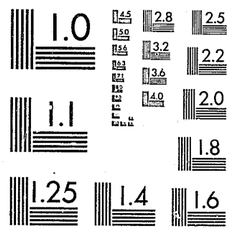

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AIRCRAFT USED FOR LAW ENFORCEMENT: AN ANALYSIS OF COST

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AIRCRAFT USED FOR LAW ENFORCEMENT:
AN ANALYSIS OF COSTS

Illinois Department of Law Enforcement
Division of Administration
Springfield, Illinois

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ABSTRACT

This paper has been written to describe the costs of operating airplanes for law enforcement. A comparison of costs also is made between the use of an airplane for traffic enforcement and a similar type of enforcement by police officers on the ground. All fixed and variable costs associated with operation of an airplane, including depreciation, are used. The salaries of the pilots, cost of facilities, and cost of assistance by officers on the ground are included. The cost data are derived from sources kept by the Illinois Department of Law Enforcement.

Total aircraft operating costs are 96 dollars per hour. Of this, 54 percent represent direct operating costs including fuel, periodic maintenance, and depreciation. Of the remaining amount salaries for the pilots and other employees account for 88 percent. When the airplanes are used for line patrol of the highway, including the cost of assistance by officers on the ground, the average cost per mile of patrol is 1.33 dollars compared to an average cost of 1.08 dollars per mile for the same type of patrol performed by the solo police officer performing ground patrol. However, the pilots produce more activity for the miles patrolled than an equivalent number of officers on the ground. In this respect, aerial patrol is less costly than a ground patrol for traffic law enforcement.

When used for enforcement of traffic violations at a specific location, particularly speed enforcement, the airplane is far superior for the detection of flagrant violators. Costs of the operation, however, are approximately 75 percent higher than the costs of a ground detail using a radar operator and chase vehicles. The primary benefit with using the airplane is its ability to observe violations in

different sections of the highway separated by several miles during a given period of observation and to remain relatively undetected by the flagrant violators. To make the aircraft more cost effective, however, requires greater productivity from the supporting personnel on the ground than is currently produced.

The airplane is a useful and important tool for law enforcement. Its high cost of operation can in part be offset by its use for traffic enforcement. For line patrol, the airplane combined with nearby ground patrols may be superior. Use for speed enforcement at specific locations is relatively costly per contact made unless the officers assisting on the ground are highly productive.

AIRCRAFT USED FOR LAW ENFORCEMENT: AN ANALYSIS OF COSTS

I. INTRODUCTION

Although the hourly operating costs of operating airplanes for law enforcement are high, the speed and coverage of airplanes make them practical to use for certain types of activity. In this respect, they may be cost-effective. Aircraft are particularly superior for coverage of large areas. The area viewed from an aircraft for manhunts, searches, general surveillance, and photography far exceeds that from the ground. Likewise, aircraft are faster than ground vehicles for the emergency transportation of people and supplies, e.g. blood, although they can not serve all locations because of the lack of landing facilities. However, in order to be used productively, the airplanes must be flown for traffic patrols. For an agency such as the Illinois State Police (ISP), these hours are spent patrolling the highway, initiating enforcement of traffic law violations, and aiding the motorists.

Regardless of their superiority for manhunts, surveillance, etc., in order to justify the expense of an airplane, its cost for use in patrolling the highways must be reasonable. It should be similar to the officer performing the same function on the ground. Where the use is for highway (line) patrol, the cost per mile and per action taken must approximate those of the solitary officer in the squad car. For selective enforcement, such as the control of speeding vehicles, the cost per stop is the comparative value. When computing costs, all expenses associated with the airplane including salaries of the pilots should be used. Because the airplane is not

effective without support from officers on the ground, their costs also are added to the operating costs.

This report is not the first review of costs. One was prepared for the Illinois State Police (ISP) in 1980.[1] However, it was devoted to those costs arising from a specific operating policy, a case study that included recommendations for improving the operation. The purpose of this new report is two-fold. First, it describes the use of aircraft primarily for traffic law enforcement. Second, it examines the cost-effectiveness of the aircraft based on an efficient use of the airplane. Although the costs remain drawn from those incurred by the ISP, they could be representative of the costs that would be incurred by any state-wide law enforcement agency.

To analyze these costs, this paper is divided into three sections. The first describes the uses of the airplane for law enforcement with specific attention given to its role in traffic law enforcement. Other studies of costs are referenced. The second section describes the costs of operating the aerial patrol. Although the data are derived from records maintained by the Illinois Department of Law Enforcement, the methods used in computing the costs are equally applicable to other agencies. Finally, a comparison between the costs of aircraft-assisted and traditional traffic enforcement comprises the third section.

II. USE OF AIRCRAFT FOR LAW ENFORCEMENT

MULTIPLE USES

Aircraft, whether fixed-wing or rotary, enable law enforcement officers to cover long distances rapidly and adequately view large areas. For example, in a manhunt the person sought generally can be located more quickly by an airborne observer than by ground observers who are limited by vertical and horizontal obstructions. When medical supplies or victims of trauma need rapid, long distance transportation, aircraft are a necessity, and the value of aerial photography is well known.

A debate exists between the value of helicopters and single-engine, fixed-wing aircraft. In terms of hourly operating costs, helicopters are more expensive. They also require specially qualified pilots. When the patrol requires surveillance of congested areas, rescue, and ability to land almost anywhere, the helicopter is a necessity. The benefits then may outweigh the increased costs. On the other hand, for an operation such as performed by the Illinois State Police, where the primary use is speed enforcement and, in the past, for patrol of long stretches of rural highway, the fixed-wing aircraft is more cost-effective. The remainder of this report is limited to describing the use and cost of fixed-wing aircraft.

