WASHINGTON OPERATIONS

PRELIMINARY POLICE PATROL AIRCRAFT REQUIREMENTS ANALYSIS

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Equipment Systems Improvement Program Report
prepared for

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LAW ENFORCEMENT ASSISTANCE ADMINISTRATION
NATIONAL INSTITUTE OF LAW ENFORCEMENT
AND CRIMINAL JUSTICE

MITRE

THE EQUIPMENT SYSTEMS IMPROVEMENT PROGRAM

Following a Congressional mandate* to develop new and improved techniques and equipment to strengthen law enforcement and criminal justice, the National Institute of Law Enforcement and Criminal Justice under the Law Enforcement Assistance Administration of the Department of Justice established the Equipment Systems Improvement Program. The objectives of the Program are to determine the priority needs of the criminal justice community to help in its fight against crime, and to mobilize industry to satisfy these needs. A close working relationship is maintained with operating agencies of the criminal justice community by assigning systems analysts to work directly within the operational departments of police, courts and corrections to conduct studies related to their operational objectives.

This document is a research report from this analytical effort. It is a product of studies performed by systems analysts of the MITRE Corporation, a not-for-profit Federal Contract Research Center retained by the National Institute to assist in the definition of equipment priorities. It is one of a continuing series of reports to support the program decisions of the Institute relative to equipment development, equipment standardization and application guidelines. Comments and recommendations for revision are invited. Suggestions should be addressed to the Director, Advanced Technology Division, National Institute of Law Enforcement and Criminal Justice, Law Enforcement Assistance Administration, U. S. Department of Justice, Washington, D. C. 20530.

Gerald M. Caplan, Director
National Institute of Law
Enforcement and Criminal Justice

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* Section 402(b) of the Omnibus Crime Control and Safe Streets Act of 1968, as amended.

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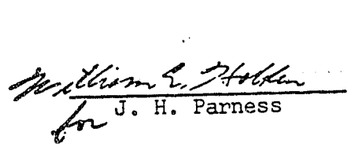
ABSTRACT:

A preliminary investigation of police aircraft requirements was made. Development requirements are given in the areas of: low altitude-low speed operation, dash speed, mission time, capacity, noise, visibility, and communications.

SUMMARY

A cursory investigation of the requirements for police aircraft was made. Analysis of the results produced recommendations for the following development requirements:

- Safer and more reliable operation in the 0-500 foot; 0-50 mph range.
- Higher dash speeds - up to 150 mph.
- A system which would reduce pilot fatigue and would allow longer mission times.
- Two-man basic vehicles convertible to three-man units.
- Substantial reduction in noise.
- Provide a high degree of ground visibility including night vision aids.
- Provide a built-in integrated communications capability.



for J. H. Parness

S. H. Roth

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1. INTRODUCTION

A preliminary analysis of police patrol aircraft mission requirements was undertaken to support the development activities of The Aerospace Corporation. The results of this analysis are documented herein.

In order to derive requirements for airborne vehicles, a number of police missions were identified. The mission requirements were then translated into performance parameters relevant to the specification of airborne vehicles. The missions reviewed are basically police missions and do not include such services as medical aid and fire department support.

2. PERFORMANCE PARAMETERS

The following basic performance parameters were investigated as a function of the mission requirements.

Loiter Speed

The low velocity capability needed to maintain contact and surveillance within a limited ground area.

Cruise Speed

The range of velocity used during general patrol or wide area search.

Max Speed

The maximum speed required of the aircraft to support a given mission.

Nominal Mission Time

The average time required to support a given mission.

Altitude

The range of altitudes most likely required to support a given mission.

Number of Personnel

The required personnel including pilot needed to support the mission aboard the vehicle.

Travel Time

The travel time desired for the aircraft to respond to a mission requirement (from wherever the aircraft might be located to the site of the mission).

