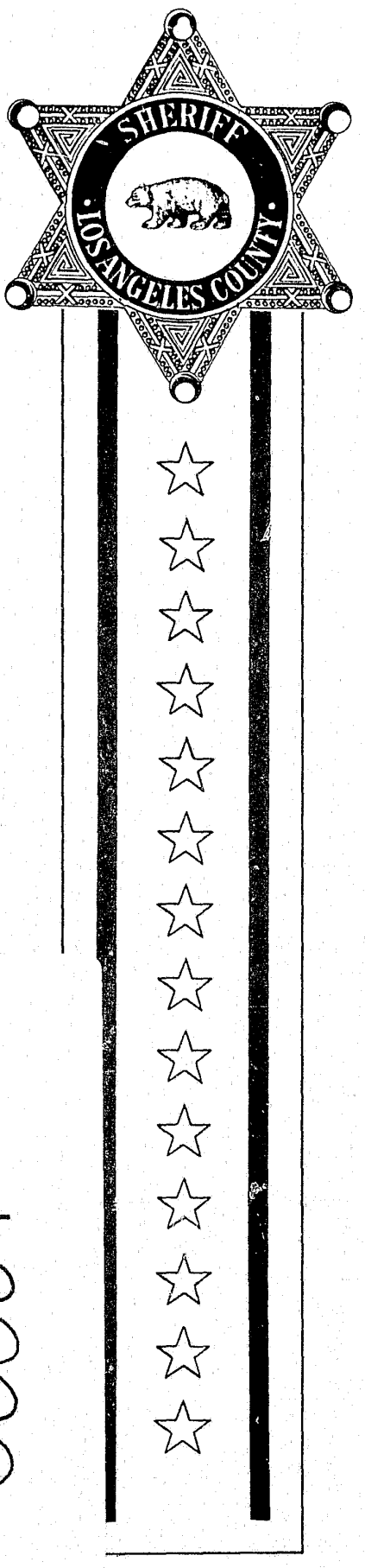

SHORT TAKE OFF – LANDING
FIXED WING, ROTARY WING
COST EFFECTIVENESS
STUDY

Final Report

LEAA # 71 – DF – 1119

Los Angeles County
SHERIFF'S DEPARTMENT
PETER J. PITCHESS, Sheriff

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THE

LOS ANGELES COUNTY SHERIFF'S DEPARTMENT

Presents

S.T.O.L., FIXED WING, ROTARY WING, COST EFFECTIVENESS STUDY

FINAL REPORT

Prepared For

LAW ENFORCEMENT ASSISTANCE ADMINISTRATION

and

CALIFORNIA OFFICE OF CRIMINAL JUSTICE PLANNING

LEAA # 71-DF-1119

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CHAPTER I

HISTORICAL DATA

INTRODUCTION

It is the traditional responsibility of law enforcement to apprehend criminals, provide essential services, and protect citizens' lives and property. Inherent with this responsibility, law enforcement is obligated to economize and streamline operations to provide optimum services at the lowest possible cost.

The use of aircraft in support of police ground units is a proven and accepted method of cost effective law enforcement. Because of the vast spectrum of aircraft available, offering a wide distribution of capabilities and costs, opinions vary greatly as to which type of aircraft is, indeed, most cost effective.

This report culminates the Federally funded S.T.O.L., Fixed Wing, Rotary Wing Cost/Effectiveness Study implemented by the Los Angeles County Sheriff's Department. The thirty-month project, which examined the merits of various police aerial mobility systems, was funded by a grant from the Law Enforcement Assistance Administration. The project evaluates a S.T.O.L. (short take-off and landing) airplane, a light fixed-wing airplane, and a rotary wing (helicopter) from the perspective of their cost effectiveness.

It is hoped that this report will provide pertinent information to law enforcement agencies and other interested parties about the S.T.O.L. project, and, therefore, contribute to the knowledge of police support systems.

PROJECT BACKGROUND

The S.T.O.L., Fixed Wing, Rotary Wing Cost Effectiveness Study was generated in an effort to evaluate the use of fixed-wing aircraft as a support tool for law enforcement, in conjunction with ground police vehicles.

Several previous studies, conducted on a limited scale, had produced conflicting results. A program with broader data bases, both operationally and geographically, was needed to resolve those disparities.

The project selectively identified the initial and maintenance costs of three types of police aerial support vehicles, namely, short take-off and landing aircraft (S.T.O.L.), light fixed-wing aircraft, and rotary wing aircraft (helicopters), and compared them relative to their effectiveness in the support of police ground units during routine police patrol and special activities.

In the latter months of 1970, communications between The Law Enforcement Assistance Administration and The Los Angeles County Sheriff's Department established the areas which the project would address. By June of 1971, a Grant application, which had been approved by The Los Angeles County Board of Supervisors, was submitted to The Law Enforcement Assistance Administration. The program was approved for funding by The Law Enforcement Assistance Administration in January of 1972.

PROJECT OBJECTIVES

The objectives of the project were to collect data on the cost effectiveness of various police mobility systems, including ground patrol vehicles, helicopters, and fixed-wing aircraft, and combinations of these. It was not the intention to compare response systems for all police incidents and situations, but only for those incidents where it was expected that the response of an aircraft would be at least as productive as the response of a ground patrol vehicle, or the response of an aircraft and one ground patrol vehicle would be at least as productive or efficient as two ground patrol vehicles. Specifically, we identified the limitations of the aircraft under various situations, taking into consideration conditions of weather, traffic, distance from the incident, and operational or regulatory constraints on the different vehicles, (i.e., altitude restrictions and minimum operational speeds for fixed-wing aircraft). Secondly, we identified means by which the effectiveness of air mobility systems could be more accurately measured. These include response time, clearance rate, and the ability to back up officers on the ground. Lastly, costs, both initial and operational, have been identified for each of the mobility systems.

BRIEF SUMMARY

The relative merit of using fixed-wing aircraft or helicopters for law enforcement services is and will always be a controversial issue.

The findings of this study have shown that mission requirements and services desired should be the prime factor when considering acquisition of equipment for a new, or as an addition to existing, aerial support program.

The rapid technological advances being made in the aircraft industry may soon outdate the results of this project. However, from the operational qualities exhibited during this program, we have concluded that the function of airship patrol in direct support of police ground units is more productively served by helicopters. Their superior ability to provide an increased measure of safety to ground personnel and their increased observation capabilities make them by far the most effective aerial support vehicle. The project helicopter was limited by operational characteristics to a maximum speed capability two-thirds that of the project airplanes. Its effectiveness upon arrival over a location, however, resulted in over twice the number of apprehensions made, per flight hour, than were experienced from the airplanes.

Mission requirements which do not include close support of ground units such as some surveillance missions, transportation flights, and specialized patrols for fire detection or traffic control may be served as well and more economically by using fixed-wing aircraft. The longer flight duration capabilities and increased crew comfort afforded by the airplanes increase their usefulness in these areas.

The project data has shown that the addition of fixed-wing aircraft can measurably increase the overall effectiveness of an existing aerial support program. Additionally, airplanes in both light fixed-wing and S.T.O.L. categories should be considered, depending on mission requirements, when formulating a new aerial support program.

CHAPTER II

IMPLEMENTATION

GEOGRAPHICAL AREA SELECTION

Los Angeles County is 4,078 square miles, containing some 78 incorporated cities, 48 of them self-policed, with a total population of 7,096,040 people.

For eleven months, beginning August 1, 1973, the operational portion of the project was flown in selected test beds, the first of which was the policing jurisdiction of the Los Angeles County Sheriff's Industry Station, an area previously unpatrolled by aircraft. This area is 114.8 square miles in size and has a permanent population of 191,029. During the fiscal year '72-73, Industry Station handled a total of 19,906 cases, of which 5258 or 26% were the seven major offenses. The total number of cases handled had increased 3% from the previous fiscal year, however, the crime rate per 10,000 population for the seven major offenses increased 7% to 275.24.

The distribution of this area is as follows:

<u>City of La Puente</u>	Area - Square miles	3.5
	Population	31,314
	'72-73 Crime Rate per 10,000	333.8
	Crime Rate Change from '71-72	-4.0%
	% Station Area (Industry)	3.0%

City of La Puente (continued	% Station Population (Industry)	16.0%
	% Station Activity (Industry)	25.0%
City of Industry	Area - Square Miles	10.8
	Population	707
	'72-73 Crime Rate per 10,000	6845.83
	Crime Rate Change from '71-72	+24.0%
	% Station Area (Industry)	9.0%
	% Station Population (Industry)	.3%
	% Station Activity (Industry)	11.0%
City of Walnut	Area - Square Miles	8.7
	Population	6,193
	'72-73 Crime Rate per 10,000	321.33
	Crime Rate Change from '71-72	+6.0%
	% Station area (Industry)	7.0%
	% Station Population (Industry)	3.0%
	% Station Activity (Industry)	4.0%
Unincorporated County Area	Area - Square Miles	91.9
	Population	152,815

Unincorporated County Area (continued)	'72-73 Crime Rate per 10,000	231.13
	Crime Rate Change from '71-72	+9.0%
	% Station Area (Industry)	80.0%
	% Station Population (Industry)	80.0%
	% Station Activity (Industry)	61.0%

The mobility systems were scheduled to allow data collection relative to each working alone, and in conjunction with each of the others.

The comparison of the fixed-wing aircraft with established helicopter patrols was accomplished in two areas, the area currently patrolled by the A.R.G.U.S. Program (Aerial Reconnaisance Ground Unit Support) and the geographical area contained in the policing jurisdiction of Los Angeles County Sheriff's Antelope Valley Station. The Argus Program, which involves 16 hours of helicopter coverage daily, is geographically comprised as follows:

City of Norwalk	Area - Square Miles	9.3
	Population	92,092
	'72-73 Crime Rate Per 10,000	261.15

City of Norwalk (continued)	Crime Rate Change from '71-72	-3.0%
City of La Mirada	Area - Square Miles	9.3
	Population	31,667
	'72-73 Crime Rate per 10,000	229.8
	Crime Rate Change from '71-72	-9.0%
City of Santa Fe Springs	Area - Square Miles	8.7
	Population	15,041
	'72-73 Crime Rate per 10,000	575.76
	Crime Rate Change from '71-72	-5.0%
City of Pico Rivera	Area - Square Miles	8.2
	Population	54,336
	'72-73 Crime Rate per 10,000	285.08
	Crime Rate Change from '71-72	+3.0%
City of South El Monte	Area - Square Miles	2.7
	Population	16,177
	'72-73 Crime Rate per 10,000	481.55
	Crime Rate Change from '71-72	-7.0%

Unincorporated County	Area - Square Miles	33.9
	Population	201,688
	'72-73 Crime Rate per 10,000	289.47
	Crime Rate Change from '71-72	+10.0%

The area contained in the policing jurisdiction of the Antelope Valley (Los Angeles County) Sheriff's Station, which is served by 8 hours of helicopter patrol daily, is the second test bed in which fixed-wing aircraft were compared with established helicopter patrols. Geographically, this area is comprised as follows:

City of Palmdale	Area - Square Miles	42.1
	Population	8900
	'72-73 Crime Rate per 10,000	421.35
	Crime Rate Change from '71-72	+14.0%
Unincorporated County Area	Area - Square Miles	1250.0
	Population	74,610
	'72-73 Crime Rate per 10,000	265.54
	Crime Rate Change from '71-72	+2.0%

Finally, during the last six weeks of the operational phase of the program, the S.T.O.L. and light fixed-wing aircraft patrolled the entire Los Angeles County Area policed by the Los Angeles County Sheriff's Department.

PROJECT AIRCRAFT SELECTION

The basic need for the project is to compare the cost and effectiveness of a S.T.O.L. airplane with that of a light fixed-wing airplane and a helicopter.

In identifying the aircraft involved in the project, frequent reference is made to the term S.T.O.L. (short take-off and landing) and an explanation of the term is necessary for a complete understanding of the capabilities of the aircraft.

Most pilots apply this acronym to an aircraft which is capable of take-offs and landings in a short distance. But to accept this, we must define "short", as the runway requirements for any light fixed-wing aircraft are short by comparison to those necessary for a commercial jet aircraft. The word "short" is relative and has no specific meaning.

The original requirements for S.T.O.L. performance were laid down quite precisely by the Guggenheim contest for aircraft design in 1929. An aircraft had to take off, climb, descend, and finally land within a column or chimney of air that had a radius of only 600 feet. Few modern aircraft can operate within this restrictive performance envelope.

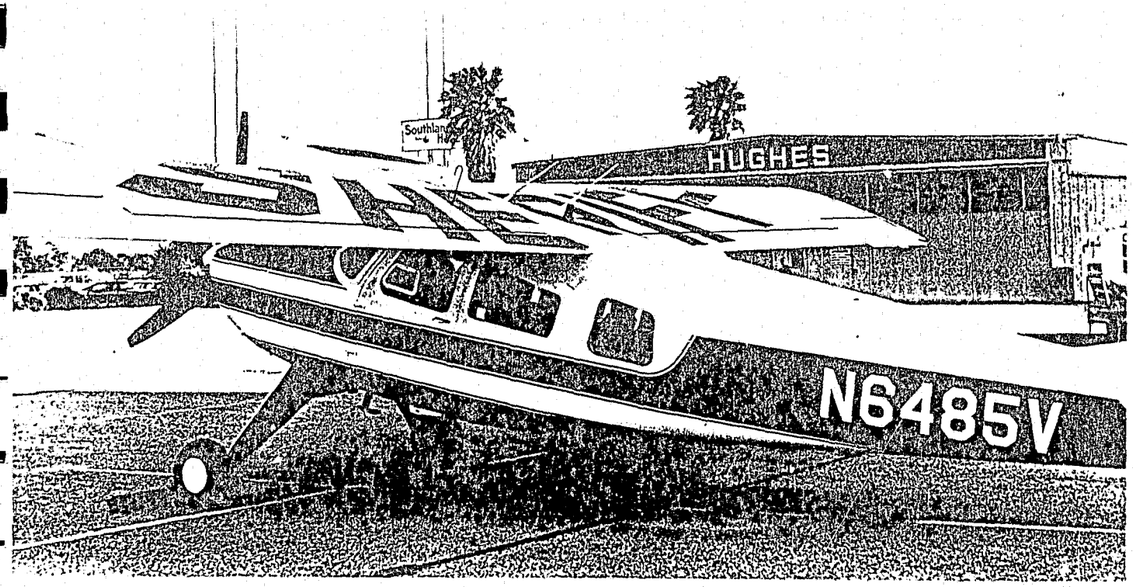
The true purpose of S.T.O.L. aircraft was to safely operate in and out of short fields surrounded by obstacles, so as time passed, the unofficial adopted definition of S.T.O.L. aircraft was revised to include any airplane that could take off and land over a 50-foot obstacle in 600 feet or less; the climbing and descending portions, which were originally required within the column of air, were deleted. Some airframe manufacturers took advantage of the loosened requirements and, as a marketing effort, began classifying any aircraft requiring less runway than its competitors as having S.T.O.L. capabilities.

Traditionally, an aircraft being utilized in a S.T.O.L. configuration must not only take off and land in a short distance, but frequently must operate within the confines of steep approach and departure gradients as well, and a safe margin of controllability must be maintained during this phase of the aircraft's operational envelope.

Therefore, the NATO International S.T.O.L. standard, which has been adopted for single-engine aircraft, is defined as the capability to operate in and out of a single strip with 660 feet (200 meters) between 50-foot obstacles, and maintain good maneuability with full stall-proof safety in event of heavy turbulence and sharp-edged gusts.

S.T.O.L. Project Aircraft

As specified in the Grant, a Helio Courier was purchased to be evaluated as the S.T.O.L. aircraft. Two problems developed relative to its acquisition. Inflationary increases had pushed the cost of a new airplane beyond the amount authorized in the Grant. This was not an insurmountable obstacle, however, the Helio Courier factory advised that it was involved in producing airplanes for military use and the availability of a new Helio Courier would be delayed until the factory re-tooled to produce civilian airplanes. Because of this problem, authorization was requested, and received, to purchase a used Helio Courier. One was located with approximately 300 previous hours of flight time, and its price was within our budgetary limitations. This airplane was purchased for use as the S.T.O.L. project airplane.



THE HELIO COURIER - S.T.O.L. AIRCRAFT

Helio Courier - N6485V Description

Model H-295, six place, single-engine, high-wing monoplane of conventional design, in tailwheel configuration, metal construction, manufactured by Helio Corporation, Bedford, Massachusetts.