AREA PATROL - SPEEDING AND OTHER VIOLATIONS

Currently the fleet of seven, Cessna 182 airplanes owned by the Illinois State Police are assigned to different geographical areas of Illinois. Each aircraft is served by two pilots, and that crew is responsible for speed enforcement as well as

other services to specific areas of the state. When conducting speed enforcement, the pilots are assisted by officers on the ground who stop the speeding motorists and other violators identified from the air.

The speed enforcement program began in 1959 with fixed-wing aircraft. Although helicopters have been tried, the fixed-wing aircraft have proven to be a better tool for enforcement.[2] They are less costly to operate. The pilots fly to a specific location or locations each day to perform "air speed-checks". By radio, the crew meets intercepting officers at the locations and it is these officers who stop the violators described by the pilots. The aerial observers function as the operator of the radar unit in the familiar radar and chase car operation.

The pilot clocks vehicles across a zone delineated by lines painted at right angles to the road. Because the length of the zone is known, the observer can convert the time from a stop watch to miles per hour. The zone used in Illinois is 660 feet long (1/8th mile), but even with this short length, a 1/10th second delay in activating the watch creates less than two percent error at a true speed of 60 miles per hour. The airplane is relatively invisible to the motorist; thus, only when the violator is caught is he aware of observation. Radar detectors and CB radios are of limited assistance to the flagrant violator.

Upon detecting a violator, the pilot (or observer) radios a description of the vehicle to an officer on the ground. To ensure continuity of observation, the pilot follows the vehicle until that officer on the ground has directed the vehicle to the side of the road. Already transmitted is a description of the vehicle, its speed, and time of detection. The intercepting officer, in turn, obtains the remainder of the documentation and writes the citation. Thus, in court, both the observer and

officer on the ground can accurately identify the violator as the one who violated the law and subsequently received the citation.[3] During 1980 in Illinois, 98.2 percent of the violators cited in this manner were found guilty.[4]

The number of interceptors can be limitless, but generally three or four are sufficient for one side of a multi-lane highway. Where more interceptors are involved, they handle both directions. Productivity appears at its highest when a crew supervisor makes the stops and controls the activity for the other officers. Rates of five citations per hour per officer, not including the supervisor, are possible with this arrangement.

LINE PATROL - INTERSTATE HIGHWAYS

Starting in 1976 and ending in 1981, the National Highway Traffic Safety Administration of the United States Department of Transportation made available grants to purchase and operate aircraft for "line patrol" along Interstate highways. These grants, administered by the Illinois Department of Transportation (IDOT), were made to help increase the amount of patrol along the 2300 miles of Interstate highways in Illinois. Of secondary importance was the decreasing availability of gasoline and its increasing cost. The traditionally long ground patrols are not fuel efficient. In this respect, airplanes could cover the same mileage with less fuel.

Cunningham, in support of such a program, argued that because traffic patrol is accepted as necessary, aerial patrol could adequately fill the need. This is particularly true because the essence of this patrol is observation.[5] The most difficult roadblock was perceived to be the link between the aircraft and ground

assistance. Without that ground assistance, the line patrol would produce few results.[6] Throughout the program of line patrol, communication with ground vehicles remained a problem. There were not enough patrol vehicles, even on nearby highways, to assist the aircraft every time a request was made. A further problem was that the airplanes were not visible to the motorist. The deterrence of violations resulting from the presence of a patrol vehicle was lacking.

The first grant received by the ISP paid for purchase and operation of two airplanes.[7] One airplane was assigned to the northern portion of Illinois Interstate 57 from Effingham to Kankakee (approximately 150 miles) and the other to the southern portion from Effingham to Cairo (approximately 170 miles). Included in the proposed tasks of the pilots were enforcement of traffic laws, traffic control, assistance to disabled vehicles, assistance at accidents, and observation and notification of hazards on the road.[8] Subsequent grants enabled ISP to add a patrol to I-80 from Joliet to Moline (the western border) and to I-55 from Joliet (at I-80) to Bloomington (I-74).

An evaluation plan prepared by IDOT addressed the following measures: reduction in accidents before and during the patrol, reduction in the number of high accident segments along the Interstate highway, improvement in services to the motorists, and a reduction in average speed.[9] A successful operation would show a significant reduction in both accidents and their severity that occurred during daylight and clear weather (time of the aerial patrol). Further, a 20 percent improvement in services to the motorist and a 5 mph reduction in speed was expected.[10]

During the first year of line patrol, accidents decreased along the patrolled segments on I-57. The percentage of those accidents resulting in an injury or fatality also decreased. On the other hand, increases in both categories occurred along all other rural Interstate segments.[11] Based on trend analysis, the number of accidents expected on the patrolled portions of Interstate highways during the first year of operation would have been 1109. Only 797 occurred, a significant decrease of 28 percent.[12] This decrease continued into the second year of operation. On the other hand, although accidents decreased, there was no apparent increase in the amount of police assistance to motorists or reduction in the speeds of the vehicles.

During the second year, more emphasis was given to enforcement of the speed limit. As a result, activity of the pilots increased, sometimes at the expense of observation of the highway. Communication with the motorist remained the weakest link. Even though symbols of the airplane were placed on the highway and publicity increased, most motorists did not appear to know that airplanes were patrolling regularly unless the motorist was stopped for a traffic violation.

III. THE COST OF OPERATING AIRPLANES

OTHER STUDIES

Numerous articles and reports on the use of both fixed-wing and rotary aircraft for law enforcement have been published. Major metropolitan police departments have used helicopters and reported on that use. In the urbanized areas, the flexibility of helicopters generally has outweighed its relatively higher operating costs and lower reliability when compared to fixed-wing aircraft. The studies of costs of helicopter operation that have been computed show a range from a low of $23.01 to a high of $119.64 per hour.[13] None of these studies fully included all costs of the aircraft as well as the costs of the pilots.

