) to the urban areas. Initial feedback from the officers suggests acceptance. There are too few data to examine differences in operating costs, productivity, and accidents. This will be a subject for a subsequent report. Unfortunately, the vehicles were introduced without establishing the same type of paired-comparison used initially.

The Department now issues, as standard, new vehicles with State Police markings but without roof-mounted lights. There remain some officers who still prefer vehicles with the light bars. Because there are enough light bars from traded vehicles, these officers can be accommodated. However, if all vehicles in the patrol fleet (approximately 1,100) were semi-marked, the Department could save in excess of 495,000 dollars annually in fuel purchases and accident repair costs (based on a savings of 380 dollars per vehicle per year). Unknown, but also of significant importance would be the increased availability of manpower because of the reduced number of injuries resulting from accidents. The program has been cost beneficial.

NOTES

1. Ted L. Stoica, Roof Mounted Light Systems on Police Vehicles, Illinois Department of Law Enforcement, Springfield, Illinois, 1982. (unpublished)
2. Ibid., p. 7.
3. Ted L. Stoica, Evaluation of Semimarked Police Vehicles, Illinois Department of Law Enforcement, Springfield, Illinois, April 1983.
4. Ibid., p. 3.
5. Ibid., p. 8.
6. Ibid., p. 10.
7. Ibid., p. 20.
8. SAS User's Guide: Statistics, 1982 Edition, SAS Institute Inc., Box 800, Cary, North Carolina, 27511, pp. 205-211.
9. Stoica, Semimarked Police Vehicles, pp. 9-10.
10. International Association of Chiefs of Police, Final Report: National Maximum Speed Limit Enforcement Practices and Procedures, U.S. Department of Transportation, National Highway Traffic Safety Administration, Washington, D.C., 1977.
11. Stoica, Roof Mounted Light Systems, p. 8.

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END