Manufacturers Specifications and Performance Data

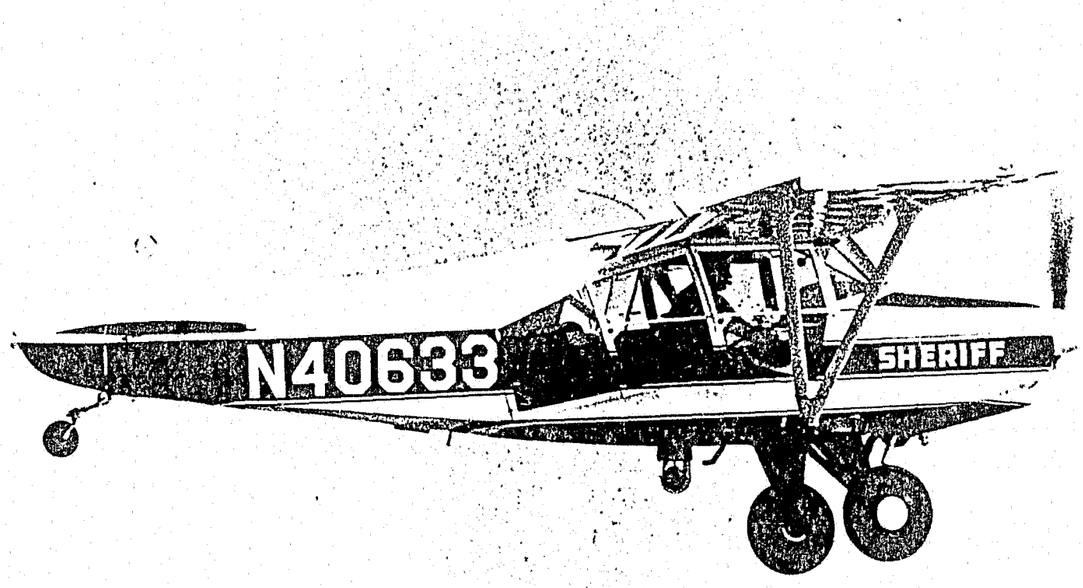
Engine:	Lycoming, GO-480-G1D6, 295 BHP, Turbo Charged
Length:	31'
Height:	8' 10"
Wing Span:	39'
Fuel Capacity:	60 gal. standard
Weight and Load: (lbs)	
Gross Weight	3400
Empty Weight	2080
Useful Load	1320
Take Off: (sea level, no wind, in feet)	
Ground Roll	335
Over 50' Barrier	610
Landing: (feet)	
Ground Roll	270
Over 50' Barrier	520
Speed: (mph)	
Minimum, fully maneuverable	30
Maximum @ Sea level	167
Service Ceiling: (feet)	20,500

Project Light Fixed-Wing Airplane

The selection process for the light fixed-wing airplane was more involved, with several airplanes considered to fill this role in the Grant Project. The airplanes considered, and rejected, for use in the project are listed below.

Piper Super Cub	This airplane was unavailable due to destruction of the tooling at the factory by flood.
Minerva Rallye	This airplane is low-wing configuration and, as such, was considered unsuitable for aerial patrol due to lack of downward visibility.
Citabria	This airplane did not have sufficient load capability to carry the required auxiliary equipment.
Sky Sentinel	This airplane, a modified Cessna 172, exceeded the budgetary limitations of the Grant considerably.
Cessna 150	This airplane does not have sufficient load capability to carry the required auxiliary equipment.
Cessna 172	The flight characteristics and load carrying capabilities of this airplane were inferior to the selected project aircraft. Additionally, the tricycle gear was felt to be less desirable than the conventional gear configuration in the event of an off-airport landing.
Cessna 182	This airplane exceeded the budgetary limitations of the program.

The selection of the Maule Rocket as the light fixed-wing airplane for the project was made because it fell within the required budgetary limitations, and filled all the desired performance criteria.



THE MAULE ROCKET - LIGHT FIXED-WING AIRCRAFT

Maule Rocket - N40633

Model M-4 Rocket, four-place, single-engine, high-wing, monoplane of conventional design in tailwheel configuration, metal wings with covered tubular fuselage. Manufactured by Maule Aircraft, Moultrie, Georgia.

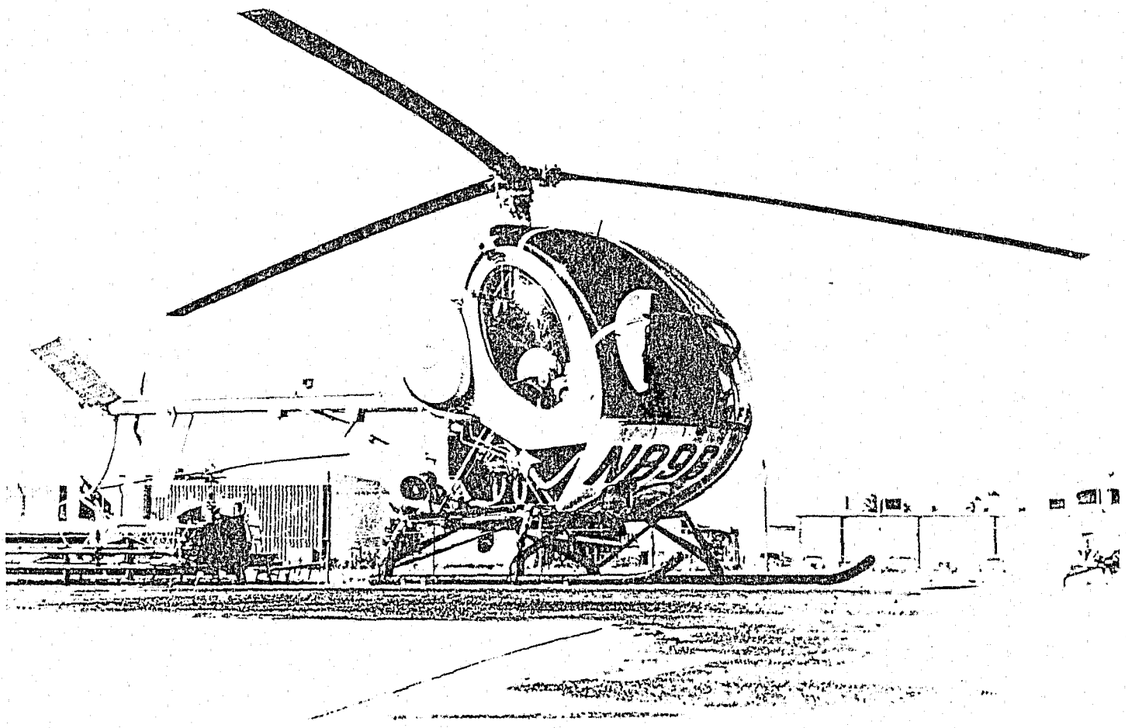
Manufacturers' Specifications and Performance Data

Engine:	220 H. P. Franklin
Gross Weight:	2300 lbs.
Empty Weight:	1220 lbs.
Useful Load:	1080 lbs.
Wing Span:	29' - 8"
Length:	22'
Height:	6' - 2"
Fuel Capacity:	42 Gals.
Oil Capacity:	8.8 Qts.
Cruise Speed:	165 MPH
Minimum Control Speed:	28 MPH
Take Off Ground Roll:	430 Ft.
Take Off Over 50' Obst:	650 Ft.
Normal Landing Roll:	390 Ft.
Service Ceiling:	18,000 Ft.

Project Helicopter

A helicopter was necessary to complete the team of aircraft

with which to conduct the operational phase of this project. As specified in the Grant, a Hughes 300 C was purchased.



THE HUGHES 300-C HELICOPTER

Hughes 300 C - N8961F

Model 269 C - 3-place helicopter, one main rotor and one anti-torque rotor configuration, skid-type gear, tubular metal construction, manufactured by Hughes Aircraft, Culver City, California.

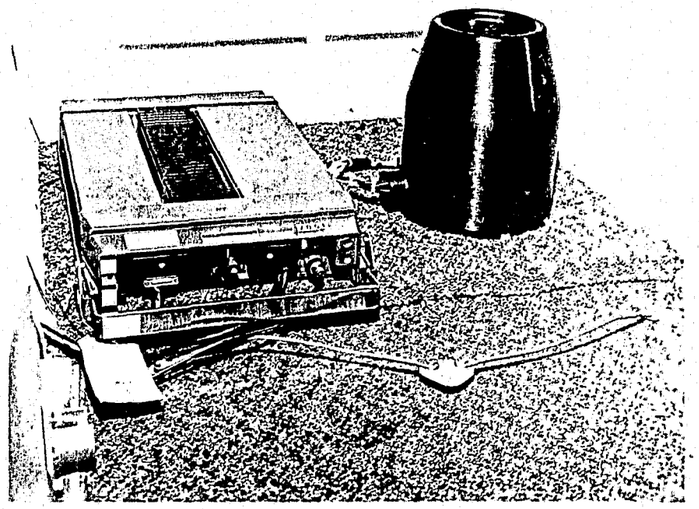
Manufacturers Specifications and Performance Data

Rotor Diameter:	26' 10"
Height:	8' 8 5/8"
Length:	30' 10"
Gross Weight:	1900 lbs.
Empty Weight:	1046 lbs.
Useful Load:	845 lbs.
Engine:	Lycoming, 190 H.P.
Speed - Maximum:	109 M.P.H.
Fuel Capacity:	30 U.S. gallons
Hover Ceiling: (Out of ground effect)	4250 Ft.
Service Ceiling:	13,200 Ft.

AUXILIARY EQUIPMENT SELECTION

In the selection of auxiliary equipment for the project helicopter, the experience of the Los Angeles Sheriff's Department, Aero Bureau, had set forth minimum standards which could be used as guidelines for equipment such as police radios, public address systems, night illumination devices, and viewing devices. However, testing and development were necessary to establish equipment requirements and installation procedures for the fixed-wing aircraft. Many items of equipment were examined with the following selections.

THE NIGHT ILLUMINATION DEVICE AND
CONTROL STICK INSTALLATION IN THE HELIO COURIER



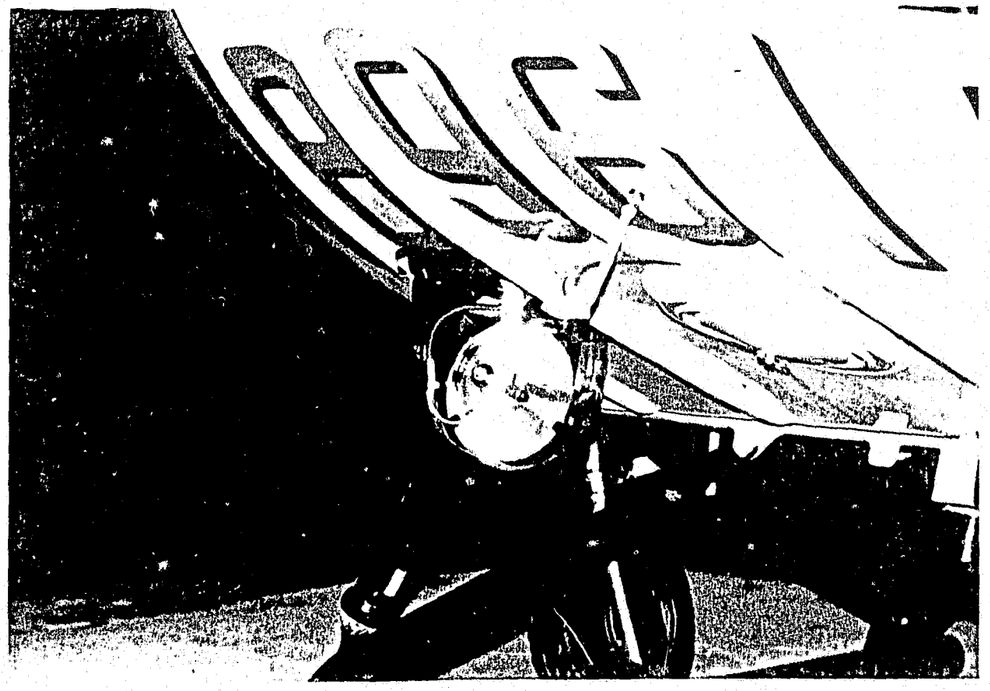
The dome-shaped power pack, separated from the lighting device for easier installation, was mounted in the aft portion of the aircraft cabin.

Night Illumination Device

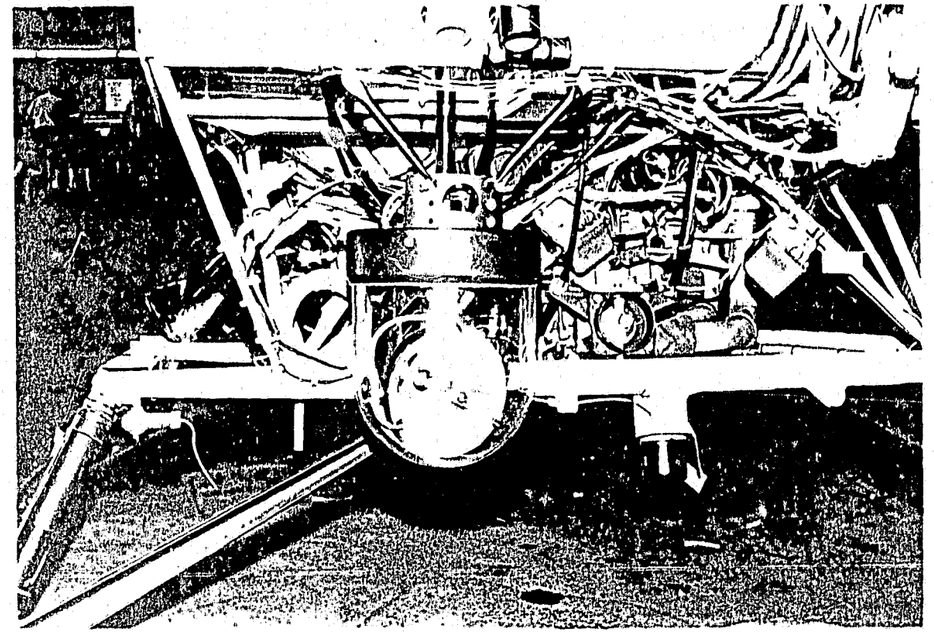
Tests were conducted of various lighting devices available at the time of equipment selection. The most effective device was felt to be the electrically remote-controlled "Locator" light manufactured by Optical Radiation Corporation, Azusa, California. This light provides 3.5 million candlepower projected in a beam width of 4°, and had the streamlining necessary for the high speeds at which the airplanes would be flown. Models A and B of this type light were utilized in the project. The only difference between the two systems was that of the electrical requirements. The A model operated on 12-volt D.C. current, the power rating of both fixed-wing airplanes. The B model, utilizing 24 volts D.C. current, met electrical needs of the helicopter.

Experience has shown that a manually controlled beam is superior to an electrically remote-controlled one in maintaining the placement of the light beam on a stationary or moving object or person on the ground.

Therefore, our mechanical staff modified these remote-controlled lights to allow manual control of the beam direction.

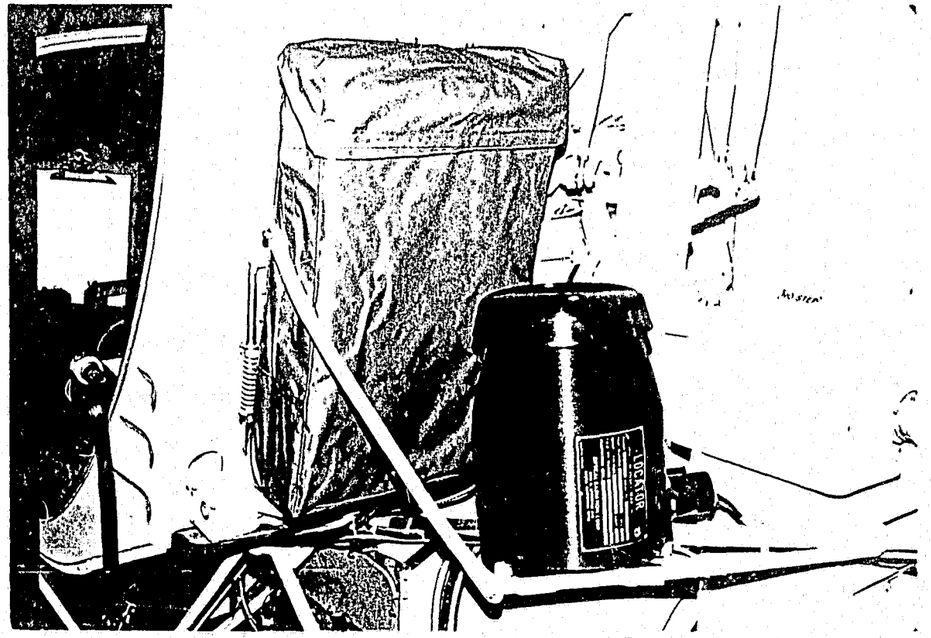


INSTALLATION OF NIGHT ILLUMINATION DEVICE
ON THE HUGHES 300 C HELICOPTER

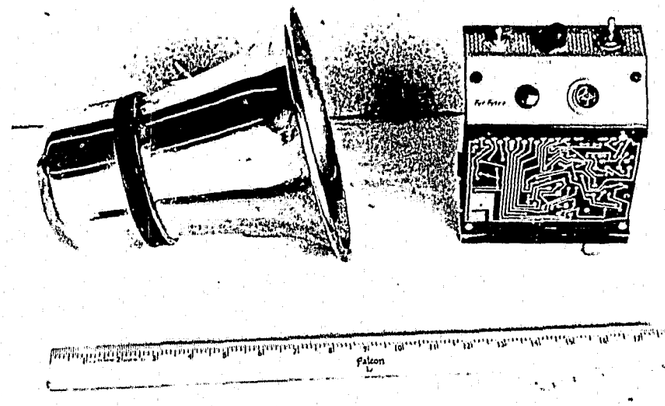


NIGHT ILLUMINATION DEVICE ON THE HUGHES 300 C HELICOPTER

The Craft's cowling has been removed for better depiction.