Noise

This is the external noise of the aircraft. In some cases, it is desirable for the aircraft to announce its presence by its sound volume; and in other cases, it would be most desirable for the aircraft to remain undetected. In the requirements assessment, external noise is indicated as desirable, not desirable, or not critical.

Observation Capability

This refers to the level of detail that an aircraft observer can discern on the ground. Two levels of capability are specified:

1. Recognition of personnel without facial identification-movements, clothing description, etc.
2. Reading of license plate numbers.

Communications Capability

This parameter refers to the radio communications capability and is defined in two levels:

1. Requirement confined to capability of communications with local jurisdiction (aircraft to base, aircraft to mobile).
2. Requirement for multi-agency communications would include (1) above and capability to communicate with adjacent jurisdictions (both base and mobile) and other agencies operating locally (such as state police).

Landing Requirements

It is the policy of the police, in general, to discourage aircraft landing in support of the mission. The exceptions are rescue operations and high priority emergency situations.

3. MISSIONS

The following is a description of the various police missions identified. These descriptions were derived from the references and from the discussions with personnel of the Aviation Divisions of the New York City; Washington, D. C.; and Suffolk County, New York, Police Departments. Support missions such as transportation, photographic reconnaissance, and VIP observation have not been considered; only direct police operations are included.

Command Post

A typical Aerial Command Post Mission might address a civil disturbance in a confined part of a city. As such, a maximum operating time of three hours would be typical (due to pilot limitations). Typical aircraft speeds would be 30 to 60 mph at 500 to 1500 feet altitude over a closed-loop or racetrack flight pattern. One or two observers would be needed to handle interagency communication (e.g., fire, sheriff) or to operate additional equipment (e.g., T.V. camera). Observation needs would be expected to be limited to the recognition of human activity (not identifying the exact individual). Exact travel time to the incident location is not considered to be a critical factor for this mission. In such missions as crowd surveillance, noise can be on asset in announcing presence.

High Speed Chase

This mission typically comes about with very short notice; and it is, therefore, necessary that travel time to the suspect's location be less than ten minutes. Beyond that time, any ground derived data (by people at the scene or from the case car officers) would be too old to nsure positive airborne tracking.

Maximum aircraft speeds needed are expected to be between 100 mph and 150 mph (based upon automobile escape speeds and typical airborne headwinds). The identification of the vehicle's license plate (through the use of optical aids, etc.) is considered desirable at the 1000 foot flying altitude. Communication needs are multi-agency, since high speed chases often cross jurisdictional boundaries. Noise identification of the aircraft has been found in many cases to impart a sense of defeat to the speeder.

Patrol and Surveillance

Typical patrol needs (preventive patrol) consist of a mix of loiter and cruising modes. The total element time and speed are expected to vary over rural and urban areas. Aircraft noise should be reduced to a level acceptable by the public at the low flying altitudes; however, the indication of the presence of the aircraft through its noise characteristics can have a deterrent effect on criminals. Therefore, a moderate level of noise is considered desirable.

Burglary and Robbery

This mission is typically initiated by a silent alarm or a citizen call. Response time of the airborne unit is very critical and will usually require the vehicle to be airborne prior to mission start (e.g., preventive patrol). Some high speed needs are envisioned, and the total element time should not exceed one hour. A low flying altitude is necessary to permit positive contact with the suspect. At the low flying altitude, aircraft noise can alert the suspects and is considered undesirable.

Covert Surveillance

Covert operations should be flown higher than general surveillance missions, and they are expected to require observation capability equal to or better than the identification of the details of an automobile license plate. Additional personnel may be required for observation and/or communications. For covert missions, noise identification of the aircraft is a detriment.

Tracking Vehicles

This mission is expected to require approximately a 3-to-1 ratio of cruise to loiter flying times. This ratio may vary depending upon local geography. An extra observer might become necessary if additional optical or electronic tracking aids are utilized. Travel time to the scene is critical. Observation should be capable of identifying a license plate. Multi-channel communication capability is also needed for this mission since vehicles tend to cross jurisdictional boundaries. This would allow aircraft personnel to establish radio contact with local enforcement agencies into whose jurisdiction the vehicle might enter.