One of the first studies to show comprehensive costs for fixed-wing aircraft was the one prepared by Raub and Henry in 1980. Costs were computed at 137.42 dollars per hour of operation in law enforcement.[14] These costs were substantially greater than the costs ranging from seven dollars to 43.76 dollars per hour computed by other authors.[15] One of the reasons for the low costs shown in other studies was the use of fuel prices from before the oil embargo of 1974. (For the ISP, the cost of fuel now exceeds 1.50 dollars per gallon.) Also missing from the computations were fully allocated costs of the aircraft, as well as the costs of the pilots.

In the remainder of this report, the methodology originally used by Raub and Henry will be followed. There are a few modifications in the assumptions; the costs are updated and the costs are applied to a generalized operation rather than operation by a specific agency. The data for these costs have been derived from

those available for Illinois Fiscal Year 1981, (FY81), from July 1, 1980 through June 30, 1981. More recent data would reflect substantial reductions in flights to meet a restricted budget. Such a restricted budget would not accurately reflect the operating costs.

CRITERIA USED IN COMPUTING COSTS

In FY81, the seven aircraft were flown 7,080 hours in law enforcement. Approximately 92 percent of this time was devoted either to area patrol or to line patrol. The remaining eight percent (566 hours) included manhunts, searches for persons or missing aircraft, surveillance (particularly of prisons), and photographic work. These latter duties often are required at short notice. If the airplanes had to be maintained solely for these duties, their use, even though beneficial, would not be cost-effective. Further, at most two airplanes might be justified, but substantially more time in non-productive flight then would be spent serving the 56,000 square miles in Illinois.

All costs associated with the operation of the airplanes are used. This includes the cost incurred by ground personnel when they support the aircraft in enforcement of the traffic laws or in assistance to disabled motorists. There are seven airplanes used for traffic law enforcement and 14 pilots currently assigned to these aircraft.[16] Each of the airplanes is the same - - single-engine, high-wing Cessna 182 aircraft - - which allows the pilots to fly any one without the need for retraining. Use of the aircraft is limited to daylight hours but prohibited under conditions of poor visibility or high winds.

The data used in this study come from several historic sources maintained by the Department of Law Enforcement including a summary of air operations maintained by the Air Operations Section of the Division of State Police, personnel records from the Bureau of Personnel, automobile records of the Bureau of Logistics, and the Traffic Information and Planning System (TIPS) a computerized accounting of the activity of sworn officers maintained by the Bureau of Data Processing (all three Bureaus are part of the Division of Administration). In addition to these sources, a number of assumptions are made concerning the interpretation of the available data.

(a) Assumptions Used for Airplane Costs

1. All single-engine airplanes have the same costs of operation for fuel, oil, and maintenance.

2. The hours flown in law enforcement work (traffic, manhunt, photography, surveillance, court) are considered as the basis for hourly cost of operation.[17] The aircraft also are flown to meetings, for required proficiency checks of the pilots, and to specific locations for maintenance. The expense associated with these hours are assumed to be a necessary part of operation and are treated as fixed cost in the computations. Hourly cost is derived by dividing total cost by hours of enforcement.

3. Flight hours are reported as tachometer hours; for this report they are considered equal to actual hours in the air.

4. Depreciation is straight line and is equal to the purchase price less the projected value at trade. The hourly cost is found by dividing the depreciated value by the expected life of the airplanes in hours.

5. The costs incurred in the operation of the twin-engine airplane are deducted from the other costs.

6. Average patrolling speed of the aircraft is assumed to be 120 miles per hour.

7. The personnel costs for the pilots are included only when the aircraft have been flown. A difficulty presented is that the pilots are engaged in aircraft related activities before and after flight. Therefore, the number of hours of flight can not be used solely as the basis for cost of the pilots. When the pilots have been on duty a full eight hour shift, the aircraft has been flown for 4.7 hours. The ratio of 8.0/4.7 or 1.702 is used to compute cost of salaries for aircraft operation.

(b) Assumptions Used for Costs of Ground Support

1. Time and mileage used in computing the cost of performing an activity also includes the cost of subsequent appearance in court based on the probability of such appearances.

2. The hourly salary is the ten-year salary plus 12 percent benefits.

3. The mileage costs are equal to the actual costs of operation and depreciation per mile. Depreciation is figured on the average price of a new vehicle of $7400 with no scrap value and a life of 72,000 miles.

4. Time and mileage for court appearances is derived from the court time reported by officers, number of arrests that were contested, and the size of the counties served.

5. The use of a radar operator with interceptors is similar to the use of the pilot with one or more interceptors; therefore, the costs between these two methods are compared. Comparisons could be drawn between the solitary officer operating radar and the aircraft, but such operations are too dissimilar to have a valid meaning in the context of this report.

The computation of costs for officers assigned to ground patrol serves two purposes. First, there are costs associated with using ground personnel to support air operations which must be considered as part of the aerial patrol operations. Second, in a subsequent section, the costs of using the airplanes for law enforcement are compared to the costs of using ground officers for the same functions. The costs for the ground officers were derived, except for salaries, from data collected by TIPS.