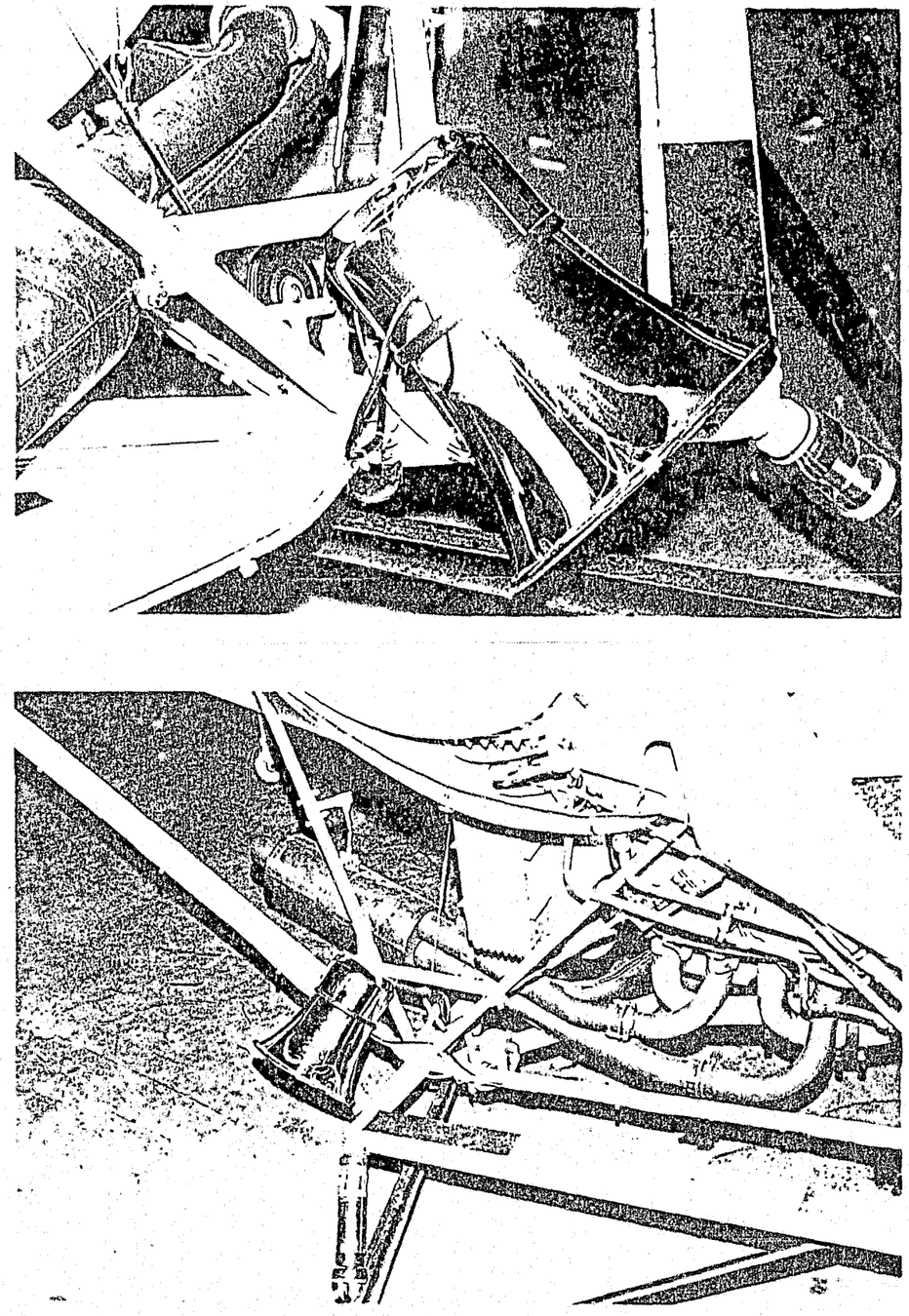
INSTALLATION OF THE DOME-SHAPED POWER PACK FOR THE
NIGHT ILLUMINATION DEVICE ON THE HUGHES 300 C HELICOPTER.



FYR FYTER PUBLIC ADDRESS SYSTEM USED IN ALL THREE PROJECT AIRCRAFT.

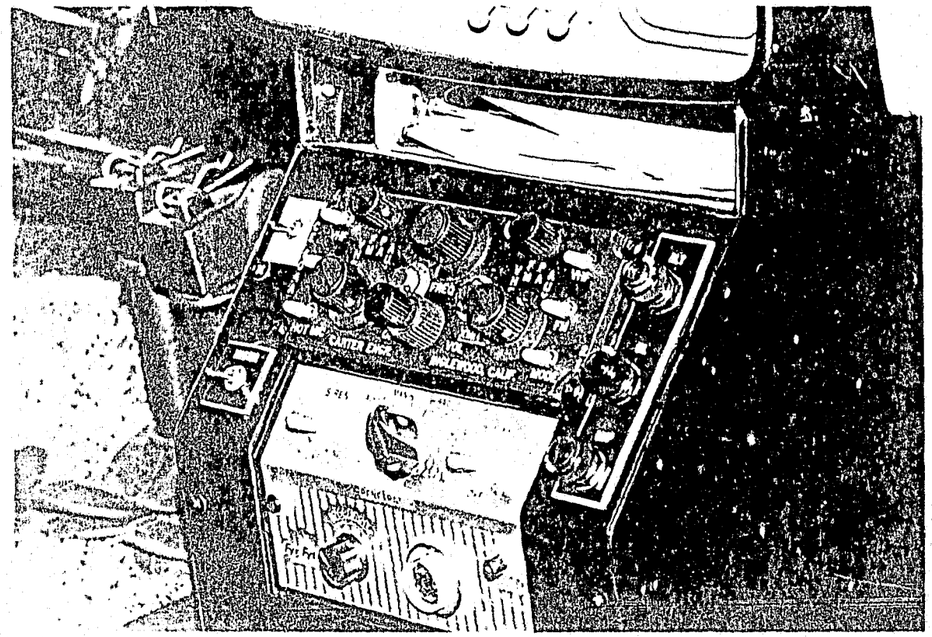
Public Address System

Several types of public address systems were considered for use in the project. Although more expensive and exotic systems were tested, the moderately priced Penetrator (tm) was found to be as effective as higher priced models and was therefore selected. Two models of the Penetrator (tm) manufactured by Fyr-Fyter, the Fire and Safety Equipment Division of Norris Industries, Newark, New Jersey, were used. Model 12 PT 75, utilizing 12 volts D.C. current, was installed in the fixed-wing airplanes, and Model 24 PT 75-100 was utilized in the 24-volt D.C. current helicopter. These systems combine a public address system and electronic siren with the capability to amplify the broadcasts emitting from the Departmental radio. Each of these systems provide 75 watts of broadcast power through a single weather-tight bell horn speaker.



THE PUBLIC ADDRESS SYSTEM
AS INSTALLED IN THE HUGHES 300-C HELICOPTER

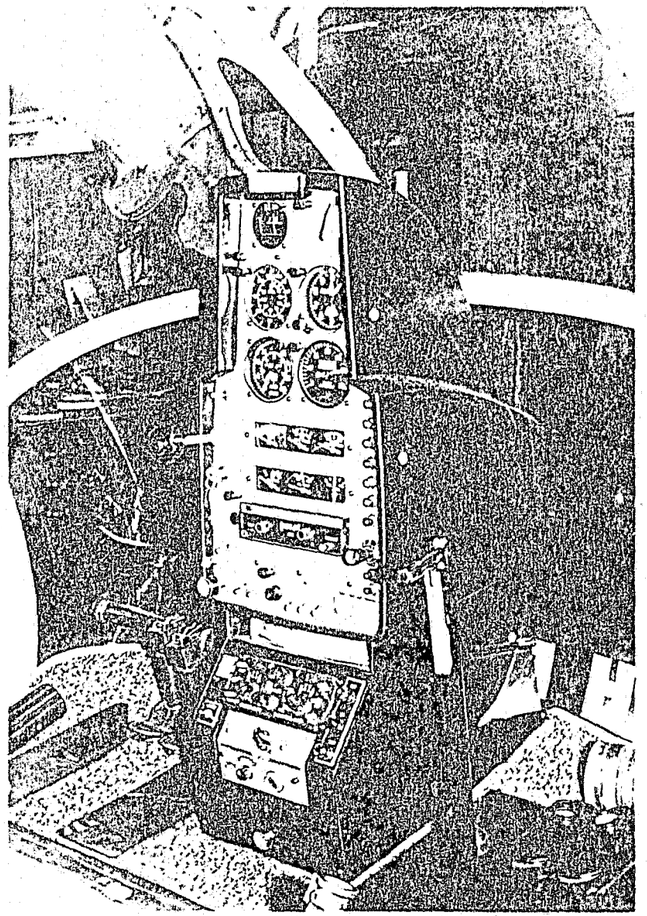
INSTALLATION OF THE PUBLIC ADDRESS SYSTEM HORN ON THE HELIO COURIER AND THE MAULE ROCKET WAS ACCOMPLISHED IN THIS MANNER.



RADIO MIXER PANEL UTILIZED IN ALL THREE-PROJECT AIRCRAFT. THIS INSTALLATION IS IN THE HUGHES 300-C HELICOPTER.

Radio Mixer Panel

The function of a radio mixer panel is that of taking input from various communication devices, aircraft VHF radio, Departmental radio, and intercom, and allow the pilot and observer the selection as to which of these several frequencies are independently or collectively monitored. Additionally, there is selection capability to allow the pilot and/or observer to transmit on any of the various radios, or the public address system.

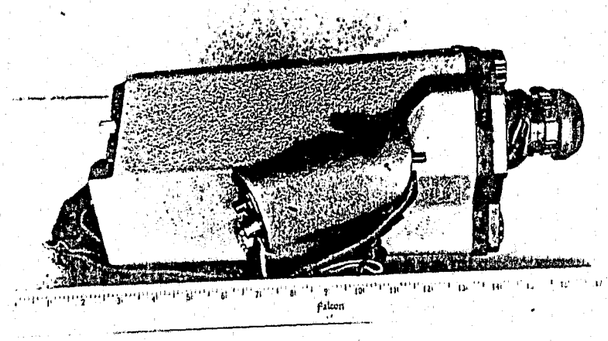


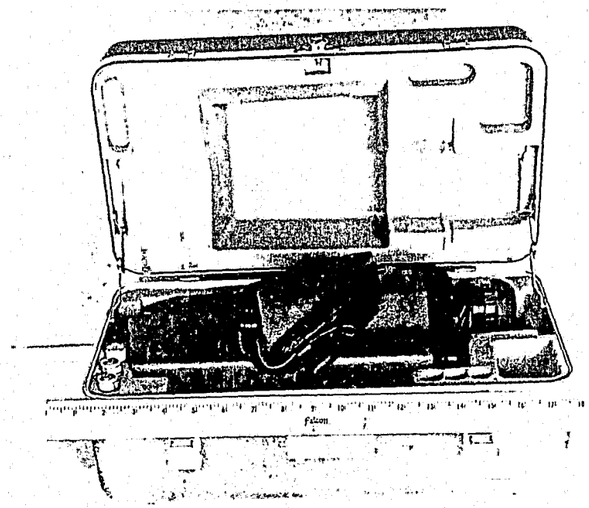
RADIO PANEL IN HUGHES 300-C HELICOPTER. THE CONTROL STICK TO RIGHT OF PANEL IS FOR THE NIGHT ILLUMINATION DEVICE.

The radio mixer panel selected for the three aircraft in this project was the Carter mixer panel CE 604 A ICS manufactured by Carter Engineering, Inglewood, California.

Stop Watches

Moderately priced stop watches were purchased for response time surveys to be conducted intermittently throughout the project.



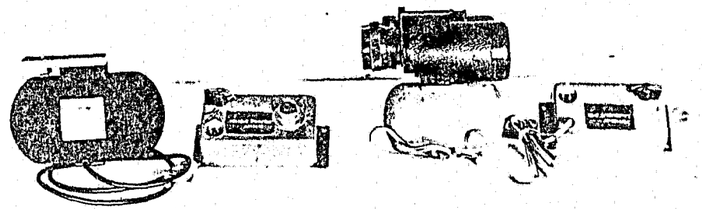


STABILIZED BINOCULARS

Stabilized Binoculars

To improve the observation capabilities from the fixed-wing aircraft, and the helicopter, gyroscopically stabilized binoculars were purchased.

The binoculars selected were Model Mark 1610, manufactured by Mark Systems Inc., Cupertino, California. They contain a battery-powered gyroscopic stabilizer installed in a case with 10 and 20-power 50 MM optics. The units are self-contained and hand-held when in use.

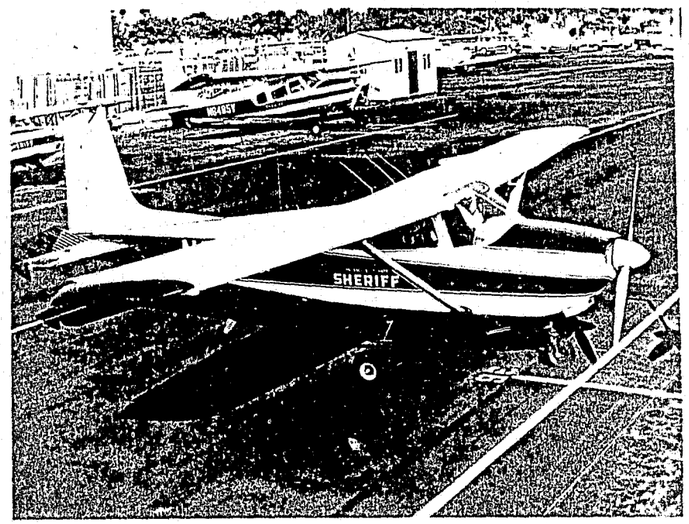


THESE ARE THE TWO STABILIZING PLATFORMS EVALUATED DURING THE PROJECT.

Stabilized Platforms

Additional stabilizing platforms were obtained to allow stabilizing capabilities for standard hand-held binoculars and photographic equipment.

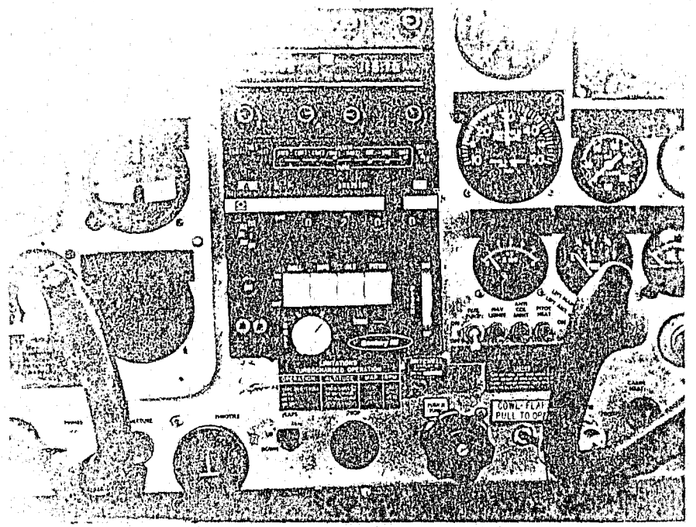
The devices are hand-held and can be attached to standard binoculars or cameras by means of adaptors. Two devices were obtained, the Kenyon Stabilizer, Model KS-E, and the Kenyon Stabilizer, Model KS-6, with the KS-6 model being the larger of the two. The devices, which are manufactured by KEN-LAB Inc., Old Lyme, Connecticut, have internal gyroscopic stabilizers which are powered by 12 or 24-volt D.C. inverters. The inverters were wired into the electrical system of the aircraft, and power the stabilizer through a plug-in cord.