Tracking Personnel

The mission is essentially to maintain visual contact with individuals moving on foot. The requirements would be loiter capability, low altitude, and silent operation for covert tracking. When tracking individuals for the purpose of apprehension, the noise can impart the sense of omnipresence to a fugitive causing him to surrender.

Nighttime Patrol

Nighttime operations are limited by pilot fatigue and observation capabilities. Nighttime patrol missions require longer loiter time (compared to daytime patrols) and require the use of optical or other

aids (e.g., searchlight) to allow the observer to recognize activity in dark areas. Pilot-observer coordination becomes critical, especially if the observer is using an aid (spotlight or low-light-level device) and is trying to direct the helicopter's pilot into specific locations. Aircraft noise is a serious public relations detriment.

Security

The security mission consists of providing airborne coverage for special visitors or events (e.g., Presidential trips, inaugurations, VIP visitors). A ratio of 3 to 1 between loiter and cruise speed is needed for a total element time of two hours. Flying altitudes are similar to patrol missions, and an extra observer may be needed to operate special equipment or to coordinate multi-agency communications (e.g., Secret Service, FBI, etc.). Since security is the main concern, aircraft noise may be desirable to impart a sense of police presence to the public.

Emergency Rescue

The mission basically involves the removal of an individual from a dangerous situation to safety or, in the case of an injured party, to a medical treatment facility. The performance needed to support this mission is hover capability, landing capability, medical litter and first aid supplies, and hoist capability. High-speed dash capability is also needed to provide timely response. A minimum two-man crew is needed to support the operation: one to land and assist party to be rescued, the other man to pilot the aircraft. The emergency rescue mission is not necessarily included as a police function and is often provided by other agencies.

Traffic

This mission consists of providing visual coverage of the traffic patterns during selected parts of the day or night. Most flying time would consist of cruising at altitudes between 750 feet and 2000 feet. An observation capability equivalent to recognizing human activity would be adequa e. Local communications network tie-ins would suffice.

4. REQUIREMENTS ANALYSIS

The performance parameters described in Section 2 were analyzed relative to the mission requirements (Section 3) and were based upon the References (Page 22) and discussions with personnel of the Aviation Division of the New York City; Washington, D. C.; and Suffolk County, New York, Police Departments. Table I is a summary of the performance parameter data as applied to the various missions. The following discussion addresses the parameters in more detail.

The police aircraft, similar to the patrol car, is a multi-mission vehicle. The basic mission is patrol, with the capability to respond to a specialized mission. It is in the most advantageous position to provide services and to respond to calls when it is airborne. Missions, such as command post and security, can often be preplanned and; where the incidence of such events is great, it would be beneficial for a specialized vehicle to support those missions. In general, however, police aircraft are considered general purpose vehicles, and the analysis addresses the requirements from that viewpoint.

4.1 Speed

The four basic speed regimes employed by law enforcement agencies in aircraft operations are:

- Hover - essentially maintaining position above a location or very slow speed movement (5-10 mph).
- Loiter - the slow speed sweeping of an area in either a circular or a linear trajectory (30-60 mph).
- Cruise - the normal point-to-point travel speed (60-90 mph).
- Dash - the maximum speed capability of the aircraft.