AIRPLANE COSTS

Basic Costs

For the purposes of this report, costs associated with aircraft operation are either fixed or variable. The fixed costs are shown on an annual basis: routine maintenance, insurance, Federal Aircraft Tax, charts and commodities, pilots' physicals, preparation of painted zones for speed enforcement, hangars, offices, and compensation for chief pilot and secretary. Of these, 55 percent represent the cost of the chief pilot and secretary. Variable costs include the pilots' salaries, depreciation, fuel and oil, and periodic maintenance. In the 1980 report on aircraft costs, depreciation was computed as a fixed cost. Traditionally the airplanes had been traded approximately every three and one-half years. However, under revised operating policies, an attempt is being made to maintain an airplane through 4500 hours (until a third major overhaul is required). Experience has shown that beyond 4500 hours of service (and including the substantial engine overhaul required at 4500 hours), the cost of maintaining an airplane may outweigh the reduced costs of depreciation.

Table 1 shows the costs associated with operating seven Illinois State Police aircraft for FY81 which ended June 30, 1981. These are representative of those costs which would be incurred by any aircraft operation. Computed on an annual basis are support personnel, hangar and office rental, and other operating costs, and computed on an hourly basis are pilots' salaries, depreciation, fuel, and maintenance. The fixed costs for FY81 amounted to 83,945 dollars.

TABLE 1

COST OF OPERATING AIRPLANES

FIXED (Annual)			
I.	Chief Pilot and Secretary		$ 46,015
II.	Hangar and Office Rental		
	Line Patrol Aircraft (4)		$ 6,385
	Area Patrol Aircraft (3)		4,445
	Total Cost of Hangar and Office		$ 10,830
III.	Other Costs		
	Maintenance (other than periodic)		$ 4,000
	Insurance*		14,000
	Federal Aircraft Tax		60
	Charts and Commodities*		1,140
	Pilots' Physicals		1,120
	Painting Speed Zones**		6,780
	Total Miscellaneous Cost		$ 27,100
	Total Fixed Cost		$ 83,945
VARIABLE (Hourly)			
IV.	Pilots		
	Number 14		
	Annual Salary and Benefits	$398,910	
	Hourly Cost		$ 16.19
V.	Depreciation		
	Number of Airplanes 7		
	Average Number of Flying Hours	4500	
	Salvage Value as proportion of new cost	0.43	
	Cost of New Aircraft	$ 68.970	
	Salvage Value	29,660	
	Net Cost	$ 39,310	
	Hourly Depreciated Cost		$ 8.74

TABLE 1 (continued)

VI. Fuel and Maintenance			
Gas and Oil			
Hours of Operation	8271.6		
Annual Cost	$166,335		
Hourly Costs			$ 20.11
Periodic Maintenance			
50-Hour Inspection	$ 295		
Hourly Cost			- 2.95
100-Hour Inspection	$ 707		
Hourly Cost			7.07
Major Overhaul (1500 hours)	$ 8130		
Hourly Cost			5.42
Total Hourly Cost of Fuel and Maintenance			$ 35.55

*Total cost adjusted by proportion of expenses allocated to twin-engine airplane.

**The painting of lines for speed zones is estimated to take two man-weeks of time for each airplane. The patrol officer's compensation is computed from 12.11 dollars per hour.

Over the past four years, trade-in value of the aircraft has remained at approximately 43 percent of the original purchase price. The net cost of the aircraft for depreciation, therefore, equals the cost of a new aircraft (June 1981 - 68,970 dollars) less a salvage value of 29,660 dollars. For a period of 4500 hours, depreciation amounts to 8.74 dollars per hour. Cost for fuel and oil add 20.11 dollars per hour. Gasoline usage at 12.8 gallons per hour and 1.55 dollars per gallon accounts for 98.6 percent of this amount. Finally, periodic maintenance, which includes a 50-hour and 100-hour check plus a major overhaul at 1500 hours, adds another 15.44 dollars per hour.

During FY81, the seven ISP aircraft were flown 8272 hours of which 7080 hours, 85.6 percent, were flown in enforcement. The hours flown in law enforcement is the base used for this cost analysis because these hours represent use directly related to police activity. The remaining 1192 hours are those for flight proficiency, maintenance, and meetings. The aircraft used for line patrol averaged 1039.7 hours of flight; those used for area patrol averaged 972.0 hours. The overall average was 1010.7 hours.

As shown in Table 2, the cost per hour of operation is 95.86 dollars. This includes all costs associated with the aircraft as well as the salaries for the pilots. Although the pilots earned an average of 16.19 dollars per hour (including benefits) in FY81, the cost of the pilot per hour of flight in law enforcement is approximately twice that amount. For each full eight-hour shift, historically, the aircraft have been flown 4.7 hours. However, those 4.7 hours only represent 4.02 hours in law enforcement; thus, for each 4.02 hours of flying in law enforcement requires one pilot for a full shift.

TABLE 2

HOURLY COSTS
OF OPERATING THE AIRPLANES

Bases For Costs		
Aircraft	7	
Hours of Operation		
Total	8271.6	
Law Enforcement	7074.8	
Ratios:		
Total Hours/Law Enforcement Hours	1.169	
Hours of Time for Pilots/ Total Hours Flown *	1.702	
Hourly Cost of Pilot	$ 16.19	
Summary of Costs		
Fixed Costs		
Personnel Other Than Pilots	$46,015	
Hangar/Office	10,830	
Other	27,100	
	$83,945	
Hourly Fixed Cost		$11.87
Hourly Pilot Cost - Adjusted		$32.21
Operational Costs - Adjusted**		
Depreciation	$ 10.22	
Fuel and Oil	23.51	
Periodic Maintenance	18.05	
Total Operational Costs		$51.78
Total Hourly Cost		$95.86

*Based on an 8-hour shift with 4.7 hours of flying

**Adjusted for the hours spent in law enforcement.

This hourly cost can not be reduced significantly because fixed costs are only 12.4 percent of the total hourly cost. Greater reductions could be achieved by using less costly aircraft, such as the Cessna 72. That aircraft costs less to purchase, maintain, and operate. However, it does not have the speed of the Cessna 182 and cannot handle the same payload. Further a mixed fleet would involve additional training to remain current on both types.