PORTIONS OF THE ROBERTSON S.T.O.L. MODIFICATION KIT INSTALLED ON THE DEPARTMENT'S CESSNA 182 CAN BE SEEN ON THE LEADING EDGES AND TOP OF THE WING.

Robertson S.T.O.L. Modification

The Cessna 182, owned by the Los Angeles Sheriff's Department, was substituted for the other fixed-wing airplanes during the later months of the program. To improve the slow flight characteristics of the aircraft for safety, and to improve performance in a law enforcement application, the Cessna was modified with a Robertson S.T.O.L. Kit purchased from Gunnell Aviation, Inc., Santa Monica, California. The modification to the wing design, and control system, allows the airplane to be operated more safely at slower speeds.

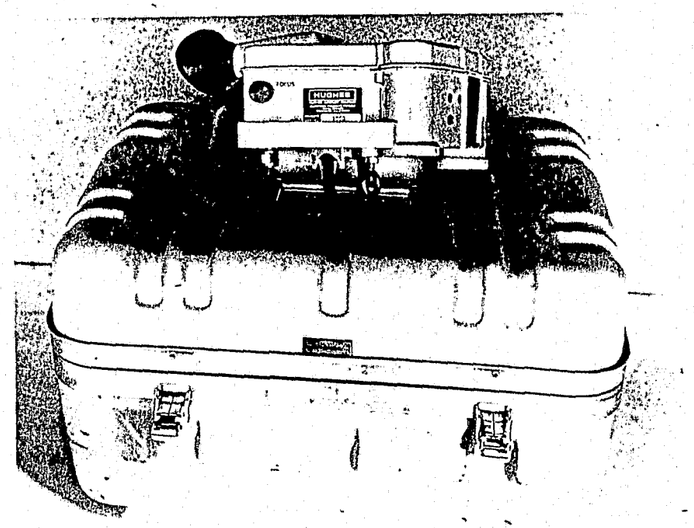


THE AUTO PILOT CONTROL PANEL, INSTALLED ON THE HELIO COURIER, CAN BE SEEN IN THE CENTER OF THIS ILLUSTRATION.

Auto Pilot

An auto-pilot was purchased and installed in the project Helio Courier to test the capabilities and effectiveness of the system in an airplane in a patrol function.

The auto-pilot, a Century III model with radio coupler and heading hold, glide-slope coupler and altitude pitch trim, altitude hold, and pitch command, was purchased from Aero Spec in Fullerton, California.

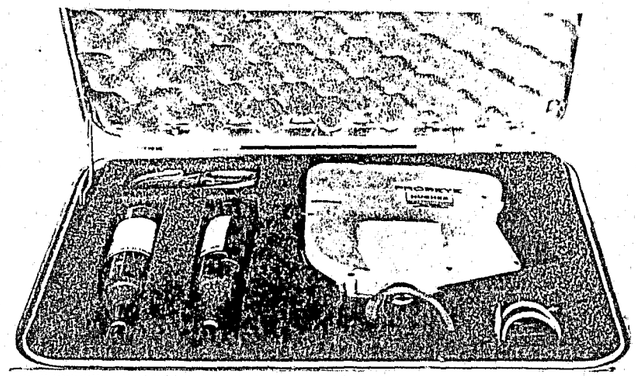


THE HEAT-SENSING OPTICAL DEVICE WITH CARRYING CASE.

Heat-Sensing Optical

To evaluate night observation capabilities, two "Probeyes" (tm), manufactured by Hughes Tool Company, Palomar, California, were obtained.

These hand-held battery-operated devices sense the residual heat given off by all objects and present this information on a small viewing screen. The operator can then observe activities on the ground at night without the use of the light, providing improved safety for the ground unit personnel.



THE HEAT-SENSING DEVICE WITH ACCESSORIES IN CARRYING CASE

AIRCRAFT MODIFICATIONS

Helio Courier - N6485V

The Helio Courier was purchased used, fully equipped for instrument flight. With the exception of the automatic pilot installation, which was performed late in the operational phase of the Grant, few modifications were necessary to begin operations. The necessary installations included a Departmental 8-frequency radio, the "Locator" Model A electronic light with a manually controlled beam application, and a "Penetrator" public address system which includes siren, yelp, and radio amplification. The second row of seats was removed and a single center-mounted seat installed in its place. The third row of seats was removed for weight reduction. The Carter Radio control panel was installed in the instrument panel and made operable from both front and rear seat by installing a remote control in the rear seat area. A switch in the front of the aircraft allowed the command of the radio to be shifted to either of the two control panels.

Wing-tip strobe lights were installed and alumi-grip polyurethane process paint in black on white design was applied. The word "Sheriff" was painted in a sunburst pattern on the

top of the wing to increase visibility and safety as well as to be a means of identification.

The streamlined "Locator" light globe was installed on the belly of the airplane. The public address speaker was recessed into the bottom skin of the airplane so as not to detract from the Helio Courier's 150 MPH performance.

The electrical system on the airplane was increased from the original 70 AMP capability to 110 AMP's to handle the high electrical loads imposed by the addition of the auxiliary equipment.

Maule Rocket - N40633

The Maule Rocket was purchased new from the factory. The modifications were more extensive on this airplane than on the Helio Courier. Installed were a Departmental radio, the "Locator" Model A with manual control modification, and the "Penetrator" public address/siren system. As with the Helio Courier, the Locator light globe and recessed speaker horn were installed in the belly of the airplane. The control for the light and public address system was placed in a position primarily for a rear-seated observer, but can be easily reached from either front seat. As with the Helio Courier, a remote control for the radio mixer

CONTINUED

1 OF 3

panel was installed in the rear seat area.

All doors on the right side of the aircraft were modified, with clear plexiglass used as a covering over the entire door frame. This increased the manufacturer's designed viewing area substantially. (The same model of aircraft is now offered for sale with this modification, from the west coast distributor of Maule aircraft.) The rear seat was moved four inches to the rear for increased leg room. Also installed were the optional oversize tires in consideration toward off-field landings and increased ground clearance for the light globe.

The electrical system on the Maule was incapable of handling increased demands made by the addition of the auxiliary equipment. A 110 AMP generator was substituted for the standard 70 AMP with satisfactory results.

The Maule was painted in the same manner and design as the Helio Courier.

Hughes 300 C - N8961F

The equipment installation on the project helicopter was less difficult due to the mechanical staff having had previous experience with this type helicopter. Installed were a Departmental radio, a "Locator", Model B, modified for manual control,

and the "Penetrator" public address/siren system.

On each of the Departmental aircraft, certain safety indicator systems are employed and, in keeping with this policy, installed on the helicopter were electrical system failure warning lights, transmission chip detector indicators, and oil pressure warning lights.

Cessna 182 - N3718D

The Cessna 182, utilized as an alternate aircraft was owned by the Sheriff's Department prior to the beginning of the project. As such, its equipment already included a Departmental radio. The plane was not equipped with an air-to-ground light, nor were there any structural changes made to improve field of vision. The Cessna was equipped through Grant funds with a Robertson S.T.O.L. kit, allowing this craft to fly with greater stability at the slower air speeds, more suitable for police reconnaissance and support.

CHAPTER III
METHODOLOGY

METHODOLOGY

Data Needed

In order to evaluate the cost effectiveness of various police mobility systems, several types of data were required. Initial cost, modification costs incurred to transform the basic vehicle into a suitable law enforcement tool, and maintenance costs including labor, parts, gas and oil were needed to obtain a complete and accurate representation of what a Department may reasonably expect to expend to initiate and maintain an aerial support program.

Data was also collected relative to the effectiveness of each mobility system. This data included response time, length of time required to complete the mission, effectiveness of the mobility system on the mission, safety of officers involved (both ground and air crews), and evaluation of auxiliary equipment used.

To accurately examine the impact of the program, the independent evaluators obtained data relative to the crime rate in the areas patrolled from the Management Staff Services Bureau of the Sheriff's Department.

How Gathered

Cost data was acquired through the use of a separate purchase requisition number for all equipment and parts necessary to maintain the project aircraft. Fuel and oil consumption records were maintained for each aircraft.

Data which addressed the effectiveness of the mobility system was acquired in several ways. The information relative to type and number of activities, response time, handling time, number of aircrew observations, and number of arrests directly attributable to aircraft participation was tabulated on punch cards for computer analysis. Both air and ground crews evaluated the performance of the mobility system on each activity by answering questions from a structured questionnaire. These answers were also tabulated for computer analysis by the independent evaluators. Memorandums were submitted by air and ground crews reporting significant events as they pertained to the project. Questionnaires designed to elicit the overall effectiveness of each mobility system, and any preconceived attitudes held by the personnel involved in the project were submitted by the evaluation team and completed by the air and ground crews. And lastly, personal interviews were conducted by the evaluators with air and ground crews.

Work Schedule

Work schedules will be discussed in two segments, the overall Grant time frames and the operational schedules. The overall time frames as outlined in the Grant, as they pertain to the Los Angeles County Sheriff's Department, were as follows:

Month one - select independent evaluators

Months one and two - purchase aircraft and auxiliary equipment

Months one to three - personnel training

Months three - develop scenarios with assistance of evaluators

Months four to twenty - data collection and analysis

The original time frames of the Grant were distorted considerably due to several delays at various points. Both administrative delays and equipment acquisition delays repeatedly forced back the starting date for the operational phase. Additional delays were experienced during the training and operational phases due to numerous and frequent mechanical difficulties with the equipment. Because of these delays, it was twice necessary to request time extensions on the original time frames. The Grant was funded by the Law Enforcement Assistance Administration in January, 1972. The first revision, approved in October, 1972, extended the grant time frame to April 15, 1973.

The second, which permitted the project to continue until June 15, 1974, was granted by the Law Enforcement Assistance Administration in March, 1973, and approved by the Los Angeles County Board of Supervisors in July, 1973. The time frames, as actually experienced, were as follows:

Months one to six - independent evaluators selected

Months one to sixteen - equipment selection and acquisition

Months twelve to nineteen - aircraft modification and crew training

Months twenty - thirty - data collection and analysis

The expected operational work schedule, based on previous experience of the Aero Bureau, was five flying hours during each shift. Each aircraft was scheduled to fly one shift per day for a possible total of 319 shifts and 1,595 flying hours.

The mechanical difficulties experienced with the various aircraft, and periods of unflyable weather resulted in an experienced work schedule, by aircraft, as follows:

Aircraft	Total Number Shifts Worked	Total Operational Flight Time	Average Flight Time Per Shift
Helio Courier	204	890.8 Hrs.	4.36 Hrs.
Maule Rocket	204	818.1 Hrs.	4.01 Hrs.
Hughes 300 C	275	1275.8 Hrs.	4.63 Hrs.

Percent of Expected Flight Time Achieved

Helio Courier	Maule Rocket	Hughes 300 C
56%	51%	80%

The factors contributing to the reduction of flight times for the various project aircraft are enumerated in the section dealing with work performed.

WORK PERFORMED

Several unanticipated factors exhibited themselves during the project which influenced the operation of the equipment. Those incidents which had a significant effect on the operational costs and availability of the project aircraft are enumerated below.

Maule Rocket - N40633 - Light Fixed-Wing Project Aircraft

On May 14, 1973, the Maule Rocket was involved in a training accident during a landing attempted in a crosswind. The landing resulted in a ground loop, a term which refers to the loss of adequate directional control during ground operations, resulting in the aircraft spinning around. The aircraft's right landing gear collapsed, also damaging its right wing and other non-structural parts. While the aircraft was grounded for repairs, the installation of the police auxiliary equipment was accomplished. Therefore, the repair did not result in a substantial amount of down time greater than that which would have been incurred during the installation of the special equipment. Additionally, the repair costs were reimbursed by insurance and therefore do not reflect in the cost data for the aircraft.

Early in the operational phase of the program, during a scheduled inspection, one cylinder of the engine was found to have

a low compression reading. Further investigation revealed that the cylinder had warped and required rebuilding. The suspected cause of the warping was overheating, resulting from inadequate cooling air over the engine during slow flight. While the cylinder was being rebuilt, the baffling under the engine cowling was modified, as recommended by the manufacturer, to improve the airflow.

The patrol speed commonly used by the aircrews at that time was 60 miles per hour <u>indicated</u> airspeed. The incident resulted in the aircraft being withheld from service for approximately two weeks.

On September 21, 1973, the engine in the Maule Rocket suffered an in-flight malfunction. A portion of one of the pistons broke off. The engine continued to run, however, and the pilot made an uneventful landing at the operations base, when it was observed the proper oil pressure was not being maintained. Subsequent inspection revealed the portion of the piston which became detached had punctured the engine case, resulting in the loss of oil, and the subsequent low pressure reading. The failure was again attributed, by the mechanical staff, to overheating due to inadequate cooling air over the engine. Upon returning the airplane to service after repair, patrol speeds were increased to 100 miles per hour to preclude the possibility

CHAPTER IV

OPERATIONAL PHASE

of a recurrence. The aircraft was out of service for approximately four weeks.

On December 3, 1973, the Maule engine again suffered an in-flight malfunction, which produced a complete loss of power, and necessitated a forced landing in a plowed field. No damage was suffered as a result of the landing. The aircraft was returned to the operations base by truck and an inspection of the engine revealed one piston had broken at the wrist-pin hole, which resulted in an engine stoppage.

The mechanical staff doubted the failure was a result of overheating, as minimum patrol speeds of 100 miles per hour, indicated, had been maintained. The cause of the failure is still under investigation by the Federal Aviation Administration.

Because of the problems the Los Angeles County Sheriff's Department had experienced with that particular engine, the manufacturer agreed to make a warranty adjustment. As the Franklin engine factory was out of production at the time of the failure, the Maule factory made available a low time replacement engine, which was installed in the project aircraft, and it was returned to service after approximately 12 weeks. The replacement engine has incurred no problems other than normal, required maintenance.

Helio Courier - N6485V - The S.T.O.L. Project Aircraft

The transitional training of pilots into a high performance aircraft in the S.T.O.L. class requires that a great amount of the time be spent in practicing the landing phase of the aircraft's operational envelope, as that is one of the major differences between S.T.O.L. aircraft and those of a more conventional type. As a result of the repetitive training, certain parts of the aircraft are subjected to stresses in excess of those experienced during normal operations. For this reason, the Helio Courier experienced excessive wear to its brake system, which resulted in the brake linings being replaced three times during the training period. No significant loss of flight time was incurred during these changes.

Shortly after acquisition of the Helio Courier, it was found that the operation of the constant speed propeller was not within acceptable tolerances. Additionally, the propeller spinner was cracked from fatigue. The repairs withheld the aircraft from service, during the training period, for approximately two weeks. The problem was experienced, most probably, because a used aircraft was purchased. Although the overall operation of the aircraft was relatively trouble free, this type of problem may be expected to occur more frequently with used equipment than with new.

On August 28, 1973, the propeller on the aircraft was damaged during a nighttime taxiing accident, when an unlighted barricade had been left on an airport taxiway during a construction project. The configuration of the Helio Courier is such that forward visibility while on the ground is very limited, and neither the pilot nor observer saw the obstruction. The repair of the resultant damage to all three blades of the propeller withheld the aircraft from service during the operational period approximately five weeks.

During a scheduled inspection of the Helio Courier on March 1, 1974, a crack was found in the engine mount assembly, the repair of which required removal of the engine. At this time, the engine had approximately one hundred hours remaining before a mandatory rebuild. It was decided it would be more economical in labor man-hours and operational time losses to rebuild the engine while it was out of the aircraft. The engine at this time was operating normally, with no unusual problems. The aircraft was out of service for approximately eight weeks during repairs.

Hughes 300 C - N8961F - Helicopter

The project helicopter performed well with minimum amounts of unscheduled maintenance until November of 1973, when investigation of a low compression reading resulted in the discovery of

a cracked valve in the engine. Repair of the malfunction withheld the aircraft from service for two weeks in the operational period.