TABLE I

REQUIREMENTS PARAMETERS VS. MISSION TYPE

PARAMETER / MISSION	LOITER SPEED TIME MPH/HOUR	CRUISE SPEED TIME MPH/HOUR	MAXIMUM SPEED TIME MPH/HOUR	NOMINAL MISSION TIME (HOURS)	ALTITUDE (Ft.)	NUMBER OF PERSONNEL	EXTERNAL NOISE	OBSERVATION CAPABILITY	COMMUNICATIONS
COMMAND POST	35-60/3	N/A	N/A	3	500-1500	2-3	D or N/C	Personnel	Multi-Agency
HIGH SPEED CHASE	N/A	N/A	100-150/0.5	0.5	1000	2	D	License Plate	Multi-Agency
PATROL - RURAL	35-60/.25	85/1.75	N/A	2	500-1000	2	ND	Personnel	Local
PATROL - URBAN	35-60/.25	60/2.75	N/A	3	500-1500	2	ND	Personnel	Local
BURGLARY & ROBBERY	35-60/0.5	N/A	100-150/0.5	1	500	2	ND	Personnel	Local
COVERT SURVEILLANCE	35-60/1	60/1	N/A	2	1000-2000	2-3	ND	Personnel	Local
TRACKING VEHICLES	35-60/.5	65/1.5	N/A	2	500-1000	2-3	ND	License Plate	Multi-Agency
TRACKING PERSONNEL	35-60/1	N/A	N/A	1	500-750	2-3	ND	Personnel	Local
NIGHTTIME PATROL	35-60/1	60/2	N/A	3	750-1000	2	ND	Personnel	Local
SECURITY	35-60/1.5	60/.5	N/A	2	500-1000	2-3	D	Personnel	Multi-Agency
RESCUE	N/A	N/A	100-150/1	1	0-750	2	N/C	Personnel	Multi-Agency
TRAFFIC	N/A	85/3	N/A	3	750-2000	2	N/C	Personnel	Local

Key:
N/A - Not Applicable
N/C - Not Critical
D - Desirable
ND - Not Desirable

The speed requirements, as a function of a mission, are shown in chart form in Figure 1. It is apparent, that the basic mode employed by police aircraft is the loiter mode. The hover mode is, in general, discouraged due to the restrictive conditions necessary for safe hovering operations. Hovering is affected by:

- The aircraft flight envelope (an example is shown in Figure 2).
- Wind direction and velocity.
- Nature of the terrain.
- Ability to make a safe landing from a hover mode in the event of engine failure.
- Vulnerability to ground fire.

The loiter mode in circular motion is often employed in place of the hover mode for safety reasons. The loiter mode is most applicable to local area search operations. The cruise mode is employed to arrive at the site of the mission when response time is not critical and in rural and traffic patrol operations. The dash mode (maximum speed) is employed to provide rapid response and to pursue vehicles in a high-speed chase. The dash capability requirement will vary with the area of application. Large area applications, where long distances need to be traveled and where open road conditions can give rise to very high ground vehicle speeds, would require the high dash speeds (up to 150 mph). For example: 10 miles can be traveled in four minutes at 150 mph but would take six minutes at 100 mph. Missions in urban areas with smaller patrol areas would find the 100 mph dash speed adequate.

The ideal requirement specification would call for the development of an aircraft which would provide all four modes of operation (hover, loiter, cruise and dash) with a high degree of reliability