Additional Pilots/Observers

All of the costs shown above assume operation with a single pilot. The crew for ISP aircraft generally consist of two pilots, one as an observer. When the second pilot is not available, they have used officers from the ground as observers for speed enforcement. The cost for an additional pilot is the same as for the principal pilot, 32.21 dollars per hour of flight.

The observer drawn from the ground troopers are less expensive because only the time directly associated with the operation is counted a cost. Also, because they generally have less years of service than the pilots; their compensation is less. Using 12.11 per hour and 4.7 hours of flight per eight-hour shift, the average cost per hour for the observer is 20.61 dollars. When computing the cost of an operation which uses two pilots or a pilot and observer, either 32.21 dollars or 20.61 dollars should be added to each hour of flight for law enforcement.

OTHER COSTS INCLUDING ROAD OFFICER

The other portion of this cost analysis is the cost of support from the ground. There are two elements - - cost of the officer and cost of the vehicle. For this

report, a ten-year base salary of 10.81 dollars is used. Added are 12 percent benefits, bringing the total hourly cost to 12.11 dollars.

Automobile costs comprise depreciation, fuel, and maintenance. As shown in Table 3, at the current average fuel consumption of 10.3 miles per gallon and a price of 1.50 dollars per gallon, the cost per mile is 14.6 cents. Maintenance adds 3.0 cents and depreciation for 72,000 miles of driving adds another 10.3 cents. The total is 27.9 cents per mile. Given a current average patrol of 149 miles per day, 220 days of duty per year, the annual costs for the officer and vehicle will be 34,335 dollars. This amounts to 156.07 dollars per eight-hour shift or 1.047 dollars for every mile driven.

As a result of a traffic stop where a citation is issued, both the ground officer and pilot may be required to attend court. For the ground officer, this involves driving to and from court as well as time spent in court. The pilot flies to and from the nearest town and joins the ground officer. According to data obtained from the Illinois Department of Law Enforcement's Traffic Information and Planning System (TIPS), the officer averages 2.1 hours per court appearance. At 12.11 dollars per hour, the cost for that time is 25.43 dollars. The drive to and from court is estimated to be 27.6 miles and takes 37 minutes.[19] On the other hand, the pilot must fly from the aircraft base to the airport nearest the court. The records kept by the pilots show this time to average one hour per trip. The costs for both the ground officer and pilots are shown in Table 4. The combined cost for a court appearance is $161.89. Current data show that 3.9 percent of the citations initiated by the aerial observers are contested; therefore, the average cost for each citation issued is 6.31 dollars.

TABLE 3

COST OF AN OFFICER ON PATROL

Base Costs			
Officer			
Salary (10-year average)			$ 10.81
12 percent benefits			1.30
Total hourly cost			$ 12.11
Automobile			
Average miles driven daily	149		
Fuel consumption	10.3	mpg	
Cost per mile (at $1.50 per gallon)			$ 0.146
Depreciation (72,000 miles, $7400 cost)			0.103
Maintenance			0.030
Total cost per mile			$ 0.279
Annual Costs			
Officer			$ 25,189
Automobile - 149 miles per day, 220 days			9,146
Total			$ 34,335
Average Cost Per 8-Hour Shift (1760 hours of duty per year)			$ 156.07

TABLE 4

COST OF AN OFFICER
ATTENDING COURT

				Ground	Pilot
Travel -					
Ground -	Distance	27.6	Miles*	$ 7.70	
	Time	37	Minutes	7.47	
Flying		1	Hour		$ 95.86
Time in Court		2.1	Hours	25.43	25.43
Total				$40.60	$121.29
Combined Cost					$161.89
Cost per Citation Issued (3.9 percent contested)				$ 6.31	

*This is an average for each county, weighted by population. The driving time is calculated from 45 miles per hour.

IV. COST FOR TRAFFIC LAW ENFORCEMENT

COST OF LINE PATROL

As described earlier, aircraft are used for two forms of traffic law enforcement: line patrol and enforcement of the speed limit at specific locations. For line patrol, the cost of the aircraft can be measured either by the miles of road patrolled or the amount of activity. If the airplane is used for patrol without initiating any action, the cost of that patrol is the cost of using the airplane divided by the miles of patrol.

When aircraft were used in Illinois for line patrol, a shift consisted of 4.7 hours of flying at 120 miles per hour. The pilot could cover 565 miles of road. Given a cost of 95.86 dollars per hour, the total cost for the shift was 450.54 dollars. This amounted to 79.7 cents per mile (shown in Table 5). Where an observer also flies (as the policy in Illinois requires), the increase in costs would range between 97 and 151 dollars depending upon whether a road trooper or pilot is used as the second officer. The use of this second person, therefore, would raise the cost per mile by at least 17.2 cents.

TABLE 5

COST OF AIRPLANE FLYING LINE PATROL

Hours of Operation	4.7
Mileage (at 120 mph)	565
Aircraft Cost per Hour	$ 95.86
Total Cost	$450.54
Cost per mile	$ 0.797

During patrol the airborne observers generate activity for a unit on the ground. Such activity includes handling an accident, a motorist assist, or citing a traffic violation. This is an additional cost. Most of the activity involves traffic enforcement. According to data available on TIPS, the completion of a traffic stop requires 14.8 minutes. As shown in Table 6, each assist by ground units adds 7.80 dollars to the cost of the patrol.