On January 14, 1974, the engine in the helicopter again suffered a problem. The incident was a result of external factors rather than internal problems. The pilot of the helicopter observed the engine temperature reading to be abnormally high. An uneventful landing was accomplished in a cleared area and a mechanic was dispatched to investigate. It was determined the high temperature was caused by wastepaper being drawn into, and becoming lodged in, the oil cooler of the engine. The malady was corrected and the helicopter was flown to the operations base for a complete inspection. The inspection revealed no obvious deficiencies. The aircraft was restricted to daytime operation for closer observation, for one week, and then returned to regular duty.

On February 8, 1974, the engine in the Hughes 300 C suffered an in-flight failure necessitating a forced landing in a parking lot of a manufacturing establishment. The landing caused no damage to the aircraft. The failure was believed precipitated from the previously mentioned over-temperature condition. A broken valve reduced the power output to a level insufficient to sustain flight. The helicopter was returned to the operations base by truck and the engine rebuilt, resulting in the aircraft being out of service for four weeks.

All Aircraft

The scheduling assignments of the various aircraft also contributed to the amount of flight time each accumulated. With the exception of one month, the project helicopter was assigned to operate during the evening shift. The mechanical staff performed required routine maintenance during the daytime hours and the aircraft was returned to service before its scheduled tour of duty, resulting in little loss of flight time while the aircraft was undergoing normally scheduled inspections.

The fixed-wing aircraft, conversely, were alternately assigned to operate on day and evening shifts, which resulted in a reduction of flight time during those months they operated during the day shift. The required inspections necessitated the airplanes be withheld from service. The condition was somewhat offset by virtue of the fact that the project aircraft were substituted, one for the other, during these inspections, however, the net effect is some reduction in flight time, although the actual amount lost would be difficult to determine.

Experience has shown that per hour cost factors, when applied to aircraft operations, tend to stabilize with increased usage. The costs associated with the fixed-wing aircraft would therefore be somewhat less had the utilization of the aircraft been greater.

DIRECT OPERATIONAL COSTS, ANTICIPATED

Manufacturers' Anticipated Costs
Based on 1200 Hours Use Per Year

Hughes 300 C	Cost/Hr.
Fuel 10 Gal. Per Hr. @ .70 (1)	$7.00
Oil Consumption 1 qt. per 5 Hrs. @ .85 (2)	0.17
Oil Changes (every 50 hrs.) 8 qts. @ .85	0.14
Airframe and Engine Maint. (scheduled & unscheduled)	5.53
Reserve for Engine Overhaul & Retirement Items	8.59
Direct Operating Costs Per Hour	$21.43

Maule Rocket	
Fuel 10 Gal. Per Hr. @ .70 (1)	$7.00
Oil Consumed 1 qt. per 5 Hrs. @ .85 (2)	0.17
Oil Changes (every 50 hrs.) 8.8 qts. @ .85	0.15
Airframe and Engine Maintenance	1.25
Reserve for Engine Overhaul	2.20
Direct Operating Costs Per Hour	$10.77

Helio Courier	
Fuel 12 Gal. Per Hr. @ .70 (1)	$8.40
Oil Consumed 1 qt. per 3 hrs. @ .85 (2)	0.28
Oil Changes (every 50 hrs.) 10 qts. @ .85	0.17
Airframes and Engine Maintenance	2.00
Reserve for Engine Overhaul	4.14
Direct Operating Costs Per Hour	$14.99

(1) Current cost of fuel at Long Beach Airport, California
(2) Current cost of oil at Long Beach Airport, California

DIRECT OPERATIONAL COSTS, EXPERIENCED

Helio Courier - N6485V

Purchase and Modification Costs

Purchase Price (used)	$50,925.00
Painting to Department Specifications	850.00
Sheriff's Radio	1,120.00
Carter Radio Mixer Panel	1,000.00
Locator Light	3,390.00
Public Address System	400.00
Rear Seat Alteration	350.00
Wing Tip Strobe Lights	210.00
Increased Capacity Electrical System	500.00
Total Equipment Cost	$58,745.00
Labor Required to Install Auxiliary Equipment, 340 Hrs. @ $7.10 per hr.	2,414.00
Total Cost In Operational Period	$61,159.00

Direct Operating Costs	Cost Per Hr.
Fuel 9.2 G.P.H. @ .43 per gal. (1)	$ 3.96
Oil, Consumption 1 qt. per 3 Hrs. @ .40 per qt. (2)	0.13
Oil Changes 10 qts. @ 50 Hr. Intervals	0.08
Parts	9.57 (3)
Labor @ $7.10 per hr.	5.25
Total Direct Operating Cost Per Hr.	$18.99

(1) Actual cost of fuel used during project
(2) Actual cost of oil used during project
(3) Includes cost of engine rebuild contracted to private firm

DIRECT OPERATIONAL COSTS, EXPERIENCED

Maule Rocket - N40633

Purchase & Modification Costs

Base Price as Purchased	$24,137.00
Painting to Departmental Specifications	900.00
Sheriff's Radio	1,120.00
Carter Radio Mixer Panel	1,000.00
Locator Light	3,390.00
Public Address System	400.00
Rear Seat Alteration	500.00
Right Side Door Modifications (Plexiglass)	500.00
Engine Malfunction Light Warning System	250.00
Large (Rough Terrain) main gear wheels	75.00
Wing Tip Strobe Lights	210.00
Increased Capacity Electrical System	300.00
Total Equipment Costs	$32,782.00
Total for Installation of Auxiliary Equipment 173 Hrs. @ 7.10 per Hr.	1,228.30
Total Cost	$34,010.30

Direct Operating Costs	Cost/Hr.
Fuel 9.2 G.P.H. @ .43 per gal. (1)	3.96
Oil Consumption 1 qt. per 5 Hrs. @ .40 per qt. (2)	0.08
Oil Changes 8.8 qts. at 50 Hr. Intervals @ .40 per qt.	0.07
Parts	6.02 (3)
Labor @ 7.10 per Hr.	7.73
Total Operating Cost Per Hour	$17.86

(1) Actual Cost of Fuel Used During Project
(2) Actual Cost of Oil Used During Project
(3) Includes Engine Rebuild Contracted to Outside Firm

Hughes 300 C - N8961F

Purchase & Modification Costs

Base Price as Purchased	$45,864.00
Sheriff's Radio	1,120.00
Carter Radio Mixer Panel	1,000.00
Locator Light	3,390.00
Public Address System	400.00
Engine, Transmission Malfunction Warning Light System	250.00
Total Equipment Costs	$52,024.00
Labor for Installation of Auxiliary Equipment, 128 Hrs. @ 7.10 per Hr.	908.80
Total Costs	$52,932.80

Direct Operating Cost	Cost/Hr.
Fuel 10.3 G.P.H. @ .43 (1)	$4.43
Oil Consumption 1 qt. per 5 Hrs. @ .40 per qt. (2)	0.08
Oil Changes 8 qts. @ 50 Hr. Intervals @ .40 per qt.	0.06
Parts	11.09 (3)
Labor @ 7.10 per hr.	4.84
Direct Operating Cost Per Hr.	$20.50

(1) Actual Cost of Fuel Used During Project
(2) Actual Cost of Oil Used During Project
(3) Includes Engine Rebuild Contracted to Outside Firm

CHAPTER V

EVALUATIONS

EVALUATIONS - AIRCRAFT

Helio Courier - S.T.O.L.

The Helio Courier flew a total of 890.8 hours during the operational phase, 56% of the expected flight time on a projected schedule of five flying hours each day, seven days a week. Of those days the aircraft flew, it experienced a daily average flight time of 4.4 hours, 88% of the expected five hours. This includes days when flight time was shortened by inclement weather or mechanical problems. Those periods the aircraft was grounded the whole shift for mechanical or weather reasons were not considered in the daily flight time average.

The most frequent cause for loss of flight time for the Helio Courier were the periods it was unable to fly for mechanical reasons, which resulted in 391.0 flying hours lost, or 25% of the expected schedule. Second on the list was weather on evening shifts (11:00 p.m. to 3:00 a.m.), which resulted in 173.0 hours, or 11% lost, and lastly, day shift weather accounted for 126.0 hours lost, or 8%.

The Federal Aviation Administration Regulations require airplanes to be flown above cities, or gatherings of people, a

minimum of 1,000 feet above ground level. Because of these regulations, fixed-wing airplanes are frequently restricted from flying due to low-lying cloud cover or reduced visibility. The helicopter, conversely, can often operate safely when the fixed-wing aircraft are prohibited from flying.

The Helio Courier was assigned to operate as a patrol vehicle, and as an airborne platform for covert surveillance, aerial intelligence, and command supervision.

As a support vehicle for patrol operations, the Helio Courier experienced the greatest number of calls handled, averaging 1.53 per flight hour. The primary reason for the good performance in responding to called-for services is the rapid response capability available with an aircraft which is able to fly at speeds of 150 M.P.H. The quality of the service rendered by the Helio Courier, however, was compromised because of its regulated minimum altitude. The air crew, upon arriving over the location of the call, had greater difficulty discerning activities on the ground. Air crews reported observation capabilities from 1,000 feet above the ground on clear days frequently were not adequate to allow them to differentiate between uniformed officers and other persons on the ground. Darkness, or periods of reduced visibility due to atmospheric

conditions, or air pollutants, reduced the observation capabilities further, and frequently the air crew was unable to distinguish marked black and white police vehicles from other vehicles. These subjective evaluations of the air crews are substantiated by the number of observations per flight hour (0.20), and the number of arrests and citations (0.06) per hour directly attributable to air crew participation. These average hourly activities are less than those experienced by the Project helicopter, which operated at the lower altitude of 500 feet above the ground.

The observation capabilities of the Helio Courier were improved somewhat by using stabilized optical devices. The evaluation of these devices will be discussed separately, as will the evaluation of the night lighting device, and the public address system, in the section devoted to performance evaluation of auxiliary equipment.

A problem experienced by the crews operating the Helio Courier as well as the other fixed-wing aircraft, when operating in the metropolitan basin of Los Angeles, is the great amount of private airplane traffic. There are thirteen airports in the area, including Los Angeles International Airport, and the private air traffic between these is frequently conducted

at the altitudes utilized by the patrol crews. The traffic density is such that evasive action was frequently necessary to avoid collision between patrol airplanes and private airplanes. It was not uncommon for this to occur two or three times during a shift on week-ends, when private airplane traffic is greatest. The air traffic density should be of major concern when considering the implementation of a fixed-wing patrol.

The function of the Helio Courier as an aerial platform for covert surveillance was satisfactory. Since most covert surveillance performed by aircraft are at altitudes higher than those used for patrol assignments, the minimum altitude requirement did not present a great problem to the success of the surveillance mission. The major problem associated with use of the Helio Courier as well as other fixed-wing aircraft, in surveillance assignments, was found to be following a vehicle through a major metropolitan district such as Los Angeles. This type of area, with many high-rise structures, makes it difficult for the air crew to maintain visual contact with a vehicle, even though the S.T.O.L. aircraft is capable of sustained slow flight. When the progress of the target vehicle is impeded by traffic density or traffic control devices, the fixed-wing aircraft is forced to enter a turn to avoid getting ahead and losing sight of it. The multi-storied structures

then obstruct the view of the vehicle. Problems of this nature did not exhibit themselves during surveillance assignments conducted in other areas. Crew members reported the reduced field of vision from the Helio Courier, both to the front and sides, generally made the task of surveillance more difficult than if it were conducted from the helicopter.

The advantages of using the Helio Courier in surveillance activities are two-fold. First, the Helio Courier is capable of remaining airborne for six hours at the lower power settings utilized in surveillance assignments. This far exceeds the two and one-half hour maximum duration of the project helicopter. Secondly, the aircraft was rated by the air crews as being more comfortable than the helicopter, and the reduced fatigue factor permits utilization of the aircraft for the longer periods available.

The Helio Courier is an ideal airplane for assignments which require extended periods in the air, or long distances to be traveled. However, considering its inability to land and the minimum flight level of one thousand feet AGL, the Helio Courier, as a vehicle in direct support of ground units, is unable to provide the level of assistance that is attainable by helicopter.

Maule Rocket - Light Fixed-Wing

The Maule Rocket flew 818.1 hours during the operational period, which was 51% of the projected schedule of five flying hours per day, seven days each week. Of those days the aircraft flew, it experienced a daily average flight time of 4.0 hours, or 80% of that expected. This includes days when flight time was shortened by inclement weather or mechanical problems.. But not included were those periods the airplane was grounded the whole shift for mechanical or weather reasons.

The Maule Rocket suffered its greatest reduction in flight time when grounded for mechanical reasons, which resulted in 565.3 hours lost, or 35% of the anticipated schedule, the most experienced by any of the project aircraft. The second most frequent reason for the loss of flight time was inclement weather on the evening shift, which resulted in 111.4 hours lost, or 7%, and inclement weather on day shift further reduced the time by 104.0 hours, also 7%. As with the Helio Courier, the Maule Rocket was governed by the minimum altitude regulations of the Federal Aviation Administration, which decreased availability during marginal weather conditions.

The Maule Rocket was utilized in patrol functions and covert surveillances.

As a support vehicle for patrol operations, the Maule Rocket averaged 1.00 calls answered per flight hour. A partial reason for the lesser number of calls handled is the assignment of this aircraft to patrol services in the Antelope Valley Station area. Although the area is vast, its low population results in fewer requests for service, thereby offering less of an opportunity quantitatively to perform. The lower population density, however, permitted the aircraft to fly at lower altitudes while patrolling in the area, improving the quality of services performed. The lower altitude enabled the aircraft to respond to calls in remote areas rapidly and overfly the location low enough to, in most cases, accurately assess the situation and advise the ground units responding of the conditions. This response capability was able, on some occasions, to discontinue the response of ground units, with resultant savings in personnel time expended.

When consideration is given to the assignment of a fixed-wing mobility system in a rural area, a careful analysis of the police service needs should be reviewed. There is a point, which has not been identified, where an aerial patrol unit is not cost-effective in a patrol function, simply due to insufficient activities. The versatility of a helicopter patrol allows the cost-effective break-even point to be achieved with a lower number of police service needs, because the heli-

copter crew can perform the more mundane tasks usually handled by ground units, such as crime reports. With the fixed-wing mobility system's effectiveness limited, due to being, for practical purposes, unable to land except in emergencies, a larger number of service needs would be required to justify the expenditures necessary for a program.

The total number of observations, arrests, and citations per hour attributable to the Maule Rocket are 0.18 and 0.03 respectively. The observation capabilities of the Maule Rocket were superior to those of the other fixed wing utilized in the project by virtue of the modification performed on the right side of the aircraft.

The Maule Rocket was the only fixed-wing aircraft used in the project which was directly involved in the apprehension of criminal suspects. The occasion presented itself during patrol of normally unoccupied summer homes remote from frequent radio car patrol. The patrol crew observed two persons attempting to enter one of the buildings through a window. The air crew elected to land on a seldom used road in front of the location and take direct action, which resulted in the physical arrest of the two suspects. A ground unit responded to the location and took custody of the suspects for transportation. Discussion of this incident with the pilot of the aircraft revealed the road selected for the landing would have accommodated

nearly any light fixed-wing aircraft, whether of conventional or tricycle landing gear design.

The Maule Rocket was used on missions of covert surveillance and transportation, although the Maule does not have the load-carrying capability or the speed of the larger Helio Courier. The manufacturer's specifications reflect a speed comparable to that of the Helio Courier, however, the increased drag from the auxiliary equipment and oversized tires reduced the speed considerably.

The crew members who operated this aircraft reported conflict problems with private aircraft in the Los Angeles basin similar to those discussed in the evaluation of the Helio Courier.

Hughes 300 C Helicopter

Prior to the inception of this project, the Los Angeles County Sheriff's Department had within its complement of aerial support equipment, six Hughes 300 B Model helicopters. The changes between the 300 B and 300 C Models are relatively minor, and previous experience had shown it to be a very effective vehicle for use in support of ground units. The familiarity of the personnel with the equipment, and previously established procedures for its use, eliminated the necessity for extensive training in the Hughes 300 C for both air crews and ground personnel.

The Hughes 300 C flew a total of 1275.8 hours, the highest achieved by any of the aircraft involved in the project in the operational period, which was 80% of the expected schedule of five flying hours per day, seven days each week. Of those days the helicopter flew, it experienced an average of 4.6 hours, 92% of that expected. As with fixed wings, not included in the computation of daily flight time average are periods when the helicopter was grounded the entire shift for mechanical or weather reasons.

Again, we find the greatest reduction in flight time attributable to mechanical difficulties. These resulted in 223.3 flying hours lost, or 14% of the expected schedule, an amount less than that experienced by either of the other aircraft.