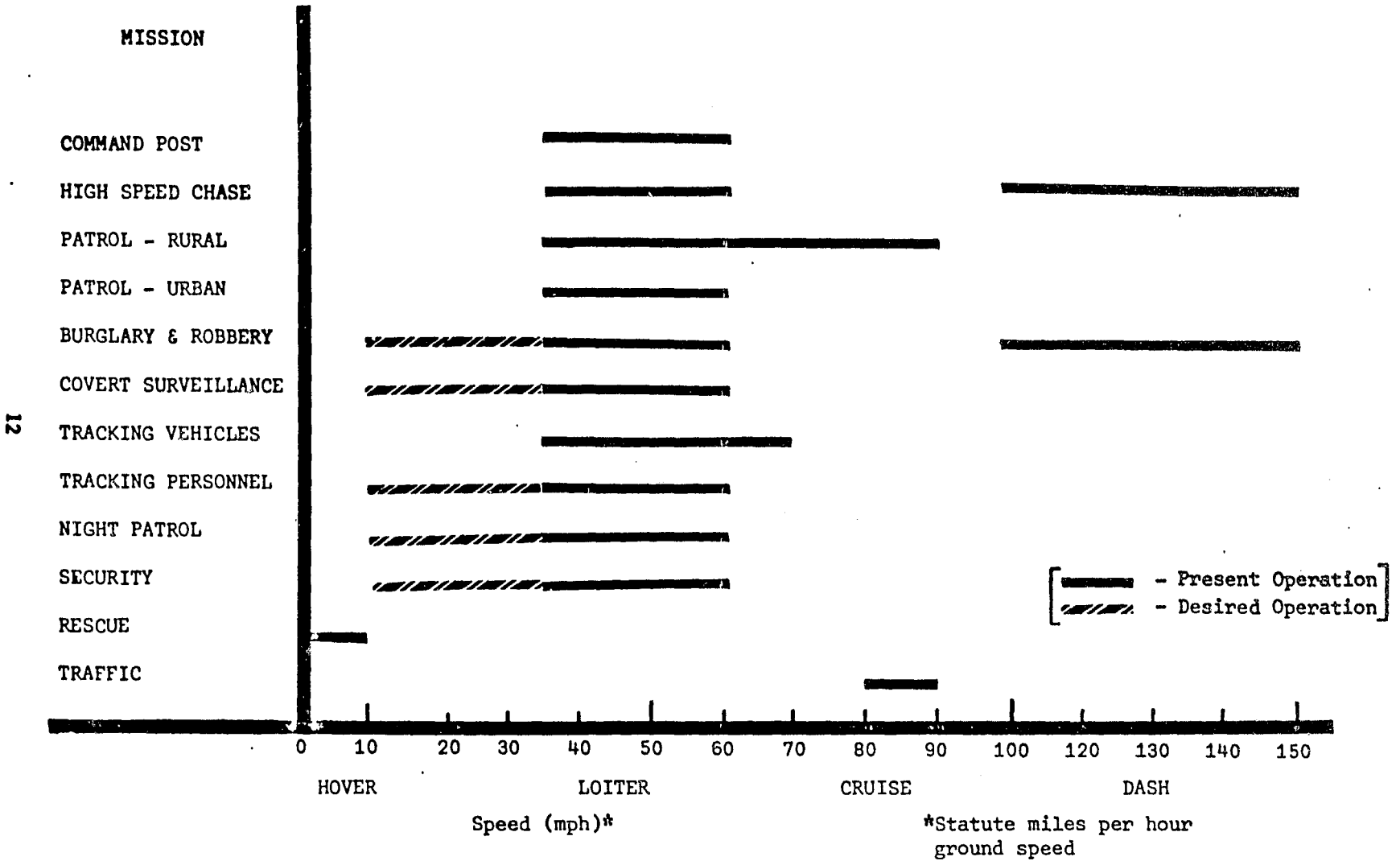

FIGURE 1 - SPEED RANGE VS. MISSION

DETERMINED UNDER THE FOLLOWING CONDITIONS:

a. Asphalt Surface
b. Calm Wind
c. Maximum Gross Weight
d. 2900 RPM

(Hughes 300 Model 269B Helicopter)