TABLE 6

COST OF GROUND ASSISTANCE
FOR THE AERIAL LINE PATROL

Travel to Intercept Offender		
Distance	10 miles	$2.79
Time (at 60 mph)	10 minutes	2.02
Handling Incident	14.8 minutes	2.99
Total Cost Per Assist		$7.80

The total cost of operating a shift of line patrol by airplane, including traffic enforcement, is calculated to be 748.97 dollars. During that shift the airplane would have covered 565 miles of roadway and the aircraft crew would have initiated 21.2 stops for traffic violations. As shown in Table 7, this is 1.33 dollars per mile of roadway patrolled and 35.41 dollars for each stop initiated. The operation of this patrol in Illinois was approximately 20 percent higher because of the added cost for the observer in the airplane.

COMPARISON WITH GROUND PATROL

The ISP officer conducting ground patrol on the Interstate highway historically has driven 149 miles and has averaged 0.6 stops per hour of patrol. A

TABLE 7

TOTAL COST OF LINE PATROL
(Single Pilot)

Coverage	
Hours per shift	4.7
Miles covered (at 120 mph)	565
Stops per hour	4.5
Percent of stops contested	3.9
Costs for a Shift	
Airplane	$450.54
Ground assistance	164.97
Court	133.46
Total	$748.97
Cost per hour	$159.36
Cost per stop	$ 35.41
Cost per mile	$ 1.33

patrol of 5.5 hours represents a full shift. Added to the 156.07 dollars for the officer and driving, is 6.70 dollars representing court appearances required for five percent of the 3.3 citations written during the shift. (A slightly higher percentage of citations written by officers using radar are contested.)

Table 8 presents a comparison between line patrol conducted by the aircraft and that conducted by an officer on the ground. To cover the same mileage as the aircraft would require 3.8 officers; thus, the aircraft at 748.97 dollars for the shift is 21 percent higher than 618.53 dollars for an equivalent length of ground patrol. On the other hand, if the amount of activity is used for a base, the airplane is 28.2

percent cheaper. For the ground patrol to achieve the same productivity as the aircraft would require 6.4 officers. These would patrol more miles of highway but would have the same number of contacts. Under this basis, the cost of ground patrol would be 1041.73 dollars compared to 748.97 dollars for the aircraft.

TABLE 8

COMPARISON OF AIR AND GROUND LINE PATROL COSTS

	Aircraft	Ground Patrol
Hours	4.7	5.5
Miles	565	149
Stops per Hour	4.5	0.6
Total Stops	21.2	3.3
Cost of Operation		
Airplane	$ 450.54	-
Ground	164.97	$ 156.07
Court	133.46	6.70
	$ 748.97	$ 162.77
Cost		
Per Hour	$ 159.35	$ 29.59
Per stop	35.41	49.32
Per mile	1.33	1.09
Cost of Equivalent Patrol per Shift		
Based on Mileage	$ 748.97	$ 618.53
Based on Activity	748.97	1041.73

COST OF AERIAL SPEED ENFORCEMENT

In its other mode of use, the pilot will circle over a marked zone on the highway and direct ground units to intercept speeding motorists. The similar operation on the ground is where one officer operates radar and the other officers

act as interceptors. The pilot calls out the speeds and identification of violators to the intercepting officer on the ground. The potential number of stops generally is limited by the number of interceptors available rather than the number of violators (because a large percentage of the motorists are exceeding the speed limit).

The ISP aircraft used for "air speed-checks" are strategically located throughout Illinois. As a result, ISP records show that the travel time to or from each session over a zone has averaged 18 minutes. Table 9 shows the cost per hour of the airplane dependent upon the length of sessions. With a pilot operating alone the costs range from 153.38 dollars for a one-hour session to 345.10 dollars for a three-hour session. The use of an observer along with the pilot will increase the costs for the airplane by approximately 20 percent.

Additionally, the cost of the operation must include the interceptors on the ground. In addition to the 12.11 dollars for each hour of assistance, there are costs associated with driving to and from the zone and setting up the team. Table 10 shows these costs dependent upon the number of hours worked. They range from 23.14 dollars for one hour to 47.36 dollars for three hours.

According to the summaries of activity submitted by the Illinois State Police pilots during the period July 1980 through June 1981, an average of three intercepting officers have assisted at a site. These officers have averaged 11.1 stops per hour or 3.7 per officer. The average time of flight over the zones has been 1.66 hours. Thus, an average operation in Illinois would have resulted in the issuance of 17.8 citations. For the pilot alone, as shown in Table 11, this activity would have cost 422.36 dollars or 23.13 dollars per stop. The use of an observer from the ground officers would increase the cost of flying by 20 percent. However,

TABLE 9

COST OF AIRCRAFT
FOR SPEED ENFORCEMENT

Flight to/from zone	0.6 hours
Cost for Aircraft per Hour	$ 95.86
Cost for Observer per Hour	$ 12.11
Observer - Pre/Post Flight	
Time - 1 hour	$ 12.1
Driving 40 Miles	11.1¢
Total	$23.27

Cost of Operation

	Length of Flight Over Zone in Hours 1	2	3
Pilot Alone	$153.38	$249.24	$345.10
Pilot and Observer	188.76	296.73	404.70

TABLE 10

COST OF GROUND INTERCEPTORS FOR AIRCRAFT
ASSISTED SPEED ENFORCEMENT

Travel to and from Zone		
Distance	20 miles	$ 5.58
Time (at 55 m.p.h.)	22 minutes	4.44
Setup	5 minutes	1.01
Total initial cost per interceptor		$11.03
Cost per hour of asistance per officer		$12.11

Cost per Hour

Hours of Operation 1	2	3
$23.14	$35.25	$47.36
35.25	52.88	70.50
31.57	47.36	63.15

use of the observer, would decrease court costs from 84.19 dollars to 28.12 dollars because the pilot no longer would be required to attend court. The overall cost with an observer, therefore, would be approximately 13 dollars less. On the other hand, the use of another pilot as observer only could increase costs; there would be no offsetting reduction in court costs.