Additionally, the helicopter lost 102.7 hours of flying time, or 6%, due to inclement weather on the evening shift. However, no flight time was lost due to weather on day shift. The day shift weather figure is less significant when considered with the helicopter's assignment during the project. The helicopter was assigned to the evening shift nine of the ten operational months. The evening weather figure, however, is significant in that the fixed-wing airplanes operating in the same time frames experienced a total of 286.4 hours lost, over twice that of the helicopter.

The helicopter experienced an average of 1.43 calls handled per hour, which is less than that of the Helio Courier, but greater than that of other aircraft participating in the project.

The quality of service rendered by the helicopter in the patrol function was greater than that experienced by the other project aircraft, averaging 0.37 observations per hour, and 0.13 arrests and citations per hour.

The performance of the helicopter in patrol functions was most satisfactory, as was expected from previous experience. The helicopter participated in all types of called-for services, from a fly-over of a vehicular traffic stop to supervision of the pursuit of a fleeing suspect. Additionally, the project helicopter participated in some rescue work, air-lifting mountain rescue personnel to juveniles stranded on a sheer incline, and providing illumination while the subjects were assisted from their hazardous position. The helicopter, on several occasions during the operational period, landed to render direct assistance to persons or Deputies on the ground, a function which is not available when utilizing fixed-wing aircraft except in some remote areas.

The helicopter is the most productive vehicle for use in support of ground units. It is able to provide more assistance in the realm of officer safety, with the capability of landing, if needed. The landing capability is not only for the benefit of fellow Deputies. Several instances during the Project, the helicopter assisted citizens in distress when the closest ground unit's extended response time precluded an efficient solution to the problem.

In the role of covert surveillance, the helicopter performed well, with the only detraction the shorter flight duration of two and one-half hours as compared to six hours with the Helio Courier. Some surveillance activities, however, can be handled as well with fixed-wing airplanes at somewhat less cost.

Because of its short-range and smaller load capability, the helicopter is not a satisfactory vehicle for long distance transportation flights.

PERFORMANCE EVALUATION - AUXILIARY EQUIPMENT

"Locator" Light - Night Illumination Device

The "Locator" light was installed on each of the three project aircraft. As shipped from the manufacturer, the units are enclosed in a single case, with the power pack section protected by an aluminum cover and the reflector and bulb within a glass globe. The directional control of the reflector is operated by electrical servos.

From our past experience with lighting devices, both manual and remotely controlled, the preference of the Los Angeles County Sheriff's Department leaned strongly toward one with manually controlled beam direction. A manually controlled device has the advantage of allowing the operator to direct the beam during the warm-up period, rather than await the appearance of the light beam and then direct it to the area needed. The manually directed beam also allows more rapid movement of the light from one area to another. For these reasons, the standard "Locator" light was modified by separating the power pack from the light globe and mounting it in a convenient position on the aircraft. The light globe, within which is contained the sodium bulb and reflector, was mounted on the bottom of the aircraft, with a manual control handle substituted for the electrical servos. The lights in the fixed wing were installed with the control

handle protruding from the cabin floor between the front and rear seats. This allowed operation of the light from either location. The installation of the light on the helicopter was accomplished ahead of the observer's seat on the right side of the cockpit.

Operationally, the "Locator" light is activated by a remotely mounted switch on the instrument panel. The unit requires a 60 to 90 second warm-up period before full illumination is achieved. This was the most frequently mentioned complaint about the light. Frequently, a situation develops which requires immediate illumination, and the warm-up period is a definite disadvantage. In the area of availability of the light, another frequently mentioned complaint was the required cooling off period between uses. Once the light was activated, it was necessary to leave it on for a minimum of 90 seconds (shortly after the end of the Grant Project, the time was increased to three minutes). When turned off, the light had to remain off for 60 seconds before re-ignition. If an attempt was made to re-light the unit before the cooling-off period was complete, the time remaining in the cooling cycle was added to the warm-up.

The "Locator" light, when used from the helicopter, provided excellent illumination. The area covered ranged from approxi-

mately 75 feet in diameter, when used at 300 feet above the ground, to approximately 150 feet in diameter when used at 500 feet.

When used from the fixed-wing airplanes, from their altitude of 1000 feet above the ground, the amount of illumination provided was unsatisfactory from the standpoint of the air crews. The ground crews reported, however, that the amount of light which reached the ground did assist them. It would appear the reason the ground crews had fewer derogatory comments about the light is the difference in primary goals of the ground and air crews. The primary goal of the ground crew is to handle whatever police service needs they are concerned with at the time. The air crew considers its primary goal the assistance it can render to the ground unit, and they are frustrated if the illumination device they are using is not adequate to allow them to accomplish that goal. The ground crews view the light as some assistance, more than they would have had if no aircraft were present, and therefore rate its illumination capabilities higher than does the aircrew.

One last comment regarding the "Locator" light is that relating to the bulb life. The manufacturer advertised a bulb life of thirty hours. The bulb life experienced by the Aero Bureau averaged approximately ten hours. Although the manufacturer

replaced defective bulbs on a warranty adjustment, the frequent bulb replacement and time lost from service was a considerable annoyance.

Public Address System

The operation of the "Penetrator" public address/siren system was most satisfactory, with no unusual maintenance problems experienced. It was found, as previous experience with the unit had shown, that the unit was able to project clearly the voice inputs when utilized from the project helicopter. Operation of the P.A. system from the airplanes, however, was less satisfactory because of the altitude limitations of those aircraft. The system was unable to amplify the inputs sufficiently to allow a clear understanding from the ground.

In the development of an aerial patrol program, selection of a public address system should be governed by the anticipated altitudes to be flown. For consistent operation in the area of 1000 feet above the ground or higher, a more powerful P.A. system should be considered, however, the "Penetrator" is a very satisfactory unit at lower altitudes.

Radio Mixer Panel

The Carter Engineering radio mixer panel operated very well in each of the three project aircraft. Not once during the program was a bad comment received from a crew member regarding its operation. As the unit is essentially a switching device, there are several possible places where malfunctions could occur; however, none were experienced.

The successful use of the Carter mixer panel in the S.T.O.L. Project has led to the inclusion of this item in other aircraft utilized by this Department.

Stopwatches

The stopwatches purchased for response time studies during the operational phase of the project received limited use. Several factors influenced the utilization of these items.

Both air and ground crews reported the operation of the stopwatch detracted from their performance by engaging them in a distracting activity at crucial times. The independent evaluation team did not feel that data relative to response times needed the accuracy afforded by equipment capable of measuring to one-fifth of a second. And the data recording system of punch cards was unable to accept entries of less than whole minutes, or zero.

Consequently, the stopwatches were seldom used and response time information was obtained from the crew members' personal watch, or from the panel clock in the aircraft.

No mechanical difficulties were experienced with the stopwatches.

Mark 1610 Stabilized Binoculars

The stabilized binoculars were evaluated from both the fixed-wing airplanes and the project helicopter. The device operated most satisfactorily from the mechanical aspect. Operationally, a few drawbacks were encountered which were a deterrent to its successful use.

The bulk of the unit, which is approximately 14 inches long and weighs approximately 7 pounds, induces a fatigue factor after a few minutes of use. The usefulness of the unit is also restricted by the close confines of an aircraft cockpit. Two other factors distracted from the overall satisfactory performance of the unit. First, while using the device when the aircraft is in a turn, the gyroscopic stabilizing device tends to process or tumble, causing the operator to lose sight of the target. Secondly, from altitudes higher than 1500 feet above the ground, operators experienced difficulty transferring from the unaided eye to the binocular and maintaining watch of a point of the ground.

Aside from these listed difficulties, the overall operation of the unit was satisfactory. An operator who was experienced with the device was able to successfully follow a vehicle a distance of approximately 45 miles over freeways and surface

streets and report the vehicle's progress to following ground vehicles by reading the freeway signs and reporting landmarks which were observable in the perimeter of view, all the while maintaining an altitude of at least 2000 feet above the ground and a distance approximately 1/2 mile behind the target vehicle.

The Mark 1610 gyroscopically-stabilized binocular is a useful tool for both patrol operations and surveillance activities, when used by an experienced operator.

Bureau personnel had been told that usage of standard or stabilized binoculars could cause some nausea or spatial disorientation. However, through the course of the project, no one reported experiencing any motion sickness or related discomfort while utilizing this equipment.

Stabilized Platforms

The two stabilizing devices obtained for evaluation during the Grant Project were the KS-E and KS-6. They performed well during the test period. Most personnel who utilized the equipment reported it to be easier to use than the larger stabilized binoculars. The devices attach to standard hand-held binoculars by means of an adaptor, which mounts on the hinge pin. Power is supplied through an inverter, which is wired into the electrical system of the aircraft. Both 12 and 24-volt inverters are available. When activated, the gyroscopic stabilizers cause the binoculars, to which they are attached, to give a floating sensation when held lightly in the hand. This action dampens out the normal aircraft vibrations. The observation capabilities are governed by the type of binoculars to which the platforms are attached. The capability of attaching these devices to photographic equipment increases their overall usefulness to a law enforcement agency. Being less expensive, smaller, and less cumbersome than most stabilized platforms or stabilized binoculars, the KS-E and KS-6 devices should be considered when selecting this type of auxiliary equipment.

Robertson S.T.O.L. Kit

Installation of the Robertson S.T.O.L. Kit was accomplished on the Cessna 182, which was substituted for the project airplanes during the last half of the operational phase of the study.

The modification decreased the take-off and landing distances. However, this improved capability served no real purpose to the patrol needs. It was found that patrol could be effectively flown at 65 MPH, a 5 MPH advantage over the unmodified version that was utilized at 70 MPH. At approximately 63 MPH, indicated the adjustable air vents, when open, set up a loud howl that was not only annoying, but interfered with communications. The stall characteristics are considerably different with the S.T.O.L. Kit. However, once these differences are experienced, there is little problem in recovery. Over-all, no real advantage to patrol efforts were derived from the installation of the Robertson S.T.O.L. Kit.

Century III Auto Pilot

The addition of an auto pilot to the equipment in the Helio Courier was performed to evaluate its function in police service activities. In a patrol function, the auto pilot is capable of flying an orbit around a point on the ground, in a no-wind condition, without control inputs by the pilot. This, coupled with unit's capability of maintaining a constant altitude, reduces the pilot workload and allows him more time to watch for conflicting air traffic. In a surveillance, or transportation role, the unit again reduces the pilot workload by assisting in navigation and holding altitude. As a piece of hardware for use in law enforcement services, it is desirable from an operational standpoint, but not necessary for a successful aerial program.

Probeye - Infrared Viewer

The Probeye, manufactured by Hughes Tool Company, Palomar, California, is a self-contained, hand-held viewing device which responds to the varying amounts of heat emitted by all objects and transforms these inputs into a visual image which is viewed through a single eyepiece.

The device was found to work extremely well in both patrol and search functions. The capability of the device to distinguish persons at night without the use of the illumination device is beneficial and improves ground personnel safety. Additionally, the device can differentiate between automobiles which have recently been driven and those which have been parked for some time. This capability is useful when conducting a special patrol for specific offenses, such as burglary prevention. An air unit can over-fly an industrial area at night and report recently driven vehicles to ground units for further investigation of possible criminal activity.

The Probeye has two drawbacks to an otherwise outstanding operation. The device cannot operate through plexiglass, which precludes its operation from an air unit which does not have removable doors or windows. Also, the unit requires cooling

which is provided by a small, pressurized bottle of argon gas. Each time the gas bottle is turned on, the gas enters the unit to initially cool it to operational temperature. The amount of gas necessary to cool the device is equal to twenty minutes of operation. Thus, frequent on-off operation of the cooling gas will use up the available four-hour supply.

The Probeye is an extremely valuable device for increasing the usefulness of an aerial support team.

NON-OPERATIONAL PROBLEMS ENCOUNTERED

The majority of problems encountered during the operational phase of the project were of a mechanical nature, however, a few non-operational problems were experienced which warrant discussion.

Problems were experienced in the area of equipment acquisition, both administrative in nature and in the realm of availability. The structure of the Los Angeles County government, with its checks and balances, is not conducive to a rapid flow of the paper work necessary when dealing with expenditures of the size required for the project. Likewise, delays were experienced obtaining approvals for various contract modifications from the State and Federal agencies involved. These problems will be experienced in any governmental agency and for all practical purposes, they are unavoidable. The availability problems were largely those of bad timing. The Helio Courier factory, being in military production, and tooling distruction at the Piper factory were unfortunate.

The first set of bids returned on the light fixed wing were unacceptable, and the bid process had to be duplicated with its attendant delays. Each of these problems, which prolonged the equipment acquisition phase of the project were unavoidable.

CONTINUED

2 OF 3

Problems were experienced in the area of parts availability for the fixed-wing aircraft. The unavailability of a replacement Franklin Engine, delays for other engine accessories for the Maule Rocket, and delays experienced with replacement blades for the Helio Courier propeller might have been avoided had the project airplanes been purchased from a manufacturer with greater parts and service capabilities. Parts and service availability should be of concern when initiating or expanding an aerial support problem.

EVALUATION

Measures of Effectiveness

Early in the operational phase of the project, at the monthly meetings held between representatives of the Los Angeles Sheriff's Department and the independent evaluation team, measures of effectiveness were developed. Because of the vast amount of data available for analysis with the aircraft scheduled to fly each day for ten months, the decision was made to forego development of scenarios and simulation models for use in measuring the effectiveness of the various mobility systems. Computer analysis of the data recorded on the daily work sheets submitted by air and ground crews was felt to provide a sufficient data base with which to evaluate the project. The measures of effectiveness upon which the evaluation of the project rested included: average response time; number of activities handled; and the quality of service rendered. An additional measure considered was the degree of personal safety provided ground personnel by the various aircraft.

The evaluators were provided duplicate punch cards upon which had been recorded information relative to the response time and quality of service rendered. One card was provided for each activity. The data which evaluated the quality of the

event was obtained by requiring the crews, both air and ground, to respond to a multiple choice questionnaire and include these answers in the portion of the daily work sheet which was key punched for tabulation.

Of the five questions answered by the air crews, four dealt with the performance of the aircraft itself and the last was related to the performance of the night illumination device.

The ground units responded to questions dealing with the type of aircraft which assisted them, the quality of assistance, and communications with the aircrew. Samples of the questionnaires listing the specific questions and answers may be found at the end of this section.

The resultant analysis of these questions was performed by the evaluation team and is included in their report, which may be found in the appendix.

The evaluators conducted personal interviews of air and ground crews participating in the project. These interviews, coupled with several questionnaires which were completed at various times during the project, allowed the evaluators an insight into personal opinions held by the crews, those held previously as well as those acquired during the project.

The analysis of these interviews and questionnaires is also included in the evaluator's report.

Those measures applied by the Los Angeles Sheriff's Department Aero Bureau to the effectiveness of the various aircraft were: the amount of flight time acquired during the project by each aircraft; those times the aircraft were unable to fly and the reasons therefore; the number of called-for services to which they responded; the number of observations made by the aircrew, and, finally, the number of arrests and traffic citations which were directly attributable to aircrew participation.

The data analyzed by the Aero Bureau was retrieved by a daily examination of the work sheets submitted by the air crews. Data was recorded on statistical forms developed for that purpose.

GROUND UNIT SPECIAL PROJECT QUESTIONNAIRE

A. Type of aerial assistance requested by radio car.

0 - None
1 - Helicopter
2 - Fixed-Wing
3 - Either fixed-wing or helicopter (no preference)

B. Type of aerial equipment which responded.

0 - None
1 - Helicopter
2 - Fixed-Wing
3 - Unknown (Not sure whether helicopter or fixed-wing)

C. Deputy's evaluation of aerial assistance.

0 - Not helpful/not applicable
1 - Helpful to mission-accomplishment
2 - Helpful to Deputy safety/survival
3 - Critical to mission-accomplishment
4 - Critical to Deputy safety/survival
5 - Detrimental to mission
6 - Value of assistance unknown

D. Reasons for requesting or not requesting aerial assist.

0 - No assistance needed
1 - Aircraft known to be unavailable
2 - Incident minor or gone prior to arrival
3 - Aircraft would have been detrimental to mission
4 - Aircraft may have been helpful/but no time to request
5 - Aircraft requested for obs. or possible containment
6 - Aircraft requested - pursuit
7 - Aircraft requested - due to its faster response time
8 - Aircraft requested for officer safety
9 - Aircraft requested for search and rescue

E. Direct radio contact between aero and ground unit

0 - No direct contact/not required
1 - No direct contact/Deputy away from radio
2 - Direct contact/minor (for acknowledgement only)
3 - Direct contact/observation information
4 - Direct contact/aircraft directed ground units

AIR CREW EVALUATION QUESTIONNAIRE

Question #1:

The aircraft
1. response could better be accomplished by other aircraft.
2. did not arrive in time to render assistance.
3. arrival time was adequate.
4. arrival made it possible to contain the location until ground units arrived.