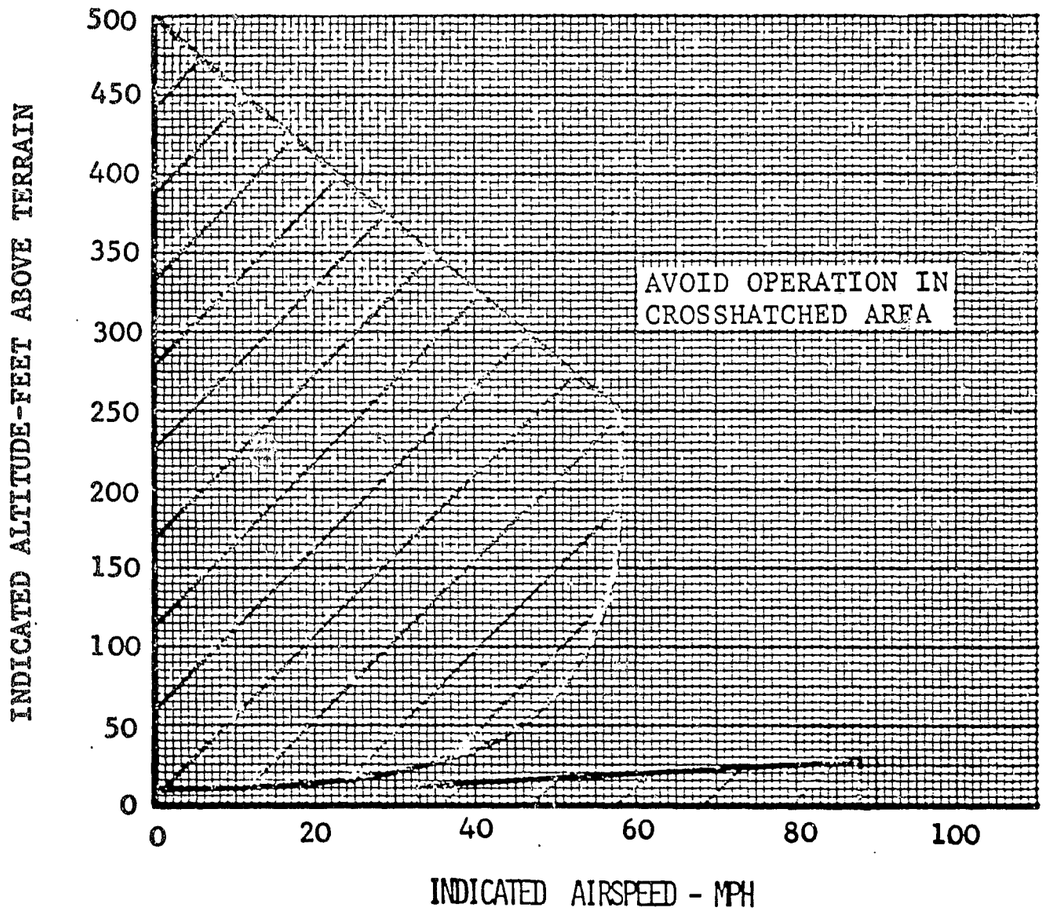

FIGURE 2 - HEIGHT VELOCITY DIAGRAM

and safety. It is recognized that this may be beyond the state-of-the-art. The current practices in the hover and loiter modes, as indicated in Figure 1 are, in part, determined by the available equipment capability. Therefore, the development requirement is to improve the low speed (0-50 mph) capabilities of the aircraft thus giving the police additional flexibility in responding to the missions. This should take the direction of a less restrictive flight envelope, safer operation over a wide range of wind velocities and direction, and less impact on flight characteristics due to terrain.

4.2 Mission Time

Table I gives times to support specific missions. This can be misleading since the basic mission of the police aircraft is a composite one. The composite mission is one of:

- patrolling to deter crime by its presence;
- detecting crime in process;
- responding to calls for aid - burglary, robbery, high-speed chase, etc.; and
- returning to patrol activities.

In addition to the basic mission, there are specialized missions of command post, security, surveillance, and tracking. These can often be preplanned with limited time envelopes. However, even in these missions, it is desirable to provide flexibility for extension beyond the nominal mission times.