TABLE 11

ESTIMATED COST OF
AN AIR SPEED OPERATION

Stops per officer per hour	3.7	
Assisting officers	3.0	
Stops per hour	11.1	
Average time over zone	1.66	hours
Citations issued	17.8	

Costs

Airplane	
Flying - 2.26 hours at $95.86 per hour	$216.64
Court - $4.73 per citation	84.19
Ground	
Assistance	93.40
Court - $1.58 per citation	28.12
Total Cost	$422.36
Cost per Stop	$ 23.73

The 422.36 dollars for a session of speed enforcement is conservative because it assumes that the pilot must make a separate trip to court for every 26 tickets issued. First, some court appearances occur in the county of the pilot's residence; he drives instead of flies. Second, there is an attempt to combine cases thereby reducing the total number of trips required.

There are a minimum number of ways that the cost of operating the aircraft for speed enforcement can be reduced. Longer periods spent circling the zone will help dilute the costs of flying to and from the zone. Major reductions in costs are possible, however, by improving in the productivity of each intercepting officer.

COMPARISON TO GROUND OPERATION

The comparative activity on the ground is the use of a radar operator and one or more "chase cars". Like the aircraft speed-check, this is an organized activity, to perform it requires more than one officer. Increases in the amount of time given to the operation and stops made by the team will result in lower unit costs because the overhead cost of a radar operator is diluted. Table 12 shows the costs associated with the operation of radar and chase cars.

TABLE 12

COST OF RADAR/CHASE CAR OPERATION

Travel To and From Location		
Distance	20 miles	$ 5.58
Time (at 55 mph)	22 minutes	4.44
Set Up	5 minutes	1.01
Total Initial Cost per Officer		$11.03
Cost per Hour of Operation per Officer		$12.11

Average Cost Per Hour

	Number of Chase Cars*			
Hours of Operation	2	3	4	5
1	$69.42	$92.56	$115.57	$138.84
2	52.88	70.50	88.13	105.75
3	47.36	63.12	78.93	94.72
4	44.60	59.47	74.34	89.21

*Plus one radar operator

Shown in Table 13 is a comparison between the productivity of an airspeed operation and that of a ground operation. The productivity of the aircraft comes from ISP records. That of the radar and chase cars is estimated from observed activity. Given the number of radar detectors and use of CB radios, the number of stops per hour for a fixed radar and chase car operation may be too liberal.

TABLE 13

CITATIONS ISSUED FROM AIR AND GROUND SPEED ENFORCEMENT

	Stops per Hour per Officer	
Number of Chase Cars	Air Assisted*	Ground Radar/Chase**
2	4.8	3.0
3	3.7	2.7
4	2.9	2.4
5	2.4	2.2
Percent of Stops Contested	3.9%	4.1%

*Records kept by the ISP Air Operations Section
**Observations of radar and two chase cars. Decreases in productivity are assumed at 50 percent of the rate of decreases for air-assisted enforcement

Finally, Table 14 presents a comparison of the cost per stop for aircraft and for radar and chase car. The estimated costs for a radar operation are substantially lower than for the airplane, even though productivity of the radar operation is lower. The use of an airplane to assist with an enforcement of the speed limit will remain more expensive even with increased productivity. To

match the cost per stop with a radar operator and two officers each making 3.0 stops per hour would require two inceptors for air operations each making 13.7 stops per hour.

TABLE 14

COMPARISON OF COSTS OF AIRCRAFT
AND RADAR/CHASE CAR
SPEED ENFORCEMENT

(Two Hours of Operation)

	Assisting Officers		
Aircraft	2	3	4
Stops	19.2	22.2	23.2
Operating Costs	$319.74	$355.00	$390.24
Court Costs	121.15	140.08	146.39
Total	$440.89	$495.08	$536.63
Cost per Stop	$ 22.96	$ 22.30	$ 23.13
Radar/Chase Car			
Stops	12.0	16.2	19.2
Operating Costs	$105.76	$141.00	$176.26
Court Costs	40.08	54.11	64.13
Total	$145.84	$195.11	$240.39
Cost per Stop	$ 12.15	$ 12.04	$ 12.52

What the cost comparisons do not show is the detection of relatively higher speed violations by the airspeed operation. This occurs because the aircraft are not detected readily by the motorist. During FY81 in Illinois, 9.4 percent of the

motorists stopped in an air operation were exceeding 75 mph. Records from fixed radar operations on the other hand show less than 2.0 percent stopped for these excessive speeds. More importantly, the records for fixed operations are based mainly on those of a solitary officer who changed locations frequently to reduce the effects of detection by the motorists. Thus, if the use of stationary radar is substantially less productive than that estimated above, the cost of an airplane could be closer to that of radar.

V. CONCLUSIONS

The airplane is an expensive tool for rural law enforcement. However, its superiority for surveillance, manhunts, and transportation generally make it a necessary component. To offset the fixed costs requires frequent use. This can be achieved by traffic patrol. As has been shown, the cost of using an airplane for patrolling long segments of rural highways, particularly Interstate highways can be competitive with traditional ground patrol. The aircraft is approximately 30 percent more expensive to operate per mile of highway than a patrol car, but the pilot will be more likely to initiate a stop for a traffic violation in that mile. Based on this productivity, the airplane can be used for patrol at a cost 28 percent cheaper than an equivalent number of officers in vehicles.

What is required for line patrol is the availability of supporting ground officers. When the airplane is flying over a segment of highway, one or more ground vehicles should be near that segment. Once the aircraft has left the area, the ground units may return to their original patrol. Also required is a better method of communicating between the airplane and the motorist. Without this communication, the deterrence of patrol is lacking.