Question #2:

The aircraft
1. assistance was minimal and could better be accomplished by other aircraft.
2. supplied light or P.A. only.
3. supplied needed communications and aerial intelligence.
4. was indirectly or directly responsible for suspect apprehension.
5. was indirectly or directly responsible for officer's safety.
6. played an integral part in preserving life and property by landing to render assistance.

Question #3:

What would have most improved the effectiveness of the aircraft assistance on this call or detail?
0. No improvement necessary.
1. Higher altitude.
2. Lower altitude.
3. Other aircraft assistance.
4. Faster helicopter model.
5. Ability to land and assist.
6. Radio communications prior to arrival.
7. Deployment and/or coordination of ground units.
8. Brighter light.
9. Other (specify on half sheet memo).

Question #4:

The aircraft
1. incurred no safety hazard.
2. did have an emergency landing place available.
3. numerous aircraft in the area did not interfere with our operations.
4. did not have an emergency landing place available.
5. was unable to safely perform due to numerous aircraft in the area.

Question #5:

The light
0. none needed/used
1. light was ineffective for aerial observation
2. light was effective for aerial observation
3. light was ineffective due to poor visibility.
4. unable to clearly depict ground personnel and assist due to poor visibility.
5. visibility did not impair performance.

Public Acceptance

Public relations is an important consideration for any law enforcement agency. The S.T.O.L. Project was initiated with a press conference conducted by Sheriff Peter J. Pitchess. The resultant newspaper articles and local television coverage was disseminated throughout the area to be patrolled. After the first week of the operational phase, it was apparent that not all residents and businessmen in the patrol area had knowledge of the project. The Industry Station telephone switchboard operator and desk personnel received frequent calls during the first months of the program. Most of the calls received were inquisitive in nature and after a brief explanation of the program, the caller expressed a positive reaction to the presence of a police aircraft in the area.

A few callers with noise or invasion of privacy complaints were satisfied after personal contact by supervisory level personnel of the Sheriff's Station. After personal contacts, there were no complainants who failed to accept the minor personal inconvenience which they perceived for the improved police service available to them with an aerial support program. The opinion expressed by a citizen at a neighborhood community meeting, to which a representative of the Aero Bureau had been invited to speak, was that the noise of the patrolling air-

craft probably provided some measure of crime deterrent in and of itself.

One significant aspect of the complaints received in relationship to type of aircraft was observed. In the Industry Station area, the area previously unpatrolled by aircraft, no complaints were received relative to the operation of the airplanes. All the complaints received pertained to the operation of the helicopter. However, when the airplanes were moved and began patrolling in the area which previously had been, and currently was patrolled by helicopters, the concerned Sheriff's Station received complaints about the noise produced by the airplanes, but no calls were received about the noise of the helicopter.

FINDINGS

The Los Angeles County Sheriff's Department has concluded, from the standpoint of cost-effectiveness, that the only satisfactory aerial-support vehicle for use in patrol activities which directly support ground units is a helicopter. Although fixed-wing mobility systems may be operated at a lower cost, their effectiveness is compromised by regulated minimum flight altitudes and operational limitations. Helicopters provide a greater degree of safety to ground personnel, with a greater psychological influence, better observation capabilities, and the ability to land in confined areas and render direct assistance when necessary. Although the airplanes were operated at lower altitudes in the sparsely populated regions of the Antelope Valley, it was found that there were insufficient requests for service to effectively utilize this potential. The experience of the Sheriff's Department with the existing helicopter patrol in this area is to use the helicopter to handle service requests in the same manner as does a ground unit. The existing patrol routinely lands to handle all varieties of police activity, including taking crime reports. This capability is not available when using fixed-wing equipment and the lower operating cost is offset by virtue of the fact that each discovery requires a ground unit to respond to the location and handle the incident. Landings can be made by the fixed wings in these

remote areas, of course, but to land in other than emergency situations unnecessarily exposes the crew to a high-risk factor. Fixed-wing patrol functions in metropolitan areas, such as the Los Angeles basin, also encounter difficulties with air pollutants which reduce visibility. When flying toward the sun on hazy or smoggy days, the two visibility factors compound one another, reducing visibility to a level unacceptable for safe flight operations. During night patrol, when pollutants are present in the air, the use of the light is also affected. The light, upon striking the haze, bounces back, allowing less light through to the ground and reducing the observation abilities of the air crew. These problems are also experienced by crew members of helicopter patrols; however, because of their lower altitude, the difficulties are much less and generally do not compromise their effectiveness.

The utilization of fixed-wing aircraft in an aerial support program can be beneficial in the areas of traffic control over major highways, surveillance activities in other than metropolitan areas, and transportation of Departmental personnel and prisoners over long distances. Unless a specific need exists for S.T.O.L. performance, the higher costs necessary to obtain and maintain an airplane in the S.T.O.L. class

is not justifiable. Operationally, the differences between airplanes in the S.T.O.L. class and those classified as light fixed-wing are insignificant with respect to police activities, the only difference experienced being that of take-off and landing capabilities.

RECOMMENDATIONS

When considering the question of further study in the area of police service patrol by aerial mobility systems, it would be unjustified to expend the funds necessary to duplicate the type of project now completed. Continued study would be justified if there was a significant change in the type of airplane to be tested, or in optical devices to improve the observation capabilities from a fixed-wing platform. A new study conducted with the currently available equipment would be justified if provisions for a minimum altitude waiver could be obtained from the Federal Aviation Administration allowing the fixed-wing aircraft to be flown at 500 to 700 feet above the ground. The possibilities of an altitude waiver, however, are remote due to safety considerations.

A study which warrants consideration would be the comparison of a turbine-powered helicopter with one of reciprocal engine power. One of the measures of effectiveness during the S.T.O.L. Project, response time to called-for services, was a major consideration in the evaluation of the mobility systems. It would be difficult to imagine that the project helicopter would perform as well as the project airplanes in this area with its 33% lower maximum speed. Had a turbine

helicopter been utilized in the S.T.O.L. Project in place of the Hughes 300 C, a more significant comparison of response times could have been made.

CHAPTER VI

COST EFFECTIVENESS EVALUATION

Cost Analysis

The analysis of the cost effectiveness of each of the project aircraft was established by applying the various activities handled to the hourly cost factors. Not considered in these computations were indirect operating costs such as overhead, insurance, depreciation, and salaries, as these will vary greatly between agencies. Only direct operating costs such as fuel, oil, parts, and labor were used, as these should remain nearly constant with only slight variations in different geographical areas.

The hourly operational costs are listed below by aircraft.

Helio Courier	$18.99
Maule Rocket	17.86
Hughes 300 C	20.50
Cessna 182	10.65

The average number of activities handled per flight hour (both called-for services and observations) by aircraft are listed below and applied to the previously listed operational costs.

Aircraft	Average No. Activities Per Hour	Cost Per Activity
Helio Courier	1.74	$10.91
Maule Rocket	1.19	15.00
Hughes 300 C	1.80	11.39
Cessna 182	1.37	7.77

The reader should note that these figures do not apply to the amount of time required for an aircraft to handle an activity, but rather the number of activities handled per hour. The aircraft may have required five minutes or less to handle an activity, with the remainder of the time spent in patrol activities.

As discussed in the performance evaluations of the project aircraft, the airplanes suffered a performance or effectiveness penalty due to their regulated minimum altitude. One measure of the observation capabilities applied to the project aircraft was what percentage of the total activities handled were observations by the air crews.

The Helio Courier handled a total of 1551 activities, both calls and observations during the Project. Of those, 187 or 12% were observations which were initiated from the airplane.

The Maule Rocket handled 975 activities, of which 151 or 15% were observations.

The Cessna 182 handled 249 activities, with 43 or 17% observations.

Finally, the Hughes 300 C, the project helicopter, handled 2302 activities, with 473 or 21% air crew observations.

Analysis of the above information shows that the helicopter experienced the greatest percentage of observations. The Cessna, Maule Rocket, and Helio Courier then follow in descending order. Although the Cessna experienced the greatest percentage of observations made by the airplanes, the limited data base make its observation percentage less reliable than that of the other airplanes. The Maule Rocket, with its greater field of view due to the door modification, experienced a greater percentage of observations than did the Helio Courier.

Another measure which shows the effectiveness of the various aircraft is that percentage of activities handled by aircraft which result in arrests directly attributable to participation of the aircrew.

The Helio Courier participated in 54 arrests, which was 3.5% of the total activities handled. The Cessna participation resulted in 7 arrests or 2.4% of the total activities. The project helicopter had 165 arrests, which was 7.2% of the total activities.

The arrest data shows the helicopter far superior to the airplane in that category, with more than a 100% improvement over

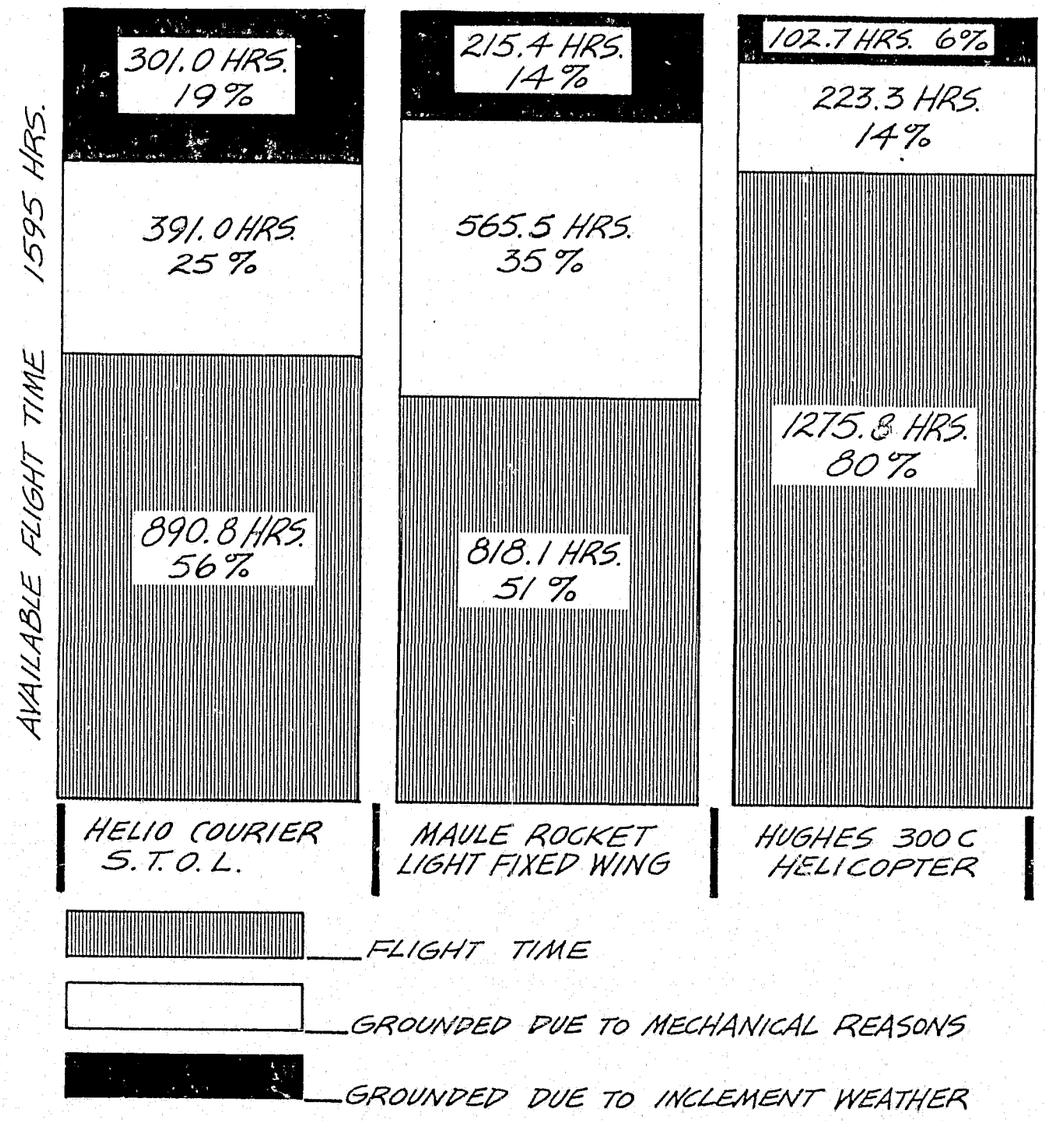
the most effective airplane.

A more comprehensive analysis of cost effectiveness is presented in the evaluator's final report. Comparison of the data presented here with that presented in the evaluator's report reveals some disparity in total number of activities and per hour averages, although general trends remain constant. These differences resulted from two variables. The evaluation team collected their data from punch cards. Data entered in the special projects column of the Deputy's daily work log was the identifier used for sorting the cards. If, through neglect or misunderstanding of procedures, no entry was made in this column, the activity would not be reflected in the statistics presented by the evaluators. Conversely, the information presented here was drawn from daily examination of the work logs without regard for the status of the special projects column.

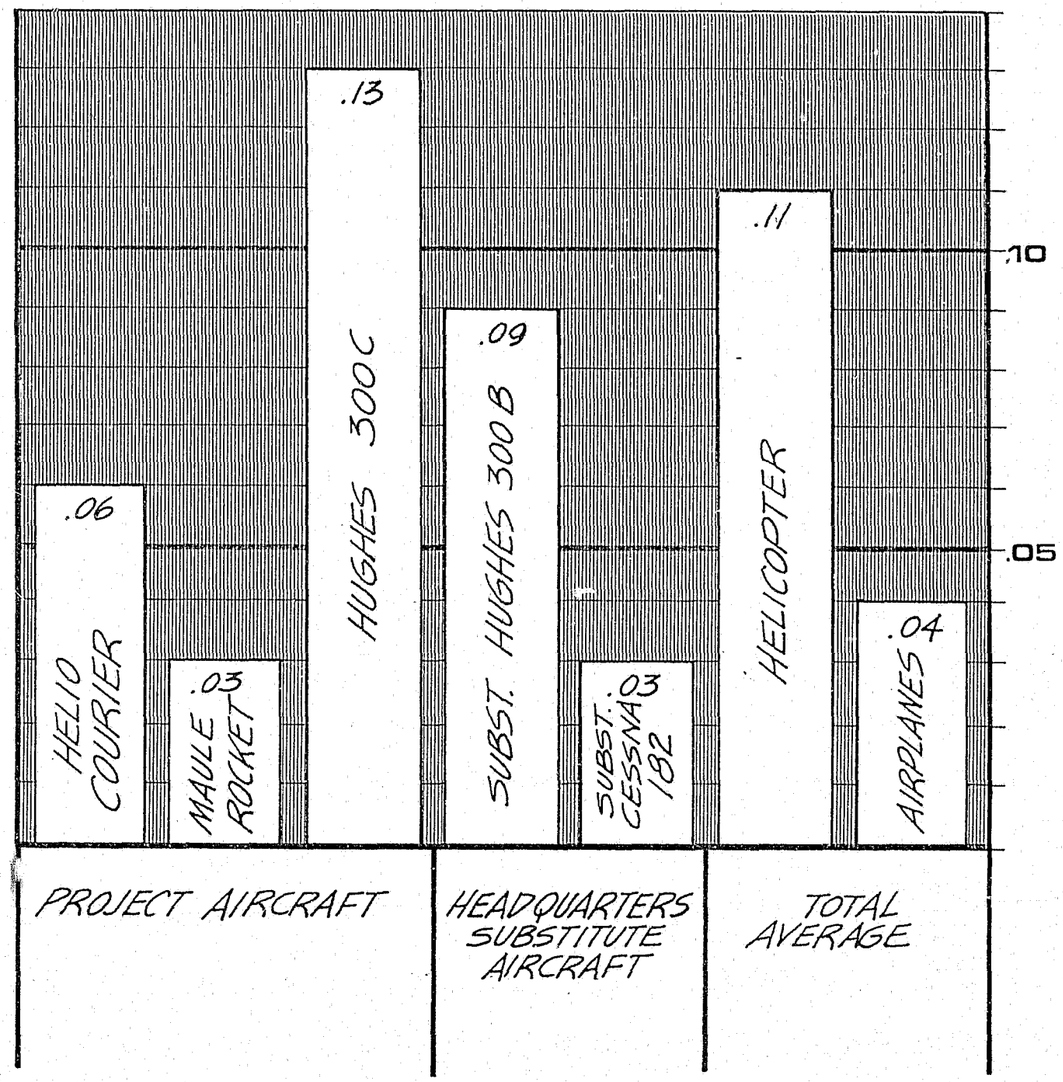
Secondly, some of the data presented in the evaluator's final report has combined totals for the project helicopter and those Departmental helicopters substituted during the operational phase. Substitute helicopter information in this section of the report is presented separately.