In current operations, the flight time is limited by pilot fatigue. This is especially true of night operations. The numbers generally quoted are three to four hours. The pilot and observer salaries represent by far the largest cost element in police aircraft operations. As an example, taking figures from the Dade County Study

on STOL Aircraft (LEAA Grant 70-DF-036) of August 15, 1971, the direct operating cost of a helicopter was $12.65 per hour. This included gas, oil, maintenance, inspections, parts, and engine overhaul based on 1200 hours of operation. The yearly salaries for the pilot and observer are given as $37,990. Using a 200-day work year at four hours a day flying time, the salary cost per flight hour would be slightly over $47.00. Increasing the flight time to six hours per day would lower the flight hour cost to approximately $32.00. Increasing the flight hours would also lower the cost per flight hour of fixed charges such as airport facilities, acquisition costs, and insurance. Therefore, from both an operational and an economic point of view, it would be desirable to extend the mission time capabilities of police aircraft. This represents a man-machine interface problem and should strongly influence any development activities. An ideal goal would be to provide the capability for a six to eight hour shift with an intermediate meal break and refueling stop.

4.3 Altitude

The range of altitudes for the various missions (Table I) is between 500 feet and 2000 feet with the exception of the rescue mission which goes down to zero altitude and landing. The 2000 foot upper end of this range is well within the capabilities of currently available equipment and, therefore, does not represent a limitation based on equipment performance. The lower end of the range (500 feet) corresponds to the altitude in conjunction with lower speeds where safety and reliability restrictions enter into mission performance (see Figure 2). The same comments apply here as in the section on speed (4.1) where, if safer and more reliable performance could be provided in the lower altitude low speed range, then more flexibility would be provided for law enforcement applications.

4.4 Personnel Capacity

The crew requirements (Table I) are for a basic two-man crew with the occasional need for a third man to support the mission. In large fleets, this could be provided by a mix of two and three-man vehicles.

4.5 Noise

The external noise associated with helicopter operations has both advantages and disadvantages. The announcement of the presence of the aircraft by its noise characteristics can deter crime by imparting the feeling of being watched to those who may be planning criminal activity. In the case of fleeing suspects, the recognition that a helicopter is in the vicinity often causes the suspect to feel escape is futile. The noise is obviously a disadvantageous in covert surveillance and tracking operations. Another disadvantage is the disturbance to the general public especially during night operations.

From a development requirement's viewpoint, it would be desirable to be able to control the noise so the police can apply it as needed. One method would be to develop a quiet aircraft and equip it with a device to indicate presence similar to a siren. It would be most desirable if the device were such as to uniquely identify the sound as coming from an aircraft so as not to confuse it with ground emergency vehicles.

4.6 Observation Capability

The most important functional capability of the police aircraft is the ability to observe ground activity from an elevated vantage point. This, in conjunction with the rapid response capability, makes the aircraft very useful in police activities. Therefore, performance requirements should include specifications on crew visibility for the

purposes of observation. (Requirements for aircraft navigation purposes are not considered here.)

The distance to the ground object determines the resolution capabilities of the unaided eye. The greater the angle of visibility relative to the horizon, the closer objects can be observed in level flight. At an angle of 45 degrees, the object distance is 41 percent greater than the aircraft altitude. Beyond 45 degrees, the improvement is very gradual with increase of angle. Therefore, 45 degrees is specified as the visibility angle below the horizon. The visibility below the horizon should be available to the crew for an arc of ± 110 degrees from the dead ahead vector. This allows 20 degrees of viewing angle in the rearward direction. This would allow an object that is 1000 feet from the plane, first observed at a right angle to the heading, to be in view for about five seconds at 60 mph.

The requirements for observation should take into account visual aids. Searchlights for night operations are common on police aircraft. Provisions should be made available for mounting and for providing adequate power supply. A typical unit can draw 60 amperes at 28 volts. Such devices as stabilized optical aids and night vision devices are being considered for police aircraft use. It is desirable to anticipate their use and incorporate provisions for them in new aircraft designs.

4.7 Communications Capability

The police aircraft, because of its wide area capability and missions which may cross jurisdictional lines, requires communications capability beyond that normally provided in a patrol car. Several agencies reported difficulties with the band-aid approach of providing communications in helicopters. The requirement is for an integrated system providing:

- aircraft communications;
- police communications - multiband - allowing crew to select local channels as well as adjacent jurisdictional channels; and
- cockpit communications to allow pilot and observer to communicate with each other and for each to individually operate the police channels.