The more difficult use to justify is the air speed-check. Here there are two problems: the cost of operating the airplane, and the productivity of the officers who are assisting. There are more than enough potential stops to keep a large number of intercepting police officers busy. (If 75 percent of the vehicles are exceeding the speed limit by five mph, a rural Interstate one-way volume of 150 vehicles per hour will yield 113 violators per hour.) Apparently, as the number of

interceptors increase, the productivity decreases rapidly. This offsets any decrease in cost per stop.

On the other hand, the officer with radar operating for any long period, e.g. one hour, from a fixed position is widely known. Enforcement directed against flagrant violators will be minimal; the effectiveness is reduced. To get that flagrant violator requires more covert means. The solo officer with a moving radar probably is the most powerful tool. However, even with two or more operating over a segment of highway, they cannot make as many contacts as the airplane with intercepting officers placed at strategic locations.

This last point is the most important. If the road is marked with zones over a length of several miles, intercepting officers can be placed at several locations. In this manner the speed of motorists can be controlled over a longer segment than with only one set of intercepting officers. This can not be accomplished as effectively with radar. More importantly, it will help control those offenders who may think that the first officer seen is the only one and that speeding again can be performed with impunity.

Although the purchase and use of an airplane solely for aerial speed enforcement is not recommended, this is a method of helping offset the high costs of purchase and storage of the aircraft. If the aircraft can be used both for line patrol and speed enforcement as well as for other law enforcement, it can be a cost-effective tool.

NOTES

1. Richard A. Raub and Bobby C. Henry, Cost of Aircraft Used for Traffic Law Enforcement by the State Police of Illinois, Illinois Department of Law Enforcement, May 1980; R. A. Raub and B. C. Henry, "Cost of Using Airplanes in Traffic Law Enforcement: A Case Study," Traffic Quarterly, 45:1, January 1981, pp. 69-84.

2. The Illinois State Toll Highway Authority, which employs Illinois State Police under contract, operates a helicopter for speed enforcement. However, this helicopter does not belong to the State Police.

3. There have been a number of court challenges to the use of aircraft particularly from the point of view that the officer making the arrest has not viewed the violation. In Kansas v. Cook, 194 Kansas 495, 399 P. 2d 835 (1964), the situation was clarified in terms of continuity of contact by the pilots from the time of the violation until the time of arrest. The legal problems that have been associated with the use of aircraft are well addressed in G. T. Felkenes, "Some Legal Aspects of Aircraft Usage as an Aid to Law Enforcement," Journal of California Law Enforcement, 3:3, January 1969, pp. 128-140.

4. Ground initiated enforcement using stationary radar and chase cars have more cases contested and a greater percent found not guilty.

5. Carl L. Cunningham, Assessment of the Illinois State Police Concept of Aerial Patrol of Interstate Highways, Illinois Department of Transportation, Division of Traffic Safety, March 1976, p. 7.

6. Ibid, p. 10.

7. Cost of purchase, fuel and oil, hangars, and maintenance were paid by the grant. Salaries for the pilots were paid by the State Police. All personnel who fly, whether pilots or observers, are sworn officers.

8. Cunningham, Attachment A.

9. Richard A. Raub, Interstate Aerial Patrol, Illinois State Police, Evaluation Plan, Illinois Department of Transportation, Division of Traffic Safety, December 1977.

10. Ibid, p. 5.

11. Philip P. Madonia and Richard A. Raub, Interstate Aerial Patrol, Illinois State Police, Interim Evaluation, Illinois Department of Transportation, Division of Traffic Safety, May, 1979, pp. 3-6.

12. James P. O'Brien and Charanjit S. Sidhu, Evaluation of Aerial Patrol of Interstate Highways by the Illinois State Police, Illinois Department of Transportation, Division of Traffic Safety, April 1980, p. 9.

13. As examples, costs for aircraft have been computed by the following authors:

    - A. R. Kidder and S. P. Zobel, S. P., Police Air Mobility, STOL Evaluations, Phase I, Cornell Aeronautical Laboratory, September 1970.
    - C. R. Guthrie, "Helicopter v. Fixed-wing: A Comparison", Journal of California Law Enforcement, 8:3, January 1974, pp. 131-139.
    - R. N. Carroll, The Utilization of Helicopters for Law Enforcement, Northwestern University Traffic Institute (unpublished), March 1973.
    - P. H. Bennett, "Use of a Helicopter for Police Work", The Chartered Institute of Transport Journal, 35:6, September 1973, pp. 236-239.

14. Raub and Henry, "Cost of Using Airplanes", p. 72.

15. Kidder, Zobel, and Guthrie also computed costs for fixed-wing aircraft.

16. There is also one twin-engine airplane, Cessna 310, that is used for executive transportation. The cost of operating that airplane is generally kept separate in the records, with the exception of the cost of the hangar and office at Capital Airport in Springfield, maps, and insurance both of which are paid in a singular payment. The relative contribution of the Cessna 310 to these costs is included in the assumptions.

17. These hours include patrol, speed checks, surveillance, relay of emergency supplies, manhunts, photography, and assistance at disasters.

18. Cost associated with twin-engine airplane:

    - Office and hangar space at Capital Airport - 50 percent of the rental paid at Capital Airport for two airplanes based there,
    - Insurance - 33 percent of the total cost of insurance because of the relatively high value of the twin and its use for executive transportation,
    - Charts - 20 percent of the total cost because more charts are used in the twin.

19. The mileage is a weighted average based on the population of each county because there is a high correlation between population and the number of vehicle stops. Each officer is assumed to live randomly throughout the county. One-way driving to the center in a grid pattern is then equal to one-half the square root of the area.

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END