From the data reviewed by the Sheriff's Aero Bureau, it is concluded that the cost effectiveness of the helicopter in a patrol function is much greater than that of the airplanes.

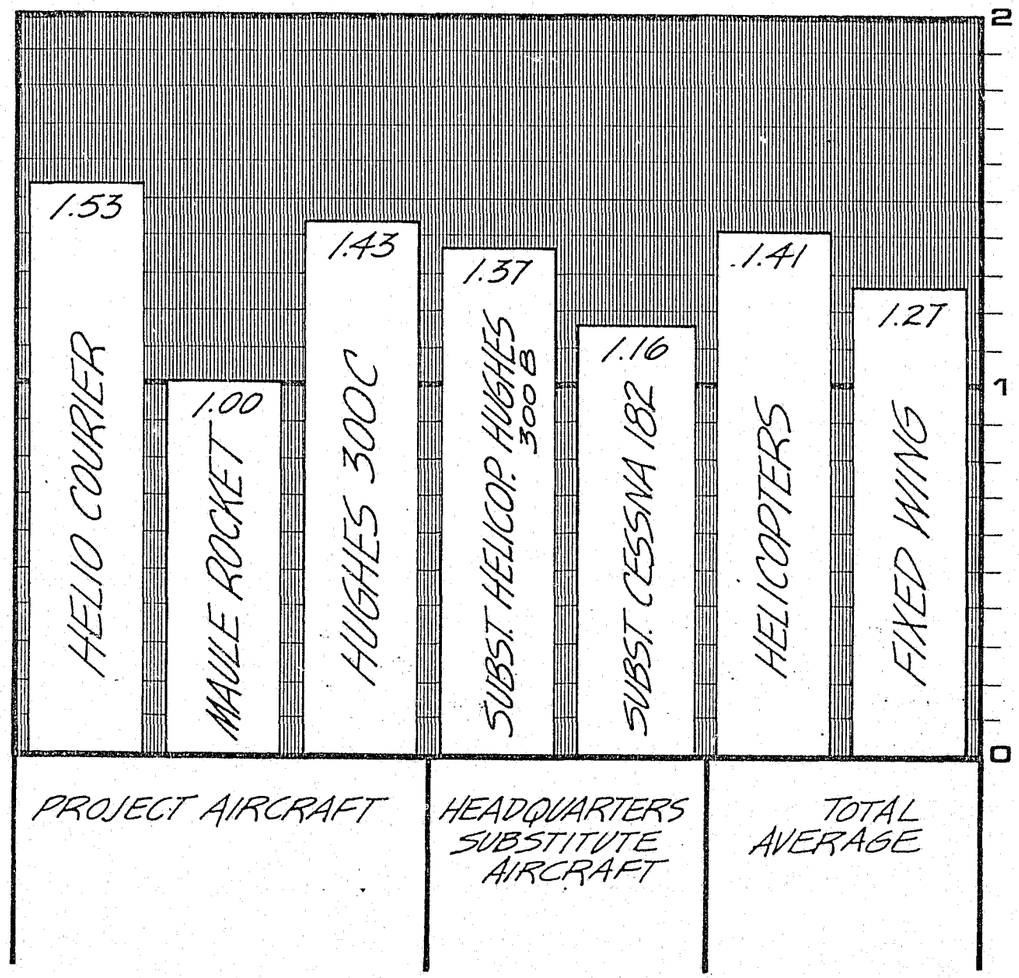
FLIGHT TIME ACCRUED BY AIRCRAFT



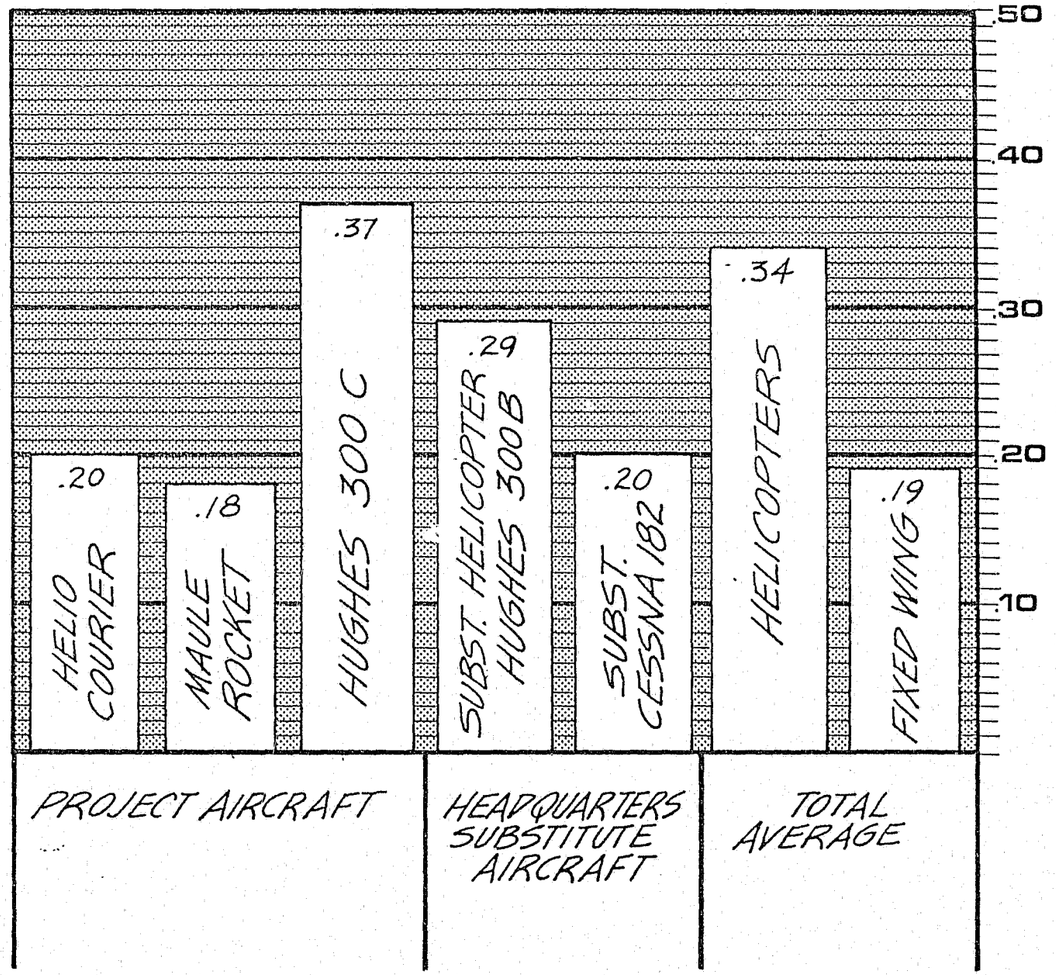
AVERAGE NUMBER OF ARRESTS AND CITATIONS PER FLIGHT HOUR BY AIRCRAFT



AVERAGE NUMBER OF CALLS PER FLIGHT HOUR BY AIRCRAFT



AVERAGE NUMBER OF OBSERVATIONS PER FLIGHT HOUR BY AIRCRAFT



CHAPTER VII

SUMMARY OF COSTS

EXPECTED

It was anticipated that the cost structure would be in line with our program proposal. The total grant award of $353,925 was broken up into five categories. Allocated to personnel salaries, overtime, and benefits was $34,350. It was expected that the personnel would expend $1,040 for travel, and grant-funded operating costs were originally estimated at $71,680. It was also expected that equipment costs would be $195,355, and consultant costs were anticipated to be $51,500.

The match requirement totalling $307,305 was divided between Personal Services, $269,408, and additional operating expenses, $37,897.

EXPERIENCED

Project expenses experienced during the operation period approximated the anticipated budgetary allocations. Grant-funded personnel expenditures ran approximately 6% under the original allocation. Matching funds for personnel expenses, however, were completely expended. Travel expenses were in line with the anticipated amount, as were Consultant Service expenditures.

Equipment costs fell 2% short of the original allotment, a

savings of $3940. Grant and match-funded operating expenses both fell well below the original allocation. A savings of 22% was realized with relation to grant-funded expenses and a 3% savings occurred relative to match-funded expenses.

Overall, grant funds which were not expended amounted to $22,391, a savings of $22,391. Match funds not spent totalled $1,115. Therefore, the total project cost was $637,724, 3.55% under the original estimate.

CHAPTER VIII

RELATED DATA

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Overall, grant funds which were not expended amounted to $22,391, a savings of $22,391. Match funds not spent totalled $1,115. Therefore, the total project cost was $637,724, 3.55% under the original estimate.

PROJECT ADMINISTRATION

Peter J. Pitchess, Sheriff of Los Angeles County, was the Director of the S.T.O.L. Light Fixed-Wing/Cost Effectiveness Study. Inspector Richard T. Freeman was selected as project coordinator, as the Aero Bureau was within the parameters of his supervisory responsibilities. The Project Manager was the Operations Lieutenant of the Aero Bureau, who commanded one supervising Sergeant pilot, four Deputy pilots, and five Deputy observers.

Operational decisions were made at monthly meetings between the project coordinator, project manager, the evaluation team, Captains of each station in which the project aircraft operated, representatives of the Sheriff's Department Grant Management Unit, and the Management Staff Services Bureau (the unit responsible for tabulation of the data from the Deputies' work logs).

Budgetary recommendations made by the Project Director, Sheriff Pitchess, were approved by the Los Angeles County Board of Supervisors.

One additional mechanic was added to the maintenance staff of the Aero Bureau to maintain the project aircraft. Additionally, the time expended by other mechanics was funded through Grant monies.

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Overall, grant funds which were not expended amounted to $22,391, a savings of $22,391. Match funds not spent totalled $1,115. Therefore, the total project cost was $637,724, 3.55% under the original estimate.

CONTRACTORS' PERFORMANCE

Public Systems Incorporated and Justice Research Association contracted with Los Angeles County to evaluate the data produced from the operational phase of the S.T.O.L. Project. The evaluation team members, during the operational period, conducted monthly meetings with representatives of the Los Angeles County Sheriff's Department wherein measures of effectiveness were established, and scheduling and other operational decisions were made. The participation during this period by the evaluators was excellent, with considerable time and effort expended toward accomplishment of project goals.

The evaluation team, however, did not produce their required periodic reports on schedule. Only one quarterly report was submitted and the interim and final reports were not completed or presented on schedule.

DISPOSITION OF EQUIPMENT

All equipment acquired by the Los Angeles County Sheriff's Department through the S.T.O.L. Grant Project is being maintained and operated in furtherance of law enforcement goals. A complete list of the equipment may be reviewed in the accompanying inventory, however, a list of the aircraft and their current assignments appears below.

The Helio Courier is being utilized in a transportation capacity, transporting Department personnel and prisoners within the State of California.

The Maule Rocket aircraft is being used as a back-up for the Helio Courier and in a surveillance vehicle capacity.

The Hughes 300 C has become an addition to the fleet of helicopters maintained by Los Angeles County Sheriff's Department for general law enforcement services.

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7-31-74
Inventory Da

EQUIPMENT INVENTORY

CCCJ Project No. D3145 Grant Title S.T.O.L., Fixed-wing, Rotary-wing, Cost/Effectiveness Study

Item	Description/Serial No.	Qty	Unit Cost	Where & When Purchased	Present Loc.	Ultimate Disposition
WATCH	Part No. 603101, 1/5 Sec, 7 jeweles, pin lever movement, 60 60 sec. dial.	24	$ 9.75 ea.	Feldman Watch Co. 9000 W. Pico Blvd. L.A., Cal. 90035 Received 10-10-72	Aero Bureau	
BINOCULAR	Stabilized image, Mark 1610 w/case, lo or 20 Power, 50 MM objective, Mark Systems Inc. 10950 N. Tantau Ave., Cupertino Calif., 95014, Ser. #410 & #413	2	$4,475 ea.	F. Morton Pitt Co. 1444 So. San Gabriel San Gabriel, Cal. 90766 Received: 9-28-72	Aero Bureau	
HELICOPTER	Hughes 269C Helicopter Ser. #0164 Reg. #N-8961F	1	$45,864	Hughes Tool Co. Aircraft Division Culver City, Ca. 90230 Received: 1-5-73	Aero Bureau	
HELIO-COURIER	Helio-Courier H-295 No. 1440-S.T.O.L., Reg. #N-6485V	1	$50,925	Munro Lyeth Jr. D.B.A. Moline Aviation 252 Santa Rosa Lane Santa Barbara, Cal. 93108 Received: 2-13-73	Aero Bureau	

"I certify that the above inventory was made on July 31, 1974 and reflects a true and current accounting of the property assigned to this grant."

Donald G. Lummus
Project Manager

7-31-74
Inventory

EQUIPMENT INVENTORY

CCJ Project No. D3145 Grant Title S.T.O.L., Fixed-wing, Cost/Effectiveness Study, #D3145

Item	Description Serial No.	Qty	Unit Cost	Where & When Purchased	Present Loc.	Ultimate Disposit
MAULE	Maule M-4-220 Ser. #2151C S.T.O.L. Reg. #N-40633	1	$24,137.73	Maule Aircraft Costa Mesa, Ca. 92627 Received: 4-10-73	Aero Bureau	
RADIOS	Carter CE 604A ICS Dual & Radio Control Systems Ser. #47364,.47365	2	$ 995.00 each	Carter Engineering Corp. 232 Glasgow Ave Inglewood, Ca. 90301 Received: 4-9-73	Aero Bureau Installed in A/C #N-40633 & N6485V	
SEARCH-LIGHT	Model B locator searchlight complete w/unwelded saddle and wiring, tube assy., Hardware, and remote handle. S/N KB 00116	1	$ 2,840.00	F. Morton Pitt Co. 1444 S. San Gabriel San Gabriel, CA. 91776 Received: 4-27-73	Aero Bureau Installed on A/C #N8961F	
SEARCH-LIGHT	Model A locator searchlight complete w/unwelded saddle and wiring, tube assy., Hardware, and remote handle. S/N KB 00118, KB 12200.	2	$ 2,840.00	F. Morton Pitt Co. 1444 S. San Gabriel San Gabriel, CA. 91776 Received: 4-27-73	Aero Bureau Installed on A/C N6485V & N40633	

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Donald C. Lowney
Project Manager

EQUIPMENT INVENTORY

CCJ Project No. D3145 Grant Title S.T.O.L., Fixed-wing, Rotary-wing, Cost/Effectiveness Study

Item	Description Serial No.	Qty	Unit Cost	Where & When Purchased	Present Loc.	Ultimate Disposition
STABILIZER	KS-E Stabilizer - Ser # 4613E 14 with inverter #4613E14/I	1	$385.00	KEN-LAB Inc. Old Lyme, Conn. Received: June 13, 1974	Aero Bureau	
STABILIZER	KS-6 Stabilizer - Ser # 46136 54 with inverter #4613110	1	$1,114.50	KEN-LAB Inc. Old Lyme, Conn. Received: June 13, 1974	Aero Bureau	
INVERTER	KI-24/28-6 Inverter Ser # 46130C1	1	$105.00	KEN-LAB Inc. Old Lyme, Conn. Received: June 13, 1974	Aero Bureau	
S.T.O.L. KIT	Robertson S.T.O.L. Modification	1	$4,830.00	Gunnell Aviation Inc. 3000 Airport Ave. Santa Monica, Calif. July 15, 1974	Aero Bureau Cessna N3718D	
AUTO PILOT	Automatic Pilot Device with necessary control connections	1	$7,515.00	Aero - Spec. 240 N. Dale Ave. Fullerton, Ca. July 24, 1974	Aero Bureau Installed on Helio Courier N6485V	
HEAT SENSING	Probeye Heat Sensing Optical Device Ser #'s 1008 and 1012	2	$3,575.00	Hughes Aircraft Co. Industrial Prod. Div. 6855 El Camino Real Carlsbad, Calif. July 26, 1974	Aero Bureau	

"I certify that the above inventory was made on July 31, 1974 and reflects a true and current accounting of the property assigned to this grant."

Donald G. Lowney
Project Manager

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