5. DEVELOPMENT REQUIREMENTS

Aircraft have been in the police inventory for many years, but it has only been in more recent years that aircraft, mostly in the form of helicopters, have been employed in regular patrols. The use of these aircraft, in regular police patrols, has been shown to be effective in the control of crime; and the use has spread significantly among law enforcement agencies in the past several years. The commercially-available aircraft have served a useful purpose and have demonstrated the value of their use in law enforcement. The purpose here is to state development requirements which can even further increase the effectiveness of police aircraft and improve efficiency.

5.1 Low-Speed/Low-Altitude Flight Characteristics

Helicopter operations in the range 0 to 500 feet altitude and 0 to 50 mph speed are severly restricted for safety reasons. This is especially true over urban areas where turbulence and wind gusts are common and unpredictable. Urban areas also provide less available space for emergency landings tending to discourage low-altitude maneuvers. Fixed-wing aircraft have lower speed limits in the 50-60 mph range and are restricted to altitudes above 1000 feet by FAA regulation. Therefore, an area for development is aircraft capability to operate in this low-altitude/low-speed range, especially in urban areas. This would provide police with additional capability where it is needed most, in the urban areas.

5.2 High Speed Dash

The maximum speed capabilities of the police helicopters are in the range 90 to 110 mph. Higher dash speed capabilities, up to 150 mph, to improve response time are desirable. This high speed capability is not to be provided at a sacrifice of low-speed/low-altitude capability.

5.3 Airborne Mission Time

The current operational flight times are generally limited to three to four hours duration. This is primarily due to pilot fatigue and, secondarily, to vehicle capabilities (e.g., fuel supply). Development of a system which would provide for longer mission times would provide for more effective and cost-beneficial use of available manpower.

5.4 Personnel Capacity

The vehicle should be designed as a basic two-man unit with a provision for a third. The third-man capability could be provided for as an option by the removal of other equipment such as rescue litter and medical supplies. It would be desirable to provide this capability in a rapid conversion form.

5.5 Noise

The noise characteristics of present helicopters are detrimental in covert missions and are annoying to the public at large (e.g. noise pollution). The development requirement is to substantially reduce the noise level. In conjunction with the noise reduction, a method should be developed for announcing the vehicle presence when it is desired such as a siren-type device or amplification of the basic helicopter noise under control of the crew. It is recommended that this device be unique to the aircraft (to distinguish it from ground emergency vehicles).

5.6 Visibility

The development of police aircraft should include, at a minimum, the following visibility requirements.

Unobstructed vision from the horizon to 45 degrees below the horizon in level flight for an arc of ± 110 degrees from the forward motion vector. This vision is to be available to the crew from their normal seated positions. This capability is independent of visibility requirements for navigation purposes. The aircraft should include searchlights for ground illumination during night operations.

5.7 Communications

The police aircraft should contain an integrated communications system providing the functions of:

- Aircraft navigation radio equipment,
- Multichannel police capability, and
- Cabin communications to allow the crew to communicate with each other.

This should be provided as an integral part of the aircraft cabin design with proper attention to human engineering for the application.

5.8 General Requirements

The following are general requirements in the design of the aircraft systems.

1. All applicable FAA rules and pilot safety criteria must be followed.
2. Emergency landing capability (and necessary facilities) are desirable.
3. Maintenance facilities or services must be provided and included in overall system design, cost and flying schedules.
4. Where applicable, the vehicle must contain sufficient personnel protection (e.g., armor plate).
5. Necessary environmental services (e.g., heater, air-conditioning, internal noise suppression) should be provided for comfort.
6. All necessary navigation equipment for day and night flying should be provided (e.g., running lights and necessary VHF aircraft radios).

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